



Demand Response and Energy Efficiency Opportunities For Silicon Valley Power

Final Report
Volume 1 of 4:
Review of Current Plans and Project Approach

Rocky Mountain Institute

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Section 1: Introduction

Silicon Valley Power (SVP), a municipal electric utility in Santa Clara, California, has retained the Rocky Mountain Institute (RMI) to obtain a good estimate of the potential for demand-side management—including energy efficiency, demand response, and distributed generation—in its service territory. This report is the first of four, and includes a discussion and review of SVP’s existing strategic plan and Operating Study, as well as a discussion of RMI’s approach to the remainder of the project.

One of the primary goals of this project is to identify all cost-effective energy efficiency, and develop implementation strategies for achieving that potential. The results of this analysis will help SVP respond to California Assembly Bill 2021.

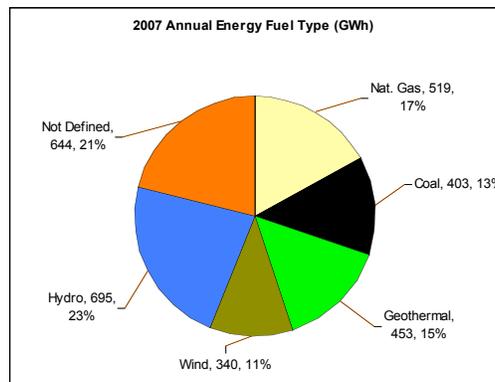
Assembly Bill 2021

In its 2003 Energy Report, the California Energy Commission (CEC) set as a goal that the state’s municipal utilities achieve 7,000 GWh in energy savings over 10 years.¹ Current information available to the CEC suggests that existing municipal utility programs may only lead to 840 GWh of savings. To assist the CEC in meeting its established target, Assembly Bill 2021 (AB2021) was passed into law on September 29, 2006. AB2021 established a set of reporting guidelines for the CEC, the California Public Utility Commission (CPUC), and all municipal utilities.

These guidelines require that the municipal utilities identify all potentially achievable cost-effective electricity efficiency savings and establish annual targets for energy savings and demand reduction for the next 10 years.² This process must be completed by June 30, 2007 and will be repeated every three years thereafter. The CEC, in consultation with the CPUC, will use the data provided by the municipal utilities to develop statewide efficiency targets. Once the efficiency targets have been developed, each municipal utility must contract an independent party to evaluate their efficiency and demand reduction programs. The utilities must report annually on the results of their programs.

Background on SVP

Silicon Valley Power has approximately 50,000 customers and an annual peak demand of approximately 450 MW in 2006. SVP’s expected generation mix by fuel type is shown in the graphic below:



¹ Overall, the CEC estimated that 30,000 GWh of electricity savings was feasible for all utilities across the state.

² Similar requirements had already been applied to Investor Owned Utilities in 2005.

This generation mix is primarily made up of low-cost hydro, renewable energy, and coal—resulting in relatively low rates compared to other utilities in California. SVP is forecasting an annual growth rate of between 6 and 7 percent for the next two years, subsequently flattening to 1.5 percent per year.

Project Outline

This project includes several primary components, which are:

Area 1. Review SVP's current electric resource plan and public benefit program.

Area 2. Assist SVP in analyzing demand-side management and energy efficiency potentials in Santa Clara and in refining demand-side management and energy efficiency implementation plans.

- *Task 2.1.* Define approach for analysis of demand-side potential, by responding to the following questions:
 - What are the most appropriate cost analysis methods for demand-side resources?
 - To what degree should we address non-monetary values?
 - Should risk analysis be based on scenarios or decision analysis methods?
 - To what degree are analyses already conducted sufficient?
 - To what degree does total cost versus rate impact determine cost-effectiveness?
 - How should SVP address equity issues?
 - How should costs and savings be allocated among customer groups?
 - To what degree does demand-side management stress energy savings vs. peak load management?
 - Should customer implementation be driven by rates or technical programs?
 - What is the optimum and maximum scale for distributed generation?
 - How should thermal energy from cogeneration be valued?
 - What is the role of distributed renewable resources?
 - How should fuel price risks and GHG liabilities be mitigated?
 - Should we prepare for hydrogen and other future technology options?
 - How do we balance between low and stable rates, environmental stewardship, and reliability?
 - What are the most effective techniques for motivating participation in demand-side management programs?
 - What are barriers to customer participation?
 - What are the criteria for determining appropriate customer incentive levels?
- *Task 2.2.* Identify criteria under which distributed generation would be cost-effective, including thermal demand profiles, electricity price, and natural gas price.
- *Task 2.3.* Identify achievable potential for cost-effective energy efficiency and demand response, over a 10-year time frame.

Area 3. Review public benefit program outreach efforts and budget to make sure they are in alignment with—and adequate for—achieving the potential identified in Area 2.

Section 2: Review of SVP Operating Study and Strategic Plan

Rocky Mountain Institute is conducting an analysis of the potential for energy efficiency, demand response, and distributed generation opportunities for the City of Santa Clara. As a first step in this process, RMI reviewed Silicon Valley Power's (SVP) Strategic Plan and Operating Study, and related documentation and analysis. This section summarizes RMI's review of these SVP planning documents as of December 2006.

Silicon Valley Power's mission statement is to "be a progressive, service-oriented utility, offering reliable, competitively priced services for the benefit of Santa Clara and its customers." To achieve this mission, SVP has established a set of specific goals, which are to:

1. Be competitive in the marketplace with a continuous focus on customer service.
2. Provide economic value to the City of Santa Clara and its customers, maintain low residential rates, and offer competitive rates for all customer classes.
3. Manage debt and resources to achieve and maintain a competitive position.
4. Be a strategically driven organization with a focus on our performance as an energy services supplier.
5. Operate Silicon Valley Power in a safe, reliable, efficient, and environmentally responsible manner.
6. Manage Silicon Valley Power successfully through electric industry restructuring.
7. Enhance value to our customers through the delivery of new products and services.
8. Manage Silicon Valley Power's participation in joint powers agencies to achieve the City of Santa Clara's goals.
9. Develop flexibility to respond to changing business environments.
10. Achieve quality communications with all stakeholders.

These goals not only define SVP's planning criteria in terms of reliability and low cost, but also address non-monetary values including customer service, community value, and environmental responsibility. The challenge in the planning and design of SVP's system is to reconcile these goals by finding solutions that are win-win, or nearly so. In other words, SVP's energy portfolio should minimize economic costs and financial risks while enhancing customer service and the environment. SVP should plan pro-actively to avoid drifting into situations where it must resolve stark tradeoffs between, for example, economic and environmental goals.

