

Energy Efficiency and Conservation: Trends and Policy Issues

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Introduction and Definitions

Energy efficiency and conservation programs can play major roles in increasing the reliability of the current electricity system and reducing the costs of meeting peak demand during periods of high temperatures and/or high prices. Experience has shown that it is crucial for the demand side of the market to be able to respond to different kinds of market conditions. Supply side solutions that maintain large amounts of capacity to meet small variations in demand levels are almost inherently more expensive.

This staff paper provides background for the June 4, 2003 efficiency workshop that is part of the public input process for the *Integrated Energy Policy Report*, a report to the Governor and Legislature. Trends in electricity and natural gas usage at the customer level and the contributions of different types of “demand side” programs and planning processes, both historically and going forward, are described first. After this review, we discuss the potential for additional energy savings and policies to support those achievements. Finally, we discuss some of the challenges associated with relying on energy efficiency and conservation to increase system adequacy. We conclude with a series of findings based on this analysis. This staff paper is divided into the following sections:

- Trends in Electricity and Natural Gas Efficiency
- 2000-2001 Energy Crisis
- California’s Current Efficiency Programs
- Joint Agency Energy Action Plan
- Potential for Additional Achievable Energy Efficiency and Its Value
- Policy Challenges to Achieving More Reliable Energy Efficiency
 - Reducing Risks Associated with Energy Efficiency
 - Linking Policy Goals and Efficiency Potential
 - Delivering the Efficiency Potential Effectively
- Conclusions

Energy efficiency and conservation fall under the heading of demand side management (DSM). This term encompasses several energy demand-reducing activities: energy efficiency, conservation, and demand responsive actions such as load management or load shifting. DSM programs are designed to achieve two basic objectives: reduce overall energy

EXAMPLES OF ENERGY EFFICIENCY:

- Replacing incandescent light bulbs with compact fluorescent bulbs, which deliver equivalent light using 70 percent less electricity.
- Installing new variable speed chillers that deliver cooling to buildings using 40 percent less energy than typical chillers.
- Identifying and repairing leaks in ductwork, which can improve heating and cooling efficiencies by as much as 25 percent.

EXAMPLES OF CONSERVATION:

- Raising a thermostat from 75 ° F to 80 ° F for air conditioning on a hot summer day.
- Waiting until the dishwasher is full to run.
- Turning lights off when the room is not in use.

consumption by promoting high-efficiency equipment and building design, and achieve load reductions by changing the patterns of energy use, primarily at times of peak demand.

Both efficiency and conservation programs can achieve energy savings, but in different ways. Energy efficiency is a term that typically refers to the permanent installation of energy efficient technologies or the elimination of energy losses in existing systems. The aim of energy efficiency is to maintain a comparable level of service, but reduce energy usage. Energy conservation typically involves using less of a resource, usually by making a behavioral choice or change. The change may last for a short duration or may be incorporated into a habit or lifestyle.

DSM also can take the form of “load management” or “load shifting.” Here a customer reduces or curtails load in response to an emergency signal from a service provider or grid operator. These are different from conservation in that the activity (and energy consumption) is not necessarily reduced, but rather shifted to another time period. Dynamic pricing is a new metered load management approach that uses price signals to induce customers to reduce energy use at specific times of the day, typically when energy is the most expensive to procure.

This report will focus on energy efficiency and conservation, specifically-end uses associated with consumer demand and their connection to system adequacy. It will also consider the relationship of efficiency and conservation to dynamic pricing and load management strategies as well as their role in other energy arenas such as renewables.

Trends in Electricity and Natural Gas Efficiency

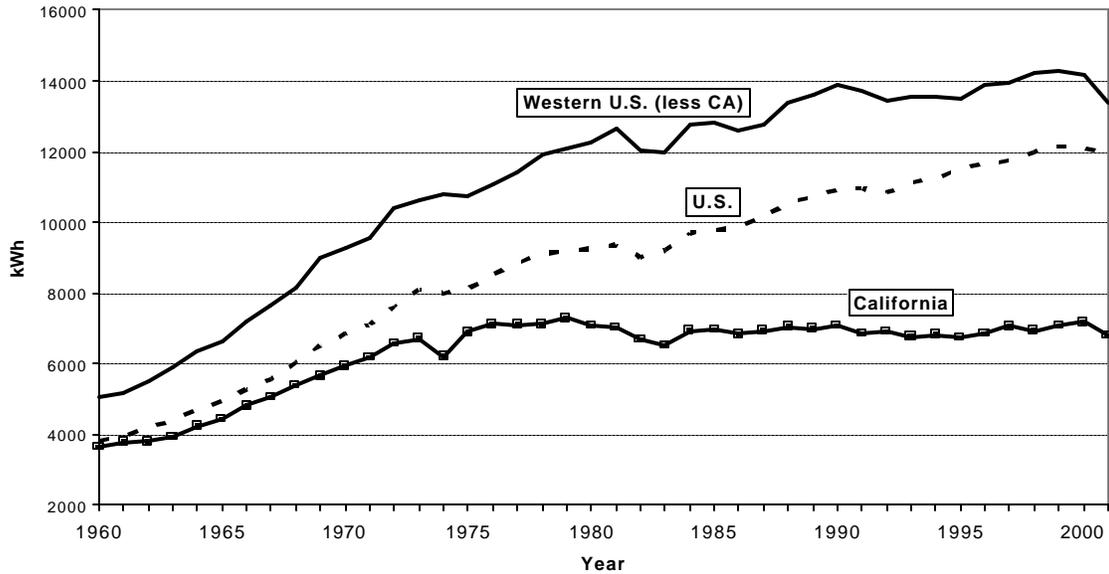
The purpose of this section is to document trends in the consumption of electricity and natural gas, efficiency program policy, program expenditures, and savings over the past decade.

Consumption Trends

Energy use is a function of demographic change, economic change, price trends, weather, and changes in consumer behavior. Californians consumed roughly 253,500 Gigawatt hours (GWh) of electricity in 2001 and needed 49,625 Megawatts (MW) of peak electric demand.¹ Population and income are the key drivers for the residential and commercial sectors. Employment is the key driver for the industrial and commercial sectors.

California continues to be the nation’s most efficient state in terms of per capita electricity consumption as shown in Figure 1. Throughout the 1990s, per capita electricity consumption virtually held constant, increasing at an average of 0.1 percent a year. Peak demand in the state would have been 15,000 MW higher than it was in 2000, had California’s per capita electricity use increased at the same rate as the rest of the country (1.7 percent over the last 25 years).² Per capita consumption is again expected to hold steady over the next decade, after decreasing in 2001 because of conservation. National per capita consumption, by contrast, is expected to increase by 0.7 percent annually between 2001 and 2025, according to the Energy Information Administration’s *Annual Energy Outlook 2003*.

Figure 1: Total Electricity Use per Capita over Time



Source: Energy Information Agency and California Energy Commission

Natural gas end-use consumption (excluding natural gas used in electricity production) in 2001 totaled 13,609 million therms (MTh).³ Natural gas consumption increased by 1.0 percent annually in the 1990s. Over the next ten years, natural gas use is expected to increase at a rate of 0.6 percent per year. California is the second largest consumer of natural gas in the nation.

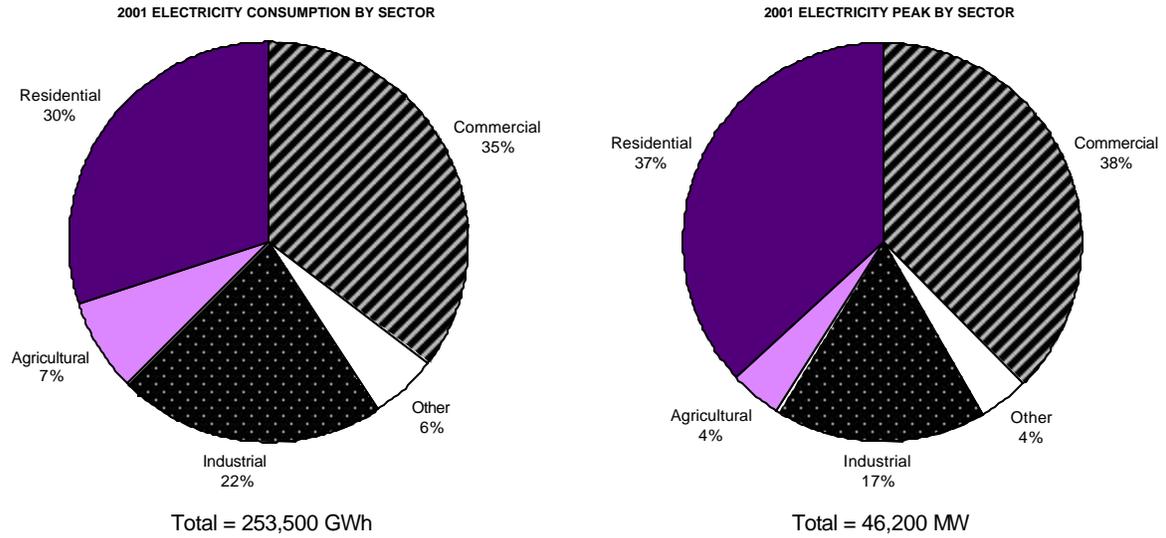
To better understand trends, we separate total consumption by sector and end-use. Sector refers to the type of customer using energy (e.g., commercial, residential, etc.), while end use is a term used to refer to the service desired from the energy (e.g., lighting or cooling).

Consumption Trends by Sector

Electricity Sector Trends

California electricity use is dominated by the residential, commercial, and industrial sectors. The commercial sector comprises 35 percent of the state's electricity consumption as shown in Figure 2. Coming in at slightly lower proportions are the residential sector (31 percent) and the industrial sector (20 percent). The agricultural sector accounts for only 8 percent of the state's electricity consumption, despite contributing the most to the state's water consumption. Transportation and street lighting account for the remaining 6 percent of electricity use. On peak, the residential and commercial sectors become larger portions of the total.⁴

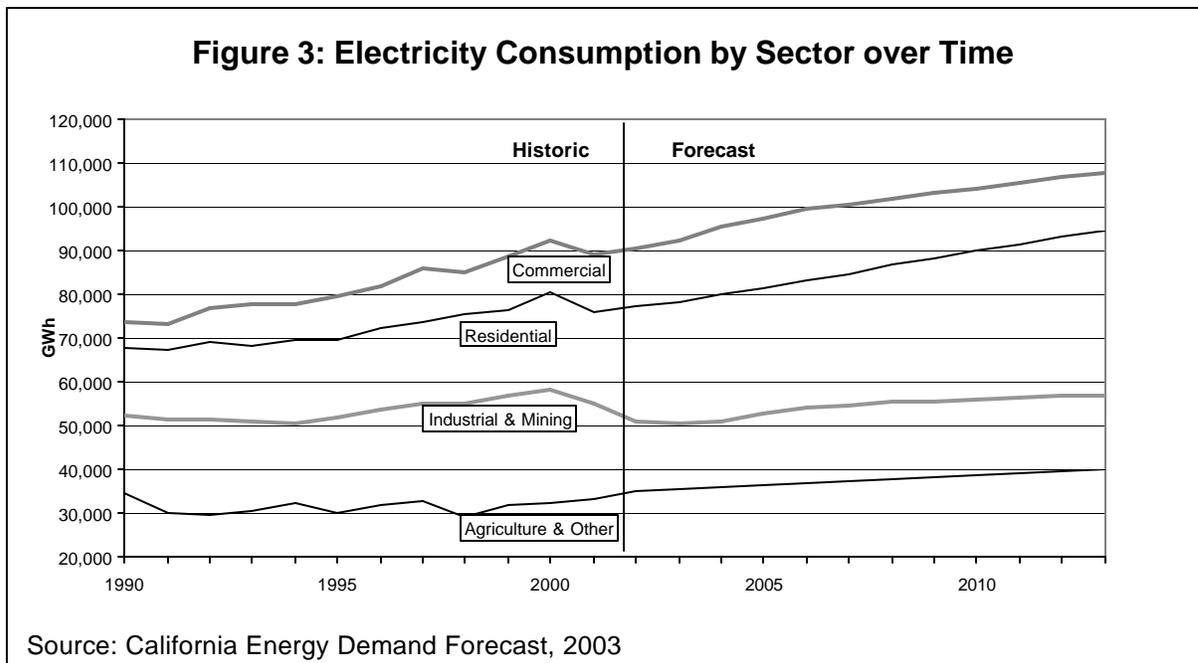
Figure 2: Electricity Consumption and Peak Use by Sector



Source: California Energy Demand Forecast, 2003

Moderate economic growth is forecasted to resume in 2004, but the robust growth in income and employment of the late 1990s through 2000 is not expected to return. This, combined with retail electricity rate cuts as bonds are paid off, contributes to demand growth averaging 2.2 percent for 2004 and 2005. Demand growth slows to an average of 1.4 percent, as retail rates and economic trends stabilize, for the rest of the forecast period.

