California Energy Efficiency Potential Study

Volume 1

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Acknowledgements

Project Oversight

Itron would like to thank several parties involved in the California energy efficiency potential studies, beginning with Mr. Rafael Friedmann and Ms. Mary Kay Gobris, the Pacific Gas & Electric Project Managers. Mr. Friedmann directed the potential analysis for the existing residential, commercial, and industrial sectors, and Ms. Gobris initially directed the potential analysis for the residential, commercial, and industrial new construction sectors. Additionally, Mr. Rob Rubin of San Diego Gas & Electric, Ms. Andrea Horwatt of Southern California Edison, and Ms. Cathy Chappell of Heschong Mahone Group helped manage the analysis, contributing their time and energy to numerous conference calls and providing oversight to preliminary drafts of the study.

Authorship Acknowledgement

Itron would like to give credit to KEMA, Inc., RLW Analytics, Inc. (RLW), and Architectural Energy Corporation (AEC). KEMA was responsible for the analysis and authoring the existing industrial section of this report. RLW developed many of the inputs, including incremental costs and energy savings and calibration shares, and authored the industrial new construction methodology section. AEC developed many of the inputs including incremental costs, energy savings, and calibration shares for commercial new construction, time-of-use energy usage for both commercial and industrial new construction, and authored the commercial new construction methodology section. Itron appreciates the opportunity to have worked with KEMA, RLW, and AEC. We recognize the important contributions and added insight that these firms have made to this analysis, which added to the depth and breadth of measures and sectors analyzed for these potential studies.

Staff Acknowledgement

As project managers, we would also like to thank the many Itron staff members who contributed long hours to make these studies a success. Mr. Gary Cullen, Mr. Tom Mayer, and Mr. Bob Ramirez are due special recognition for spending many hours analyzing the CEUS, RASS, and DEER datasets, compiling ASSET input files, and running the ASSET model used to estimate the potential in existing buildings. Ms. Katherine Wolf contributed to numerous new construction conference calls, making sure that all the needed elements were contained in the new construction analyses and working the long hours needed to run the ASSET model. Many thanks also to Mr. Brad Souza, who stepped in and helped run the model, working late into the night to help insure that the work was completed.

Lastly, this project would not have been completed without the intellectual and motivational assistance provided by Frederick D. Sebold, PhD. Dr. Sebold provided guidance and insight, and was willing to postpone his retirement to help insure that this project resulted in a product in which the team, the company, and the State could take pride.

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Executive Summary

ES.1 Introduction

Overview

This report summarizes the findings of three recent studies of gross energy efficiency potential in California. The primary focus is on the Energy Efficiency Potential Study, which assessed the gross potential for electricity and gas savings in existing residential and commercial buildings. The Energy Efficiency Potential Study was conducted by a team of firms consisting of Itron, Inc. (Itron), KEMA, and Quantum Consulting under the management of PG&E. The study was overseen by a Project Advisory Committee (PAC) consisting of representatives from Pacific Gas and Electric (PG&E), Southern California Edison Company (SCE), Southern California Gas Company (SoCalGas), San Diego Gas & Electric Company (SDG&E), the California Public Utilities Commission (CPUC), the California Energy Commission (CEC), and Natural Resources Defense Council (NRDC).

In order to provide a comprehensive view of California's gross energy efficiency potential, this report also incorporates the results of two other studies: an analysis of industrial gross energy efficiency potential, conducted by KEMA, Inc., and a study of gross potential in residential, commercial, and industrial new construction, conducted by Itron, Inc. under a separate contract.

All three studies focus on forecasting the gross technical, economic, and market potential through 2016 resulting from the installation of energy efficiency measures funded through publicly funded energy efficiency programs. The geographic area covered by these three studies includes the service areas of the four major investor-owned utilities (IOUs): PG&E, SCE, SoCalGas, and SDG&E. Previous similar studies were completed in 2002 and 2003 by KEMA-Xenergy, Inc.[1] The three studies covered by this report, taken together, consider potential energy savings resulting from the installation of high efficiency measures for retrofit, replace-on-burnout, conversions, and new construction situations. Energy savings resulting from changes in behavior, or requiring major redesign of existing systems, were not included in the scope of this work.

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[1] KEMA-Xenergy, Inc. *California Statewide Commercial Sector Energy Efficiency Potential Study. Final Report. Volumes 1 and 2*. July 2002.
KEMA-Xenergy, Inc. *California Statewide Residential Sector Energy Efficiency Potential Study. Final Report. Volumes 1 and 2*, April 2003.
KEMA-Xenergy, Inc. *California Statewide Commercial Sector Natural Gas Energy Efficiency Potential Study, Final Report. Volumes 1 and 2.* May 2003 (revised July 2003).
All prepared for Pacific Gas & Electric Company.

Study Objectives and Scope

The primary objective of the work underlying this report was to produce estimates of remaining potential energy savings that might be obtainable in the near (2006-2008) and foreseeable (2009-2016) future through publicly funded energy efficiency programs in the existing and new residential, industrial, and commercial sectors.[2] The findings from this study will be used by the four California IOUs and their program planners to focus utility program offerings by technologies, sectors, and climate zones. The results will help determine where potential savings remain and which technologies offer the most efficient opportunities for energy savings. The results from this study will also help the utilities assess and, to the extent possible, meet the energy saving goals set by the CPUC. The CPUC has established aggressive energy saving goals for electric and natural gas savings for the four state IOUs over the years 2004-2013.

Types of Potential

This study analyzes the remaining technical, economic, and market energy efficiency potentials for the four California IOUs. Technical potential refers to the savings potential that would be captured if all energy efficiency measures were installed in all feasible applications. Economic potential indicates the savings potential that would be achieved if measures were installed in all feasible cost-effective applications. In this context, cost-effectiveness is assessed using a total resource cost (TRC) test, which takes into account the value of savings evaluated at avoided costs, incremental measure costs, and program administrative costs. Market potential denotes the savings that can be expected to result from specific scenarios relating to program designs and market conditions.

Market Potential Scenarios

Market potential was estimated under three scenarios relating to incentive levels. One scenario reflects the continuation of the incentives in effect during 2004. The results for this scenario were calibrated to actual program accomplishments for the 2004 program year.[3] Another set of market potential estimates was derived on the assumption that incentives are increased to cover full incremental measure costs. A third set of estimates was developed to reflect a scenario in which incentives are equal to the average between current (2004) incentives and full incremental costs. The full incremental cost or average scenario-level rebates are implemented beginning in 2006.

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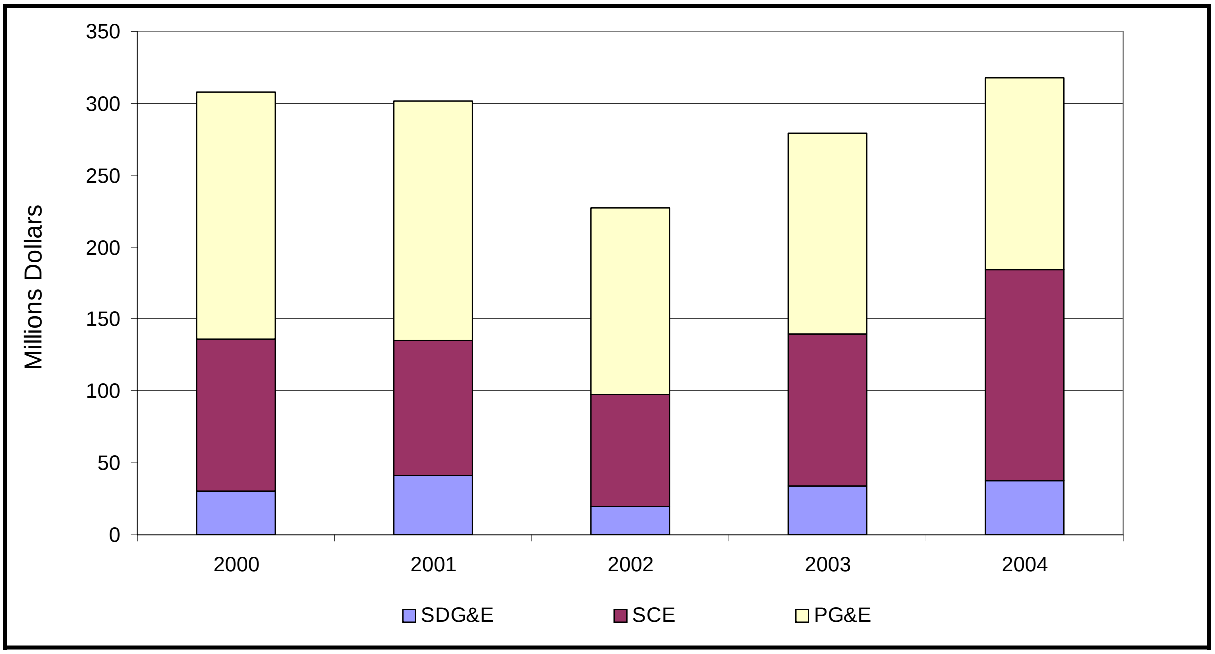
[2] CPUC Interim Opinion R. 01-08-028, August 23, 2001 stated the study was designed to "…enhance the industry understanding of energy efficiency resources available to the state over the current Public Goods Charge (PGC) authorization period. 2002-11."

