ENERGY EFFICIENCY LEADERSHIP IN CALIFORNIA

Preventing the Next Crisis

Authors
Devra Bachrach, NRDC
Matt Ardema, SVMG
Alex Leupp, SVMG

Natural Resources Defense Council
Silicon Valley Manufacturing Group
April 2003

ACKNOWLEDGMENTS

The William and Flora Hewlett Foundation provided crucial support for this report, and for an ongoing energy-efficiency collaboration between NRDC and SVMG. The authors gratefully acknowledge the contributions of Sylvia Bender, Mark Bolinger, Justin Bradley, Susan Brown, Chris Calwell, Ralph Cavanagh, Kathryn Cotter, Rick Counihan, Emily Cousins, Huston Eubank, Carl Guardino, Don Hall, Dimitry Holl, Jim Holland, Noah Horowitz, Lynn Hunsaker, Mukesh Khattar, Jonathan Koomey, Anthony Marek, Lynn Marshall, Steve McCarty, Jerry Meek, Ben Mehta, Lainie Motamedi, Joe Pon, Brenda Price, Joseph Romm, Jenifer Seal, Zenaida Tapawan-Conway, and John Wilson.

REPORT PRODUCTION

NRDC Reports Manager
Emily Cousins

Production
Bonnie Greenfield

Cover Design
Jenkins & Page

NRDC President
John Adams

NRDC Executive Director
Frances Beinecke

NRDC Director of Communications
Alan Metrick

SVMG President and CEO
Carl Guardino

SVMG Director of Energy Programs
Justin Bradley

SVMG Associate Director of Energy Programs
Alex Leupp

SVMG Energy Policy Coordinator
Matt Ardema

Cover photos: Compact florescent bulb: Department of Energy. Landscape: Photodisc.

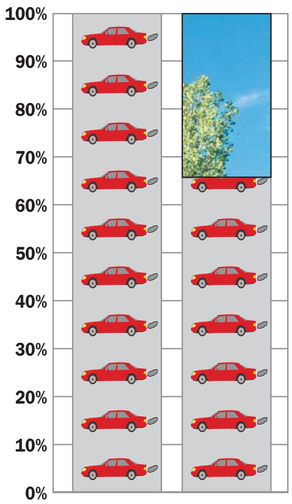
For additional copies of this report, send $7.50 plus $3.50 shipping and handling to NRDC Publications Department, 40 West 20th Street, New York, NY 10011. California residents must add 7.25 percent sales tax. Please make checks payable to NRDC in U.S. dollars.

The full text of this report also appears at www.nrdc.org and www.svmg.org.

This report is printed on 100 percent recycled paper with 30 percent post-consumer content.

TABLE OF CONTENTS

CLEARING THE AIR



The conservation in 2001 and 2002 reduced pollution emissions by nearly 8 million tons of carbon dioxide and 2,700 tons of smog-forming nitrogen oxides relative to 2000. The carbon pollution savings are equivalent to taking 1.5 million passenger vehicles (one-third of Bay Area vehicles) off the road for an entire year.

Californians are maintaining a strong commitment to energy conservation following the state's recent energy crisis. New data from the California Energy Commission show that instead of slipping back into old habits in 2002, Californians sustained much of the conservation seen during the crisis, even accounting for the dampening effect of a slower economy. Thanks to these efforts, California residents and businesses have demonstrated some of the best possible ways to protect the economy and the environment.

The first six months of demand reductions in 2001 alone saved Californians an estimated $660 million in spot market electricity purchases and helped avoid up to $20 billion in projected costs of summertime rolling blackouts. The conservation in 2001 and 2002 reduced pollution emissions by nearly 8 million tons of carbon dioxide and 2,700 tons of smog-forming nitrogen oxides relative to 2000. The carbon pollution savings are equivalent to taking 1.5 million passenger vehicles (one-third of Bay Area vehicles) off the road for an entire year.

Even more promising for California's continued economic and environmental health, Californians locked in about one-quarter of the demand reductions achieved during 2001, or about 1,000 MW (equivalent to two large power plants), through investments in energy efficiency. But soaring natural gas prices and warnings of another regional drought are continuing reminders that we must not be complacent.

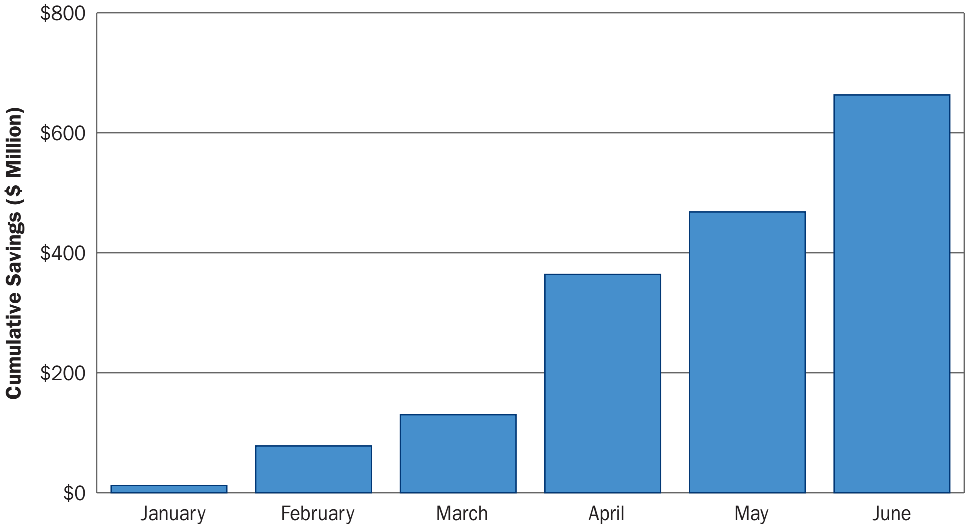
Opportunities for California to take advantage of additional inexpensive energy efficiency improvements abound. New evidence shows that over the next decade, California could realistically and cost-effectively reduce its electricity needs by at least 5,900 MW—the equivalent of 12 giant power plants—while avoiding the environmental damage associated with electricity generation. This added investment in efficiency would return an estimated $12 billion to Californians' pocketbooks.

Smart investments and policies will help achieve these energy and cost savings. Our report highlights recent policy progress that has California poised to take advantage of these cost-effective resources. Policymakers and regulators have restored utilities' responsibility to manage a robust portfolio of long-term investments for the benefit of their customers, reversing one of the fundamental mistakes of electricity industry restructuring in California. Just as importantly, regulators are also aligning the utilities' financial incentives with the interests of their customers to ensure that the utilities are rewarded for providing reliable and affordable service rather than increases in electricity use.

These policy gains will stimulate investments in energy efficiency that can help:

- Keep California's economy strong by decreasing the cost of our energy services;
- Free up hundreds of MW of power each year without the environmental impacts that would accompany electricity generation;
- Avert supply shortfalls that can send prices soaring; and
- Reduce California's global warming emissions.

FIGURE 1
Californians' Conservation Saved Over Half a Billion Dollars in Spot Market Purchases (2001)



Sources: California Department of Water Resources, California Energy Commission

Our report's case studies of Silicon Valley companies provide concrete examples of energy efficiency improvements that can reduce energy costs for both companies themselves and their customers. These companies are getting more work out of less energy, boosting profits and productivity. If California continues to make sound policy and investment decisions, more residents and businesses will enjoy similar savings.

California now has an unprecedented opportunity to channel the positive momentum of the past few years into a new wave of cost-effective investments in energy efficiency. Reinvigorating these investments will help stimulate the economy, protect our environment, and ensure that California never faces another energy crisis.

CHAPTER 1

California's Record

Less Energy, More Growth

To overcome the energy crisis of 2001, California launched an aggressive energy conservation campaign with impressive results. New data from the California Energy Commission show that instead of slipping back into old habits in 2002, Californians sustained a full half of the conservation seen during the crisis, even when adjusted for the dampening effect of a slower economy.[1] The most successful statewide energy conservation campaign in history is all the more impressive considering that before the campaign even began, California's per capita electricity use was already 40 percent lower than the rest of the nation's.[2]

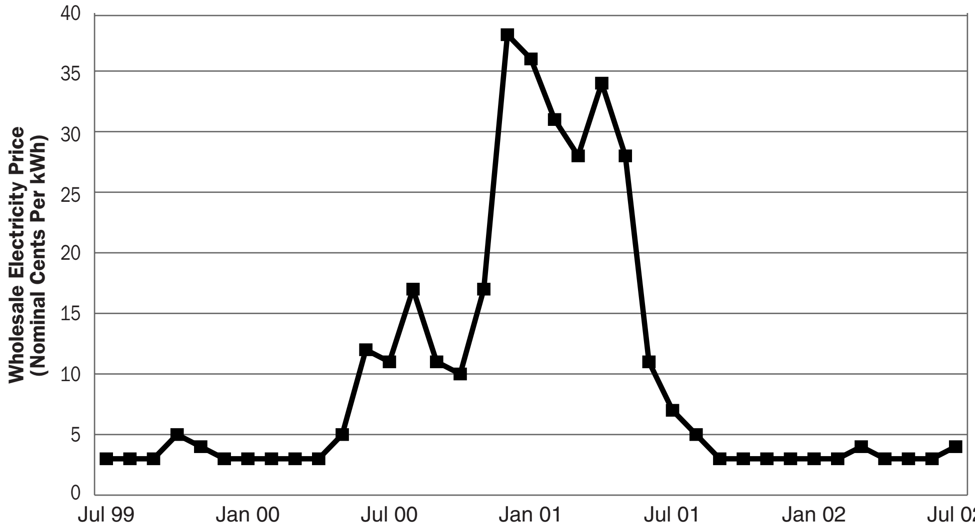
Californians' efforts saved money and protected the environment at the same time. The first six months of demand reductions in 2001 alone saved Californians an estimated $660 million in spot market electricity purchases and helped avoid up to $20 billion in projected costs of summertime rolling blackouts.[3] The combined conservation achievements in 2001 and 2002 reduced pollution emissions by nearly 8 million tons of carbon dioxide and 2,700 tons of smog-forming nitrogen oxides relative to 2000. The carbon pollution savings are equivalent to taking 1.5 million passenger vehicles (one-third of Bay Area vehicles) off the road for an entire year.[4]

The crisis that prompted this conservation campaign began in late 2000, when skyrocketing wholesale electricity prices precipitated financial crises at California's largest utilities (see Figure 2). A confluence of factors contributed to the high prices, including a sharp rise in natural gas prices, low hydropower supplies in the Northwest, and market manipulations.[5] In early May 2001, the National Electric Reliability Council grimly forecasted hundreds of hours of rolling blackouts in store for California during the summer of 2001.[6] Not one blackout occurred that summer. The demand reductions that helped avert these disasters were no accident. The state leveraged a host of policies and incentives already in place to help Californians reduce their energy demand.

Our purpose here is not to dwell on the many causes of California's electricity crisis, but instead to learn from this chapter in our history. Californians can take pride in their impressive conservation accomplishments, but soaring natural gas prices and warnings of another regional drought are continuing reminders that we must not be complacent.[7]

Our report reviews California's record of energy efficiency improvements, while

FIGURE 2
California Wholesale Spot Market Electricity Prices



Sources: University of California Energy Institute, California Department of Water Resources[8]

looking toward the future and the potential for additional cost-effective investments. Case studies of Silicon Valley companies provide concrete examples of how individual companies can cut their energy bills and reduce costs for their customers as well. For the state as a whole, our report highlights policies and actions that will enable California to sustain the positive momentum of the past few years. Reinvigorating investments in energy efficiency and conservation will help California prevent the next electricity crisis from ever appearing on the horizon.