Figure 3, showing statewide annual consumption by sector over time, illustrates these factors. With the technology boom of the late 1990s, nonresidential demand grew rapidly at 2.6



Source: California Energy Demand Forecast, 2003

percent per year. Growth was even faster in the commercial sector, as California’s economy continued shifting away from manufacturing toward a service economy. In 1980, commercial consumption was 42 percent of nonresidential consumption, and by 2000 it had increased to 50 percent. This trend is forecasted to continue, but at a much slower rate, with the commercial share of nonresidential demand increasing to 52 percent over the next decade.

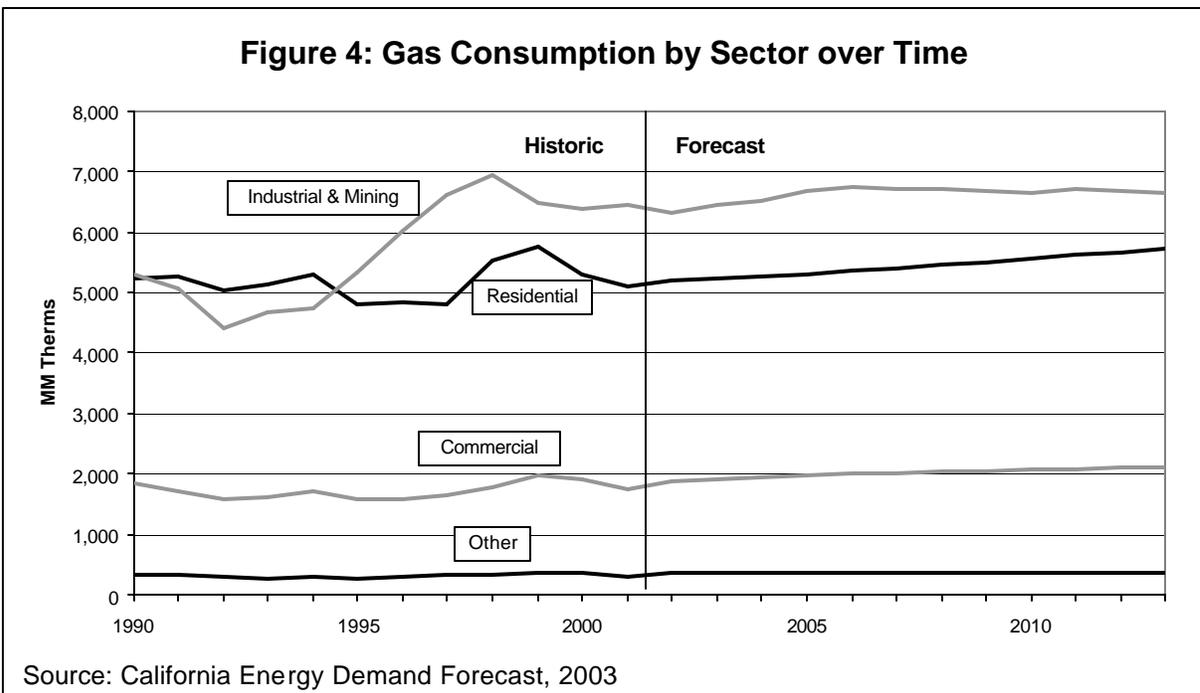
Annual growth rates for peak demand by sector show a similar ordering of sectors. The commercial sector peak grew by 1.7 percent during the 1990s, compared to 1.6 percent for residential and 0.6 percent for industrial. Projected annual growth rates in the period 2001-2013 show the residential sector growing slightly faster than commercial because of slower economic growth.⁵

Natural Gas Sector Trends

Natural gas consumption is divided into two approximately equal categories: “direct” and “indirect” consumption. Direct consumption refers to natural gas that is burned at the end use level, such as for heating a home; indirect consumption refers to natural gas that is burned to produce electricity, and in so doing indirectly serves customers’ end use needs.⁶

Residential buildings account for 38 percent of direct use. Commercial buildings use approximately 13 percent of the total. The combination of industrial and mining consumption accounts for 46 percent of the annual direct total.

Residential use as a percentage of the total has declined since the early 1990s as industrial use steadily increased. This decline is due in large part to the impacts of building and appliance standards and the small number of new gas appliances entering the market.⁷ Going forward, growth is projected to be strongest in the commercial and residential sectors (averaging 1 percent and 0.9 percent respectively) and weakest in the industrial sector (0.1 percent).⁸ Figure 4 shows the historic and forecasted trends for direct gas consumption by sector.



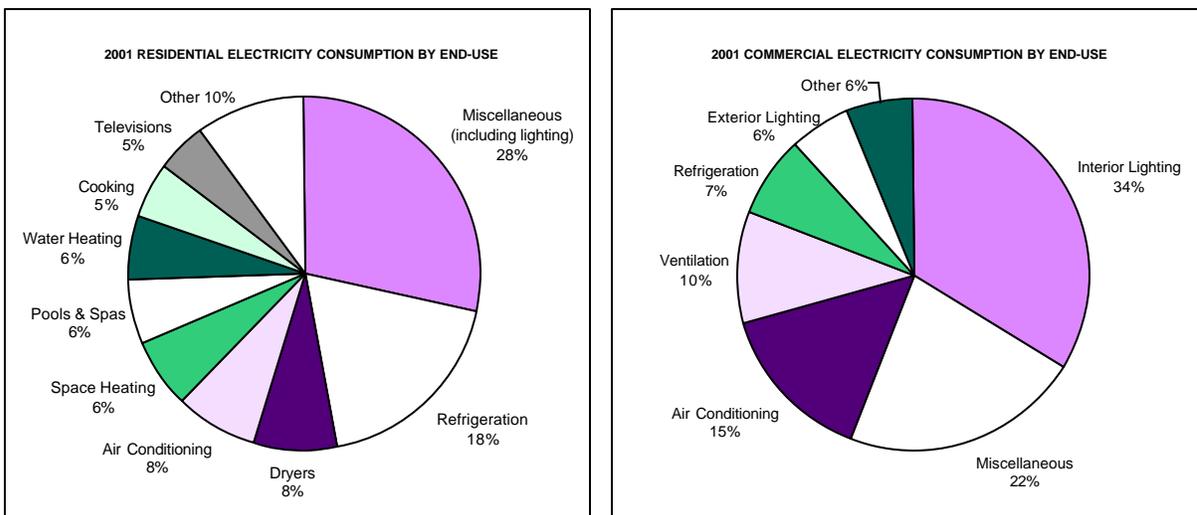
End Use Consumption Trends

Understanding how the resources are actually used in energy consuming activities known as end uses is crucial to any discussion on energy efficiency. As noted above, the greatest use of both electricity and natural gas is for end uses in residential and commercial buildings.

Trends in Electricity End Use Consumption

The breakdown of electricity consumption into specific end-uses for both the residential and commercial sectors is shown in Figure 5. The largest electricity-consuming end uses in the residential sector are categorized as “miscellaneous” (e.g., lighting, fans and electronics) and refrigeration. Air conditioning, dryers, and space heating are the next largest uses, each accounting for between 6-9 percent of residential consumption. In the commercial sector, interior lighting, “miscellaneous” (a category that includes elevators, escalators, and many other end uses), air conditioning, and ventilation each contribute more than 10 percent to the commercial sector annual consumption.

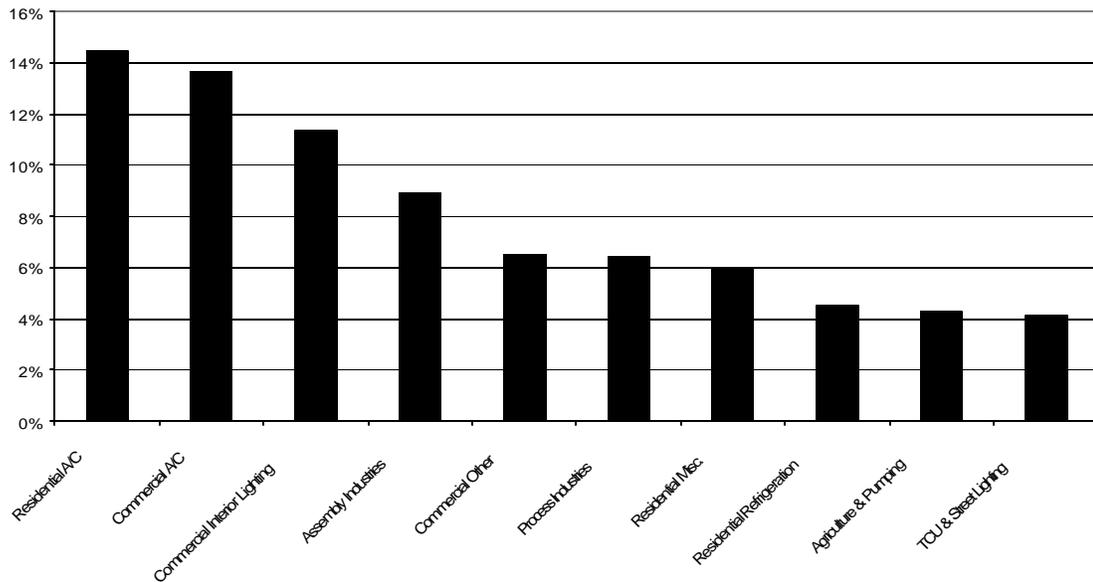
Figure 5: Residential and Commercial Electricity End-Use Breakdown, 2001



Source: California Energy Demand Forecast, 2003

Figure 6 summarizes the top 10 contributors to peak load. Residential and commercial air conditioning end uses clearly dominate peak load. Cooling residential and commercial buildings accounts for 28 percent of the total peak load and 36 percent of peak load associated with buildings. Other residential end uses contributing more than 10 percent to peak total demand are again in the “miscellaneous” category (e.g., lighting, fans, and electronics), and refrigeration. Commercial interior lighting is a large contributor to peak demand as well.

Figure 6: Top 10 Components of Peak Demand in 2001



Source: California Energy Demand Forecast, 2003

A recent study from Lawrence Berkeley National Laboratory examined trends in end-uses by comparing 1999 end-use breakdowns from the Energy Commission models to a residential sector estimate from 1975.⁹ Aggregate electricity consumption increased by almost 70 percent in these twenty-five years. Most of this growth was concentrated in the miscellaneous category (lighting, small appliances, consumer electronics, and computers), clothes dryers, and dishwashers. The increase is likely caused by the increase in the saturation of these devices and appliances. Surprisingly, both space heating and air conditioning consumption remained relatively constant between 1975 and 1999. The authors suggest that overall residential electricity end-uses have had low growth rates compared to growth in housing and equipment.

Natural Gas End Use Trends

The most significant residential natural gas uses are space heating and hot water heating, each of which comprises about 40 percent of all residential gas use.¹⁰ The commercial sector is more complicated because of the vast diversity of end uses. Looking at direct consumer end uses, the most significant commercial natural gas end uses are heating (35-40 percent) and hot water heating (10 percent). These percentages have remained relatively constant over the last decade.

Another way to analyze natural gas usage is by building type. Restaurants account for the largest share of commercial usage (22 percent), followed by miscellaneous buildings (e.g., auto repair shops), offices, hospitals, and hotels.¹¹

Program Policy and Expenditure Trends

Public purpose program funding is available to further both electricity and natural gas efficiency, but approximately 80 percent of the funds are collected from electric ratepayers and consequently are used in programs to reduce the demand for electricity. While natural gas and municipal utilities also are included in public purpose legislation, the following discussion of program policy and expenditures applies to investor-owned utility electricity programs.

A public goods charge (PGC) applies to each electric utility customer's bill to support public programs for energy efficiency, low-income services, renewable energy, and energy-related research and development. Approximately 1.0 percent of each customer's electric bill and 0.7 percent of each natural gas bill supports the public benefit programs. Legislation (SB 995) signed in September 2000 extended the public purpose funding through December 31, 2011, authorizing \$5 billion for energy efficiency, low-income, renewables, and research and development programs over that time period. Energy efficiency programs receive the largest portion of the funds, and in contrast to the other programs, must meet cost-effectiveness criteria.

Spending on energy efficiency exhibits a long history of expansion and contraction¹² that is related to changing fuel prices and a combination of regulatory and legislative policy decisions. The last decade alone is characterized by three shifts in policy emphasis, which in turn altered key program directions.

