California's Secret Energy Surplus

The Potential for Energy Efficiency

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MICHAEL RUFO AND FRED COITO

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TOWARD A SUSTAINABLE ENERGY FUTURE

California's Secret Energy Surplus:

The Potential For Energy Efficiency

FINAL REPORT

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XENERGY is an energy consulting, information technology and energy services firm headquartered in Burlington, MA with offices in Oakland, CA and across the country. Founded in 1975, XENERGY is part of the KEMA Consulting Group, an international consultancy providing technical and management consulting services to the electric and gas industry. KEMA Consulting is a wholly-owned subsidiary of KEMA NV, headquartered in Arnhem, The Netherlands.

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This study estimates potential energy and peak demand savings from energy-efficiency measures in California. In contrast to energy conservation, which often involves short-term behavioral changes, energy-efficiency opportunities are typically physical, long-lasting changes to buildings and equipment that result in decreased energy use while maintaining constant levels of energy service. It was recently estimated that roughly 70 percent of California's peak demand reduction in the summer of 2001 is attributable to short-term conservation behavior rather than long-lasting efficiency improvements (Goldman et al. 2002). Our study shows that significant additional and long-lasting *energy-efficiency* potential exists.

ES.1 Study Scope

As a result of California's conscious efforts to fund and promote energy efficiency through programs and state standards since the mid-1970s,[1] the state was already the most efficient in the country in terms of per capita electricity use prior to the recent energy crisis. Since then, the state has faced supply shortages, rate increases, price volatility, and future price and supply uncertainty—all of which have combined to warrant comprehensive analysis of energy-efficiency potential. This study focuses on assessing electric energy-efficiency potential in all sectors in California. The study assesses technical, economic, and achievable potential savings over the mid-term, which we define as the next 10 years, and is restricted to energy-efficiency measures and practices that are presently commercially available. This study leverages recent work conducted by the major investor-owned utilities in California and the California Energy Commission. These studies provided an extensive foundation for estimates of potential in existing commercial and residential buildings. The current effort would not be possible without these recent underlying studies. To expand coverage to all sectors and vintages in the state for the 10-year forecast period, significant additional work was conducted to estimate potentials for the industrial sector and for new buildings constructed between now and 2011.

ES.2 Key Findings

If all measures analyzed in this study were implemented where technically feasible, we estimate that overall technical peak demand savings would be close to 15,000 megawatts (MW). If all measures that are economic were implemented, potential peak demand savings would amount to roughly 10,000 MW. Because achieving efficiency savings requires programmatic support, we estimate savings under several future investment scenarios. As shown in Figure E-1, net program peak savings potential ranges from roughly 1,800 MW under current funding (Business-as-Usual) to 3,500 MW if funding is doubled (Advanced Efficiency), to 5,900 MW if funding is

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[1] It is estimated that California's efficiency standards and programs have saved roughly 10,000 MW (the equivalent of 20 large power plants) over the past 25 years (California State and Consumer Services Agency 2002).

quadrupled (Maximum Efficiency). In Figure E-2, we show how achieving the energy-efficiency savings identified in this study would affect forecasted peak demand in the state. Without energy-efficiency programs, projected peak demand in the state is expected increase from around 53,000 MW today to rough 63,000 MW by 2011. With implementation of all cost-effective program potential, we estimate that growth in peak demand could be cut in half.

Figure ES-1

Potential Efficiency-Based Reductions under Increasing Program Funding

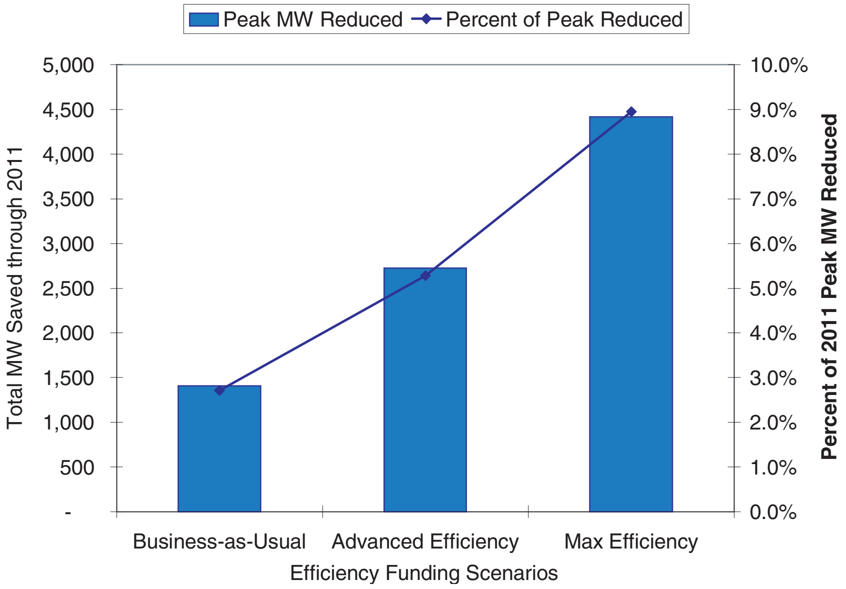
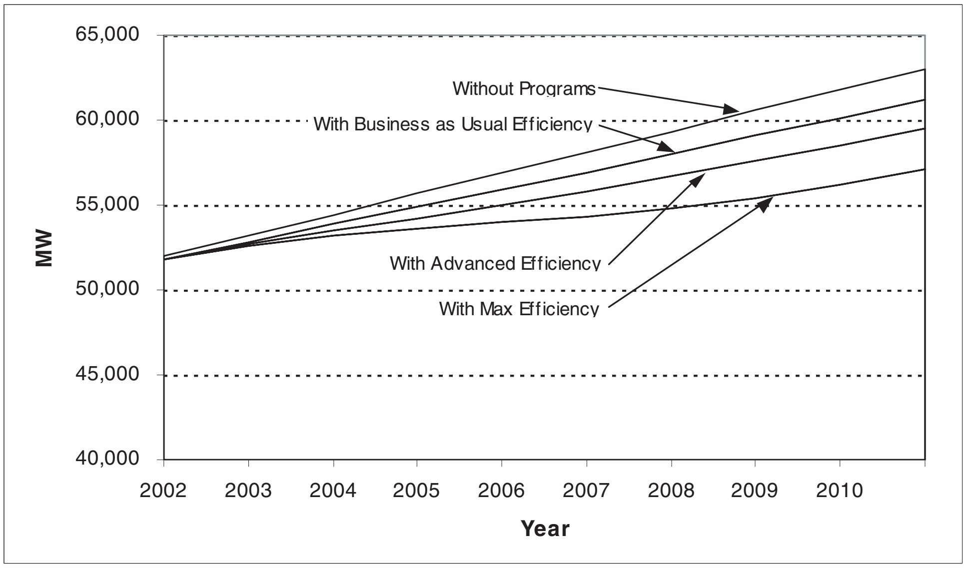


Figure ES-2

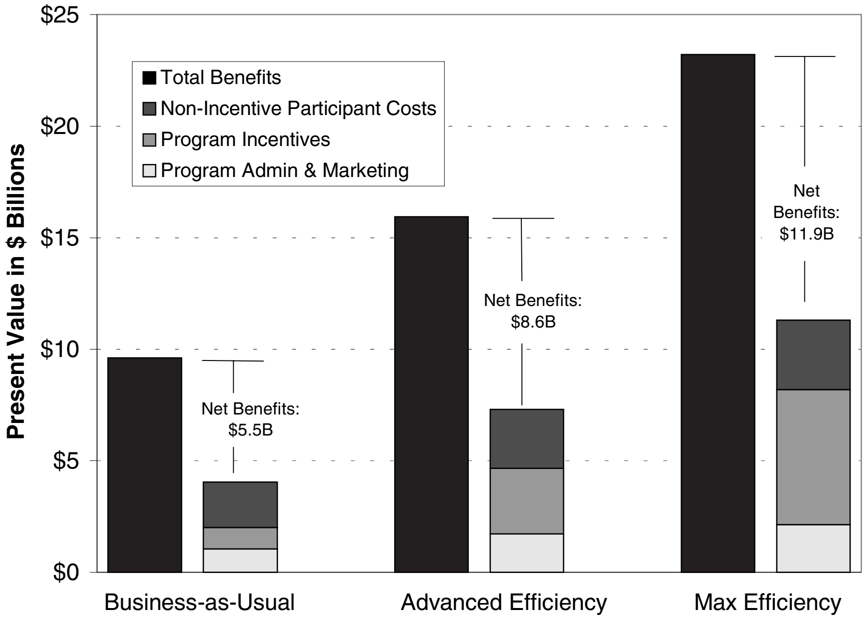
California Peak Demand Forecast and Efficiency Potentials



We estimate that more than $2 billion would be spent on programs to promote efficiency in California over the next 10 years if current efficiency program spending levels continue—an investment projected to yield roughly $5.5 billion in savings. Further, the study shows that increasing funds for these programs would not only reduce consumption, but would also capture billions of dollars in additional savings. As shown in Figure E-3, by doubling the amount spent on such programs, the state could save over $15 billion on electricity costs, at a net savings of $8.6 billion. If all of the 10-year achievable potential were captured, savings would exceed $20 billion, with net benefits of $11.9 billion. Efficiency potential is also analyzed in this study under several alternative forecasts of future energy supply costs. Efficiency potential is shown to be robust across a wide range of plausible future energy supply costs.

Figure ES-3

Benefits and Costs of Electric Energy-Efficiency Savings—2002 to 2011*



*Value of benefits and costs over life of measures, nominal discount rate = 8 percent, inflation rate = 3 percent.

The results of this study demonstrate that energy-efficiency resources can play a significantly expanded role in California's electricity resource mix over the next decade. While it is extremely important to have determined that more cost-effective, electric efficiency savings can be achieved, this study does not seek to answer the larger resource-planning question of how much energy efficiency ought to be purchased as part of a well-diversified overall portfolio of electric resources for the state. To determine the optimal mix of electric resources over the next 10 years, a new analytical framework will be needed. Although developing such a framework is not a part of the current study, we see it as the next logical step in a process that is critical to putting California's mix of future electric resources back on track. Under one such approach, *portfolio management*, the long-run management of a diverse set of demand and supply-side resources is selected to minimize risks (including price volatility) and long-run costs, taking environmental costs into account.

1. INTRODUCTION

In the 1980s and early 1990s, a number of studies estimating energy-efficiency potential in California were conducted periodically. These studies were abandoned, however, with the advent of electric restructuring in the state. Recently, a number of factors—supply shortages, rate increases, price volatility, future price and supply uncertainty—have combined to warrant a detailed analysis of energy-efficiency potential.

This study estimates potential electricity and peak demand savings from energy-efficiency measures in California, the world's fifth biggest economy. In contrast to energy conservation, which often involves short-term behavioral changes, energy-efficiency opportunities are typically physical, long-lasting changes to buildings and equipment that result in decreased energy use while maintaining constant levels of energy service. Examples of energy efficiency include:

- Compact fluorescent lighting systems that deliver equivalent light using 70 percent less electricity than incandescent light bulbs

- New variable-speed drive chillers that deliver cooling to buildings using 40 percent less energy than typical systems in today's buildings

- Energy management control systems that eliminate energy waste and optimize building operation

- Identification and repair of leaks in industrial compressed air systems that otherwise result in wasteful increases in product costs.

These types of improvements, and hundreds of others, reduce electricity consumption without affecting the end-use services (e.g., light, heat, "coolth," drivepower, and the like) that consumers and businesses require for comfort, productivity, and leisure.

This report provides both detailed and aggregated estimates of the costs and savings potential of energy-efficiency measures in California. In addition, forecasts are developed of savings and costs associated with different levels of program funding over a 10-year period. Program savings and cost-effectiveness estimates are also evaluated under several possible future scenarios that take into account uncertainty in electricity rates and wholesale energy costs.

We leverage recent work conducted by the authors for the major investor-owned utilities in California and the California Energy Commission.[1] These studies provided an extensive foundation

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[1] These studies addressed energy-efficiency potential in the commercial and residential sectors for existing buildings. See, for example, *California Statewide Commercial Sector Energy Efficiency Potential Study*, prepared by XENERGY Inc. for Pacific Gas & Electric Company, funded with California Public Goods Charge Energy Efficiency Funds, July, 2002; and *California Statewide Industrial Market Characterization*, prepared by XENERGY Inc. for Pacific Gas & Electric Company, funded with California Public Goods Charge Energy Efficiency Funds, December, 2001. Residential sector results were developed through funding from the California Energy Commission, results forthcoming.

for estimates of potential in existing commercial and residential buildings. The current effort would not be possible without these recent underlying studies, and we thank the sponsors of those studies for their permission to build upon their work. To expand coverage to all sectors and vintages in the state for the 10-year forecast period, significant additional work was conducted in this study to estimate potentials for the industrial sector and for new buildings constructed between now and 2011.

The recent electricity crisis in California has led policy makers, utilities, planners, and the public to revisit the role that energy efficiency can play in heading off or minimizing the impacts of such crises in the future. For over two decades, California has been a leader in energy planning and was among the first states to formally recognize the value of energy efficiency. The State took some of the largest strides in treating energy-efficiency as an energy resource and went far toward institutionalizing efficiency as a viable alternative to conventional energy sources. In response to the market-oriented electricity restructuring process embarked on in California in the mid-1990s, formal resource planning in which energy efficiency could compete against conventional supply-side alternatives was abandoned. As a result, efficiency programs languished in the period just prior to the California energy crisis. Fortunately, enough of the efficiency infrastructure was left in place to allow the state to rapidly ramp up energy-efficiency expenditures in 2000 and 2001. These efforts, combined with conservation efforts, and regulatory interventions, tamed the crisis.

Of course, few are convinced that California's energy woes are over or that all of the underlying problems that led to price disruptions have been solved. This report does not offer a blueprint for resolving all of California's electricity problems. The report is part of the Hewlett Energy Initiative, a series of research papers and projects on the California power crisis to be released throughout 2002. The focus of this report is principally on characterization of the energy-efficiency resource in California. Our results point to the need to develop an energy resource planning process that balances appropriately among resources and formally recognizes the availability and value of energy efficiency as an alternative to unlimited power plant construction and a hedge against volatile energy prices.

This study builds on past research to examine what the potential is now for energy efficiency to help meet California's future energy needs. It builds upon prior studies and makes clear the case for formal incorporation of energy efficiency in energy resource planning activities and methods. We supplement prior research with new analysis to present a comprehensive assessment of the potential for efficiency improvements. We also describe the wide range of benefits associated with energy-efficiency improvements. These discussions provide the foundation for a discussion of the role that energy efficiency can play as one part of a robust response to future energy uncertainties. This study is not intended as the last, but rather the first, word on electric efficiency potential in the state. Additional research is needed to build upon, expand, and corroborate the results of this initial effort.

Consistent with our mid-term focus, the study is restricted to energy-efficiency measures and practices that are presently commercially available. These are the measures that are of most immediate interest to energy-efficiency program planners. The study data, framework, and models can be easily leveraged in the future to add estimates of potential for emerging technologies. In addition, the scope of this study is focused on measures that could be relatively easily substituted for or applied to existing technologies on a retrofit basis. As a result, measures and savings that might be achieved through integrated redesign of existing energy-using systems, as might be possible during major renovations or remodels, are not included. This is another area in which the current results can be expanded and improved upon.

Finally, note that the analysis for this study were conducted in 2001 and early 2002, a time characterized by unprecedented changes in energy consumption and behavior among consumers and businesses in California in response to the energy crisis. As a result, the estimates of potential presented in this study do not reflect the unusual level of energy conservation that occurred in 2001. The effects of 2001 were not well enough understood to incorporate into the study at the time that the primary analysis were conducted. Future updates of this study should incorporate revised energy consumption baseline information that accounts for any permanent changes in conservation resulting from the recent energy crisis.

2. METHODS AND SCENARIOS

In this chapter, we give a brief overview of the concepts, methods, and scenarios used to conduct this study. Additional methodological details are provided in Appendix B.

2.1 Characterizing the Energy-Efficiency Resource

Energy efficiency has been characterized for some time now as an alternative to energy supply options such as conventional power plants that produce electricity from fossil or nuclear fuels. In the early 1980s, researchers developed and popularized the use of a conservation supply curve paradigm to characterize the potential costs and benefits of energy conservation and efficiency. Under this framework, technologies or practices that reduced energy use through efficiency were characterized as "liberating 'supply' for other energy demands" and could therefore be thought of as a resource and plotted on an energy supply curve. The energy-efficiency resource paradigm argued simply that the more energy efficiency, or "nega-watts" produced, the fewer new plants would be needed to meet end users' power demands.

2.1.1 Defining Energy-Efficiency Potential

Energy-efficiency potential studies were popular throughout the utility industry from the late 1980s through the mid-1990s. This period coincided with the advent of what was called least-cost or integrated resource planning (IRP). Energy-efficiency potential studies became one of the primary means of characterizing the resource availability and value of energy efficiency within the overall resource planning process.

Like any resource, there are a number of ways in which the energy-efficiency resource can be estimated and characterized. Definitions of energy-efficiency potential are similar to definitions of potential developed for finite fossil fuel resources like coal, oil, and natural gas. For example, fossil fuel resources are typically characterized along two primary dimensions: the degree of geologic certainty with which resources may be found and the likelihood that extraction of the resource will be economic. This relationship is shown conceptually in Figure 2-1.

Somewhat analogously, this energy-efficiency potential study defines several different *types* of energy-efficiency *potential*, namely: technical, economic, achievable, program, and naturally occurring. These potentials are shown conceptually in Figure 2-2 and described below.

Technical potential is defined in this study as the *complete* penetration of all measures analyzed in applications where they were deemed *technically* feasible from an *engineering* perspective. **Economic potential** refers to the *technical potential* of those energy conservation measures that are cost-effective when compared to supply-side alternatives. **Maximum achievable potential** is defined as the amount of economic potential that could be achieved over time under the most aggressive program scenario possible. Achievable **program potential** refers to the amount of savings that would occur in response to specific program savings that would occur in response to specific program funding and measure incentive levels.

Savings associated with program potential are savings that are projected beyond those that would occur naturally in the absence of any market intervention. **Naturally occurring potential** refers to the amount of savings estimated to occur as a result of normal market forces, that is, in the absence of any utility or governmental intervention.

Figure 2-1

Conceptual Framework for Estimates of Fossil Fuel Resources

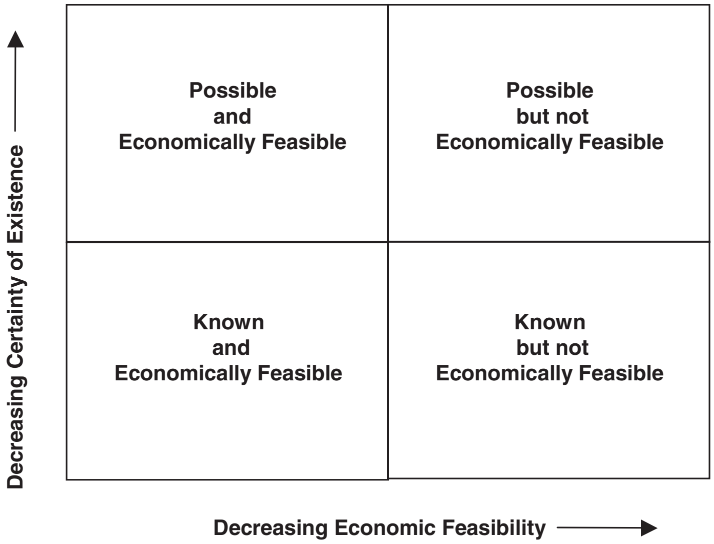
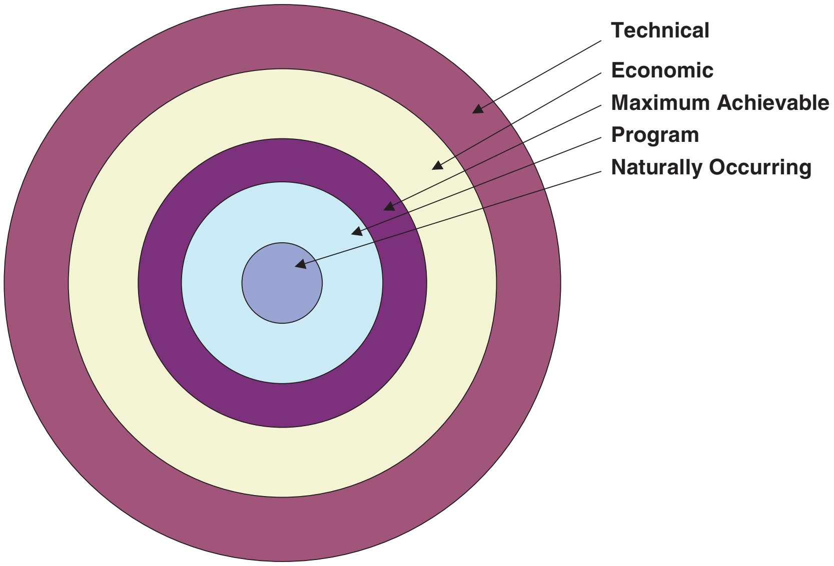


Figure 2-2

Conceptual Relationship Among Energy-Efficiency Potential Definitions



2.2 Summary of Analytical Steps Used in this Study

The crux of this study involves carrying out a number of basic analytical steps to produce estimates of the energy-efficiency potentials introduced above. The basic analytical steps for this study are shown in relation to one another in Figure 2-3. The bulk of the analytical process for this study was carried out in a model developed by XENERGY for conducting energy-efficiency potential studies. Details on the steps employed and analysis conducted are described in Appendix B. The model used, DSM ASSYST™, is an MS-Excel-based model that integrates technology-specific engineering and customer behavior data with utility market saturation data, load shapes, rate projections, and marginal costs into an easily updated data management system. The key steps implemented in this study are:

Step 1: Develop Initial Input Data

- Develop list of energy-efficiency measure opportunities to include in scope

- Gather and develop technical data (costs and savings) on efficient measure opportunities

- Gather, analyze, and develop information on building characteristics, including total square footage or total number of households, electricity consumption and intensity by end use, end-use consumption load patterns by time of day and year (i.e., load shapes), market shares of key electric consuming equipment, and market shares of energy-efficiency technologies and practices.

Step 2: Estimate Technical Potential and Develop Supply Curves

- Match and integrate data on efficient measures to data on existing building characteristics to produce estimates of technical potential and energy-efficiency supply curves.

Step 3: Estimate Economic Potential

- Gather economic input data such as current and forecasted retail electric prices and current and forecasted costs of electricity generation, along with estimates of other potential benefits of reducing supply such as the value of reducing environmental impacts associated with electricity production

- Match and integrate measure and building data with economic assumptions to produce indicators of costs from different viewpoints (e.g., societal and consumer)

- Estimate total economic potential.

Step 4: Estimate Maximum Achievable, Program, and Naturally Occurring Potentials

- Gather and develop estimates of program costs (e.g., for administration and marketing) and historic program savings

- Develop estimates of customer adoption of energy-efficiency measures as a function of the economic attractiveness of the measures, barriers to their adoption, and the effects of program intervention

- Estimate maximum achievable, program, and naturally occurring potentials

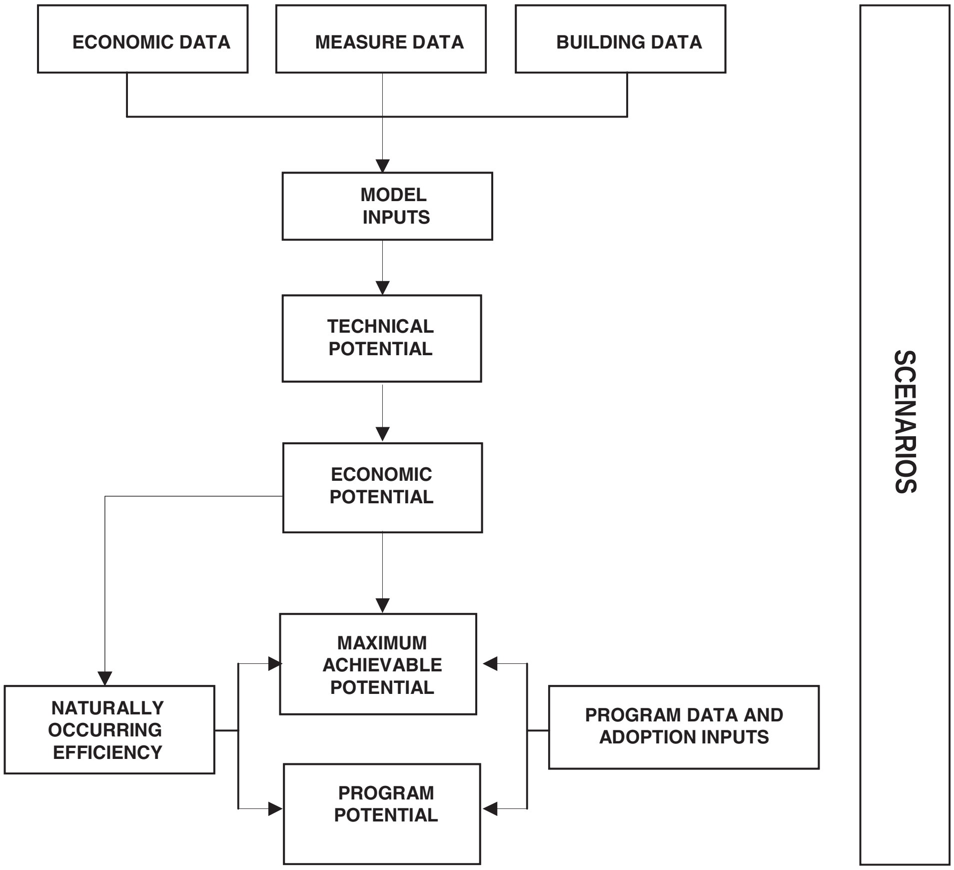
- Develop alternative economic estimates associated with alternative future scenarios.

Step 5: Scenario Analyses

- Recalculate potentials under alternate economic scenarios.

Figure 2-3

Conceptual Overview of Study Process



2.3 Scenario Analysis

In this section we describe scenarios under which we estimate energy-efficiency potential in this study. Scenario analysis is a tool commonly used to address uncertainty, which is inherent to forecasts. By constructing alternative scenarios, one can examine the sensitivity or robustness of one's predictions to changes in key underlying assumptions.

In this study, we construct scenarios of energy-efficiency potential for two key reasons. First, our estimates of potential are forecasts of future adoptions of energy-efficiency measures that are a function of data inputs and assumptions that are themselves forecasts. For example, as described earlier in this chapter, our estimates of potential depend on estimates of measure availability, measure costs, measure savings, measure saturation levels, electricity rates, and avoided costs. Each of the inputs to our analysis is subject to some uncertainty, though the amount of uncertainty varies among the inputs. The second key reason that we construct scenarios is that the final quantity with which we are most interested in this study, achievable potential, is by definition amenable to policy choices. Achievable potential is dependent on the level of resources and types of strategies employed to increase the level of measure adoption that would otherwise occur. In California, the level of resources and types of strategies are determined by policies and objectives of the institutions charged with enabling, governing, and administering public purpose energy-efficiency programs.[1] Over the past 20 years in California, funding levels for energy efficiency have changed dramatically over time.

Thus, we chose to develop scenarios to address uncertainty in factors over which one has limited direct control (e.g., future avoided costs and rates) as well as those that are controllable by definition (e.g., efficiency program funding levels).

2.3.1 Scenario Elements

As noted above, there is uncertainty associated with many of the inputs to our estimates of energy-efficiency potential. However, the level of uncertainty varies among inputs, and not all inputs are equally important to the final results. We determined that the greatest uncertainty in our estimates of economic and achievable potential (which are considered of more policy importance than estimates of technical potential) is that associated with future wholesale and retail electricity prices and future program funding levels. As a result, we limited the scenario analysis for the current study to these two dimensions. Each dimension, energy cost and funding level, is referred to as a scenario *element*. As discussed below, we developed three energy cost elements (Base, Low, and High) and three program funding level elements (Business-as-Usual, Advanced Efficiency, and Maximum Achievable Efficiency). These elements are then combined into nine achievable potential scenarios.

2.3.2 Overview of Energy Cost Scenarios

As noted above, we determined that a key uncertainty in our estimates of economic and achievable potential (which are considered of more policy importance than estimates of technical potential) is that associated with future wholesale and retail electricity prices. This study was conducted in the 2001-2002

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[1] The minimum funding level for efficiency programs is determined by the public goods charge (PGC) authorized in Senate Bill (SB) 1194 and signed into law by Governor Gray Davis in 2000. Under SB 1194, the major investor-owned utilities (IOUs) in California are required to collect the PGC through a surcharge on customer bills. The California Public Utilities Commission (CPUC) has regulatory authority over how the IOUs administer the energy-efficiency funds.

time frame, a period that coincided with the recent California energy crisis. The advent of the energy crisis created considerable uncertainty in industry estimates of wholesale and retail electricity prices in California. As a result, we created three future energy cost scenarios: Base, Low, and High.

Base Energy Cost Scenario

The base avoided costs for energy and distribution are summarized in Figures 2-4 and 2-5, respectively. The base avoided-cost values also are provided in Appendix D. The energy avoided costs shown were required and approved by the CPUC for 2001 energy-efficiency programs. The California utilities derived their 2001 energy avoided-cost forecasts by applying CPUC-required on-peak multipliers to an avoided-cost forecast developed by the California Energy Commission (CEC) just prior to the California energy crisis. These multipliers were ordered by the CPUC in fall 2000 to account for the skyrocketing market clearing prices observed in summer 2000. The basis for the multipliers was a study conducted by JBS Energy Inc. in September 2000. Continued use of these multipliers has been required as part of the CPUC's energy-efficiency policy rules for PY2002. As can be seen from Figure 2-4, the primary effect of the multipliers was to significantly increase the summer period prices for the first 2 years of the forecasts. On-peak avoided costs are at 60 cents per kWh for 2001 and 2002 before dropping to roughly 26 cents in 2003.

Figure 2-4

Base Avoided Energy Costs

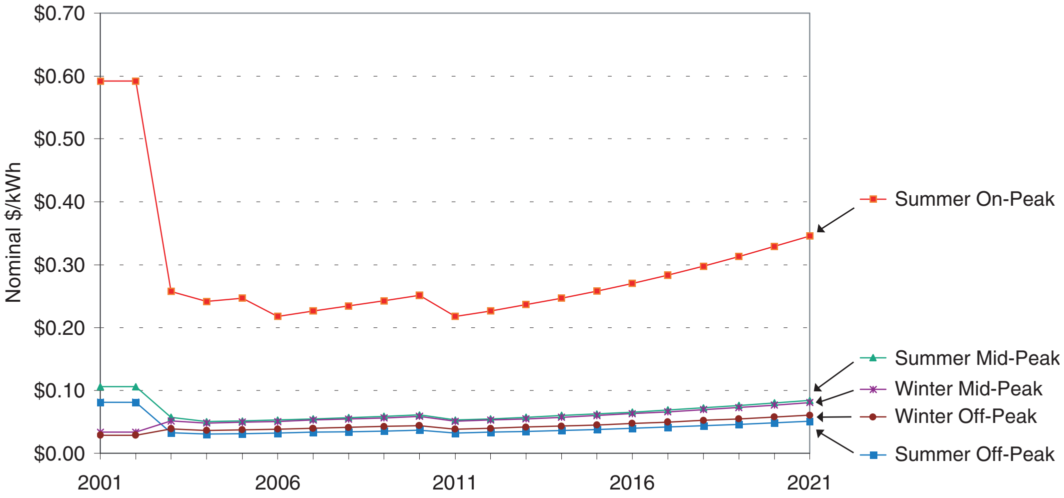
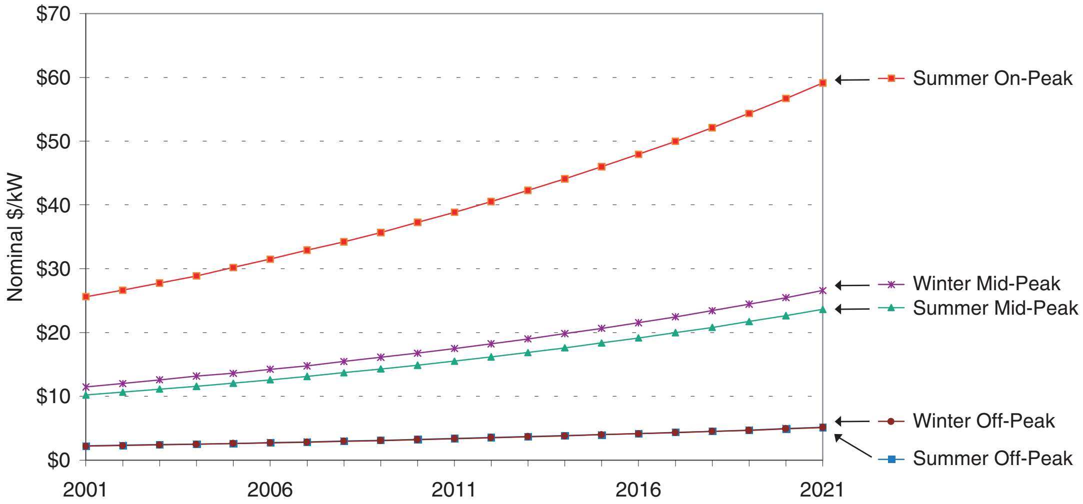


Figure 2-5

Base Avoided Transmission and Distribution Costs

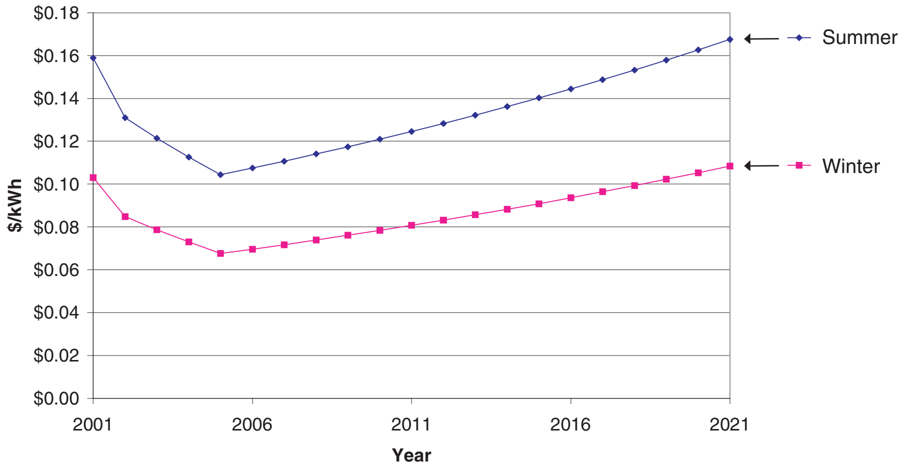


The base avoided-cost values, which average around 8.5 cents per kWh saved per year (in real terms) over the 20-year forecast period, are higher than those used in energy-efficiency cost-effectiveness analysis conducted prior to 2001. However, these base avoided costs are not far off from the average price of the long-term power contracts purchased by the California Department of Water Resources (DWR) during the height of the energy crisis, although they are lower than the wholesale market prices seen in Summer 2001.

An example of the Base rate forecasts used in this study is shown in Figure 3-3 for the commercial sector. We used average current rates as the starting point for each customer class. For the commercial and industrial sectors, our Base scenario rate forecast starts out at current levels and then declines to values that would be equivalent to levels that the pre-energy-crisis rates would have achieved by 2006 if they had increased by inflation. This assumption was taken directly from the CEC's October draft of their California Energy Outlook 2002-2012 report, the most defendable public rate forecast available at the time the commercial analysis was conducted. The residential rate forecast is from the CEC's Final California Energy Outlook 2002-2012 report (published in February 2002). The actual rate forecasts by scenario and sector are shown in Appendix D.

Figure 2-6

Example Base Run Rate Forecast—Commercial Sector



The base energy cost element is summarized in Table 2-1.

Table 2-1

Summary of Base Energy Cost Element

Cost Type	Description	Source
Avoided Costs	Annual energy avoided-cost averages roughly 7 cents per kWh saved. Avoided costs for transmission and demand equal roughly 1.5 cents per kWh saved. See Appendix B for specific values.	CPUC authorized avoided costs for major IOU's 2001 cost-effectiveness analysis (CPUC 2000)
Rates	Current commercial and industrial rates decrease to return to nominally normal levels by 2006, residential rates increase slightly over time.	CEC 2001a and 2002. CEC's Draft (October) and Final (February 2002) California Energy Outlook 2002-2012. Because of the timing of our analysis, the October rate forecast was used for commercial and industrial, and the February forecast for residential.

Low and High Energy Cost Scenarios

Because of the tremendous uncertainty around estimates of future wholesale and retail energy costs in California, we developed both Low and High energy cost scenarios as alternatives to the Base energy cost scenario. The purpose of developing the Low and High energy cost scenarios is to bind the Base energy costs by two moderately extreme cases. Although many different combinations of alternative future avoided costs and rates are possible, we choose to create two simple cases.

The Low avoided energy costs are simply half of the Base scenario avoided costs throughout the forecast period. The High avoided costs were set at 25 percent above the Base avoided costs throughout the forecast period. The high avoided-cost scenario captures possible futures in which energy efficiency has a very high value. This could be as a result of a future energy price spike, like the 2000-2001 experience, or because environmental impacts are valued more highly than they are today, for example, to meet a greenhouse gas reduction goal.

The Low retail rates were set at 1998 frozen levels and then increased from 2001 by inflation. In the High element, current retail rates continue to rise by inflation throughout the forecast period and do not return to pre-crisis levels; that is, the energy-crisis related rate increases of 2001 are permanent in the High element. The actual avoided cost and retail rates for the Low and High elements are provided in Appendix D. A summary of the elements is provided in Table 2-2.

Table 2-2

Summary of Low and High Energy Cost Elements

	Energy Costs Element	
Cost Type	Low	High
Avoided Costs	50 percent lower than Base energy avoided costs. Average 3.5 cents per kWh saved for energy (5 cents per kWh saved total including 1.5 cents per kWh saved for transmission and distribution).	25 percent higher than Base energy avoided costs. Average 9 cents per kWh saved for energy (10.5 cents per kWh saved total including 1.5 cents per kWh saved for transmission and distribution).
Retail Rates	1998 frozen rates escalated by inflation.	Current actual rates that persist throughout forecast period on a nominal basis.