Minimizing future supply costs while balancing risk, reliability, and environmental stewardship is a complex process. It becomes even more complex when a utility is exposed to price, weather, performance, and regulatory risks. Managing risk and cost in an uncertain environment demands a portfolio approach in order to diversify risks and to build in responsiveness to future uncertainty and plausible departures from the business-as-usual course.

To support these goals, SVP developed a strategic plan, most recently updated in November 2002, and an Operating Study, generally updated every two years.

Strategic Plan, November 2002

Silicon Valley Power's Strategic Plan outlines 10 strategic issues along with milestones and strategies to address each issue. These issues are listed below. The strategic plan elements that are **highlighted in boldface** are the elements that are most directly related to the goals of this project.

1. Provide customers with phased access to alternate suppliers
2. **Energy supply pricing strategy**
3. **Customer service/marketing**
4. Retail service area
5. Debt management
6. **Resource/supply cost competitiveness**
7. **Safe, reliable and efficient energy distribution**
8. Organizational development
9. Quality communications
10. Review of the City's application of contribution in lieu of taxes

While many milestones and strategies within this plan could be bolstered by the implementation of demand-side resources, direct reference to energy efficiency and demand response is noticeably absent from the plan. RMI recommends that future iterations of the Strategic Plan consider these resources directly.

2003-2012 Operating Study

Silicon Valley Power is currently in the process of updating its Operating Study for the time period 2007-2016. The most recent complete Operating Study was conducted in 2002 for the time period 2003-2012. The goals of this study were to:

- Review SVP's near-term resource needs;
- Evaluate the potential impacts of the Enron bankruptcy (reassignment of the Enron power contracts); and
- Highlight areas of uncertainty.

We assume that the issue pertaining to Enron, which was a central feature of the 2003 plan, has been resolved at this time. Therefore, the following comments address the portions of the 2003-2012 Operating Study pertaining to SVP's near-term resource needs and areas of uncertainty.

In the 2003-2012 Operating Study, SVP predicted that its peak demand would increase from roughly 425 MW in 2002 to 600 MW in 2012. The bulk of this growth was projected to occur between 2002 and 2007 (average annual growth rate of roughly 6 percent), and taper off to roughly 2 percent per year between 2007 and 2012. Initial forecasting results from the on-going 2007-2016 Operating Study project a peak demand of 470 MW in 2007 with an average annual 1.5 percent growth between 2007 and 2016. These results indicate that substantially less growth was realized between 2002 and 2007 than predicted. Of interest is whether this lower-than-expected growth was due to lower-than-expected economic growth in the region, or due to increased efficiency and demand-side management.

Since the 2003 study, SVP has constructed the DVR Power Plant in 2005, which provides 147 MW of capacity. Additionally, SVP has established a new wind contract, bringing SVP's eligible renewable energy resources to approximately 30 percent. Beyond this, future energy and capacity needs are assumed to be met through power purchases.

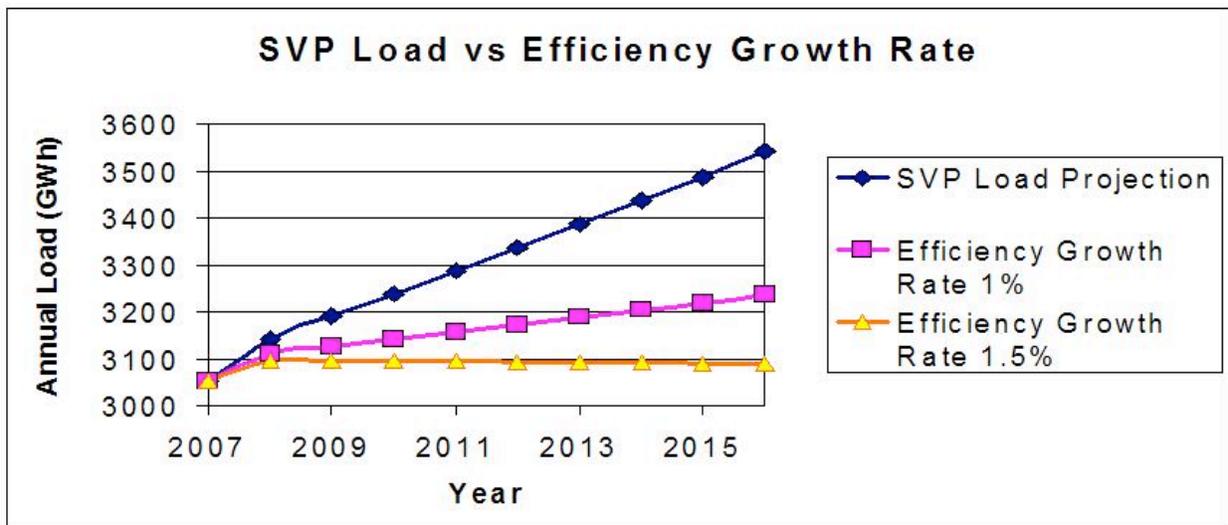
While the 2003 study provides a thorough evaluation of potential supply-side measures that would meet SVP's expected load growth, there is little focus on the potential for demand-side management, such as energy efficiency or demand response. When considered in conjunction with conventional supply-side resources, demand-side resources are an effective way to create

a cost-effective, reliable resource portfolio. Additionally, since SVP projects an energy deficit long before a capacity deficit, demand-side resources that lower total energy demand could be quite valuable. For example, many efficiency programs slightly lower energy demand constantly over the course of a day, but have little impact on peak capacity demand. On the other hand, demand response programs are designed specifically to target peak capacity, but because that reduction is generally shifted to an off-peak period, there is little reduction in total energy consumption.

SVP's 2003 and 2007 plans both create a heavy reliance on the purchase of capacity and/or energy from external market resources. In fact, achieving balance between energy and capacity requirements is identified as an ongoing issue. The typical energy purchases considered are 25 MW blocks that deliver 219 GWh per year, and are projected to cost \$70-80/MWh.

By contrast, RMI typically finds costs for energy efficiency resources as low as \$15-20/MWh. Costs for demand reduction exhibit a similar discount from the market rates for capacity. Furthermore, depending on cost spreads, capturing distributed resources within SVP's own territory could potentially alleviate dependence on the California power markets, and the volatility risk that they represent.

There is strong precedent for an integrated demand-side approach. A number of states have used efficiency to reduce their annual energy sales by 1-2 percent.³ The figure below shows that with SVP's current projections, an annual rate of efficiency growth of only 1 percent of the 2007 annual load could cut the need for energy purchases by more than half, while an efficiency growth rate of 1.5 percent could completely offset the anticipated load growth, with minor exceptions in the early years.