Pre-Restructuring Period

In the early 1990s programs were planned and carried out as part of an integrated resource planning process conducted by the PUC and Energy Commission. Spending on energy efficiency and other DSM activities were recognized as "viable cost-effective alternatives to supply-side energy generation projects."¹³ Funding for programs rose to \$500 million by 1994, only to decline again with the growing uncertainty surrounding restructuring. Primary program strategies centered on customer assistance through audits and financial incentives in the form of rebates or direct payments.

Restructuring Period

With the passage of AB 1890 in 1996, energy efficiency programs entered a new period. California's restructuring legislation held programs and funding in place at a time when most states eliminated both. AB 1890 authorized about \$240 million a year for energy efficiency programs administered by the investor-owned utilities and overseen by the PUC, and temporarily, the California Board for Energy Efficiency, which served as a public advisory board.

Table 1: Funding Levels for Public Purpose Programs in 2002

Public Purpose Program	Funding Level
Energy Efficiency	\$300 Million
Renewables	\$135 Million
RD&D	\$62.5 Million
Low income energy efficiency	\$23 Million

Source: Office of Ratepayer Advocates, 2002

Significant program changes occurred in the restructuring period. Policy focus began to shift toward creating “well-functioning markets” in which consumers and producers could make informed choices about energy-using equipment and services. Funding for “market transformation” or upstream” programs increased substantially. Utilities were directed to move to statewide programs with consistent program designs and coordinated implementation efforts. Evaluation moved away from documenting energy savings to measuring market effects.

Post-Restructuring Period

2000 marked a major turning point in public benefit programs. Funding was renewed for ten years. Increasing concern about wholesale prices and reliability prompted a change in 2001 back toward resource acquisition-style programs in order to quickly reduce energy consumption and achieve load reductions. Unspent funds from previous years augmented funding to levels not seen since the early 1990s. This period will be covered in greater detail in the “Energy Crisis Initiatives, Achievements and Lessons” section.

The energy efficiency public benefit programs are undergoing a further re-examination in the PUC’s current rulemaking R.01-08-028. Several new policy directions have emerged or are emerging in this proceeding.

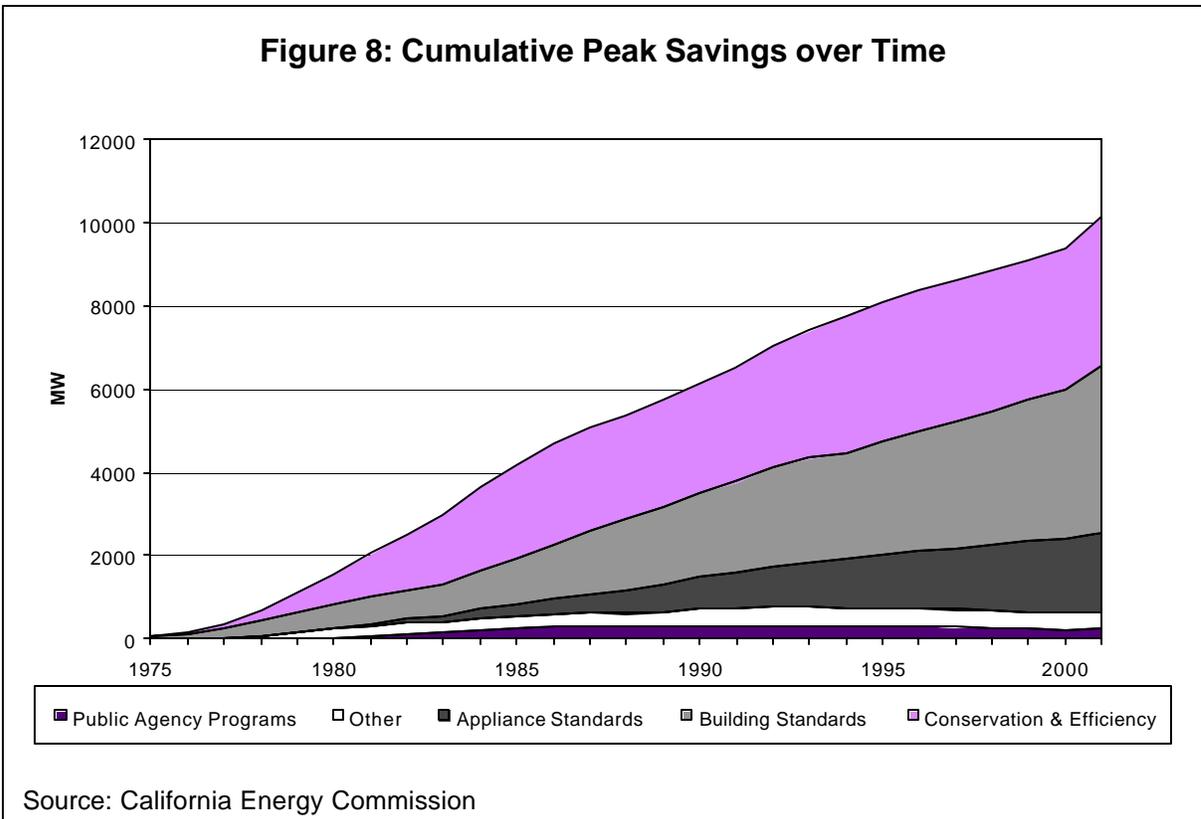
- The PUC opened the door to local government initiatives to leverage local organizational knowledge in meeting the needs of small business and particular communities, e.g. Spanish-speaking, rural. Twenty percent of PGC funds were set aside for “third-party” proposals from private-for-profit, non-profit, and public entities to provide local programs.
- Ongoing funding for statewide consumer marketing and outreach campaigns aimed at energy efficiency rather than conservation is being supported.
- The PUC has committed to developing policy direction on the issue of future program administration as part of this rulemaking. It is too early to tell what changes may result.
- Reducing pressure on key transmission sectors in San Francisco is the goal of a joint government/utility pilot project combining energy efficiency with other DSM strategies.

The PUC authorized a series of evaluation studies in 2002 intended to move toward a more strategic program planning process for public benefit programs. Four studies, which are scheduled to be completed in 2003, will:

- Summarize the separate potential studies into a framework useful for portfolio management and integrated resource planning;
- Update the incremental costs and savings data for efficient technologies in a web-based environment;
- Benchmark energy efficiency best program practices; and
- Develop a new evaluation, measurement, and verification framework to update the cost-effectiveness tests (specifically avoided costs), add quantification of non-energy benefits, and include measures of uncertainty.

Savings Trends

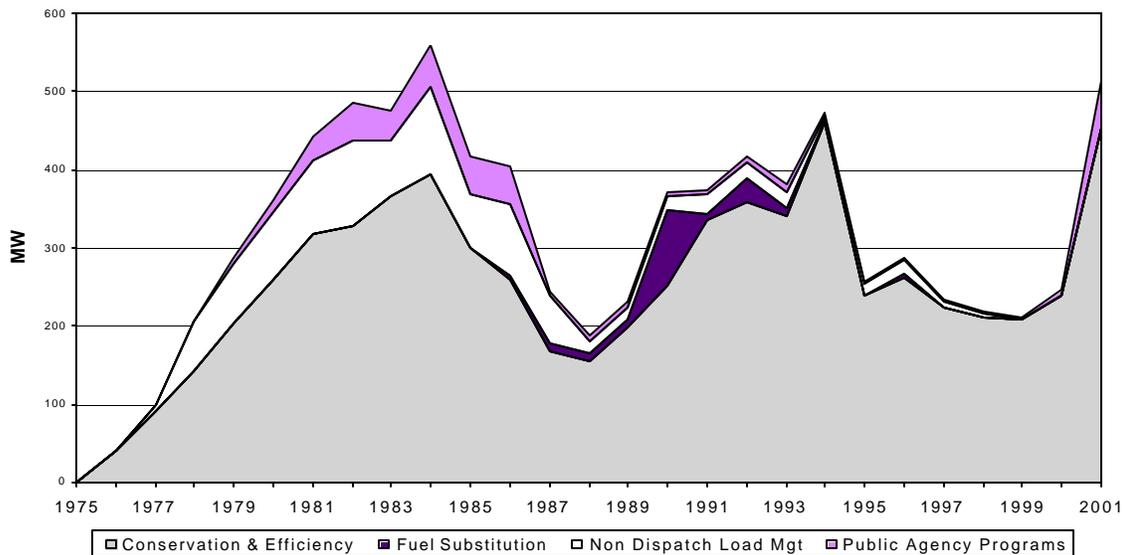
California's efficiency initiatives have made a substantial contribution to slowing the growth of electricity and natural gas use over the past 26 years. As shown in Figure 8, the cumulative effects of all of California's electric efficiency programs and standards are more than 10,000 MW and 35,000 GWh in savings through 2001. This savings is equivalent to the output of thirty-three 300-MW power plants. Program savings, which account for half of the cumulative effects, are most dramatic in residential and commercial buildings. National gas efficiency programs have saved two billion therms over this same period.



The pattern of electricity savings from investor-owned utility programs has generally tracked expenditure levels over the past 26 years. This point is illustrated showing peak savings in Figure 9. The highest efficiency savings historically occurred in 1994, the year of highest funding. The downturn of spending in both the late 1980s and 1990s is apparent. Augmented funding in 2000, however, triggered a new incremental high of 453 MW.¹⁴ First-year energy savings of 1,800 GWh were achieved in 1994, but more typically are 1,000 GWh. First-year peak demand savings from the investor-owned utility public benefit programs have averaged at least 200 MW in recent years.

Historically, as much as 80 percent of these savings are attributable to the nonresidential sector. The residential proportion of both energy and peak program savings has been increasing faster since 1999. New construction program savings have remained steady as a share of first-year peak demand savings, but are declining as a share of first-year electric energy savings in recent years.

Figure 9: First Year Savings from Energy Efficiency Programs over Time



Source: California Energy Commission

Since energy efficiency building and appliance regulations went into effect in 1978, the Energy Commission estimates that Californians have reduced their utility bills by at least \$20 billion. The Commission predicts that by the year 2011, residents of the state will save an additional \$57 billion in electricity costs. Every dollar saved through energy efficiency is a dollar that can be spent elsewhere.

Improvements in electric energy efficiency will ultimately reduce the amount of energy that is required from fossil-fuel generating plants. Reducing generation from such facilities leads to a concurrent reduction in power plant emissions such as nitrogen oxides (NO_x), sulfur dioxide (SO₂), and carbon dioxide (CO₂), thus benefiting all Californians with a cleaner, healthier environment.

Energy Crisis Initiatives, Achievements and Lessons

The summer of 2000 was marked by increases in the wholesale price of power and isolated supply shortfalls. By the winter of 2001, constrained electricity supplies forced rolling blackouts throughout the state. These circumstances led to renewed interest in demand-side programs as a resource that could help alleviate electric system adequacy problems. California government authorities used a series of executive, legislative, and regulatory policy responses centering on energy efficiency to respond to the reliability crisis.¹⁵

Initiatives

Early in 2001, Governor Davis's executive order declaring a State of Emergency triggered a series of state responses, set energy and peak reduction goals for the state overall, and

established minimum peak reduction objectives for state buildings. Later executive orders authorized and funded the “20/20” program, a 20 percent credit for investor-owned utility electric customers who reduced their summer month bills compared to the previous year by 20 percent, and *Flex Your Power*, a statewide mass media and outreach campaign managed by the State and Consumer Services Agency.