The avoided-cost component of the Low energy cost element is fairly similar to the level of avoided costs that were in use prior to the energy crisis and, hence, are certainly a plausible bound on the low side. The rate component of the Low energy cost element is hypothetical by definition in that the rates are set at 1998 frozen values, putting them below what customers are currently experiencing. Nonetheless, the faster rates return to pre-crisis levels relative to our Base rate forecast, the more applicable the Low element would become.

The High element was developed when the energy crisis was still in full force, that is, before wholesale electricity prices had stabilized and fallen. It was designed to capture the possibility that extremely high market prices might continue or occur again in the near future. From today's vantage point, the High element seems unlikely; however, as mentioned above, there are a number of high-impact, low-probability events that could occur in an energy future reflected by the High element (e.g., a future energy crisis similar to the one just experienced, a mandate to reduce greenhouse gases, or a high market trading value for carbon dioxide or other power plant pollutants).

2.3.3 Efficiency Funding Scenarios

In this study, we constructed three different future funding level elements for California electric energy-efficiency programs. These program-funding elements are used to model achievable potential. Across all energy cost scenarios, the funding level elements are labeled *Business-as-Usual*, *Advanced Efficiency*, and *Maximum Efficiency*. Total program funding expenditures increase sequentially from Business-as-Usual to Maximum Efficiency. Business-as-Usual, the lowest expenditure level, generally approximates spending levels in recent years. Advanced Efficiency represents a 100-percent increase over Business-as-Usual. Maximum Efficiency, the highest expenditure element, is used to generate our estimates of maximum achievable potential. Maximum Efficiency funding equates to roughly a 400-percent increase over Business-as-Usual funding. The average program expenditures for each of the funding scenarios is shown, by component, in Table 2-3. These funding levels are discussed further below in the presentation of program potential results.

Table 2-3

Summary of Program Expenditures

(Average Expenditures Over the 10-Year Analysis Period in Millions of $ per Year)

	Cost Components				
Funding Level	Marketing	Administration	Incentives	Total	Average % of Measure Cost Paid*
Business-as-Usual	$66	$62	$116	$243	33%
Advanced Efficiency	$88	$124	$360	$572	66%
Maximum Efficiency	$124	$141	$763	$1,028	100%

Components

The components of program funding that vary under each of the program funding levels are:

1. Total marketing expenditures
2. The amount of incremental measure costs paid through incentives
3. Total administration expenditures.

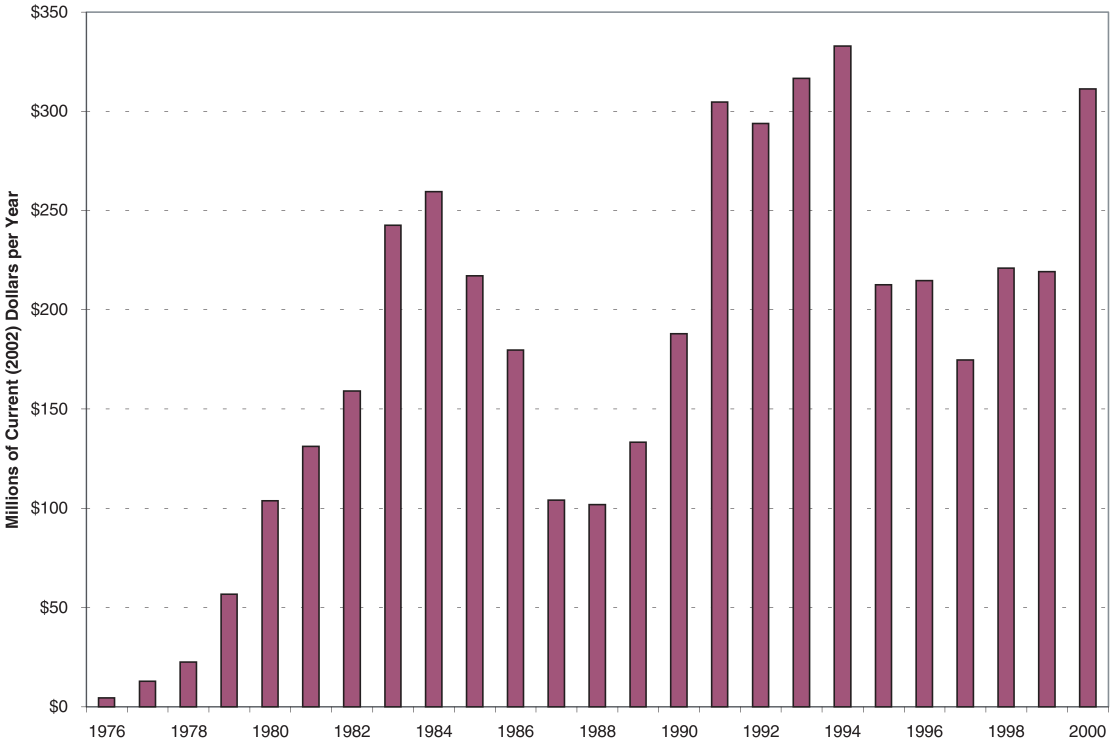
First, customers must be aware of efficiency measures and associated benefits in order to adopt those measures. In our analysis, program marketing expenditures are converted to increases in awareness. Thus, under higher levels of marketing expenditures, higher levels of awareness are achieved. Second, program-provided measure incentives lead to increased adoptions through increases in participants' benefit-cost ratios, as described in Appendix B. The higher the percentage of measure costs paid by the program, the higher the participant benefit-cost ratio and number of measure adoptions. Third, purely administrative costs, though necessary and important to the program process, do not directly lead to adoptions; however, they must be included in the program funding because they are an input to program benefit-cost tests.

Business as Usual Funding

For the Base energy cost scenario, our Business-as-Usual funding was constructed to reflect the level of expenditures for the major investor-owned utilities' (IOUs') programs at different points in time over the past 5 years. We reviewed actual expenditures reported in utility CPUC filings for residential and nonresidential programs. As shown in Figure 2-7, over the period 1996 to 2000, reported program expenditures for the three electric investor-owned utilities in California averaged roughly $200 million per year. Our Business-as-Usual funding is $240 million per year, which accounts for the fact that the electric IOUs represent about 82 percent of California's energy consumption. Thus, the $240 million per year figure assumes the non-IOUs devote the same amount proportionally to electric efficiency programs, as do the IOUs.

Figure 2-7

Annual Electric Energy-Efficiency Program Expenditures for Major IOUs (in current dollars)



Source: Historic data compiled by CEC staff. Smith 2002, deflated using GDP price deflator.

We reviewed the same sources identified above to estimate program administration and marketing costs. Precise estimates of these costs were difficult to make from the sources available at the time. In general, we estimated that program expenditures made up slightly less than half of the total program costs, under the Business-as-Usual case, with financial incentives making up the rest. Marketing costs average $66 million per year and administration costs $62 million.

The total incentives dollars are estimated directly in our model as a function of predicted adoptions. What we specify in the model is the percent of incremental measure cost paid by the program. We attempted to set these percentages as closely as possible to the utility incentive levels in recent years. While not exact due to actual variations in incentives across measures and across program years, we believe that the percent of measure costs paid in our Business-as-Usual funding element, which average about one-third of measure costs, reasonably approximates actual program incentive levels over the past few years. Total incentives average $116 million per year under the Business-as-Usual case.

In the Business-as-Usual funding element, total marketing costs increase by inflation over the 10-year analysis period. We set administration costs to vary slightly over time as a function of program activity levels. The percent of incremental measure costs paid over time is generally held constant (though incentive levels are ramped up over time under the higher funding scenarios).

Advanced Efficiency Funding

Advanced Efficiency represents a 100-percent increase in funding from Business-as-Usual. We increased funding levels by increasing both the total marketing expenditures and the per-unit incentive levels. Administration levels increase as a function of increases in program activity. Marketing costs average $88 million per year, and the average fraction of incremental costs paid for by incentives increases from roughly one-third in Business-as-Usual to approximately two-thirds in Advanced Efficiency.

Maximum Efficiency Funding

The Maximum Efficiency funding level is used to estimate maximum achievable potential. The key characteristic of this funding level is that 100 percent of incremental measure costs is paid for by the program (after a ramp-up from existing incentive levels over the first few forecast years). In addition, marketing costs increase to an average of $124 million per year.

3. ELECTRIC EFFICIENCY POTENTIAL IN CALIFORNIA

In this section we present estimates of electric energy-efficiency potential under the scenarios described in Section 2. To provide context for these results, we begin with a brief introduction to forecasted peak demand for California for the study period 2002 to 2011.

3.1 Baseline Energy and Demand Forecasts

Before presenting our estimates of energy-efficiency potential, it is important for readers to be familiar with the baseline forecasts of peak demand and energy for California for the period 2002 to 2011. To estimate energy-efficiency potential over time, it is necessary to benchmark savings to a forecast of electricity consumption. Fortunately, in California there is a consistent statewide process in place for electricity forecasting at the California Energy Commission (CEC). The CEC has conducted such forecasts for many years.

On average, the CEC's forecasts have proven fairly accurate over time; however, like virtually all forecasts, the CEC's methods are not intended to predict extraordinary changes in usage associated with unexpected events like the energy crisis of the second half of 2000 and most of 2001. As has been documented extensively elsewhere, energy consumption and peak demand decreased dramatically in 2001. This reduction can be seen in Figure 3-1. This reduction occurred as the result of a combination of voluntary demand response from consumers and installation of energy-efficient equipment, spurred both by the crisis itself and increased energy-efficiency program efforts.[1,2] The relative share of the energy and demand savings in 2001 attributable to voluntary conservation efforts versus installation of major energy-efficient equipment[3] is not currently known with certainty. However, it is likely that the majority of the reduction (roughly 70 percent) was due to voluntary conservation efforts.[4]

In response to the extraordinary reduction in peak demand and consumption that occurred in 2001, the CEC developed several possible patterns of future electricity peak demand and consumption. These scenarios were based on alternative assumptions about the level and persistence of voluntary impacts and permanent,

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[1] For an analysis of the 2001 summer demand reduction, see *The Summer 2001 Conservation Report*, published by the California State and Consumer Services Agency, produced by the CEC under the direction of the Governor's Conservation Team, February 2002.

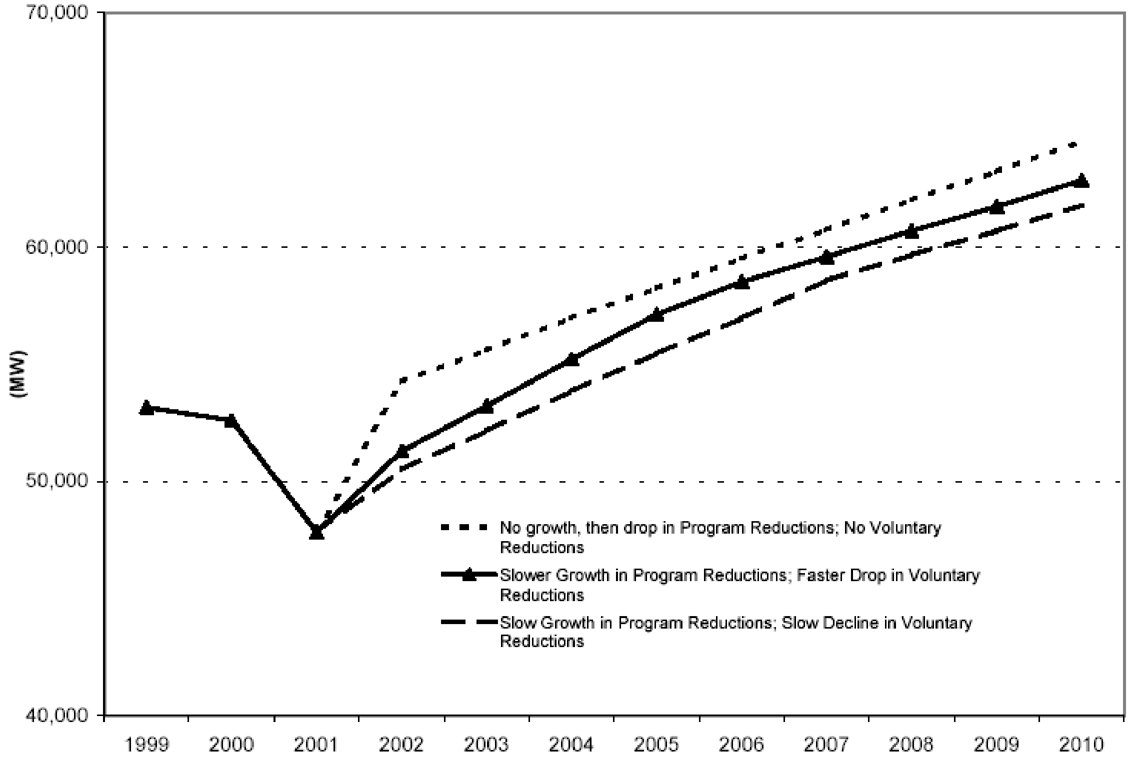
[2] According to CEC 2002, key factors driving both voluntary and hardware changes included demand reduction programs, electricity price increases, the 20/20 rebate program, winter rolling outages, and media exposure of the energy crisis and its potential costs to the State and consumers.

[3] *Conservation* refers here to behavioral changes in energy use, such as turning up thermostat settings during cooling periods; *efficiency* refers to permanent changes in equipment that result in increased energy service per unit of energy consumed, e.g., the installation of a more efficient air conditioner.

[4] See Goldman, Barbose, and Eto 2002, *California Customer Load Reductions during the Electricity Crisis: Did They Help To Keep the Lights On?*, Lawrence Berkeley National Laboratory, for an analysis of conservation and efficiency reactions to the energy crisis in 2001.

program impacts. *Program* impacts, as used in the CEC's forecast scenarios, refer to the emergency program efforts initiated in response to the State's energy crisis, that is, programs funded under SB 5X, AB 970, and AB 29X, not the public goods-charge-based efficiency programs administered by the State's electric utilities. As shown in Figure 3-1, the CEC developed three future scenarios, the middle of which was selected as the most likely case. Under the CEC's forecast, peak demand is projected to be roughly 63,000 MW and energy sales 320,000 GWh per year by 2011. We used the CEC's forecast data to provide the basis for our baseline estimates of energy consumption and peak demand. More information on the CEC's forecasts and the baseline data underlying our estimates of energy-efficiency potential is provided in Appendix A.

Figure 3-1
CEC Peak Demand Forecasts



Source: California Energy Commission (CEC) 2001a. *2002 – 2012 Electricity Outlook*. P700-01-004.

3.2 Potential and Benefits 2002 to 2011—Base Energy Costs

This section presents overall energy-efficiency potential results under our Base energy cost forecast scenario. We begin by presenting estimates of technical and economic potential and then discuss our estimates of achievable potential. Definitions of the different types of potentials and our energy cost forecast scenarios are provided in Section 2 of this report and discussed further in Appendix B. Potentials were estimated using the bottom-up methodologies described in the same appendix. We analyzed potential for 232 unique measures across dozens of market segment applications.[5] Roughly 10,000 measure-market segment combinations were analyzed.

3.2.1 Technical and Economic Potential

In Figures 3-2 and 3-3 we present our overall estimates of total technical and economic potential for peak demand and electrical energy in California. **Technical potential** represents the sum of all savings achieved if all measures analyzed in this study were implemented in applications where they are deemed applicable and physically feasible. As described in Appendix B, **economic potential** is based on efficiency measures that are cost-effective based on the total resource cost (TRC) test, a benefit-cost test used by the California Public Utilities Commission and others to compare the value of avoided energy production and power plant construction to the costs of energy-efficiency measures and program activities necessary to deliver them. The value of both energy savings and peak demand reductions are incorporated into the TRC test.

If all measures analyzed in this study were implemented where technically feasible, we estimate that overall technical demand savings would be roughly 14,800 MW, about 22 percent of projected total peak demand in 2011. If all measures that pass the TRC test were implemented, economic potential savings would be 9,600 MW, about 15 percent of total base demand in 2011. These figures correspond to the equivalent of 30 and 19 mid-sized (500 MW) power plants. Technical energy savings potential is estimated to be roughly 56,000 GWh, about 18 percent of total commercial energy usage projected in 2011. Economic energy savings are estimated at 40,000 GWh, about 13 percent of base usage.

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[5] Market segment applications included building types, utility service territories, climate zones, and building vintages.

Figure 3-2
Technical and Economic Potential (2011)
Peak Demand Savings—MW

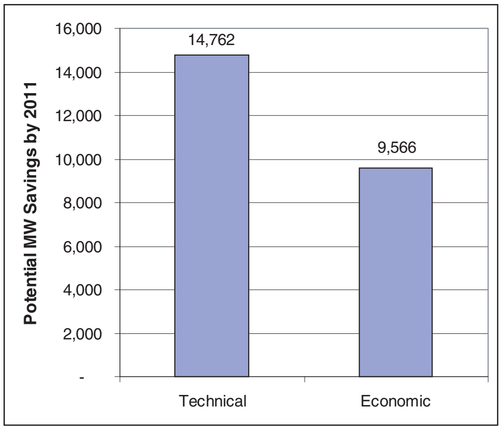
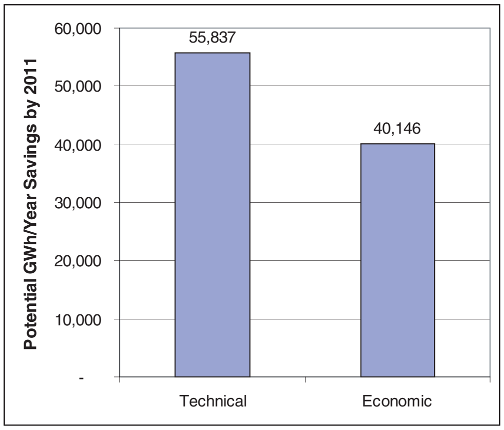


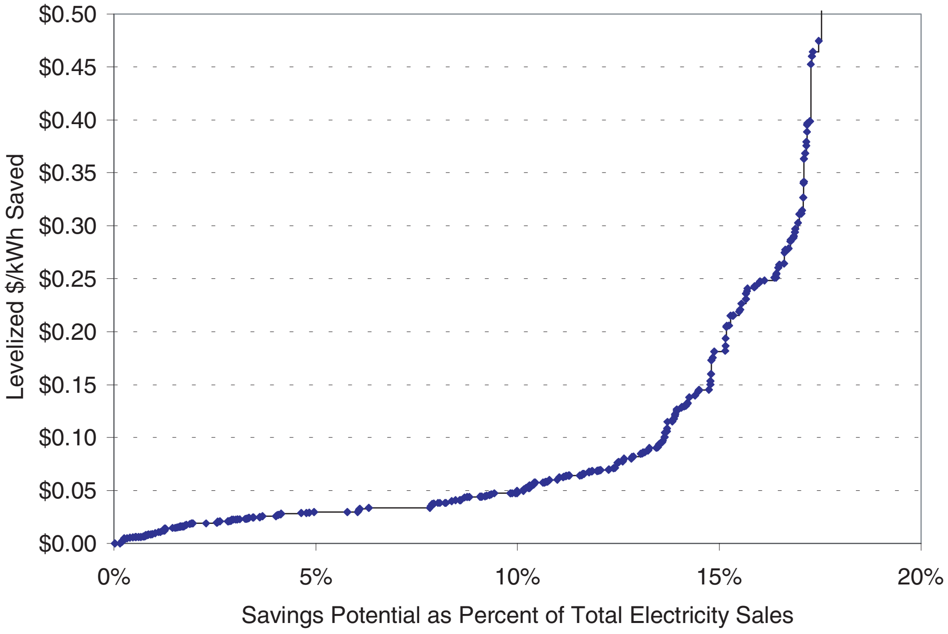
Figure 3-3
Technical and Economic Potential (2011)
Energy Savings—GWh per Year



A common way to illustrate the amount of energy-efficiency savings available for a given cost is to construct an energy-efficiency supply curve. A supply curve typically consists of two axes—one that captures the cost per unit of saving electricity (e.g., levelized $/kWh saved) and the other that shows the amount of savings that could be achieved at each level of cost. Measures are sorted on a least-cost basis, and total savings are calculated incrementally with respect to measures that precede them. The costs of the measures are levelized over the life of the savings achieved. (See Appendix C for more information on construction of efficiency supply curves.)

The overall energy-efficiency supply curve constructed for this study is shown in Figure 3-4. The curve is shown in terms of savings as a percentage of total energy consumption for the state in the year 2011. The curve shows that roughly 28,000 GWh per year of savings are available (9 percent of project consumption in 2011) from measures with levelized costs below 5 cents per kWh saved. Approximately 40,000 GWh per year of savings are available from measures with levelized costs below 8.5 cents per kWh saved (8.5 cents is roughly the break-even point for measures that pass the TRC benefit-cost test under the Base energy cost forecast). Savings potentials and levelized costs for the individual measures that comprise the supply curve are provided in Appendix C. End use and measure savings are discussed later in this chapter.

Figure 3-4
Energy-Efficiency Supply Curve—Potential in 2011*



*Levelized cost per kWh saved is calculated using an 8-percent nominal discount rate.

3.2.2 Achievable Potentials

In this section we present our overall achievable potential results under the Base energy cost scenario. In contrast to technical and economic potential estimates, achievable potential estimates take into account market and other factors that affect adoption of efficiency measures. Our method of estimating measure adoption takes into account market barriers and reflects actual consumer and business implicit discount rates (see Appendix B for this methodology). **Achievable potential** refers to the amount of savings that would occur in response to one or more specific program interventions. *Net* savings associated with program potential are savings that are projected beyond those that would occur naturally in the absence of any market intervention. Because achievable potential will vary significantly as a function of the specific type and degree of intervention applied, we develop estimates for multiple scenarios. As discussed in Section 2, the achievable potential scenarios analyzed for this study are Business-as-Usual, Advanced Efficiency, and Maximum Efficiency. The Business-as-Usual funding scenario represents continuation of the minimum funding level allowed by law under the legislation enabling California's IOUs to collect a public goods charge for energy-efficiency programs. The Advanced Efficiency scenario represents roughly a doubling of funding as compared with the Business-as-Usual. **Maximum achievable efficiency potential** is the amount of economic potential that could be achieved over time under the most aggressive program scenario possible.[6] We estimate that the programmatic funding necessary in the Maximum Efficiency is about four times the Business-as-Usual spending.

We forecasted program energy and peak demand savings under each achievable potential scenario for a 10-year period beginning in 2002. We calibrated our energy-efficiency adoption model to actual program accomplishments over the historic period 1996 to 2000. Our estimates of achievable potentials and their affect on forecasted demand and energy consumption are shown in Figures 3-5 through 3-8.

As shown in Figure 3-5, by 2011 *net*[7] peak demand savings are projected to be roughly 1,800 MW under Business-as-Usual, 3,500 MW under Advanced Efficiency, and 5,900 MW under Maximum Efficiency futures. In Figure 3-6 we show how these savings would affect forecasted peak demand.

In Figure 3-7, we show projected net annual energy savings of 10,000 GWh under Business-as-Usual, 19,000 GWh under Advanced Efficiency, and 30,000 GWh under Maximum Efficiency futures. In Figure 3-8 we show how these savings would affect forecasted energy consumption.

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[6] Experience with efficiency programs shows that maximum achievable potential will always be less than economic potential for two key reasons. First, even if 100 percent of the extra costs to customers of purchasing an energy-efficient product are paid for through program financial incentives such as rebates, not all customers will agree to install the efficient product. Second, delivering programs to customers requires additional expenditures for administration and marketing beyond the costs of the measures themselves. These added program costs reduce the amount of potential that it is economic to acquire.

[7] Again, *net* refers throughout this chapter to savings beyond those estimated to be naturally occurring, that is, from customer adoptions that would occur in the absence of any programs or standards.

Figure 3-5
Achievable Peak Demand Savings—MW

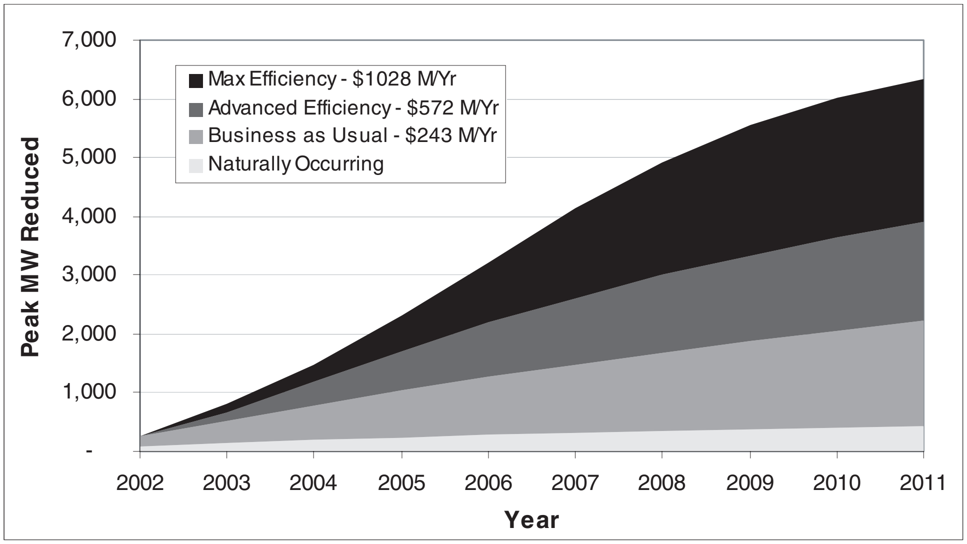
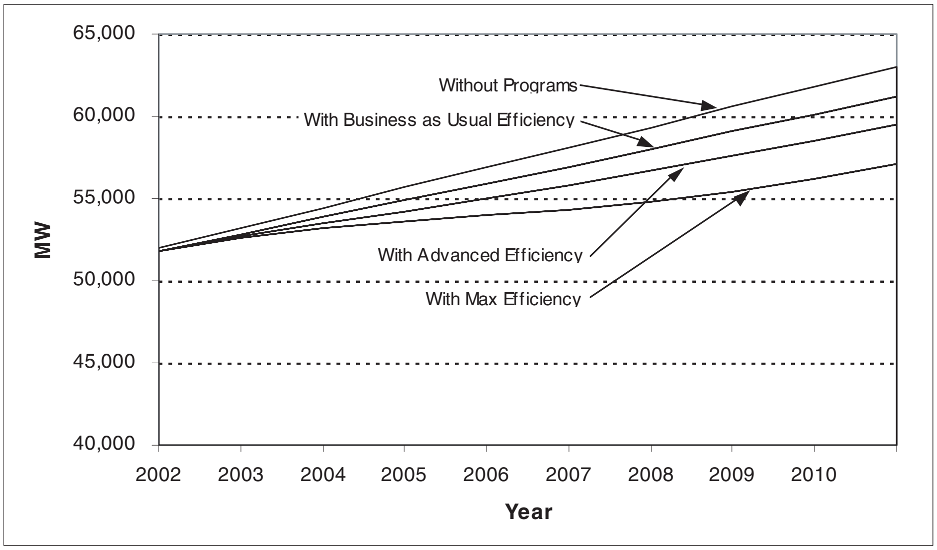


Figure 3-6
Peak Demand Forecast and Achievable Efficiency Potentials*



*No programs forecast based on CEC 2002.

Figure 3-7
Achievable Electricity Savings—GWh per Year

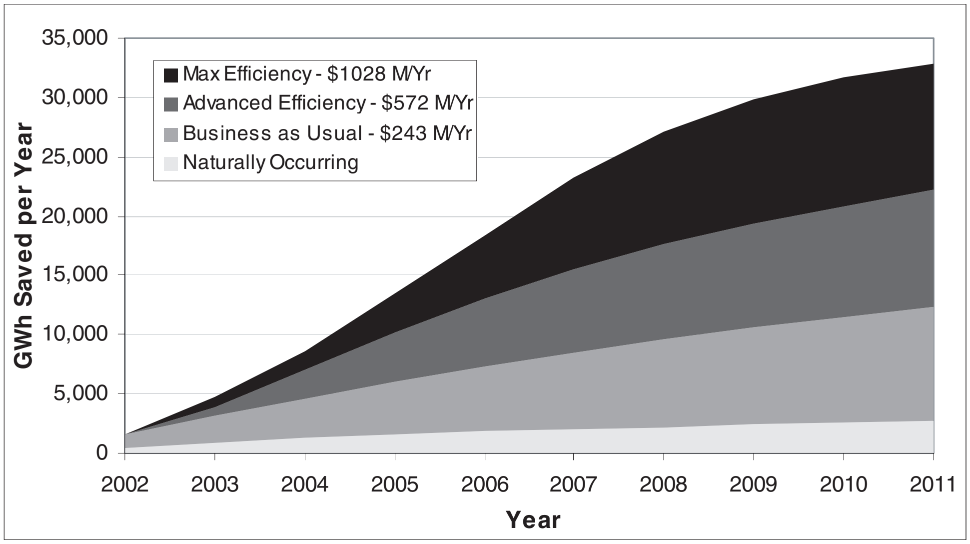
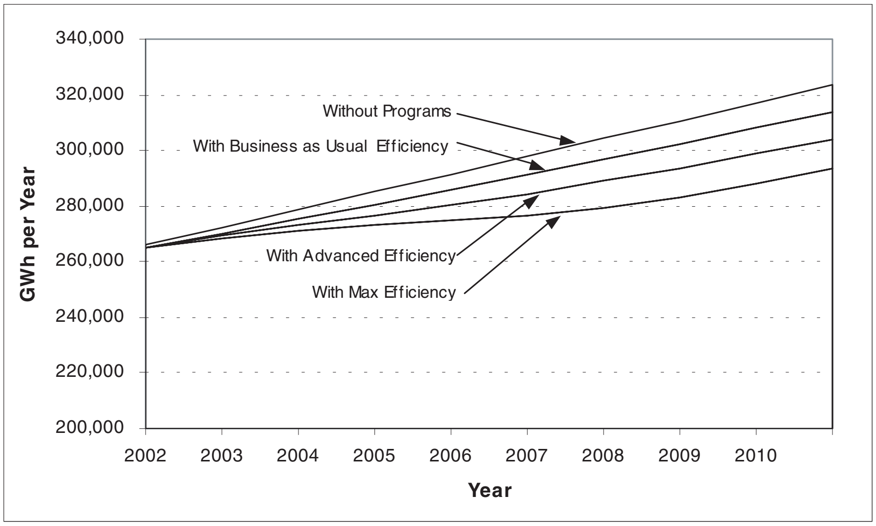


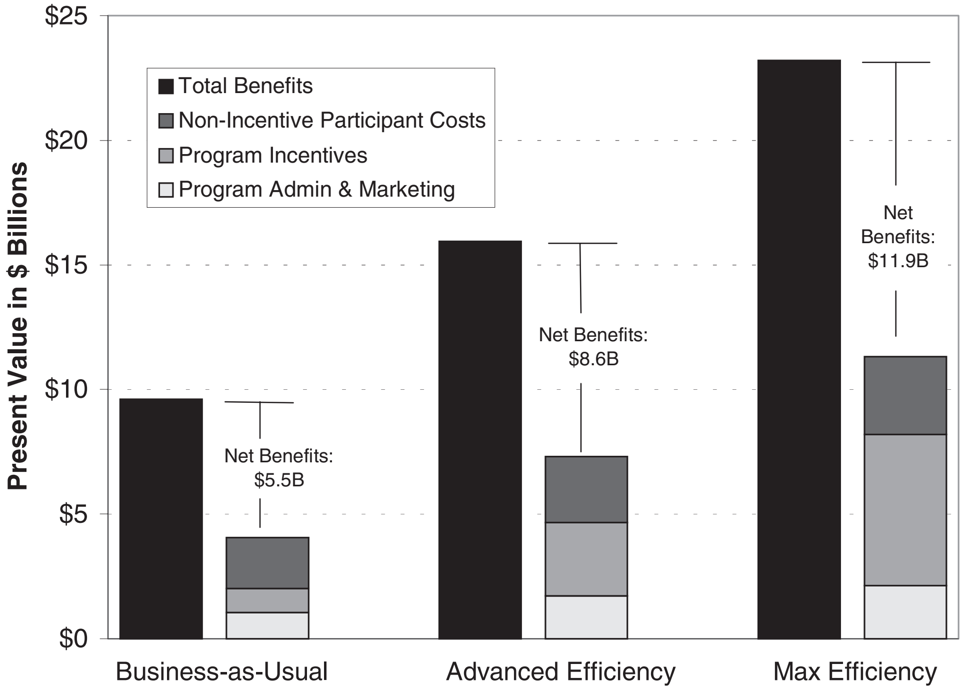
Figure 3-8
Electricity Forecast and Achievable Efficiency Potentials*



*No programs forecast based on CEC 2002.

The costs and benefits associated with the each funding scenario, under Base energy costs, over the 10-year period are shown in Figure 3-9. As shown in the figure, total program costs (administration, marketing, and incentives) are $2 billion under Business-as-Usual, $4.7 billion under Advanced Efficiency, and $8.2 billion under Max Efficiency. Total avoided-cost benefits are $9.6 billion under Business-as-Usual, $15.9 billion under Advanced Efficiency, and $23.2 billion under Max Efficiency. Net avoided-cost benefits, which are the difference between total avoided-cost benefits and total resource costs (which include participant costs in addition to program costs), are $5.5 billion under Business-as-Usual, $8.6 billion under Advanced Efficiency, and $11.9 billion under Max Efficiency.

Figure 3-9
Benefits and Costs of Electric Energy-Efficiency Savings—2002 to 2011*



*Present value of benefits and costs over normalized 20-year measure lives, nominal discount rate = 8 percent, inflation rate = 3 percent.

All of the funding scenarios are cost effective based on the TRC test, which is the principal test used in California to determine program cost effectiveness. The TRC benefit-cost ratios (under the Base energy cost forecast) are 2.4, 2.2, and 2.0 for the Business-as-Usual, Advanced Efficiency, and Max Efficiency scenarios, respectively. Key results from our efficiency scenario forecasts are summarized in Table 3-1.

Table 3-1
Summary of 10-Year Net Achievable Potential Results (2002-2011)*

Scenario	Result	Business-as-Usual	Advanced Efficiency	Max Efficiency
Base	Program Costs:	$2,003 M/Yr	$4,663 M/Yr	$8,196 M/Yr
	Participant Costs:	$2,052 M/Yr	$2,646 M/Yr	$3,111 M/Yr
	Benefits:	$9,604 M/Yr	$15,949 M/Yr	$23,203 M/Yr
	Net GWh Savings:	9,637	19,445	30,090
	Net MW Savings:	1,788	3,480	5,902
	Program TRC:	2.37	2.18	2.05

*Present value of benefits and costs over 20-year normalized measure lives for 10 program years (2002-2011), nominal discount rate = 8 percent, inflation rate = 3 percent, GWh and MW savings are cumulative through 2011.

3.3 Breakdown of Potential and Benefits

In this section we provide additional information on the estimates of electric efficiency potential developed for this study. We discuss results by customer class, vintage, end use, and type of measure. In Figures 3-10 and 3-11, we present estimates of technical and economic potential by customer class for peak demand and energy, respectively. For energy savings, technical and economic potential are similar by customer class and reflect that fact that each of the classes make up about a third of energy consumption in the state (a breakdown of consumption by class is provided in Appendix A). Peak demand technical and economic potential is skewed away from the industrial sector, which should be expected given the higher load factor of industrial customers. Residential customers have significant peak demand savings potential, driven primarily by residential air-conditioning usage, which is highly coincident with the state's summer peak.

Figure 3-10
Technical and Economic Potential (2011)
Demand Savings by Sector—MW

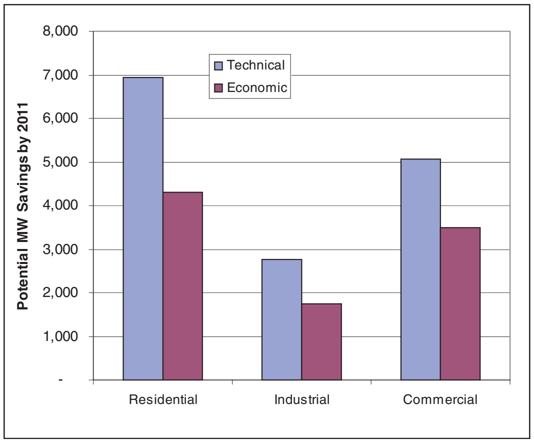
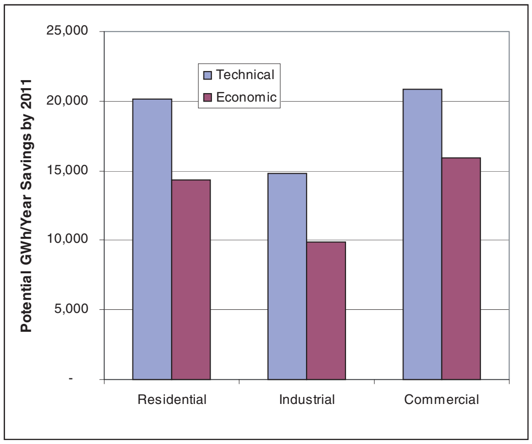


Figure 3-11
Technical and Economic Potential (2011)
Energy Savings by Sector—GWh per Year



Net achievable potential estimates by customer class for the period 2002 to 2011 are presented in Figures 3-12 and 3-13. These figures present the Business-as-Usual, Advanced Efficiency, and Maximum Efficiency funding scenarios. Note that under Business-as-Usual, the commercial sector dominates impacts, accounting for roughly 58 percent of savings, while the residential sector accounts for 24 percent and the industrial sector only 18 percent. As a percent of each sector's base-case consumption, the Business-as-Usual savings represent 6 percent of projected commercial consumption in 2011, 3 percent of residential consumption, and 2 percent of industrial. These forecasts are consistent with the historic pattern of efficiency program savings across customer classes (see Appendix A for a summary of historic program accomplishments). Under the Advanced efficiency scenario, residential savings increase over two-fold, industrial impacts about 70 percent, and commercial impacts only 50 percent. The large increase in residential impacts under the Advanced Efficiency funding is primarily attributable to high levels of projected adoption of compact fluorescent lamps and fixtures (CFLs). Under the Maximum Efficiency funding, residential and commercial impacts increase marginally as compared to Advanced Efficiency, whereas industrial savings increase dramatically.