[3] Program accomplishments were extracted from the IOUs' 2005 Q1 reports for measures in their 2004 programs. For programs with non-specific measure savings, the savings were allocated to measures in the same end-use, if end use was specified, if not they were allocated across the board. Further, the utilities were contacted to verify measure specific savings – SCE and SDG&E responded.

ES.2 Background on California Energy Efficiency Program Impacts and Future Savings Goals

The 2000-2001 energy crisis led to an escalation of energy prices in California and to an increase in the importance of energy efficiency programs. Annual spending on energy efficiency programs by the major California IOUs for planning years 1995-1999 averaged less than $220 million per year (in 2000 dollars).[4] Energy efficiency expenditures by utilities increased significantly in the 2000-2004 period, as shown in Figure ES-1. Annual spending for energy efficiency programs by PG&E, SCE, and SDG&E exceeded $300 million in planning years 2000, 2001, and 2004, with an average of $286 million spent for planning years 2000-2004 (in program year dollars).[5]

Figure ES-1: Utility Energy Efficiency Program Spending – 2000-2004



Data courtesy of California Energy Commission *California Energy Demand 2006-2016 Staff Energy Demand Forecast*, September 2005.

Annual first-year impacts from energy efficiency programs have risen with the increases in funding. Historically, first-year impacts averaged approximately 1,000 GWh, with nonresidential programs representing 80% and residential programs claiming the remaining 20% of the savings.[6] Figure ES-2 and Figure ES-3 illustrate the first-year energy and demand savings claimed by the IOU energy efficiency programs for the years 2000-2004.

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4 KEMA-Xenergy. Data from the *California Statewide Residential Sector Energy Efficiency Potential Study, Volume 1 of 2*, Fred Coito and Mike Rufo. April 2003.

5 Annual funding and savings values from the California Energy Commission Staff Paper *Funding and Energy Savings From Investor-Owned Utility Energy Efficiency Programs in California for Program Years 2000 Through 2004*, August 2005.

6 KEMA-Xenergy, op. cit. April 2003.

Figure ES-2: First-Year GWh Savings by Utility for Energy Efficiency Programs

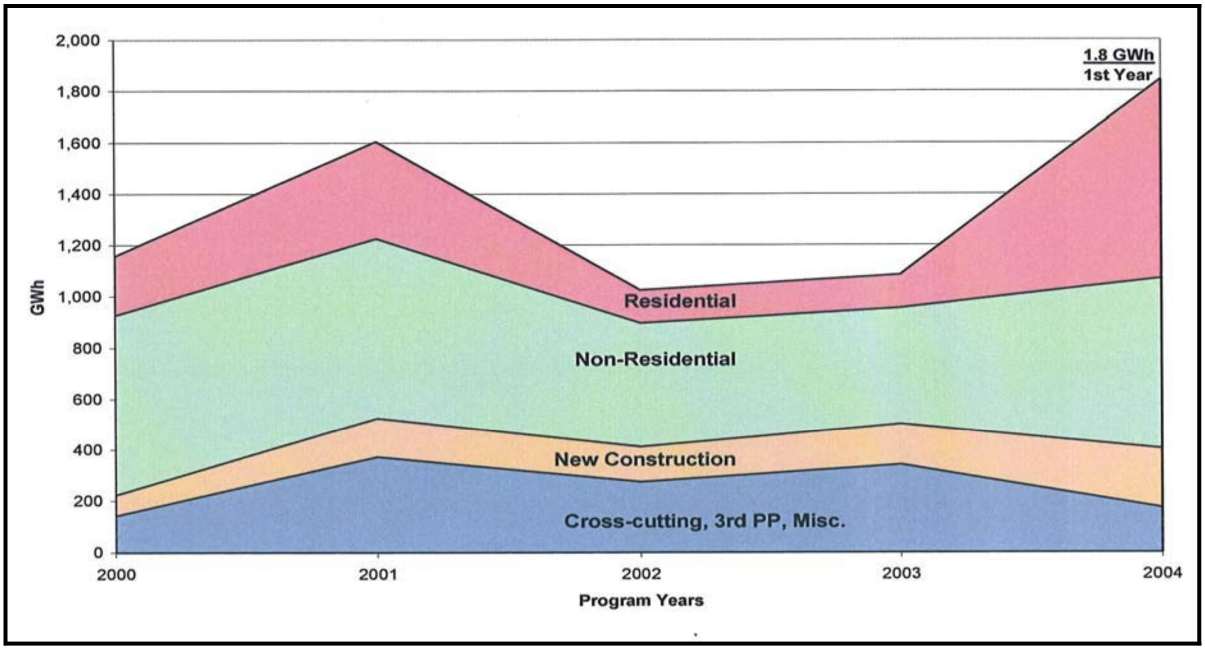

Figure courtesy of the CEC: *Funding and Energy Savings from Investor-Owned Utility Energy Efficiency Programs in California for Program Years 2000 Through 2004,* August 2005. Figure ES-2 is a reproduction of Figure 5 in the CEC report.

Figure ES-3: First-Year Peak Savings of Utility Energy Efficiency Programs

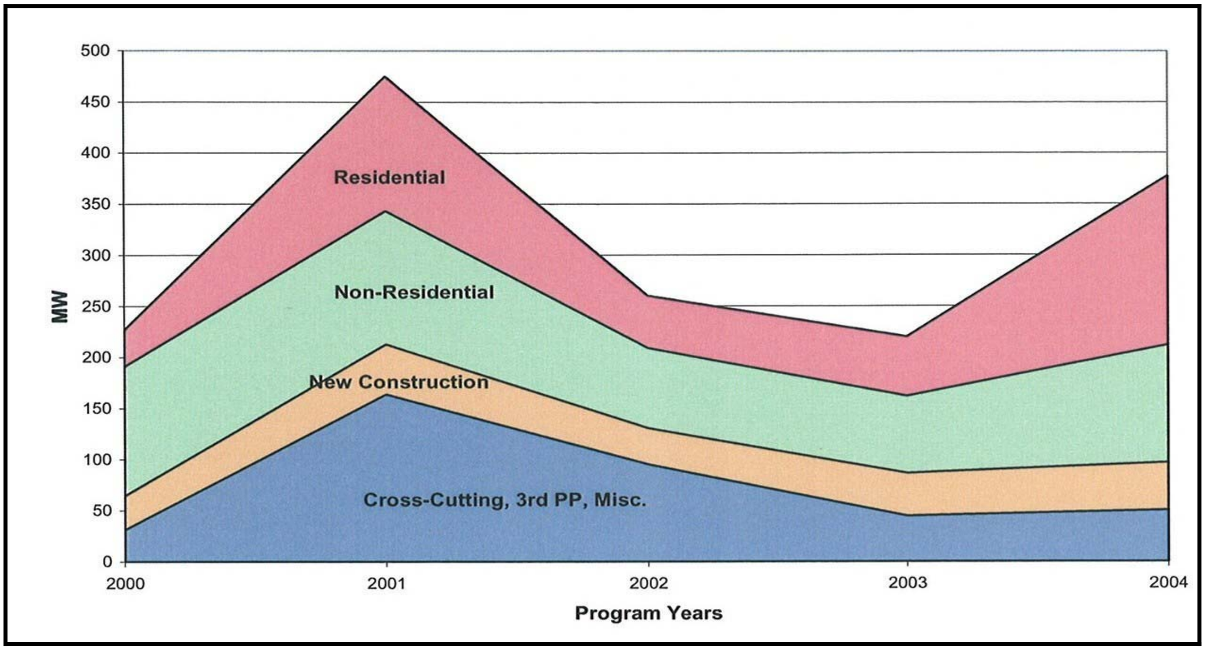

Figure courtesy of the CEC: *Funding and Energy Savings from Investor-Owned Utility Energy Efficiency Programs in California for Program Years 2000 Through 2004,* August 2005. Figure ES-3 is a reproduction of Figure 6 in the CEC report.

The California Public Utilities Commission (CPUC) has established aggressive goals and funding schedules for the four California IOUs for 2004-2013. The 2004-2008 energy efficiency goals for the IOUs are listed in Table ES-1.[7] Meeting these goals will require the utilities to continue operating their existing energy efficiency programs effectively while expanding these and new programs into technologies and segments not previously the primary focus of the energy efficiency programs. The goals set by the CPUC reinforce the importance of this study, which provides guidance to the utilities on where the savings opportunities exist.