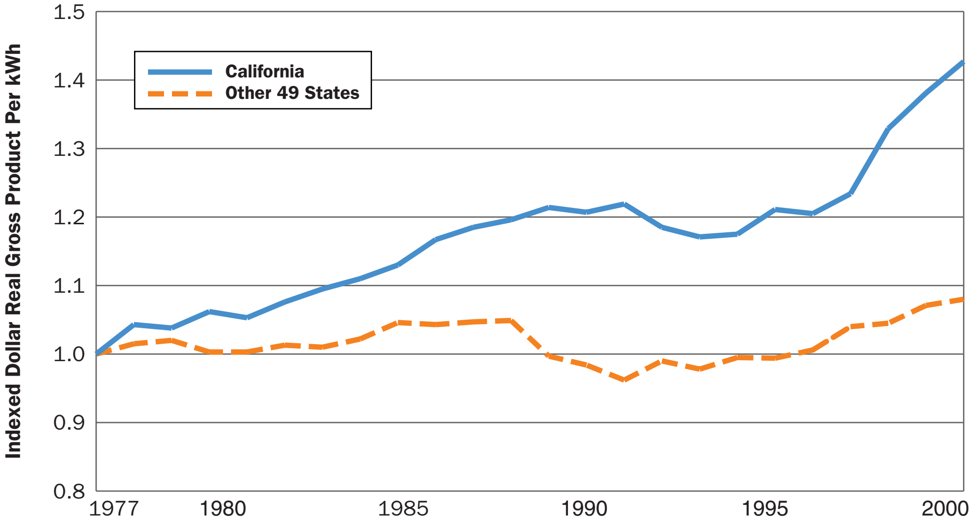
CALIFORNIA'S SUSTAINED EFFICIENCY IMPROVEMENTS

California has long been a leader in enabling residents and businesses to get more work out of less energy by using efficiency improvements. Thanks to numerous dedicated policy and regulatory leaders, the utilities, and energy efficiency advocates, California's energy efficiency programs and standards have provided a model for energy efficiency programs across the country.

California has experienced remarkable population and economic growth. Population grew by 40 percent over the past two decades and gross state product more than doubled.[9] With two key drivers of electricity use increasing rapidly, one might expect California's electricity use to have mirrored this growth. To the contrary, thanks to sustained energy efficiency efforts, California outperformed the rest of the nation by doing more with less energy.

Highly productive use of electricity has enabled California to sustain higher economic growth while using less electricity than the rest of the United States (see Figure 3). California's inflation-adjusted economic-output per unit of electricity consumed has increased over 40 percent since 1977, while the rest of the nation has increased economic-output per unit of consumption by only 8 percent.

FIGURE 3
Change in Economic Productivity of Electricity Use: California vs. Other 49 States



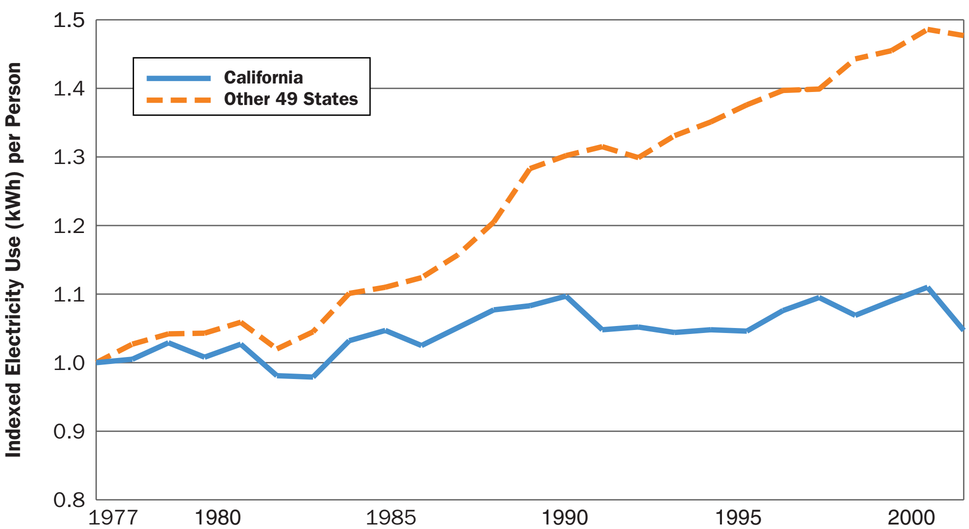
Sources: U.S. Bureau of Economic Analysis, U.S. Energy Information Administration, Edison Electric Institute, California Energy Commission

Highly productive use of electricity has enabled California to sustain higher economic growth while using less electricity than the rest of the United States.

Without sacrificing quality of life or productivity, Californians only slightly increased electricity use per person over the past two decades, while the rest of the nation saw per capita electricity use increase by nearly 50 percent (see Figure 4). California's targeted energy efficiency incentives and strong standards have ensured that Californians are better off today without using appreciably more electricity. In fact, the California Energy Commission (CEC) reports that California has the lowest electricity consumption per capita in the nation.[10]

The CEC estimates that since inception, the utility energy efficiency programs

FIGURE 4
Change in Per Capita Electricity Use: California vs. Other 49 States



Sources: U.S. Census Bureau, California Department of Finance, U.S. Energy Information Administration, Edison Electric Institute, California Energy Commission and state building and appliance standards have removed nearly 10,000 MW from California's peak electricity demand—avoiding the need to build 20 large-scale power plants in neighborhoods and open space across California.[11]

Demand Reductions in 2001

The demand reductions achieved in 2001 effectively utilized the state's well-established energy efficiency infrastructure, and culminated in what the California State and Consumer Services Agency called "the most aggressive and comprehensive energy conservation and efficiency effort in the history of our state."[12] The strategies for increasing efficiency and reducing demand in 2001 included:

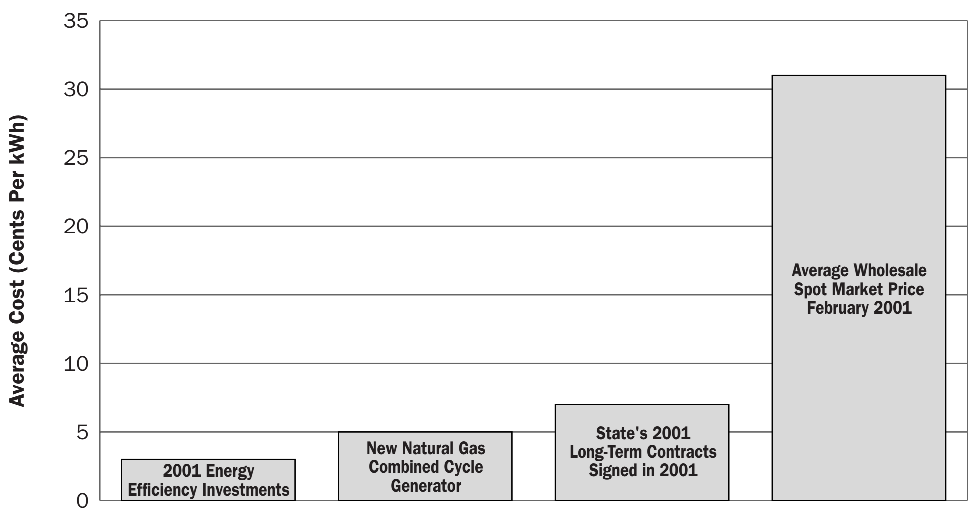
- Additional funding for utilities' energy efficiency programs;
- Specialized programs administered by the CEC focused on reducing peak demand; and
- The governor's 20/20 program, which provided 20 percent bill reductions to customers who cut energy use by 20 percent.

The CEC reports that California has the lowest electricity consumption per capita in the nation.

A legislative infusion of more than $500 million supported these additional energy efficiency and conservation programs, more than doubling overall energy efficiency funding levels in 2001 relative to 2000.[13] Silicon Valley's two consumer-owned utilities, the City of Palo Alto and Silicon Valley Power, launched similarly aggressive programs with notable results. Extensive media coverage of the crisis also helped draw attention to the value of demand reductions.

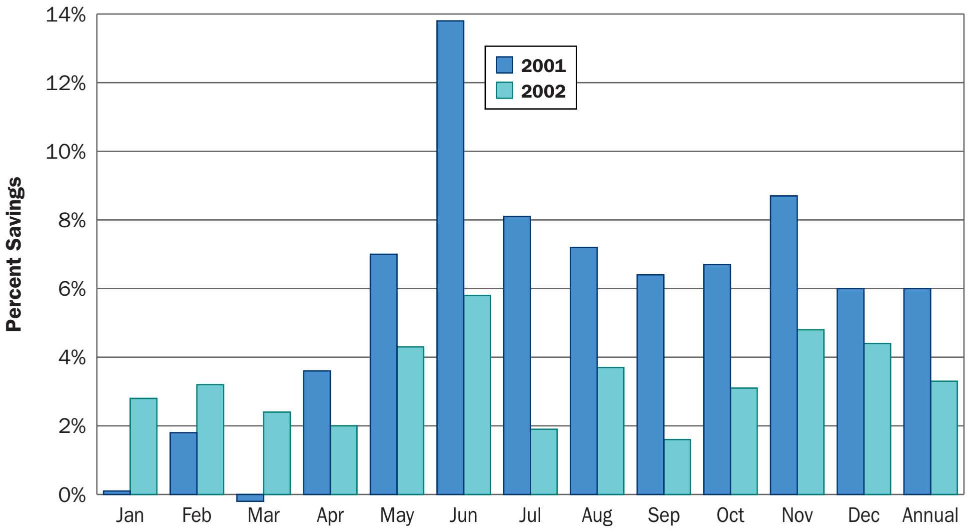
Californians heeded the call to action, embracing conservation and energy efficiency programs with unprecedented enthusiasm:

FIGURE 5
Cost Comparison of Energy Efficiency and Electricity Investments



Sources: California Measurement Advisory Council, California Energy Commission, Lawrence Berkeley National Laboratory, California State Auditor, and California Department of Water Resources[14]

FIGURE 6
Reductions in Weather-Adjusted Monthly Electricity Consumption Relative to 2000



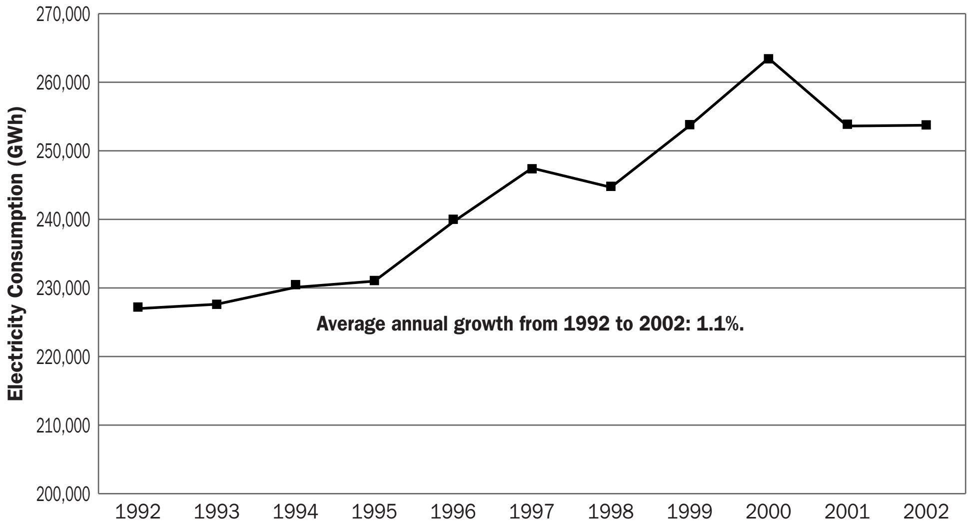
Source: California Energy Commission

- Relative to 2000, energy use was down an average of 7.9 percent during the critical summer of 2001 and peak demand was down an average of 8.4 percent.
- Contrary to widespread claims, weather during summer 2001 was not cooler than the previous year, and California's economy continued to see modest growth (the gross state product was 2.3 percent higher in 2001 than 2000). When adjusted for economic growth and weather conditions, the average reduction in peak demand during summer 2001 was more than 10 percent.
- For the entire year, weather-adjusted energy consumption and average peak demand were down 6 percent and 7.7 percent, respectively.[15]
- Conservation efforts were impressively widespread; a full one-third of residential customers reduced their demand by more than 20 percent and qualified for the governor's 20/20 program.[16]

Subsequent analysis of the efforts of 2001 demonstrated that conservation and efficiency were among the fastest solutions available to avert blackouts. A report by Lawrence Berkeley National Laboratory (LBL) estimates that Californians' conservation avoided between 50 and 160 hours of rolling blackouts during the summer of 2001, sparing the California economy the devastating impact of the predicted blackouts. Even more promising for California's continued economic health, the LBL report estimates that about one-quarter of the demand reductions initiated in 2001 (or about 1,000 MW of savings) will persist well into the future.[17] The cost over the lifetime of the efficiency projects undertaken during 2001 will be an average of 3¢ per kWh—much less than the normal cost of electricity generation, and significantly less than the average cost of the long-term contracts for electricity the state entered into during 2001 at 7¢ per kWh (see Figure 5).[18]

The cost over the lifetime of the efficiency projects undertaken during 2001 will be an average of 3¢ per kWh—much less than the normal cost of electricity generation.