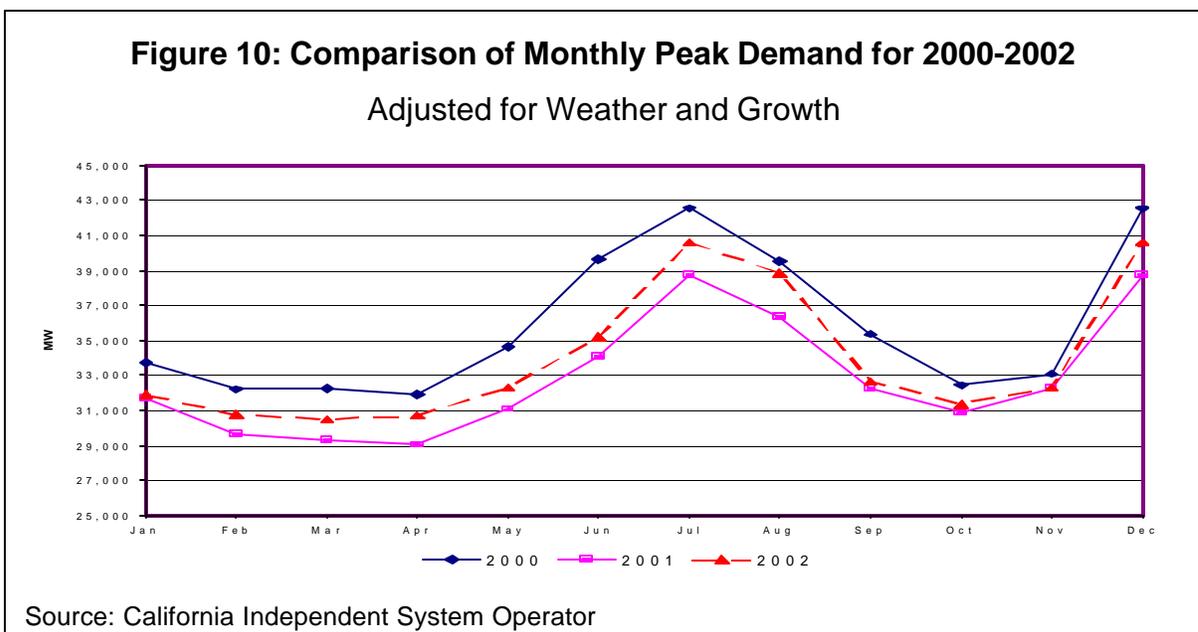
During 2000-2001, the legislature passed AB 970, SB X1 5 and AB X1 29 setting policy and allocating an additional \$1.1 billion for demand-side programs of several types. Energy efficiency programs, most of which emphasized lowering peak demand, received about \$850 million of the total.

Parallel to actions by the governor and legislature, the PUC used its regulatory authority to adopt a “Summer Initiative” in July 2000 as a “rapid-response procedure.” Further regulatory action in early 2001 authorized the investor-owned utilities to redesign their programs toward immediate energy savings and demand reduction, and away from longer-term market transformation activities.

Achievements

California’s efforts in 2001 averted the anticipated large-scale summer blackouts and widespread economic losses. California’s experience has received nationwide attention as a model for the power of multiple entities responding to a problem together. Investor-owned utilities, municipal utilities, state agencies, local governments, and other third-parties delivered energy efficiency services to California consumers through as many as 218 distinct programs.¹⁶

Relative to 2000, peak demand in the California Independent System Operator (CAISO)¹⁷ control area, adjusted for weather and growth, was down an average of 10.4 percent during the critical months of June to September based on data from the CAISO. Adjusted for weather and growth, annual energy consumption in the CAISO dropped by 6.7 percent in 2001 compared to 2000. Figure 10 compares peak demand for 2000, 2001, and 2002. Peak



demand for 2002 remains approximately 50 percent of peak demand in 2000.

A recent study, *California Summary Study of 2001 Energy Efficiency Programs*, provides a summary of energy savings resulting from all of the programs that were put in place in response to the crisis.¹⁸ Energy efficiency program expenditures of approximately \$893 million yielded an estimated first-year energy savings of over 4.76 million MWh and reduced demand by 3,389 MW.¹⁹ These Figures reflect the best estimation of the *Summary Study* authors, based on comparisons to established benchmarks, professional judgment, and adjustments to reported savings based on uncertainty.

Lessons

Despite widespread national reliability concerns during 2000-2001, few states used energy efficiency as a response strategy. Twenty-one states reported reliability problems, but most relied solely on load management and demand response.²⁰ California's programs proved to be the most notable exception.

A great deal of variability existed in the availability, quality, and consistency of program documentation with so many different entities administering programs. Differing assumptions and conventions made it difficult to compare program cost-effectiveness.

California's recent energy crisis offers several specific examples of system adequacy benefits gained through energy efficiency and conservation strategies. Key findings from consumer research conducted in 2001 and 2002 by Dr. Loren Lutzenhiser and others reveal:²¹

- Unexpected consumer demand elasticity added flexibility to the energy market.
- Changes in consumption for 2001 compared to 2000 were not weather-driven, but structural changes in behavior.
- Changes in behavior rather than efficiency improvements accounted for most of the 2001 reduction.
- Consumer willingness to turn off air conditioners largely contributed to lower consumption.
- The reductions in consumption were not evenly spread across the population.
- Persistence of some behavioral changes continued long after the immediate crisis had passed.
- Behavioral changes were often not induced by prices, but by civic concerns and altruistic motives. For example, some people shifted energy use to off peak periods, even though it meant no savings on their bills.
- Rapid deployment and implementation of energy efficiency efforts by a variety of entities proved both possible and useful in a crisis situation.

California's Current Efficiency Programs

The investor-owned electric and gas utilities, municipal utilities, and the Energy Commission are the primary agencies delivering energy efficiency programs in California today. The

future role of local governments and other state agencies may be increasing in response to evolving PUC policies. A description of the current programs offered by the primary energy efficiency entities follows.

Investor-Owned Utilities

The investor-owned utilities administer 14 statewide electric and gas programs intended to share program design, targeted measures, incentive levels, savings assumptions, and evaluation methods across all service territories. The primary end-use targets for the programs are:

- Lighting & Appliances,
- Heating, Ventilation and Air Conditioning (HVAC) Systems, and
- Motors.

The utilities also administer programs that encourage energy efficiency for home retrofits and renovations, and during the new construction of buildings and homes. Most of these programs are funded through the public goods charge, while others are funded through special purpose legislation such as that which was provided for the Summer 2000 Energy Efficiency Initiative or Senate Bill X1 5.

These programs typically target particular end uses within a market segment using a combination of information, energy management services, incentives, and upstream programs targeted at distributors and manufacturers. There is an emphasis on leveraged efforts, especially with the federal ENERGY STAR® program.

Another group of “cross-cutting” programs emphasizes education and training in support of the hardware programs. These efforts cut across all market sectors and aim at improving the upstream sales and distribution of energy efficient products, increasing awareness of products through marketing and outreach, demonstrating emerging technologies, and supporting upgrades and enhancements to the building and appliance standards.

Each of the four utilities offers at least two and as many as seven “local programs” that target needs within individual service territories. Southern California Edison, for example, offers pump tests and Pacific Gas & Electric offers schools a K-12 curriculum resource program.

Table 2: 2003 IOU PGC Energy Efficiency Program Funding

Program Type	Budget	Program Targets		
		kWh	kW	Therms
Statewide Programs				
Residential	\$73,479,371	122,340,871	27,030	7,146
Non-Residential	\$102,511,125	526,246,526	49,972	14,585
Cross-Cutting	\$29,504,461	273,415,236	26,078	3,981
Statewide Marketing & Outreach	\$20,507,459	N/A	N/A	N/A
<i>Total Statewide</i>	<i>\$205,494,957</i>	<i>922,002,633</i>	<i>103,080</i>	<i>25,712</i>
Local Programs				
Residential	\$1,476,000	2,850,295	N/A	448
Non-Residential	\$5,442,740	8,512,307	N/A	624
Cross-Cutting	\$7,562,380	N/A	N/A	N/A
<i>Total Local</i>	<i>\$14,481,120</i>	<i>11,362,602</i>	<i>N/A</i>	<i>1,072</i>
Grand Total	\$240,483,536	933,365,235	103,080	26,784

Source: CPUC Decision 03-04-055: Interim Opinion on 2003 Statewide/Utility Local Energy Efficiency Programs and other Studies

Municipal Utilities

As spelled out in the restructuring legislation, investment by municipal utilities in public benefit programs must equal at least 2.85 percent of 1994 revenues. California's public utilities typically offer programs across all market sectors using information, audits, rebates, and financing to promote efficiency. Renewables, low-income, and R&D programs are included in municipal utility program offerings.

California Energy Commission

The Warren-Alquist Act conferred on the Commission a range of public purpose programs intended to stimulate the market for energy alternatives that were less polluting, less reliant on imported fuels, and less consuming of finite natural resources. The Energy Commission also promotes reduced energy consumption and increased efficiency through periodic upgrades to the building and appliance standards.

Building and Appliance Standards

The Energy Efficiency Standards for Residential and Nonresidential Buildings set minimum levels of insulation in new construction, regulate windows, and mandate installation of efficient equipment, appliances, and lighting. Changes to the standards occur in three-year cycles to coincide with changes to the complete building code, account for improvements in conservation technologies, changes in the cost of fuels and energy-conserving strategies, and

improved capabilities in analyzing building energy performance. The latest standards revision, mandated by AB970 (2000), emphasized peak demand savings and went into effect on June 1, 2001. New Outdoor Lighting Standards are targeted for adoption October 1, 2003.

The Commission coordinates the investigation of new Standards ideas through PGC-funded research by the utilities and their contractors. More than half of the new measures proposed for inclusion in the 2005 Standards are being tested and evaluated through the utilities' PGC-funded Codes and Standards support program.

Appliance Energy Efficiency Standards assure consumers that any appliance they purchase in California meets minimum state or federal efficiency levels. The Commission conducted an expedited rulemaking process in 2001 to respond to trends in electricity peak demand. The result was unanimous adoption on February 6, 2002 of a new set of efficiency standards. They include new or upgraded standards for residential central air conditioners, commercial air conditioners, refrigerated beverage vending machines, commercial refrigerators and freezers, exit signs, traffic signals, torchiere lighting fixtures, commercial clothes washers, and distribution transformers. Most of these new minimum efficiency standards became effective on March 1, 2003.

Programs

The Energy Commission received \$377 million in 2000-2001 legislative funding to implement programs that would provide "immediate benefits in peak energy demand reduction and more efficient use of energy."²² Twelve new program elements were launched under a broad program known as the Peak Load Reduction Program beginning in the fall of 2000. Roughly 565 MW of new peak savings had been installed as of December 31, 2002.²³ As these programs wind down, the Energy Commission's program emphasis is returning to public agency energy efficiency, industry and agriculture, and support for the building and appliance standards.

Public agency programs provide low interest loans and technical assistance for energy efficiency improvements in public and non-profit schools, hospitals, local governments, special districts and public care facilities. In 2003 the program entered into a \$30 million Revenue Bond agreement to further these efforts.

The Energy Commission participates in three U.S. Department of Energy programs. Two of them target industry and agriculture through demonstration of energy efficient and pollution prevention technology, and the development of technology roadmaps for food processing and other industries. The third federal program develops community partnerships to increase awareness of energy efficiency in existing buildings.

Energy Action Plan

California's principle energy agencies²⁴ joined together in early 2003 to create an Energy Action Plan which defines goals and actions to eliminate outages and excessive price spikes in electricity or natural gas. The goal of the Plan is to:

Ensure that adequate, reliable, and reasonably-priced electrical power and natural gas supplies, including prudent reserves, are achieved and provided

through policies, strategies, and actions that are cost-effective and environmentally sound for California's consumers and taxpayers.

The Action Plan specifies a "loading order" of energy resources to guide efforts to achieve the goal. Energy efficiency and conservation place are placed first in line followed by renewable energy resources and distributed generation as "preferred resources." Additional clean, fossil fuel, central-station generation is placed third, to allow the preferred resources "sufficient investment and adequate time to 'get to scale.'" The bulk transmission grid and distribution facility infrastructure will be improved at the same time to support interconnection of new generation.

The Action Plan designates six specific actions to decrease per capita electricity use through efficiency and conservation:

- Improve new and remodeled building efficiency by 5 percent.
- Improve air conditioner efficiency by 10 percent above federally mandated standards.
- Make every new state building a model of energy efficiency.
- Create customer incentives for aggressive energy demand reduction.
- Provide utilities with demand response and energy efficiency investment rewards comparable to the return on investment in new power and transmission projects.
- Increase local government conservation and energy efficiency programs.

Given the success of the combined state response in lowering consumption and peak demand in 2000-2001 and California's status as the state with the lowest per capita electricity consumption, it may seem as though achieving these goals through additional savings would be difficult. But research shows that California has much more potential for both electric and gas savings that could cost-effectively be achieved through existing technology, emerging technologies, and conservation behavior.

Additional Achievable Energy Savings

Future Energy Savings Available through Existing Technology

This section begins with a detailed discussion of future energy savings available from electricity. Additional achievable natural gas savings will be discussed at the conclusion of the section. Less detail is provided for natural gas because of several key data and methodological uncertainties.

Staff analysis and a leading research organization concur that a doubling of current energy efficiency expenditures statewide could reduce projected peak load by 1,700 to 1,800 MW in 10 years time – a 12 percent reduction in projected demand. In the report *California's Secret Energy Surplus: The Potential for Energy Efficiency*²⁵, Xenergy, Inc. evaluated both technically and economically feasible measures for reducing California's electricity use. The authors considered only measures that could be relatively easily substituted for, or applied to, already-installed technologies on a retrofit basis. Neither emerging technologies nor savings

that might be achieved through an integrated redesign of a building’s existing energy-using systems were considered for this study.