Table ES-1: First-Year Impacts of 2004-2008 Energy Efficiency Goals

	PG&E			SCE		SCG	SDG&E		
	GWh	MW	MM Therms	GWh	MW	MM Therms	GWh	MW	MM Therms
2004	744	161	10.95	826	179	11.48	268	58	3.88
2005	744	161	12.25	826	170	13.37	268	58	3.72
2006	829	180	14.54	922	200	14.94	281	61	2.08
2007	944	205	16.54	1046	227	19.84	285	62	2.37
2008	1053	229	19.54	1167	253	23.51	284	62	3.00

Data courtesy of CEC. The IOU savings goals are from the *California Energy Demand 2006-2016 Staff Energy Demand Forecast*, August 2005.

ES.3 Methodology

Most of the analysis was conducted using a model developed by Itron[8] called ASSET. The analysis of potential in existing industrial buildings was conducted using DSM ASSYST, a model developed by KEMA. Figure ES-4 depicts the overall framework of the ASSET model. As shown, the model requires utility data, information on customer characteristics, and technology data. Utility data include utility program costs, avoided costs of energy and demand, and program features. Customer characteristics encompass size (number of homes, floor stock), load profiles, and various aspects of adoptions-related behavior (awareness, willingness, etc.). Technology features include costs and lifetimes as well as savings associated with applications by specific customer segments.

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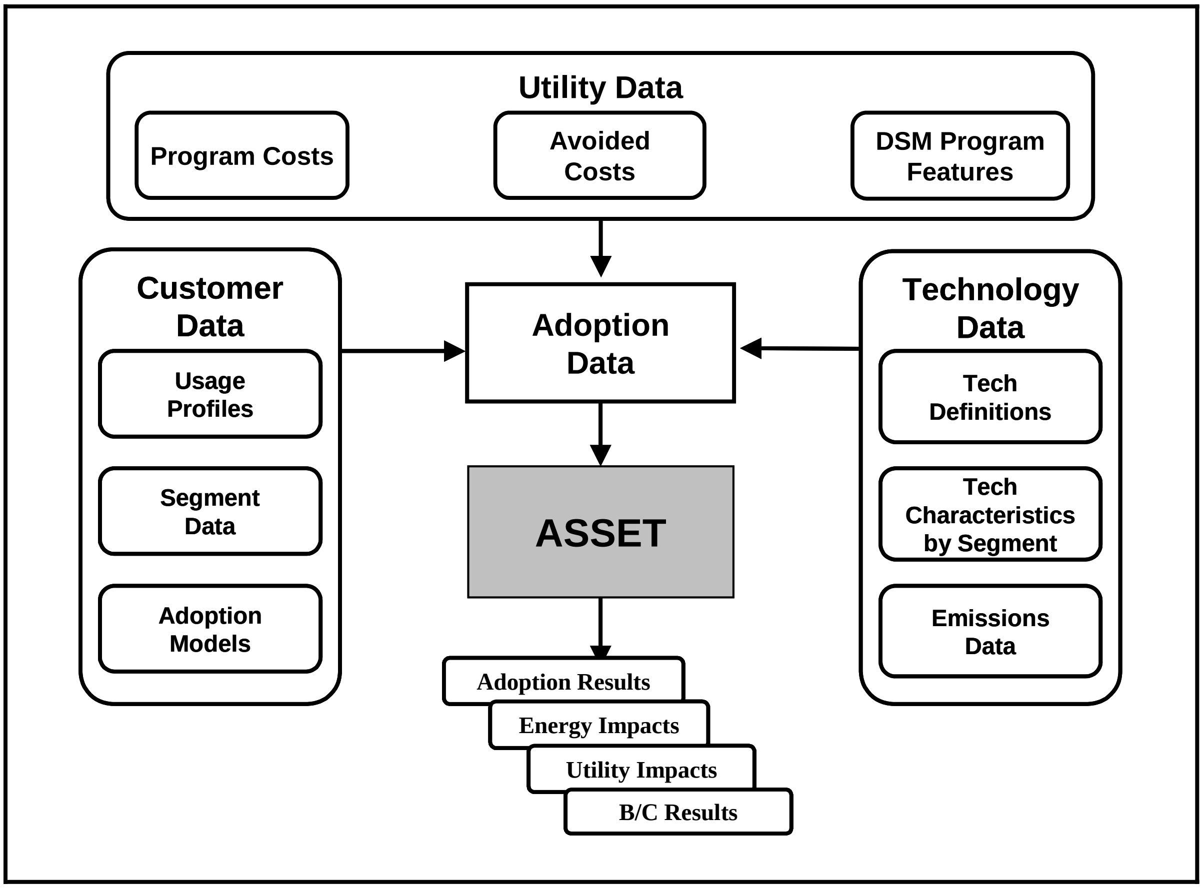
7 The IOU savings goals are from the CEC *California Energy Demand 2006-2016 Staff Energy Demand Forecast*, September 2005.

8 The model was developed by Regional Economic Research, Inc. (RER). RER was acquired by Itron in 2003.

Figure ES-4: Overview of ASSET Framework



Inputs used to implement the ASSET analysis were developed from a variety of sources. The Database for Energy Efficiency Resources (DEER) was the primary source of information for efficiency measure impacts and costs. Due to the timing of this study and the release of the 2005 DEER database, the residential forecast used the 2001 DEER database[9] while the commercial forecast used impacts and costs from the 2005 DEER database.[10] This information was supplemented by other sources, such as utility submittals, where necessary. The *CPUC Policy Manual* was the primary source of measure lifetime information. Technical feasibility was based on professional judgment, supplemented by survey data on specific related end-use characteristics. Indicators of applicability of specific measures were derived from the Residential Appliance Saturation Survey (RASS)[11] and the California

9 Xenergy, Inc. *2001 DEER (Database for Energy Efficient Resources) Update Study*. Prepared for the California Energy Commission. August 2001.

10 Itron, Inc. *2004-2005 Database for Energy Efficiency Resources (DEER) Update Study: Final Report*. Prepared for Southern California Edison. December 2005.

11 KEMA-Xenergy, Inc. *California Statewide Residential Appliance Saturation Study*. Prepared for the California Energy Commission. June 2004.

Energy Use Survey (CEUS).[12] Legal and market availability of measures were based on a review of codes and standards as well as professional judgment relating to commercialization of new technologies. Base shares and technology densities of measures were estimated based primarily on the Residential New Construction Baseline Study of Building Characteristics (RNCBS),[13] California Residential Market Share Tracking Study (RMST),[14] RASS,[15] and CEUS.[16]

Table ES-2: Input Data Sets and Purpose

Input Data Set	Purpose
2001 DEER	Residential cost and energy savings.
2005 DEER	Commercial cost and energy savings.
RASS 2004	Residential base share and technology density for non-lighting measures.
RMST 2004	Residential base share for lighting.
RNCBS 2004	Residential technology density for lighting.
CEUS 2006	Commercial base share and technology density.

ES.4 Summary of Results

Table ES-3 through Table ES-5 summarize the results of the study. These results are further illustrated in Figure ES-5 through Figure ES-10. All results relate to the annual savings obtained by 2016 from measure adoptions through 2016. The start year for each sector is listed in the table. The analysis for existing buildings is calibrated to the 2004 IOU program accomplishments while the new construction analysis is calibrated to the 2003 IOU program accomplishments. The calibration year is the start year for all analysis other than for existing industrial buildings, where the start year is the calibration year +1 (2005). The emerging technology estimates begin in 2006 to allow the time necessary of emerging technologies to enter the market place. Savings are in gross form, in the sense that they are not adjusted for naturally occurring adoptions. Savings are net of known changes in standards, in the sense that they change the base measure and incremental savings in years when standards change.

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12 Itron, Inc. *California Commercial Energy Use Survey*. CEC-400-2006-005. Prepared for the California Energy Commission. March 2006.

13 Itron, Inc. *Residential New Construction Baseline Study of Building Characteristics – Homes Built After 2001 Codes*. Prepared for Pacific Bas and Electric. August 2004.

14 Itron, Inc. *California Lamp Report 2004*. Prepared for Southern California Edison. June 15, 2005.

15 KEMA-Xenergy, Inc. *California Statewide Residential Appliance Saturation Study*. Prepared for the California Energy Commission. June 2004.

16 Itron, Inc. *California Commercial Energy Use Survey*. CEC-400-2006-005. Prepared for the California Energy Commission. March 2006.