FIGURE 7
California's Annual Electricity Consumption, 1992–2002



Source: California Energy Commission

The rapid loss of part of the conservation response reinforces the value of investments that can lock in the savings to provide long-term environmental and economic benefits.

Conservation Persists in 2002

The CEC reports that half of the conservation initiated during the crisis persisted in 2002 (adjusted to account for weather and economic conditions), despite reduced investments in conservation and energy efficiency programs and public education.[19]

- Peak demand in the summer of 2002 increased somewhat over the summer of 2001, when adjusted for weather and economic growth, but remained 5.1 percent lower than the peak demand in the summer of 2000.
- For 2002 as a whole, energy consumption and average peak demand remained 3.2 percent and 4.5 percent lower than in 2000, respectively, adjusted for weather and economic conditions.[20]
- One-third of residential customers reduced their demand in the summer months of 2002 by at least 20 percent relative to 2000 levels to qualify for the 20/20 program, matching the success of the program in 2001.[21]

This level of continued conservation is promising, but the rapid loss of part of the conservation response reinforces the value of investments that can lock in the savings to provide long-term environmental and economic benefits.

CHAPTER 2

A Return on Investment

Additional Savings from Efficiency

Looking toward the future, California can reap significant cost savings and environmental benefits by increasing investments in energy efficiency. While fortifying the state's energy efficiency infrastructure, California should expand its investments to take advantage of the abundant and inexpensive efficiency improvements that are now available.

Like transmission lines and power plants, California's energy efficiency infrastructure is critical to the state's ability to maintain affordable and reliable energy services.

A CRITICAL INFRASTRUCTURE

Like transmission lines and power plants, California's energy efficiency infrastructure—a collection of institutions, policies, and experts—is critical to the state's ability to maintain affordable and reliable energy services. California's energy efficiency infrastructure can help:

- Keep California's economy strong by decreasing the cost of our energy services;
- Free up hundreds of MW of power each year without the environmental impacts that would accompany electricity generation;
- Avert supply shortfalls that can send prices soaring;
- Prevent the electricity grid from becoming overloaded by freeing up power without using transmission lines; and
- Reduce California's global warming emissions.

Energy efficiency also provides a hedge against the volatility of natural gas prices, helping stabilize energy bills (see Figure 8). This infrastructure must be properly maintained to ensure its reliability.

The Path to Efficiency

This critical infrastructure develops and implements strategies to improve the energy efficiency of California's economy. The process of introducing new energy-efficient technologies into the marketplace, gaining significant market penetration, and integrating the technologies into everyday life occurs in three broad phases.

FIGURE 8
Daily NYMEX Natural Gas Futures Prices (First Nearby Contract)
January 1998–March 2003

Source: NYMEX[22]

Developing Efficient Technologies: Private industry, university, and government researchers develop new energy-efficient technologies, such as efficient lights, air conditioners, and motors. The Public Interest Energy Research (PIER) program overseen by the California Energy Commission supports the development and demonstration of some of these new technologies. The PIER program awards approximately $20 million a year to help make promising new efficiency ideas a reality. These funds help leverage the private investments in new efficient technologies.

Gaining Market Share: Utility energy-efficiency programs help a wide range of new and innovative energy-efficient technologies gain traction in the marketplace. Incentives and information provided by the programs spur consumers to make wise investment decisions, while the utilities simultaneously use this energy efficiency resource to meet their customers' energy needs for less than it would cost to generate the avoided electricity. The California Public Utilities Commission (PUC) oversees the investor-owned utilities' energy efficiency programs and is responsible for ensuring that the benefits of the energy efficiency programs are distributed equitably. To achieve this, special energy efficiency programs are dedicated to serve the needs of low-income customers.

The utilities rely on knowledgeable in-house staff capable of overseeing and administering hundreds of millions of dollars in contracts each year to manage the energy efficiency programs. In addition, the utilities use an extensive network of energy efficiency professionals, consultants, and contractors with years of experience at delivering new technologies into the marketplace to implement many of the efficiency programs. The American Council for an Energy-Efficient Economy (ACEEE) awarded California's investor-owned utilities its coveted "Champion of

Energy Efficiency" award in 2002 in recognition of the utilities' unprecedented achievements in 2001.

The utilities' diverse portfolio of energy efficiency programs involves varied technologies ranging from energy-efficient residential light bulbs to industrial motors to air conditioners. (Appendices I and II provide details on Silicon Valley's energy efficiency programs and links to websites with details on California's additional efficiency programs.) Close coordination with national energy efficiency initiatives through organizations such as the Consortium for Energy Efficiency and the Environmental Protection Agency's Energy Star program ensures that California's efficiency programs help drive the adoption of new technologies nationwide.

Making Efficiency the Standard: Once the new generation of efficient technologies is commonly used by Californians, the CEC oversees a process that locks in the efficiency gains, ensuring economic and environmental savings for years to come. Through an extensive public process, the CEC periodically upgrades the state's building code, which sets minimum requirements for the performance of buildings, as well as standards for electricity-using equipment. These standards ensure that consumers are able to choose among a wide variety of high-quality appliances without having to worry about unknowingly purchasing a low-quality appliance that would cost significantly more over its lifetime.

California's efficiency programs help drive the adoption of new technologies nationwide.

Fortunately for all California residents and businesses, California's energy efficiency infrastructure was robust enough to quickly deliver significant conservation and energy efficiency resources to help calm the electricity crisis in 2001. However, years of relative neglect of the energy efficiency infrastructure during the mid- and late-1990s, illustrated by the low funding levels in Figure 9, created additional stress that contributed to the electricity crisis. A commitment to sustained funding for California's energy efficiency infrastructure, with a stable base of funding and addi-

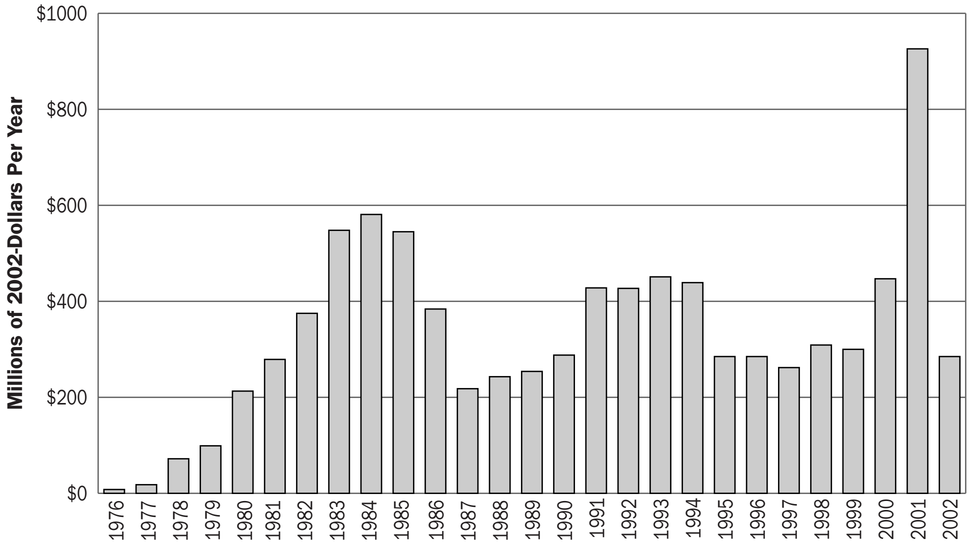
TORCHIERES: AN EFFICIENCY SUCCESS STORY

Researchers at organizations such as the Lawrence Berkeley National Laboratory developed an energy-efficient torchiere as a replacement for the popular but fire prone 300-watt halogen torchieres. The efficient torchieres use about one-fifth of the electricity of the older halogen torchieres and operate at safer temperatures.

After several years of research, development, and demonstration, the efficient torchieres began to gain market share. Utility programs encourage consumers to purchase these efficient torchieres and torchiere "swaps"—where halogen torchiere owners can trade for new torchieres—have become a popular event, particularly at safety-conscious places like college campuses.

The success of efficient torchieres helped persuade the California Energy Commission to upgrade its torchiere standards. The CEC expects the new standard to save Californians hundreds of millions of dollars each year in reduced energy costs.

FIGURE 9
California's Investments in Energy Efficiency



Sources: California Energy Commission; California Measurement Advisory Council; California Public Utilities Commission[23]

California could quadruple annual investments in energy efficiency and still not exhaust the pool of available energy efficiency resources that are cheaper than generation alternatives.

tional procurement of energy efficiency resources as needed, will help reduce the risk that California faces such a crisis again.

THE POTENTIAL FOR ENERGY EFFICIENCY

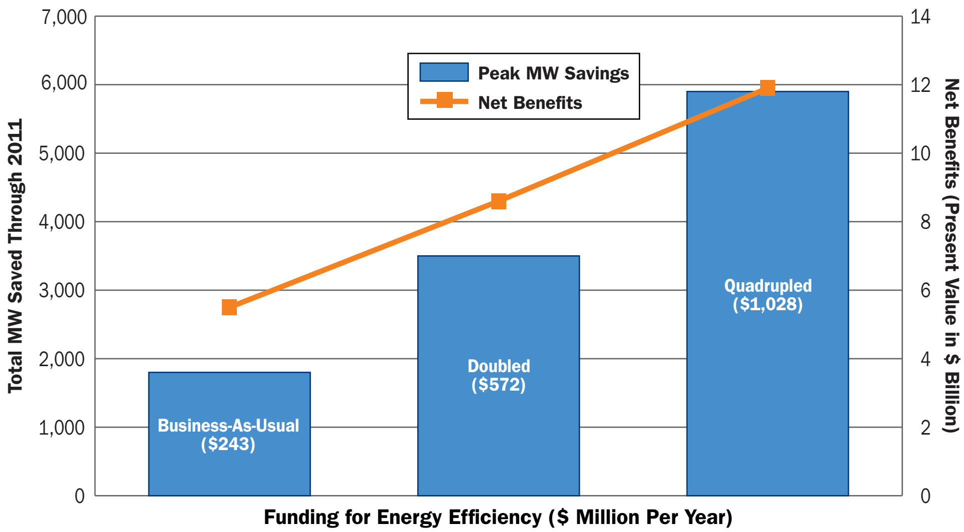
Untapped opportunities to take advantage of cost-effective energy efficiency in California abound. One might be inclined to speculate that with the impressive gains in energy efficiency over the past few years, California might be reaching the limit of its ability to take advantage of energy efficiency resources, but that could not be farther from the truth. Instead, a recent report demonstrates that California could *quadruple* annual investments in energy efficiency (to levels comparable to 2001 funding from all sources) and still not exhaust the pool of available energy efficiency resources that are cheaper than generation alternatives.[24]

The potential benefits of increasing energy efficiency investments for California's economy and environment are impressive. The report conservatively estimates that if California were to approximately quadruple statewide investments in energy efficiency (from $243 million per year to $1.03 billion), we could:

- Reduce demand by 5,900 MW over the next ten years—avoiding the need to build 12 giant power plants and gaining the associated public health and environmental benefits;
- Return an estimated $12 billion in net benefits to Californian's pocketbooks.

Similarly, a doubling of investments in energy efficiency could cost-effectively reduce demand by 3,500 MW, and return nearly $9 billion in net benefits.

FIGURE 10
Potential Demand Reductions and Net Benefits Under Increasing Energy Efficiency Program Funding Scenarios



Source: Xenergy

These energy efficiency improvements are achievable. Two technologies used by almost every Californian at home or at work—lights and air conditioners—provide the bulk of the potential savings.

These energy efficiency improvements are achievable. The estimates do not rely on exotic or yet-undeveloped technologies. Instead, the estimates conservatively use only energy efficiency measures that are commercially available; in fact, two technologies used by almost every Californian at home or at work—lights and air conditioners—provide the bulk of the potential savings. Similarly, these estimates do not simply assume we snap our fingers to create full-blown efficiency programs; rather, the estimates are based on years of experience with what California's energy efficiency infrastructure can realistically deliver.

As California's largest utilities return to their role as electricity-resource portfolio managers, they will quickly realize that they can most cheaply and reliably meet their customers' energy needs by beginning with this large pool of energy efficiency resources.

CHAPTER 3

MAINTAINING MOMENTUM

Legislative and Regulatory Actions

The PUC's decision reaffirms the utilities' obligation to consider investment in "all cost-effective energy efficiency" in resource procurement.