Figure 3-12
Net Achievable Peak Demand Savings (2011) by Sector—MW

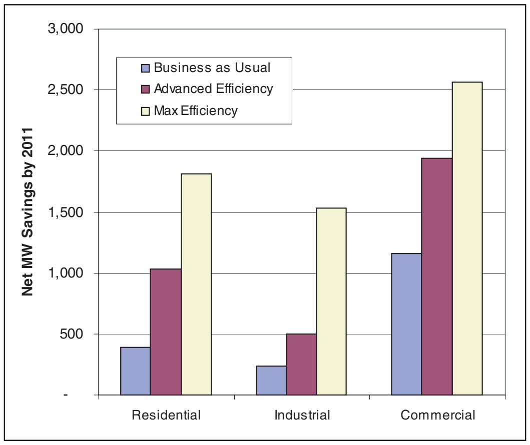
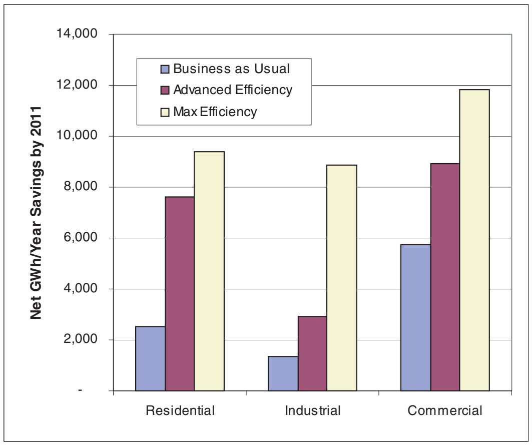
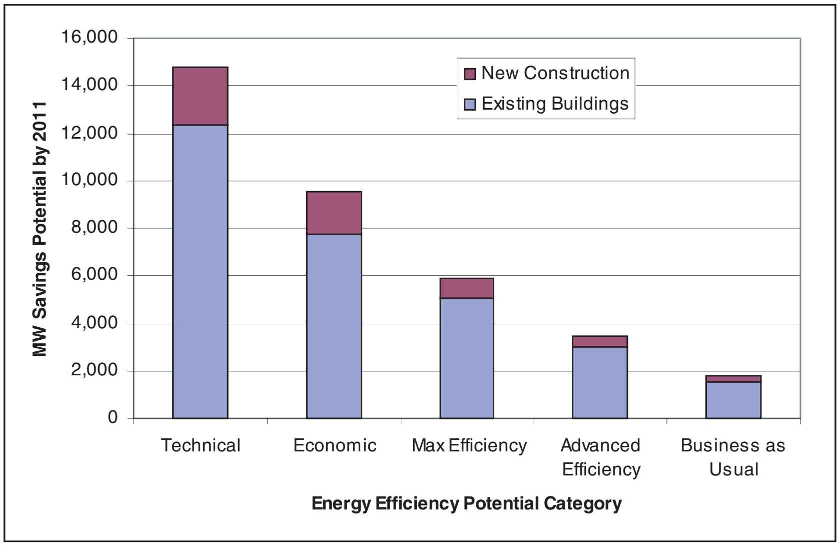


Figure 3-13
Net Achievable Energy Savings (2011) by Sector—GWh per Year



In Figure 3-14, we summarize the relative share of potential accounted for by existing versus new buildings over the 2002 to 2011 period. New construction represents roughly 10 to 15 percent of the estimated achievable potential. This range is consistent with the fraction of total program savings represented new construction throughout the 1990s in California (again, see Appendix A).

Figure 3-14
Potential Peak Demand Savings by Vintage (2011) - MW



In Figures 3-15 through 3-20, we present the distribution of economic efficiency potential by end use. Further detail on potential by individual measure is provided in Appendix C.

In the residential sector, lighting efficiency accounts for the majority of energy savings potential, while air conditioning measures account for 68 percent of potential peak demand savings. This follows somewhat from these end uses share of current energy and peak demand (see Appendix A). Lighting savings are represented by one key measure: CFLs. The contribution of this measure to total residential economic energy savings potential is large because per-unit CFL savings are very high (generally, 70 to 75 percent savings per incandescent lamp replaced). Prior to the energy crisis in 2001, the saturation of CFLs in California households was very low at about 1 percent of applicable incandescent lamps (RLW 2000 and RER 2002a). In the second quarter of 2001, the market share of CFLs shot up to 8 percent of medium screw-based lamp sales in California, before dropping to 6 percent in the third and fourth quarters. This was an unprecedented increase and accounts for a significant share of the energy-efficiency program savings that occurred in 2001. An important research question is whether the high penetration of CFLs can be maintained and increased with continued and expanded program efforts as simulated under our Advanced Efficiency scenario. With respect to peak demand opportunities, the residential measures with the most significant peak demand reduction potential are:

- Window efficiency improvements (new double-pane, low-e windows and retrofit window film)
- High-efficiency air conditioners (SEER 12, 13, and 14+)
- Improved diagnostics, repair, and maintenance
- Thermal expansion valves
- Cool roofs (high reflectivity roofs)
- Whole house fans (for off-peak and mid-peak cool down).

Figure 3-15
Residential Economic Demand Savings Potential by End Use (2011)

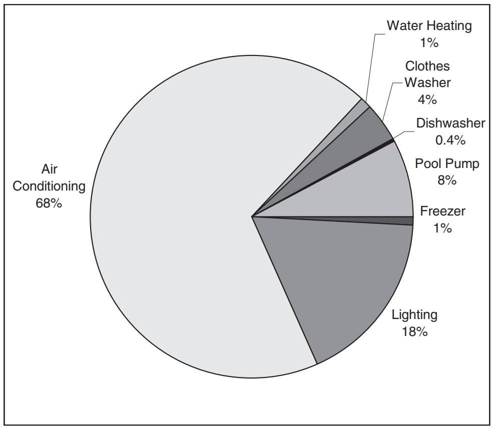
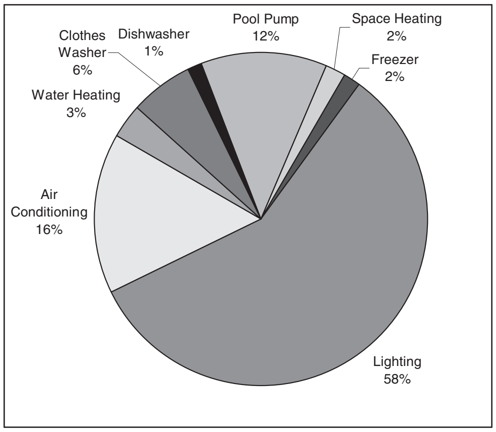


Figure 3-16
Residential Economic Energy Savings Potential by End Use (2011)



The industrial sector is notoriously heterogeneous, being composed of hundreds of different types of manufacturing, production, and assembly plants for thousands of different products. This distribution of potential industrial sector savings by end use is shown in Figures 3-17 and 3-18. The relative mix of end-use savings is fairly similar for both energy and peak demand. This is because the industrial sector has the highest load factor of all customer classes. Motor and process applications account for the majority of potential savings, followed by lighting, compressed air, and space cooling. These savings follow somewhat proportionally from the distribution of base consumption in the sector (see Appendix A for breakdown of industrial consumption by end use); however, lighting savings are higher as a proportion of base consumption as compared with other end uses.

Although there is a great need for more research to better understand industrial potential in California (in particular, little statistically representative data is available on current measure saturation levels), there were several recent sources available to help us with the initial estimates for this study. Key among these sources is a series of industry-specific efficiency potential studies conducted by Lawrence Berkeley National Laboratory (Martin, et al., 1999 – 2000b and Worrell, et al., 1999) and several recent studies conducted by XENERGY (XENERGY 2001d, 2000a, and 1998b). Details on industrial savings opportunities can be found in these references. Examples of key measures include variable-speed drive motor and pump applications, proper motor and pump sizing, redesign of pumping systems to reduce unnecessary flow restrictions, improved operations and maintenance, reducing compressed air system leaks, and optimizing compressed air storage configurations. Lighting and space cooling savings measures are similar to those in the commercial sector. In addition, there are hundreds of measures specific to individual industrial process applications.

Figure 3-17
Industrial Economic Demand Savings Potential by End Use (2011)

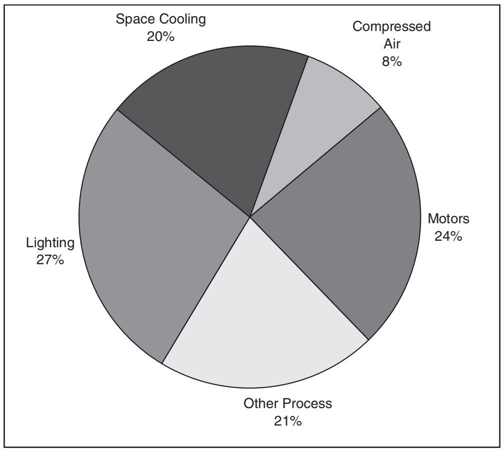
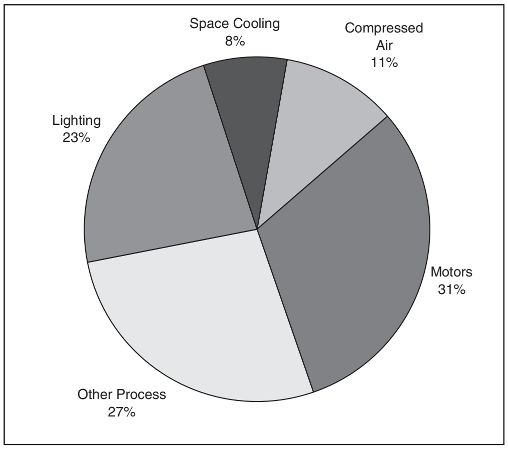


Figure 3-18
Industrial Economic Energy Savings Potential by End Use (2011)



This distribution of commercial sector savings by end use is shown in Figures 3-19 and 3-20. Despite the significant adoption of high-efficiency lighting throughout the 1990s, interior lighting still represents the largest end-use savings potential in absolute terms for both energy and peak demand. As expected, cooling potential represents a significant portion of the total peak demand savings potential. Refrigeration energy savings potential is roughly equal to that of cooling but is significantly less important in terms of peak demand potential.

In terms of energy savings, the T8 lamp/electronic ballast (T8/EB) combination continues to hold the position it held at the outset of the 1990s as the measure with the largest potential, even though we estimate that current saturation levels are over 50 percent. Automated perimeter dimming represents a significant savings opportunity as well, though at a cost that generally puts it above the economic threshold. Refrigeration compressor and motor upgrades, occupancy sensors for lighting, office equipment power management, and CFLs round out the measures that represent the largest opportunities.

With respect to peak demand savings, perimeter dimming represents the largest demand savings opportunity, followed by the T8/EB combination. Cooling measures become more significant in terms of peak impacts with high-efficiency chillers and packaged units, as well as chiller tune-ups making up a large share of total potential demand savings. Occupancy sensors and T8/EB plus reflectors also capture at least 5 percent of the total demand savings potential, as they did with respect to energy savings. These measures, when combined, represent about two-thirds of demand reduction potential.

Figure 3-19
Commercial Economic Demand Savings Potential by End Use (2011)

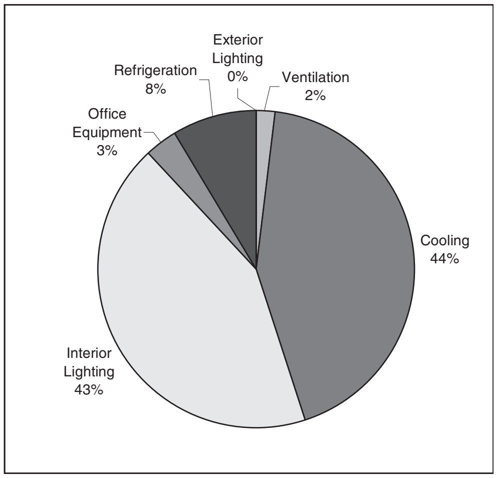
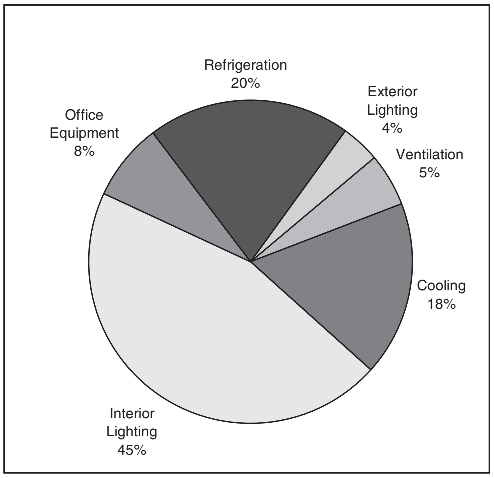


Figure 3-20
Commercial Economic Energy Savings Potential by End Use (2011)



3.4 Electric Efficiency Under Forecast Uncertainty

In this section we present estimates of energy-efficiency potential for several forecast scenarios. Scenario analysis is a tool commonly used to address uncertainty, which is inherent to forecasts. By constructing alternative scenarios, one can examine the sensitivity or robustness of one's predictions to changes in key underlying assumptions.

As defined in Section 2, we created three alternative energy cost forecasts for this study. The results for the Base energy cost scenario are presented above in Sections 3.2 and 3.3. The purpose of developing the Low and High energy cost scenarios is to provide a sensitivity analysis on the effect of uncertain rates and avoided energy costs on estimates of economic and achievable potential. Because of the tremendous uncertainty around estimates of future wholesale and retail energy costs in California, we developed both Low and High energy cost scenarios as alternatives to the Base energy cost scenario. The Low avoided energy costs are simply half of the Base scenario avoided costs throughout the forecast period. The High avoided costs were set at 25 percent above the Base avoided costs throughout the forecast period.

The High avoided-cost scenario captures possible futures in which energy efficiency has a very high value. This could be as a result of a future energy price spike, similar to the 2000-2001 experience, or because environmental impacts are valued more highly than they are today, for example, to meet a greenhouse gas reduction goal.

The Low retail rates were set at 1998 frozen levels and then increased from 2001 by inflation. In the High element, current retail rates continue to rise by inflation throughout the forecast period and do not return to pre-crisis levels; that is, the energy-crisis related rate increases of 2001 are permanent in the High element. The actual avoided-cost and retail rate values for the Low and High elements are provided in Appendix D and summarized further in Section 2.

In Figures 3-21 and 3-22 we present economic and net achievable potential results by energy cost scenario for peak demand reductions and energy savings, respectively. The first thing to notice on these figures is that economic potential is about 9 percent higher under the High scenario and roughly 16 percent lower under the Low scenario than economic potential under the Base avoided-cost forecast. The swing in economic potential is roughly 2,500 MW against Base economic potential of roughly 9,600 MW.

Figure 3-21
Potential Net Demand Savings Under Different Energy Cost Scenarios (2011)

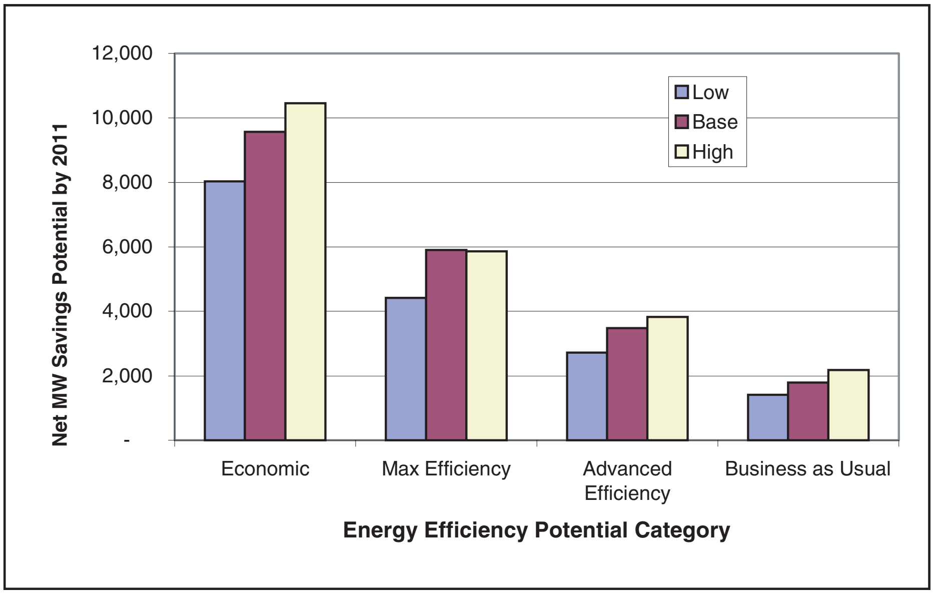
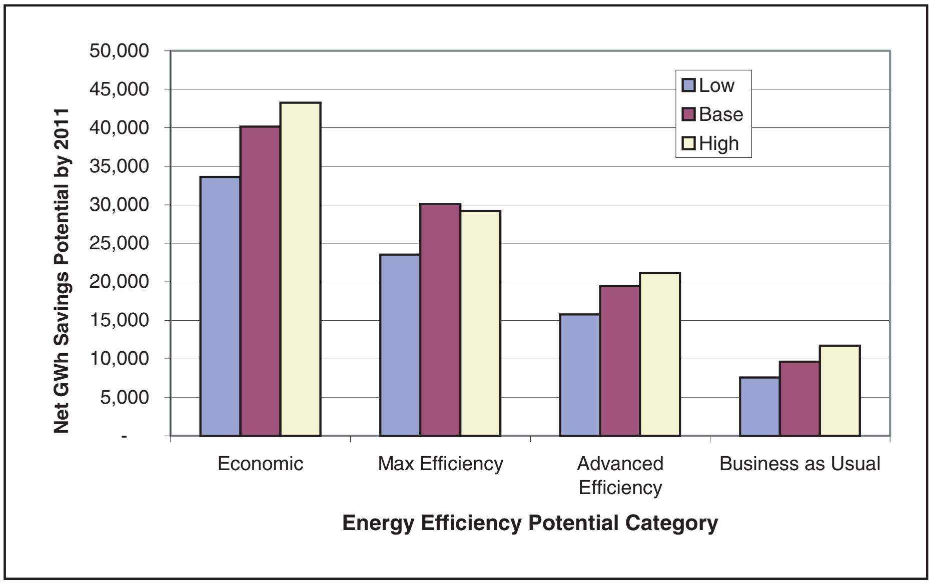
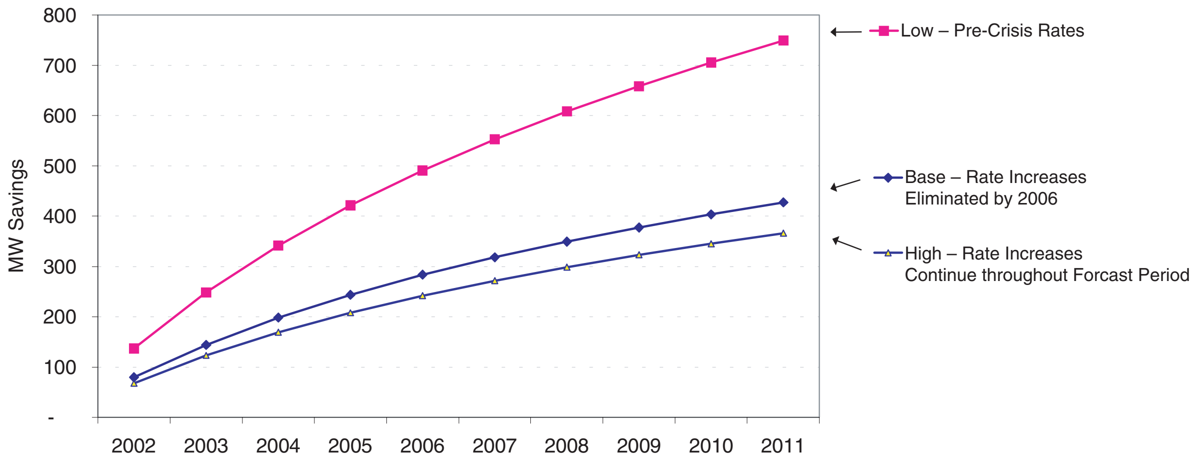


Figure 3-22
Potential Net Energy Savings Under Different Energy Cost Scenarios (2011)



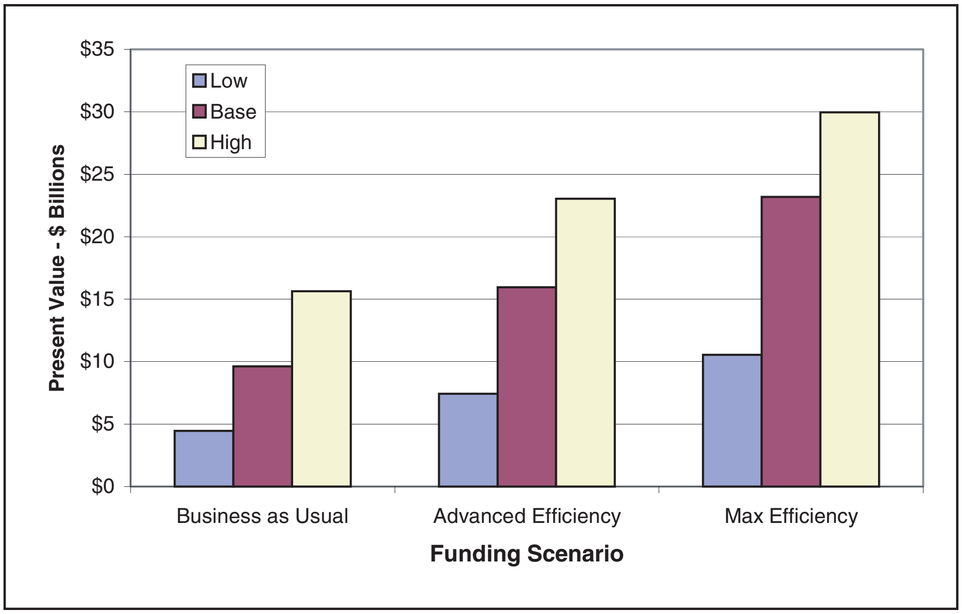
For the Business-as-Usual and Advanced Efficiency cases, the pattern of savings under the alternative energy cost scenarios is similar to the pattern of the economic potentials. However, for the Maximum Achievable case, estimated savings are proportionally lower under the Low scenario (that is, as would be expected given the relationship between the economic potentials), but not proportionally higher under the High scenario (net Maximum Achievable savings are actually very slightly *lower* under the High as compared to Base scenario). The reason for this is not immediately obvious: it is because naturally occurring energy-efficiency savings are significantly higher under the High as compared to Base energy costs. Naturally occurring savings are much higher under the High scenario because of the associated higher rate forecast. Under higher rates, more customers are forecasted to adopt measures in the absence of programs because measures become more economically attractive (paybacks are shorter and return on investments higher). This is shown in Figure 3-23. Naturally occurring peak demand savings are almost twice as high under the High as compared to Base energy cost scenarios (750 MW versus 430 MW by 2011). As a result, net Maximum Achievable savings are similar under the two scenarios.

Figure 3-23
Naturally Occurring Demand Savings Under Different Energy Cost Scenarios



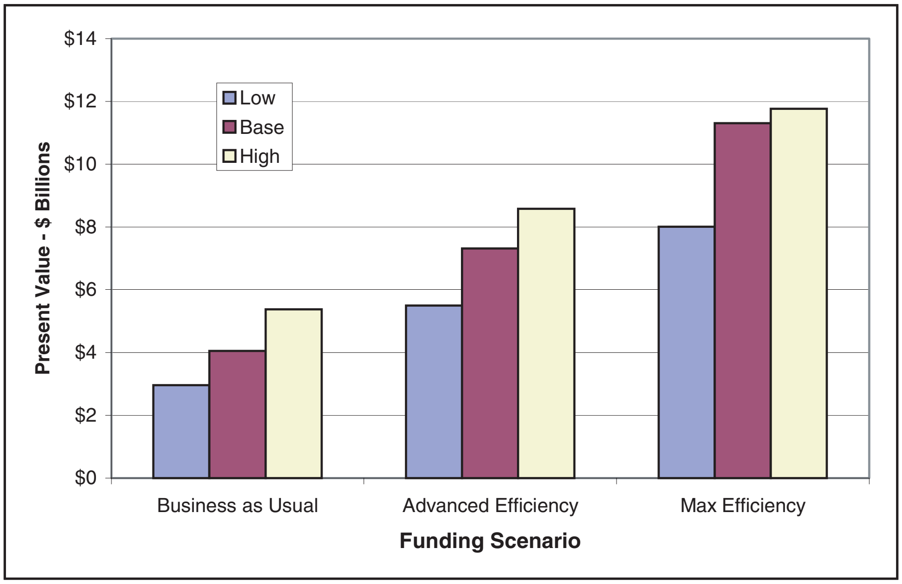
In Figure 3-24 we show total avoided cost savings for each achievable potential case under all three energy cost scenarios. A summary of the key scenario results is provided at the end of this section in Table 3-3. Total avoided cost savings are roughly 45 percent lower under the Low energy costs and 30 to 60 percent higher under the High scenario. Program costs under each scenario are shown in Figure 3-25. Program costs generally follow in proportion to the energy savings under each scenario. Net avoided-cost benefits, which are calculated as total avoided-cost benefits minus program costs and any remaining incremental measure costs to participants, are shown in Figure 3-26. The differences in net avoided costs are more extreme, with net avoided costs being 73 to 79 percent lower under the Low energy costs scenario and 53 to 85 percent higher under the High scenario. The net benefit scenario results are more extreme because the ratio of benefits to costs changes under each scenario, as does the amount of savings.

Figure 3-24
Total Avoided-Cost Benefits over 10 Years (2002-2011)*



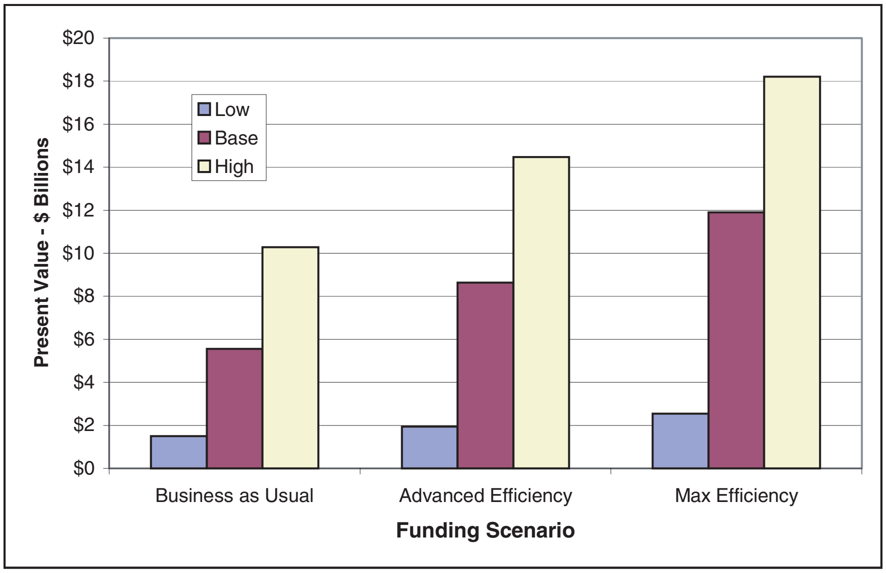
*Present value of avoided-cost benefits over normalized 20-year measure lives, nominal discount rate = 8 percent, inflation rate = 3 percent.

Figure 3-25
Total Program Costs over 10 Years (2002-2011)*



*Present value of program costs over normalized 20-year measure lives, nominal discount rate = 8 percent, inflation rate = 3 percent.

Figure 3-26
Net Avoided-Cost Benefits over 10 Years (2002-2011)*



*Present value of avoided cost benefits over normalized 20-year measure lives, nominal discount rate = 8 percent, inflation rate = 3 percent.

Benefit-cost ratios are shown in Table 3-2. Benefit-cost ratios range from 2.4 to 2.1 under the Base scenario, to 1.5 to 1.3 under the Low cost scenario, to 2.9 to 2.5 under the High cost forecast. Perhaps somewhat surprisingly to some readers, even the Maximum Efficiency case is cost effective under all of the energy cost assumptions, even though virtually all of the measure costs are paid for by the efficiency program incentives. This is partly because incentives are treated as a societal transfer payment in the TRC test and do not affect it directly (see Appendix B for TRC definition). In addition, only those measures that pass the measure-level TRC test are included in the program forecasts.

Table 3-2
TRC Ratios under Different Scenarios

	Funding Level		
Cost Scenario	**Business as Usual**	**Advanced Efficiency**	**Max Efficiency**
Low	1.5	1.4	1.3
Base	2.4	2.2	2.1
High	2.9	2.7	2.5

While it is useful to know that all of the program potential forecasts were cost effective under all of our energy cost scenarios, cost-effectiveness screening does not answer the larger resource-planning question of how much energy efficiency is optimal from a societal or utility perspective. To determine the optimal mix of resources, a broader analytical framework is necessary, as we discuss in Section 5.

Table 3-3
Summary of 10-Year Net Achievable Potential Results (2002-2011) by Scenario*

Scenario	Result	Business-as-Usual	Advanced Efficiency	Max Efficiency
Base	Program Costs:	$2,003 M/Yr	$4,663 M/Yr	$8,196 M/Yr
	Participant Costs:	$2,052 M/Yr	$2,646 M/Yr	$3,111 M/Yr
	Benefits:	$9,604 M/Yr	$15,949 M/Yr	$23,203 M/Yr
	Net GWh Savings:	9,637	19,445	30,090
	Net MW Savings:	1,788	3,480	5,902
	Program TRC:	2.37	2.18	2.05
Low	Program Costs:	$1,569 M/Yr	$3,589 M/Yr	$5,917 M/Yr
	Participant Costs:	$1,394 M/Yr	$1,907 M/Yr	$2,089 M/Yr
	Benefits:	$4,454 M/Yr	$7,436 M/Yr	$10,542 M/Yr
	Net GWh Savings:	7,569	15,769	23,522
	Net MW Savings:	1,408	2,725	4,415
	Program TRC:	1.50	1.35	1.32
High	Program Costs:	$2,369 M/Yr	$5,098 M/Yr	$8,056 M/Yr
	Participant Costs:	$3,006 M/Yr	$3,478 M/Yr	$3,711 M/Yr
	Benefits:	$15,649 M/Yr	$23,036 M/Yr	$29,972 M/Yr
	Net GWh Savings:	11,733	21,146	29,199
	Net MW Savings:	2,178	3,824	5,862
	Program TRC:	2.91	2.69	2.55

*Present value of benefits and costs over 20-year normalized measure lives for 10 program years (2002-2011), nominal discount rate = 8 percent, inflation rate = 3 percent, GWh and MW savings are cumulative through 2011.

4. CONCLUSIONS, IMPLICATIONS, AND RECOMMENDATIONS

In this section, we summarize our key conclusions from this study, discuss implications of the results for energy resource planning in California, and provide recommendations for further analysis and research.

4.1 Summary of Conclusions

Key conclusions from this study are summarized below:

- Over the next 10 years, there is significant remaining achievable and cost-effective potential for electric energy-efficiency[1] savings beyond the Business-as-Usual savings that are likely to occur under continuation of current public goods funding levels.
- Capturing this additional achievable potential would require an increase in public goods funding levels for energy-efficiency programs.
    - For example, doubling public goods funding levels could increase peak MW savings by 2011 from 1,800 MW (under the Business-as-Usual scenario) to roughly 3,500 MW (under the Advanced Efficiency scenario) and produce net benefits of $8.6 billion over the lives of the measures implemented.
- Most of the potential savings are obtainable from energy-efficiency measures that are readily available today, for example:
    - 1,400 MW from efficient fluorescent lighting in commercial/industrial facilities
    - 1,800 MW from high-efficiency air conditioners in all buildings and homes
    - 800 MW from compact fluorescent lamps in the residential sector
    - 1,500 MW from more efficient industrial processes and motor systems.
- There is considerable uncertainty in two of the principal forecasting inputs necessary for analyzing the cost-effectiveness of electric energy efficiency: the avoided-cost benefits of efficiency (that is, the energy purchases and investments in power plant capacity and transmission and distribution infrastructure that would be avoided if demand is decreased through greater efficiency)[2] and retail rates.

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[1] Recall that as defined in this study, in contrast to energy *conservation*, which often involves short-term behavioral changes, energy-*efficiency* opportunities are typically physical, long-lasting changes to buildings and equipment that result in decreased energy use while maintaining constant levels of energy service.

[2] See Appendix B for a presentation of the benefit-cost framework used for this study.

- Estimates of achievable potential under our Advanced Efficiency scenario are fairly robust when run against widely ranging scenarios of future energy costs; however, by definition, less of the technical potential for efficiency is cost effective under our Low energy cost scenario and more is cost effective under our High energy cost forecast.

- The largest gaps between our estimates of economic potential and Business-as-Usual achievable potential are in the residential and industrial sectors. That is, as compared with the commercial sector, a smaller percentage of the economic potential in the residential and industrial sectors is likely to be captured under the Business-as-Usual funding level.

- Although there was a significant amount of solid, empirical data upon which to build the analysis conducted for this study, several key data and methodological uncertainties require significant further work. The majority of these are discussed under the recommendations section at the end of this chapter.

4.2 Implications of Results for Energy Resource Planning

An issue of particular importance raised by this study is the need to move beyond static cost-effectiveness analysis of energy efficiency to a resource portfolio analysis in which the benefits and costs of all potential energy resources (demand and supply) are integrated.

4.2.1 What is the "Right" Amount of Efficiency Funding

As discussed in Section 3, all of the energy-efficiency funding scenarios analyzed in this study were cost effective based on the total resource cost (TRC) test, which the California Public Utilities Commission (CPUC) uses as its principal measure of the ratio of program benefits to program costs. (The TRC test is defined in Appendix B.) If all of the efficiency scenarios analyzed pass the TRC test, one may rightly wonder why current efficiency spending levels are only one-fourth of the highest level shown to be cost effective in this study.

There are several reasons for this. First, the amount of money spent on efficiency programs by the investor-owned utilities (IOUs) in California is directly related to the amount of money collected for such programs from the public goods charge (PGC) on customer bills. The PGC is authorized by SB 1194[3] at a minimum level of roughly $240 million per year. Although the law allows for the PGC to be increased, there is no clear process established for doing so. (Note that *short-term* funding for energy efficiency increased significantly in 2000 and 2001 through

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[3] The minimum funding level for efficiency programs is determined by the PGC authorized in Senate Bill (SB) 1194 and signed into law by Governor Gray Davis in 2000. Under SB 1194, the major IOUs in California are required to collect the PGC through a surcharge on customer bills. The CPUC has regulatory authority over how the IOUs administer the funds.

special legislative action as the state faced an unprecedented supply shortage and price increases, but these were *one-time* temporary funding authorizations[4] separate from the PGC.)

Second, as shown in our scenario results, the amount of efficiency that is cost-effective to purchase is sensitive to assumptions about future avoided costs, about which there is considerable uncertainty. For example, economic potential under our Low energy cost forecast is about 16 percent lower than economic potential under the Base forecast. The uncertainty surrounding electricity and natural gas price forecasts and whether any of the California Department of Water Resources long-term power contracts can be restructured complicates analysis of the avoided-cost value of further reducing consumption in the future.

Third, as discussed below, use of a static cost-effectiveness test, like the TRC, does not provide all of the information necessary to determine the optimal level of investment in energy efficiency. Thus, although the Maximum Efficiency funding scenario in this study is shown to be cost effective based on the TRC test, policy makers and resource planners recognize that the test is designed to serve a *screening rather than optimization* function, and therefore would want to consider the option of increasing funds for efficiency programs against a full portfolio of other resource choices.

Thus, while it is useful to know that all of the achievable potential forecasts were cost effective under all of our future energy cost scenarios, static cost-effectiveness screening does not answer the larger resource-planning question of how much energy efficiency ought to be purchased through the public goods process. The TRC test, like other static benefit-cost tests, is useful for screening purposes but has a number of limitations when used as a basis for major resource planning decisions. For example, the TRC test uses fixed avoided-cost forecasts, does not explicitly consider the cost and availability of other resources (for example, renewable energy sources or demand response to time-differentiated pricing), does not consider location effects (e.g., areas facing transmission constraints), and does not take into account price volatility and risk. Ideally, avoided-cost values should change in a dynamic analytical process that allows response to changes in demand reduction, new power plant construction, supply from renewable energy, price-induced conservation behavior, and price volatilities. Clearly, in order to determine the optimal mix of resources, a broader analytical framework is necessary. Although developing such a framework is not a part of the current study, we see it as the next logical step in a process that is critical to putting California's mix of future electric resources back on track.

4.2.2 An Emerging Framework: Portfolio Management

Recently, a number of industry analysts have begun articulating a broad approach to resource planning that builds upon the lessons learned from both traditional resource planning and the results of electric restructuring. Among others, Harrington, et al., 2002, have articulated *portfolio management* as such an approach. They define portfolio management as:

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[4] These state funding bills included AB970, SB X1 5, and SB X1 29.

> …the long run management of a diverse set of demand and supply side resources selected to minimize risks and long run costs, taking environmental costs into account. The essential characteristic of portfolio management is resource *diversity*. Not mindless diversity, but diversity carefully selected and managed to reduce risk, particularly the risk of price volatility, a salient feature of the wholesale markets.

Prior to electric industry restructuring, the objectives noted above for portfolio management would read reasonably well as the goals underlying the principal resource planning tool used in most of the United States: integrated resource planning (IRP). In that world, utilities were vertically integrated monopolies with the responsibility to build, own, and manage three key assets: generation, transmission, and distribution. Under IRP, many utilities were required to compare the costs, benefits, and functions of a wide array of demand- and supply-side resources, often under alternative future scenarios, to arrive at a well-balanced portfolio of resources that addressed multiple objectives, including minimization of long-term prices and the environmental impacts of electricity production and consumption.

With the advent of restructuring, many utilities, including California's IOUs, divested themselves of generation, and, in some cases, transmission. Under this unbundled market structure, no single entity could be seen as having control over the full suite of supply and demand resources as had been the case previously. Instead, virtually all resource choices were left to the restructured marketplace. This might not be a problem if the essential assumptions upon which theories of purely competitive markets are based were satisfied. Unfortunately, as described by Harrington, et al., 2002, there is strong evidence that these conditions have not been satisfied, and the results can be seen in a variety of failures including the fact that current markets "generally lack a demand response mechanism; transmission investments continue to be made on a planned socialized cost basis; no market participant is making trade-offs between supply- and demand-side options; and distribution companies in many states are trying to balance responsibilities between requirements for what may be very short-term generation needs versus longer-term distribution system operations."

Harrington, et al., 2002 go on to propose that the objectives of portfolio management are to obtain:

- System reliability
- Stable, affordable prices (including reduced price volatility)
- Minimized negative impact on the environment
- Markets untainted by market power
- System security
- The least costly mix of resources given the achievement of the preceding goals.