Electric Energy Potential

As shown in Table ES-3 and Figure ES-5 the technical potential for annual electric energy savings is estimated to be 63,814 GWh by 2016. Of this, 53,150 GWh is economic, in the sense that the measures it represents pass the total resource cost (TRC) test. The market potential for electric energy savings depends upon the level of incentives offered for the covered measures.

Under the current incentive scenario, which assumes that incentives stay at their 2004 levels, market potential amounts to 16,226 GWh by 2016. With incentives half way between 2004 values and full incremental costs (the average scenario), market potential would be 20,065 GWh as of 2016. Under the most aggressive scenario, in which incentives cover full incremental measure costs, market potential is 23,974 GWh. As illustrated in Figure ES-6, 53% of the market potential under the current incentives scenario relates to existing residential construction. Another 18% is associated with existing commercial buildings, followed by 14% in industrial buildings. Emerging technologies (which are listed separately here) account for another 7%, and new construction accounts for the rest.

Table ES-3: Annual Electric Energy Potential (GWh) by IOU – 2016

	Technical	Economic	Market Current	Market Average	Market Full
Residential Existing Buildings (2004-2016)	25,807	19,226	8,445	10,309	11,757
Commercial Existing Buildings (2004-2016)	13,932	11,290	3,000	4,104	4,720
Industrial Existing Buildings (2005-2016)	5,485	4,973	2,338	2,915	3,380
Residential New Construction* (2003-2016)	1,099	635	147	147	255
Commercial New Construction* (2003-2016)	4,553	4,093	978	978	1,938
Industrial New Construction* (2003-2016)	457	452	243	243	261
Emerging Technologies* (2006-2016)	12,481	12,481	1,075	1,369	1,663
Total	**63,814**	**53,150**	**16,226**	**20,065**	**23,974**

* New construction did not estimate the average market potential so the current market potential has been used in the market average column. For emerging technologies, all analyzed measures are economic.

Figure ES-5: Annual Electric Energy Potential (GWh) by IOU – 2016

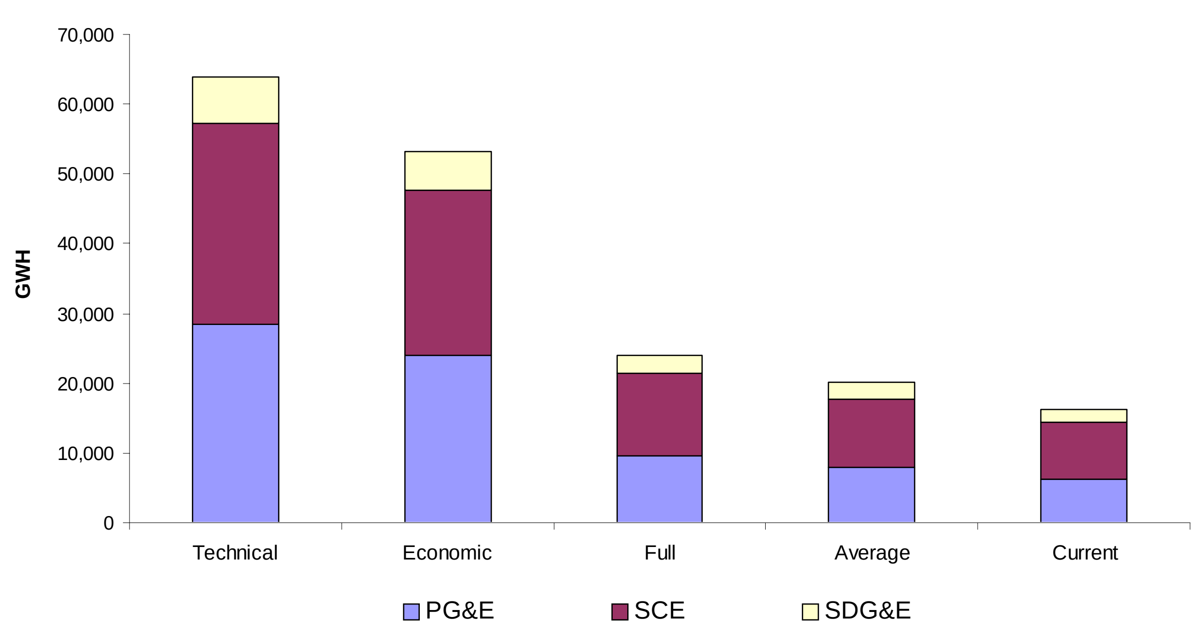
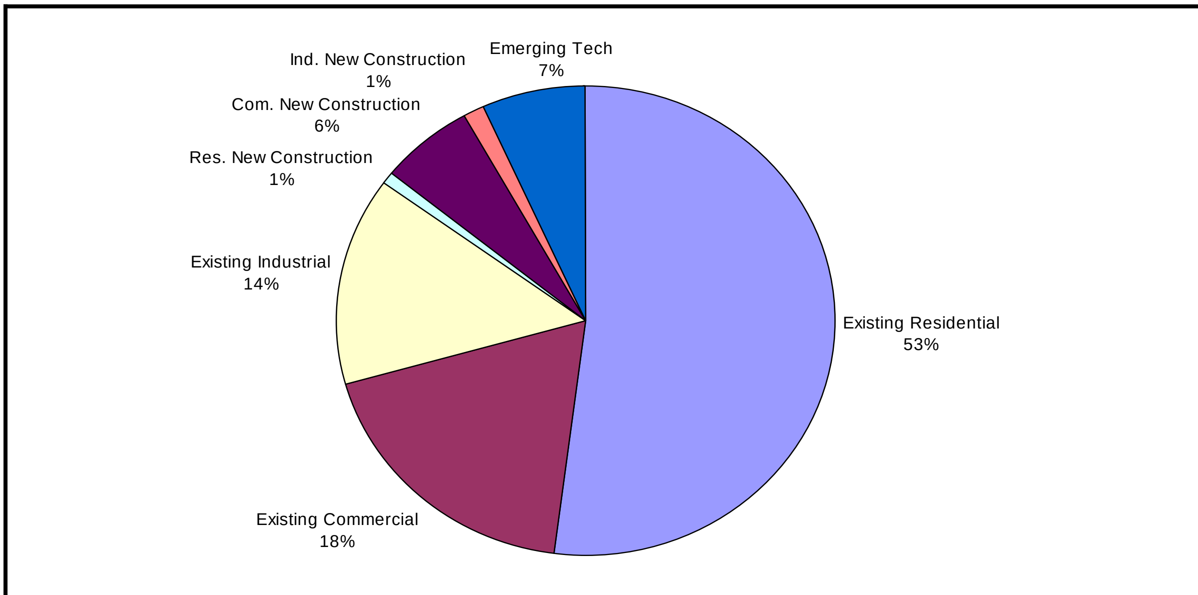


Figure ES-6: Distribution of Electric Energy Market Potential, Current Incentives – 2016



Peak Demand Potential

Table ES-4 and Figure ES-7 indicate the potential for peak demand savings by 2016. As shown there, the total technical potential for peak demand reductions is 15,483 MW in 2016. The corresponding economic potential, based on the application of the TRC test, is 11,151 MW. Market potential ranges from 2,594 to 4,887 MW across the three incentive scenarios.

As shown in Figure ES-8, 45% of the market potential for demand savings is associated with measures installed in existing residential homes, with another 18% and 11% relating to the existing commercial and industrial sectors, respectively.

Table ES-4: Annual Electric Peak Demand Potential (MW) – 2016

	Technical	Economic	Market Current	Market Average	Market Full
Residential Existing Buildings (2004-2016)	5,365	2,729	1,161	1,827	2,233
Commercial Existing Buildings (2004-2016)	3,096	1,996	461	787	982
Industrial Existing Buildings (2005-2016)	755	657	285	370	447
Residential New Construction* (2003-2016)	948	533	142	142	254
Commercial New Construction* (2003-2016)	961	879	215	215	436
Industrial New Construction* (2003-2016)	70	69	39	39	41
Emerging Technologies* (2006-2016)	4,288	4,288	291	392	494
Total	**15,483**	**11,151**	**2,594**	**3,772**	**4,887**

* New construction did not estimate the average market potential so the current market potential has been used in the market average column. For emerging technologies, all analyzed measures are economic.