California's lawmakers and regulators are assembling the pieces for a renaissance of responsible investments in the electricity industry. Policy leaders are making progress to enable utilities to examine resource options on a level playing field, and to align the utilities' financial incentives with the interests of their customers. If successful, this will encourage the utilities to choose the most cost-effective and reliable portfolio of resources to serve customer energy service needs.

UTILITIES RESUME PORTFOLIO MANAGEMENT

Among the California legislature's most important 2002 actions was the restoration of the utilities' responsibility to manage a portfolio of resources to meet customer demand. In Assembly Bill 57 (AB 57), the legislature provided guidance to the utilities and the PUC on the utilities' "procurement of electricity and electricity demand reductions." The bill also revived a longstanding mandate of California law that instructs utilities "to seek to exploit all practicable and cost-effective conservation and improvements in the efficiency of energy use and distribution that offer equivalent or better system reliability."[25]

Why was restoration of the utilities' portfolio management responsibilities necessary? When California restructured the electricity industry in the late 1990s, it eliminated the utilities' longstanding responsibility for electricity resource investments, and the utilities ceased assembling a diverse and robust portfolio of resources to meet their customers' needs. Instead, the utilities became mere passive conveyors of day-by-day, hour-by-hour spot market prices. When the spot market went through the roof, precipitating the crisis, Governor Davis and the legislature led the way to restore long-term planning and stability to the electricity industry through AB 57.

In a unanimous decision in October 2002, the PUC started the new utility procurement system. The PUC's decision reaffirms the utilities' obligation to consider investment in "all cost-effective energy efficiency" in resource procurement, including resources above and beyond those being acquired through the limited public goods charge.[26] Utilities' procurement budgets are now once again fully available for energy efficiency investment throughout California, and these investments may increase substantially as utilities pursue these cost-effective resources. This revives an essential part of resource portfolio management that made the state an international energy efficiency leader in the early 1990s.

The PUC is now defining the parameters under which the utility portfolio managers will operate. Utilities will likely receive financial incentives to reward superior performance in procuring both supply-side and demand-side resources. This provides an opportunity for the PUC to level the playing field among competing resources and to encourage the utilities to procure a reliable and diverse portfolio of cost-effective resources.

Recent experience has demonstrated that the utilities are capable of procuring new electricity and electricity demand reduction resources, despite fears that credit difficulties would hamper their ability. The utilities' long-term resource portfolios will likely bring needed stability to the industry.[27]

Portfolio Management at Consumer-Owned Utilities

Although California's investor-owned utilities have arguably been through more tumultuous times in recent years than the consumer-owned utilities (also known collectively as "public power"), the unexpected increases in electricity costs should reawaken interest among consumer-owned utilities in managing an integrated portfolio of demand- and supply-side resources as well. None of the consumer-owned utilities in California manage their resource portfolios in an integrated manner. For example, the Los Angeles Department of Water and Power, the nation's largest municipal utility, fails to take full advantage of some of the cheapest resources available to its consumer-owners because it does not optimize its energy efficiency investments together with its portfolio of electricity supplies.[28] As with the investor-owned utilities, consumer-owned utilities' public-benefits fund investments in energy efficiency should represent a floor, not a ceiling, on these investments. Utilities that do not integrate all cost-effective energy efficiency into their portfolios cannot provide least-cost electricity service.

The unexpected increases in electricity costs should reawaken interest among consumer-owned utilities in managing an integrated portfolio of demand- and supply-side resources.

ALIGNING CUSTOMER AND UTILITY INCENTIVES

The first step to allow energy efficiency investments to compete on an equal footing with power plant investments is to ensure that utilities can profit—or at least be financially indifferent—when pursuing either supply- or demand-side resources. Although this was well-established regulatory practice in California for more than a decade, the PUC put this policy on hold in the mid-1990s when California began its attempt at electric industry restructuring. The utilities reverted to an outmoded and counterproductive form of price regulation that directly links utility revenues to the amount of electricity sold. Under this form of price regulation, even when an investment in energy efficiency is the cheapest resource option for a utility and would reduce customer bills, the utility loses money. Naturally, no utility enthusiastically pursues resources that reduce the volume of electricity sold under these circumstances. Appendix III provides a simple illustration of the problem utilities face under this outmoded form of price regulation and the best solution to it.

Under direction from the legislature, the PUC is once again breaking the link between the utilities' revenues and the volume of electricity sold.[29] The utilities welcome this change in regulation and have proposed new policies in their current rate cases before the PUC to effectively break this link. This win-win policy change benefits utilities through increased financial stability and benefits customers as the utilities resume their role as portfolio managers and are able to assemble a least-cost resource portfolio for their customers' benefit, unconstrained by conflicted incentives.

Aligning Incentives at Consumer-Owned Utilities

Although it may not be immediately obvious, consumer-owned utilities in California face many of the same predicaments as the investor-owned utilities due to the use of outmoded mechanisms to determine revenues. Publicly owned utilities are not profit driven like the investor-owned utilities, but they still face significant financial pressures. With the same revenue mechanism that links financial health to sales volume, consumer-owned utilities are just as dependent on increasing kWh sales as investor-owned utilities and are penalized for taking advantage of least-cost resources that decrease electricity sales. Updating their revenue mechanism to break the link between financial health and the amount of electricity sold would greatly benefit California's consumer-owned utilities by increasing financial stability for the utility, assuring timely transfers to their associated city governments where relevant, and by reducing bills for their consumer-owners.

The first step is to ensure that utilities can profit—or at least be financially indifferent—when pursuing either supply- or demand-side resources.

SUSTAINED FINANCIAL INCENTIVES FOR ENERGY EFFICIENCY

For decades, a small fraction of every Californian utility customer's bill (less than 3 percent) has been dedicated to improving energy efficiency, avoiding the need for more than 20 large power plants since 1975.[30] Programs funded through this "public goods charge" give homes and businesses incentives to save electricity more cheaply than it can be generated. Long before the price spikes during the recent crisis, independent assessments had pegged the net benefits to California's economy at almost $3 billion from 1990 until 1998 alone, compared to the cost of generating the displaced electricity. The average cost of the saved energy was about 2.5¢ per kWh.[31]

No brief summary can do justice to the diversity of energy efficiency programs that have emerged under the public goods charge; Appendix I provides utility-specific website addresses and telephone numbers that will direct readers to details on virtually all major efforts across California. Funding for most of these energy efficiency programs remained essentially constant in 2002 relative to historical funding (nearly $300 million annually), although overall funding for energy efficiency programs statewide shrank substantially relative to 2001 as emergency appropriations granted by the legislature during the crisis were exhausted.

In 2000, Governor Davis and the legislature ensured that the energy efficiency programs supported by the public goods charge, at both public and private utilities, would receive a minimum level of funding until 2012. Sustained funding is essential to maintain California's energy efficiency infrastructure. However, long-term

KEY COMPONENTS OF EFFECTIVE ENERGY EFFICIENCY PROGRAMS

- ▶ **Full integration into resource procurement** is essential to ensure that California avoids commitments to more costly generation.
- ▶ **Long-term planning horizons** are needed to effectively convince the nation's largest manufacturers, distributors, and retailers to change their product lines in response to the programs. For instance, a clothes-washer manufacturer will only commit to make a major investment to produce more efficient machines with assurance that the programs will be in effect long enough to make the investment worthwhile.
- ▶ **Timely approval** of the programs is necessary to allow major market participants enough time to respond to the programs. For example, a major store like Home Depot must know the programs' details about six months in advance in order to influence its stocking and advertising decisions.
- ▶ **Statewide coordination** among California's regulated and consumer-owned utilities' efficiency programs has improved dramatically in the past few years. A company with offices in multiple locations in California can now participate in several utility efficiency programs while satisfying just one set of common requirements. Manufacturers are more likely to respond to California's programs when there are common specifications statewide.
- ▶ **Rigorous measurement and verification** of program impacts should continue to provide independent evaluations of savings.

planning is equally important, and California has been unable to meet this challenge for energy efficiency in recent years.

An Unanswered Question

Since California began restructuring its electricity industry, the PUC has not resolved the question of who should administer the energy efficiency programs. For many years until the mid-1990s, the utilities ran some of the most effective programs in the nation. But as the PUC tried to create a new industry paradigm, the agency temporarily ended the utilities' role as electric-resource portfolio managers and began exploring ways to transfer responsibility of the efficiency programs to another entity. Year after year, the PUC has fallen back on the utilities to run the programs nonetheless, but has severely limited their effectiveness by restricting their authority to terms of a year or even less.

The question of who should administer the energy efficiency programs has fundamentally changed since the PUC began exploring possible answers in the mid-1990s. The issue is no longer who should manage a limited fund set aside for energy efficiency, disconnected from the management of the rest of the utilities' systems. The urgent question now before the PUC is: Does California want energy efficiency to be fully integrated into the utilities' resource portfolios? Both the legislature and the PUC have clearly stated their intention to have energy efficiency become an integral part of the utilities' overall portfolios. Prompt resolution of the administration issue will enable the utilities to create the integrated procurement system envisioned by the PUC. This will help ensure that Californians are able to take advantage of the inexpensive efficiency opportunities that remain available.

Both the legislature and the PUC have clearly stated their intention to have energy efficiency become an integral part of the utilities overall portfolios.

SETTING THE STANDARD

In November 2002, new and improved standards for home appliances and equipment went into effect, ensuring Californians access to a wide variety of high-quality appliances that provide guaranteed energy savings. The CEC implemented an impressive list of updated standards on an accelerated schedule in response to the energy crisis, including a long overdue end to the sale of wasteful and dangerous halogen torchiere lamps. Notable gains were also made in reducing the energy use and cost to consumers of refrigerated-beverage vending machines, traffic signals, exit signs, commercial coin-operated clothes washers, and commercial air conditioners. Thanks to these standards, Californians will save an estimated $650 million a year and avoid the need to build a medium-sized power plant every year.[32]

In July of this year, the CEC expects to complete upgrades in the state's building code that will be effective in 2005. This upgrade is expected to reduce the energy needed to light homes and offices through improved outdoor lighting standards and by providing incentives to use natural daylight in commercial buildings. The new code should also provide additional incentives for improved energy-efficient windows and "cool roofs" that reduce air conditioner loads. In upgrading the code, the CEC is using improved methods to assess the value of energy savings and will provide more credit to measures that save energy during expensive peak times. Overall, the upgrade is likely to increase energy savings by 5 to 10 percent, compared to the current building code.

The PUC's goal is to reach 100 percent of low-income customers who want to participate in its assistance programs.

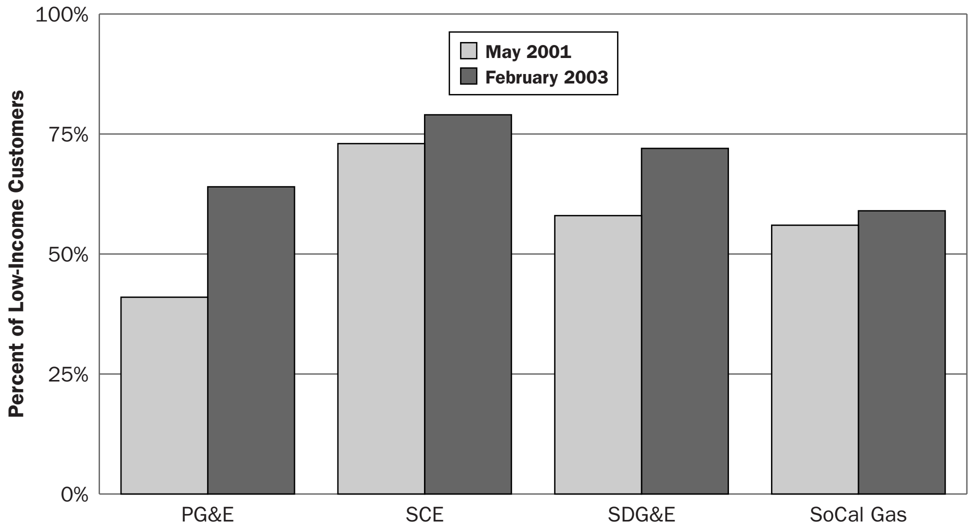
LOW-INCOME SERVICES

Over the past few years, the PUC intensified its effort to ensure equitable access to energy services for all Californians to temper the impact of price increases. Funding for low-income customer energy efficiency services and bill discounts totaled about $425 million in 2002.[33] Part of this funding was provided by the legislature during the crisis, but with support from groups like the Latino Issues Forum, the PUC intends to make additional funds available in order to continue increasing participation in the programs. Future program funding levels will be guided in part by a study of low-income customer needs that is now underway.[34]

The utilities' amplified efforts to reach the low-income community have yielded considerable progress (see Figure 11). During the first nine months alone, from May 2001 to February 2002, the utilities added about 420,000 households to the CARE bill discount program, weatherized more than 50,000 homes, and provided other energy efficiency measures to an additional 50,000 families.[35]

The PUC's goal is to reach 100 percent of low-income customers who want to participate in its assistance programs. The Low-Income Oversight Board provides valuable advice to the PUC on how it can achieve this goal. The PUC sets annual targets for the utilities to continue increasing participation in the CARE program, and the PUC is looking to partner with other government agencies to automatically enroll customers who participate in other low-income programs such as Medi-Cal and Healthy Families. The utilities are also encouraged to increase collaboration with

FIGURE 11
Percent of Eligible Low-Income Customers Participating in Utility Assistance Programs



Source: California Public Utilities Commission[36]

community-based organizations to sign up eligible customers and to leverage the state's Low-Income Home Energy Assistance Program (LIHEAP) and its network of community-based organizations to increase participation in the low-income energy efficiency programs.[37]

Both NRDC and SVMG have worked to help secure adoption of policies to support low-income customers, and we remain committed to ensuring that both environmental quality and equity goals are met in the delivery of energy services.