Initial assumptions made for the 2007 study do address demand-side management—8 MW of interruptible capacity is assumed in each month in 2007. To supplement this capacity, RMI recommends that the results of its analyses from this study be incorporated into the on-going 2007-2016 Operating Study process.

³ American Council for an Energy Efficient Economy. *Technical, Economic, and Achievable Potential for Energy-Efficiency in the U.S.—a Meta Analysis of Recent Studies*. 2004.

The 2003 study identifies some areas of uncertainty and risks that SVP faces, including:

- A significant amount of capacity being supplied by “energy limited” peakers that provide only a small amount of SVP’s energy requirements, and
- The associated low level of dispatchability, if loads are lower than expected.

Demand-side resources could help to reduce these risks as well as the risks associated with market volatility and pending climate change regulations. The value of demand-side resources should be evaluated in the context of this potential.

Current Demand-Side Programs

Silicon Valley Power has a large portfolio of existing efficiency programs, as well as a demand response voluntary power pool. SVP’s efficiency programs are outlined below.

Residential Programs

- **Santa Clara Green Power**—green pricing program that assesses an additional \$0.015/kWh to support wind and solar energy development.
- **Refrigerator rebate**—\$50 rebate on a new Energy Star refrigerator when the refrigerator to be replaced is recycled.
- **Attic Insulation rebate**—Up to a \$175 rebate for installing attic insulation.
- **Whole House Fan rebate**—\$200 rebate for installing a whole house fan.
- **Free energy audits**—Free home energy inspections to identify energy efficiency opportunities.
- **LCD Monitor rebate**—\$20 rebate for purchasing an Energy Star LCD computer monitor.
- **Home Solar System rebate**—\$3/watt rebate up to \$9,000 for the installation of a home solar system.
- **Neighborhood Solar Program**—Supports development of solar systems at local non-profit organizations through a \$5/customer/month neighborhood fee.
- **Room Air Conditioner recycling**—\$25 rebate for an old air conditioner that is recycled.
- **Refrigerator Recycling rebate**—\$35 rebate for recycling older working refrigerators.

Commercial Programs

- **Free energy audits**—Free business energy inspections to identify energy efficiency opportunities.
- **Turnkey services**—Construction management services identify and implement cost-saving opportunities, obtain competitive bids from vendors, monitor construction, and ensure rebates for energy-efficient equipment.
- **Lighting rebates**—Rebates for replacing T12 tubes with T8s, and for retrofitting old exit signs with new LED signs.
- **Heating and Cooling rebates**—Rebates for installing efficient HVAC process motors, air conditioning systems, and efficient chillers.
- **New Construction rebates**—Rebates for using energy-efficient equipment in new, expanded, or renovated buildings.
- **LCD Monitor rebate**—\$20 rebate for purchasing an Energy Star LCD computer monitor.
- **Customer Directed rebate**—Customized rebate for projects that decrease electrical usage at a facility located in SVP’s service territory.
- **Commercial Washing Machine rebate**—\$350 rebate for replacing old, inefficient washing machines with more energy-efficient ones.

- **Business Design Assistance**—Design assistance to commercial and industrial customers during major facility retrofits and new construction.
- **Business Motor/VFD rebate**—Rebates for premium efficiency motors and qualifying variable frequency motors drives.
- **Business Food Service Equipment rebate**—Rebates for the purchase of Energy Star qualified food service equipment.
- **Business Chiller rebate**—\$45-90/ton rebates for new, efficient chillers.
- **Business New Technology**—Grants for customers who implement exceptionally creative uses of energy technology.
- **Business Solar rebate**—\$2.50/watt rebate up to \$125,000 for the installation of a business solar system.
- **Energy Innovation**—Customized rebates to implement efficiency projects that are innovative or not yet tested.

Recommendations Based on SVP Strategic Plan and Operating Study

1. Cost-effective energy efficiency potential and program options: A comprehensive analysis of end-use efficiency potential has not been conducted for SVP’s service area. Therefore, it is not known whether SVP’s program portfolio captures all cost-effective efficiency. A more thorough analysis of potential will be conducted as part of this study, with the goal of identifying whether there is potential to expand SVP’s existing efficiency programs to maximize efficiency improvements up to the full long-run marginal supply costs (all efficiency that passes the total resource cost test).⁴

Often, significant efficiency can be achieved without associated rate increases—a priority for the City of Santa Clara. Additional efficiency can reduce total customer *bills* even if they, to a lesser degree, increase *rates*. For SVP, the ability to capture all efficiency that passes the total resource cost test depends in part on whether the City of Santa Clara will accept rate increases. Historically, rate increases have not been viable. If this pattern continues, SVP should pursue all potential efficiency that can be achieved without corresponding rate increases. However, SVP should also consider working with the City Council to establish a policy to avoid the disadvantages of least-rate criterion.

Finally, there is a significant knowledge gap regarding efficiency potential in high-tech industries such as data centers. Therefore, research should be conducted into the potential for energy reductions in these types of facilities. An initial review of available information pertaining to this topic will be included as part of this report.

2. Prioritization of public benefit program funding: The City of Santa Clara has established a policy by which public benefit funding collected from a particular rate class must be spent on programs for that same rate class. Historically, SVP has chosen its portfolio of efficiency programs based largely on customer input.

As SVP continues to develop its efficiency program portfolio, it should systematically target funding for end-uses that have the largest potential for realizing energy reductions. Any end-uses that have a large potential for efficiency that are not already part of SVP’s efficiency portfolio will be identified in this project.

⁴ That is, efforts should be made to capture all efficiency potential with a cost of saved energy less than the marginal cost of generating power.

SVP should also examine the possibilities for targeting funds for purposes that benefit the entire city or specific customer segments that are least likely to benefit from cost-effective efficiency programs, such as low-income housing organizations, to improve overall equity.

3. Legislative and regulatory risks and initiatives: California passed Assembly Bill 2021 (AB2021) on September 29, 2006. AB2021 requires all publicly owned electric utilities to estimate all potentially achievable cost-effective energy efficiency savings, and to establish targets for annual efficiency savings for the next 10-year period. Developing this estimate is one of the key goals of this project. However, SVP should continue to monitor developments pertaining to this policy. For example, AB2021 does not provide a clear definition of “cost-effective” efficiency potential, but the California Energy Commission (CEC) and NCPA have indicated that the total resource cost test should be the basis for cost-effectiveness.⁵ This definition has a large impact on the amount of efficiency that is achievable.