4.2.3 New Approaches Needed to Assess Risk-Reduction Benefits of Efficiency

We believe new analytical methods are needed to improve upon strategic resource planning processes developed during the period of IRP in the early 1990s. Research is needed that explicitly tackles the question of how investments in demand- and supply-side resources should be optimized in California. What is needed is an approach that builds on the lessons learned from both the IRP period of the late 1980s and early 1990s, and the market-based experiments of the last 6 years. Such an approach would require supply-side forecasts and integration analysis that explicitly incorporate price uncertainty, price volatility, and significant probabilities of future energy "events" such as supply shortages and concomitant price spikes.

Historically, as discussed above, the development of energy-efficiency strategy has been based on integrated resource plans. While this work was admirable, its core elements were based directly on supply planning, planning that was grounded on an investment paradigm that focused on the net present value of revenue and cost streams. By contrast, modern investment theory considers not only the revenue and cost streams, but also the uncertainty around those streams.

This consideration of risk causes modern finance to seek methods of risk mitigation that cause the risk taken to be commensurate with the likely return. The level of cost uncertainty or volatility seen in electricity markets is very high. To help protect ratepayers from future price uncertainty, we believe that energy providers and policy makers need to consider the full range of risk mitigation alternatives. Energy efficiency provides a clear risk management opportunity. The advantages of energy efficiency as a hedge should be analyzed against alternatives requiring market premiums within a process that achieves the overall goals of portfolio management.[5]

4.3 Recommendations for Further Efficiency Potential Research

Further research is needed to improve both the data and methods required for accurate estimation of electric energy-efficiency potential in California. The primary areas of research needed to reduce uncertainty in key inputs to efficiency potential estimates include the following:

- ***Improve estimates of current efficient measure saturation.*** Initial estimates of measure saturation data used for this study were obtained from sources for which data collection occurred in the mid-1990s (PG&E 1999, SDG&E 1999a, SCE 1996). These estimates of saturation were updated to our base year 2000 by estimating saturation accomplishments associated with the California utilities' programs from

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[5] Renewable resources and price-responsive demand also appear to offer hedging benefits see, for example, Bolinger and Wiser, 2002 and Hirst 2002.

the mid-1990s to 2000. These estimates are uncertain. Fortunately, the California Energy Commission (CEC) is in the process of conducting two major updates to energy-efficiency saturation data for the commercial and residential sectors. New estimates of measure saturation that account for actions through 2002 will be available in the second half of 2003. Once available, these new saturation estimates should be used to update estimates of remaining potential in the state.

- ***Improve estimates of sustained conservation and efficiency resulting from 2001 energy crisis.*** As is well documented, the energy crisis of 2001 spawned a sharp drop in energy consumption and peak demand, much of which is hypothesized to be attributable to conservation behavior rather that efficient hardware improvements. For example, a recent study by Lawrence Berkeley National Laboratory (Goldman, Eto, Barbose 2002) estimates that about one-quarter of the 8-percent drop in peak demand in California in 2001 is attributable to equipment-based efficiency and on-site generation installations (which will persist for many years) while the remainder of the 2001 reduction in peak load (~3,000 MW) is attributable to behavioral and energy management practice changes for which it is difficult to predict the extent to which savings will persist. Because of the lack of adequate information available during the time of our study on the components and durability of energy and peak demand reductions in 2001, our study used 2000 as the base year for estimates of hardware-based electric efficiency. These estimates will need to be adjusted to account for both permanent efficiency improvements in 2001 (and 2002) and any sustained conservation behavior. On-going research is critically needed to better understand, characterize, and forecast the components of savings (that is, at the sector, end use, and measure level) associated with the 2001 energy crisis and the extent to which they persist.

- ***Improve estimates of efficiency potential for the industrial and new construction sectors.*** As noted in the introduction to this report, our study leverages two recent and comprehensive studies of efficiency potential (XENERGY 2002a and b) conducted for Pacific Gas & Electric Company (on behalf of the CPUC) and the CEC. These studies were conducted for the existing construction segment of the commercial and residential buildings sectors. Estimates of potential for the industrial and new construction sectors developed for the current study require significant expansion and enhancement to be on par with the research underlying the commercial and residential sectors. Fortunately, the CPUC has allocated funds in 2002 for developing and improving estimates of efficiency potential for these and other market segments.

- ***Improve forecasts and tracking of customer adoption of efficiency measures.*** Forecasting customer adoption of energy-efficient technologies and practices requires a strong empirical foundation. The key need in this area is further collection and development of historic and current measure penetration data to use as the basis for calibrating forecasting models like those used in this study (see Appendix B). A concurrent need is to develop a statewide database of measures adopted with public goods funds or other programmatic support. Currently, there is no measure-level database of all statewide program accomplishments available in a single, consistent format. There is also a need to improve tracking of measure adoption outside of programs (naturally occurring penetration as defined in Section 2 and Appendix B). Currently, there is a successful multi-year project to track the market share of energy-efficient products and practices in the residential sector (this work is managed by Southern California Edison on behalf of the CPUC with public goods funds, see RER 2002a and b); a related (though less comprehensive) project is in progress for the nonresidential sector (managed by the CEC also on behalf of the CPUC with public goods funds).

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APPENDIX A. ELECTRICITY USE IN CALIFORNIA

In this appendix we provide a background discussion of electricity use in California. We begin by presenting historical use for the State, and then focus on historic accomplishments of California energy-efficiency programs and policies. We then provide a short discussion comparing California energy use with the rest of the U.S. Finally, we discuss the California Energy Commission (CEC) electricity forecasts that form the base for our analysis.

A.1 Historic Electricity Consumption

California has long been one of the fastest growing states in the United States. Its population has grown from 20 million in 1970 to 34 million in 2000. The gross state product increased over the same period from \$112 billion[1] to \$1,260 billion. Because electricity use is strongly correlated with population and economic growth, the State's energy use has also increased over the past 40 years. The State's energy consumption and percent change in annual electricity use since 1960 are shown in Figure A-1. In the 13 years preceding the country's first energy crisis in 1973, electricity use in California almost tripled, from 50,000 GWh per year to almost 150,000 GWh per year. The annual rate of electricity growth during these years averaged over 5 percent per year. Over the following quarter century, the average rate of growth of electricity was significantly reduced in California. Electricity growth averaged 3.2 percent per year in the 1980s and only 2.2 percent per year in the 1990s.[2] In fact, while per capita electricity consumption has increased by 50 percent since 1973 in the United States[3] as a whole; remarkably, per capita use in California has been held constant. As a result, California is the nation's most efficient state in terms of per capita electricity consumption. As discussed in Section 3 of this report, much of this is likely a direct result of the State's conscious efforts to fund and promote energy efficiency through programs and state standards.

To understand and estimate the potential for further efficiency improvements in California's electrical energy use, it is important to understand how electricity is used in the State. Two key dimensions of electricity use are sector and end use. Sector refers to the type of customer using electricity (e.g., commercial, residential, etc.), while end use is a term used to refer to service desired by the electricity (e.g., lighting or cooling). Electricity use in California has long been dominated by

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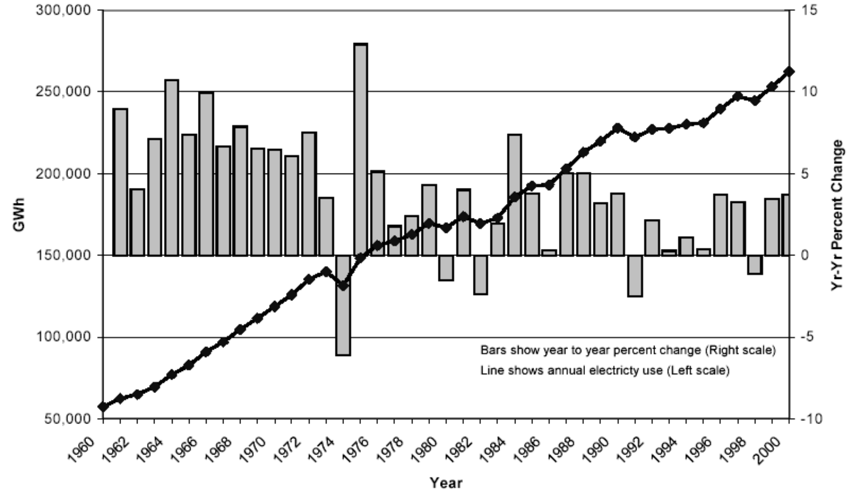
[1] Source: U.S. Department of Commerce, Bureau of Economic Analysis

[2] Brown, R.E. and Jonathan G. Koomey, 2002. *Electricity Use in California: Past Trends and Present Usage Patterns*, Review Draft, Lawrence Berkeley National Laboratory, LBNL-47992. January.

[3] Note that although per capita use in the US has grown significantly since the 1973 energy crisis, the 1.6 percent rate of growth was well below the 5 percent rate of annual growth in the fifteen years preceding the 1973 crisis.

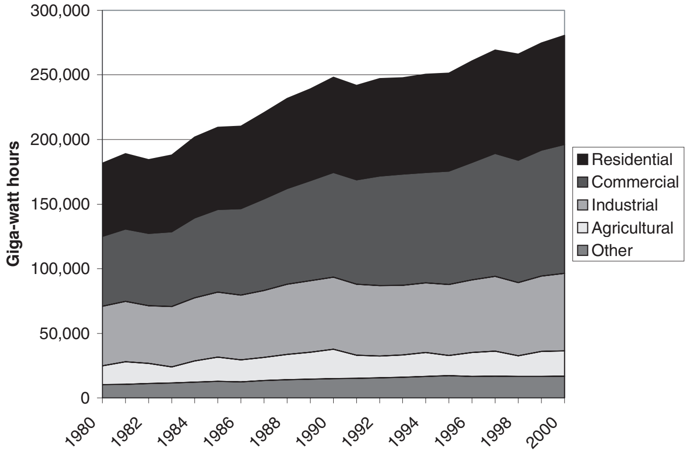
the residential, commercial, and industrial sectors, as shown in Figures A-2 and A-3. The commercial sector makes up the largest share of recent electricity consumption, representing 36 percent of the State's usage, followed by the residential sector at 30 percent and the industrial sector at 21 percent. The agricultural sector, which dominates the State's water use, makes up 7 percent of its electricity consumption, while other customers, such as transportation and street lighting accounted for the remaining 6 percent. In 1980, the commercial sector represented only 30 percent of total usage. Since 1980, the commercial sector has grown most rapidly, averaging 3 percent per year, while the industrial sector grew most slowly, averaging just 1.3 percent per year. Residential use grew by 2 percent per year over the same period.

Figure A-1
California Electricity Consumption: 1960 – 2000*



*Excludes line losses.
Source: California Energy Commission (CEC) 2001a. *2002 - 2012 Electricity Outlook*. P700-01-004.

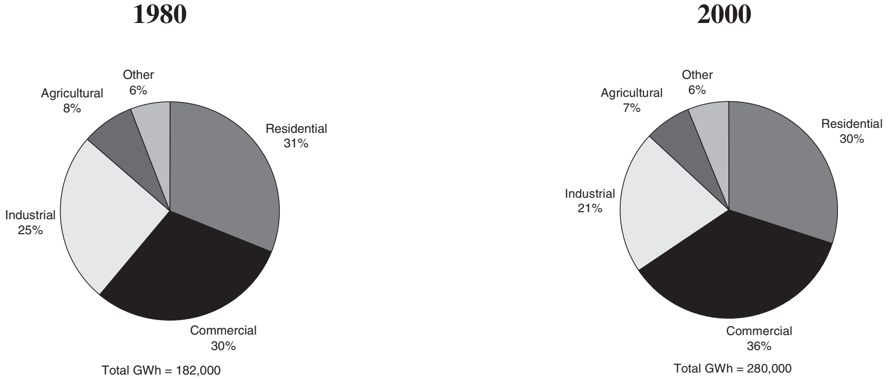
Figure A-2
California Electricity Consumption by Sector: 1960 – 2000*



*Includes line losses.

Source: California Energy Commission (CEC) 2000. *California Energy Demand: 2000-2010*. P200-00-002.

Figure A-3
Breakdown of California Electricity Use by Sector: 1980 and 2000

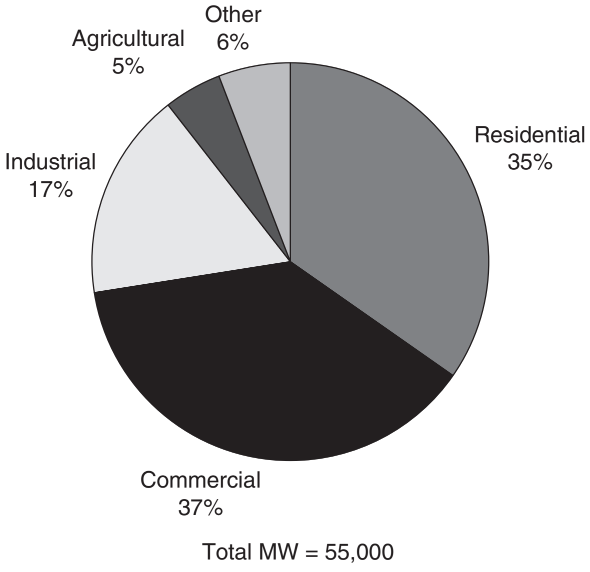

1980

2000

Source: Brown, R.E. and Jonathan G. Koomey, 2002 and CEC 2000. *California Energy Demand: 2000-2010*.

When we look at peak electrical demand in the State, shown in Figure A-4, we see that the commercial and residential sectors are even more significant, accounting for a combined 73 percent of peak load in 2000. Rates of growth for peak demand by sector have been similar to those for electricity consumption over the past 20 years.

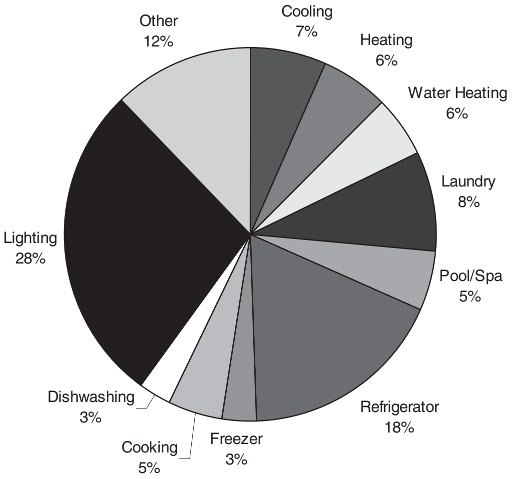
Figure A-4
California Peak Electricity Demand by Sector: 2000*



*Includes line losses.
Source: California Energy Commission (CEC) 2001a. *2002 - 2012 Electricity Outlook*. P700-01-004.

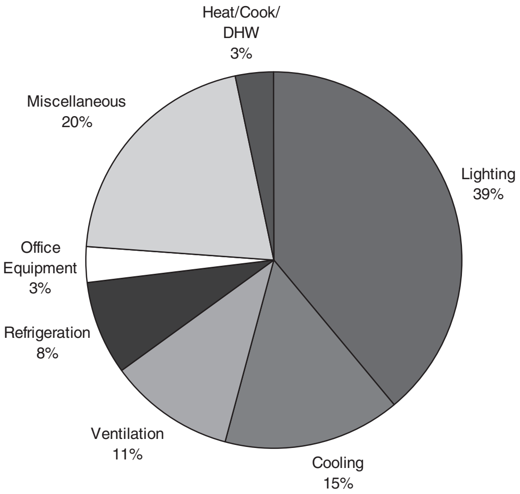
Electricity is used within each sector for a wide variety of purposes. For example, in the residential and commercial sectors, building occupants use electricity to obtain lighting, thermal comfort, refrigeration, and other services. In the industrial sector, electricity is used primarily to manufacture products that are used throughout all sectors of the economy. Agricultural electricity use provides for the pumping of water for crops and refrigeration for dairies. Electricity is used to provide street lighting and the movement of electric trains for mass transit systems. Figures A-5 through A-7 show the end-use breakdown for the three major energy consuming sectors: residential, commercial, and industrial.

Figure A-5
Residential Energy End-Use Breakdown, 2000



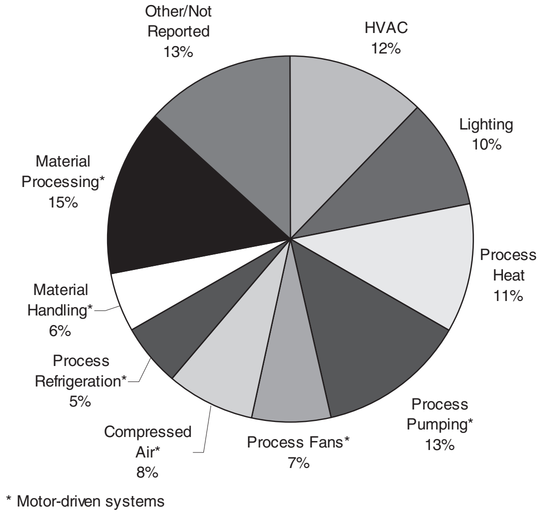
Source: CEC 2000. *California Energy Demand 2000-2010* and XENERGY analysis.

Figure A-6
Commercial Energy End-Use Breakdown, 2000



Source: CEC 2000. *California Energy Demand 2000-2010* and XENERGY analysis.

Figure A-7
Manufacturing Energy End-Use Breakdown, 2000



Source: U.S. DOE Manufacturing Energy Consumption Survey, Utility Billing Data, and XENERGY analysis.

Because California is a summer peaking state, that is, the maximum amount of electricity needed occurs during the hottest days of the summer, it should not be surprising that electricity to provide the cooling and ventilation of residential and commercial buildings accounts for the largest share of peak demand, roughly one-third of total, or approximately 16,000 MW of peak demand in 1999. Commercial lighting makes up the next single largest end-use share of peak demand at over 5,000 MW. Other key contributors to peak demand include industrial manufacturing (roughly 6,000 MW) and residential lighting and refrigerators (5,000 to 6,000 MW).[4] Key contributors to peak demand are presented graphically in Figure A-8.

A.2 Historic Accomplishments of California Energy-Efficiency Programs and Policies

California has long been both a national and international leader in developing programs and policies aimed at increasing the efficiency with which electricity is used in the State's economy. Spending on programs, however, has increased and decreased, sometimes dramatically, over time. Some of the key milestones and trends in the 25-year history of efficiency programs in the State include the following:

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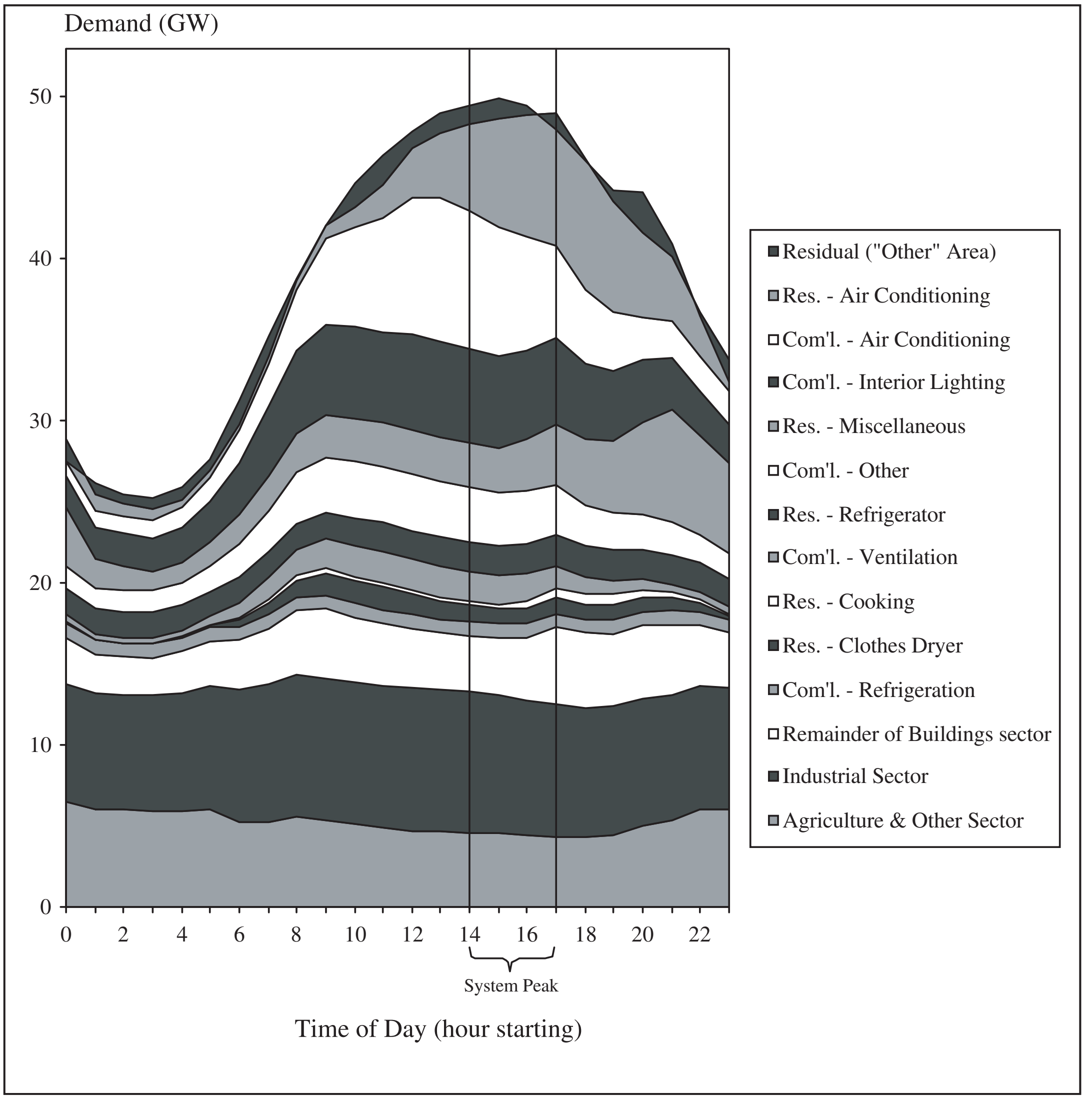
[4] Figures cited are from Brown and Koomey's (2002) analysis of CEC and FERC data for 1999.

- In the mid-1970s, the State, through the CEC, developed comprehensive energy codes to require that new residential and commercial buildings and appliances meet minimum energy-efficiency standards. The CEC subsequently worked on 3-year cycles to continuously review and upgrade building standards. In 2001, the CEC adopted a set of emergency standards in response to the energy crisis.

Figure A-8
Largest Contributors to California Peak Demand



Source: Brown and Koomey 2002.

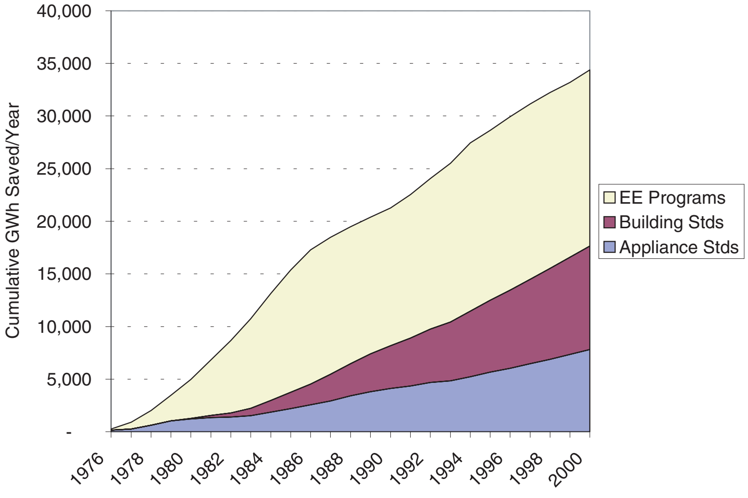
- In the late 1970s and 1980s, energy regulators and utilities developed and implemented the first utility-based energy savings programs for the State's major IOUs. These programs focused on squeezing out unnecessary energy waste and installing first-generation efficient equipment. Spending on these programs grew rapidly in the early 1980s but then plummeted in the late 80s as wholesale energy prices decreased.

- In the early 1990s, a group of government, utility, and public interest groups worked together to develop a process for reinvigorating investment in energy efficiency. The California Collaborative, as the group was known, developed an incentive mechanism that rewarded utilities for effective investments in energy-efficiency programs. The work of the Collaborative led to a new surge in efficiency investments that lasted until 1996, when the process of electric restructuring led to another dramatic drop in efficiency program spending.

- In the late 1990s, recognizing their long-term value to the State, California held programs and funding in place during restructuring, at a time when other states completely eliminated programs and funding. Nonetheless, programs in the late 1990s faced several challenges: funding levels were lower than during the earlier part of the decade, policy objectives shifted from resource acquisition to market transformation, and the nexus of program oversight shifted temporarily to the California Board for Energy Efficiency.

Savings from the State's appliance and building standards occur every year directly as a function of construction of new buildings and purchases of new appliances covered by the standards. Because standards require minimum efficiency levels, these savings are immediate and permanent and tend to follow building construction activity levels. Savings from efficiency programs, run primarily by utilities, vary over time mainly as a function of program expenditure levels. As shown in Figures A-9 and A-10, cumulative energy and peak demand savings from programs and standards were approximately 34,000 GWh per year and 9,000 MW, respectively, through the year 2000. Savings from energy-efficiency programs accounted for roughly half of the impacts.

Figure A-9
Energy Savings Impacts of Energy-Efficiency Programs and Standards



Source: Historic data compiled by CEC staff. Smith 2002.

Savings from energy-efficiency programs have varied widely throughout the past 25 years as a function of changes in annual funding levels. As shown in Figure A-11, spending levels have peaked twice, once in 1984 and once in 1993, while expenditure downturns and valleys occurred in the latter half of both the 1980s and the 1990s. These dramatic funding swings have reflected changes in policy makers' perceptions about energy prices and the need for new power plants, as well as philosophical shifts in the State's political and regulatory orientation. Expenditures increased in 2000 primarily because of the use of carryover funds that were not expended in previous years and a surge in program demand driven by the increase in wholesale and retail[5] electricity prices that occurred in the second half of the year.

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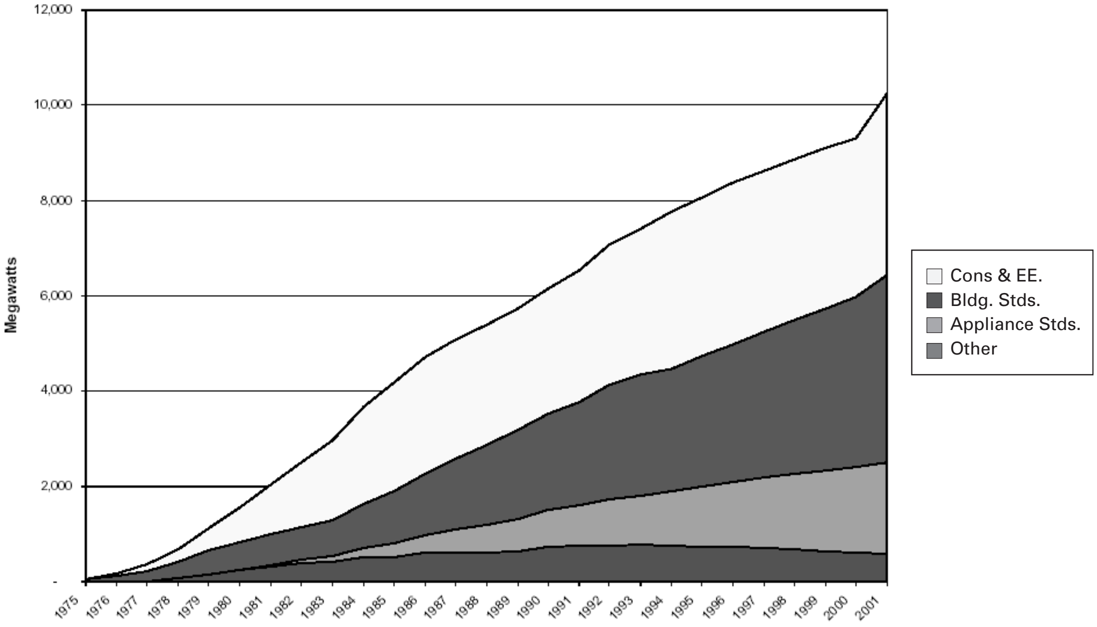
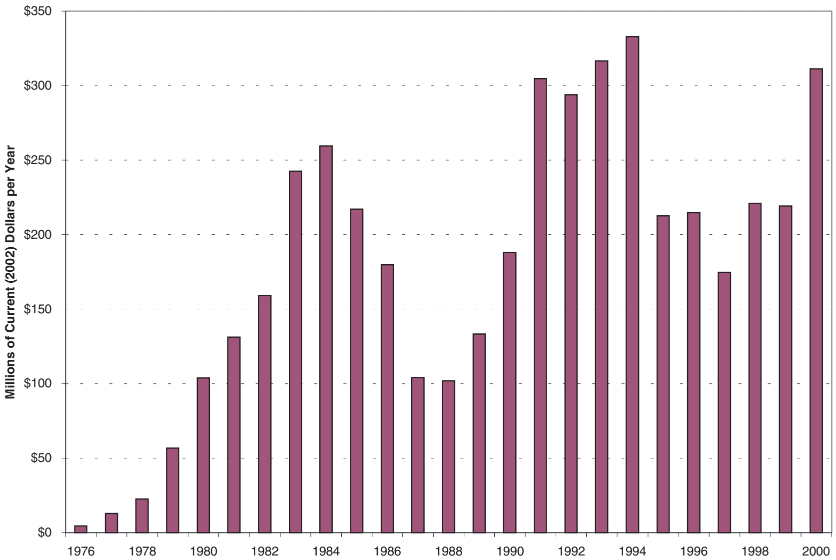
[5] Only customers in the SDG&E service territory were exposed to increased retail prices in the summer of 2000.

Figure A-10
Peak Demand Impacts of Energy-Efficiency Programs and Standards



Source: California State and Consumer Services Agency 2002

Figure A-11
Annual Electric Energy-Efficiency Program Expenditures for Major IOUs (in current dollars)



Source: Historic data compiled by CEC staff. Smith 2002.

Annual program impacts for major IOU electric efficiency programs are shown in Figures A-12 and A-13. The pattern of energy savings over time generally follows expenditure levels. First-year energy savings of 1,800 GWh have been achieved during spending peaks, but first-year savings have tended to average around 1,000 GWh. Peak demand savings have averaged around 200 MW but reached a peak of over 400 MW in 1994. Nonresidential program savings have accounted for an average of 80 percent of energy savings historically, but represented closer to 70 percent of savings in recent years.

Figure A-12
First-Year Electric Energy Savings for Major IOUs' Efficiency Programs

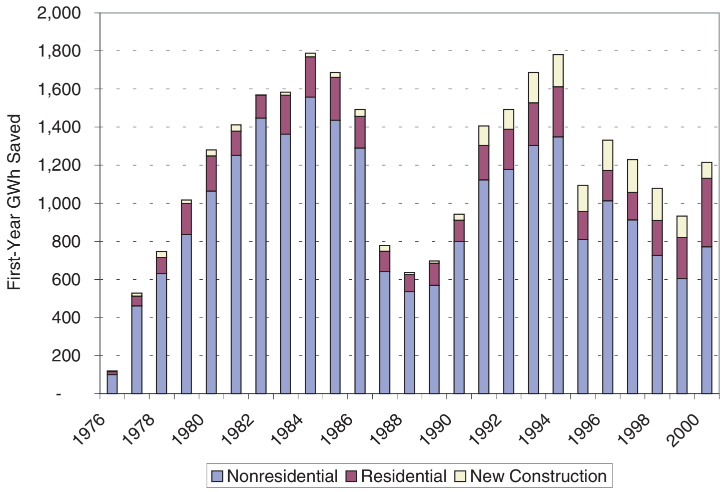
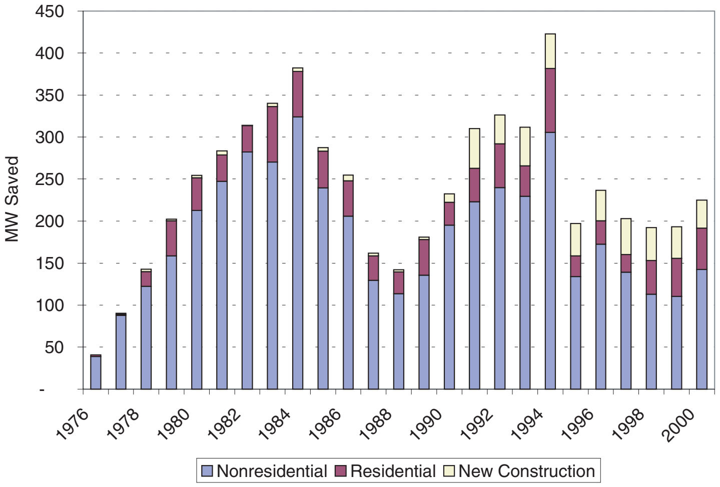
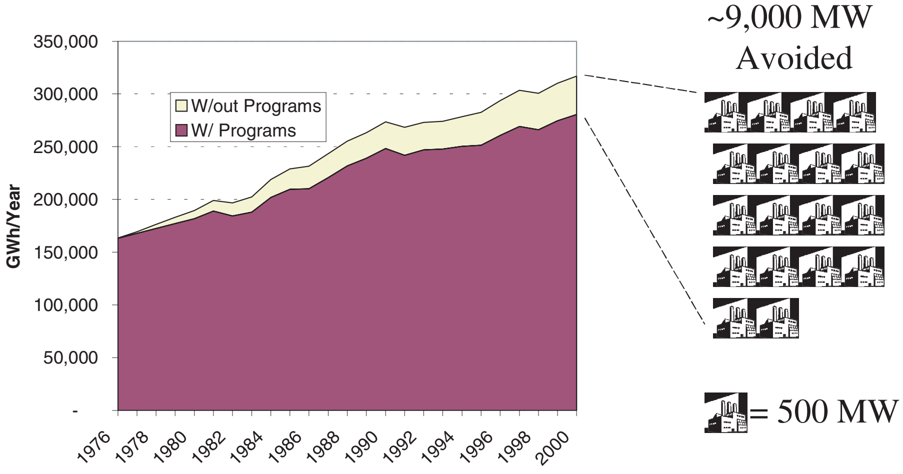


Figure A-13
First-Year Peak Demand Savings for Major IOUs' Efficiency Programs



The cumulative effect of California's efficiency programs and standards is shown in relation to actual energy consumption over the past 25 years in Figure A-14. According to CEC estimates, these programs and policies have resulted in savings of 9,000 MW, equivalent to avoiding construction of 18 500-MW power plants.

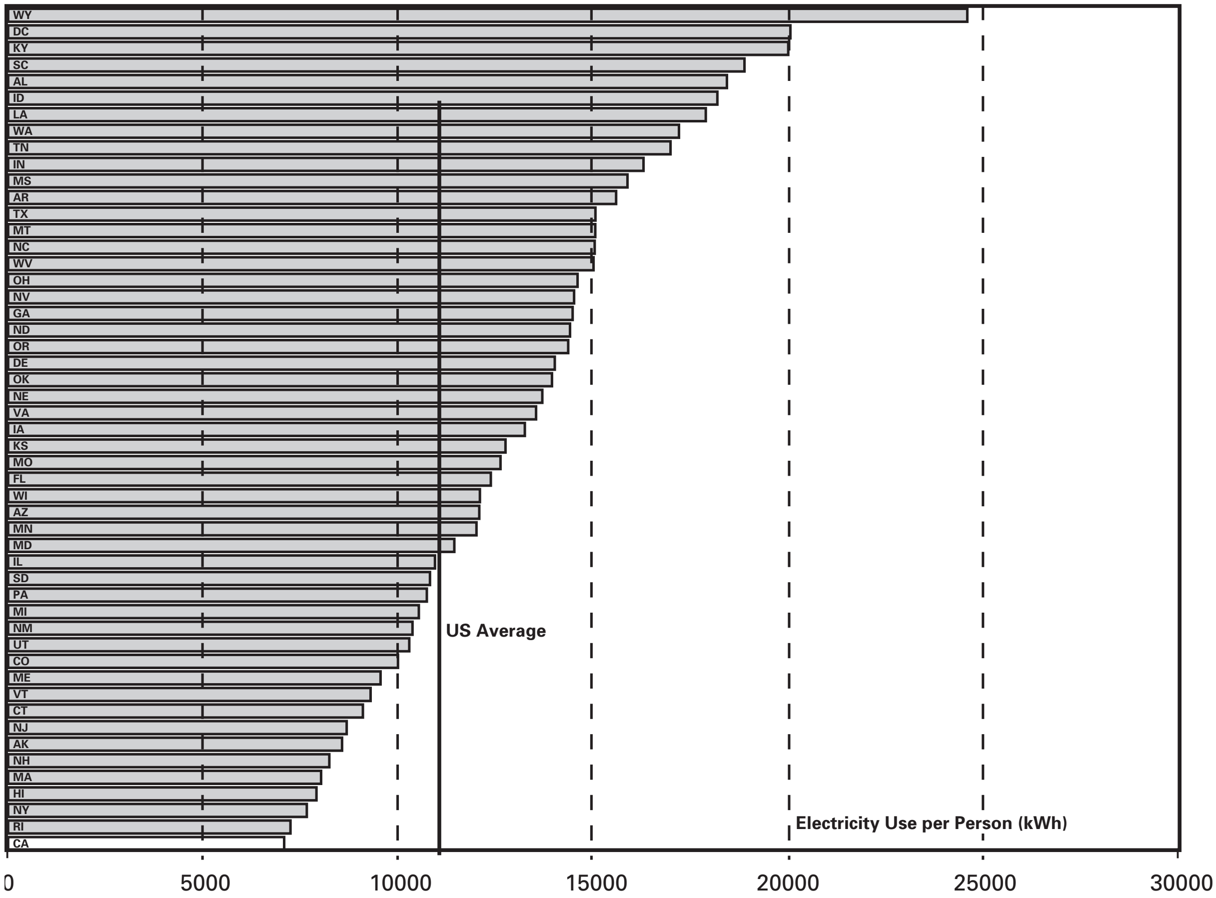
Figure A-14
Cumulative Impact of California Efficiency Programs and Standards



A.3 Efficiency of California Electrical Use Compared to Rest of U.S.