CHAPTER 4

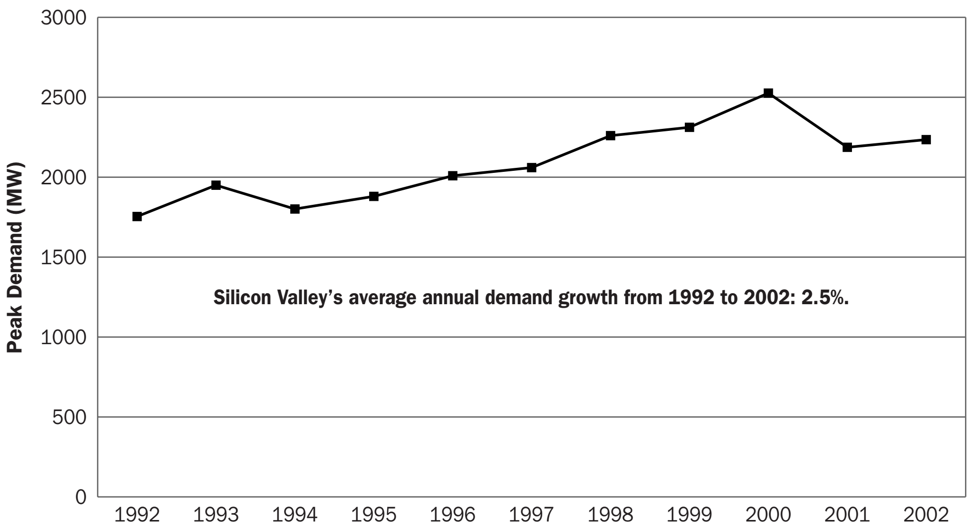
Silicon Valley Innovation

Case Studies in Productive Efficiency Improvements

Silicon Valley's innovation is increasing productivity using less and less energy through improvements in the efficiency of high-tech products and through companies' own demand reductions.

California's high-tech sector is helping build the robust and reliable electricity system of our future, providing a crucial part of the solution to an overstressed electricity system. While fueling vigorous nationwide economic growth, California's technology sector's energy use came under increased scrutiny as California's electricity crisis dominated the headlines. The information economy's electricity consumption is not destined to surge to unmanageable levels, contrary to misunderstandings that became widespread during the crisis. Instead, Silicon Valley's innovation is increasing productivity using less and less energy through improvements in the efficiency of high-tech products and through companies' own demand reductions. Silicon Valley companies' significant conservation achievements in 2001 helped the region avert rolling blackouts and provided valuable cost savings.

FIGURE 12
Silicon Valley Peak Electricity Demand, 1992–2002



Source: PG&E. Peak demand for Santa Clara County, excluding the cities of Santa Clara and Palo Alto.

The Lawrence Berkeley National Laboratory found that even at the height of the dot-com boom in 1999, the electricity used by all of the office and communications equipment vital to the information economy (including the manufacturing of that equipment) accounted for only 3 percent of total U.S. electricity use.[38] And the Center for Energy and Climate Solutions has identified numerous ways in which information technologies enable reductions in energy use for buildings and manufacturing that swamp the electricity used by the information technologies themselves.[39] Silicon Valley is estimated to have 15 percent of the U.S. data centers that form the backbone of the information economy. This first-generation of inefficient data centers use about 1.2 percent of the electricity consumed in Silicon Valley, and as we discuss in further detail below, Silicon Valley leaders are already beginning to envision the new highly efficient data centers of the future.[40]

In line with the entrepreneurial spirit underlying Silicon Valley's success, many Silicon Valley companies constantly strive to increase their energy efficiency, improving both their bottom line and their environmental stewardship. For instance:

- Bulky and inefficient cathode-ray-tube (CRT) monitors have given way to sleek liquid-crystal displays (LCDs) that use about 80 percent less energy;
- Increasingly common laptop computers use about one-quarter of the energy of a comparable desktop computer;
- And with electricity-saving software properly installed, most of these devices will power down to only a few watts during periods of inactivity.[41]

Companies are using advanced technologies to reduce demand at critical times to help maintain the highly reliable energy services that the information economy demands.

Energy efficiency is such an important business strategy that IBM, for example, launched a worldwide, low-power computing research center in late 2001 to increase the efficiency of computer chips, servers, software, and other computing devices.[42] Other bright minds in Silicon Valley are focusing on how to improve the efficiency of the ubiquitous power supplies that convert alternating-current to direct-current in a wide variety of electronic devices. An estimated 6 percent of the nation's electricity flows through these inefficient power supplies; more efficient designs could displace the power output of seven large-scale power plants.[43]

Advances in metering and communication technologies have enabled companies to respond to market conditions and adjust their energy use in real time. Working with agencies including the CEC, PUC, and the California Power Authority, companies are using advanced technologies to reduce demand at critical times to help maintain the highly reliable energy services that the information economy demands.[44]

The members of the Silicon Valley Manufacturing Group have been at the forefront of the effort to ensure that California avoids another power crisis through improvements in the efficiency of their products, demand reductions in their facilities, and constructive participation in the policy-making process. The case studies that follow provide concrete examples of how Silicon Valley companies use energy efficiency to lower their own energy costs and their customers' energy costs, while also improving environmental quality.

APPLIED MATERIALS

Applied Materials, the world's largest supplier of wafer fabrication solutions, enables semiconductor manufacturers to produce more powerful, portable, and affordable chips. Established in 1967, Applied Materials is headquartered in Santa Clara and employs approximately 14,000 people worldwide.

Semiconductor manufacturing facilities (known as "fabs") use significant amounts of energy worldwide. The semiconductor manufacturing industry in the United States is estimated to use more than 15 billion kWh each year, with a peak demand of approximately 3,500 MW.[45] The average fab consumes about 130 million kWh per year, roughly equivalent to 20,000 Californian households.[46]

Within a semiconductor fab, wafer fabrication equipment accounts for about 40 percent of the facility's energy usage.[47] Since electricity can be a fab's single largest operating cost, Applied Materials has made a concerted effort to provide more energy-efficient wafer fabrication systems to lower its customers' costs.[48] The other 60 percent of a fab's energy is used primarily to keep the circulating air cool and extremely clean.[49] Organizations such as the Lawrence Berkeley National Laboratory, the Environmental Protection Agency, and the Rocky Mountain Institute are working with fab owners to make their facilities more energy efficient (for example, through energy-efficient air conditioning system improvements).[50]

HIGHLIGHTS

APPLIED MATERIALS

- **Efficient pumps and motors improved efficiency of products.**
- **New efficient pump technology could save 10 percent of a fab's total electricity demand.**
- **Newly installed motion sensors reduce facility electricity use by about 900 kWh per day.**
- **The company is capable of reducing demand by up to 2.2 MW during critical periods.**

Twenty percent of a semiconductor fab's electricity use is tied directly or indirectly to pumps. Applied Materials has developed an integrated point-of-use pump (iPUP™) that uses 20 to 50 percent less electricity than a conventional remote pump at full power, and 75 percent less in idle mode. The iPUP could potentially save 10 percent of a semiconductor fab's total electricity demand. The iPUP technology not only saves energy and reduces expenses for fabs, but it is also quieter and more compact. The efficient pumps, which have been helping customers reduce their energy expenses since 2001, are available on Applied Materials' new generation of equipment that now comprises nearly half of Applied Materials' sales. The efficient pumps are also sold as an option on Applied Material's previous generation of equipment. The iPUP is now reducing energy use in semiconductor fabs in Europe, North America, and Asia. Applied Materials has also integrated variable frequency motors into much of its equipment to reduce energy use when the equipment is operating at partial load.

In conjunction with SEMATECH, the semiconductor industry's international research consortium, Applied Materials' energy reduction task force is identifying additional opportunities to improve the energy efficiency of its products. The energy reduction task force is developing new energy efficiency metrics to describe the improvements it is making and to determine the feasibility of the new improvements it considers. The International Technology Roadmap for Semiconductors, the result of a worldwide industry consensus-building process coordinated by SEMATECH, predicts that by utilizing new technologies, fabs will reduce energy use by up to 28 percent by 2004, and up to 50 percent by 2007.[51]

Over the past several years, Applied Materials has also implemented energy conservation measures in its own facilities to reduce its operating costs and to protect the environment. For example, Applied Materials installed motion sensors to turn off non-critical devices, such as computer monitors and task lighting, in unoccupied areas. These motion sensors reduce Applied Materials' electricity use by about 900 kWh every day (equivalent to the amount of electricity two Californian households use in about a month). During the electricity crisis, Applied Materials took the lead in forming a power reduction pool for Silicon Valley Power. Applied Materials was able to reduce power usage by as much as 2.2 MW during critical periods through real-time demand response measures such as reduced lighting and air conditioning use.

HEWLETT PACKARD

In May 2002, Hewlett Packard (HP) and Compaq Computer Corporation merged, creating a global leader in computing and imaging technologies and services. Worldwide, the new HP's 135,000 employees serve more than 1 billion customers. HP continues to be headquartered in Palo Alto, employing 11,000 Californians at 63 facilities throughout Silicon Valley.

Energy efficiency is a long-standing HP priority. Both Compaq and HP significantly improved the efficiency of their buildings prior to their merger. For example, in 2000, Compaq's Fremont facility doubled its manufacturing space and occupancy without increasing its energy consumption through a variety of energy conservation methods and controls. In 2001, Compaq's energy efficiency and conservation investments reduced overall energy consumption by 16 percent over the prior year at its Silicon Valley facilities. At the same time, HP installed new energy-efficient chillers and reduced its lighting energy needs in many buildings, while carefully maintaining an optimal work environment. HP also encouraged its employees to turn off computers, monitors, and other devices when not in use. Energy use was down a full 7 percent at

HIGHLIGHTS

HEWLETT PACKARD

- **Efficiency investments save HP more than $2 million each year.**
- **Prior to the merger, Compaq cut energy use by 16 percent in 2001, and HP reduced its energy use by 7 percent.**
- **Investments included lighting upgrades, energy-efficient chillers, and power monitoring systems.**

HP in 2001 compared to a year earlier. These conservation and efficiency improvements save HP more than 25 million kWh and $2 million each year.

At the new HP, these energy efficiency and conservation investments continue to yield energy and cost savings. In 2002, HP installed electrical power meters at many of its Silicon Valley locations, which report daily electricity consumption back to its headquarters. This information enables management to promptly identify and correct the performance of buildings that are using more energy than necessary. For only about $150,000, this system allows HP to keep its finger on the pulse of its facilities' energy performance. HP expects the project to reduce energy use by at least one percent.

HP continues to look for opportunities to make financially sound investments in energy efficiency improvements. One of the projects underway this year is to eliminate HP's remaining old-fashioned electro-mechanical timers that control outdoor lighting. These old-fashioned timers are difficult to adjust for daylight savings time or holiday schedules (and often in reality are not adjusted). Control of the outdoor lighting will be integrated into the facilities' energy management system controls, allowing for more accurate control of the lights and their energy use.

ORACLE

Oracle, one of the world's largest software companies, is headquartered in Redwood Shores at a distinctive 1.8 million square foot campus overlooking the San Francisco Bay. Oracle employs about 7,000 people at its headquarters campus, out of a total of more than 42,000 employees worldwide. Although Oracle's headquarters campus is relatively new, Oracle has been able to find numerous energy-saving opportunities to help improve its bottom line.