4. Distributed generation potential: SVP conducted an analysis of distributed generation opportunities in 2000,⁶ and found that this resource was not cost-effective. This result is largely due to the fact that SVP is not a natural gas utility, and therefore cannot capture the value of displaced natural gas consumption due to the cogeneration of heat and power. While it is difficult to get customer gas consumption data with which to re-evaluate the cost-effectiveness of distributed generation, SVP should determine the criteria under which this resource would be viable. At such time that distributed generation becomes cost-effective, SVP should integrate this resource into its operational study planning process.

5. Demand response and dynamic pricing: SVP’s mild climate and relatively flat load profile (load factor of approximately 74 percent) mean that demand response is likely of less value to SVP than to some other California utilities. Even so, there may be potential to realize some cost-effective demand response potential, building on SVP’s experience with an interruptible voluntary power pool. This project will determine whether or not cost-effective demand response potential exists within SVP’s service area.

6. Renewable power procurement: SVP’s resource portfolio already contains approximately 30 percent renewable energy—more than twice the statewide average. Additionally, SVP’s recent investment in the Big Horn wind farm is coupled with hydro to minimize the inherent variability of the wind resource. This “firming” means that a high penetration of wind will not have the same operational impacts on SVP’s system as it otherwise would. Should SVP choose to add any additional renewable energy, it will be important to both minimize the cost of these resources and to develop strategies to mitigate variability of intermittent renewables, including SVP’s existing hydro-firming strategy, as well as firming through hourly load following and seasonal complementarity.

7. Risk management regarding supply adequacy, energy prices, and emissions costs: SVP has one of the most reliable electric systems in California. However, SVP does still face risks associated with fuel price volatility for its fossil-fuel-fired generation resources, as well as potential costs associated with carbon. SVP should continue to develop tools to manage risks, including resource portfolio diversification, financial instruments such as gas price hedging or options on future capacity, trades with other utilities with complementary risk profiles, and physical assets that reduce exposure to generation and transmission markets or that are

⁵ Personal communication with CEC and NCPA on 1 February 2007.

⁶ Schiller Associates. *Distributed Generation Technology Assessment and Policy Analysis*. June 12, 2000.

complementary to other portfolio resources in their time profiles as capacity and energy sources.

Section 3: Approach to SVP Demand-Side Resource Evaluation

The goal of this project is to estimate the potential for cost-effective demand-side management—including energy efficiency, demand response, and distributed generation—in SVP’s service area, and to assist SVP in developing implementation strategies to achieve that potential. Demand-side resources have historically not been fully integrated into SVP’s electric planning process. However, under certain system conditions, these resources have the potential to support SVP’s robust electric resource portfolio to manage total cost, market prices and other risks, reliability, environmental impacts, and program implementation feasibility.

A thorough evaluation and plan for developing demand-side resources needs to address a number of critical issues discussed below, which are used to develop the approach that RMI will use in its assessment. These issues fall into six broad categories:

- General Valuation
- Rates and Cost Recovery
- Energy Efficiency and Demand Response
- Distributed Generation
- Integration of Plan Elements
- Participation

3.1 General Valuation

A. What are the most appropriate cost analysis methods for demand-side resources?

Overall, well-designed and effective demand-side resource programs should:

- Capture the potential for efficiency and demand response investments to the extent that they limit the costs, risks, and environmental impact of supply sources;
- Reduce customer bills and enhance economic competitiveness;
- Limit the impact on non-participating customers’ rates; and
- Promote equity among various ratepayer classes.

There are a variety of well-established tests that can be used to measure the cost impacts of demand-side resources (see table below).

Effectiveness Tests for Utility Measures

Utility analysts use a variety of tests to judge the effects of any particular utility program or rate change. Each of them is designed to identify the relative costs and benefits to a set of players involved in the transaction. Here is a quick outline of the common ones and what they measure.

Name of Test	What it measures	Costs	Benefits
Participant Cost	<i>Are expenditures lowered for program participants?</i>	Cost of technology	Incentive from utility Bill savings (lost revenues)
Utility Cost	<i>Are utility revenue requirements lowered?</i>	Incentive to customer Program delivery cost	Avoided supply costs
Rate Impact Test (RIM)	<i>Are utility rates lowered?</i>	Incentive paid to customer Lost revenues Program delivery cost	Avoided supply costs
Total Resource Cost (TRC)	<i>Are total customer expenditures lowered?</i>	Cost of technology Program delivery cost	Avoided supply costs
Societal cost test	<i>Are total societal costs lowered?</i>	Cost of technology Program delivery cost	Avoided supply costs Avoided external costs

Using the tests shown in the table above allows for appropriate design and evaluation of demand-side resource programs. SVP uses the Total Resource Cost (TRC) test, in conjunction with the Rate Impact Measure (RIM) and Participant Cost (PCT) to determine the cost-effectiveness of its efficiency programs. RMI agrees that the TRC test most accurately assesses the value of demand-side programs, since it calculates the *total* cost impact, rather than the impact to any particular stakeholder.

If there is value to be had from a TRC perspective, capturing it is largely a matter of program design. However, no single test is sufficient for evaluating demand-side resources; they should be used in combination to ensure that the perspectives of all stakeholders are addressed. The results of the Participant, Utility, and Rate Impact Measure tests will point out how the benefits of a program are distributed, and how they might need to be redistributed to be fair.

Of course, the goal of any cost analysis is to determine which resources are cost-effective and which are not. Therefore, how SVP and the CEC define “cost-effective” largely determines which of the previously described cost tests are appropriate. This definition is still pending.

While the utility cost tests described above can be applied to all forms of demand-side resources, there are important technical and operational differences between these resources that must be addressed in the evaluation process. Specifically, end-use efficiency and demand response primarily affect demand, whereas distributed generation affects supply. Furthermore, end-use efficiency primarily reduces overall energy use (kWh), whereas demand response primarily reduces peak capacity (kW). The unique characteristics of these resources are discussed below.

End-use Efficiency

In traditional utility planning, least-cost principles suggest identifying and realizing all end-use efficiency potential that has a lower cost than the cost of producing power, including costs incurred by both the utility and its customers. Additionally, efficiency could reduce the price exposure that SVP faces from its fossil-fuel resources, as well as from its GHG emissions.

Over 60 percent of SVP's energy in 2007 is expected to be provided by hydro, other renewable energy and inexpensive baseload coal. Therefore, a key question is whether there is end-use efficiency potential that can be implemented for less than the relatively low marginal cost⁷ of these resources.

For end-use efficiency, it is important to distinguish between the "rate" charged to customers versus the total bill that those customers pay. For example, end-use efficiency or demand response measures that are judged cost-effective from a TRC perspective could reduce the overall bill paid by participating customers, even if it sometimes increases rates. However, because of this potential for (typically small) rate increases, overall bills paid by non-participating customers may increase slightly.