Figure ES-7: Annual Electric Peak Demand Potential (MW) by IOU – 2016

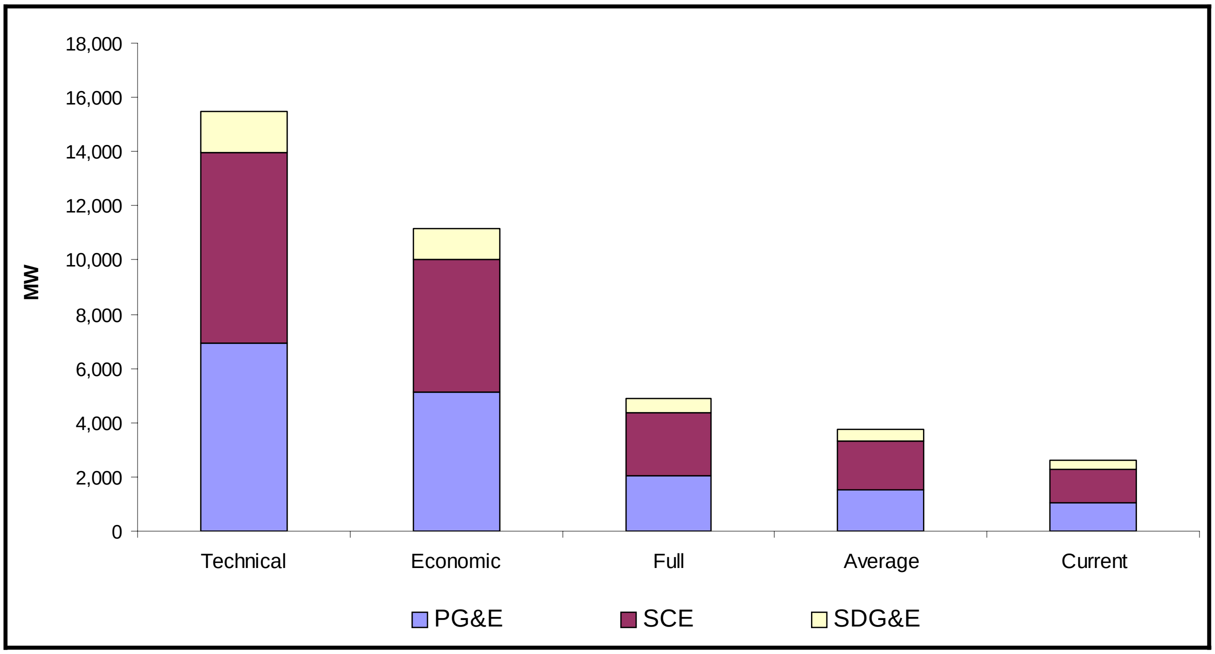
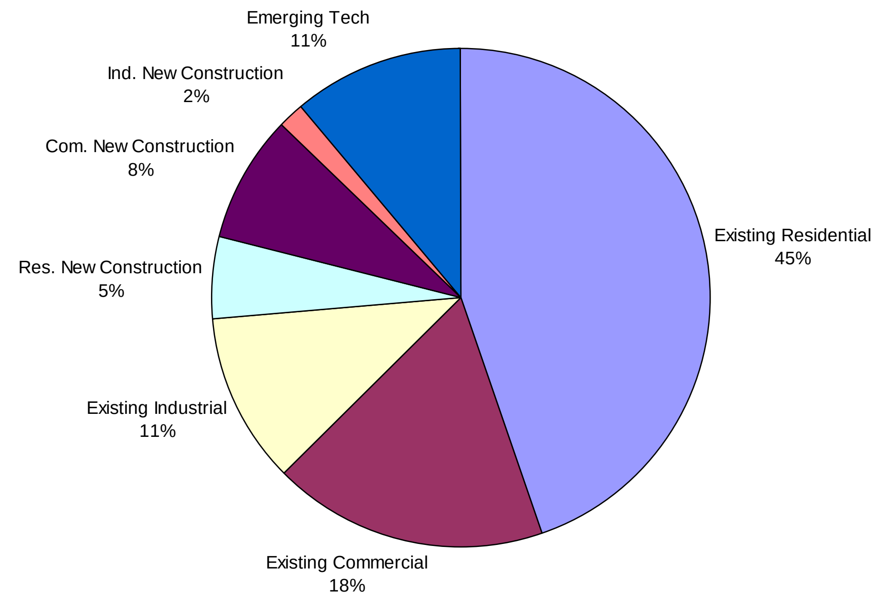


Figure ES-8: Distribution of Electric Peak Demand Market Potential, Current Incentives – 2016



Natural Gas Potential

Table ES-5 and Figure ES-9 depict the potential for natural gas savings by 2016. As shown, the total technical potential for annual gas savings is 2,336 million therms by 2016. Of this, 1,453 million therms of annual savings is economic. The market potential for natural gas savings by 2016 ranges from 247 million therms under the current incentive scenario to 622 million therms under the full incremental cost incentive scenario. As illustrated in Figure ES-10, 38% of the market potential for natural gas savings under the current incentives market scenario comes from existing residential construction. Share of commercial and industrial existing construction are 12% and 21% respectively. Emerging technologies account for another 16%, with the rest being attributable to new construction.

Table ES-5: Natural Gas Potential (Million Therms) – 2016

	Technical	Economic	Market Current	Market Average	Market Full
Residential Existing Buildings (2004-2016)	972	303	88	178	231
Commercial Existing Buildings (2004-2016)	109	38	27	44	56
Industrial Existing Buildings (2005-2016)	469	468	67	142	212
Residential New Construction* (2003-2016)	190	78	18	18	44
Commercial New Construction* (2003-2016)	66	36	11	11	20
Industrial New Construction* (2003-2016)	n/a	n/a	n/a	n/a	n/a
Emerging Technologies* (2006-2016)	530	530	36	47	59
Total	**2,336**	**1,453**	**247**	**440**	**622**

* New Construction did not estimate the Average Market Potential so the Current Market Potential has been used in the Market Average column. For Emerging Technologies all analyzed measures are assumed to be economic. Industrial New Construction did not include gas measures.

Figure ES-9: Natural Gas Potential (Million Therms) by IOU – 2016

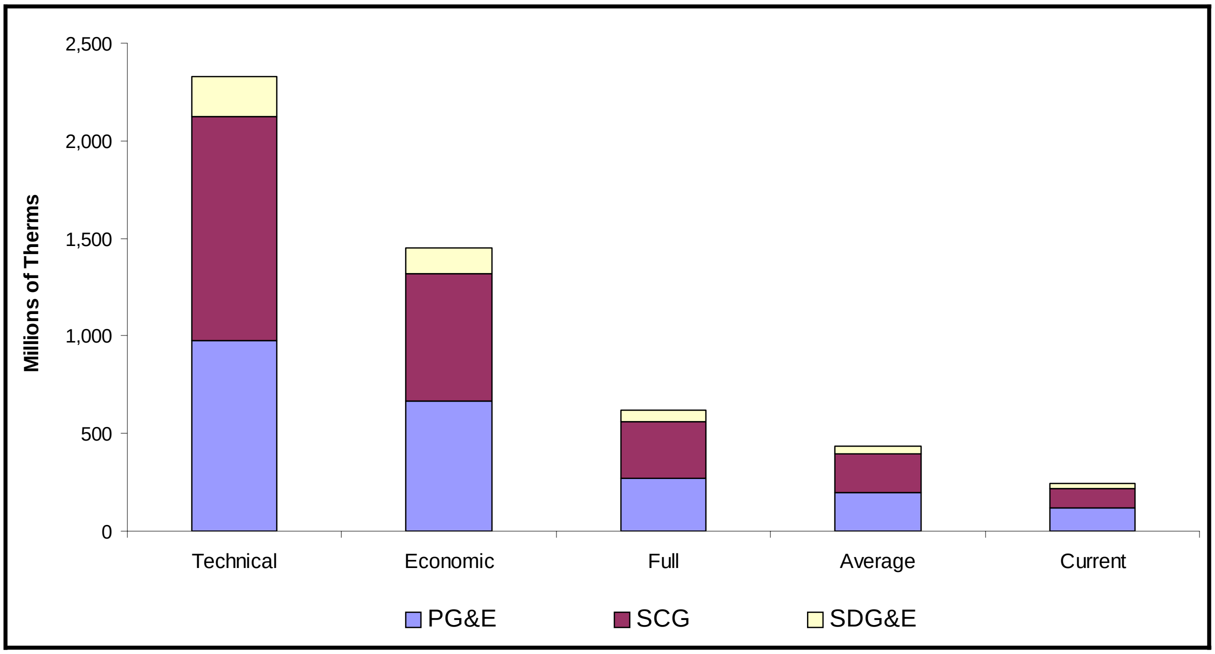
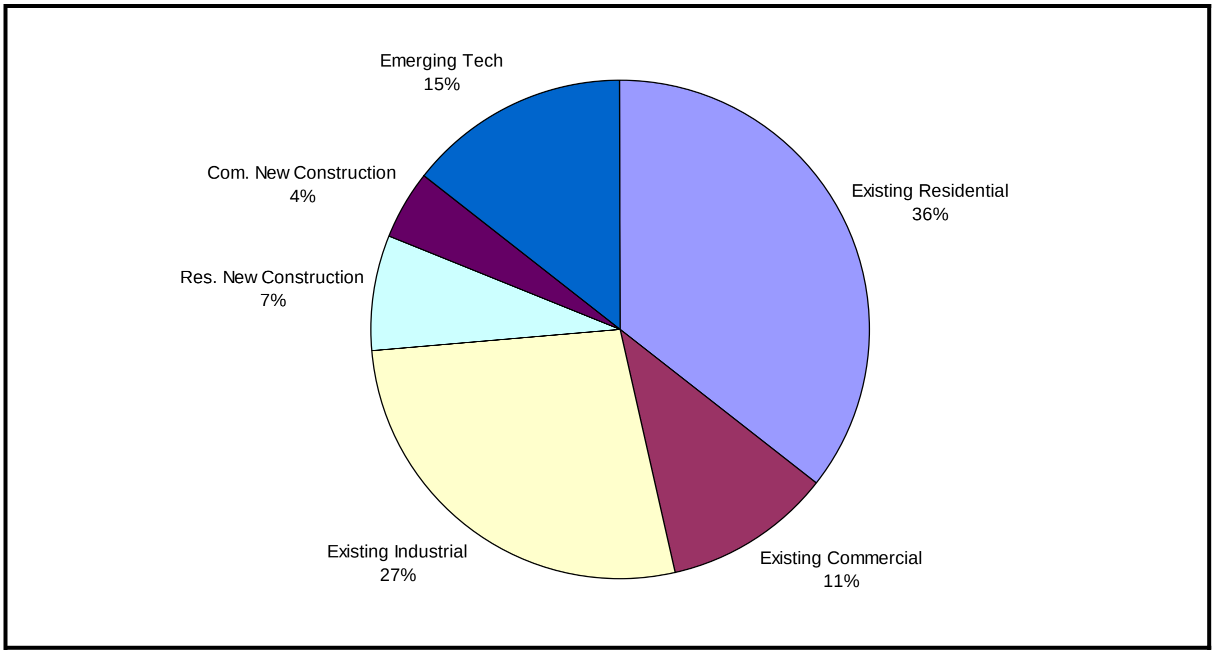