Partly as a result of the State's assertive energy programs and policies, California is the nation's most efficient state in terms of per capita electricity consumption, as shown in Figure A-15. Electricity use in California and the rest of the U.S. is a function of many factors. Generally, electricity use increases during times of increased economic activity and population growth and decreases or remains flat during periods of weak economic activity or net decreases in population growth. Electricity use changes as a result of another key factor: *efficiency*. Efficiency measures the amount of work or useful services that are obtained from a unit of energy consumed. The more efficient an energy-using system, the more work or useful service, such as light or heat, that is obtained per unit of energy consumed. Note that *efficiency* is not the same as *conservation*. Conservation involves using less of a resource, usually through behavioral changes, such as raising a thermostat setting from 75° to 78° F for air conditioning on a hot day. As a result of the availability of gains from efficiency and conservation, the relationship between economic growth and electricity use is far from constant.

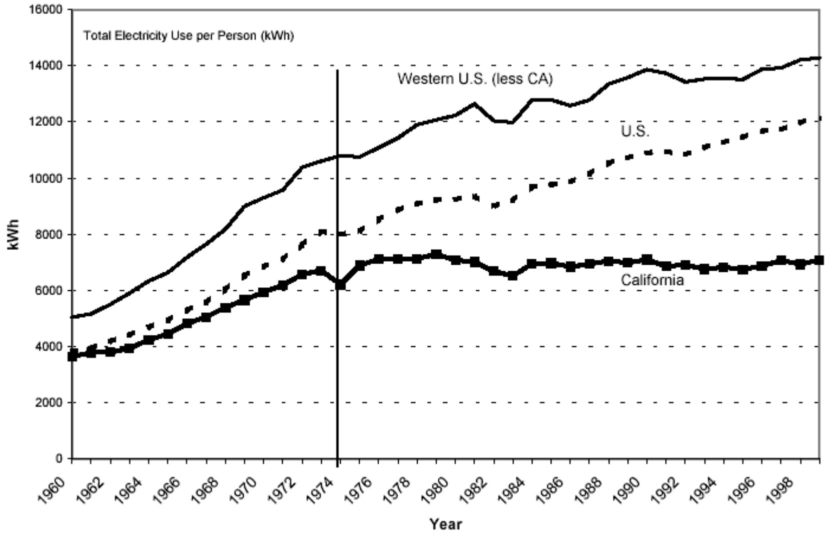
Figure A-15
California is Most Efficient: per Capita Electricity Consumption by State



Source: California Energy Commission (CEC) 2001a.2002 - *2012 Electricity Outlook*. P700-01-004.

As shown in Figure A-16, since 1974 electricity use per person in the U.S. has grown at an annual rate of 1.7 percent. Over the same time period, however, per capita electricity use in California has remained almost constant, growing at only 0.1 percent per year; while per capita use in the rest of the western U.S. grew at 1.2 percent. Because of its focus on continuously improving its energy standards and efficiency programs, California has become the nation's most efficient state in terms of per capita electricity use. Had California's per capita electricity use increased at the same rate as did the rest of the country's over the last quarter century, peak demand in the State would have been 15,000 MW higher than it was in 2000. This would have required the construction and siting of roughly 30 additional major power plants throughout the State.

Figure A-16
Electricity Consumption per Capita: 1960 - 2000



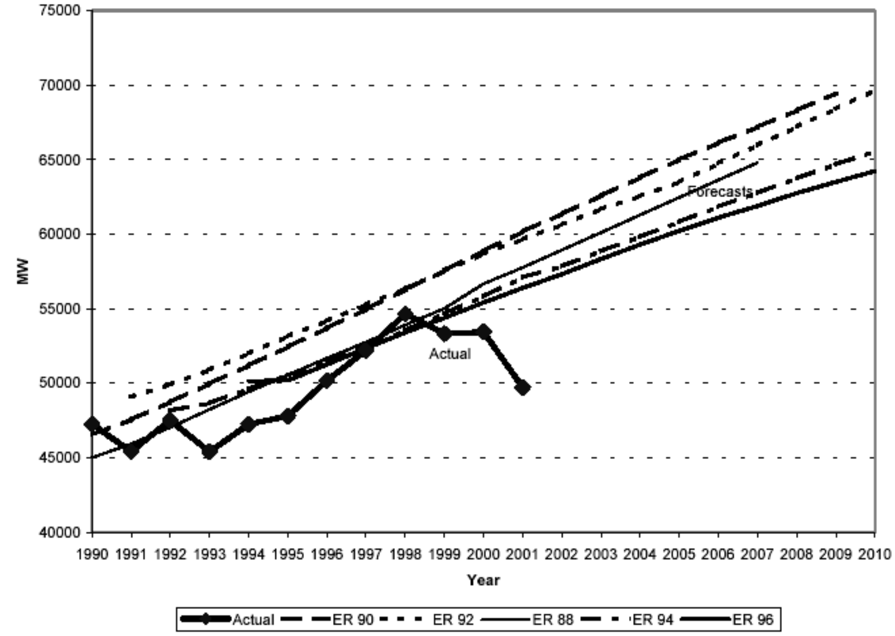
Source: California Energy Commission (CEC) 2001a. *2002 - 2012 Electricity Outlook*. P700-01-004.

A.4 CEC Forecasts of Future Consumption and Peak Demand

A.4.1 Historic Forecasts

To estimate energy-efficiency potential over time, it is necessary to benchmark savings to a forecast of electricity consumption. Fortunately, in California there is a consistent statewide process in place for electricity forecasting at the CEC. The CEC has conducted such forecasts for many years. Throughout much of the 1980s and 1990s, these forecasts were produced as part of biannual Electricity Reports (ER). Examples of forecasts produced for 1988 (ER88) through 1996 (ER96) are shown in Figure 2-11. Note that the historic forecasts assume normal weather and economic conditions. Actual consumption and peak demand in any given year can vary considerably in response to these to conditions.

Figure A-17
CEC Peak Demand Forecasts Versus Actual



Source: California Energy Commission (CEC) 2001a. *2002 - 2012 Electricity Outlook*. P700-01-004.

A.4.2 2001: An Extraordinary Year

On average, the CEC's forecasts have proven fairly accurate over time; however, like virtually all forecasts, the CEC's methods are not intended to predict extraordinary changes in usage associated with unexpected events like the energy crisis experienced in the second half of 2000 and most of 2001. As has been documented extensively elsewhere, energy consumption and peak demand decreased dramatically in 2001. This reduction is shown on a monthly basis, normalized for changes in weather and economic conditions, in Figure A-18. This reduction occurred as the result of a combination of voluntary demand response from consumers and installation of energy-efficient equipment spurred both by the crisis itself and increased energy-efficiency program efforts.[6,7] The fraction

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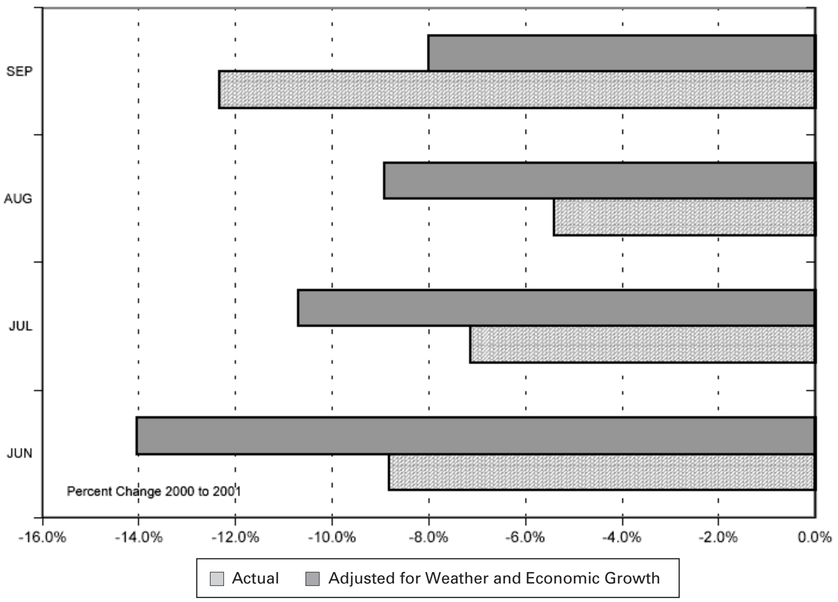
[6] For an analysis of the 2001 summer demand reduction, see *The Summer 2001 Conservation Report*, published by the California State and Consumer Services Agency, produced by the CEC under the direction of the Governor's Conservation Team, February 2002.

[7] According to CEC 2001a, key factors driving both voluntary and hardware changes included demand reduction programs, electricity price increases, the 20/20 rebate program, winter rolling outages, and media exposure of the energy crisis and its potential costs to the State and consumers.

of the reduction in 2001 attributable to voluntary conservation efforts versus installation of major energy-efficient equipment[8] is not currently known with certainty. However, it is likely that the majority of the reduction was due to voluntary conservation efforts. For example, Goldman et al. (2002), estimate that roughly 70 percent of Summer 2001 peak demand reduction was attributable to voluntary conservation efforts.

Figure A-18
Summer 2001 Peak Demand Reductions



Source: California Energy Commission (CEC) 2001a. *2002 - 2012 Electricity Outlook*. P700-01-004.

A.4.3 Current Forecast Scenarios

In response to the extraordinary reduction in peak demand and consumption that occurred in 2001, the CEC's latest forecast deviates from its previous forecasting approach, in that it focuses on scenarios rather than single-point estimates over time. According to the CEC (2001a):

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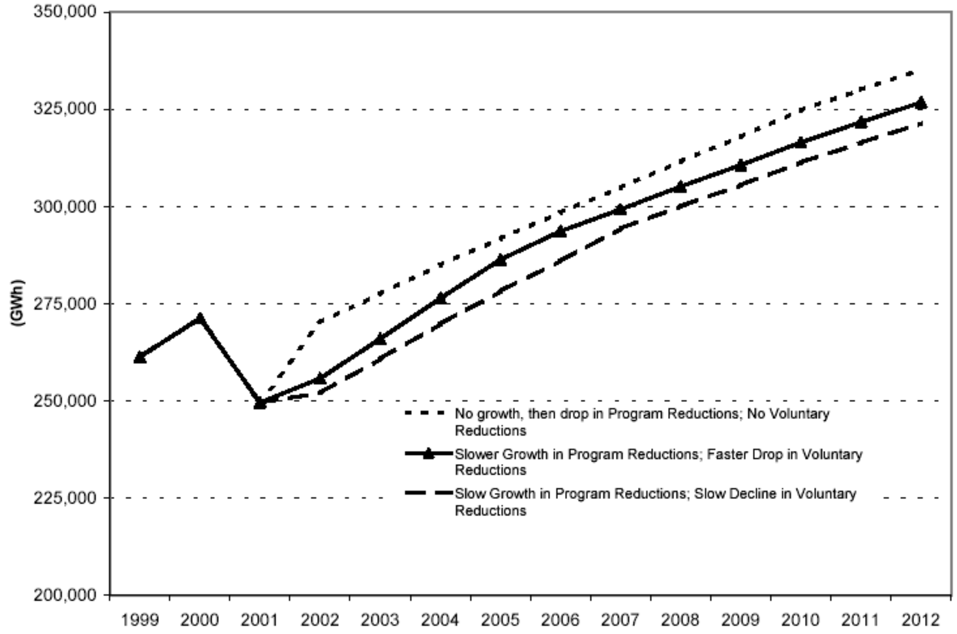
[8] *Conservation* refers here to behavioral changes in energy use, such as turning up thermostat settings during cooling periods; *efficiency* refers to permanent changes in equipment that result in increased energy service per unit of energy consumed, e.g., the installation of a more efficient air conditioner.

> The uncertainty about what caused the demand reduction in the summer of 2001, in particular, the uncertainty about how much was due to temporary, behavioral changes and how much was due to permanent, equipment changes, contributes to increased uncertainty about future electricity use trends. To capture this uncertainty about future electricity use, three scenarios were developed. These scenarios combine different levels of temporary and permanent reductions to capture a reasonable range of possible electricity futures.

The CEC developed several possible patterns of future trends in summer 2001 demand reductions. These patterns were based on alternative assumptions about the level and persistence of voluntary impacts and permanent, program impacts. (Note that *program* impacts, as used in the CEC's forecast scenarios, refer to the emergency program efforts initiated in response to the State's energy crisis, i.e., programs funded under SB 5X, AB 970, and AB 29X, not the public goods charge-based efficiency programs administered primarily by the State's major IOUs.) The CEC developed three scenarios, one of which was selected as the most likely case, while the other two scenarios represent higher and lower cases. Figures A-19 and A-20 show these energy and peak demand forecast scenarios.

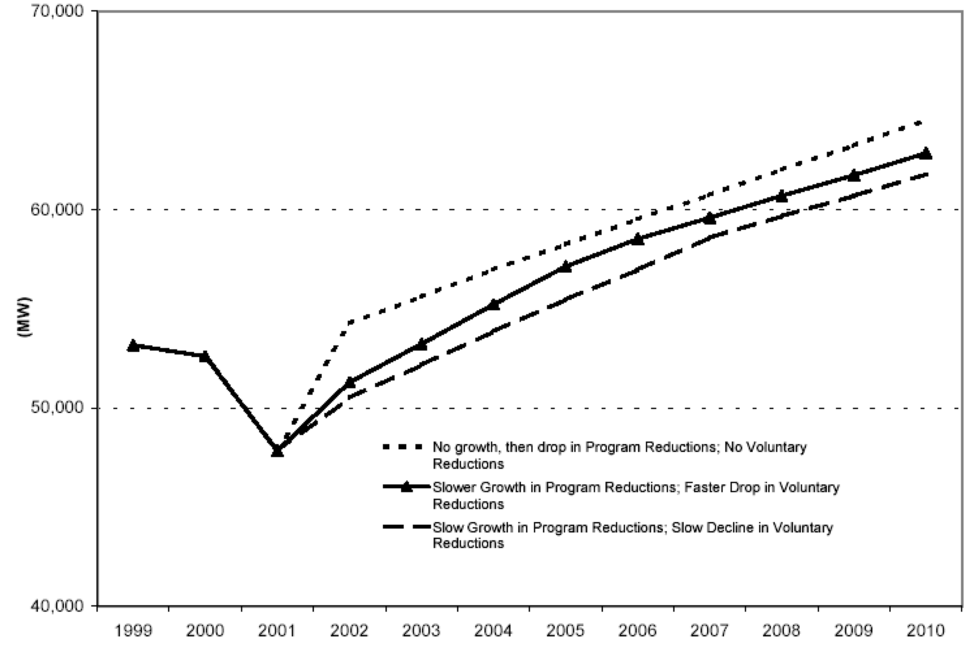
Figure A-19
CEC Energy Consumption Forecasts



Source: California Energy Commission (CEC) 2001a. *2002 - 2012 Electricity Outlook*. P700-01-004.

The electricity demand forecast scenario the CEC believes is the most likely scenario, is labeled "Slower Growth in Program Reductions; Faster Drop in Voluntary Reductions" and assumes that program impacts increase in 2002 but stay constant after that, while voluntary impacts decrease more rapidly. Under this scenario, 50 percent of the peak load reductions that occurred in 2001 persist for several years. The lower demand forecast scenario, labeled "Slow Growth in Program Reductions; Slow Decline in Voluntary Reductions," assumes that program impacts grow from 2001 to 2006 while impacts of voluntary reductions drop slowly over the period after an initial drop of 1,000 MW in 2002. Under the lower scenario, roughly 75 percent of 2001 reductions persist. The higher scenario, labeled, "No growth, then drop in Program Reductions; No Voluntary Reductions," assumes that there are no impacts from voluntary actions in 2002 and after, while impacts of programs stay constant until 2005 and then start declining. Under the higher scenario, only about 13 percent of the 2001 reductions persist.

Figure A-20
CEC Peak Demand Forecasts



Source: California Energy Commission (CEC) 2001a. *2002 - 2012 Electricity Outlook*. P700-01-004.

A.4.4 Use of 2000 for Base Energy and Peak Demand for this Study

Note that for this study we relied primarily on data from the CEC's previous energy forecast (CEC 2000), which predated the unprecedented drop in peak demand and energy use that occurred in response to the energy crisis. As a result, our estimates of efficiency potential presented in this report are exclusive of voluntary, behavioral reductions and efficiency improvements that occurred in 2001.

APPENDIX B. METHODOLOGY DETAILS

B.1 Overview

In this section, we elaborate on the methods used to conduct this study that were introduced in Section 2. We explain the specific steps and methods employed at each stage of the analytical process necessary to produce the results presented in this report. As outlined in Section 2, these steps are:

1) Develop initial input data

2) Estimate technical potential and develop supply curves

3) Estimate economic potential

4) Estimate maximum achievable, program, and naturally occurring potentials

5) Perform scenario analysis.

B.2 Step 1: Develop Initial Input Data

B.2.1 Development of Measure List

This subsection briefly discusses how we developed the list of energy-efficiency measures included in the study for the residential, commercial, and industrial sectors. The study scope was restricted to energy-efficiency measures and practices that are presently commercially available. These are measures that are of most immediate interest to energy-efficiency program planners. The study data, framework, and models can be easily changed, however, to include estimates of potential for emerging technologies. In addition for the retrofit markets, the scope of this study was focused on measures that could be relatively easily substituted for or applied to existing technologies on a retrofit basis. Thus, measures and savings that might be achieved through integrated redesign of existing energy-using systems, as might be possible during major renovations or remodels, are not included. This is another area in which the current results can be expanded upon.

For the residential and commercial sectors, the measure lists were developed by starting with the list of measures included in the *DEER 2001 Update Study* (XENERGY 2001c), with some aggregation to prototypical applications. The measure list for the DEER Update study was developed in consultation with a CALMAC stakeholder group that included the major IOUs, California Energy Commission (CEC), and California Public Utilities Commission (CPUC). We then reviewed the recent program application filings of the major investor-owned utilities (IOUs) to the CPUC and added measures that might have significant potential but were not on the *DEER 2001 Update Study* list.

For the industrial lighting and space cooling end uses, the efficiency measures from the commercial measure list were employed, as we deemed the measures affecting these end uses to be sufficiently similar between the two sectors. Industrial motors, compressed air, and other process measures were developed from several sources including the *California Industrial Sector Market Characterization Study* (XENERGY 2001d), the *United States Industrial Motor Systems Market Opportunities Assessment* (XENERGY 1998b), the *Assessment of the Market for Compressed Air Services* (XENEGY 2000a), Lawrence Berkeley National Laboratories (LBNL) industry studies (Martin 1999, Martin 2000a, Martin 2000b, Worrell, 1998, Worrell 1999), and recent program filings submitted to the CPUC by IOUs and third parties.

B.2.2 Technical Data on Efficient Measure Opportunities

Estimating the potential for energy-efficiency improvements requires a comparison of the costs and savings of energy-efficiency measures as compared to standard equipment and practices. Standard equipment and practices are often referred to in energy-efficiency analysis as *base cases*. For the residential and commercial sectors, most of the measure cost data for this study were obtained from the *DEER 2001 Update Study*. Additional measure cost information was obtained from the work papers associated with the energy-efficiency program applications of the major IOUs for 2001, as well as other secondary sources and interviews with utility program managers and other industry experts. For the industrial sector, studies cited in the previous paragraph were also utilized to develop cost estimates.

Estimates of measure savings as a percentage of base equipment usage were developed from a variety of sources, including:

- Industry-standard engineering calculations
- Results from building energy simulation model analysis conducted for the California Conservation Inventory Group's *Technology Energy Savings Study* (NEOS 1994)
- Results from the *DEER 2001 Update Study* for residential measures
- A comprehensive refrigeration study conducted by LBNL (LBNL 1995)
- Energy-efficiency program applications to the CPUC
- Secondary sources.

B.2.3 Technical Data on Building Characteristics

As noted above, estimating the potential for energy-efficiency improvements involves comparison of the energy impacts of existing, standard-efficiency technologies with those of alternative high-efficiency equipment. This, in turn, dictates a relatively detailed understanding of the statewide energy characteristics of each energy-consuming sector. As described further in Section B.3, a variety of data are needed to estimate the average and total savings potential for individual measures across the entire California marketplace. The key data needed for our representation of California electricity consumption included:

- Total count of energy-consuming units (floor space of commercial buildings, number of residential dwellings, and the base kWh-consumption of industrial facilities)

- Annual energy consumption for each end use studied (both in terms of total consumption in GWh and normalized for intensity on a per-unit basis, e.g., kWh/ft^2)

- End-use load shapes (that describe the amount of energy used or power demand over certain times of the day and days of the year)

- The saturation of electric end uses (for example, the fraction of total commercial floor space with electric air conditioning)

- The market share of each base equipment type (for example, the fraction of total commercial floor space served by 4-foot fluorescent lighting fixtures (CFLs)

- Market share for each energy-efficiency measure in scope (for example, the fraction of total commercial floor space already served by CFLs).

These key data elements are discussed briefly in the following subsections.

Floor Space, Dwellings, and End-Use Energy Consumption

The primary source of commercial floor space, residential dwellings, and their associated end-use energy consumption data was the CEC end-use forecasting database. In the end-use forecasting approach, end-use energy consumption is expressed as the product of consuming units (building floor space/residential dwellings), the fraction of units associated with a given end use (the end-use saturation), and the energy intensity of the end use (commercial EUIs, expressed in kWh per square foot, and residential UECs, expressed in kWh per dwelling). These three data elements have been collected and estimated from various sources over time and form the foundation upon which the CEC energy demand forecasts are developed.

For the industrial sector, end use energy consumption was developed from the *California Industrial Sector Market Characterization Study*. In this study, end-use energy fractions developed from MECS (the U.S. DOE Manufacturing Energy Consumption Survey) were applied to utility billing data at the 2-digit SIC code level to provide end-use consumption estimates.

Load Shapes, Energy and Peak Factors

Load shape data was used to develop energy and peak factors. Energy and peak factors are used to allocate annual energy usage and associated measure impacts into utility costing periods and to provide estimates of peak demand savings based on cost period energy usage. The factors were developed by end-use, building type, and where possible, California IOU service area. The analysis by costing period is necessary because avoided-cost benefits (which are described later in this section) vary significantly by time of day, type of day, and month of year.

In the case of the electric energy factors, these factors are computed based on predefined costing periods (e.g., season, day of the week, and hours of the day) divided by annual energy use. The end result is a series of values for each period such that the sum of the periods is equal to one. Pacific Gas and Electric, Southern California Edison, and San Diego Gas and Electric typically use costing definitions that differ very slightly from each other. To maintain consistency of our study's results across the utilities, we choose one utility's costing periods to use for our analysis. The costing period definitions used for this study are shown in Table B-1.

Table B-1
Costing Period Definitions Used for Electric Energy Factors

	Season	
Period	Summer (May 1 - Oct 31)	Winter (All Other Months)
Peak	1 P.M. to 6 P.M. Weekdays	(none)
Partial-Peak	9 A.M. to 12 P.M. Weekdays 7 P.M. to 9 P.M. Weekdays	9 P.M. to 9 P.M. Weekdays
Off-Peak	10 P.M. to 8 P.M. Weekdays All Weekends and Holidays	10 P.M. to 8 P.M. Weekdays All Weekends and Holidays

The peak factors are based on the same predefined periods as the energy factors. In this case, the peak demand within a cost period is divided by the average demand within that same period; that is, the peak factor is the ratio of peak to average demand in a period. This is done for both noncoincident demands as well as for coincident demands. In the case of coincident demands, the time of coincidence was set to be the time at which the California electric system typically peaked within each marginal costing period. The most important of these periods, from a cost and reliability perspective is the Summer Peak Period. Our analysis indicated that 4 P.M. corresponded to the maximum system peak as registered by the California Independent System Operator in 2000. Our estimates of peak demand by end use were developed to correspond to a 4 P.M. system peak.

Base Technology Shares (Applicability Factors)

The technology or equipment mix within an end use determines the applicability of energy-efficiency measures for that end use. For example, high-efficiency DX air conditioning measures are only applicable to the portion of the space cooling end use that is served by DX air conditioning (as opposed to other air conditioning equipment such as central plant chillers). Data on base technology shares were developed from a number of sources, including:

- The CEC end-use forecasting database
- Utility commercial end-use surveys (CEUS)
- Utility residential appliance saturation surveys (RASS)
- LBNL reports on commercial refrigeration (LBL-37397) and office equipment (LBL-37397)
- The *United States Industrial Motor Systems Market Opportunities Assessment*
- The *California Industrial Sector Market Characterization Study*.

Existing Energy-Efficient Measure Saturations

To assess the amount of energy-efficiency savings available, estimates of the current saturation of energy efficient measures are necessary. The primary sources of data used for the measure saturation estimates were:

- The utility CEUS studies
- The *Statewide Residential Lighting and Appliance Saturation Study* (RLW 2000)
- The California Residential Market Share Tracking Studies (RER 2000b, RER 2002a, RER 2002b)
- The *United States Industrial Motor Systems Market Opportunities Assessment*.

In some cases, judgmental adjustments to these saturation estimates were required to bring them up to date because the available sources were several years old. In these cases, we examined program tracking data to estimate increases in measure saturation that were likely to have occurred between the time each source-study was conducted and the present.

B.3 Step 2: Estimate Technical Potential and Develop Energy-Efficiency Supply Curves

As defined previously, **technical potential** refers to the amount of energy savings or peak demand reduction that would occur with the *complete* penetration of all measures analyzed in applications where they were deemed *technically* feasible from an *engineering* perspective. Total technical potential is developed from estimates of the technical potential of individual measures as they are applied to discrete market segments (commercial building types, residential dwelling types, etc.).

B.3.1 Core Equation

The core equation used to calculate the energy technical potential for each individual efficiency measure, by market segment, is shown below (using a commercial example):[1]

Technical		Total		Base Case				Not				
Potential	=	Square	X	Equipment	X	Applicability	X	Complete	X	Feasibility	X	Savings
of Efficient		Feet		EUI(kWh/ft^2)		Factor		Factor		Factor		Factor
Measure												

where:

- **Square feet** is the total floor space for all buildings in the market segment. For the residential analysis, the **number of dwelling units** is substituted for square feet.

- **Base-case equipment EUI** is the energy used per square foot by each base-case technology in each market segment. This is the consumption of the energy-using equipment that the efficient technology replaces or affects. For example, if the efficient measure were a CFL, the base EUI would be the annual kWh per square foot of an equivalent incandescent lamp. For the residential analysis, unit energy consumption (UECs), energy used per dwelling, are substituted for EUIs.

- **Applicability factor** is the fraction of the floor space (or dwelling units) that is applicable for the efficient technology in a given market segment, for the example above, the percentage of floor space lit by incandescent bulbs.

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[1] Note that stock turnover is not accounted for in our estimates of technical and economic potential, stock turnover *is accounted for* in our estimates of achievable potential as described in Section B.5.1. Our definition of technical potential assumes instantaneous replacement of standard efficiency with high-efficiency measures.

- **Not complete factor** is the fraction of applicable floor space (or dwelling units) that has not yet been converted to the efficient measure; that is, (one minus the fraction of floor space that already has the energy-efficiency measure installed).

- **Feasibility factor** is the fraction of the applicable floor space (or dwelling units) that is technically feasible for conversion to the efficient technology from an *engineering* perspective.

- **Savings factor** is the reduction in energy consumption resulting from application of the efficient technology.

Technical potential for peak demand reduction is calculated analogously.

An example of the core equation is shown in Table B-2 for the case of a prototypical 75-Watt incandescent lamp, which is replaced by an 18-Watt CFL in the office segment of the SCE service territory.

Table B-2
Example of Technical Potential Calculation – Replace 75-W Incandescent with 18-W CFL in the Office Segment of the SCE Service Territory

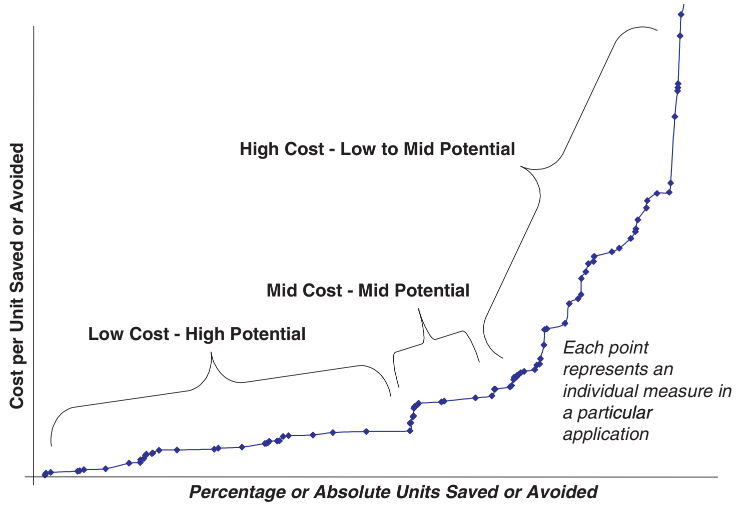
Technical Potential of Efficient Measure =	Total Square Feet	X Base Case Equipment EUI(kWh/ft^2)	X Applicability Factor	X Not Complete Factor	X Feasibility Factor	X Savings Factor
7.7 Million kWh	471 million	11.4	0.011	0.20	0.90	0.72

Technical energy-efficiency potential is calculated in two steps. In the first step, all measures are treated *independently*; that is, the savings of each measure are not marginalized or otherwise adjusted for overlap between competing or synergistic measures. By treating measures independently, their relative economics are analyzed without making assumptions about the order or combinations in which they might be implemented in customer buildings. However, the total technical potential across measures cannot be estimated by summing the individual measure potentials directly. The cumulative savings cannot be estimated by adding the savings from the individual savings estimates because some savings would be double counted. For example, the savings from a measure that reduces heat gain into a building, such as window film, are partially dependent on other measures that affect the efficiency of the system being used to cool the building, such as a high-efficiency chiller; the more efficient the chiller, the less energy saved from the application of the window film.

B.3.2 Use of Supply Curves

In the second step cumulative technical potential is estimated using an energy-efficiency supply curve approach.[2] This method eliminates the double-counting problem. In Figure B-1, we present a generic example of a supply curve. As shown in the figure, a supply curve typically consists of two axes—one that captures the cost per unit of saving a resource or mitigating an impact (e.g., $/kWh saved or $/ton of carbon avoided) and the other that shows the amount of savings or mitigation that could be achieved at each level of cost. The curve is typically built up across individual measures that are applied to specific base-case practices or technologies by market segment. Savings or mitigation measures are sorted on a least-cost basis and total savings or impacts mitigated are calculated incrementally with respect to measures that precede them. Supply curves typically, but not always, end up reflecting diminishing returns, i.e., as costs increase rapidly and savings decrease significantly at the end of the curve.

Figure B-1
Generic Illustration of Energy-Efficiency Supply Curve



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[2] This section describes conservation supply curves as they have been defined and implemented in numerous studies. Readers should note that Stoft 1995 describes several technical errors in the definition and implementation of conservation supply curves in the original and subsequent conservation supply curve studies. Stoft concludes that conservation supply curves are not “true” supply curves in the standard economic sense but can still be useful (albeit with his recommended improvements) for their intended purpose (demonstration of cost-effective conservation opportunities).

As noted above, the cost dimension of most energy-efficiency supply curves is usually represented in dollars per unit of energy savings. Costs are usually annualized (often referred to as "levelized") in supply curves. For example, energy-efficiency supply curves usually present levelized costs per kWh or kW saved by multiplying the initial investment in an efficient technology or program by the "capital recovery rate" (CRR):

$$\mathrm{CPR} = \frac{d}{1-(1+d)^{-n}}$$

where d is the real discount rate and n is the number of years over which the investment is written off (i.e., amortized).

Thus,

Levelized Cost per kWh Saved = Initial Cost x CRR/Annual Energy Savings

Levelized Cost per kW Saved = Initial Cost x CRR/Peak Demand Savings

The levelized cost per kWh and kW saved are useful because they allow simple comparison of the characteristics of energy efficiency with the characteristics of energy supply technologies. However, the levelized cost per kW saved is a biased indicator of cost-effectiveness because all of the efficiency measure costs are arbitrarily allocated to peak savings. To address this bias, Koomey, et al. (1990a and b) recommend calculation of the conservation load factor (CLF), which allows efficiency measures and supply options to be calculated together on a traditional energy supply screening curve. The CLF is calculated as:

CLF = Average Annual Load Savings/Peak Load Savings

where average annual load savings are the annual savings divided by 8,760 hours per year and peak savings are the reductions coincident with the system peak hour.

Our estimates of levelized costs per kWh and kW saved, along with estimates of CLF, are presented in Appendix C for each of the measures analyzed in this study.

Returning to the issue of energy-efficiency supply curves, Table B-3 shows a simplified numeric example of a supply curve calculation for several energy-efficiency measures applied to commercial lighting for a hypothetical population of buildings. What is important to note is that in an energy-efficiency supply curve, the measures are sorted by relative cost: from least to most expensive. In addition, the energy consumption of the system being affected by the efficiency measures goes down as each measure is applied. As a result, the savings attributable to each subsequent measure decrease if the measures are interactive. For example, the occupancy sensor measure shown in Table B-3 would save more at less cost per unit saved if it were applied to the base-case consumption before the T8 lamp and electronic ballast combination. Because the T8 electronic ballast combination is more cost-effective, however, it is applied first, reducing the energy savings potential for the occupancy sensor. Thus, in a typical energy-efficiency supply curve, the base-case end-use consumption is reduced with each unit of energy-efficiency that is acquired. Notice in Table B-3 that the total end-use GWh consumption is recalculated after each measure is implemented, thus reducing the base energy available to be saved by the next measure.

Table B-3 shows an example that would represent measures for one base-case technology in one market segment. These calculations are performed for all of the base-case technologies, market segments, and measure combinations in the scope of the study. The results are then ordered by levelized cost and the individual measure savings summed to produce the energy-efficiency potential for the entire sector (as presented in Section 3 of this report).

In the next subsection, we discuss how economic potential is estimated as a subset of the technical potential.

Table B-3
Sample Technical Potential Supply Curve Calculation for Commercial Lighting
(Note: Data are illustrative only)

Measure	Total End Use Consumption of population (GWh)	Applicable, Not Complete and feasible (1000s of ft^2)	Average kWh/ft^2 of population	Savings %	GWh Savings	Levelized Cost ($/kWh)
Base Case: T12 lamps with Magnetic Ballast	425	100,000	4.3	N/A	N/A	N/A
1. T8 w. Elec. Ballast	425	100,000	4.3	21%	89	$0.04
2. Occupancy Sensors	336	40,000	3.4	10%	13	$0.11
3. Perimeter Dimming	322	10,000	3.2	45%	14	$0.25
With all measures	309		3.1	27%	116	

B.4 Step 3: Estimate Economic Potential

Economic potential is typically used to refer to the *technical potential* of those energy conservation measures that are cost effective when compared to either supply-side alternatives or the price of energy. Economic potential takes into account the fact that many energy-efficiency measures cost more to purchase initially than do their standard-efficiency counterparts. The incremental costs of each efficiency measure are compared to the savings delivered by the measure to produce estimates of energy savings per unit of additional cost. These estimates of energy-efficiency resource costs can then be compared to estimates of other resources such as building and operating new power plants.

B.4.1 Cost Effectiveness Tests

To estimate economic potential, it is necessary to develop a method by which it can be determined that a measure or program is *economic*. There is a large body of literature in which the merits of different approaches to calculating whether a public purpose investment in energy efficiency is cost effective are debated (Chamberlin and Herman 1993, RER 2000, Ruff 1988, Stoft 1995, and Sutherland 2000). In this report, we adopt the cost-effectiveness criteria used by the CPUC in its decisions regarding the cost-effectiveness of energy-efficiency programs funded under the State's public goods charge. The CPUC uses the total resource cost (TRC) test, as defined in the California Standard Practice Manual (CASPM 2001), to assess cost effectiveness. The TRC is a form of societal benefit-cost test. Other tests that have been used in analysis of program cost-effectiveness by energy-efficiency analysts include the utility cost, ratepayer impact measure (RIM), and participant tests. These tests are discussed in detail the CASPM.

Before discussing the TRC test and how it is used in this study, we present below a brief introduction to the basic tests as described in the CASPM:[3]

- **Total Resource Cost Test** - The TRC test measures the net costs of a demand-side management program as a resource option based on the total costs of the program, including both the participants' and the utility's costs. The test is applicable to conservation, load management, and fuel substitution programs. For fuel substitution programs, the test measures the net effect of the impacts from the fuel not chosen versus the impacts from the fuel that is chosen as a result of the program. TRC test results for fuel substitution programs should be viewed as a measure of the economic efficiency implications of the total energy supply system (gas and electric). A variant on the TRC test is the societal test. The societal test differs from the TRC test in that it includes the effects of externalities (e.g. environmental, national security), excludes tax credit benefits, and uses a different (societal) discount rate.

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[3] These definitions are direct excerpts from the California Standard Practice Manual, October 2001.

- **Participant Test** - The participant test is the measure of the quantifiable benefits and costs to the customer due to participation in a program. Since many customers do not base their decision to participate in a program entirely on quantifiable variables, this test cannot be a complete measure of the benefits and costs of a program to a customer.

- **Utility (Program Administrator) Test** - The program administrator cost test measures the net costs of a demand-side management program as a resource option based on the costs incurred by the program administrator (including incentive costs) and excluding any net costs incurred by the participant. The benefits are similar to the TRC benefits. Costs are defined more narrowly.

- **Ratepayer Impact Measure Test** - The ratepayer impact measure (RIM) test measures what happens to customer bills or rates due to changes in utility revenues and operating costs caused by the program. Rates will go down if the change in revenues from the program is greater than the change in utility costs. Conversely, rates or bills will go up if revenues collected after program implementation are less than the total costs incurred by the utility in implementing the program. This test indicates the direction and magnitude of the expected change in customer bills or rate levels.

The key benefits and costs of the various cost-effectiveness tests are summarized in Table B-4.

Table B-4
Summary of Benefits and Costs of California Standard Practice Manual Tests

Test	Benefits	Costs
Total Resource Cost Test	Generation, transmission and distribution savings Participants avoided equipment costs (fuel switching only)	Generation costs Program costs paid by the administrator Participant measure costs
Participant Test	Bill reductions Incentives Participants avoided equipment costs (fuel switching only)	Bill increases Participants measure costs
Utility (Program Administrator) Test	Generation, transmission and distribution savings	Generation costs Program costs paid by the administrator Incentives
Ratepayer Impact Measure Test	Generation, transmission and distribution savings Revenue gain	Generation costs Revenue loss Program costs paid by the administrator Incentives

Generation, transmission and distribution savings (hereafter, energy benefits) are defined as the economic value of the energy and demand savings stimulated by the interventions being assessed. These benefits are typically measured as induced changes in energy consumption, valued using some mix of avoided costs. Statewide values of avoided costs are prescribed for use in implementing the test. Electricity benefits are valued using three types of avoided electricity costs: avoided distribution costs, avoided transmission costs, and avoided electricity generation costs.