The Santa Clara City Council has historically been averse to rate increases, so it is unclear whether any rate increase will be allowed, regardless of overall bill impacts. However, RMI believes that an approach which focuses strictly on achieving the lowest rates tends to underestimate the economic potential of energy efficiency and demand response, and to forego investments that cost less than the marginal cost of supply resources. Furthermore, lowered bills help support the economic growth of the region.

For energy efficiency, it is very difficult to achieve a zero rate impact, yet easy to avoid a large rate impact. While these programs will likely cause a small rate increase, it is also important to note that any type of new centralized generation resource will also have a similar, albeit probably larger, effect. Energy efficiency measures on the other hand, will likely have a positive impact for participants by reducing total bills paid. These two strategies could be used in combination to minimize or eliminate rate impact altogether.

Recommendations for designing and evaluating energy efficiency programs include:

- From a community standpoint, the TRC perspective is the appropriate measure for ranking energy efficiency measures and contrasting energy efficiency investments with supply alternatives. If an efficiency measure passes the TRC, then there is value to be captured. The key is designing the program such that that value is allocated to benefit the appropriate parties.
- When accounting for the benefits of efficiency measures, it is important to comprehensively include avoided costs, including transmission and distribution costs, line losses, reserve capacity, and future emission costs. SVP currently bases its cost test analysis of efficiency programs on PG&E's avoided costs, as a proxy.
- The Utility Cost (UCT), Participant (PCT), and Rate Impact (RIM) perspectives should be carefully balanced to ensure lower average bills and sufficient incentives to achieve participation, but not so much as to encourage free riders, to prevent any undue burden on customers, and to promote equity.

⁷ Marginal cost is an economic term describing the cost of producing one additional kWh of energy. In general, the marginal cost of energy starts out low for baseload plants, and increases through mid-peaking units and is highest for peaking units.

- Because no single program will appeal to, or benefit, all customers, the utility should, as SVP currently does, offer a portfolio of programs so people can freely choose to participate in some, but not others.

It is important to note that RMI's analysis will indicate where the most significant potential for increased end-use efficiency exists, not an absolute answer. Examples from national average efficiency potential and California efficiency potential help indicate areas—sectors, building types, end-uses, and technologies—that should be analyzed more closely should SVP decide to develop more aggressive efficiency programs. However, any analysis of efficiency potential is only as accurate as the data available (discussed in Section 3.3 below).

Demand Response

Unlike energy efficiency, demand response primarily impacts peak capacity demand. Therefore, the cost-effectiveness of demand response depends largely on the value of peak capacity to SVP. Because SVP has a relatively flat load shape and a relatively low price differential between peak and off-peak power, capacity value may be low.

Distributed Generation

When evaluating distributed generation—here limited to combined heat and power (CHP), or cogeneration, and combined cooling heat and power (CCHP), or trigeneration—according to the cost tests described above, there are several unique factors that must be included. These are:

- **“Net” heat rate**—the total fuel consumed divided by the total energy produced. With cogeneration, more useful energy is produced due to the capture and use of “waste” heat, so the net heat rate is lower than the heat rate of the electric generator alone.
- **Electricity and capacity avoided cost**—distributed generation is actual supply, and can therefore supply ancillary services, in addition to reducing both electricity and capacity demanded from conventional supply-side resources.
- **Transmission and distribution avoided cost**—carefully sited distributed generation can alleviate congestion on the transmission and distribution system, as well as reduce line losses associated with moving power long distances. Each of these factors is associated with a real dollar value.
- **Operational impacts**—In some locations, distributed generation can contribute to system reliability by alleviating congestion and providing smaller, more diverse sources of power close to load. In other locations, distributed generation can pose a challenge to system operation and reliability due to frequency variations, transmission capacity demand in case of failure, and other factors. These are significant concerns to SVP, since its high system reliability is a major attraction to its commercial and industrial customers.
- **Benefit of gas savings**—The cost-effectiveness of distributed generation could also be substantially lessened because SVP is an electric utility solely, not a natural gas utility, so savings associated with displacement of heating loads will not accrue directly to SVP.

A cost analysis of distributed generation for SVP's customers is challenging due to the lack of availability of natural gas consumption data for individual customers. Therefore, rather than identifying whether cogeneration is cost-effective now, RMI will identify the criteria that *would need to exist* to make cogeneration viable. These criteria include necessary thermal demand over the course of a year, electricity prices, and natural gas prices.

B. To what degree should we address non-monetary values?

Demand-side resources can have many additional system impacts beyond direct costs and savings. In addition to energy savings and peak load reductions, additional impacts that are typically not counted include:

For the customer:

- Labor cost savings from less frequent replacements;
- Improved credit-worthiness due to fixed cost reductions;
- Reduced air-conditioning loads, especially in commercial buildings;
- Opportunities to address maintenance backlog;
- Potential to downsize cooling and power service capacity in new construction; and
- Increased information burden.

For the utility:

- Greater certainty and a degree of control over demand forecast and capacity needs;
- Deferred growth in capacity needs and possible reliability improvement;
- Reduced exposure to the costs and risks of the power, fuel and emission markets;
- Potential transmission and distribution grid cost savings and loss reductions;
- Reduced emissions of local pollutants and greenhouse gases (GHGs) from power plants; and
- Increased, decentralized management burden.

Some of these impacts that are not traditionally valued can be assessed quantitatively. For example, GHG emissions should be treated as expected future costs, albeit with an uncertain value. Given current industry and political trends as well as the growing awareness and desire to address climate change, RMI believes that assigning monetary values to GHGs is the economically responsible course of action. Future values assigned to GHG emissions, via any policy or market mechanism, will come with a cost that will impact utility operation and the rates seen by customers.

It seems less likely that other pollutants that are currently market externalities will be monetized in the near future, however implementing more aggressive efficiency plans and higher penetration of renewable, clean resources to address possible pending carbon legislation also have the added benefit of reducing emissions across the board. This further limits exposure from other future policies that penalize the release of pollutants from electricity generation.

Other non-monetary impacts are primarily realized on a societal level, such as the impact of air pollution on public health. Air quality is likely improved by implementing efficiency, and possibly demand response. On the other hand, distributed generation can have negative impacts including noise and local air emissions. For those impacts for which precise quantitative values are unknown or difficult to estimate, we recommend evaluating the impact of these variables qualitatively.

C. Should risk analysis be based on scenarios or decision analysis methods?

When applied to utility planning, decision analysis models have the advantage of producing quantitative metrics, such as the expected value of total costs, which are readily comparable

among alternatives. However, forward-looking analysis such as utility planning is difficult to translate in decision analysis tools, as many input parameters need to be estimated by expert judgment in the absence of deep historical probability data.