Figure ES-10: Distribution of Natural Gas Market Potential, Current Incentives – 2016



ES.5 Caveats

Any study of this sort is subject to a number of caveats. Several important caveats affecting this study follow.

Scenario Simulations Rather than Forecasts. Each of the simulations of market potential presented in this report reflects a specific set of assumptions about incentive levels. None of these scenario-specific simulations should be considered a forecast of what is likely to occur over time, since program designs, incentive levels, rates, and rebated measures are constantly evolving and adapting to the existing context. The estimated accomplishments of the scenario models presented here are based on the best available information for key input variables, along with key assumptions concerning program design, floor space growth, and rates, which may not be borne out by reality over time. In a sense, energy efficiency markets in California can be expected to be a blend of the various scenarios, and energy efficiency accomplishments can be expected to reflect elements of each of the scenario simulations. Given the blending of these various elements, with the major increase in program budgets in the 2006-2008 period, we can probably expect program accomplishments over these years to more closely resemble the simulated results of the average incentives or full incentives scenarios, rather than the current incentives scenario.

Market Saturation and Diminishing Program Accomplishments. One of the primary findings of this study is that the simulated total annual program accomplishments under each of the scenarios tends to diminish over time as the markets for energy efficiency measures mature. For some measures, markets may become relatively saturated, leaving little additional market potential for the measures in question.[17] Program goals—both those set by policy makers as well as those set by program planners and resource planners—should be set taking this into account. For instance, it should be recognized that running more aggressive programs in one year diminishes that amount of potential left for subsequent years, and may ultimately lead to reduced program accomplishments. At the same time, while this phenomenon has important implications for program planning, it is *partly* an artifact of the primary focus on existing measures. While we have attempted to include some consideration of emerging technologies, even this analysis was focused on currently commercialized technologies. It should be recognized that new measures will also emerge over time and others will decrease in price, which will reduce barriers to adoption. The promotion of these measures through utility and third party programs will provide new sources of program accomplishments. One way to interpret the results of this study in this area is that the maintenance of high levels of annual program accomplishments will necessitate enhancements in the mix of measures offered by these programs over time.

Sensitivity of Simulations to Program Activity. Comparisons of the various market potential scenarios provide indications of the sensitivity of program accomplishments to the level of program activity. As indicated by the titles of the market potential scenarios, the aggressiveness of program designs is represented by the levels of incentives. This aspect of the analysis is subject to two important caveats. First, relatively little empirical work has been done to estimated customer responses to variations in incentive levels, so the results are subject to a significant degree of uncertainty. More research needs to be conducted on this point. Second, program interventions go far beyond financial incentives, and undoubtedly affect awareness of energy efficiency options as well as willingness to purchase those options at a given incentive level. As a result, the differences across these scenarios may understate the impacts of increased program activities. Somewhat mitigating this potential bias, however, it should be recognized that increases in sensitivity to more aggressive programs would be largely timing effects, since the more rapid realization of potential under an aggressive scenario can be expected to diminish the incremental potential for future programs.

General Market Conditions. All of the market potential scenarios depicted in this report assume a given set of future market conditions (other than incentive rates). Obviously, key market conditions like retail rates, avoided costs, and technology costs may follow a very

[17] To reach some of the remaining markets it may be necessary to change program designs to include integrated solutions (ex: building retrocommissioning). Changes in program designs could lead to synergies that could postpone the onset of diminishing returns. Program design changes, including the implementation of integrated solutions, were not modeled in this analysis.

different path than assumed for the purposes of this study. As these conditions change, simulations will need to be revisited.[18]

Comparisons with Previous Studies. A comparison of this study with the previous studies done by KEMA-Xenergy is not straightforward or completely possible. These comparisons reflect a variety of factors, including different periods (most importantly different starting points), availability of different data on key factors (e.g., current saturations of energy efficiency technologies, or end-use load shapes), different emphases, calibration to different program results, changing policy and/or program goals, modeling assumptions, etc. In general, once we control for these factors, the results of this study are generally consistent with those presented in earlier reports covering California's market for energy efficiency.

[18] Future studies may want to rethink the breakout of measures, climate zones, and market conditions analyzed. This study analyzed numerous measures and climate zones under one set of avoided costs, rates, and economic growth assumptions. In the future researchers may want to reduce the number of climate zones analyzed for non-weather sensitive measures and implement sensitivity analysis to key economic assumptions. Reducing the climate zone disaggregation, however, may reduce the usefulness of the analysis for program planners who wish to focus their efforts on geographic regions with untapped potential and is not appropriate for weather sensitive measures.

1

Introduction

This report summarizes the findings of three recent studies of gross energy efficiency potential in California. The primary focus is on the Energy Efficiency Potential Study, which assessed the gross potential for electricity and gas savings in existing residential and commercial buildings. The Energy Efficiency Potential Study was conducted by a team of firms consisting of Itron, Inc. (Itron), KEMA, and Quantum Consulting under the management of PG&E. The study was overseen by a Project Advisory Committee (PAC) consisting of representatives from Pacific Gas and Electric (PG&E), Southern California Edison Company (SCE), Southern California Gas Company (SoCalGas), San Diego Gas And Electric Company (SDG&E), the California Public Utilities Commission (CPUC), the California Energy Commission (CEC), and Natural Resources Defense Council (NRDC).

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[1] KEMA-Xenergy, Inc. *California Statewide Commercial Sector Energy Efficiency Potential Study. Final Report. Volumes 1 and 2*. July 2002.
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savings resulting from changes in behavior, or requiring major redesign of existing systems, were not included in the scope of this work.

1.1 Overview of Study Objectives and Scope

The primary objective of the work underlying this report was to produce estimates of remaining potential energy savings that might be obtainable in the near (2006-2008) and foreseeable (2009-2016) future through publicly funded energy efficiency programs in the existing and new residential, industrial, and commercial sectors.[2] Some of the key questions addressed with this research include the following:

- What is the remaining technical, economic, and market potential for energy efficiency through the year 2016?
- What is the marginal gain in energy efficiency market potential if program funding is increased?
- How does the potential for energy efficiency vary by market sector and climate zone?

The findings from this study will be used by the four California IOUs and their program planners to focus utility program offerings by technologies, sectors, and climate zones. The results will help locate where potential savings remain and which technologies offer the most efficient opportunities for energy savings. The results from this study will help the utilities assess and, to the extent possible, meet the energy saving goals set by the CPUC.

The CPUC has established aggressive energy saving goals for electric and natural gas savings for the four state IOUs over the years 2004–2013. Given the near-term and forward-looking nature of these goals, this study analyzed the remaining potential from commercially available energy efficiency measures in new and existing residential, commercial, and industrial buildings, and in emerging technologies that are forecast to be commercially available and cost-effective by 2008.