Participant costs are comprised primarily of incremental measure costs. Incremental measure costs are essentially the costs of obtaining energy efficiency. In the case of an add-on device (say, an adjustable-speed drive or ceiling insulation), the incremental cost is simply the installed cost of the measure itself. In the case of equipment that is available in various levels of efficiency (e.g., a central air conditioner), the incremental cost is the excess of the cost of the high-efficiency unit over the cost of the base (reference) unit.

Administrative costs encompass the real resource costs of program administration, including the costs of administrative personnel, program promotions, overhead, measurement and evaluation, and shareholder incentives. In this context, administrative costs are not defined to include the costs of various incentives (e.g., customer rebates and salesperson incentives) that may be offered to encourage certain types of behavior. The exclusion of these incentive costs reflects the fact that they are essentially transfer payments. That is, from a societal perspective they involve offsetting costs (to the program administrator) and benefits (to the recipient).

B.4.2 Use of the Total Resource Cost to Estimate Economic Potential

We use the TRC test in two ways in this study. First, we develop an estimate of economic potential by calculating the TRC of individual measures and applying the methodology described below. Second, we develop estimates of whether different program scenarios are cost effective.

Economic potential can be defined either inclusively or exclusively of the costs of programs that are designed to increase the adoption rate of energy-efficiency measures. *In this study, we define economic potential to exclude program costs.* We do so primarily because program costs are dependent on a number of factors that vary significantly as a function of program delivery strategy. There is no single estimate of program costs that would accurately represent such costs across the wide range of program types and funding levels possible. Once an assumption is made about program costs, one must also link those assumptions to expectations about market response to the types of interventions assumed. Because of this, we believe it is more appropriate to factor program costs into our analysis of *maximum achievable and program potential*. Thus, our definition of *economic potential* is that portion of the technical potential that passes our economic screening test (described below) exclusive of program costs. Economic potential, like technical potential, is a theoretical quantity that will exceed the amount of potential we estimate to be achievable through current or more aggressive program activities.

As implied in Table B-4 and defined in the CASPM 2001, the TRC focuses on resource savings and counts benefits as utility avoided supply costs and costs as participant costs and utility program costs. It ignores any impact on rates. It also treats financial incentives and rebates as transfer payments; i.e., the TRC is not affected by incentives. The somewhat simplified benefit and cost formulas for the TRC are presented in Equations B-1 and B-2 below.

$$\text{Benefits} = \sum_{t=1}^{N} \frac{\text{Avoided Costs of Supply}_{p,t}}{(1+d)^{t-1}} \qquad \textbf{Eqn. B-1}$$

$$\text{Costs} = \sum_{t=1}^{N} \frac{\text{Program cost}_t + \text{Participant Cost}_t}{(1+d)^{t-1}} \qquad \textbf{Eqn. B-2}$$

where
d = the discount rate
p = the costing period
t = time (in years)
n = 20 years

A nominal discount rate of 8 percent is used, as required by the CPUC for program filings by major IOUs in 2001.[4] We use a *normalized* measure life of 20 years to capture the benefit of long-lived measures. Measures with measure lives shorter than 20 years are "re-installed" in our analysis as many times as necessary to reach the normalized 20-year life of the analysis.

The avoided costs of supply are calculated by multiplying measure energy savings and peak demand impacts by per-unit avoided costs by costing period.[5] Energy savings are allocated to costing periods and peak impacts estimated using the load shape factors discussed in Section B.2.3.

As noted previously, in the *measure-level* TRC calculation used to estimate economic potential, program costs are excluded from Equation B-2. Using the supply curve methodology discussed previously, measures are ordered by TRC (highest to lowest) and then the *economic* potential is calculated by summing the energy savings for all of the technologies for which the marginal TRC test is greater than 1.0. In the example in Table B-5, the economic potential would include the savings for measures 1 and 2, but exclude saving for measure 3 because the TRC is less than 1.0 for measure 3. The supply curve methodology when combined with estimates of the TRC for individual measures produces estimates of the economic potential of efficiency improvements. By definition and intent, this estimate of economic potential is a theoretical quantity that will exceed the amount of potential we estimate to be achievable through program activities in the final steps of our analyses.

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[4] We recognize that the 8-percent discount is much lower than the implicit discount rates at which customers are observed to adopt efficiency improvements. This is by intent since we seek at this stage of the analysis to estimate the potential that is cost-effective from primarily a societal perspective. The effect of implicit discount rates is incorporated into our estimates of program and naturally occurring potential.

[5] The per-unit avoided-cost values used in this study are shown in Appendix B.

Table B-5
Sample Use of Supply Curve Framework to Estimate Economic Potential
(Note: Data are illustrative only)

Measure	Total End Use Consumption of Population (GWh)	Applicable, Not Complete and Feasible Sq. Feet(000s)	Average kWh/ft^2 of Population	Savings %	GWh Savings	Total Resource Cost Test	Savings Included in Economic Potential?
Base Case: T12 lamps with Magnetic Ballast	425	100,000	4.3	N/A	N/A	N/A	N/A
1. T8 w. Elec. Ballast	425	100,000	4.3	21%	89	2.5	Yes
2. Occupancy Sensors	336	40,000	3.4	10%	13	1.3	Yes
3. Perimeter Dimming	322	10,000	3.2	45%	14	0.8	No
Technical Potential w. measures				27%	116		
Economic Potential w. measures for which TRC>1.0				24%	102		

B.5 Step 4: Estimate Maximum Achievable, Program, and Naturally occurring Potentials

In this section we present the method we employ to estimate the fraction of the market that adopts each energy-efficiency measure in the presence and absence of energy-efficiency programs. In Section 2 of this report we introduced the concepts of *maximum achievable*, program, and naturally occurring potentials. We defined:

- **Maximum achievable potential** as the amount of economic potential that could be achieved over time under the most aggressive program scenario possible
- **Program potential** as the amount of savings that would occur in response to one or more specific market interventions
- **Naturally occurring potential** as the amount of savings estimated to occur as a result of normal market forces, that is, in the absence of any utility or governmental intervention.

Our estimates of program potential are the most important results of this study. Estimating technical, economic, and maximum achievable potentials are necessary steps in the process from which important information can be obtained; however, the end goal of the process is better understanding how much of the remaining potential can be captured in programs, whether it would be cost-effective to increase program spending, and how program costs may be expected to change in response to measure adoption over time.

According to our definitions and the method described in this section, maximum achievable potential is really a type of program potential that defines the upper limit of savings from market interventions. Therefore, in the remainder of this section, we will often discuss our general method using the term "program potential" to represent both program and maximum achievable potential. The assumptions and data inputs used for the specific program scenarios and maximum achievable potential scenarios developed for this study are described in Section 3 of this report.

B.5.1 Adoption Method Overview

We use a method of estimating adoption of energy-efficiency measures that applies equally to be our program and naturally occurring analysis. Whether as a result of natural market forces or aided by a program intervention, the rate at which measures are adopted is modeled in our method as a function of the following factors:

- The availability of the adoption opportunity as a function of capital equipment turnover rates and changes in building stock over time
- Customer awareness of the efficiency measure
- The cost-effectiveness of the efficiency measure
- Market barriers associated with the efficiency measure.

The method we employ is executed in the measure penetration module of XENERGY's DSM ASSYST model.

In this study, only measures that pass the measure-level total resource cost test are put into the penetration module for estimation of customer adoption.

Availability

A crucial part of the model is a stock accounting algorithm that handles capital turnover and stock decay over a period of up to 20 years. In the first step of our achievable potential method, we first calculate the number of customers for whom each measure will apply. The input to this calculation is the total floor space available for the measure from the technical potential analysis, i.e., the total floor space multiplied by the applicability, not complete, and feasibility factors described previously. We call this the *eligible* stock. The stock algorithm keeps track of the amount of floor space available for each efficiency measure in each year based on the total eligible stock and whether the application is new construction, retrofit or replace-on-burnout.[6]

Retrofit measures are available for implementation by the entire eligible stock. The eligible stock is reduced over time as a function of adoptions[7] and building decay.[8] Replace-on-burnout measures are available only on an annual basis, approximated as equal to the inverse of the service life.[9] The annual portion of the eligible market that does not accept the replace-on-burnout measure does not have an opportunity again until the end of the service life.

New construction applications are available for implementation in the first year. Those customers that do not accept the measure are given subsequent opportunities corresponding to whether the measure is a replacement or retrofit-type measure.

Awareness

In our modeling framework, customers cannot adopt an efficient measure merely because there is stock available for conversion. Before they can make the adoption choice, they must be aware and informed about the efficiency measure. Thus, in the second stage of the process, the model calculates the portion of the available market that is *informed*. An initial user-specified parameter sets the initial level of awareness for all measures. Incremental awareness occurs in the model as a function of the amount of money spent on awareness/information building and how well those information-building resources are directed to

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[6] Replace-on-burnout measures are defined as the efficiency opportunities that are available only when the base equipment turns over at the end of its service life. For example, a high-efficiency chiller measure is usually only considered at the end of the life of an existing chiller. By contrast, retrofit measures are defined to be constantly available, for example, application of a window film to existing glazing.

[7] That is, each square foot that adopts the retrofit measure is removed from the eligible stock for retrofit in the subsequent year.

[8] Buildings do not last forever. An input to the model is the rate of decay of the existing floor space. Floor space typically decays at a very slow rate.

[9] For example, a base-case technology with a service life of 15 years is only available for replacement to a high-efficiency alternative each year at the rate of 1/15 times the total eligible stock. For example, the fraction of the market that does not adopt the high-efficiency measure in year t will not be available to adopt the efficient alternative again until year $t + 15$.

target markets. User-defined program characteristics determine how well information-building money is targeted. Well-targeted programs are those for which most of the money is spent informing only those customers that are in a position to implement a particular group of measures. Untargeted programs are those in which advertising cannot be well focused on the portion of the market that is available to implement particular measures. The penetration module in DSM ASSYST has a target effectiveness parameter that is used to adjust for differences in program advertising efficiency associated with alternative program types.

The model also controls for information retention. An information decay parameter in the model is used to control for the percentage of customers that will retain program information from one year to the next. Information retention is based on the characteristics of the target audience and the temporal effectiveness of the marketing techniques employed.

Adoption

The portion of the total market this is available and informed can now face the choice of whether or not to adopt a particular measure. Only those customers for whom a measure is available for implementation (stage 1) and, of those customers, only those who have been informed about the program/measure (stage 2), are in a position to make the implementation decision.

In the third stage of our penetration process, the model calculates the fraction of the market that adopts each efficiency measure as a function of the participant test. The participant test is a benefit-cost ratio that is calculated in this study as follows:

$$\text{Benefits} = \sum_{t=1}^{N} \frac{\text{Customer Bill Savings (\$)}_t}{(1+d)^{t-1}}$$

Eqn. B-3

where
d = the discount rate
t = time (in years)
n = 20 years

$$\text{Costs} = \sum_{t=1}^{N} \frac{\text{Participant Cost (\$)}_t}{(1+d)^{t-1}}$$

Eqn. B-4

We use a *normalized* measure life of 20 years in order to capture the benefits associated with long-lived measures. Measures with lives shorter than 20 years are “re-installed” in our analysis as many times as necessary to reach the normalized 20-year life of the analysis.

The bill reductions are calculated by multiplying measure energy savings and customer peak demand impacts by retail energy and demand rates.[10]

The model uses measure implementation curves to estimate the percentage of the informed market that will accept each measure based on the participant's benefit-cost ratio. The model provides enough flexibility so that each measure in each market segment can have a separate implementation rate curve. The functional form used for the implementation curves is:

$$y= \frac{a}{\left(1+e^{-1n\frac{x}{4}}\right) \text{ x } (1+e^{-c1n(bx)})}$$

where:

y = the fraction of the market that installs a measure in a given year from the pool of informed applicable customers;

x = the customer's benefit-cost ratio for the measure;

a = the maximum annual acceptance rate for the technology;

b = the inflection point of the curve. It is generally one over the benefit-cost ratio that will give a value of 1/2 the maximum value; and

c = the parameter that determines the general shape (slope) of the curve.

The primary curves utilized in this study are shown in Figure B-2. These curves produce base year program results that are calibrated to actual measure implementation results associated with major IOU commercial efficiency programs over the past several years. Different curves are used to reflect different levels of market barriers for different efficiency measures. A list of market barriers is shown in Table B-6. It is the existence of these barriers that necessitates program interventions to increase the adoption of energy efficiency measures. (For more information on market barriers see Eto, Prahl, Schlegel 1997, Golove and Eto 1996, DeCanio 2000, DeCanio 1998.)

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[10] The retail rate values used in this study are shown in Section 2 and Appendix D.

Note that for the moderate, high barrier, and extremely high curves, the participant benefit-cost ratios have to be very high before significant adoption occurs. This is because the participant benefit-cost ratios are based on a 15-percent discount rate. This discount rate reflects likely adoption if there were no market barriers or market failures, as reflected in the no-barriers curve in the figure. Experience has shown, however, that actual adoption behavior correlates with implicit discount rates several times those that would be expected in a perfect market.[11]

The model estimates adoption under both naturally occurring and program intervention situations. There are only two differences between the naturally occurring and program analysis. First, in any program intervention case in which measure incentives are provided, the participant benefit-cost ratios are adjusted based on the incentives. Thus, if an incentive that pays 50 percent of the incremental measure cost is applied in the program analysis, the participant benefit-cost ratio for that measure will double (since the costs have been halved). The effect on the amount of adoption estimated will depend on where the pre- and post-incentive benefit-cost ratios fall on the curve. This effect is illustrated in Figure B-3.

In this study achievable potential energy-efficiency forecasts were developed for several scenarios ranging from base levels of program intervention, through moderate levels, up to an aggressive energy-efficiency acquisition scenario. Uncertainty in rates and avoided costs were also characterized in alternate scenarios. The final results produced are annual streams of achievable program impacts (energy and demand by time-of-use period) and all societal and participant costs (program costs plus end-user costs).

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[11] For some, it is easier to consider adoption as a function of simple payback. However, the relationship between payback and the participant benefit-cost ratio varies depending on measure life and discount rate. For a long-lived measure of 15 years with a 15-percent discount rate, the equivalent payback at which half of the market would adopt a measure is roughly 6 months, based on the high barrier curve in Figure 4-3. At a 1-year payback, one-quarter of the market would adopt the measure. Adoption reaches near its maximum at a 3-month payback. The curves reflect the real-world observation that implicit discount rates can average up to 100 percent.

Figure B-2
Primary Measure Implementation Curves Used in Adoption Model

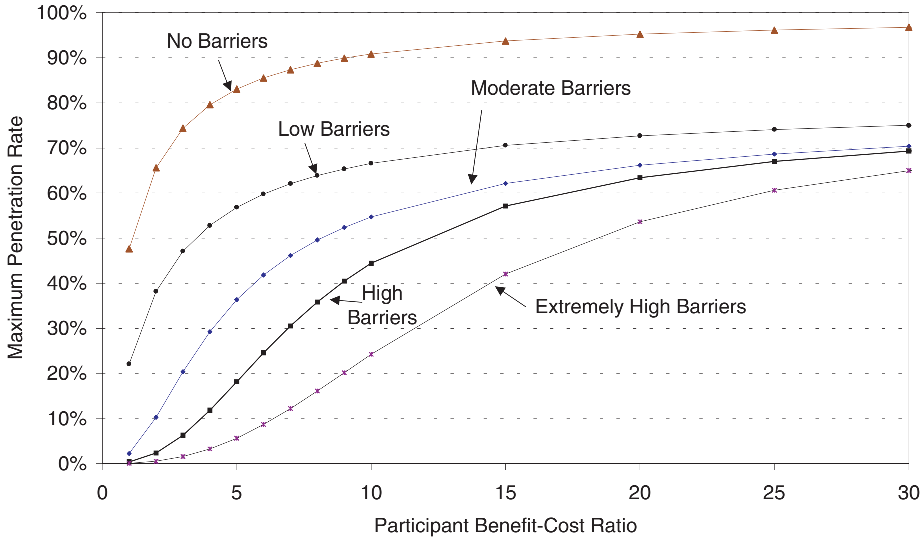


Figure B-3
Illustration of Effect of Incentives on Adoption Level as Characterized in Implementation Curves

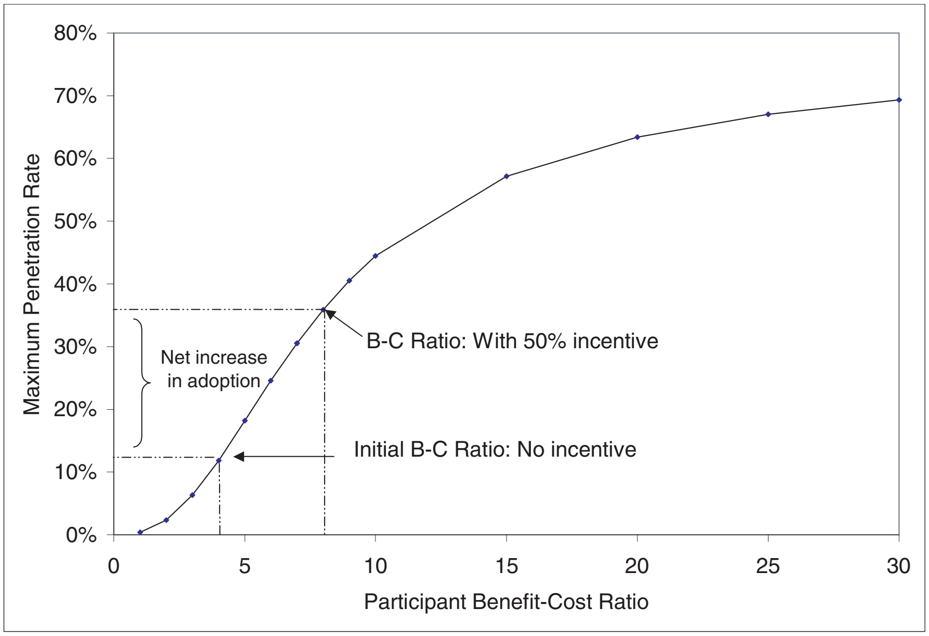


Table B-6
Summary Description of Market Barriers from Eto, Prahl, Schlegel 1997

Barrier	Description
Information or Search Costs	The costs of identifying energy-efficient products or services or of learning about energy-efficient practices, including the value of time spent finding out about or locating a product or service or hiring someone else to do so.
Performance Uncertainties	The difficulties consumers face in evaluating claims about future benefits. Closely related to high search costs, in that acquiring the information needed to evaluate claims regarding future performance is rarely costless.
Asymmetric Information and Opportunism	The tendency of sellers of energy-efficient products or services to have more and better information about their offerings than do consumers, which, combined with potential incentives to mislead, can lead to sub-optimal purchasing behavior.
Hassle or Transaction Costs	The indirect costs of acquiring energy efficiency, including the time, materials and labor involved in obtaining or contracting for an energy-efficient product or service. (Distinct from search costs in that it refers to what happens once a product has been located.)
Hidden Costs	Unexpected costs associated with reliance on or operation of energy-efficient products or services - for example, extra operating and maintenance costs.
Access to Financing	The difficulties associated with the lending industry's historic inability to account for the unique features of loans for energy savings products (i.e., that future reductions in utility bills increase the borrower's ability to repay a loan) in underwriting procedures.
Bounded Rationality	The behavior of an individual during the decision-making process that either seems or actually is inconsistent with the individual's goals.
Organization Practices or Customs	Organizational behavior or systems of practice that discourage or inhibit cost-effective energy-efficiency decisions, for example, procurement rules that make it difficult to act on energy-efficiency decisions based on economic merit.
Misplaced or Split incentives	Cases in which the incentives of an agent charged with purchasing energy efficiency are not aligned with those of the persons who would benefit from the purchase.
Product or Service Unavailability	The failure of manufacturers, distributors or vendors to make a product or service available in a given area or market. May result from collusion, bounded rationality, or supply constraints.
Externalities	Costs that are associated with transactions, but which are not reflected in the price paid in the transaction.
Non-externality Pricing	Factors other than externalities that move prices away from marginal cost. An example arises when utility commodity prices are set using ratemaking practices based on average (rather than marginal) costs.
Inseparability of Product Features	The difficulties consumers sometimes face in acquiring desirable energy-efficiency features in products without also acquiring (and paying for) additional undesired features that increase the total cost of the product beyond what the consumer is willing to pay.
Irreversibility	The difficulty of reversing a purchase decision in light of new information that may become available, which may deter the initial purchase, for example, if energy prices decline, one cannot resell insulation that has been blown into a wall.

B.6 Scenario Analysis

The various scenarios developed for this study are described in Section 2 of this report. For this step, we re-run our economic and achievable potential model multiple times utilizing the different energy-cost and program-expenditure assumptions associated with each scenario. Economic and naturally-occurring potentials vary across energy cost scenarios but remain constant across program-expenditure scenarios. Maximum-achievable and program potentials vary across both energy-cost and program expenditure scenarios.

APPENDIX C. MEASURE POTENTIAL RESULTS

This appendix presents estimates of measure-specific energy-efficiency potential. Definitions and methods used to develop these estimates are provided in Appendix B.

DSM ASSYST ADDITIVE SUPPLY ANALYSIS **Year** **2011**

Vintage: Existing

Sector: Commercial Scenario: Base

End Use	Measure Number	Measure	GWH Savings	MW Savings	Levelized Cost per KWh Saved $/kWH	Levelized Cost per KW Saved $/kW	Total Resource Cost Test TRC	Conservation Load Factor (CLF)
Interior Lighting	114	RET 4L4'T8, 1EB	936.7	197.3	$0.04	$185	3.0	0.54
Interior Lighting	115	RET 2L4'T8, 1EB, Reflector	453.0	95.9	$0.01	$27	27.8	0.54
Interior Lighting	117	Occupancy Sensor, 4L4' Fluorescent Fixtures	509.6	137.2	$0.05	$167	3.2	0.42
Interior Lighting	118	Continuous Dimming, 5L4' Fluorescent Fixtures	727.2	333.8	$0.25	$536	0.8	0.25
Interior Lighting	133	RET 2L4'T8, 1EB	827.6	166.0	$0.07	$342	1.7	0.57
Interior Lighting	134	RET 1L4'T8, 1EB, Reflector OEM	270.9	54.6	$0.00	$12	21320.4	0.57
Interior Lighting	136	Occupancy Sensor, 8L4' Fluorescent Fixtures	590.1	153.6	$0.05	$173	3.2	0.44
Interior Lighting	137	Continuous Dimming, 10L4' Fluorescent Fixtures	825.8	370.7	$0.22	$499	0.8	0.25
Interior Lighting	153	RET 2L8'T12, 60W, 1EB	980.9	183.3	$0.07	$383	1.5	0.61
Interior Lighting	154	RET 1L8'T12, 60W, 1EB, Reflector	417.5	77.7	$0.01	$56	22.4	0.61
Interior Lighting	155	Occupancy Sensor, 4L8' Fluorescent Fixtures	148.2	37.0	$0.07	$290	1.9	0.46
Interior Lighting	156	Continuous Dimming, 5L8' Fluorescent Fixtures	364.7	164.5	$0.32	$708	0.6	0.25
Interior Lighting	166	CFL Screw-in, Modular 18W	818.2	140.1	$0.02	$144	4.1	0.67
Interior Lighting	176	Halogen PAR Flood, 90W	333.3	61.7	$0.14	$732	0.8	0.62
Interior Lighting	177	Metal Halide, 50W	308.9	57.3	$0.26	$1,427	0.4	0.62
Exterior Lighting	211	ROB 2L4'T8, 1EB	125.5	1.2	$0.06	$6,208	1.0	>1
Exterior Lighting	212	Outdoor Lighting Controls (Photocell/Timeclock)	53.0	0.0	$0.06	N/A	0.9	>1
Exterior Lighting	221	High Pressure Sodium 250W Lamp	360.1	3.1	$0.05	$6,151	1.1	>1
Exterior Lighting	222	Outdoor Lighting Controls (Photocell/Timeclock)	214.1	0.0	$0.02	N/A	2.6	>1
Space Cooling	301	Centrifugal Chiller, 0.51 kW/ton, 300 tons	540.3	356.1	$0.02	$26	11.5	0.17
Space Cooling	302	Window Film (Standard)	40.3	27.9	$0.22	$324	1.3	0.17
Space Cooling	303	EMS - Chiller	257.1	166.1	$0.10	$150	2.0	0.18
Space Cooling	304	Cool Roof - Chiller	32.6	18.4	$0.48	$857	0.5	0.20
Space Cooling	305	Chiller Tune Up/Diagnostics	16.0	25.8	$0.21	$128	1.8	0.07
Space Cooling	306	Cooling Circ. Pumps - VSD	124.7	82.2	$0.15	$224	1.3	0.17
Space Cooling	311	DX Tune Up/ Advanced Diagnostics	332.3	184.6	$0.23	$407	0.8	0.21
Space Cooling	312	DX Packaged System, EER=10.9, 10 tons	502.9	278.5	$0.07	$120	2.7	0.21
Space Cooling	313	Window Film (Standard)	212.9	111.8	$0.09	$168	2.8	0.22
Space Cooling	314	Evaporative Pre-Cooler	192.7	107.1	$0.33	$587	0.6	0.21
Space Cooling	315	Prog. Thermostat - DX	312.7	52.0	$0.02	$135	4.8	0.69
Space Cooling	316	Cool Roof - DX	186.0	89.3	$0.20	$406	1.2	0.24
Ventillation	401	Fan Motor, 5hp, 1800rpm, 89.5%	112.7	19.9	$0.09	$520	1.4	0.65
Ventillation	402	Variable Speed Drive Control, 5 HP	85.8	4.9	$0.07	$1,168	1.4	>1
Ventillation	411	Fan Motor, 15hp, 1800rpm, 92.4%	39.7	6.9	$0.02	$123	5.8	0.66
Ventillation	412	Variable Speed Drive Control, 15 HP	190.2	10.8	$0.04	$626	2.4	>1
Ventillation	421	Fan Motor, 40hp, 1800rpm, 94.1%	24.3	4.7	$0.05	$271	2.2	0.59
Ventillation	422	Variable Speed Drive Control, 40 HP	236.3	13.1	$0.02	$356	3.9	>1
Refrigeration	501	High-efficiency fan motors	678.6	93.2	$0.04	$297	2.1	0.83
Refrigeration	502	Strip curtains for walk-ins	84.7	11.6	$0.01	$102	6.2	0.83
Refrigeration	503	Night covers for display cases	310.7	0.0	$0.02	N/A	2.4	>1
Refrigeration	504	Evaporator fan controller for MT walk-ins	19.2	0.0	$0.12	N/A	0.4	>1
Refrigeration	505	Efficient compressor motor retrofit	407.9	56.0	$0.01	$46	13.7	0.83
Refrigeration	506	Compressor VSD retrofit	295.0	21.3	$0.05	$658	1.5	>1
Refrigeration	507	Floating head pressure controls	218.2	0.0	$0.01	N/A	6.8	>1
Refrigeration	508	Refrigeration Commissioning	127.0	17.5	$0.07	$520	1.2	0.83
Refrigeration	509	Demand Hot Gas Defrost	50.5	6.9	$0.01	$49	12.9	0.83
Refrigeration	510	Demand Defrost Electric	0.0	0.0	N/A	N/A	N/A	>1
Refrigeration	511	Anti-sweat (humidistat) controls	279.8	20.2	$0.02	$222	4.5	>1
Office Equipment	611	Power Management Enabling	329.6	34.7	$0.05	$516	2.7	>1
Office Equipment	621	Purchase LCD monitor	186.1	32.5	$5.98	$34,229	0.0	0.65
Office Equipment	623	Network Power Management Enabling	501.9	51.2	$0.01	$55	26.1	>1
Office Equipment	631	Power Management Enabling	144.2	11.5	$0.02	$298	5.6	>1
Office Equipment	641	External hardware control	176.0	0.0	$0.45	N/A	0.2	>1
Office Equipment	642	Nighttime shutdown	127.2	0.0	$2.03	N/A	0.0	>1

DSM ASSYST ADDITIVE SUPPLY ANALYSIS			Year	2011				
		Vintage: New			Levelized	Levelized	Total	Conservation
		Sector: Commercial Scenario: Base			Cost per	Cost per	Resource	Load
End	Measure		GWH	MW	KWh Saved	KW Saved	Cost Test	Factor
Use	Number	Measure	Savings	Savings	$/kWH	$/kW	TRC	(CLF)
Lighting	111	10 % More Efficient Design (Lighting)	822.6	165.9	$0.02	$98	7.2	0.57
Lighting	112	20 % More Efficient Design (Lighting)	814.3	164.2	$0.03	$148	4.8	0.57
Space Cooling	301	Centrifugal Chiller, 0.51 kW/ton, 500 tons	210.7	128.4	$0.01	$20	16.4	0.19
Space Cooling	304	Cool Roof - Chiller	22.4	12.7	$0.30	$523	0.8	0.20
Space Cooling	306	Centrifugal Chiller, Optimal Design, 0.4 kW/ton, 500 tons	101.9	61.6	$0.06	$97	5.1	0.19
Space Cooling	312	DX Packaged System, EER=10.9, 10 tons	165.6	93.2	$0.06	$115	2.8	0.20
Space Cooling	314	Evaporative Pre-Cooler	67.4	38.1	$0.31	$556	0.6	0.20
Space Cooling	316	Cool Roof - DX	147.8	74.0	$0.10	$201	2.5	0.23
Ventillation	401	Fan Motor, 5hp, 1800rpm, 89.5%	35.8	6.3	$0.09	$503	1.4	0.65
Ventillation	402	Variable Speed Drive Control, 5 HP	45.9	2.4	$0.06	$1,212	1.4	>1
Ventillation	411	Fan Motor, 15hp, 1800rpm, 92.4%	10.9	1.9	$0.02	$139	5.2	0.67
Ventillation	412	Variable Speed Drive Control, 15 HP	97.8	5.2	$0.04	$667	2.3	>1
Ventillation	421	Fan Motor, 40hp, 1800rpm, 94.1%	6.2	1.2	$0.07	$354	1.7	0.60
Ventillation	422	Variable Speed Drive Control, 40 HP	155.2	8.3	$0.02	$424	3.4	>1
Refrigeration	501	High-efficiency fan motors	214.5	29.5	$0.04	$319	2.0	0.83
Refrigeration	502	Strip curtains for walk-ins	86.2	11.9	$0.01	$108	5.9	0.83
Refrigeration	503	Night covers for display cases	48.1	0.0	$0.02	N/A	2.2	>1
Refrigeration	504	Evaporator fan controller for MT walk-ins	7.2	0.0	$0.13	N/A	0.4	>1
Refrigeration	505	Efficient compressor motor retrofit	160.9	22.1	$0.01	$47	13.7	0.83
Refrigeration	506	Compressor VSD retrofit	46.5	3.4	$0.05	$710	1.4	>1
Refrigeration	507	Floating head pressure controls	126.7	0.0	$0.01	N/A	6.3	>1
Refrigeration	508	Refrigeration Commissioning	76.5	10.5	$0.08	$558	1.1	0.83
Refrigeration	509	Demand Hot Gas Defrost	52.8	7.3	$0.01	$50	12.7	0.83
Refrigeration	511	Anti-sweat (humidistat) controls	91.6	6.6	$0.02	$244	4.1	>1
Office Equipment	611	Power Management Enabling	146.9	15.6	$0.06	$565	2.4	>1
Office Equipment	621	Purchase LCD monitor	48.5	8.5	$10.37	$59,108	0.0	0.65
Office Equipment	623	Network Power Management Enabling	228.8	23.5	$0.01	$96	14.3	>1
Office Equipment	631	Power Management Enabling	85.0	6.8	$0.04	$479	3.4	>1
Office Equipment	641	External hardware control	24.5	0.0	$1.03	N/A	0.1	>1
Office Equipment	642	Nighttime shutdown	83.9	0.0	$0.00	N/A	99999.0	>1

DSM ASSYST ADDITIVE SUPPLY ANALYSIS **Year** **2011**
Vintage: Existing
Sector: Industrial **Scenario: Base**

End Use	Measure Number	Measure	GWH Savings	MW Savings	Levelized Cost per KWh Saved $/kWH	Levelized Cost per KW Saved $/kW	Total Resource Cost Test TRC	Conservation Load Factor (CLF)
Motors	101	Replace 1-5 HP Motor	248.7	34.1	$0.10	$698	0.8	0.83
Motors	102	Add 1-5 HP VSD	447.1	61.3	$0.14	$1,019	0.6	0.83
Motors	103	Motor Practices Level 1	607.0	83.2	$0.06	$440	1.3	0.83
Motors	104	Motor Practices Level 2	539.1	73.9	$0.24	$1,764	0.3	0.83
Motors	121	Replace 21-50 HP Motor	78.1	10.7	$0.09	$661	0.9	0.83
Motors	122	Add 21-50 HP VSD	319.0	43.7	$0.04	$278	2.1	0.83
Motors	123	Motor Practices Level 1	404.3	55.4	$0.03	$211	2.7	0.83
Motors	124	Motor Practices Level 2	361.9	49.6	$0.12	$840	0.7	0.83
Motors	151	Replace 201-500 HP Motor	143.5	19.7	$0.03	$201	2.8	0.83
Motors	152	Add 201-500 HP VSD	516.6	70.8	$0.01	$106	5.4	0.83
Motors	153	Motor Practices Level 1	598.6	82.0	$0.02	$152	3.7	0.83
Motors	154	Motor Practices Level 2	554.9	76.0	$0.08	$586	1.0	0.83
Compressed Air	202	CAS Level 1	433.9	59.5	$0.02	$168	3.4	0.83
Compressed Air	203	CAS Level 2	453.6	62.2	$0.05	$362	1.6	0.83
Compressed Air	204	CAS Level 3	325.5	44.6	$0.13	$936	0.6	0.83
Other Process	301	Process Level 1	1,031.8	141.4	$0.03	$190	3.0	0.83
Other Process	302	Process Level 2	1,219.7	167.1	$0.05	$345	1.7	0.83
Other Process	303	Process Level 3	767.3	105.1	$0.25	$1,831	0.3	0.83
Lighting	401	RET 2L4'T8, 1EB	835.2	174.0	$0.04	$211	2.2	0.55
Lighting	402	Occupancy Sensor, 4L4' Fluorescent Fixtures	80.0	21.4	$0.07	$257	1.6	0.43
Lighting	403	Continuous Dimming, 5L4' Fluorescent Fixtures	235.2	115.3	$0.28	$567	0.6	0.23
Lighting	411	RET 2L8'T12, 60W, 1EB	371.8	77.5	$0.07	$328	1.4	0.55
Lighting	412	Occupancy Sensor, 4L8' Fluorescent Fixtures	52.3	14.0	$0.07	$246	1.7	0.43
Lighting	413	Continuous Dimming, 5L8' Fluorescent Fixtures	127.4	62.4	$0.31	$636	0.5	0.23
Lighting	421	CFL Hardwired, Modular 36W	561.1	116.9	$0.06	$277	1.7	0.55
Lighting	422	Metal Halide, 50W	149.5	31.2	$0.62	$2,965	0.2	0.55
Space Cooling	501	Centrifugal Chiller, 0.51 kW/ton, 500 tons	136.8	69.1	$0.02	$45	5.4	0.23
Space Cooling	502	Window Film (Standard)	40.8	20.6	$0.09	$170	1.4	0.23
Space Cooling	503	EMS - Chiller	62.5	31.5	$0.14	$287	0.9	0.23
Space Cooling	504	Cool Roof - Chiller	25.2	12.7	$0.29	$574	0.4	0.23
Space Cooling	505	Chiller Tune Up/Diagnostics	3.8	5.1	$0.13	$97	1.9	0.08
Space Cooling	506	Cooling Circ. Pumps - VSD	30.5	15.4	$0.21	$407	0.6	0.23
Space Cooling	511	DX Tune Up/ Advanced Diagnostics	132.7	67.0	$0.26	$516	0.5	0.23
Space Cooling	512	DX Packaged System, EER=10.9, 10 tons	202.0	102.0	$0.08	$151	1.7	0.23
Space Cooling	513	Window Film (Standard)	98.9	49.9	$0.04	$74	3.4	0.23
Space Cooling	514	Evaporative Pre-Cooler	77.1	38.9	$0.38	$744	0.3	0.23
Space Cooling	515	Prog. Thermostat - DX	108.3	16.9	$0.03	$171	2.8	0.73
Space Cooling	516	Cool Roof - DX	106.3	53.7	$0.13	$248	1.0	0.23