RMI's approach is to use scenarios, informed by a decision analysis perspective, but without the quantitative formality of decision analysis models. Sensitivity analysis is used to rank the importance of key parameters, and scenarios assess the combined impact of such parameters, which can help inform decision-making and identify solutions that provide a robust set of results under a range of future assumptions. RMI will utilize scenario's available from SVP, including SVP's base and high load forecasts.

D. To what degree are analyses already conducted sufficient?

Silicon Valley Power is currently in the process of updating its Operating Study for 2007-2017. This process includes the development of updated load forecasts, which implicitly include existing efficiency in SVP's service area. In addition, analyses have been conducted regarding the cost-effectiveness of SVP's portfolio of efficiency programs, utilizing a model developed by the Northern California Power Agency (NCPA) and its consultant, E3. However, SVP has not, to date, comprehensively analyzed its cost-effective efficiency potential, or its demand response and distributed generation potential.

3.2 Rates and Cost Recovery

A. To what degree does total cost versus rate impact determine cost-effectiveness?

The definition of cost-effectiveness is critical to the development of an efficiency potential estimate per AB2021. RMI recommends that the basic criterion for evaluating the cost-effectiveness of demand-side programs should be the TRC perspective, which aims to minimize total customer costs (participants and non-participants taken as a group). This is in line with the stated opinions of the CEC and NCPA.⁸

While the City of Santa Clara is averse to raising rates, RMI believes that requiring the absolute minimization of rates (i.e., zero rate impact) leads to foregoing efficiency investments that cost less than supply resources.

However, all four cost tests should be evaluated for each proposed measure, and used together to evaluate the viability of a particular program or resource. Assessing all cost tests ensures that decision-making is a well-rounded and comprehensive process.

B. How should SVP address equity issues?

The issue of equity arises primarily as regards end-use efficiency. End-use efficiency programs can sometimes result in a small rate increase, and while the program would reduce the total electric bills paid by participating customers, an associated rate increase would lead to slightly higher bills paid by non-participating customers.

To minimize this equity issue, overall rate impact can be limited to a maximum, non-zero level, and the equity issues can be reduced by designing programs to be offered to a wide range of

⁸ Personal communication with CEC and NCPA on 1 February 2007.

customer segments, thereby reducing the number of non-participants. This can also be addressed by developing many different programs targeting different customer segments, so as many customers as possible have participation options.

C. How should costs and savings be allocated among customer groups?

SVP is limited in its ability to allocate efficiency spending among different customer groups due to the City of Santa Clara's policy requiring all efficiency money collected from a particular rate class be spent on programs for that rate class. However, within a particular rate class, carefully allocating program costs to customer groups provides another mechanism to minimize cross subsidies from non-participants to participants. The number of non-participants can be further limited by effective outreach and marketing campaigns to educate ratepayers about various programs and their associated energy and bill savings.

3.3 Energy Efficiency and Demand Response

One of the primary goals of this project is to develop estimates of cost-effective energy efficiency and demand response potential. However, any estimate is only as good as the data available. RMI will make use of several data sources in order to develop this estimate for SVP.

To estimate SVP's energy efficiency potential, RMI will first analyze SVP's own customer billing data for business and residential customers to assess the utility's system profile, including system load, customer demand by sector, end use and building type. Once analyzed, this data will be used to calibrate extensive energy efficiency estimates made in a recent study for California's energy efficiency potential led by Itron, Inc. (see "California Energy Efficiency Potential Study").

The study covers the service areas of the three major California IOUs, PG&E, SCE, and SDG&E, which have considerably variable climate patterns, customer breakdowns, and end use breakdowns. Therefore, the primary focus of RMI's analysis will be to customize the results from the Itron report to reflect the specific climate, customer mix, and end use profiles of SVP's system.

California Energy Efficiency Potential Study

Significant effort has been put into developing estimates of efficiency potential for California's Investor Owned Utilities (IOUs). Specifically, a recent comprehensive report titled *The California Energy Efficiency Potential Study*, was produced by Itron, Inc., KEMA, Inc., RLW Analytics, Inc. and Architectural Energy Corp in May 2006.

The report summarized the findings of three studies of gross energy efficiency potential in California, including a potential efficiency study of the industrial sector conducted by KEMA, Inc. and a residential, commercial and industrial sector study conducted by Itron, Inc. Integrated together, the report forecasts California's publicly funded energy efficiency potential through 2016 based on "efficiency measures for retrofit, replace-on-burnout, conversions and new construction."¹

To estimate efficiency potential, Itron made assumptions regarding the types of buildings found in each of the IOUs' service areas, as well as how those buildings use energy. These two data types are referred to as building type breakdowns and end use breakdowns, respectively. Itron then determined efficiency potential for each end use in each building type, and aggregates those estimates to calculate an overall efficiency estimate for each IOU.

To do this, RMI will utilize a number of SVP data sources, including most importantly:

- **SVP climate zone**—The Itron report includes efficiency estimates for different climate zones. RMI will extract the efficiency potential data for climate zone 4, which covers the majority of SVP’s service area.
- **SVP customer data**—Detailed data on SVP’s approximately 50,000 customers, including monthly consumption, bill, and NAICS code, will be used to determine the relative contribution of various commercial and industrial customers to annual energy demand. This so-called building type breakdown will be compared to ITRON’s assumed building type breakdown for PG&E, and the efficiency potential adjusted accordingly.
- **SVP commercial and industrial energy audits**—As part of SVP’s efficiency program portfolio, free energy audits are offered to customers. These audits identify baseline energy consumption in a building, as well as how much of that energy is used in different end uses. The audits then make recommendations on cost-effective efficiency measures that could be implemented in that building. Baseline end-use consumption data from these audits can inform an efficiency potential estimate by identifying how energy is actually used in SVP’s specific service area. These SVP-specific end use breakdowns will be used to adjust the Itron estimates of efficiency potential.

Together, these data will be used to modify California statewide efficiency potential to the specific characteristics of SVP’s service area.

RMI’s approach to estimating demand response potential begins by first reviewing the utility’s system load profile to gain an understanding of when the utility’s system peak occurs, as well as the peak day load profile. Next, the corresponding daily load profile is constructed for each customer class to estimate their relative contributions to the utility system peak. End use contributions for each customer class are then identified and potential for demand response estimated, based on existing literature. The potential by end use and customer class is then aggregated into a total demand response potential for the utility system. Finally, cost effectiveness of automated demand response technologies is evaluated and program design strategies provide for capturing the any demand response potential.