1.2 Types of Potential

This study analyzes the remaining technical, economic, and market energy efficiency potentials for the four California IOUs. *Technical potential* refers to the savings potential that would be captured if all energy efficiency measures were installed in all feasible applications. This study uses a combination of the "phased-in" and "immediate" approaches

[2] CPUC Interim Opinion R. 01-08-028, August 23, 2001 stated the study was designed to "…enhance the industry understanding of energy efficiency resources available to the state over the current Public Goods Charge (PGC) authorization period. 2002-11."

to estimating technical potential. Measures modeled as retrofits or conversions (such as lighting) are immediately converted to the highest efficiency technology. Measures modeled as replace-on-burnout (such as air conditioning) are phased in as the old, low efficiency measures burnout.

Economic potential indicates the savings potential that would be achieved if measures were installed in all feasible cost-effective applications. In this context, cost-effectiveness is assessed using a total resource cost (TRC) test, which takes into account the value of savings, value of avoided costs, incremental measure costs, and program administrative costs.

Market potential denotes the savings that can be expected to result from specific scenarios relating to program designs and market conditions. The results presented in this report for market potential under existing program designs have been calibrated to actual program accomplishments for the 2004 program year. This was the first year in which funding levels were raised to foster the achievement of the new energy savings goals. One set of estimates of market potential over the planning period reflects the continuation of the incentives in effect during 2004. Another set of market potential estimates, called maximum achievable potential, was derived on the assumption that incentives are increased to cover full incremental measure costs. Yet a third set of estimates was developed to reflect an average market scenario in which incentives are equal to the average between current (2004) incentives and full incremental costs.

1.3 Organization of the Report

The executive summary provides a high-level summary of the results, the important differences between this study and the previous statewide potential study, and a listing of the key factors contributing to the primary differences.

- Section 2 provides a brief description of California's energy consumption and recent changes and accomplishments in the utilities' energy efficiency programs.
- Section 3 describes the approach used in the study. The section also presents and compares key assumptions used in this analysis and the previous statewide analysis of energy efficiency potential.
- Section 4 presents estimates of technical, economic and market potential for existing residential housing.
- Section 5 offers estimates of technical, economic and market potential for existing commercial buildings.
- Section 6 compares the estimates of potential for the existing residential and commercial sectors to those from the previous KEMA-Xenergy 2002/2003 potential study.

- Section 7 summarizes estimates of potential for the industrial sector, based on a recent study by KEMA, Inc.
- Section 8 summarizes estimates of potential for residential new construction, based on a companion study conducted by Itron, Inc.
- Section 9 summarizes estimates of potential for commercial new construction, also based on a companion study conducted by Itron, Inc. and AEC.
- Section 10 summarizes estimates of potential for industrial new construction, also based on a companion study conducted by Itron, Inc., RLW Analytics, and AEC.
- Section 11 presents a summary of estimates of potential for emerging technologies.
- Section 12 discusses conclusions and implications of the results of the study and provides recommendations.
- Appendix A describes the energy efficiency measures analyzed in this study.
- Appendix B provides the avoided cost information.
- Appendix C provides the detailed ASSET inputs for the residential model.
- Appendix D provides the detailed ASSET inputs for the commercial model.
- Appendix E provides the detailed DSM ASSYST™ inputs for the industrial model.
- Appendix F provides the detailed residential results.
- Appendix G provides the detailed commercial results.
- Appendix H provides the detailed industrial results.
- Appendix I provides the detailed residential new construction results.
- Appendix J provides the detailed commercial new construction results.
- Appendix K provides the detailed industrial new construction results.
- Appendix L provides the detailed emerging technologies results.
- Appendix M presents the documentation for Itron's ASSET model.
- Appendix N presents the documentation for KEMA's DSM ASSYST™ model.
- Appendix O provides the residential new construction methodology.
- Appendix P provides the commercial new construction methodology.
- Appendix Q provides the industrial new construction methodology.
- Appendix R presents a glossary.
- Appendix S presents a bibliography.

2

Energy Usage and Efficiency Program Background

This section presents a brief background of California's energy usage, energy efficiency programs, and a description of recent changes in these programs. The very brief discussion of energy usage helps to ground the energy efficiency savings forecast as a percentage of estimated usage. The description of energy efficiency program accomplishments and future goals forms the basis for the starting point for this study, "the 2004 study," and the previous energy efficiency forecast, "the 2000 study."[1]

2.1 Background on California Electricity Usage

Electricity consumption for PG&E, SCE, and SDG&E, and the annual growth rate of consumption over the 1980 to 2002 period is listed in Table 2-1. Consumption grew during the 1980s and 1990s, and declined during the 2000-2001 energy crisis. During 2002, PG&E experienced continued decline in consumption while SDG&E's consumption grew. This is consistent with the underlying economic activity in the two utility's service territories. The bay area economy continued to struggle following declines in the technology sector while San Diego's economy remained relatively strong.

Table 2-1: Electricity Consumption by Utility, 1980-2002

	PG&E		SCE		SDG&E	
Year	Consumption GWh	Annual Growth Rate	Consumption GWH	Annual Growth Rate	Consumption GWh	Annual Growth Rate
1980	66,197		59,624		9,729	
1990	86,806	2.7%	81,673	3.2%	14,798	4.3%
2000	101,980	1.6%	96,496	1.7%	18,684	2.4%
2001	98,748	-3.2%	90,506	-6.2%	17,908	-4.2%
2002	97,888	-0.9%	90,515	0.0%	18,604	3.6%

Data from *California Energy Demand 2003-2013 Forecast*, California Energy Commission, February 2003. The data include loads served by private supply, but do not include energy losses.

[1] The results for this study will be referred to as the 2004 study because the models are calibrated to the 2004 IOU program results and the base incentive levels are those in the 2004 energy efficiency programs. The 2002/2003 KEMA-Xenergy studies will be referred to as the 2000 study because these modes are calibrated to the 1996-2000 program year IOU program results.

While California's consumption of electricity has grown, California has worked to reduce energy consumption through the development of energy efficiency programs. These programs have focused on achieving energy savings with new building standards, new appliance standards, and incentives to encourage the replacement of inefficient technologies with high efficiency measures. These programs have contributed to Californians' having the lowest per capita energy usage among all 50 states. Table 2-2 list the per capita electricity usage for five states. In 2001, California's per capita electricity usage was the lowest in the United States at 6,818 kWh. Wyoming had the highest per capita usage at 26,208 kWh.[2]

Table 2-2: Per Capita Electricity Usage in 2001

State	Per Capita Electricity Usage (kWh)	Ranking
Wyoming	26,208	50th
North Carolina	14,347	35th
Oregon	13,208	25th
Illinois	10,839	15th
California	6,818	1st

Data from the CEC web site http://www.energy.ca.gov/electricity/us_percapita_electricity.html.

The divergence of California's per capita consumption from those of other states is illustrated in Figure 2-1. Over the last 30 years, the nation's per capita electricity usage has grown over 45% while California's per capita electricity usage has remained flat.[3] The break in per capita consumption in California and the rest of the U.S. occurred in the 1970s. This period represents the beginning of large-scale energy efficiency programs in California.

Figure 2-2 illustrates the per capita electricity consumption in California for the period 1980-2004 and the California Energy Commission's (CEC's) forecast of per capita consumption through 2016. Per capita consumption through 2016 is forecast to remain relatively constant at the 2004 level.

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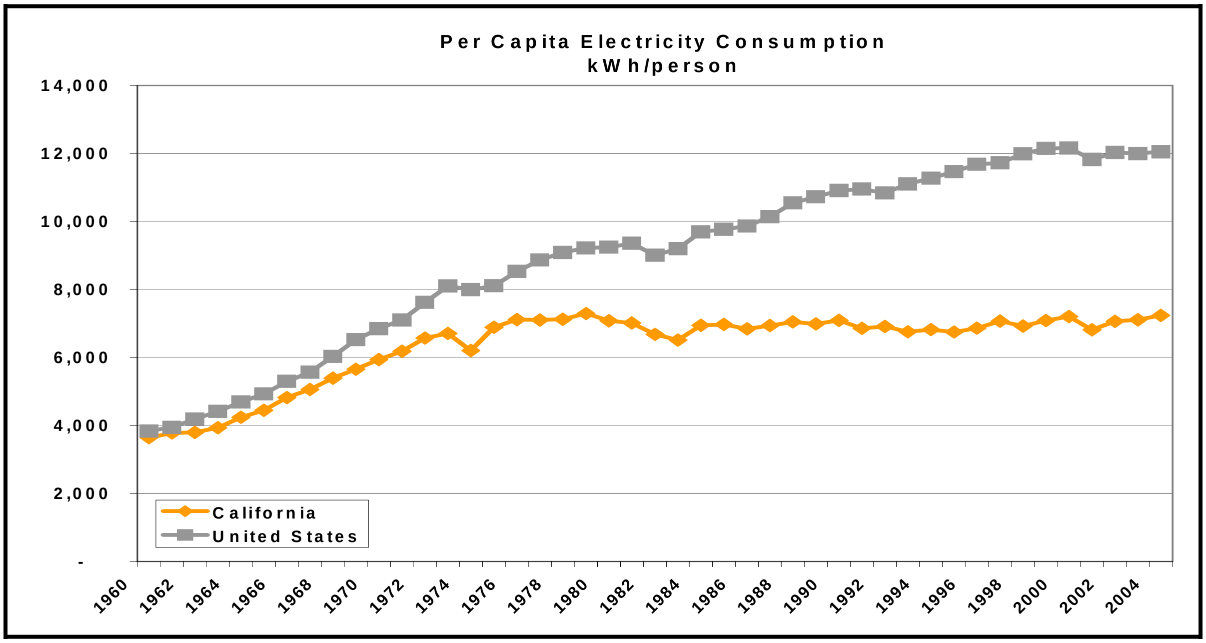
2 California Energy Commission, http://www.energy.ca.gov/electricity/us_percapita_electricity.html, U.S. per capita electricity usage, 2001.