DSM ASSYST ADDITIVE SUPPLY ANALYSIS **Year** **2011**

Vintage: New

Sector: Industrial Scenario: Base

End Use	Measure Number	Measure	GWH Savings	MW Savings	Levelized Cost per KWh Saved $/kWH	Levelized Cost per KW Saved $/kW	Total Resource Cost Test TRC	Conservation Load Factor (CLF)
Motors	101	Replace 1-5 HP Motor	39.2	5.4	$0.10	$709	0.8	0.83
Motors	102	Add 1-5 HP VSD	85.0	11.6	$0.12	$858	0.7	0.83
Motors	103	Motor Practices Level 1	130.0	17.8	$0.05	$329	1.7	0.83
Motors	104	Motor Practices Level 2	84.3	11.5	$0.25	$1,805	0.3	0.83
Motors	121	Replace 21-50 HP Motor	13.7	1.9	$0.09	$676	0.8	0.83
Motors	122	Add 21-50 HP VSD	67.7	9.3	$0.03	$235	2.4	0.83
Motors	123	Motor Practices Level 1	96.9	13.3	$0.02	$158	3.6	0.83
Motors	124	Motor Practices Level 2	63.3	8.7	$0.12	$860	0.7	0.83
Motors	151	Replace 201-500 HP Motor	25.3	3.5	$0.03	$205	2.8	0.83
Motors	152	Add 201-500 HP VSD	112.2	15.4	$0.01	$88	6.5	0.83
Motors	153	Motor Practices Level 1	143.7	19.7	$0.02	$115	5.0	0.83
Motors	154	Motor Practices Level 2	98.0	13.4	$0.08	$599	1.0	0.83
Compressed Air	202	CAS Level 1	113.4	15.5	$0.02	$111	5.1	0.83
Compressed Air	203	CAS Level 2	75.6	10.4	$0.05	$375	1.5	0.83
Compressed Air	204	CAS Level 3	54.2	7.4	$0.13	$968	0.6	0.83
Other Process	301	Process Level 1	179.4	24.6	$0.03	$190	3.0	0.83
Other Process	302	Process Level 2	212.1	29.1	$0.05	$345	1.7	0.83
Other Process	303	Process Level 3	133.4	18.3	$0.25	$1,831	0.3	0.83
Lighting	401	RET 2L4'T8, 1EB	143.8	30.0	$0.04	$211	2.2	0.55
Lighting	402	Occupancy Sensor, 4L4' Fluorescent Fixtures	13.8	3.7	$0.07	$257	1.6	0.43
Lighting	403	Continuous Dimming, 5L4' Fluorescent Fixtures	40.5	19.9	$0.28	$566	0.6	0.23
Lighting	411	RET 2L8'T12, 60W, 1EB	64.0	13.3	$0.07	$328	1.4	0.55
Lighting	412	Occupancy Sensor, 4L8' Fluorescent Fixtures	9.0	2.4	$0.07	$246	1.7	0.43
Lighting	413	Continuous Dimming, 5L8' Fluorescent Fixtures	21.9	10.8	$0.31	$635	0.5	0.23
Lighting	421	CFL Hardwired, Modular 36W	96.6	20.1	$0.06	$276	1.7	0.55
Lighting	422	Metal Halide, 50W	25.7	5.4	$0.62	$2,961	0.2	0.55
Space Cooling	501	Centrifugal Chiller, 0.51 kW/ton, 500 tons	24.7	12.5	$0.02	$45	5.4	0.23
Space Cooling	502	Window Film (Standard)	7.4	3.7	$0.09	$170	1.4	0.23
Space Cooling	503	EMS - Chiller	11.3	5.7	$0.14	$287	0.9	0.23
Space Cooling	504	Cool Roof - Chiller	4.5	2.3	$0.29	$575	0.4	0.23
Space Cooling	505	Chiller Tune Up/Diagnostics	0.7	0.9	$0.13	$97	1.9	0.08
Space Cooling	506	Cooling Circ. Pumps - VSD	5.5	2.8	$0.21	$407	0.6	0.23
Space Cooling	511	DX Tune Up/ Advanced Diagnostics	22.5	11.4	$0.26	$521	0.5	0.23
Space Cooling	512	DX Packaged System, EER=10.9, 10 tons	34.3	17.3	$0.08	$152	1.6	0.23
Space Cooling	513	Window Film (Standard)	16.8	8.5	$0.04	$75	3.4	0.23
Space Cooling	514	Evaporative Pre-Cooler	13.1	6.6	$0.38	$752	0.3	0.23
Space Cooling	515	Prog. Thermostat - DX	18.4	2.9	$0.03	$172	2.8	0.73
Space Cooling	516	Cool Roof - DX	18.0	9.1	$0.13	$251	1.0	0.23

DSM ASSYST ADDITIVE SUPPLY ANALYSIS			Year	2011				
		Vintage: Existing			Levelized	Levelized	Total	Conservation
		Sector: Residential Scenario: Base			Cost per	Cost per	Resource	Load
End	Measure		GWH	MW	KWh Saved	KW Saved	Cost Test	Factor
Use	Number	Measure	Savings	Savings	$/kWH	$/kW	TRC	(CLF)
Central AC	101	10 to 12 SEER Split-System Air Conditioner	329.7	413.4	$0.26	$211	1.4	0.09
Central AC	102	10 to 13 SEER Split-System Air Conditioner	115.6	140.2	$1.16	$960	0.4	0.09
Central AC	103	10 to 14 SEER Split-System Air Conditioner	83.5	103.9	$4.87	$3,910	0.1	0.09
Central AC	105	TXV	148.5	192.0	$0.13	$100	2.9	0.09
Central AC	109	Programmable Thermostat (0.4)	25.0	47.2	$0.24	$128	2.2	0.06
Central AC	110	Ceiling Fans	21.0	14.1	$1.91	$2,839	0.2	0.17
Central AC	111	Whole House Fans	229.5	170.5	$0.56	$749	0.5	0.15
Central AC	112	Attic Venting	76.2	79.8	$0.63	$601	0.9	0.11
Central AC	113	Basic HVAC Diagnostic Testing And Repair	187.8	240.4	$0.21	$161	1.9	0.09
Central AC	114	Duct Repair (0.32)	99.0	121.4	$0.26	$214	1.6	0.09
Central AC	115	Duct Insulation (0.4)	34.7	46.0	$0.10	$79	3.1	0.09
Central AC	116	Cool roofs	117.7	124.0	$12.96	$12,301	0.0	0.11
Central AC	118	Default Window With Sunscreen	454.5	589.2	$0.47	$366	0.5	0.09
Central AC	119	Double Pane Clear Windows to Double Pane, Med Low-E Coating	1,007.5	1,317.5	$0.02	$15	13.3	0.09
Central AC	120	Ceiling R-0 to R-19 Insulation-Batts (0.29)	66.2	68.6	$0.12	$116	2.7	0.11
Central AC	121	Ceiling R-19 to R-38 Insulation-Batts (0.27)	23.5	21.3	$2.64	$2,910	0.1	0.13
Central AC	122	Wall 2x4 R-0 to Blow-In R-13 Insulation (0.14)	41.3	60.6	$0.34	$232	1.2	0.08
Central AC	123	Infiltration Reduction (0.4)	7.1	12.1	$2.49	$1,469	0.2	0.07
Room AC	141	HE Room Air Conditioner - SEER 10.3	56.4	82.3	$0.46	$315	0.7	0.08
Room AC	142	Direct Evaporative Cooler	245.1	354.0	$0.72	$501	0.5	0.08
Room AC	143	Programmable Thermostat	4.1	8.6	$0.78	$371	0.6	0.05
Room AC	144	Ceiling Fans	1.1	0.9	$14.10	$17,385	0.0	0.14
Room AC	145	Whole House Fans	10.7	9.9	$4.56	$4,941	0.1	0.12
Room AC	146	Attic Venting	2.6	3.3	$7.03	$5,593	0.1	0.09
Room AC	147	Basic HVAC Diagnostic Testing And Repair	14.2	20.8	$1.03	$704	0.5	0.08
Room AC	148	Cool roofs	4.9	6.2	$105.47	$84,475	0.0	0.09
Room AC	150	Default Window With Sunscreen	27.9	40.3	$2.36	$1,634	0.3	0.08
Room AC	151	Double Pane Clear Windows to Double Pane, Med Low-E Coating	122.9	175.6	$0.05	$32	6.0	0.08
Room AC	152	Ceiling R-0 to R-19 Insulation-Batts	10.8	13.6	$0.40	$317	1.5	0.09
Room AC	153	Ceiling R-19 to R-38 Insulation-Batts	0.9	1.0	$22.07	$20,024	0.0	0.10
Room AC	154	Wall 2x4 R-0 to Blow-In R-13 Insulation	1.1	1.9	$6.59	$3,723	0.1	0.06
Room AC	155	Infiltration Reduction	0.3	0.6	$26.46	$13,459	0.0	0.06
Space Heating	181	Heat Pump Space Heater	553.8	0.0	$0.08	N/A	0.8	>1
Space Heating	182	Programmable Thermostat	33.1	0.0	$0.20	N/A	0.4	>1
Space Heating	183	Ceiling R-0 to R-19 Insulation-Batts	152.5	0.0	$0.06	N/A	0.8	>1
Space Heating	184	Ceiling R-19 to R-38 Insulation-Batts	71.0	0.0	$0.88	N/A	0.1	>1
Space Heating	185	Floor R-0 to R-19 Insulation-Batts	31.5	0.0	$0.39	N/A	0.1	>1
Space Heating	186	Wall 2x4 R-0 to Blow-In R-13 Insulation	233.6	0.0	$0.14	N/A	0.3	>1
Space Heating	187	Infiltration Reduction	13.3	0.0	$1.31	N/A	0.1	>1
Lighting	201	CFL, 0.5 hr/day	521.5	45.6	$0.09	$1,033	0.7	>1
Lighting	211	CFL, 2.5 hr/day	4,636.8	405.1	$0.03	$385	2.5	>1
Lighting	221	CFL, 6.0 hr/day	2,515.4	219.7	$0.03	$342	2.8	>1
Refrigerator	301	HE Refrigerator - Energy Star	849.8	110.3	$0.18	$1,400	0.5	0.88
Freezer	401	HE Freezer	208.0	28.3	$0.06	$470	1.4	0.84
Water Heating	501	Heat Pump Water Heater (EF=2.9)	754.1	72.3	$0.15	$1,516	0.6	>1
Water Heating	502	HE Water Heater (EF=0.93)	117.8	11.3	$0.06	$602	1.5	>1
Water Heating	503	Solar Water Heat	311.8	29.9	$0.66	$6,835	0.1	>1
Water Heating	504	Low Flow Showerhead	53.8	5.2	$0.03	$280	3.2	>1
Water Heating	505	Pipe Wrap	29.5	2.8	$0.02	$166	5.3	>1
Water Heating	506	Faucent Aerators	35.0	3.4	$0.02	$253	3.5	>1
Water Heating	507	Water Heater Blanket	152.8	14.6	$0.01	$88	10.0	>1
Clothes Washer	602	SEHA CW Tier 2 (EF=3.25)	784.3	143.9	$0.06	$350	1.6	0.62
Clothes Dryer	701	HE Clothes Dryer (EF=.52)	201.3	29.0	$0.29	$2,004	0.4	0.79
Dishwasher	801	Energy Star DW (EF=0.58)	234.8	20.4	$0.09	$1,009	1.1	>1
Pool	901	High Efficiency Pool Pump and Motor	1,527.0	271.8	$0.03	$161	3.7	0.64

DSM ASSYST ADDITIVE SUPPLY ANALYSIS **Year 2011**

Vintage: New

Sector: Residential Scenario: Base

End Use	Measure Number	Measure	GWH Savings	MW Savings	Levelized Cost per KWh Saved $/kWH	Levelized Cost per KW Saved $/kW	Total Resource Cost Test TRC	Conservation Load Factor (CLF)
HVAC	101	AB970	391.2	521.2	$0.00	$0	99999.0	0.09
HVAC	102	15% Above AB970	185.8	229.9	$0.40	$322	0.8	0.09
HVAC	103	20% Above AB970	64.8	85.7	$1.99	$1,509	0.1	0.09
Lighting	201	CFL, 0.5 hr/day	78.5	6.9	$0.09	$1,033	0.7	>1
Lighting	211	CFL, 2.5 hr/day	697.9	61.0	$0.03	$385	2.5	>1
Lighting	221	CFL, 6.0 hr/day	378.6	33.1	$0.03	$342	2.8	>1
Refrigerator	301	HE Refrigerator - Energy Star	124.3	16.1	$0.18	$1,396	0.5	0.88
Freezer	401	HE Freezer	32.6	4.4	$0.06	$470	1.4	0.84
Water Heating	501	Heat Pump Water Heater (EF=2.9)	114.2	10.9	$0.14	$1,442	0.6	>1
Water Heating	502	HE Water Heater (EF=0.93)	17.8	1.7	$0.05	$573	1.5	>1
Water Heating	503	Solar Water Heat	48.8	4.7	$0.63	$6,521	0.1	>1
Water Heating	505	Pipe Wrap	4.3	0.4	$0.02	$164	5.4	>1
Water Heating	507	Water Heater Blanket	22.3	2.1	$0.01	$87	10.1	>1
Clothes Washer	602	SEHA CW Tier 2 (EF=3.25)	116.8	21.4	$0.06	$346	1.6	0.62
Clothes Dryer	701	HE Clothes Dryer (EF=.52)	29.9	4.3	$0.28	$1,935	0.4	0.79
Dishwasher	801	Energy Star DW (EF=0.58)	35.8	3.1	$0.09	$992	1.1	>1
Pool	901	High Efficiency Pool Pump and Motor	216.7	38.6	$0.03	$164	3.6	0.64

APPENDIX D. ENERGY COST DATA

This appendix presents the energy cost and retail rate forecasts used to assess measure and program cost-effectiveness for each customer sector. These forecasts are described in Section 2.

ECONOMIC PARAMETERS

BASE ECONOMIC SCENARIO

UTILITY NAME	**Statewide**
SECTOR	Commercial
BATCH #	1
UTILITY DISCOUNT RATE	8.0%
CUSTOMER DISCOUNT RATE	15.0%
GENERAL INFLATION RATE (Measure)	3.0%
BASE YEAR	2001
START YEAR	2001
DIFFERENCE	0
UTILITY LINE LOSS RATE	8.5%

ENERGY COSTS AND RATES

RATE TYPE	COMMERCIAL
ENERGY UNITS	$/KWh
DEMAND UNITS	$/KW

Rate/Time Periods	1	2	3	4	5	
Name	Summer On-Peak	Partial-Peak	Summer Off-Peak	Partial Peak	Winter Off-Peak	
Abbreviation	SOP	SPP	SOFF	WPP	WOFF	TOTAL
Hours	768	896	2752	1638	2706	8760
Monthly Adjustment fo	6	0	0	6	0	

	AVOIDED ENERGY COSTS BY TIME PERIOD					AVOIDED DEMAND COSTS BY TIME PERIOD					COMMERCIAL ENERGY RATES					COMMERCIAL DEMAND RATES					Environmental Adder to be Subtracted for RIM
	SOP	SPP	SOFF	WPP	WOFF	SOP	SPP	SOFF	WPP	WOFF	SOP	SPP	SOFF	WPP	WOFF	SOP	SPP	SOFF	WPP	WOFF	
Year	$/KWh	$/KWh	$/KWh	$/KWh	$/KWh	$/KW	$/KW	$/KW	$/KW	$/KW	$/KWh	$/KWh	$/KWh	$/KWh	$/KWh	$/KW	$/KW	$/KW	$/KW	$/KW	$/KWh
2001	0.59	0.11	0.08	0.03	0.03	25.63	10.21	2.23	11.45	2.21	0.16	0.16	0.16	0.10	0.10	6.70	0.00	0.00	1.65	0.00	0.01
2002	0.59	0.11	0.08	0.03	0.03	26.65	10.65	2.33	12.01	2.30	0.13	0.13	0.13	0.08	0.08	6.90	0.00	0.00	1.70	0.00	0.01
2003	0.26	0.06	0.03	0.05	0.04	27.73	11.11	2.43	12.58	2.40	0.12	0.12	0.12	0.08	0.08	7.11	0.00	0.00	1.75	0.00	0.01
2004	0.24	0.05	0.03	0.05	0.04	28.88	11.58	2.53	13.16	2.50	0.11	0.11	0.11	0.07	0.07	7.32	0.00	0.00	1.80	0.00	0.01
2005	0.25	0.05	0.03	0.05	0.04	30.20	12.08	2.64	13.63	2.61	0.10	0.10	0.10	0.07	0.07	6.79	0.00	0.00	1.67	0.00	0.01
2006	0.22	0.05	0.03	0.05	0.04	31.49	12.59	2.75	14.22	2.72	0.11	0.11	0.11	0.07	0.07	6.29	0.00	0.00	1.55	0.00	0.01
2007	0.23	0.06	0.03	0.05	0.04	32.90	13.13	2.87	14.76	2.84	0.11	0.11	0.11	0.07	0.07	5.83	0.00	0.00	1.44	0.00	0.01
2008	0.23	0.06	0.03	0.05	0.04	34.24	13.69	2.99	15.46	2.96	0.11	0.11	0.11	0.07	0.07	6.01	0.00	0.00	1.48	0.00	0.01
2009	0.24	0.06	0.04	0.06	0.04	35.69	14.28	3.12	16.14	3.08	0.12	0.12	0.12	0.08	0.08	6.19	0.00	0.00	1.52	0.00	0.01
2010	0.25	0.06	0.04	0.06	0.04	37.27	14.89	3.25	16.78	3.22	0.12	0.12	0.12	0.08	0.08	6.37	0.00	0.00	1.57	0.00	0.01
2011	0.22	0.05	0.03	0.05	0.04	38.86	15.52	3.39	17.51	3.35	0.12	0.12	0.12	0.08	0.08	6.56	0.00	0.00	1.62	0.00	0.01
2012	0.23	0.06	0.03	0.05	0.04	40.54	16.18	3.53	18.23	3.50	0.13	0.13	0.13	0.08	0.08	6.76	0.00	0.00	1.67	0.00	0.01
2013	0.24	0.06	0.03	0.06	0.04	42.28	16.88	3.68	19.00	3.65	0.13	0.13	0.13	0.09	0.09	6.96	0.00	0.00	1.71	0.00	0.01
2014	0.25	0.06	0.04	0.06	0.04	44.09	17.61	3.84	19.81	3.80	0.14	0.14	0.14	0.09	0.09	7.17	0.00	0.00	1.77	0.00	0.01
2015	0.26	0.06	0.04	0.06	0.05	45.98	18.36	4.01	20.66	3.97	0.14	0.14	0.14	0.09	0.09	7.39	0.00	0.00	1.82	0.00	0.02
2016	0.27	0.07	0.04	0.06	0.05	47.94	19.15	4.18	21.54	4.14	0.14	0.14	0.14	0.09	0.09	7.61	0.00	0.00	1.87	0.00	0.02
2017	0.28	0.07	0.04	0.07	0.05	49.99	19.97	4.35	22.47	4.31	0.15	0.15	0.15	0.10	0.10	7.84	0.00	0.00	1.93	0.00	0.02
2018	0.30	0.07	0.04	0.07	0.05	52.13	20.82	4.54	23.43	4.50	0.15	0.15	0.15	0.10	0.10	8.07	0.00	0.00	1.99	0.00	0.02
2019	0.31	0.08	0.05	0.07	0.06	54.36	21.71	4.73	24.43	4.69	0.16	0.16	0.16	0.10	0.10	8.32	0.00	0.00	2.05	0.00	0.02
2020	0.33	0.08	0.05	0.08	0.06	56.68	22.64	4.94	25.48	4.89	0.16	0.16	0.16	0.11	0.11	8.56	0.00	0.00	2.11	0.00	0.02
2021	0.35	0.08	0.05	0.08	0.06	59.10	23.61	5.15	26.57	5.10	0.17	0.17	0.17	0.11	0.11	8.82	0.00	0.00	2.17	0.00	0.02

ECONOMIC PARAMETERS

HIGH ECONOMIC SCENARIO

UTILITY NAME	**All**	Statewide
SECTOR	COM	Commercial
BATCH #	1	
UTILITY DISCOUNT RATE	8.0%	
CUSTOMER DISCOUNT RATE	15.0%	
GENERAL INFLATION RATE (Measure)	3.0%	
BASE YEAR	2001	
START YEAR	2001	
DIFFERENCE	0	
UTILITY LINE LOSS RATE	8.5%	

ENERGY COSTS AND RATES

RATE TYPE	COMMERCIAL
ENERGY UNITS	$/KWh
DEMAND UNITS	$/KW

Rate/Time Periods	1	2	3	4	5	
Name	Summer On-Peak	Partial-Peak	Summer Off-Peak	Partial Peak	Winter Off-Peak	
Abbreviation	SOP	SPP	SOFF	WPP	WOFF	TOTAL
Hours	768	896	2752	1638	2706	8760
Monthly Adjustment fo	6	0	0	6	0	

	AVOIDED ENERGY COSTS BY TIME PERIOD					AVOIDED DEMAND COSTS BY TIME PERIOD					COMMERCIAL ENERGY RATES					COMMERCIAL DEMAND RATES					Environmental Adder to be Subtracted for RIM
	SOP	SPP	SOFF	WPP	WOFF	SOP	SPP	SOFF	WPP	WOFF	SOP	SPP	SOFF	WPP	WOFF	SOP	SPP	SOFF	WPP	WOFF	
Year	$/KWh	$/KWh	$/KWh	$/KWh	$/KWh	$/KW	$/KW	$/KW	$/KW	$/KW	$/KWh	$/KWh	$/KWh	$/KWh	$/KWh	$/KW	$/KW	$/KW	$/KW	$/KW	$/KWh
2001	0.74	0.13	0.10	0.04	0.04	25.63	10.21	2.23	11.45	2.21	0.16	0.16	0.16	0.10	0.10	6.70	0.00	0.00	1.65	0.00	0.01
2002	0.74	0.13	0.10	0.04	0.04	26.65	10.65	2.33	12.01	2.30	0.16	0.16	0.16	0.11	0.11	6.90	0.00	0.00	1.70	0.00	0.01
2003	0.32	0.07	0.04	0.06	0.05	27.73	11.11	2.43	12.58	2.40	0.17	0.17	0.17	0.11	0.11	7.11	0.00	0.00	1.75	0.00	0.01
2004	0.30	0.06	0.04	0.06	0.05	28.88	11.58	2.53	13.16	2.50	0.17	0.17	0.17	0.11	0.11	7.32	0.00	0.00	1.80	0.00	0.01
2005	0.31	0.06	0.04	0.06	0.05	30.20	12.08	2.64	13.63	2.61	0.18	0.18	0.18	0.12	0.12	7.54	0.00	0.00	1.86	0.00	0.01
2006	0.27	0.07	0.04	0.06	0.05	31.49	12.59	2.75	14.22	2.72	0.18	0.18	0.18	0.12	0.12	7.77	0.00	0.00	1.91	0.00	0.01
2007	0.28	0.07	0.04	0.07	0.05	32.90	13.13	2.87	14.76	2.84	0.19	0.19	0.19	0.12	0.12	8.00	0.00	0.00	1.97	0.00	0.01
2008	0.29	0.07	0.04	0.07	0.05	34.24	13.69	2.99	15.46	2.96	0.20	0.20	0.20	0.13	0.13	8.24	0.00	0.00	2.03	0.00	0.01
2009	0.30	0.07	0.04	0.07	0.05	35.69	14.28	3.12	16.14	3.08	0.20	0.20	0.20	0.13	0.13	8.49	0.00	0.00	2.09	0.00	0.01
2010	0.31	0.08	0.05	0.07	0.06	37.27	14.89	3.25	16.78	3.22	0.21	0.21	0.21	0.13	0.13	8.74	0.00	0.00	2.15	0.00	0.01
2011	0.27	0.07	0.04	0.06	0.05	38.86	15.52	3.39	17.51	3.35	0.21	0.21	0.21	0.14	0.14	9.00	0.00	0.00	2.22	0.00	0.01
2012	0.28	0.07	0.04	0.07	0.05	40.54	16.18	3.53	18.23	3.50	0.22	0.22	0.22	0.14	0.14	9.27	0.00	0.00	2.28	0.00	0.01
2013	0.30	0.07	0.04	0.07	0.05	42.28	16.88	3.68	19.00	3.65	0.23	0.23	0.23	0.15	0.15	9.55	0.00	0.00	2.35	0.00	0.01
2014	0.31	0.08	0.05	0.07	0.05	44.09	17.61	3.84	19.81	3.80	0.23	0.23	0.23	0.15	0.15	9.84	0.00	0.00	2.42	0.00	0.01
2015	0.32	0.08	0.05	0.08	0.06	45.98	18.36	4.01	20.66	3.97	0.24	0.24	0.24	0.16	0.16	10.13	0.00	0.00	2.50	0.00	0.02
2016	0.34	0.08	0.05	0.08	0.06	47.94	19.15	4.18	21.54	4.14	0.25	0.25	0.25	0.16	0.16	10.44	0.00	0.00	2.57	0.00	0.02
2017	0.35	0.09	0.05	0.08	0.06	49.99	19.97	4.35	22.47	4.31	0.26	0.26	0.26	0.17	0.17	10.75	0.00	0.00	2.65	0.00	0.02
2018	0.37	0.09	0.05	0.09	0.07	52.13	20.82	4.54	23.43	4.50	0.26	0.26	0.26	0.17	0.17	11.07	0.00	0.00	2.73	0.00	0.02
2019	0.39	0.10	0.06	0.09	0.07	54.36	21.71	4.73	24.43	4.69	0.27	0.27	0.27	0.18	0.18	11.41	0.00	0.00	2.81	0.00	0.02
2020	0.41	0.10	0.06	0.10	0.07	56.68	22.64	4.94	25.48	4.89	0.28	0.28	0.28	0.18	0.18	11.75	0.00	0.00	2.89	0.00	0.02
2021	0.43	0.11	0.06	0.10	0.08	59.10	23.61	5.15	26.57	5.10	0.29	0.29	0.29	0.19	0.19	12.10	0.00	0.00	2.98	0.00	0.02

ECONOMIC PARAMETERS

LOW ECONOMIC SCENARIO

UTILITY NAME	**All**	Statewide
SECTOR	COM	Commercial
BATCH #	1	
UTILITY DISCOUNT RATE	8.0%	
CUSTOMER DISCOUNT RATE	15.0%	
GENERAL INFLATION RATE (Measure)	3.0%	
BASE YEAR	2001	
START YEAR	2001	
DIFFERENCE	0	
UTILITY LINE LOSS RATE	8.5%	

ENERGY COSTS AND RATES

RATE TYPE	COMMERCIAL
ENERGY UNITS	$/KWh
DEMAND UNITS	$/KW

Rate/Time Periods	1	2	3	4	5	
Name	Summer On-Peak	Partial-Peak	Summer Off-Peak	Partial Peak	Winter Off-Peak	
Abbreviation	SOP	SPP	SOFF	WPP	WOFF	TOTAL
Hours	768	896	2752	1638	2706	8760
Monthly Adjustment fo	6	0	0	6	0	

	AVOIDED ENERGY COSTS BY TIME PERIOD					AVOIDED DEMAND COSTS BY TIME PERIOD					COMMERCIAL ENERGY RATES					COMMERCIAL DEMAND RATES					Environmental Adder to be Subtracted for RIM
	SOP	SPP	SOFF	WPP	WOFF	SOP	SPP	SOFF	WPP	WOFF	SOP	SPP	SOFF	WPP	WOFF	SOP	SPP	SOFF	WPP	WOFF	
Year	$/KWh	$/KWh	$/KWh	$/KWh	$/KWh	$/KW	$/KW	$/KW	$/KW	$/KW	$/KWh	$/KWh	$/KWh	$/KWh	$/KWh	$/KW	$/KW	$/KW	$/KW	$/KW	$/KWh
2001	0.30	0.05	0.04	0.02	0.01	25.63	10.21	2.23	11.45	2.21	0.09	0.09	0.09	0.07	0.07	6.70	0.00	0.00	1.65	0.00	0.01
2002	0.30	0.05	0.04	0.02	0.01	26.65	10.65	2.33	12.01	2.30	0.09	0.09	0.09	0.08	0.08	6.90	0.00	0.00	1.70	0.00	0.01
2003	0.13	0.03	0.02	0.03	0.02	27.73	11.11	2.43	12.58	2.40	0.09	0.09	0.09	0.08	0.08	7.11	0.00	0.00	1.75	0.00	0.01
2004	0.12	0.03	0.02	0.02	0.02	28.88	11.58	2.53	13.16	2.50	0.10	0.10	0.10	0.08	0.08	7.32	0.00	0.00	1.80	0.00	0.01
2005	0.12	0.03	0.02	0.02	0.02	30.20	12.08	2.64	13.63	2.61	0.10	0.10	0.10	0.08	0.08	7.54	0.00	0.00	1.86	0.00	0.01
2006	0.11	0.03	0.02	0.03	0.02	31.49	12.59	2.75	14.22	2.72	0.10	0.10	0.10	0.08	0.08	7.77	0.00	0.00	1.91	0.00	0.01
2007	0.11	0.03	0.02	0.03	0.02	32.90	13.13	2.87	14.76	2.84	0.11	0.11	0.11	0.09	0.09	8.00	0.00	0.00	1.97	0.00	0.01
2008	0.12	0.03	0.02	0.03	0.02	34.24	13.69	2.99	15.46	2.96	0.11	0.11	0.11	0.09	0.09	8.24	0.00	0.00	2.03	0.00	0.01
2009	0.12	0.03	0.02	0.03	0.02	35.69	14.28	3.12	16.14	3.08	0.11	0.11	0.11	0.09	0.09	8.49	0.00	0.00	2.09	0.00	0.01
2010	0.13	0.03	0.02	0.03	0.02	37.27	14.89	3.25	16.78	3.22	0.12	0.12	0.12	0.10	0.10	8.74	0.00	0.00	2.15	0.00	0.01
2011	0.11	0.03	0.02	0.03	0.02	38.86	15.52	3.39	17.51	3.35	0.12	0.12	0.12	0.10	0.10	9.00	0.00	0.00	2.22	0.00	0.01
2012	0.11	0.03	0.02	0.03	0.02	40.54	16.18	3.53	18.23	3.50	0.12	0.12	0.12	0.10	0.10	9.27	0.00	0.00	2.28	0.00	0.01
2013	0.12	0.03	0.02	0.03	0.02	42.28	16.88	3.68	19.00	3.65	0.13	0.13	0.13	0.10	0.10	9.55	0.00	0.00	2.35	0.00	0.01
2014	0.12	0.03	0.02	0.03	0.02	44.09	17.61	3.84	19.81	3.80	0.13	0.13	0.13	0.11	0.11	9.84	0.00	0.00	2.42	0.00	0.01
2015	0.13	0.03	0.02	0.03	0.02	45.98	18.36	4.01	20.66	3.97	0.13	0.13	0.13	0.11	0.11	10.13	0.00	0.00	2.50	0.00	0.02
2016	0.14	0.03	0.02	0.03	0.02	47.94	19.15	4.18	21.54	4.14	0.14	0.14	0.14	0.11	0.11	10.44	0.00	0.00	2.57	0.00	0.02
2017	0.14	0.03	0.02	0.03	0.02	49.99	19.97	4.35	22.47	4.31	0.14	0.14	0.14	0.12	0.12	10.75	0.00	0.00	2.65	0.00	0.02
2018	0.15	0.04	0.02	0.03	0.03	52.13	20.82	4.54	23.43	4.50	0.15	0.15	0.15	0.12	0.12	11.07	0.00	0.00	2.73	0.00	0.02
2019	0.16	0.04	0.02	0.04	0.03	54.36	21.71	4.73	24.43	4.69	0.15	0.15	0.15	0.12	0.12	11.41	0.00	0.00	2.81	0.00	0.02
2020	0.16	0.04	0.02	0.04	0.03	56.68	22.64	4.94	25.48	4.89	0.16	0.16	0.16	0.13	0.13	11.75	0.00	0.00	2.89	0.00	0.02
2021	0.17	0.04	0.03	0.04	0.03	59.10	23.61	5.15	26.57	5.10	0.16	0.16	0.16	0.13	0.13	12.10	0.00	0.00	2.98	0.00	0.02

ECONOMIC PARAMETERS

BASE ECONOMIC SCENARIO

UTILITY NAME	**Statewide**
SECTOR	Industrial
BATCH #	1
UTILITY DISCOUNT RATE	8.0%
CUSTOMER DISCOUNT RATE	15.0%
GENERAL INFLATION RATE (Measure)	3.0%
BASE YEAR	2001
START YEAR	2001
DIFFERENCE	0
UTILITY LINE LOSS RATE	5.0%

ENERGY COSTS AND RATES

RATE TYPE	INDUSTRIAL
ENERGY UNITS	$/KWh
DEMAND UNITS	$/KW

Rate/Time Periods	1	2	3	4	5	
Name	Summer On-Peak	Partial-Peak	Summer Off-Peak	Partial Peak	Winter Off-Peak	
Abbreviation	SOP	SPP	SOFF	WPP	WOFF	TOTAL
Hours	768	896	2752	1638	2706	8760
Monthly Adjustment fo	6	0	0	6	0	

	AVOIDED ENERGY COSTS BY TIME PERIOD					AVOIDED DEMAND COSTS BY TIME PERIOD					INDUSTRIAL ENERGY RATES					INDUSTRIAL DEMAND RATES					Environmental Adder to be Subtracted for RIM
Year	SOP $/KWh	SPP $/KWh	SOFF $/KWh	WPP $/KWh	WOFF $/KWh	SOP $/KW	SPP $/KW	SOFF $/KW	WPP $/KW	WOFF $/KW	SOP $/KWh	SPP $/KWh	SOFF $/KWh	WPP $/KWh	WOFF $/KWh	SOP $/KW	SPP $/KW	SOFF $/KW	WPP $/KW	WOFF $/KW	$/KWh
2001	0.59	0.11	0.08	0.03	0.03	25.63	10.21	2.23	11.45	2.21	0.10	0.10	0.10	0.10	0.10	0.00	0.00	0.00	0.00	0.00	0.01
2002	0.59	0.11	0.08	0.03	0.03	26.65	10.65	2.33	12.01	2.30	0.08	0.08	0.08	0.08	0.08	0.00	0.00	0.00	0.00	0.00	0.01
2003	0.26	0.06	0.03	0.05	0.04	27.73	11.11	2.43	12.58	2.40	0.07	0.07	0.07	0.07	0.07	0.00	0.00	0.00	0.00	0.00	0.01
2004	0.24	0.05	0.03	0.05	0.04	28.88	11.58	2.53	13.16	2.50	0.07	0.07	0.07	0.07	0.07	0.00	0.00	0.00	0.00	0.00	0.01
2005	0.25	0.05	0.03	0.05	0.04	30.20	12.08	2.64	13.63	2.61	0.06	0.06	0.06	0.06	0.06	0.00	0.00	0.00	0.00	0.00	0.01
2006	0.22	0.05	0.03	0.05	0.04	31.49	12.59	2.75	14.22	2.72	0.06	0.06	0.06	0.06	0.06	0.00	0.00	0.00	0.00	0.00	0.01
2007	0.23	0.06	0.03	0.05	0.04	32.90	13.13	2.87	14.76	2.84	0.07	0.07	0.07	0.07	0.07	0.00	0.00	0.00	0.00	0.00	0.01
2008	0.23	0.06	0.03	0.05	0.04	34.24	13.69	2.99	15.46	2.96	0.07	0.07	0.07	0.07	0.07	0.00	0.00	0.00	0.00	0.00	0.01
2009	0.24	0.06	0.04	0.06	0.04	35.69	14.28	3.12	16.14	3.08	0.07	0.07	0.07	0.07	0.07	0.00	0.00	0.00	0.00	0.00	0.01
2010	0.25	0.06	0.04	0.06	0.04	37.27	14.89	3.25	16.78	3.22	0.07	0.07	0.07	0.07	0.07	0.00	0.00	0.00	0.00	0.00	0.01
2011	0.22	0.05	0.03	0.05	0.04	38.86	15.52	3.39	17.51	3.35	0.07	0.07	0.07	0.07	0.07	0.00	0.00	0.00	0.00	0.00	0.01
2012	0.23	0.06	0.03	0.05	0.04	40.54	16.18	3.53	18.23	3.50	0.08	0.08	0.08	0.08	0.08	0.00	0.00	0.00	0.00	0.00	0.01
2013	0.24	0.06	0.03	0.06	0.04	42.28	16.88	3.68	19.00	3.65	0.08	0.08	0.08	0.08	0.08	0.00	0.00	0.00	0.00	0.00	0.01
2014	0.25	0.06	0.04	0.06	0.04	44.09	17.61	3.84	19.81	3.80	0.08	0.08	0.08	0.08	0.08	0.00	0.00	0.00	0.00	0.00	0.01
2015	0.26	0.06	0.04	0.06	0.05	45.98	18.36	4.01	20.66	3.97	0.08	0.08	0.08	0.08	0.08	0.00	0.00	0.00	0.00	0.00	0.02
2016	0.27	0.07	0.04	0.06	0.05	47.94	19.15	4.18	21.54	4.14	0.09	0.09	0.09	0.09	0.09	0.00	0.00	0.00	0.00	0.00	0.02
2017	0.28	0.07	0.04	0.07	0.05	49.99	19.97	4.35	22.47	4.31	0.09	0.09	0.09	0.09	0.09	0.00	0.00	0.00	0.00	0.00	0.02
2018	0.30	0.07	0.04	0.07	0.05	52.13	20.82	4.54	23.43	4.50	0.09	0.09	0.09	0.09	0.09	0.00	0.00	0.00	0.00	0.00	0.02
2019	0.31	0.08	0.05	0.07	0.06	54.36	21.71	4.73	24.43	4.69	0.09	0.09	0.09	0.09	0.09	0.00	0.00	0.00	0.00	0.00	0.02
2020	0.33	0.08	0.05	0.08	0.06	56.68	22.64	4.94	25.48	4.89	0.10	0.10	0.10	0.10	0.10	0.00	0.00	0.00	0.00	0.00	0.02
2021	0.35	0.08	0.05	0.08	0.06	59.10	23.61	5.15	26.57	5.10	0.10	0.10	0.10	0.10	0.10	0.00	0.00	0.00	0.00	0.00	0.02

ECONOMIC PARAMETERS

HIGH ECONOMIC SCENARIO

UTILITY NAME	**Statewide**
SECTOR	Industrial
BATCH #	1
UTILITY DISCOUNT RATE	8.0%
CUSTOMER DISCOUNT RATE	15.0%
GENERAL INFLATION RATE (Measure)	3.0%
BASE YEAR	2001
START YEAR	2001
DIFFERENCE	0
UTILITY LINE LOSS RATE	5.0%

ENERGY COSTS AND RATES

RATE TYPE	INDUSTRIAL
ENERGY UNITS	$/KWh
DEMAND UNITS	$/KW

Rate/Time Periods	1	2	3	4	5	
Name	Summer On-Peak	Summer Partial-Peak	Summer Off-Peak	Winter Partial Peak	Winter Off-Peak	
Abbreviation	SOP	SPP	SOFF	WPP	WOFF	TOTAL
Hours	768	896	2752	1638	2706	8760
Monthly Adjustment for r	6	0	0	6	0	