A. To what degree does demand-side management stress energy savings vs. peak load management?

Typically, demand response is used to reduce a utility’s peak load. Under these programs, curtailed load is merely delayed until an off-peak time (effectively flattening the load curve), so will likely not result in significant energy savings. End-use efficiency programs, however, primarily focus on energy savings across the entire load profile, lowering aggregate demand by providing the same desired service with less total energy consumption.

Thus, demand response programs and energy efficiency programs can complement one another nicely. Energy efficiency reduces peak and off-peak loads alike—which one or both depends on what end uses are targeted—offsetting load growth and delaying costly transmission upgrades. Demand response gives load managers additional flexibility and reduces the need for peaking supplies. Additionally, if energy efficiency savings are greater than overall load growth, peak hours and intensity are also reduced, resulting in further grid stability and savings. Furthermore, demand response can be leveraged more effectively after energy efficiency has already trimmed the load and reduced system congestion.

The “peakiness” of a utility’s load shape determines the attractiveness of demand response programs. SVP has a relatively flat load shape, which means that peak load management has less potential to provide financial benefits to SVP than to many utilities. Therefore, SVP should focus on energy savings, although savings during on-peak time intervals will have the most value in terms of avoided purchases (or financial savings due to surplus sales) at the margin.

B. Should customer implementation be driven by rates or technical programs?

Implementation of energy efficiency and demand response programs should be carefully structured to target the optimal load, customer and grid characteristics. The two different ways to implement demand response and end-use efficiency are through changes to the rate structure, and/or technical programs that provide incentives for preferred customer behavior.

Rates can be designed to reflect actual marginal costs at different times of the day (time-of-use rates). By sending price signals to customers when it is cheaper or more expensive to produce energy, customers should respond by shifting flexible loads to times with cheaper rates, thus lowering total utility costs. This is appropriate when a significant fraction of load is made up of large industrial users that have energy managers to manage task scheduling. For residential and retail customers, this method is not as effective, as loads are rigid and the customer is less likely to monitor rates that vary during the day and adjust behavior accordingly. Furthermore, because SVP’s marginal costs do not change substantially over the course of a day or year, TOU rates may not be appropriate.

Technical programs generally target specific customers or end-uses, and represent the strategy that SVP currently uses to implement its efficiency programs (as described in Section 2). Technical programs provide rebates or other incentives that reward upgrading old, outdated, inefficient appliances, pumps, and motors, or target large users to sign up for demand response programs. Technical programs work best when incentives are provided and directed at many different end-uses.

Rate development and the associated metering upgrades are usually expensive, and SVP’s marginal costs are fairly flat. Therefore, SVP should probably emphasize technical programs over new rates.

3.4 Distributed Generation

Distributed generation can refer to a wide variety of technologies, including small-scale renewable resources, back-up generators, combined heat and power (CHP), and combined cooling, heating and power (CCHP). RMI’s analysis in this section will focus on the latter two, collectively referred to here as cogeneration.

SVP conducted a study on the viability of cogeneration in its system in 2000, which found that cogeneration was not cost-effective at the time. This result is likely due to the fact that SVP is not a natural gas utility, and therefore cannot capture the value of displaced natural gas savings. In addition, SVP has low electric rates compared to other parts of California.

There is no particular reason to believe that the economics of cogeneration have changed since SVP’s 2000 analysis. Additionally, a new analysis of cost-effectiveness is not viable, due to the lack of natural gas consumption data for SVP’s large customers. Therefore, RMI will use technical and economic models to determine the criteria under which cogeneration *would be*

cost-effective for SVP. These criteria include monthly thermal demands, electricity prices, and natural gas prices.

A. What is the optimum and maximum scale for distributed generation?

By providing an independent power source near the customer, distributed generation has the potential to improve the reliability of electric service to critical customer loads. Premium reliability has a high value in sensitive industries such as data management and semiconductor fabrication, a notable segment of SVP's customer base. Cogeneration can provide firm power at greater net efficiencies than large, centralized sources, and under certain system circumstances, can also reduce transmission and distribution losses and load on the utility system.

In order to effectively gauge the optimum and maximum achievable scale for cogeneration, we will need to make several informed assumptions. First, since cogeneration provides power and thermal energy at the customer site, the sizing and performance can be limited by the customers' demand for either electricity or heat. Systems that are sized to meet a customer's thermal load may generate excess power that can then be available to be sold to the grid. Thus, SVP's ability to purchase excess electricity via net metering or some other mechanism will play a large role in the scale, feasibility, and cost-effectiveness of distributed generation.

Alternatively, another business model could be considered in which the distributed generation systems are owned and operated by the utility rather than the customer. Assuming that utility ownership of the cogeneration system or sales of excess power is possible, we will consider the potential for cogeneration to produce surplus power that could be exported to the grid. Second, while the ability to use waste heat on-site still limits the potential for economical combined heat and power, we can increase this potential by including the prospect of absorption or other cooling technology that can be driven by waste heat from the generator (combined heating cooling and power). This approach also provides more uniform thermal energy demand over the year.

While there are clear economies of scale for larger units, distributed benefits including thermal integration, customer reliability and possibly grid benefits weigh in the favor of smaller, more distributed units.

B. How should thermal energy from cogeneration be valued?

The magnitude of customer cogeneration potential and the economic performance of cogeneration depend strongly on the ability to capture and use waste heat from the prime mover to offset other purchased energy (gas for heat, electricity for cooling). Without any thermal energy displacement, on-site generation is not likely to be cost-effective. Thus, thermal energy delivered by cogeneration savings should be credited as fuel savings, based on the heating-only fuel it displaces. This fuel savings can be credited against the fuel use of the generator, thus improving its effective, or "net", heat rate,⁹ or conversion efficiency, and emissions rate.

C. What is the role of distributed renewable resources?

The benefits provided by distributed renewable resources, such as solar photovoltaics, can extend beyond the as-available power they provide. These benefits include reducing the

⁹ Effective heat rate refers to the total fuel consumed divided by the total energy produced. With cogeneration, more useful energy is produced due to the capture and use of "waste" heat.

system's peak by providing power coincident with peak demand (this is especially true in California where insolation is highly coincident with peak), avoiding energy costs and associated losses, providing flexibility based on shorter lead times and reducing the risk of overbuilding. On the other hand, most distributed renewable resources are intermittent—their output is variable—and large-scale implementation can impose operational impacts on the utility's system. Distributed renewable resources are often significantly more costly than centralized renewables such as large-scale wind and geothermal.

One potential added value of distributed renewable resources is the potential for deferring investments in utility distribution capacity. To the extent possible, RMI will review sample load shape data to determine the coincident peak factor and the potential for shaving SVP's peak using photovoltaics.