Oracle's investments in energy efficiency over the past two years have provided valuable savings. Altogether, the investments have a payback time of less than eight months. Energy use has steadily decreased at Oracle's headquarters campus since 2000, even while the number of employees occupying the campus has increased slightly. The average monthly electricity use per employee at the headquarters campus was down by about 15 percent in 2001 compared to 2000. Further energy efficiency improvements last year brought the monthly average electricity savings per employee to 20 percent over 2000 levels.

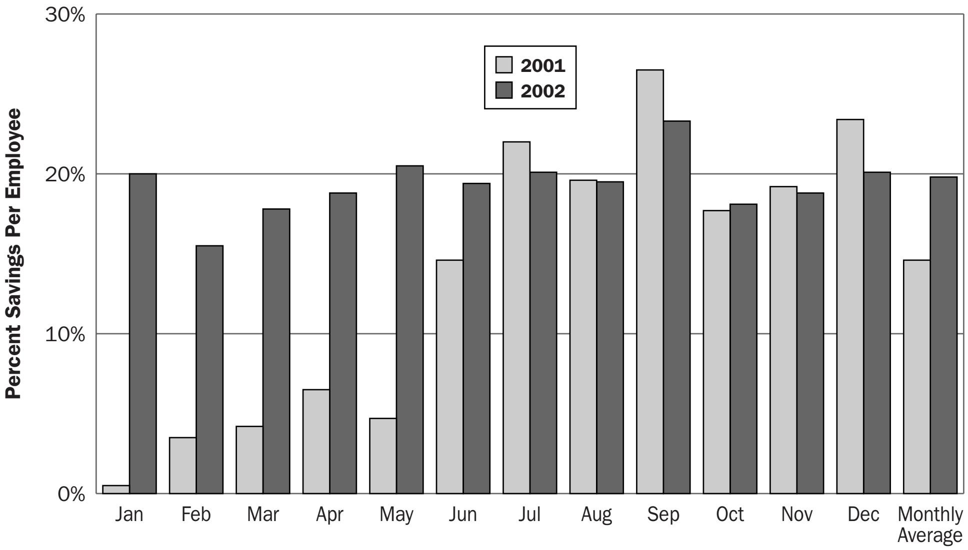
Investments in lighting upgrades yielded considerable savings. Oracle replaced halogen flood lamps and incandescent lamps with fluorescent lamps that provide the

HIGHLIGHTS

ORACLE

- **Efficiency investments save Oracle nearly $900,000 each year.**
- **The company reduced average monthly electricity use per employee by 15 percent in 2001 and 20 percent in 2002, relative to 2000.**
- **Investments included lighting upgrades and de-lamping, re-commissioning HVAC systems, efficient fan motor upgrades, and occupancy sensors.**
- **Oracle is capable of reducing demand by up to 18 percent in real time.**

FIGURE 13
Monthly Electricity Savings Per Employee Compared to the Same Month in 2000



Source: Oracle

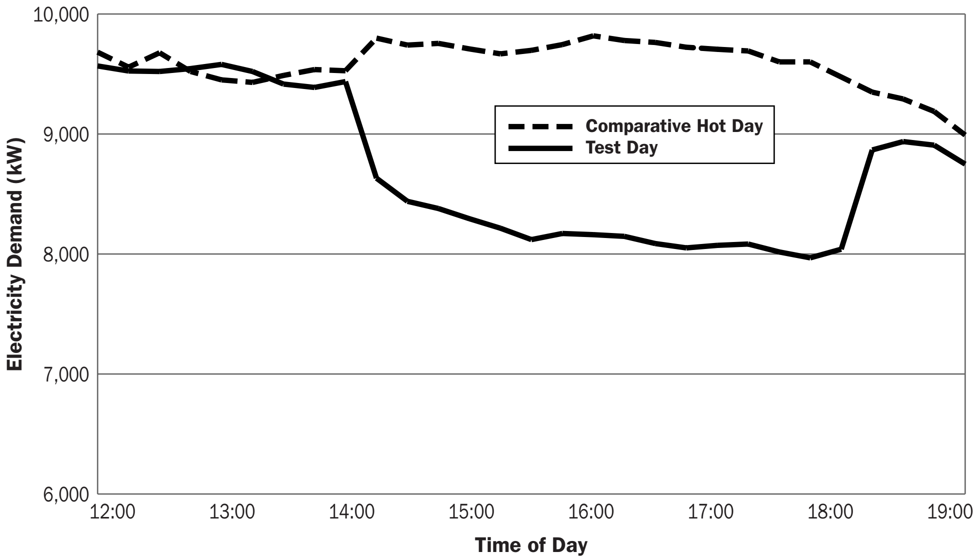
same amount of light while using 80 percent less energy in lobbies and elevators. Rooftop aircraft warning lights were also replaced with long-lasting compact fluorescent lamps, saving energy and reducing the labor costs to replace these lights, which are mounted on the outer perimeter of building roofs up to 16 stories high. Oracle also removed some of the lamps in places where very bright lighting levels are unnecessary, such as elevators, hallways, stairwells, and break rooms. In most locations, half of the lamps were removed from fixtures and occupants continue to feel that the spaces have ample light.

All of Oracle's lighting changes were done in phases, beginning with a pilot project to get feedback from the building occupants and management on the proposed change. Security and safety teams reviewed all pilot projects with possible safety implications. Upon successful completion of a pilot, Oracle implemented the lighting change throughout the building and then in buildings campus-wide. Many successful projects were taken to other Oracle facilities as well.

Controls upgrades and re-commissioning of heating, ventilation, and air-conditioning (HVAC) systems yielded even more energy savings for Oracle. Over the years, the controls of HVAC systems are changed or bypassed in response to the changing needs of the space or during maintenance, which can leave the HVAC system operating in an inefficient manner. Re-commissioning brings HVAC systems back into their optimal operating range, improving comfort for employees while using less energy. Oracle also upgraded some of its fan motors to variable frequency drives. Unlike older fan systems that vary airflow while using almost the same amount of energy, variable frequency drives use less energy when providing lower airflows.

Other energy-saving projects yielded significant energy reductions for Oracle as well. Most Oracle employees spend their time working on a computer; when they leave their desks, power strips with integrated occupancy sensors now automatically

FIGURE 14
Real-Time Demand Reduction Pilot Test



Source: Oracle

turn off their computer monitors, personal desk lamps, and radios. And the cold drinks they might have left their desks to get are now cooled in more efficient beverage coolers. On each floor of Oracle's buildings, a beverage cooler with a 40-watt lamp provided cold drinks for employees. Removing these lamps produced synergies that reduced each beverage cooler's demand by a total of 55 watts (a direct savings of 40 watts from removing the lamp, and an additional 15-watt savings from avoiding the need to cool the waste heat generated by the lamp).

Oracle also prepared its facilities to reduce demand in real time during critical hours to help avoid the need for rotating outages. Oracle turns off lights in perimeter offices with glass windows, turns off overhead lights where employees are able to work with desk lamps, and requests that employees switch to use laptops if they are able to and turn off any other personal appliances. Using advanced controls, air conditioning is also carefully calibrated during such hours. When called upon, Oracle is now able to reduce demand by as much as 18 percent during critical hours.

Not only are these energy efficiency investments saving Oracle over $870,000 per year in utility expenses, the savings will multiply as Oracle takes its experience at its headquarters campus to its other campuses across the United States and abroad.

ROCHE PALO ALTO

The Roche Palo Alto research center is one of four pharmaceutical research sites of the international Roche Group. The site employs 1,000 men and women whose research focuses on the discovery and early clinical development of new medicines to treat serious illnesses.

HIGHLIGHTS

ROCHE

- **Energy efficiency investments reduce energy bills by more than $1.25 million each year.**
- **Efficiency improvements cut electricity use by 16 percent and natural gas use by 23 percent in 2001.**
- **Investments included lighting upgrades, HVAC upgrades, spot cooling, facility energy monitoring, and efficient fan motor upgrades.**

Investments in energy efficiency and demand reductions in 2001, in response to the California electricity crisis, produced significant savings for Roche. Roche cut its electricity needs at its Palo Alto campus through numerous investments, including lighting upgrades, high-efficiency fan motors, and water-chilled coolers. Roche upgraded its 30-year-old inefficient HVAC systems with support from the City of Palo Alto Utilities. The upgraded HVAC systems are more energy efficient, and enable additional savings by utilizing outside air for heating or cooling when conditions allow. The HVAC system upgrade at Roche's Central Plant, which provides cooling and heating water for the majority of the Roche campus, reduces energy use at the plant by nearly 60 percent. As a result of these investments, Roche's overall electricity use decreased by 16 percent in 2001 compared to 2000 and natural gas use decreased by 23 percent over the same time period.

Roche continues to benefit from the efficiency improvements implemented in 2001 and has made additional investments in efficient technologies and HVAC system controls to further reduce energy demand. A new system to spot-cool specific areas in its facilities enables Roche to save energy by cooling only where it is needed, rather than adjusting the temperature for an entire floor or building. At the same time, Roche increased monitoring of energy use and facility temperatures so that it can modify HVAC controls to ensure optimal facility conditions and minimize wasted energy. These investments reduced Roche's total electricity use by 2 percent in 2002, on top of the considerable energy savings achieved in 2001, while the occupancy of Roche's buildings has remained essentially constant. Roche's energy efficiency investments over the past two years reduce its energy expenses by more than $1.25 million each year. In 2002, the Association Of Energy Engineers recognized Roche's utilities manager, Jerry Meek, for his leadership in energy efficiency achievements by naming him an Energy Manager of the Year for the Western States.

Roche continues to pursue opportunities to reduce its energy demand and expenses. In 2003, Roche plans to upgrade the fume hoods used in its laboratories. The fume hoods, which are widely used in high-tech industries, expel large volumes of conditioned air from buildings to remove fumes from laboratory work areas. The fume hoods each cost about $8,000 per year to operate, making them Roche's single largest consumer of electricity. Roche plans to upgrade its fume hoods with sensors that will safely decrease airflow when not in use, thereby dramatically decreasing energy use. A pilot upgrade of several fume hoods has shown positive results, suggesting that the upgrade project will yield significant energy and cost savings.

ROCKY MOUNTAIN INSTITUTE'S LOW-POWER DATA CENTERS DESIGN CHARRETTE

For three days in February, 90 computer industry, utility, and building industry experts brought their collective expertise to a design charrette (i.e., an intensive brainstorming session) to envision the energy-efficient data centers of the future. The charrette was organized by the Rocky Mountain Institute (RMI), which specializes in enabling a diverse group of people to "think outside the box" to solve some of society's most pressing problems.[52] The charrette participants emerged with a collection of ideas to improve the energy efficiency of next-generation data centers by an order of magnitude (89 percent), while maintaining the high levels of reliability that the information economy demands.

Data centers, also known as "server farms" or "dot-com hotels," house the computer and networking equipment that form the backbone of the information economy. Trying to keep up with the predictions of Moore's law, server manufacturers have been packing more and more heat-generating components into smaller and smaller spaces. One of the primary challenges now facing the industry is how to keep computer equipment cool enough that it is able to function reliably.[53]

Predictions of data-center energy use during the dot-com boom seriously alarmed utilities across the country in 2000 as they received requests to serve tens and sometimes hundreds of MW of new load at data centers. For example, PG&E reported that data centers requested more than 300 MW of power in 2000 and an additional 1,000 MW of power by 2003—equivalent to more than doubling the utility's yearly average load growth—with half of it concentrated in one or a few locations, threatening to overstress PG&E's grid infrastructure.[54] To the relief of utility planners, loads of this magnitude never materialized. Data centers had not provided utilities with accurate predictions of energy use, in part due to multiple layers of pancaked safety margins, partial loads in the data centers, and fewer data centers than predicted were actually built after the collapse of the dot-com bubble.

A concise summary cannot do justice to the richness of creative ideas for improving the efficiency of data centers that emerged from RMI's charrette. Only ideas that would maintain the integrity and reliability of the information services that data centers provide were considered. Some of the most promising efficiency improvements include:

- Energy-efficient processor chips, which now have the chip industry's attention thanks to start-up Transmeta Corporation's efficient Crusoe processor;
- Properly sized power supplies that are efficient over a wide range of loads, as opposed to current power supplies that waste about half the energy they supply due to oversized and inefficient designs; and
- Fluid cooling systems that are about three times as efficient as current air conditioning systems (while keeping the cooling fluid completely isolated from sensitive electronics through the use of advanced heat transfer technologies such as carbon fiber heat tubes).