The authors evaluated the potential for energy savings under three future program investment scenarios:

1. continued current energy efficiency funding,
2. a 100 percent increase in current funding (the “advanced efficiency scenario”), and
3. a 400 percent increase in current funding (the “maximum efficiency scenario”).

“Maximum achievable potential” is defined as the amount of economic potential that could be achieved over time under the most aggressive program scenario possible.

Table 3 summarizes the results for these scenarios looking forward 10 years from 2001. For the Maximum Efficiency Scenario, Xenergy found the potential for 5,900 MW in savings in 10 year’s time. Given that peak demand in the state is projected to increase by approximately 10,000 MW by 2011, implementation of all cost-effective program potential (as represented by the Maximum Efficiency Scenario) would cut growth in peak demand by 50 percent.

Equally impressive are the estimated ancillary benefits from these investments in energy efficiency. The report findings indicate that increasing funding to energy efficiency programs would not only reduce consumption, but also capture billions of dollars in additional savings. By doubling the amount spent on efficiency programs, the state could save over \$15 billion on electricity costs, for a net savings of \$8.6 billion. If all of the 10-year achievable potential were captured, savings would exceed \$20 billion, for a net saving of \$11.9 billion.

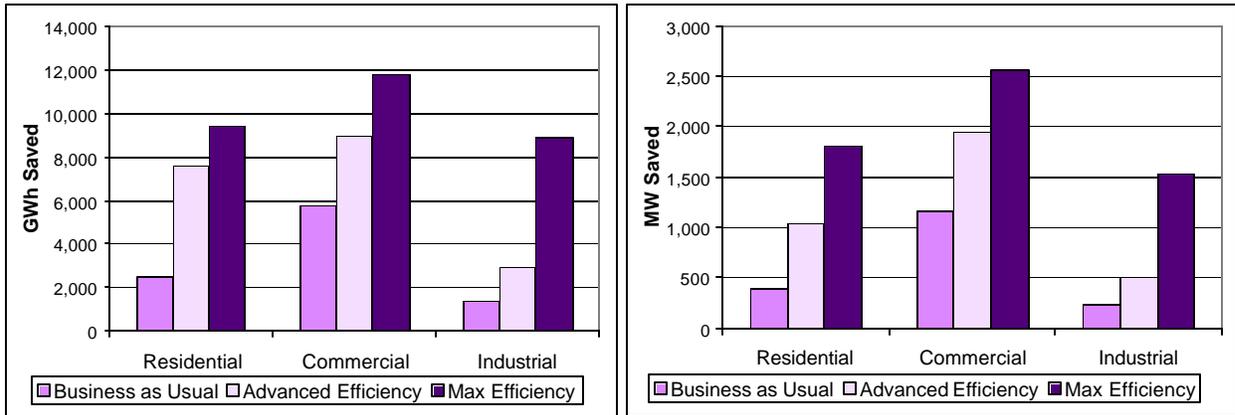
Table 3: Summary of 10-Year Net Achievable Energy Efficiency Potential (2002-2011)

	Business as Usual Scenario	Advanced Efficiency Scenario	Maximum Efficiency Scenario
Program Costs	\$2.003 Billion	\$4.663 Billion	\$8.196 Billion
Participant Costs	\$2.052 Billion	\$2.646 Billion	\$3.111 Billion
Total Costs	\$4.055 Billion	\$7.309 Billion	\$11.307 Billion
Estimated Benefits	\$9.604 Billion	\$15.949 Billion	\$23.203 Billion
Net Savings	\$5.549 Billion	\$8.640 Billion	\$11.896 Billion
GWh Savings	9,637	19,445	30,090
Net MW Savings	1,788	3,480	5,902

Note: Monetary values in billions of dollars. Present value of benefits over 20-year normalized measure lives for 10 program years (2002-2011), nominal discount rate = 3 percent, GWh and MW savings are cumulative through 2011.

Source: Xenergy, 2003

Figure 11: Net Achievable Savings by Sector



Source: Xenergy, 2002

Net achievable potential estimates by customer class for the period 2002-2011 are presented in Figure 11. The greatest economic potential for electricity savings lies with the commercial sector, the least with the industrial sector, and the residential sector lies between the two. Averaged across all three sectors, new construction accounts for roughly 10 to 15 percent of the estimated achievable savings potential.

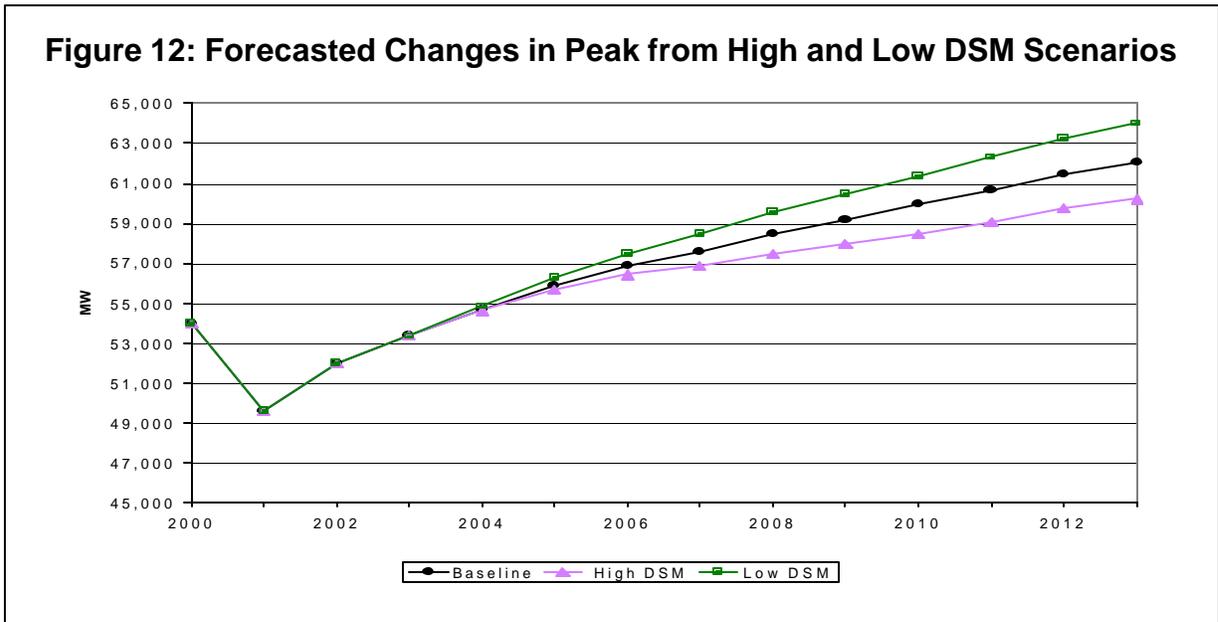
These findings point to a significant level of achievable and cost-effective potential for electric energy-efficiency savings over and above the Business-as-Usual approach, which holds current PGC funding levels constant. Capturing this additional achievable potential, however, would require an increase in existing PGC funding levels for energy efficiency programs.

Energy Commission staff used the results of this study in preparing its energy demand forecast, specifically for the evaluation of alternative DSM scenarios. Staff’s baseline forecasts for both electricity and natural gas demand assume current levels of funding for utility energy efficiency programs going forward. To estimate the effects on demand of increased investment in energy efficiency, staff used scenarios developed as part of a series of more detailed studies of energy efficiency potential in California underlying the Energy Foundation study.²⁶ Figure 12 illustrates these two scenarios compared to the baseline forecast.

The High DSM Scenario estimates the effect on demand of doubling the amount of energy efficiency spending statewide beginning in 2004 and continuing through 2013. Increasing PGC spending on electricity efficiency to \$572 million per year from \$240 million per year (based on average spending 1996-2000), reduces demand by about 1,800 MW in 2013. Eliminating all spending on energy efficiency after 2003 would increase demand in 2013 by 1,900 MW.

Shifting to natural gas, the potential estimates are divided into separate calculations by market sector. Increasing residential natural gas program spending over the next 10 years from \$230 million to \$380 million could save an additional \$208 million on natural gas costs, going from an estimated savings of \$317 million under current funding to \$525 million. Increasing commercial natural gas program spending over the next 10 years from \$74 million

to \$185 million could save an additional \$165 million on natural gas costs. Savings would increase from an estimated savings of \$143 under current funding to \$308 million. These



estimates are much more uncertain than the electric estimates because of data limitations.²⁷

Achieving the Potential Savings from Existing Technology

Achievement of this economic potential, under any of the funding scenarios, is tempered by other market realities, such as low customer awareness, high perceived costs, and lack of availability. A discussion of supporting policy directions that could help capture more of the available potential concludes this section.

Policies to Support Achievement of Potential Savings from Existing Technology

Buildings Sector Support

The stock of buildings built before any energy codes existed in California is quite large. The standards currently apply to these existing buildings only in a limited way, (e.g., when improvements are proposed that require a building permit). While 100,000 new dwelling units are built each year, about 1.4 million²⁸ dwelling units are renovated each year. Opportunities in the replacement market represent a very large energy savings and demand reduction potential for the state. Less than 25 percent of the HVAC equipment and less than 40 percent of the windows sold in California go into new construction.

Recognizing these opportunities, the Legislature passed Assembly 549 (Chapter 905, Statutes of 2001) which mandate the Energy Commission, with the assistance of the investor-owned utilities, to “investigate options and develop a plan to decrease wasteful peak load energy consumption in existing residential and nonresidential buildings.” A final report is scheduled to be delivered by December 2003, but this date may be extended to mid-2005. A mix of

strategies that emphasize voluntary and regulatory approaches to supplement current incentive programs is likely to be proposed. Programs could be directed at new market actors, such as real estate appraisers or title companies.

Further support in capturing additional potential savings could come through regional building standards. Federal appliance standards fall short of their optimal economic achievements in unique geographic regions such as California's Central Valley and the high deserts of Southern California. There is a need for either regional federal standards or easing federal preemption waiver criteria so that states could adopt region-specific standards. This is especially important for maximizing the savings from climate-sensitive heating and air conditioning equipment.

Collaboratives

The current public benefit programs offer several examples of partnership efforts between utilities and local governments, non-profit organizations, and trade associations. For example, programs targeting rebates for small business owners partner with vendors, community-based organizations and non-profit organizations. The Collaborative for High Performance Schools is another successful example of state government, utilities, and non-profit agencies working together for a common goal that includes energy efficiency as part of sustainable school design.

Incorporating energy efficiency into new office buildings must begin at the very earliest stages of project development. For new state buildings that would mean as soon as the annual Capital Outlay plans are released. In reviewing these plans, buildings over a certain size might be identified as candidates for energy reviews. A collaborative effort of a variety of state agencies would strengthen the effort.

The goal of reducing energy consumption could be aided by new collaborations across public benefit programs. Successful collaborations exist now between the Public Interest Energy Research and the utilities to demonstrate emerging technologies, and the Energy Commission's standards development process and the utility Codes and Standards program.

Expanding energy efficiency programs to include collaboration with distributed generation or renewable technology measures should also be considered. Such efforts have proven successful in other states, such as New York.

Leveraging Codes and Standards

The State has an outstanding record of capturing energy efficiency benefits of equipment in building and appliance standards. The information on how well this equipment is actually operated after installation is inadequate, however. Optimizing the potential savings from equipment means ensuring that it is installed properly and continues to be maintained and operated correctly over a useful life period. Increased program emphasis on quality installation of technologies, including diagnostic testing and field verification in the residential sector and commissioning and retro-commissioning in the commercial sector, is needed to leverage the full savings potential of measures included in the standards.

More attention to promoting efficient strategies for using equipment after it is installed is another way to enhance the value of the standards. For example, more efficient office

equipment is being purchased, but it is unclear whether the market is willing to do power management and manual shutdowns to fully utilize the savings potential.

Additional Savings Available from Adoption of Emerging Technologies

The potential for future energy savings, particularly peak demand savings, would exceed current projections if emerging technologies were considered. New research is fostering development of several new technologies including:

- Residential reflective roofing products
- Air conditioning equipment better optimized for homes in California's hot dry climates.
- Commercial air conditioning equipment that provide sufficient outdoor ventilation to maintain healthy indoor air more effectively, particularly in areas of high occupancy, such as school classrooms.

Equally important, public interest research is expanding the opportunities to reduce energy use and peak demand by moving beyond current technologies by developing new products and knowledge to support more efficient design, construction, and operational practices.