	AVOIDED ENERGY COSTS BY TIME PERIOD					AVOIDED DEMAND COSTS BY TIME PERIOD					INDUSTRIAL ENERGY RATES					INDUSTRIAL DEMAND RATES					Environmental Adder to be Subtracted for RIM
											Need to work out GS-2 as proxy										
	SOP	SPP	SOFF	WPP	WOFF	SOP	SPP	SOFF	WPP	WOFF	SOP	SPP	SOFF	WPP	WOFF	SOP	SPP	SOFF	WPP	WOFF	
Year	$/KWh	$/KWh	$/KWh	$/KWh	$/KWh	$/KW	$/KW	$/KW	$/KW	$/KW	$/KWh	$/KWh	$/KWh	$/KWh	$/KWh	$/KW	$/KW	$/KW	$/KW	$/KW	$/KWh
2001	0.74	0.13	0.10	0.04	0.04	25.63	10.21	2.23	11.45	2.21	0.10	0.10	0.10	0.10	0.10	0.00	0.00	0.00	0.00	0.00	0.01
2002	0.74	0.13	0.10	0.04	0.04	26.65	10.65	2.33	12.01	2.30	0.10	0.10	0.10	0.10	0.10	0.00	0.00	0.00	0.00	0.00	0.01
2003	0.32	0.07	0.04	0.06	0.05	27.73	11.11	2.43	12.58	2.40	0.10	0.10	0.10	0.10	0.10	0.00	0.00	0.00	0.00	0.00	0.01
2004	0.30	0.06	0.04	0.06	0.05	28.88	11.58	2.53	13.16	2.50	0.10	0.10	0.10	0.10	0.10	0.00	0.00	0.00	0.00	0.00	0.01
2005	0.31	0.06	0.04	0.06	0.05	30.20	12.08	2.64	13.63	2.61	0.11	0.11	0.11	0.11	0.11	0.00	0.00	0.00	0.00	0.00	0.01
2006	0.27	0.07	0.04	0.06	0.05	31.49	12.59	2.75	14.22	2.72	0.11	0.11	0.11	0.11	0.11	0.00	0.00	0.00	0.00	0.00	0.01
2007	0.28	0.07	0.04	0.07	0.05	32.90	13.13	2.87	14.76	2.84	0.11	0.11	0.11	0.11	0.11	0.00	0.00	0.00	0.00	0.00	0.01
2008	0.29	0.07	0.04	0.07	0.05	34.24	13.69	2.99	15.46	2.96	0.12	0.12	0.12	0.12	0.12	0.00	0.00	0.00	0.00	0.00	0.01
2009	0.30	0.07	0.04	0.07	0.05	35.69	14.28	3.12	16.14	3.08	0.12	0.12	0.12	0.12	0.12	0.00	0.00	0.00	0.00	0.00	0.01
2010	0.31	0.08	0.05	0.07	0.06	37.27	14.89	3.25	16.78	3.22	0.12	0.12	0.12	0.12	0.12	0.00	0.00	0.00	0.00	0.00	0.01
2011	0.27	0.07	0.04	0.06	0.05	38.86	15.52	3.39	17.51	3.35	0.13	0.13	0.13	0.13	0.13	0.00	0.00	0.00	0.00	0.00	0.01
2012	0.28	0.07	0.04	0.07	0.05	40.54	16.18	3.53	18.23	3.50	0.13	0.13	0.13	0.13	0.13	0.00	0.00	0.00	0.00	0.00	0.01
2013	0.30	0.07	0.04	0.07	0.05	42.28	16.88	3.68	19.00	3.65	0.14	0.14	0.14	0.14	0.14	0.00	0.00	0.00	0.00	0.00	0.01
2014	0.31	0.08	0.05	0.07	0.05	44.09	17.61	3.84	19.81	3.80	0.14	0.14	0.14	0.14	0.14	0.00	0.00	0.00	0.00	0.00	0.01
2015	0.32	0.08	0.05	0.08	0.06	45.98	18.36	4.01	20.66	3.97	0.14	0.14	0.14	0.14	0.14	0.00	0.00	0.00	0.00	0.00	0.02
2016	0.34	0.08	0.05	0.08	0.06	47.94	19.15	4.18	21.54	4.14	0.15	0.15	0.15	0.15	0.15	0.00	0.00	0.00	0.00	0.00	0.02
2017	0.35	0.09	0.05	0.08	0.06	49.99	19.97	4.35	22.47	4.31	0.15	0.15	0.15	0.15	0.15	0.00	0.00	0.00	0.00	0.00	0.02
2018	0.37	0.09	0.05	0.09	0.07	52.13	20.82	4.54	23.43	4.50	0.16	0.16	0.16	0.16	0.16	0.00	0.00	0.00	0.00	0.00	0.02
2019	0.39	0.10	0.06	0.09	0.07	54.36	21.71	4.73	24.43	4.69	0.16	0.16	0.16	0.16	0.16	0.00	0.00	0.00	0.00	0.00	0.02
2020	0.41	0.10	0.06	0.10	0.07	56.68	22.64	4.94	25.48	4.89	0.17	0.17	0.17	0.17	0.17	0.00	0.00	0.00	0.00	0.00	0.02
2021	0.43	0.11	0.06	0.10	0.08	59.10	23.61	5.15	26.57	5.10	0.17	0.17	0.17	0.17	0.17	0.00	0.00	0.00	0.00	0.00	0.02

ECONOMIC PARAMETERS

LOW ECONOMIC SCENARIO

UTILITY NAME	**Statewide**
SECTOR	Industrial
BATCH #	1
UTILITY DISCOUNT RATE	8.0%
CUSTOMER DISCOUNT RATE	15.0%
GENERAL INFLATION RATE (Measure)	3.0%
BASE YEAR	2001
START YEAR	2001
DIFFERENCE	0
UTILITY LINE LOSS RATE	5.0%

ENERGY COSTS AND RATES

RATE TYPE	INDUSTRIAL
ENERGY UNITS	$/KWh
DEMAND UNITS	$/KW

Rate/Time Periods	1	2	3	4	5	
Name	Summer On-Peak	Partial-Peak	Summer Off-Peak	Partial Peak	Winter Off-Peak	
Abbreviation	SOP	SPP	SOFF	WPP	WOFF	TOTAL
Hours	768	896	2752	1638	2706	8760
Monthly Adjustment fc	6	0	0	6	0	

	AVOIDED ENERGY COSTS BY TIME PERIOD					AVOIDED DEMAND COSTS BY TIME PERIOD					INDUSTRIAL ENERGY RATES					INDUSTRIAL DEMAND RATES					Environmental Adder to be Subtracted for RIM
	SOP	SPP	SOFF	WPP	WOFF	SOP	SPP	SOFF	WPP	WOFF	SOP	SPP	SOFF	WPP	WOFF	SOP	SPP	SOFF	WPP	WOFF	
Year	$/KWh	$/KWh	$/KWh	$/KWh	$/KWh	$/KW	$/KW	$/KW	$/KW	$/KW	$/KWh	$/KWh	$/KWh	$/KWh	$/KWh	$/KW	$/KW	$/KW	$/KW	$/KW	$/KWh
2001	0.30	0.05	0.04	0.02	0.01	25.63	10.21	2.23	11.45	2.21	0.06	0.06	0.06	0.06	0.06	0.00	0.00	0.00	0.00	0.00	0.01
2002	0.30	0.05	0.04	0.02	0.01	26.65	10.65	2.33	12.01	2.30	0.06	0.06	0.06	0.06	0.06	0.00	0.00	0.00	0.00	0.00	0.01
2003	0.13	0.03	0.02	0.03	0.02	27.73	11.11	2.43	12.58	2.40	0.06	0.06	0.06	0.06	0.06	0.00	0.00	0.00	0.00	0.00	0.01
2004	0.12	0.03	0.02	0.02	0.02	28.88	11.58	2.53	13.16	2.50	0.06	0.06	0.06	0.06	0.06	0.00	0.00	0.00	0.00	0.00	0.01
2005	0.12	0.03	0.02	0.02	0.02	30.20	12.08	2.64	13.63	2.61	0.07	0.07	0.07	0.07	0.07	0.00	0.00	0.00	0.00	0.00	0.01
2006	0.11	0.03	0.02	0.03	0.02	31.49	12.59	2.75	14.22	2.72	0.07	0.07	0.07	0.07	0.07	0.00	0.00	0.00	0.00	0.00	0.01
2007	0.11	0.03	0.02	0.03	0.02	32.90	13.13	2.87	14.76	2.84	0.07	0.07	0.07	0.07	0.07	0.00	0.00	0.00	0.00	0.00	0.01
2008	0.12	0.03	0.02	0.03	0.02	34.24	13.69	2.99	15.46	2.96	0.07	0.07	0.07	0.07	0.07	0.00	0.00	0.00	0.00	0.00	0.01
2009	0.12	0.03	0.02	0.03	0.02	35.69	14.28	3.12	16.14	3.08	0.08	0.08	0.08	0.08	0.08	0.00	0.00	0.00	0.00	0.00	0.01
2010	0.13	0.03	0.02	0.03	0.02	37.27	14.89	3.25	16.78	3.22	0.08	0.08	0.08	0.08	0.08	0.00	0.00	0.00	0.00	0.00	0.01
2011	0.11	0.03	0.02	0.03	0.02	38.86	15.52	3.39	17.51	3.35	0.08	0.08	0.08	0.08	0.08	0.00	0.00	0.00	0.00	0.00	0.01
2012	0.11	0.03	0.02	0.03	0.02	40.54	16.18	3.53	18.23	3.50	0.08	0.08	0.08	0.08	0.08	0.00	0.00	0.00	0.00	0.00	0.01
2013	0.12	0.03	0.02	0.03	0.02	42.28	16.88	3.68	19.00	3.65	0.08	0.08	0.08	0.08	0.08	0.00	0.00	0.00	0.00	0.00	0.01
2014	0.12	0.03	0.02	0.03	0.02	44.09	17.61	3.84	19.81	3.80	0.09	0.09	0.09	0.09	0.09	0.00	0.00	0.00	0.00	0.00	0.01
2015	0.13	0.03	0.02	0.03	0.02	45.98	18.36	4.01	20.66	3.97	0.09	0.09	0.09	0.09	0.09	0.00	0.00	0.00	0.00	0.00	0.02
2016	0.14	0.03	0.02	0.03	0.02	47.94	19.15	4.18	21.54	4.14	0.09	0.09	0.09	0.09	0.09	0.00	0.00	0.00	0.00	0.00	0.02
2017	0.14	0.03	0.02	0.03	0.02	49.99	19.97	4.35	22.47	4.31	0.10	0.10	0.10	0.10	0.10	0.00	0.00	0.00	0.00	0.00	0.02
2018	0.15	0.04	0.02	0.03	0.03	52.13	20.82	4.54	23.43	4.50	0.10	0.10	0.10	0.10	0.10	0.00	0.00	0.00	0.00	0.00	0.02
2019	0.16	0.04	0.02	0.04	0.03	54.36	21.71	4.73	24.43	4.69	0.10	0.10	0.10	0.10	0.10	0.00	0.00	0.00	0.00	0.00	0.02
2020	0.16	0.04	0.02	0.04	0.03	56.68	22.64	4.94	25.48	4.89	0.10	0.10	0.10	0.10	0.10	0.00	0.00	0.00	0.00	0.00	0.02
2021	0.17	0.04	0.03	0.04	0.03	59.10	23.61	5.15	26.57	5.10	0.11	0.11	0.11	0.11	0.11	0.00	0.00	0.00	0.00	0.00	0.02

ECONOMIC PARAMETERS

BASE ECONOMIC SCENARIO

UTILITY NAME	**Statewide**
SECTOR	Residential
BATCH #	1
UTILITY DISCOUNT RATE	8.0%
CUSTOMER DISCOUNT RATE	15.0%
GENERAL INFLATION RATE (Measure)	3.0%
BASE YEAR	2001
START YEAR	2001
DIFFERENCE	0
UTILITY LINE LOSS RATE	8.5%

ENERGY COSTS AND RATES

RATE TYPE	RESIDENTIAL
ENERGY UNITS	$/KWh
DEMAND UNITS	$/KW

Rate/Time Periods	1	2	3	4	5	
Name	Summer On-Peak	Partial-Peak	Summer Off-Peak	Winter Partial Peak	Winter Off-Peak	
Abbreviation	SOP	SPP	SOFF	WPP	WOFF	TOTAL
Hours	768	896	2752	1638	2706	8760
Monthly Adjustment fo	6	0	0	6	0	

	AVOIDED ENERGY COSTS BY TIME PERIOD					AVOIDED DEMAND COSTS BY TIME PERIOD					RESIDENTIAL ENERGY RATES					RESIDENTIAL DEMAND RATES					Environmental Adder to be Subtracted for RIM
	SOP	SPP	SOFF	WPP	WOFF	SOP	SPP	SOFF	WPP	WOFF	SOP	SPP	SOFF	WPP	WOFF	SOP	SPP	SOFF	WPP	WOFF	
Year	$/KWh	$/KWh	$/KWh	$/KWh	$/KWh	$/KW	$/KW	$/KW	$/KW	$/KW	$/KWh	$/KWh	$/KWh	$/KWh	$/KWh	$/KW	$/KW	$/KW	$/KW	$/KW	$/KWh
2001	0.59	0.11	0.08	0.03	0.03	25.63	10.21	2.23	11.45	2.21	0.12	0.12	0.12	0.12	0.12	0.00	0.00	0.00	0.00	0.00	0.01
2002	0.59	0.11	0.08	0.03	0.03	26.65	10.65	2.33	12.01	2.30	0.12	0.12	0.12	0.12	0.12	0.00	0.00	0.00	0.00	0.00	0.01
2003	0.26	0.06	0.03	0.05	0.04	27.73	11.11	2.43	12.58	2.40	0.13	0.13	0.13	0.13	0.13	0.00	0.00	0.00	0.00	0.00	0.01
2004	0.24	0.05	0.03	0.05	0.04	28.88	11.58	2.53	13.16	2.50	0.14	0.14	0.14	0.14	0.14	0.00	0.00	0.00	0.00	0.00	0.01
2005	0.25	0.05	0.03	0.05	0.04	30.20	12.08	2.64	13.63	2.61	0.14	0.14	0.14	0.14	0.14	0.00	0.00	0.00	0.00	0.00	0.01
2006	0.22	0.05	0.03	0.05	0.04	31.49	12.59	2.75	14.22	2.72	0.14	0.14	0.14	0.14	0.14	0.00	0.00	0.00	0.00	0.00	0.01
2007	0.23	0.06	0.03	0.05	0.04	32.90	13.13	2.87	14.76	2.84	0.14	0.14	0.14	0.14	0.14	0.00	0.00	0.00	0.00	0.00	0.01
2008	0.23	0.06	0.03	0.05	0.04	34.24	13.69	2.99	15.46	2.96	0.14	0.14	0.14	0.14	0.14	0.00	0.00	0.00	0.00	0.00	0.01
2009	0.24	0.06	0.04	0.06	0.04	35.69	14.28	3.12	16.14	3.08	0.14	0.14	0.14	0.14	0.14	0.00	0.00	0.00	0.00	0.00	0.01
2010	0.25	0.06	0.04	0.06	0.04	37.27	14.89	3.25	16.78	3.22	0.14	0.14	0.14	0.14	0.14	0.00	0.00	0.00	0.00	0.00	0.01
2011	0.22	0.05	0.03	0.05	0.04	38.86	15.52	3.39	17.51	3.35	0.15	0.15	0.15	0.15	0.15	0.00	0.00	0.00	0.00	0.00	0.01
2012	0.23	0.06	0.03	0.05	0.04	40.54	16.18	3.53	18.23	3.50	0.15	0.15	0.15	0.15	0.15	0.00	0.00	0.00	0.00	0.00	0.01
2013	0.24	0.06	0.03	0.06	0.04	42.28	16.88	3.68	19.00	3.65	0.16	0.16	0.16	0.16	0.16	0.00	0.00	0.00	0.00	0.00	0.01
2014	0.25	0.06	0.04	0.06	0.04	44.09	17.61	3.84	19.81	3.80	0.16	0.16	0.16	0.16	0.16	0.00	0.00	0.00	0.00	0.00	0.01
2015	0.26	0.06	0.04	0.06	0.05	45.98	18.36	4.01	20.66	3.97	0.17	0.17	0.17	0.17	0.17	0.00	0.00	0.00	0.00	0.00	0.02
2016	0.27	0.07	0.04	0.06	0.05	47.94	19.15	4.18	21.54	4.14	0.17	0.17	0.17	0.17	0.17	0.00	0.00	0.00	0.00	0.00	0.02
2017	0.28	0.07	0.04	0.07	0.05	49.99	19.97	4.35	22.47	4.31	0.18	0.18	0.18	0.18	0.18	0.00	0.00	0.00	0.00	0.00	0.02
2018	0.30	0.07	0.04	0.07	0.05	52.13	20.82	4.54	23.43	4.50	0.18	0.18	0.18	0.18	0.18	0.00	0.00	0.00	0.00	0.00	0.02
2019	0.31	0.08	0.05	0.07	0.06	54.36	21.71	4.73	24.43	4.69	0.19	0.19	0.19	0.19	0.19	0.00	0.00	0.00	0.00	0.00	0.02
2020	0.33	0.08	0.05	0.08	0.06	56.68	22.64	4.94	25.48	4.89	0.19	0.19	0.19	0.19	0.19	0.00	0.00	0.00	0.00	0.00	0.02
2021	0.35	0.08	0.05	0.08	0.06	59.10	23.61	5.15	26.57	5.10	0.20	0.20	0.20	0.20	0.20	0.00	0.00	0.00		0.00	0.02

ECONOMIC PARAMETERS

HIGH ECONOMIC SCENARIO

UTILITY NAME	**Statewide**
SECTOR	Residential
BATCH #	1
UTILITY DISCOUNT RATE	8.0%
CUSTOMER DISCOUNT RATE	15.0%
GENERAL INFLATION RATE (Measure)	3.0%
BASE YEAR	2001
START YEAR	2001
DIFFERENCE	0
UTILITY LINE LOSS RATE	8.5%

ENERGY COSTS AND RATES

RATE TYPE	RESIDENTIAL
ENERGY UNITS	$/KWh
DEMAND UNITS	$/KW

Rate/Time Periods	1	2	3	4	5	
Name	Summer On-Peak	Summer Partial-Peak	Summer Off-Peak	Winter Partial Peak	Winter Off-Peak	
Abbreviation	SOP	SPP	SOFF	WPP	WOFF	TOTAL
Hours	768	896	2752	1638	2706	8760
Monthly Adjustment for rat	6	0	0	6	0	

	AVOIDED ENERGY COSTS BY TIME PERIOD					AVOIDED DEMAND COSTS BY TIME PERIOD					RESIDENTIAL ENERGY RATES					RESIDENTIAL DEMAND RATES					Environmental Adder to be Subtracted for RIM
	SOP	SPP	SOFF	WPP	WOFF	SOP	SPP	SOFF	WPP	WOFF	SOP	SPP	SOFF	WPP	WOFF	SOP	SPP	SOFF	WPP	WOFF	
Year	$/KWh	$/KWh	$/KWh	$/KWh	$/KWh	$/KW	$/KW	$/KW	$/KW	$/KW	$/KWh	$/KWh	$/KWh	$/KWh	$/KWh	$/KW	$/KW	$/KW	$/KW	$/KW	$/KWh
2001	0.74	0.13	0.10	0.04	0.04	25.63	10.21	2.23	11.45	2.21	0.12	0.12	0.12	0.12	0.12	0.00	0.00	0.00	0.00	0.00	0.01
2002	0.74	0.13	0.10	0.04	0.04	26.65	10.65	2.33	12.01	2.30	0.12	0.12	0.12	0.12	0.12	0.00	0.00	0.00	0.00	0.00	0.01
2003	0.32	0.07	0.04	0.06	0.05	27.73	11.11	2.43	12.58	2.40	0.12	0.12	0.12	0.12	0.12	0.00	0.00	0.00	0.00	0.00	0.01
2004	0.30	0.06	0.04	0.06	0.05	28.88	11.58	2.53	13.16	2.50	0.12	0.12	0.12	0.12	0.12	0.00	0.00	0.00	0.00	0.00	0.01
2005	0.31	0.06	0.04	0.06	0.05	30.20	12.08	2.64	13.63	2.61	0.13	0.13	0.13	0.13	0.13	0.00	0.00	0.00	0.00	0.00	0.01
2006	0.27	0.07	0.04	0.06	0.05	31.49	12.59	2.75	14.22	2.72	0.13	0.13	0.13	0.13	0.13	0.00	0.00	0.00	0.00	0.00	0.01
2007	0.28	0.07	0.04	0.07	0.05	32.90	13.13	2.87	14.76	2.84	0.14	0.14	0.14	0.14	0.14	0.00	0.00	0.00	0.00	0.00	0.01
2008	0.29	0.07	0.04	0.07	0.05	34.24	13.69	2.99	15.46	2.96	0.14	0.14	0.14	0.14	0.14	0.00	0.00	0.00	0.00	0.00	0.01
2009	0.30	0.07	0.04	0.07	0.05	35.69	14.28	3.12	16.14	3.08	0.14	0.14	0.14	0.14	0.14	0.00	0.00	0.00	0.00	0.00	0.01
2010	0.31	0.08	0.05	0.07	0.06	37.27	14.89	3.25	16.78	3.22	0.15	0.15	0.15	0.15	0.15	0.00	0.00	0.00	0.00	0.00	0.01
2011	0.27	0.07	0.04	0.06	0.05	38.86	15.52	3.39	17.51	3.35	0.15	0.15	0.15	0.15	0.15	0.00	0.00	0.00	0.00	0.00	0.01
2012	0.28	0.07	0.04	0.07	0.05	40.54	16.18	3.53	18.23	3.50	0.16	0.16	0.16	0.16	0.16	0.00	0.00	0.00	0.00	0.00	0.01
2013	0.30	0.07	0.04	0.07	0.05	42.28	16.88	3.68	19.00	3.65	0.16	0.16	0.16	0.16	0.16	0.00	0.00	0.00	0.00	0.00	0.01
2014	0.31	0.08	0.05	0.07	0.05	44.09	17.61	3.84	19.81	3.80	0.17	0.17	0.17	0.17	0.17	0.00	0.00	0.00	0.00	0.00	0.01
2015	0.32	0.08	0.05	0.08	0.06	45.98	18.36	4.01	20.66	3.97	0.17	0.17	0.17	0.17	0.17	0.00	0.00	0.00	0.00	0.00	0.02
2016	0.34	0.08	0.05	0.08	0.06	47.94	19.15	4.18	21.54	4.14	0.18	0.18	0.18	0.18	0.18	0.00	0.00	0.00	0.00	0.00	0.02
2017	0.35	0.09	0.05	0.08	0.06	49.99	19.97	4.35	22.47	4.31	0.18	0.18	0.18	0.18	0.18	0.00	0.00	0.00	0.00	0.00	0.02
2018	0.37	0.09	0.05	0.09	0.07	52.13	20.82	4.54	23.43	4.50	0.19	0.19	0.19	0.19	0.19	0.00	0.00	0.00	0.00	0.00	0.02
2019	0.39	0.10	0.06	0.09	0.07	54.36	21.71	4.73	24.43	4.69	0.19	0.19	0.19	0.19	0.19	0.00	0.00	0.00	0.00	0.00	0.02
2020	0.41	0.10	0.06	0.10	0.07	56.68	22.64	4.94	25.48	4.89	0.20	0.20	0.20	0.20	0.20	0.00	0.00	0.00	0.00	0.00	0.02
2021	0.43	0.11	0.06	0.10	0.08	59.10	23.61	5.15	26.57	5.10	0.20	0.20	0.20	0.20	0.20	0.00	0.00	0.00	0.00	0.00	0.02

ECONOMIC PARAMETERS

LOW ECONOMIC SCENARIO

UTILITY NAME	**Statewide**
SECTOR	Residential
BATCH #	1
UTILITY DISCOUNT RATE	8.0%
CUSTOMER DISCOUNT RATE	15.0%
GENERAL INFLATION RATE (Measure)	3.0%
BASE YEAR	2001
START YEAR	2001
DIFFERENCE	0
UTILITY LINE LOSS RATE	8.5%

ENERGY COSTS AND RATES

RATE TYPE	RESIDENTIAL
ENERGY UNITS	$/KWh
DEMAND UNITS	$/KW

Rate/Time Periods	1	2	3	4	5	
Name	Summer On-Peak	Summer Partial-Peak	Summer Off-Peak	Winter Partial Peak	Winter Off-Peak	
Abbreviation	SOP	SPP	SOFF	WPP	WOFF	TOTAL
Hours	768	896	2752	1638	2706	8760
Monthly Adjustment for	6	0	0	6	0	

	AVOIDED ENERGY COSTS BY TIME PERIOD					AVOIDED DEMAND COSTS BY TIME PERIOD					RESIDENTIAL ENERGY RATES					RESIDENTIAL DEMAND RATES					Environmental Adder to be Subtracted for RIM
Year	SOP $/KWh	SPP $/KWh	SOFF $/KWh	WPP $/KWh	WOFF $/KWh	SOP $/KW	SPP $/KW	SOFF $/KW	WPP $/KW	WOFF $/KW	SOP $/KWh	SPP $/KWh	SOFF $/KWh	WPP $/KWh	WOFF $/KWh	SOP $/KW	SPP $/KW	SOFF $/KW	WPP $/KW	WOFF $/KW	$/KWh
2001	0.30	0.05	0.04	0.02	0.01	25.63	10.21	2.23	11.45	2.21	0.10	0.10	0.10	0.10	0.10	0.00	0.00	0.00	0.00	0.00	0.01
2002	0.30	0.05	0.04	0.02	0.01	26.65	10.65	2.33	12.01	2.30	0.10	0.10	0.10	0.10	0.10	0.00	0.00	0.00	0.00	0.00	0.01
2003	0.13	0.03	0.02	0.03	0.02	27.73	11.11	2.43	12.58	2.40	0.10	0.10	0.10	0.10	0.10	0.00	0.00	0.00	0.00	0.00	0.01
2004	0.12	0.03	0.02	0.02	0.02	28.88	11.58	2.53	13.16	2.50	0.10	0.10	0.10	0.10	0.10	0.00	0.00	0.00	0.00	0.00	0.01
2005	0.12	0.03	0.02	0.02	0.02	30.20	12.08	2.64	13.63	2.61	0.11	0.11	0.11	0.11	0.11	0.00	0.00	0.00	0.00	0.00	0.01
2006	0.11	0.03	0.02	0.03	0.02	31.49	12.59	2.75	14.22	2.72	0.11	0.11	0.11	0.11	0.11	0.00	0.00	0.00	0.00	0.00	0.01
2007	0.11	0.03	0.02	0.03	0.02	32.90	13.13	2.87	14.76	2.84	0.11	0.11	0.11	0.11	0.11	0.00	0.00	0.00	0.00	0.00	0.01
2008	0.12	0.03	0.02	0.03	0.02	34.24	13.69	2.99	15.46	2.96	0.12	0.12	0.12	0.12	0.12	0.00	0.00	0.00	0.00	0.00	0.01
2009	0.12	0.03	0.02	0.03	0.02	35.69	14.28	3.12	16.14	3.08	0.12	0.12	0.12	0.12	0.12	0.00	0.00	0.00	0.00	0.00	0.01
2010	0.13	0.03	0.02	0.03	0.02	37.27	14.89	3.25	16.78	3.22	0.12	0.12	0.12	0.12	0.12	0.00	0.00	0.00	0.00	0.00	0.01
2011	0.11	0.03	0.02	0.03	0.02	38.86	15.52	3.39	17.51	3.35	0.13	0.13	0.13	0.13	0.13	0.00	0.00	0.00	0.00	0.00	0.01
2012	0.11	0.03	0.02	0.03	0.02	40.54	16.18	3.53	18.23	3.50	0.13	0.13	0.13	0.13	0.13	0.00	0.00	0.00	0.00	0.00	0.01
2013	0.12	0.03	0.02	0.03	0.02	42.28	16.88	3.68	19.00	3.65	0.14	0.14	0.14	0.14	0.14	0.00	0.00	0.00	0.00	0.00	0.01
2014	0.12	0.03	0.02	0.03	0.02	44.09	17.61	3.84	19.81	3.80	0.14	0.14	0.14	0.14	0.14	0.00	0.00	0.00	0.00	0.00	0.01
2015	0.13	0.03	0.02	0.03	0.02	45.98	18.36	4.01	20.66	3.97	0.14	0.14	0.14	0.14	0.14	0.00	0.00	0.00	0.00	0.00	0.02
2016	0.14	0.03	0.02	0.03	0.02	47.94	19.15	4.18	21.54	4.14	0.15	0.15	0.15	0.15	0.15	0.00	0.00	0.00	0.00	0.00	0.02
2017	0.14	0.03	0.02	0.03	0.02	49.99	19.97	4.35	22.47	4.31	0.15	0.15	0.15	0.15	0.15	0.00	0.00	0.00	0.00	0.00	0.02
2018	0.15	0.04	0.02	0.03	0.03	52.13	20.82	4.54	23.43	4.50	0.16	0.16	0.16	0.16	0.16	0.00	0.00	0.00	0.00	0.00	0.02
2019	0.16	0.04	0.02	0.04	0.03	54.36	21.71	4.73	24.43	4.69	0.16	0.16	0.16	0.16	0.16	0.00	0.00	0.00	0.00	0.00	0.02
2020	0.16	0.04	0.02	0.04	0.03	56.68	22.64	4.94	25.48	4.89	0.17	0.17	0.17	0.17	0.17	0.00	0.00	0.00	0.00	0.00	0.02
2021	0.17	0.04	0.03	0.04	0.03	59.10	23.61	5.15	26.57	5.10	0.17	0.17	0.17	0.17	0.17	0.00	0.00	0.00	0.00	0.00	0.02

APPENDIX E. PRICE SPIKE SCENARIO COMPARISON

As discussed in Section 2 of this report, alternate future energy cost scenarios are developed to test the sensitivity and robustness of energy efficiency to wide ranging estimates of future avoided costs. Our High cost scenario, which increases avoided costs by 25 percent as compared to the Base energy cost scenario, was intended to capture the effect of a high-price energy future. The high-price energy future might result from a future energy crisis or an increase in the value associated with greenhouse gas and other pollutant reductions (for example, because of public or market incentives associated with a greenhouse gas reduction commitment). In this appendix, we present the results of a very simple comparison of our High energy cost scenario with simulated energy cost futures that include price spikes that mimic the recent energy crisis. These simulations are intended to capture the effect of price spikes similar to those that occurred in California from late 2000 through 2001. Ultimately, the energy-efficiency potential of the price spike scenarios was not estimated because the avoided costs in the High scenario roughly matched the price spike scenarios, as discussed below.

The price spike scenarios are 3X Price Spike and 6X Price Spike. These were created using the Base scenario as the starting point (see Appendix D for energy cost data). In the 3X scenario, the avoided energy costs in 2005 and 2006 were multiplied by a factor of 3. Similarly, in the 6X scenario the Base avoided energy costs for 2005 and 2006 were multiplied by a factor of 6. For example, the annual summer peak prices for the scenarios are shown in Figure E-1.

The effects of the 3X and 6X price spikes are dramatic. However, using an 8-percent nominal rate, the discounted value of the price spike scenarios are muted. The discounted annual peak prices for the scenarios are shown in Figure E-2. The 20-year, rolling average, discounted, annual summer peak prices for the scenarios are shown in Figure E-3. The 20-year, rolling sums, discounted annual summer peak prices are shown in Figure E-4. Over the 20-year forecast period, the effect of the price spikes in 2005 and 2006 are largely averaged out. As it turns out, the 3X scenario is actually about 10 percent less than the High scenario on a present-value basis (i.e., summing the sums across the forecast period). The 6X scenario is roughly 10 percent more than the High scenario on a present-value basis.

As a result, we conclude that the High scenario reasonable captures the range of potential costs associated with another energy crisis that might occur in the near term.

Figure E-1

Forecasted Summer Peak Nominal Avoided Energy Cost Scenarios

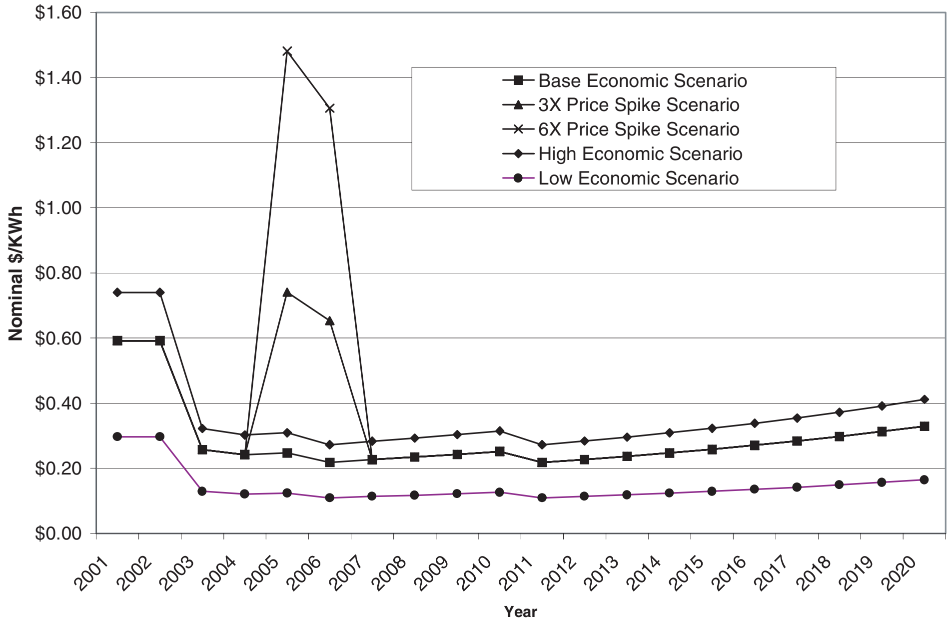


Figure E-2

Forecasted Summer Peak Discounted Avoided Energy Cost Scenarios

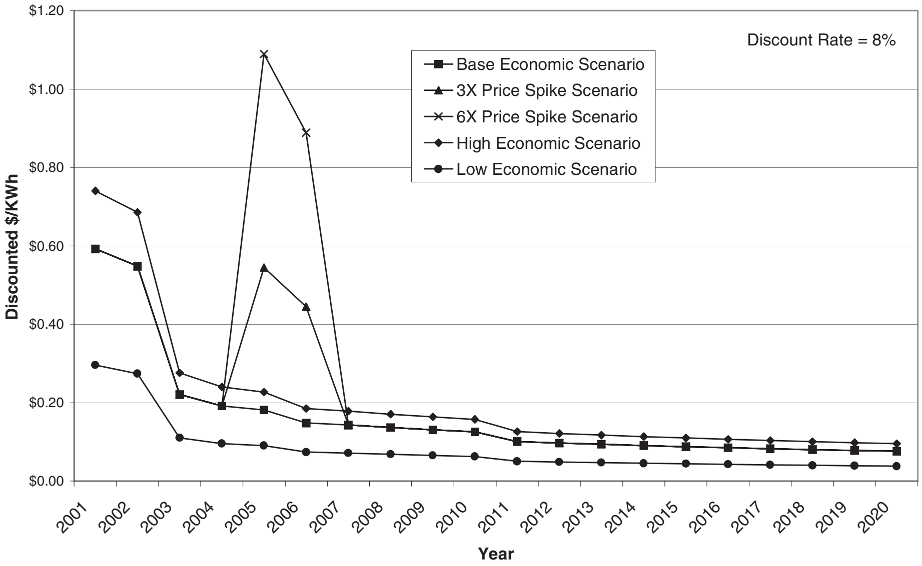


Figure E-3

20-Year Rolling Avg. Discounted Summer Peak Avoided Energy Costs

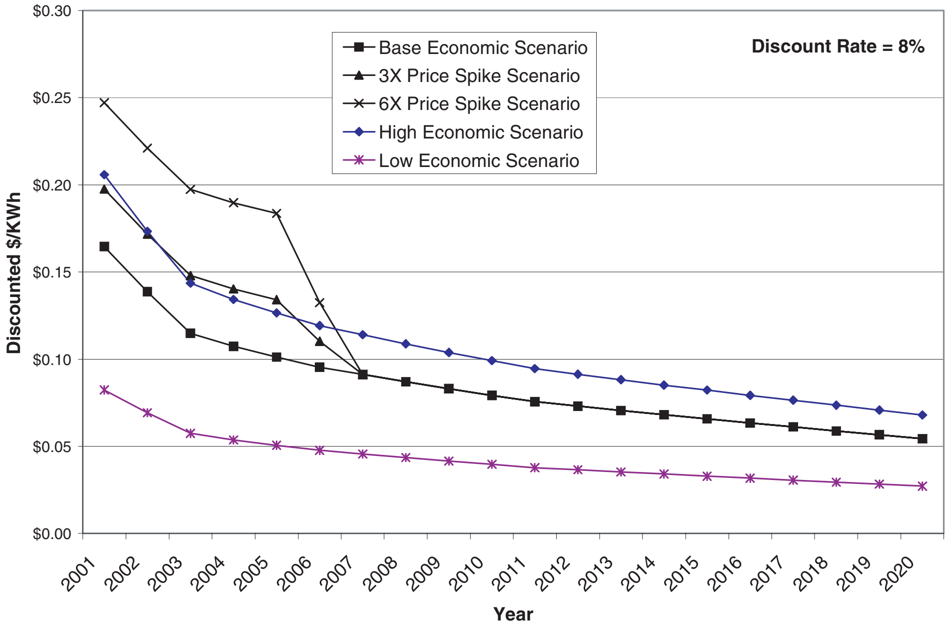
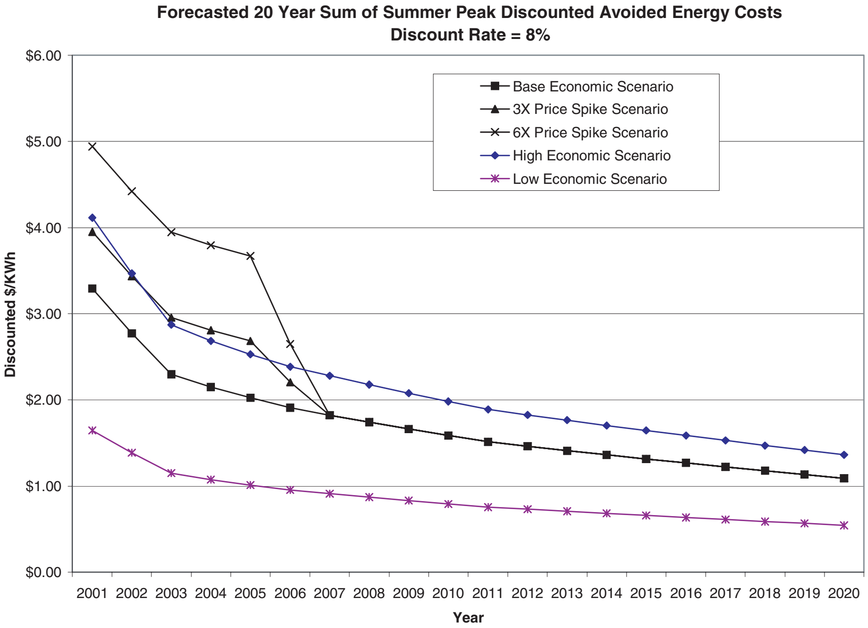


Table E-4
20-Year Rolling Sums of Summer Peak Avoided Costs



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