The charrette participants envision a modular data center design that allows customers to add and remove servers as needed without degrading the energy

HIGHLIGHTS

RMI'S DATA CENTERS DESIGN CHARRETTE

- **The energy efficiency of data centers could be improved by an order of magnitude while maintaining reliability.**
- **A modular data center could be created that is faster and cheaper to build.**
- **Energy-efficient processor chips, properly sized power supplies, and fluid cooling systems could increase efficiency.**

performance of the data center. The energy-efficient data center envisioned by the charrette will reduce electricity use and the associated environmental damage. It is also likely to be significantly cheaper because the system is optimized as a whole, helping reduce infrastructure costs and overall equipment requirements.

Is there hope that these creative ideas will become reality? Although there is now an excess of internet-hosting data center space on the market, corporate data centers (which provide data storage, computing power, and internet access for corporations) are still being built at a rapid pace. Most of these are not massive stand-alone facilities like US DataPort's 2.1 million square foot facility in San Jose, but instead are smaller data centers (less than 1,000 square feet) integrated into corporate buildings and using less than 0.5 MW apiece.[55] RMI, the charrette participants, and Lawrence Berkeley National Laboratory (which is developing a roadmap for improving the efficiency of the computer industry with support from the CEC) will all use the ideas generated at the charrette to enable the next-generation of data centers to be more reliable, cheaper, quieter, and energy efficient.[56]

CHAPTER 5

Conclusion

Energy efficiency improvements in Silicon Valley exemplify Californians' drive for continual progress. Through the coordinated efforts of policymakers and citizens, we can avoid another electricity crisis. Energy efficiency and conservation will be a prominent part of this strategy, while simultaneously strengthening our economy, helping to stabilize our energy bills in the face of increasingly volatile fossil fuel prices and cleaning the air that we breathe.

California's record of steady demand reductions is impressive. And while much has been accomplished, there remains a great deal more that we can do. We must all work to maintain the momentum of the past few years, to realize the enormous benefits of increased investments in energy efficiency. There is no better way to ensure that all Californians have access to reliable, clean, and affordable energy services.

California Utility Energy Efficiency Programs

Getting Access

Alameda Power and Telecom: www.alamedapowerandtelecom.com; (510) 748-3947

Anaheim Public Utilities: www.anaheim.net/utilities; (714) 765-4250, general energy efficiency; (714) 939-9020, residential; (714) 765-4259, business

Azusa Light and Water: www.azusalw.com; (626) 812-5225

Burbank Utilities: www.burbank-utilities.com; (818) 238-3730, energy conservation; (818) 238-3638, public benefits; (818) 238-3562, energy solutions program

City of Healdsburg Electric Utility Department: www.ci.healdsburg.ca.us; (707) 431-3346

City of Long Beach Gas and Electric: www.ci.long-beach.ca.us/gas; (562) 570-2000

City of Palo Alto Utilities: www.cpau.com; (650) 329-2241

City of Pasadena Water & Power: www.ci.pasadena.ca.us/waterandpower; (626) 744-6970

City of Redding Water & Electric: www.reddingelectricutility.com; (530) 339-7300

City of Riverside PUD: www.ci.riverside.ca.us/utilities; (909) 826-5485

City of Roseville Water & Electric: www.rosevilleelectric.org; (916) 79-POWER (797-6937)

City of Vernon Water & Electric: www.cityofvernon.org/departments/utilities/utilities.htm; (323) 583-8811

Imperial Irrigation District: www.iid.com/power; (800) 303-7756

Lodi Electric Utility: www.lodielectric.com; (209) 333-6762 or (209) 333-6815

Los Angeles Department of Water & Power: www.greenla.com; (800) GREEN LA (473-3652)

Modesto Irrigation District: www.mid.org; (209)526-7458 or (209)526-7366, Energy Management Dept.; (800) 433-4327, low-income rebates; (209) 527-0978, weatherization

Pacific Gas & Electric: www.pge.com; (800) 468-4743, business; (800) 933-9555, residential

Plumas-Sierra Rural Electric Cooperative: www.psln.com/psrec/electric/index.html; (530) 832-4261; (800) 555-2207, customer service

Sacramento Municipal Utility District: www.smud.com; (916) 732-6609, business; (888) 742-7683, residential

San Diego Gas & Electric: www.sdge.com; (800) 411-SDGE (7343)
Silicon Valley Power-City of Santa Clara: www.siliconvalleypower.com; (408) 244-SAVE, residential energy conservation hotline; (408) 615-5694, business hotline
Southern California Gas: www.socalgas.com; (800) 427-2000, business; (800) 427-2200, residential; (213) 244-5644, incentives for licensed contractors
Southern California Edison: www.sce.com; (800) 736-4777
Truckee Donner PUD: www.tdpud.org; (530) 587-3896, customer service; (530) 582-3931, Conservation Dept.
Turlock Irrigation District: www.tid.org; (209) 883-8300

Utility Energy Efficiency Programs in Silicon Valley

Three major utilities serve Silicon Valley electricity customers: Pacific Gas and Electric, Silicon Valley Power, and The City of Palo Alto Utilities. The following is a sample of the types of efficiency programs these utilities offer.

Pacific Gas and Electric (PG&E): PG&E provides energy services to approximately 13 million people in northern and central California. PG&E's energy efficiency programs, which can be found at www.pge.com, include:

- **Rebates:** A wide variety of rebates for energy-efficient products including lighting, air conditioning, motors, and appliances.
- **Standard Performance Contracts (SPC):** Financial incentives to commercial customers based on verified energy savings for custom-designed projects.
- **New Building Construction Program/Savings-by-Design:** Design assistance and incentives for new energy-efficient buildings.
- **Energy Audits:** Non-residential energy audits to inspect customer facilities and identify low-cost and no-cost energy-saving measures customers can implement.

Silicon Valley Power (SVP): SVP serves more than 46,000 electric customers in Santa Clara County. Information on SVP's energy efficiency programs can be found at www.siliconvalleypower.com. These programs include:

- **Lighting Incentives:** Customers can purchase and install new energy-efficient ballasts, lamps, and lighting fixtures at reduced costs.
- **Customer Directed Rebates:** Incentives for customer-designed energy efficiency projects. The program provides flexibility for customers to tailor projects to their individual needs.
- **HVAC (Heating, Ventilation, and Air Conditioning) Program:** Rebates on the purchase and installation of new efficient HVAC systems.

The City of Palo Alto Utilities (CPAU): CPAU provides utility services to Palo Alto residents and businesses. CPAU offers a variety of residential and business energy efficiency programs, which can be found at www.cpau.com. CPAU's commercial advantage program includes rebates for efficiency projects such as:

- ▶ **Lighting:** Rebates for lighting upgrades, occupancy motion sensors, and lighting time clocks.
- ▶ **HVAC:** Rebates for upgrading or installing efficient heating, ventilation, and air conditioning equipment.
- ▶ **Custom Rebates:** Rebates for custom energy efficiency projects that do not qualify for standard rebates, based on verifiable energy savings.

Aligning Incentives Through Price Regulation of Utilities

Illustrating the Problem and the Solution

The Problem

Utility regulators or consumer-owned utility directors establish an electricity sales forecast for the year(s) ahead, determine a revenue requirement (which includes both fixed and variable costs of electricity production), and set rates by dividing the revenue requirement by the sales forecast.

A Simplified Illustration:

Sales forecast = 100 kWh
Variable cost = 4¢ per kWh (mostly operating costs of power plants)
Fixed cost = $6 (mostly return on rate base)
Revenue requirement = $4 variable cost + $6 fixed cost = $10
Rate per kWh = 10¢ per kWh ($10 / 100kWh)

If actual annual electricity sales diverge from the forecast, the utility will either under- or over-recover the fixed-cost element of its revenue requirement.

Illustration of Sales Below Forecast:
Actual annual sales = 95 kWh
Variable costs total 4¢ per kWh x 95 kWh = $3.80
Fixed costs = $6
Actual revenue requirement = $9.80 ($3.80 + $6)
Actual revenues = $9.50 (95 kWh x 10¢ per kWh)
Utility has under-collected its fixed costs.

Illustration of Sales Above Forecast:
Actual annual sales = 105 kWh

Variable costs total 4¢ per kWh x 105 kWh = $4.20
Fixed costs = $6
Actual revenue requirement = $10.20
Actual revenues = $10.50 (105 kWh x 10¢ per kWh)
Utility has over-collected its fixed costs.

The bottom line is that every kWh of reduced sales loses the company 6¢ in fixed cost recovery; every kWh of increased sales yields an equal windfall. If rates are "tiered" to promote efficient use, the problem worsens.

The Solution

There are two basic strategies to solve the problem:

1. Convert the fixed costs into a fixed charge on every bill so their recovery is not tied to the volume of electricity sold. But this reduces the customer's reward for conservation, so it is not a preferable solution.

2. Retain volumetric pricing where the customer pays for each kWh of electricity used, but "true up" rates every year to compensate for under- or over-collections in the previous year, after comparing actual sales to forecast sales. This solution has been used successfully by a number of regulators to eliminate utility incentives to increase electricity sales in order to increase profits.

ENDNOTES

1 Adjusted for both weather and economic conditions, 49 percent of the 2001 conservation persisted in 2002. Unadjusted, 65 percent of the conservation persisted. The ISO data covers about 85 percent of statewide electricity use. This data includes restated results for 2001 demand reductions, using higher quality data sources. Personal communication with Lynn Marshall, California Energy Commission (CEC), *Total Conservation in the ISO Area*, April 1, 2003 (www.energy.ca.gov/electricity/peak_demand_reduction.html).

2 In 1999, California's average per capita electricity consumption was 7,591 kWh per year, while the other 49 states' average was 13,530 kWh per year. Data compiled from the Energy Information Administration, Edison Electric Institute, California Energy Commission, U.S. Census Bureau, and the California Department of Finance.

3 California Department of Water Resources, California Energy Resources Scheduling Division, *Energy Costs for 2001/2002*, February 2003 (www.cers.water.ca.gov/); California Energy Commission, *supra* at note 1. C.A. Goldman, J.H. Eto, and G.L. Barbose, *California Customer Load Reductions during the Electricity Crisis: Did They Help to Keep the Lights On?,* Lawrence Berkeley National Laboratory, LBNL-49733, May 2002 (http://eetd.lbl.gov/ea/EMS/EMS_pubs.html), p. 1.

4 The average NO_x emissions factor of California's in-state electricity generation is 0.3 lbs per MWh. California Energy Commission, *Environmental Performance Report of California's Electric Generation Facilities*, P700-01-01, July 2001; Personal communication with Mignon Marks, California Energy Commission, March 25, 2003. The average CO_2 emissions factor for electricity consumed in California is 0.11 kg C per kWh. L. Price, C. Marnay, J. Sathaye, S. Murtishaw, D. Fisher, A. Phadke, Lawrence Berkeley National Laboratory, and G. Franco, California Energy Commission, "The California Climate Action Registry: Development of Methodologies for Calculating Greenhouse Gas Emissions from Electricity Generation," *Proceedings of the ACEEE 2002 Summer Study on Energy Efficiency in Buildings*, 9:317-328, 2002 (www.energy.ca.gov/papers/2002-08-18_aceee_presentations/PANEL-09_PRICE.PDF). Data on average emissions of Bay Area vehicles provided by the California Air Resources Board (CARB) using Emfac2002 V2.2 Sept 23, 2002. Personal communication with Jeff Long, CARB, March 24, 2003.

5 J. Peterson and R. Alonso-Zaldivar, *Energy Market Manipulated, Regulators Say*, *Los Angeles Times*¸ March 27, 2003.

6 In May 2001, NERC wrote: "NERC's best estimate is that there will be about 260 hours of exposure to involuntary firm demand curtailment (rotating blackouts) in the CAISO control area during the course of this summer." North American Electric Reliability Council, *2001 Summer Special Assessment: Reliability of the Bulk Electricity Supply in North America*, May 2001, p. 11.

7 In the first half of March 2003, natural gas prices on the New York Mercantile Exchange were more than double prices a year earlier. Personal communication with Mark Bolinger, Lawrence Berkeley National Laboratory, March 20, 2003. In April 2003, stream flows in the Northwest are projected to be less than 80 percent of normal. National Weather Service Northwest River Forecast Center data; Personal communication with John Taves, Bonneville Power Administration, March 27, 2003.