Possibilities include:

- New equipment design guidelines
- Construction protocols for quality construction practices
- Diagnostic tools and commissioning processes to identify and fix equipment and systems problems that prevent optimum efficiency for already installed and operating equipment.

Future Energy Savings Available from Conservation

Energy efficiency depends upon consumers' abilities to identify savings potentials, to select appropriate technologies, and to install and use them correctly. Studies of energy use behavior change during the 2001 crisis showed significant household conservation action, including efficiency investment. Based on studies by Lawrence Berkeley National Laboratory and the Energy Commission, it appears that 25-30 percent of the customer load reductions observed in 2001 were the result of energy efficient investment and on-site generation gains. Behavior changes contributed the other 70-75 percent of the observed load reductions in 2001.²⁹

Follow-up surveys by Dr. Loren Lutzenhiser in the fall of 2002 suggest that residential sector conservation is continuing, and that there is potential for additional consumer actions in the future. In terms of continuing conservation, findings include:

- Voluntary conservation continued to produce energy savings, with about one half of the 2001 crisis savings persisting in 2002, controlling for differences in weather between the two years.

- A majority of households reported a variety of continuing conservation actions in 2002. These ranged from retrofits to building shells, new appliance purchases, turning off lights and appliances, and continued non-use of air conditioning.
- While some consumers reported a decline in their conservation actions, others reported new efficiency choices, and the adoption of new conservation behaviors in 2002.
- The patterns of continued conservation behavior were segmented, with different consumer groups (e.g., homeowners, renters, hard-to-reach segments) continuing with different sorts of actions.
- Consumers reported continuing concerns about the California energy situation, a willingness to continue conserving energy, and a seriousness about their commitments. A large majority also supported continued action by government agencies and utilities to encourage and support energy conservation by households, businesses, and governments.

In terms of the potential for additional future savings, the studies suggest that:

- Consumers are clearly willing to respond positively to credible requests for demand savings in crisis or system emergency conditions. Many may have remembered earlier habits and patterns of energy savings that, even if subsequently stopped, could be readily recalled in an emergency situation.
- Nearly 3/4 of the households reporting purchase of new appliances during the past two years said that they took energy efficiency into account in making those choices.
- In terms of measured energy savings from residential conservation actions taken during 2001, the most significant individual impacts were associated with building shell improvements and voluntary non-usage of air conditioning.³⁰ Building improvements, improved cooling efficiency (higher efficiency air conditioning, non-air conditioner cooling), and improved shell/air conditioner management (both behavioral and automated) would seem to offer proven targets for future energy and demand savings.
- Relatively low levels of program and incentive recognition by consumers in both the 2001 and 2002 surveys suggest opportunities for better informational efforts in support of efficiency and conservation goals.

Discussion Topics for the Workshop: Challenges to Achieving Reliable Energy Efficiency

1) The Potential and Certainty of Energy Efficiency and Conservation

Energy efficiency has two major risk characteristics that are perceived to compromise its contributions to electric system reliability. 1) the impacts of efficiency are neither readily predictable nor easily quantifiable; and 2) energy-saving measures cannot be called upon as resources in real time. The next section will discuss how these two characteristics could be managed to increase the value of energy efficiency to the smooth functioning of a competitive market.

Predicting and Quantifying the Impacts of Efficiency to Reduce Risk

California is a leader in the nation in terms of energy efficiency policies and achievements. We have a public benefits funding system. We have strong complementary strategies between public benefit programs and the building and appliance efficiency standards. We have an excellent track record in measuring demand and estimating load growth. To utilize energy efficiency as a component of a procurement portfolio, however, will require greater assurances that the savings will be delivered. Efficiency impacts could be made more predictable and more readily quantifiable in three ways, 1) rigorous evaluation, 2) applying social science research, and 3) data collection.

Reducing Risk through Evaluation

A return to a more vigorous and defensible evaluation framework will be necessary, if energy efficiency is to be valued as a reliable resource. Evaluations should be used to estimate the load impacts (peak and annual energy savings) of programs and to estimate the uncertainty range around this point estimate. Monitoring, measurement, and verification of installations using established protocols will be increasingly important. Standard measures of performance, such as Energy Use Index or unit cost and cost savings, would enable comparisons across programs. Improved methods for measuring attribution of savings to programs would assist in fulfilling program goals, while avoiding double counting of savings. New methods and practices will be needed to measure the consumer response to impacts of demand response programs, including ongoing voluntary conservation efforts. Verifying not only what happened, but how those measures or changes in consumer behavior translated into load impacts by time period will be important.

Cost-effectiveness historically relies on point estimate program results that do not account for major uncertainties in the actual outcomes of the investments. Point estimates appear more precise than they actually are, and can discriminate against programs with riskier, but potentially better results.

Estimating the contribution of efficiency resources to the utility system portfolio and comparing their cost to other supply and demand options requires the development of new portfolio analysis tools. Such tools are necessary to look at the effect of marginal resource additions on grid reliability and overall system costs.

Reducing Risk through Social Science Research

The field of behavioral economics links economics with sociology, anthropology, psychology and other behavioral sciences in the study of decision-making. If energy efficiency is to be valued as a reliable resource, the application of this field to energy efficiency is necessary. Behavioral economics has been stimulated by the growing body of evidence that the standard economic model of rational behavior has serious shortcomings as a model of individual decision-making. For example, many key constraints that keep consumers from making energy-efficient choices are related more to asymmetric information and trust issues than first-costs.

Behavioral economics and other social science approaches offer the promise of a productive effort to understand the nature of energy-related decision-making as well as the nature and magnitude of the perceived under-adoption of energy-efficient practices and technologies. Most measure level savings can be reduced or lost if the customer is not motivated to maintain the equipment or behavior. Understanding what types of media, information materials, or other messages resonate with consumers could lead to higher persistence of load impacts.

Reducing Risk through Data Collection

One of the most valuable lessons of the last thirty years is that analyzing how people use energy and how energy use changes over time can yield valuable policy insights. Demand and load forecasts provide the basis for energy policy decisions and financial resource allocations. Energy load forecasts determine future energy supply-demand balances. Demand analysis is used to evaluate conservation potential, develop energy efficiency policies and programs, and to estimate the amount of conservation that can be relied upon when supplies are short. Forecast and demand analysis tools evaluate consumer reactions to new time-varying rate designs.

The complexity of the new energy market is imposing additional requirements for data. Energy Commission assessments will be the basis for resource adequacy planning and procurement activities. Shorter time horizons for forecasts are important. Forecasts for smaller regions than utility planning areas are needed, particularly for targeted energy efficiency in transmission-deficient areas. Forecasts could be improved by a more complete understanding of the contribution of various end-uses to historical growth in annual energy consumption and peak load, particularly in the commercial sector. Data requirements for these new types of analyses include:

- Load data from utilities and other market providers
- Site-specific interval meter data
- End-use characteristics in all market sectors
- Saturation data for energy-using equipment
- Market tracking data to estimate penetration of efficient technologies
- Consumer behavior
- Equipment operational patterns and practices
- Geographic and seasonal detail for supply-demand congestion assessments
- Natural gas storage data plus flow and price data for strategic points (e.g., Topock)

Making Energy Efficiency More Responsive in Real Time

Historical achievements of past energy efficiency programs and current market data suggest that a large fraction of California's anticipated load growth over the next decade can be displaced through a combination of energy efficiency, pricing reforms, and load management programs. A number of energy efficiency and shorter term demand response activities could

be designed and implemented to complement or coordinate with each other, both in the short-run and the long-run. Some promising approaches that would permit program synergies between energy efficiency, demand response, and distributed generation include:

- increasing the focus on peak load-reductions in energy efficiency programs;
- coordinated marketing, information, education, and implementation;
- assessing facility equipment and operations;
- introducing new technology opportunities; and
- integration of efficiency with dynamic pricing and metering.

The first two of these approaches contributed to the successful reduction of both energy use and peak load in 2001. Current investor-owned utility programs should continue to combine the synergies of peak load as well as longer-term market orientation. State policy would need to continue to support some form of coordinated informational efforts that actively encourage purchase of energy-efficient products and services as well as keep conservation and efficiency in the public's mind.

Energy efficiency programs can increase opportunities for short-term callable demand response by targeting equipment that enables these actions, (e.g., dual lighting switches, dimmable ballasts, lighting controls and sensors, energy management control systems, and HVAC controls and equipment). Increasing the deployment of communications-controlled appliances and equipment could be an additional focus of energy efficiency programs.

The most promising technology innovations for both energy efficiency and demand response involve pricing and metering. Dynamic pricing strategies should increase interest in energy efficiency to reduce end-use peak loads that are both coincident with high cost periods and harder to shift, like space cooling and refrigeration. For end-use loads that are easier to shift, like laundry, dishwashers, and pool pumps, however, energy efficiency may be less economically valuable to the consumer when usage could be shifted to cheaper off-peak prices than in the current rate structure.

Successful load shifting via dynamic pricing depends upon: 1) getting the prices right in the first place, 2) consumers' willingness to adopt dynamic rates (unless imposed), 3) their responsiveness in conserving energy in the short run, and/or 4) their adopting efficiency technologies with demand responsive characteristics. While not specifically examining consumer views on demand response, the findings from the 2002 household survey and other research by Lutzenhiser are relevant to policy and energy savings potentials in this area.³¹ The research shows that:

- Overall energy costs are of concern to consumers, but detailed price information was not seen as particularly important.
- Residential customers in California have shown a willingness to conserve, particularly under exceptional circumstances.
- Consumers recognize that energy systems problems have become a fact of life, therefore, they can, in effect, be "demand responsive."

- Consumer concerns about affordable energy services would suggest that dynamic pricing policies would have to provide demonstrable bill savings to consumers.
- Time-of-use rate experiments show fairly universal acceptance of time-of-use rates and associated shifts in demand, but also fairly low rates of volunteering for such programs.

If customers get price signals, it will be much easier to structure programs to reduce load on peak rapidly. A universally imposed rate may be required to achieve desired savings. Unwanted equity impacts and unanticipated costs also may occur as risk is shifted to the individual consumers under dynamic pricing. The more familiar benefits of simple load control energy efficiency devices, such as remote air conditioning and pool pump cycling devices, could be lost to consumers.

A statewide test of dynamic pricing for residential and small commercial customers sponsored by the state's investor-owned utilities, state energy agencies, and consumer groups will be testing some of these concerns starting mid-2003. The pilot test is designed to monitor customer energy use in response to different time of use rates or critical peak "price" signals over a 12 to 18 month period for a stratified sample of 2,500 customers. This research will help answer many of the policy questions associated with determining the most effective combination of energy efficiency, dynamic pricing, and load management.

2) The Need for Goals to Fulfill the Potential for Energy Efficiency and Conservation

This section describes actions of other states in setting goals for energy efficiency and reviews a variety of different metrics for goals. A discussion of the goals and actions in the Energy Action Plan follows. The section concludes with a discussion of methods for developing an energy efficiency program funding level.

Goals for Energy Efficiency and Conservation

Energy Efficiency Public Program Policy Goals

A recent survey of state public benefit programs identified a variety of goals for ratepayer-funded energy efficiency programs. The two most common goals proved to be resource acquisition and market transformation.³² The authors of this study conclude that the two goals, while not mutually inconsistent, do result in different kinds of efficiency program designs and different approaches to measurement of results. Less common goals for public benefit programs were environmental improvements (e.g., program specifically targeted to reduce use that particularly impacts air quality) and economic development goals (e.g., process improvements in older manufacturing sites).

The PUC established new energy efficiency program goals in awarding funding for 2002-2003.³³ The priority order of the goals, outlined as criteria for program proposal selection, are: long-term annual energy savings, cost-effectiveness, addressing market failures or barriers, equity considerations, electric peak demand savings, innovation, and synergies and coordination with programs run by other entities. With these criteria, the PUC seeks to

achieve a balanced portfolio of programs in all sectors, with particular emphasis on residential and small businesses.

Metrics for Quantified Energy Efficiency Goals

The State has adopted a goal in the renewable energy sector. The Energy Commission and the PUC have adopted or are adopting various vision statements for distributed generation and demand responsiveness. While there are visionary policy statements supporting cost-effective energy efficiency and specific efficiency actions in the Energy Action Plan, the state's energy agencies have not formulated a specific target for per capita consumption.

At least twelve states have adopted Renewable Portfolio Standards, but only three states have a state target for energy efficiency. Each of these states uses a different metric to assess progress toward the goal. New York's target, for example, is reflective of the policy objective to build a competitive energy services market.