3.5 Integration of Plan Elements

A. How should fuel price risks and GHG liabilities be mitigated?

The risks posed by future fuel price volatility and potential regulation of GHG emissions must be accurately reflected as explicit future costs and risks in the evaluation of supply and demand-side resource options. SVP's absolute GHG emissions are small (roughly 590,000 metric tons), but its intensity is 0.49 metric tons CO₂ per MWh, whereas the California average intensity is 0.35 metric tons CO₂ per MWh. RMI recommends applying a GHG cost "adder" in order to calculate SVP's risk exposure to potential GHG emissions regulation.

Strategies to mitigate these future costs and risks could include financial instruments, such as hedging contracts, options on future capacity, and forward contracts for carbon offsets. Another approach is to further diversify SVP's energy portfolio by investing more aggressively in lower-risk resources such as energy efficiency, renewables, and possibly external carbon offsets.

B. Should we prepare for hydrogen and other future technology options?

The present cost, durability and fuel supply issues surrounding hydrogen fuel cell technology make it difficult to justify as a near-term generation or cogeneration option. The fuel cell industry expects the technology to mature and resolve these problems during the 10-20 year resource-planning horizon. As such, SVP should continue to monitor developments in this industry for possible long-term integration into resource planning.

C. How do we balance between low and stable rates, environmental stewardship, and reliability?

By focusing on the economic and financial value, albeit uncertain, of reliability, environmental, and other attributes, we are able to evaluate alternatives comprehensively using total cost as the basis of comparison. Using sensitivity analysis and scenarios to represent a range of plausible future states, we can also identify resource portfolios that are robust or at least minimally sensitive to risks such as fuel costs or emission limits.

RMI's approach ensures that normal system reliability can be incrementally better, and certainly will not be worse than at present. SVP's location relative to the regional grid and supply sources is such that distributed generation or load reductions contribute more than their nominal capacity value to increasing load serving capacity in the region. This is because distributed resources, both supply- and demand-side, do not have the losses associated with transmission

and distribution, and in some cases can provide additional services, such as bundled community-heating or cooling to further offset loads. When a distributed generation source is added to the grid, it can serve a load that is proportionally bigger than the centralized plant that it replaced. Also, when demand response reduces load, the generation capacity that it offset is greater than its actual consumption due to such losses.

Finally, we will explore the potential for incremental improvement in local system reliability in the case of severe system emergency (prolonged grid outage) through the use of distributed generation capacity connected to allow it to serve critical local loads under such conditions.

3.6 Participation

A. What are the most effective techniques for motivating participation in demand-side management programs?

Participation in energy efficiency programs can be motivated by several factors. The most important factor for residential, commercial, and industrial customers is realizing cost savings from reduced energy use. Many energy efficiency measures have relatively quick payback periods, especially when there are utility, state, or federal incentives that offset the upfront cost of implementing the measure. In addition to savings from reducing energy-use, industrial and commercial users often will save money by reducing their peak load. Therefore, one of the most effective techniques for motivating participation is to educate customers about cost savings potential, and to provide a financial incentive that encourages participation without providing an unnecessary windfall.

Another motive for participating in energy efficiency programs is the environmental benefit associated with using less energy, which tends to motivate energy efficiency strategies that have longer payback periods that don't make sense on a purely financial basis. Environmental benefits, when combined with minor savings are enough to motivate action among certain customer groups.

Some energy-efficient products, such as compact-fluorescents, have the added benefit of lasting significantly longer than their less-efficient counterpart. In certain applications, the labor and maintenance costs of replacement are more significant than the price differential, and outweigh the cost savings of the light's reduced energy consumption.

Customers express a variety of reasons for participating in demand response programs, ranging from monetary savings, to the desire to help avoid blackouts, to a sense of corporate responsibility¹⁰. Successful demand response programs increase customer awareness of the benefits of demand response and enhance their customer's ability to participate through use of control technologies like smart thermostats and energy information. Other customers recognize that participating in demand response programs could help avoid future blackouts, which are hugely disruptive to commerce and communities. This last reason is the primary motivator for participation in SVP's voluntary power pool.

¹⁰ Peak Load Management Alliance (PLMA). 22002. *DR: Design Principles for Creating Customer and Market Value*. www.plma.com.

B. What are barriers to customer participation?

Numerous concerns and uncertainties deter customers from participating in demand-side programs, which include:

- *Financial viability*—customers may believe that incentives offered for participation are inadequate, or they may be uncertain as to the financial payback of different energy efficiency measures.
- *Performance impact*—customers may be concerned that they will not be able to maintain occupant comfort or product quality during a demand response event.
- *Information gap*—customers may be overwhelmed by the number of program options, may not have the perception of a utility emergency on a scale that warrants a response, or may be uncertain about how much load is available for reduction during an event.
- *Long-term effectiveness*—customers may not be motivated to properly maintain their demand-side equipment, and the effect of the demand response or efficiency program over time may therefore be lessened.
- *Technology*—customers may have energy management systems or other control technologies installed, but may underutilize them; others may have very little investment in building automation and controls.

Utilities can address many of these concerns through smart program design and coordinated assistance. Successful demand-side programs provide customers with a limited choice of programs and allow them to participate in more than one program (e.g., a pricing program and an emergency program). No single demand response or energy efficiency program will fit all commercial and industrial customers. Even within an industry, different facilities have different technical, financial, and informational needs, and will be at different stages of decision-making.

Utilities should provide an integrated package of services to move customers through various stages of program participation and technology adoption. The services must be coordinated to increase customer awareness about program and technology options and program incentives, provide financial assistance for enabling technologies, and provide brokerage/mediation assistance such as locating and hiring contractors¹¹. In particular, small (<100 kW) and medium customers (100 – 500 kW) may not have established relationships with vendors. Customers will be more likely to participate if utilities work with them on designing and implementing demand-side programs.

C. What are the criteria for determining appropriate customer incentive levels?

There are two competing objectives for incentive-based demand-side management programs. Incentives need to be lucrative enough to elicit participation to meet program goals. At the same time, they should be set just above the price point for decision-making so as to maximize the impact of program funds. An appropriate incentive level will thus be just large enough to ensure ample participation. Getting the incentive level right will ensure that total system benefits of the program are maximized.

¹¹ California Energy Commission (CEC). 2004. *Enhanced Automation Educational Campaign*. Final Report.

Section 4: Conclusions

Using selected approaches discussed in this report, RMI will work with SVP to develop high-level technical and economic potential estimates for energy efficiency, demand response, and distributed generation. We will then assess potential means of developing programs to capture this potential, and methods of increasing customer participation.