8 June 1998 to December 1999 data from the California Power Exchange archived by the UC Energy Institute at www.ucei.berkeley.edu/ucei/datamine/px_umcp.html; January 2000 to June 2002 data from the California Department of Water Resources, *supra* at note 3.

9 California Department of Finance Demographic Research Unit, *E-7 Historical State Population Estimates*, January 2002 (www.dof.ca.gov/HTML/DEMOGRAP/repndat.htm); U.S. Bureau of Economic Analysis, *Gross State Product Data*, June 2002 (www.bea.doc.gov/bea/regional/gsp).

10 California Energy Commission, *2002-2012 Electricity Outlook Report*, P700-01-004F, February 2002.

11 California Energy Commission, *The Energy Efficiency Public Goods Charge Report: A Proposal for a New Millennium,* P400-99-020, December 1999, p. 11.

12 California State and Consumer Services Agency, *The Summer 2001 Conservation Report*, February 2002 (www.energy.ca.gov/efficiency/index.html).

13 Senate Bill 5X (Sher, Chapter 7, Statutes of 2001) and Assembly Bill 29X (Kehoe, Chapter 8, Statutes of 2001).

14 The average lifecycle cost of the 2001 energy efficiency investments is 3¢ per kWh. Global Energy Partners for CALMAC, *supra* at note 17. The average lifecycle cost of a new natural-gas combined-cycle generator is estimated to be around 5.1¢ per kWh, including a hedged fuel contract. California Energy Commission Staff Draft Report, *Comparative Cost of California Central Station Electricity Generation Technologies*, #100-03-001SD, February 2003; M. Bolinger, R. Wiser, and W. Golove, *Quantifying the Value That Wind Power Provides as a Hedge Against Volatile Natural Gas Prices*, Lawrence Berkeley National Laboratory, LBNL-50484, June 2002. The average cost of the state's long-term electricity contracts signed by the Department of Water Resources in 2001 is 7¢ per kWh. California state auditor, *supra* at note 17. The average spot market price for electricity in February 2001 was 31¢ per kWh. California Department of Water Resources, *supra* at note 3.

15 California Energy Commission, *supra* at note 1. Summer is the months June through September, inclusive. Monthly reductions in peak demand, adjusted for weather and economic conditions, were 14.1 percent, 10.7 percent, 8.9 percent, and 8.0 percent for June, July, August, and September, respectively.

16 The 20/20 program provided customers with a 20 percent discount on their bill for reducing consumption by at least 20 percent over the same month in 2000. C.A. Goldman et al., *supra* at note 3, p. 13.

17 Ibid, p. 6, 22.

18 Global Energy Partners, *California Summary Study of 2001*, for the California Measurement Advisory Council (CALMAC), Report ID# 02-1099, March 2003; California State Auditor, *California Energy Markets: Pressures Have Eased, but Cost Risks Remain*, 2001-009, 2001.

19 California Energy Commission, *supra* at note 1.

20 Ibid. Summer is the months June through September.

21 California Energy Markets, "Residential Customers Still Cotton to Conservation," December 13, 2002, No. 699.

22 Personal communication with Mark Bolinger, Lawrence Berkeley National Laboratory, March 20, 2003.

23 Graph includes investments in both electric and natural-gas energy efficiency, but excludes municipal utility investments. The 1976–1999 data was compiled by California Energy Commission staff. The 2000 and 2001 figures include the public goods charge funds and additional money provided by the legislature. The 2002 figures are the utilities' approved energy efficiency budgets, not the actual recorded expenditures, plus the local programs administered by the PUC that are funded for both 2002 and 2003. The California Consumer Price Index was used to bring expenditures into 2002 dollars. Personal communication with Sylvia Bender, California Energy Commission, March 10, 2003; Utility Gas Energy Efficiency Program Annual Reports in the PUC's 2001 Annual Earnings Assessment Proceeding A.01-05-003, May 2001; Global Energy Partners, *supra* at note 17; California Public Utilities Commission Decisions D.02-03-056, D.02-05-046, and D.02-06-026; California Division of Labor Statistics and Research, *Consumer Price Index Historic Data (1914–2002)*, March 2003 (www.dir.ca.gov/DLSR/statistics_research.html).

24 M. Rufo and F. Coito, *California's Secret Energy Surplus: The Potential for Energy Efficiency,* Xenergy Inc., for the Energy Foundation and the Hewlett Foundation, 2002 (www.energyfoundation.org/energyseries.cfm).

25 Assembly Bill 57 (Wright, Chapter 835, Statutes of 2002), Sections 1(a) and 1(c) with reference to California Public Utilities Code Section 701.1. AB 57 also established an annual renewable energy procurement target equivalent to one percent of retail sales (Section 2(b)(9)(A)), which within weeks had been fleshed out substantially in SB 1078 (commonly referred to as the "renewable portfolio standard").

26 California Public Utilities Commission Decision No. 02-10-062, October 2002.

27 For further discussion of utility resource portfolio management, see the Regulatory Assistance Project, *Portfolio Management*, for the Energy Foundation and the Hewlett Foundation, July 2002 (www.raponline.org).

28 D. Bachrach, *Program Evaluation of the Los Angeles Department of Water and Power Public-Benefits Programs*, Natural Resources Defense Council, January 2003.

29 California Public Utilities Code Section 739.10 states: "The commission shall ensure that errors in estimates of demand elasticity or sales do not result in material over or undercollections of the electrical corporations." The PUC expects to break the link between utility revenues and throughput in each of the utilities' rate cases now before the Commission (Proceedings A.02-11-017 (PG&E), A.02-05-004 (SCE), A.02-12-028 (SDG&E) and A.02-12-027 (SoCal Gas)).

30 California Energy Commission, *supra* at note 11.

31 See Sheryl Carter, *Investments in the Public Interest: California's Public Benefit Programs Under Assembly Bill 1890,* Natural Resources Defense Council, January 2000.

32 The California Energy Commission expects the updated appliance standards to save 134 MW each year. M. Martin and J. Holland, *2001 Update, Assembly Bill 970, Appliance Efficiency Standards Life Cycle Cost Analysis,* California Energy Commission, P400-01-028, November 2001 (Amended February 2002) (www.energy.ca.gov/appliances/documents/2003-02-26_ADD_COST_EFFECT.PDF).

33 Households with incomes at or below 175 percent of the federal poverty guidelines (just over $30,000 for a family of four), or households that qualify for other government low-income programs, qualify for the PUC low-income programs. Low-income customers with a senior or disabled head of household at 200 percent of the federal poverty guidelines are also eligible for the low-income energy efficiency program. California Public Utilities Commission Decision 01-06-010, June 2001. The 2002 CARE budget was about $305 million, and the low-income energy efficiency budget was about $120 million. California Public Utilities Commission Decision 02-09-021, September 2002, and Decision 02-12-019, December 2002.

34 California Public Utilities Commission Decision 03-01-020, January 2003.

35 California Public Utilities Commission Decision 02-07-033, July 2002.

36 Note that February 2003 participation rates were adjusted to reflect the number of eligible customers based on 2000 census data, whereas the May 2001 rates were not. California Public Utilities Commission Decision 01-06-010, June 2001; PG&E, SCE, SDG&E, and SoCal Gas' Monthly Status Reports on Rapid Deployment in PUC Docket R.01-08-027, March 21, 2003.

37 California Public Utilities Commission Decision 02-07-033, July 2002; California Public Utilities Commission Decision 01-05-033, May 2001.

38 K. Kawamoto, J.G. Koomey, B. Nordman, R.E. Brown, M.A. Piette, M. Ting, and A.K. Meier, *Electricity Used by Office Equipment and Network Equipment in the U.S.*, Lawrence Berkeley National Laboratory, LBNL-45917, February 2001. This estimate was subsequently confirmed by another detailed analysis by Arthur D. Little, Inc., K.W. Roth, F. Goldstein, and J. Kleinman, *Energy Consumption by Office and Telecommunications Equipment in Commercial Buildings,* Arthur D. Little Reference No. 72895-00, January 2002. See also the 2002 RAND report that concludes that "even large growth in the deployment and use of digital technologies will only modestly increase electricity consumption in the United States over the next two decades." W. Baer, S. Hassell, and B. Vollaard, *Electricity Requirements for a Digital Society,* RAND, 2002 (www.rand.org/publications/MR/MR1617/).

39 For example, information technologies improve supply chain efficiencies and reduce inventory needs, thereby reducing the associated warehouse building energy consumption. J. Romm, "The Internet and the New Energy Economy," *Resources, Conservation and Recycling* 36, October 2002, p. 197-210.

40 This source considers Silicon Valley to include the counties of Santa Clara, San Mateo, San Francisco, and Alameda. J. Mitchell-Jackson, J.G. Koomey, M. Blazek, B. Nordman, *National and Regional Implications of Internet Data Center Growth in the US, Resources, Conservation and Recycling* 36, October 2002, p. 175-185.

41 The comparison of a laptop and desktop computer does not include the energy used by the desktop's monitor, since some laptops are used as a desktop replacement with an external monitor. K.W. Roth et al, supra at note 37.

42 F. Beck, *Energy Smart Data Centers: Applying Energy Efficient Design and Technology to the Digital Information Sector,* Renewable Energy Policy Project, November 2001.

43 Nationwide, more efficient power supplies could save 32 billion kWh per year and cut the annual national energy bill by $2.5 billion. C. Calwell and T. Reeder, *Power Supplies: A Hidden Opportunity for Energy Savings,* Ecos Consulting, for the Natural Resources Defense Council, May 2002.

44 For more information on demand response programs in California, and the CEC and PUC's proceedings to implement dynamic pricing and advanced metering, see www.cpuc.ca.gov/static/industry/electric/demand, www.energy.ca.gov/demandresponse, www.capowerauthority.ca.gov/DemandResPartnership/default.htm, and www.consumerenergycenter.org/enhancedautomation.

45 Pacific Northwest Pollution Prevention Resource Center, *Energy and Water Efficiency for Semiconductor Manufacturing,* February 2000 (www.pprc.org/pprc/pubs/topics/semicond/semicond.html).

46 R. Mallela, International SEMATECH, *Sustainable Growth Through Emphasis on ESH Improvements,* February 2, 2002 (www.future-fab.com/documents.asp?grID=210&d_ID=931).

47 Ibid.

48 Lawrence Berkeley National Laboratory, Environmental Energy Technologies Division, Applications Team, *Energy Efficient Cleanroom Information Site: A Business Perspective,* April 2002 (http://ateam.lb.gov/cleanroom/business.html).

49 R. Mallela, *supra* at note 45.

50 Lawrence Berkeley National Laboratory, *supra* at note 47; Environmental Protection Agency, *Labs for the 21st Century,* December 2002 (www.epa.gov/labs21century/index.htm); A.B. Lovins, Negawatts for Fabs, Rocky Mountain Institute, 1998 (www.rmi.org/images/other/E-NegawattsForFabs.pdf).

51 International Semiconductor Industry Associations, *International Technology Roadmap for Semiconductors 2002 Update,* 2002 (http://public.itrs.net/).

52 The Rocky Mountain Institute's low-power data centers design charrette website is at www.rmi.org/sitepages/pid626.php. RMI's charrette report will be available at the end of April.

53 L. Bruno, *Coooool!, Red Herring,* February 2003.

54 F. Beck, *supra* at note 41; Additional examples can be found in J.D. Mitchell-Jackson, *Energy Needs in an Internet Economy: A Closer Look at Data Centers,* May 2001 (http://enduse.lbl.gov/Projects/InfoTech.html).

55 Personal communication with Neil Rasmussen, American Power Conversion Corporation, February 12 and 21, 2003.

56 LBL's energy-efficient data center website is at http://datacenters.lbl.gov.

ABOUT NRDC

The Natural Resources Defense Council (NRDC) is a national nonprofit environmental organization with more than 550,000 members. Since 1970, our lawyers, scientists, and other environmental specialists have been working to protect the world's natural resources and improve the quality of the human environment. NRDC has offices in New York City, Washington, D.C., Los Angeles, and San Francisco. Visit us on the World Wide Web at www.nrdc.org.

ABOUT SVMG

David Packard of Hewlett-Packard, founded the Silicon Valley Manufacturing Group (SVMG) in 1978. Today, the Group represents 180 of the Valley's most respected private sector employers, which collectively provide approximately 225,000 local jobs—or nearly one of every four in Silicon Valley. Energy is one of SVMG's five priority areas, which also include transportation, housing, environment, and education. David Packard's vision of the Manufacturing Group was an organization where members got involved directly in the business of policy. SVMG adheres to a collaborative and positive approach to solving problems and issue advocacy.