An energy efficiency metric is dependent on the policy objective. Is the objective economic well-being, higher productivity, increased employment and income, resource conservation, or improved environmental quality? Different objectives call for different indicators. From the global warming perspective, absolute carbon emissions are the most important indicators. If economic productivity is the policy objective, then energy expenditures per dollar of Gross State Product might be a more suitable indicator.

Other States' Efficiency Targets

Texas: A 10 percent reduction in system load through energy efficiency programs by January 1, 2004. Fuel switching and renewable technologies are eligible.

New York: An energy efficiency target of a 25 percent reduction below 1990 primary energy use/unit of Gross State Product by 2010. A 35 percent reduction in state building energy use by 2010; along with a 10 percent increase in renewable power by 2005, going up to 20 percent by 2010.

Iowa: A 10 percent reduction in overall end-use of energy through energy efficiency and conservation.

California's economy tends to move out of step with the rest of the nation. Our economic recoveries tend to lag other states, and our growth rates tend to outpace them. Using an indicator such as Gross State Product would magnify the affects of technology boom and bust cycles. Whereas California's Gross State Product is typically highly variable, employment is much more stable. Given California's situation, a measure of savings per unit of employment may provide a better metric.

Examples of four different metrics for measuring savings combining both historic and forecast data are provided in Appendix A of this paper: consumption per capita, peak demand per capita, consumption per Gross State Product, and consumption per employment (jobs) (Figures 13-16). Two "per Capita" examples are included to illustrate that peak demand would be an inappropriate metric given its weather-dependent nature. Peak demand needs to be weather adjusted. Weather-adjusted peak data is available only from 2000 going forward. Additional work would be required to create a historical record of weather-adjusted peak data.

Commission staff is interested in opening a discussion at the workshop or receiving written input on the usefulness of metrics such as these in an integrated resource planning

framework. Are these metrics useful for establishing an overall state energy efficiency target?

Energy Action Plan Goals

The overall Action Plan goal calls for optimizing energy efficiency to meet California's energy needs in ways that are cost-effective and environmentally sound. The Action Plan proposes actions to improve air conditioner efficiency by a target of 10 percent above federally mandated standards and improve new and remodeled building efficiency by 5 percent – a target which is based on the Energy Commission's 2005 building standards. California has had great success with its buildings and appliance standards in the past, and should continue to pursue standards as a means of pushing the development and installation of higher efficiency products and buildings.

These measures are important for achieving California's efficiency potential, but alone are not sufficient. Even if California is granted a waiver from the federal air conditioner standards and is able to implement a standard more stringent than the federal standard, the Energy Commission's 2005 building and appliance standards combined are projected to reduce the growth in California's electricity peak by less than 250MW in the year 2013. While not insignificant, this is less than 5 percent of the achievable peak savings.

What is the “Right” Amount of Funding for Energy Efficiency?

The larger resource planning issue of how much energy should be purchased through the public good process is difficult to answer. The detailed potential studies conducted by Xenergy identify cost-effective maximum achievable savings at funding levels that range up to 300-450 percent over current public benefits funding. The Energy Commission DSM scenario analysis used a 100 percent increase as a comparison to continuing with business-as-usual funding. The procurement proposals from the investor-owned utilities include funding increases between 66-75 percent of current funding.

Developing an estimate for the “right” amount of funding could follow any one of four options that have been used in California at one time or another:

- Method 1: Make program funding decisions on the program savings results from the previous three-five years using cost-effectiveness tests such as the Total Resources Cost test.
- Method 2: Attempt to model how much energy efficiency is needed as part of a procurement cost exercise which values least-cost resources.
- Method 3: Look at historical funding patterns and decide if more savings are needed based on an assessment of energy market conditions in the next five years.
- Method 4: Use conservation supply curves to fund programs until the expected avoided supply costs are reached.

Staff would like to hear discussion at the workshop or receive input on the relative merits of these options in an integrated planning environment.

3) Delivering Energy Efficiency More Effectively

What is changing the most about publicly supported energy efficiency programs nationwide is their structure and delivery, according to research completed by the American Council for an Energy-Efficient Economy. A variety of organizational approaches are being taken, the form being a function of “a state’s individual circumstances, regulatory structure, experience with DSM, and politics.”³⁴

Organizational Issues

Changes in the structure and delivery of public benefit programs in California remains a work in progress. A discussion of how California might alter its current administrative structure is currently slated to be part of the PUC’s R.01-08-028. California has been proceeding on an ad hoc basis for six year. The process of integrated resource planning would be aided by adding certainty to the administrative structure for public benefit programs. A full exploration of potential structures and administrators will take place in the PUC’s rulemaking. Examples of policy directions for an administrative structure that could aid in achieving a larger share of energy efficiency’s potential include:

- Identification of a state five-year goal for efficiency that is tied to an appropriate policy metric.
- A consistent schedule for program planning and a 3-4-year time horizon for delivery.
- A diverse set of program implementers or administrators to add the local expertise of community-based organizations and local governments and the business relationships of trade organizations to utility program experience.
- Support for innovative strategies, delivery agents, and communication channels in the organizational structure with some tolerance for risk of failure.
- Well-designed administrator incentives tied to achievable short- and long-term goals, with flexibility in the strategies proposed to achieve them.
- Inclusion of more components of the state’s public benefits portfolio, including PIER programs, renewable programs, utility public-goods-charge programs (investor-owned and municipal), state government programs, and building and appliance standards, in a collaborative planning process.
- Independent evaluation that incorporates both rigorous measurement and verification of savings and continuous improvement of programs.
- Strategic research to enable programs to be responsive to changing circumstances and market conditions.

Public Benefit Administrative Models from Other States

Not all state public benefit programs look alike. The American Council for an Energy-Efficient Economy undertook a national review and assessment of public benefit programs in 2000 which sorted administrative styles into three basic categories: 1) utility administration; 2) independent administration by a government or other non-utility entity; and 3) a “hybrid” approach.³⁵

Eighteen states had established public benefit programs at the time of this research. A total of 7 states had individual utilities administering energy efficiency programs. Some type of collaborative advisory process is present in several of these states.

Six additional states had chosen an independent entity of some type to administer energy efficiency programs. Four used a state government agency, while two others opted for a competitively selected administrator, typically a non-profit agency.

“Hybrid” public benefit efficiency programs, such as California’s, are administered by the utilities, but generally with some amount of direction and oversight from state regulators, who set guidelines, review and approve utility program plans, and grant final approvals. The amount of direction and oversight in these five states can vary from substantial to administrative only.

While none of these models may be completely suitable for California’s complex market infrastructure, the achievements and lessons of these alternative models may be useful in a planning process. A combination of models may be appropriate for achieving different policy objectives.

OTHER STATE MODELS

Vermont (Independent Entity): Vermont administers all ratepayer-funded public benefits energy efficiency using an “energy-efficiency utility” model. This model, referred to as “Efficiency Vermont,” uses a single, statewide non-utility entity to centralize administration of all energy efficiency efforts. “Efficiency Vermont” operates under contract to the Vermont Public Service Board (PSB). Energy efficiency surcharge collections go directly to a PSB fiscal agent, never becoming funds of the state. Efficiency Vermont acts as an independent contractor to the state under a detailed contract which includes policy guidance, legal and accounting rules, and performance measures. The responsibility for program design, marketing, delivery lies entirely with Efficiency Vermont, which has wide latitude in program design and implementation. The Vermont Department of Public Service, which coordinates with the PSB on efficiency policy, has responsibility to review the savings claims and assess market potential.

Wisconsin (State Entity): Wisconsin’s “Focus on Energy” represents a transition from a utility-delivered resource acquisition program to a government-overseen market transformation program. The Wisconsin legislature directed that the existing utility energy efficiency and renewable energy programs transition to the state Department of Administration (DOA) over a three-year period ending in 2002. The role of the DOA is to specify outcomes for the various program components, but to leave the detailed program design and implementation proposals to contracted nonprofit program administrators. A further DOA responsibility is to work closely with its program administrators and evaluation contractor to measure performance and assess outcomes. Focus on Energy contains a clear market transformation orientation and considers a full range of benefits; however, there is tension with the more traditional resource acquisition goals.

OTHER STATE MODELS (Continued)

New Jersey (Utility Administration): In 1999, New Jersey enacted the Electric Demand and Energy Competitive Act, which mandated funding for energy efficiency and renewable energy programs. In 2001 the New Jersey Board of Public Utilities commissioned the state's seven electric and gas utilities to deliver a single set of market transformation programs. The utilities work collaboratively with the National Resources Defense Council and a panel of national energy efficiency experts.

New York (Semi-Independent State Agency): In its transition to a competitive retail electricity market in 1996, New York established a System Benefit Charge to fund public benefit programs in energy efficiency, low-income energy affordability, R&D, and environmental protection. Administration of these programs is delegated to the New York State Energy Research and Development Authority (NYSERDA) and offered under the name New York Energy Smart™. A Memorandum of Understanding formalizes the operating relationships between NYSERDA, the New York Public Service Commission, and the New York State Department of Public Service. An advisory group serves to review implementation plans and guide program evaluation.

Conclusions

Energy efficiency and conservation are a key component of our future ability to permit healthy economic growth. Efficiency and conservation have enormous benefits: they reduce electric and natural gas load growth; contribute to flexibility and adequacy of the electric and natural gas systems; offer consumers control over their energy use; offer economic contributions to the Gross State Product; and provide environmental benefits in the form of reduced air emissions and water savings. While many efficiency activities can realize all of these benefits to varying degrees, it is necessary to decide which benefits are the most significant for the current situation. This will determine how much of the estimated efficiency potential California should pursue and direct the efforts to formulate policy direction for energy conservation and efficiency program design and implementation.

Commission staff offer the following findings based on this review and analysis:

1. Given the apparent cost-effective opportunities remaining, DSM potential should be weighed along with generation, transmission, and storage options in developing the *Integrated Energy Policy Report's* integrated infrastructure outlooks.
2. If we are to move beyond short-term solutions and begin to improve market signals so that emergency measures are no longer required, policies will be needed to help protect against economic shocks and inequities to consumers as we move toward new market structures. Energy efficiency programs will need to:
 - Help consumers understand new rate structures and how energy efficiency and price responsiveness strategies could benefit them;
 - Identify the most viable demand strategies for different market segments;
 - Support testing and promotion of technologies to allow end users to easily respond to high energy prices; and
 - Help consumers protect themselves from surprise bill risks.

3. If energy efficiency is to be used effectively as part of a resource portfolio, more rigorous measurement and evaluation, emphasizing savings estimates and associated uncertainties will be needed to assure its adequacy.
4. In order to provide robust analyses for resource adequacy planning and procurement activities, forecasts will need to cover shorter time-horizons and more geographically-specific areas, such as transmission planning areas. Data collection efforts and analysis will need to be expanded to support these forecasts and resource analyses.
5. Because occupant behavior is a strong driver of many building end-uses, a better understanding of how occupants interact with buildings and equipment is needed. Support for social science research as part of measurement and evaluation activities would need to be supported.
6. If the full benefits of energy efficiency are to be realized, administrative certainty for public benefit programs is needed. Support for local government and other non-profit groups to fill market needs that are not being met should be continued. A combination of administrative models may be appropriate for achieving different policy objectives.
7. New collaborative efforts between energy efficiency public purpose programs and other public purpose areas, such as renewables should be supported. Legislative support may be needed to allow ratepayer funding to be used on collaborative efforts between areas such as efficiency and renewables.
8. Regional federal energy appliance standards or less stringent criteria for obtaining a waiver from federal preemption would optimize the economic benefits and energy savings potential for building and appliance standards in unique geographic areas.
9. Given that more than three-quarters of California's existing housing stock was built before Title 24 buildings standards were in force, this market is a natural target for aggressive action. A variety of strategies that emphasize both voluntary and regulatory approaches to supplement current incentive programs would be appropriate.
10. Much less is understood about end-use energy consumption of natural gas compared to electricity.

End Notes

¹ For details see *California Energy Demand 2003-2013 Forecast*. February 11, 2003. Staff draft report, 100-03-02SD.

² Rufo, M. and F. Coito. 2002. *California's Secret Energy Surplus: The Potential for Energy Efficiency*. Final report prepared by Xenergy Inc. for The Energy Foundation and The Hewlett Foundation.

³ 2003 CEC Energy Demand Forecast

⁴ 2003 CEC Energy Demand Forecast

⁵ 2003 CEC Energy Demand Forecast, p. C-9

⁶ Nearly half of the total gas consumed in California is used in generating facilities. The percentages used here are percentages of direct use.

⁷ California Energy Demand 2000-2010. Staff Report. P200-00-002.

⁸ California Energy Demand, 2003-2013. Revised Staff Draft Report.

⁹ Brown, R.E. and J.G. Koomey. 2002. *Electricity Use in California: Past trends and Present Usage Patterns*. Review draft submitted to *Energy Policy*.

¹⁰ 2003 CEC Energy Demand Forecast

¹¹ *California Statewide Commercial Sector Natural Gas Energy Efficiency Potential Study. Draft Report*. January 14, 2003. Prepared by Xenergy Inc. for Chris Ann Dickerson, Project Manager, PG&E.

¹² A detailed history of the public benefit programs is provided in: Office of Ratepayer Advocates. 2002. *The Public Purpose Energy Efficiency Surcharge: Trends and patterns in the Costs and Benefits of Utility Administered Energy Efficiency Programs*. Public Utilities Commission.

¹³ See page. 1-1 of the Office of Ratepayer Advocates report cited above.

¹⁴ *CPUC 2001 Energy Efficiency and Conservation Programs*. December 2001. Report to the Legislature. Prepared by the Energy Division. p.4.

¹⁵ For a multi-state review of “reliability-focused energy efficiency programs” implemented in the summer of 2001, see Kushler, M., E. Vine, and D. York. 2002. *Energy Efficiency and Electric System Reliability: A Look at Reliability-Focused Energy Efficiency Programs Used to Address the Electricity Crisis of 2001*. Washington D.C.: American Association for an Energy Efficient Economy.

¹⁶ For a complete listing see Appendix A in: Global Energy Partners, LLC. 2003. *California Summary Study of 2001 Energy Efficiency Programs*. Final Report. Submitted to Southern California Edison and The California Measurement Advisory Council.

¹⁷ The California Independent System Operator covers 84 percent of the state.

¹⁸ Global Energy Partners, LLC. *California Summary Study of 2001 Energy Efficiency Programs*.

¹⁹ Programs outside the scope of coverage included demand responsiveness programs, load-shifting programs, low-income programs, renewables programs, smaller municipal utilities, and code changes. The impacts of the 20/20 program and *Flex Your Power* program were included.

²⁰ Kushler, *Using Energy Efficiency to Help Address System Reliability*

²¹ See Lutzenhiser, L. S. Bender and M. Gossard. 2002. "Crisis in Paradise: Understanding the Household Conservation Response to California's 2001 Energy Crisis," in Proceedings of the 2002 ACEEE Summer Study on Energy Efficiency in Buildings. Washington D.C.: American Council for an Energy Efficiency Economy; Lutzenhiser, L., et. al. 2003. *Household Energy Use as a Result of the California Energy Crisis*. Draft report in progress for the California Energy Commission; and Goldman, C., J. Eto and G. Barbose. May 2002. *California Customer Load Reductions during the Electricity Crisis: Did they Help to Keep the Lights On?* LBNL-49733. Lawrence Berkeley National Laboratory.

²² Senate Bill 5x, Section 1 (c). (Statutes of 2001)

²³ For a full description of the program elements see: *Final 2002 Report: Evaluation of the California Energy Commission's AB29x and SB5x Peak Load Reduction Program Elements*. May 5, 2003. Prepared by Nexant for the California Energy Commission and the California State Legislature. Commission Publication 400-09-070.

²⁴ The three agencies are the Consumer Power and Conservation Financing Authority, the Energy Commission, and the Public Utilities Commission.

²⁵ Produced by Xenergy for The Energy Foundation and The Hewlett Foundation, 2002

²⁶ *California Statewide Commercial Sector Natural Gas Energy Efficiency Potential Study, Study*. Draft Report. 2 vols. Study ID #SW039A. Prepared for Pacific Gas and Electric Company. Oakland: Xenergy.; *California State Residential Sector Energy Efficiency Potential Study, Final Report*. Study ID#SW063. Prepared for Pacific Gas and Electric Company, Oakland: KEMA-XENERGY. April 2003; *California Statewide Commercial Sector Energy Efficiency Potential Study*. Final Report. 2 vols. Study ID #SW039A. Prepared for Pacific Gas & Electric Company. Oakland: Xenergy. These studies used Energy Commission data as the foundation of their analyses, so the results are largely consistent with the assumptions embedded in Energy Commission staff's baseline forecast and DSM scenario analysis

²⁷ These estimates are drawn from the commercial natural gas and residential studies cited above.

²⁸ This is based on an estimated 12 percent of the housing stock being renovated annually, and a stock of approximately 12 million units.

²⁹ See Lutzenhiser (2003) and Goldman (2002) cited above.

³⁰ Controlling for the effects of other factors, including weather, dwelling size, income, appliances, and household composition.

³¹ For a review of these findings, see Lutzenhiser, L., et al. 2003 *Time for Time-of-Use: A Review of residential Dynamic Pricing Issues*. Work in progress for the California Energy Commission.

³² Harrington, C. and C. Murray. 2003. *Who Should Deliver Ratepayer Funded Energy Efficiency: A Survey and Discussion Paper*. Montpelier, VT. The Regulatory Assistance Project. May 2003. pp. 7-9. (<http://www.raonline.org>)

³³ Public Utilities Commission. November 29, 2001. *Interim Opinion Adopting Energy Efficiency Policy Rules*. Decision 01-11-066. pp. 5-7.

³⁴ Kushler, M. and P.Witte. 2000. *A Review and Early Assessment of Public Benefit Policies Under Electric Restructuring, Volume 2: A Summary of Key Features, Stakeholder Reactions, and Lessons Learned to Date*. Washington, D.C.: American Council for an Energy-Efficiency Economy. P.12.

³⁵ Kushler, M. and P.Witte. 2000. P.iv.

APPENDIX

Figure 13: Net Peak Demand per Capita

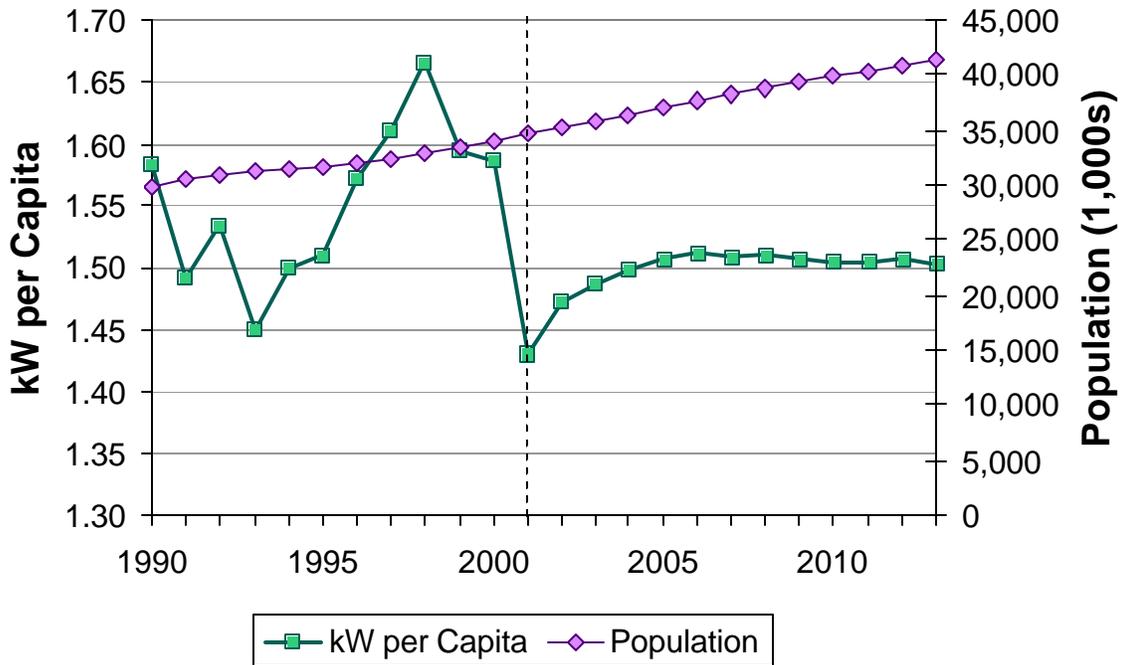


Figure 14: Electricity Consumption per Capita

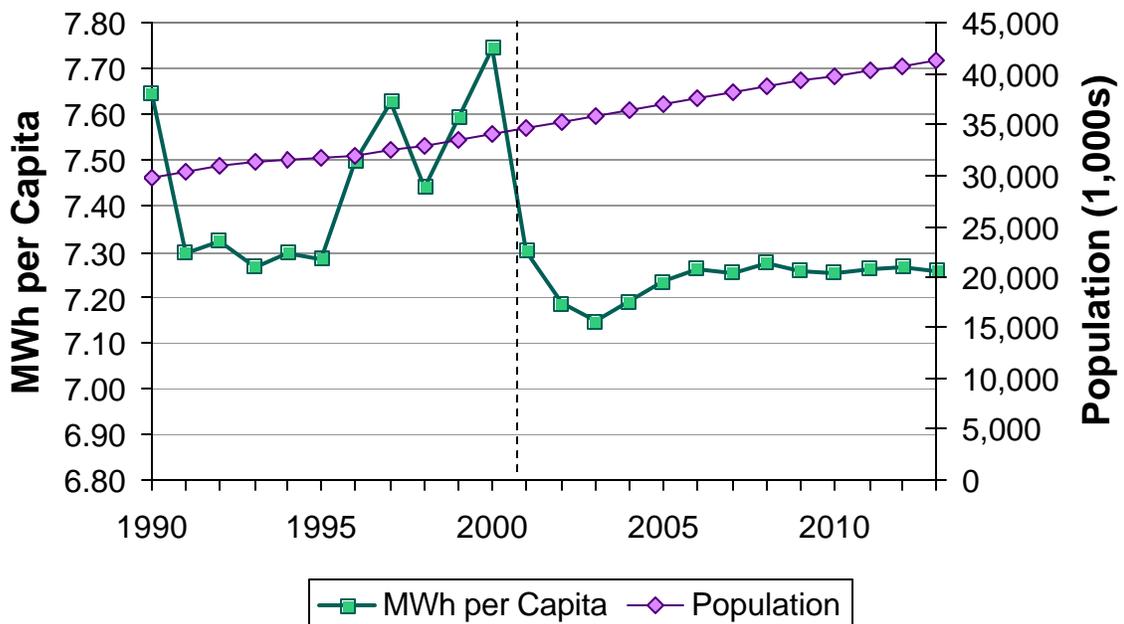


Figure 15: Electricity Consumption per Million Dollars Gross State Product (\$2001)

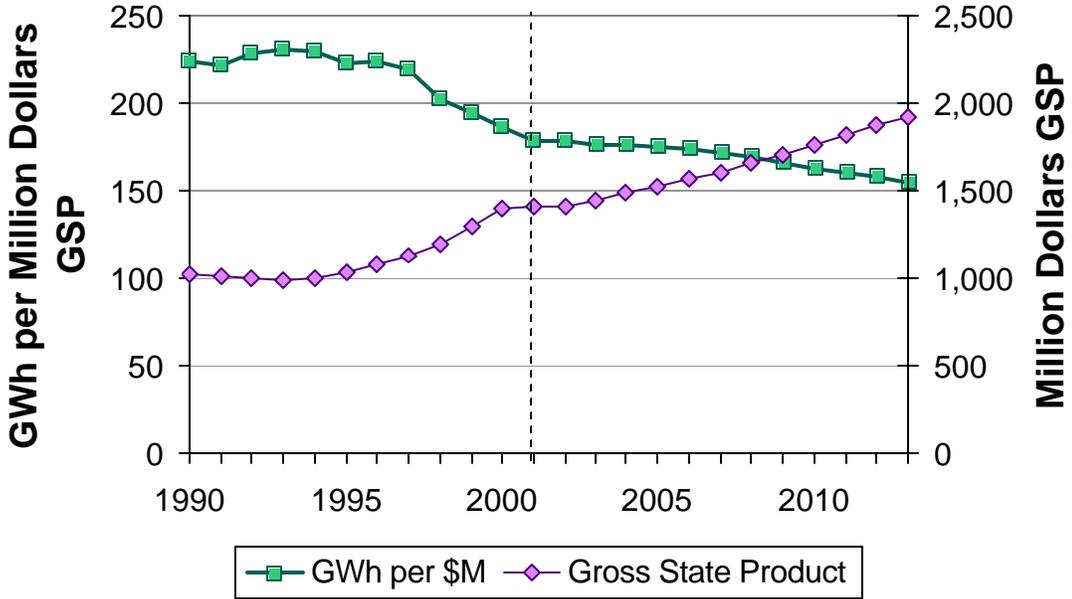


Figure 16: Electricity Consumption per 1,000 Jobs