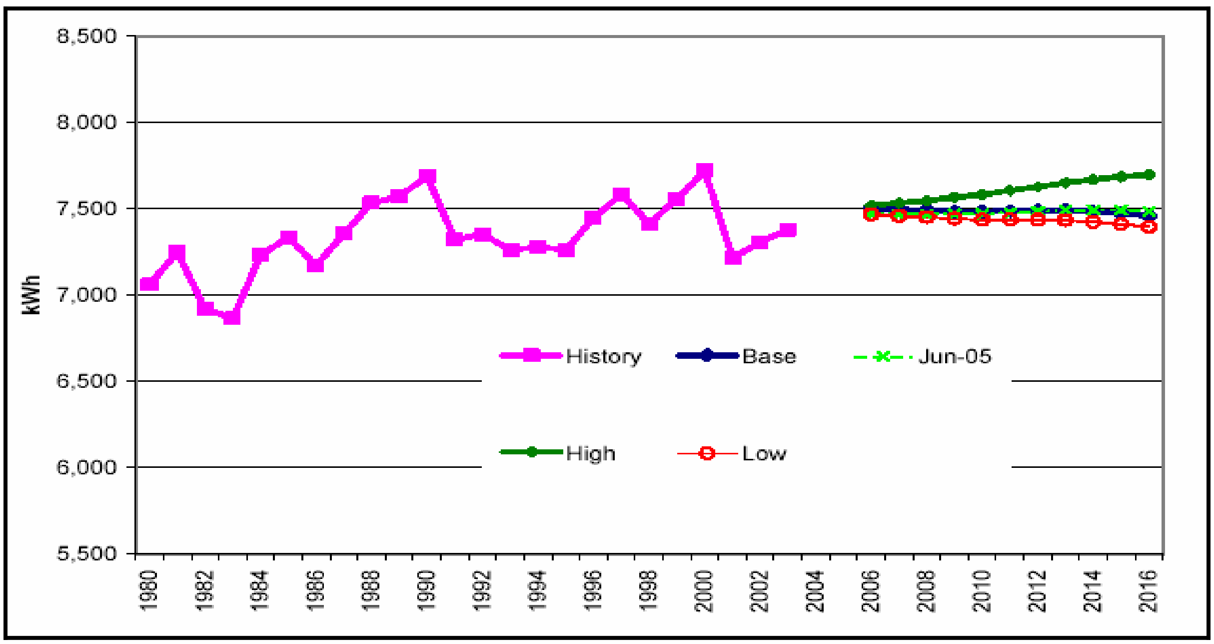
3 California Energy Commission. *2002–2012 Electricity Outlook*. 2001.

Figure 2-1: Per Capita Electricity Usage – 1960-2004



CEC Publication. February 2006. Figure courtesy of Mike Messenger.

Figure 2-2: Per Capita Electricity Consumption for California – 1980-2016

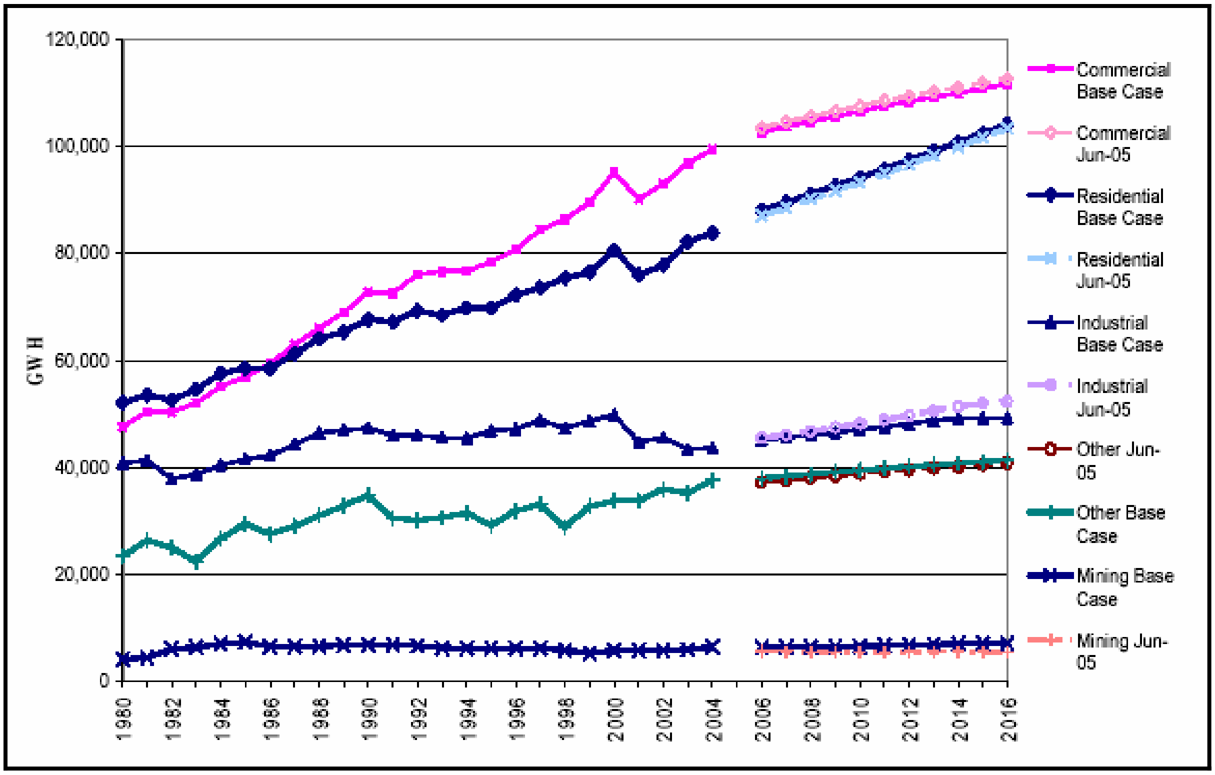


Data from California Energy Commission *California Energy Demand 2006-2016 Forecast*, September 2005. Reproduction of Figure 2 in the CEC document.

Examining the consumption of electricity by sector and end use helps to provide a benchmark from which to judge past energy efficiency achievements and future energy efficiency goals. Figure 2-3 illustrates past consumption trends and the CEC forecast of statewide electricity consumption by sector from 1980 to 2012. The figure shows that since the mid-1980s, the largest consumer of electricity has been the commercial sector, followed closely by the residential sector. During the 1980s and 1990s, the commercial sector's consumption of electricity grew by approximately 3% a year while the residential sector's consumption grew by approximately 2% a year. The industrial sector's annual growth rate has been much smaller than that of either the residential or commercial sectors.

The CEC forecast of electricity consumption for the 2004-2016 period assumes that the economic recovery will take hold in 2004, personal incomes will continue to grow, and the impacts of individual conservation methods learned during the 2000-2001 energy crisis will diminish. From 2004 to 2016, the residential sector's consumption is forecast to grow at 1.8% a year while commercial consumption is estimated to grow at the slightly slower rate of approximately 1% a year. The minor increase in forecast electricity consumption in the industrial sector is due to a forecast increase in mining and drilling activities.

Figure 2-3: California Electricity Consumption by Sector – 1980-2016



Data from California Energy Commission *California Energy Demand 2006-2016 Forecast*, September 2005. Reproduction of Figure 3 in the CEC document.

A rough estimate of residential and commercial end-use consumption for 2016 was calculated using unit energy consumption (UEC) and saturation data from the Residential Appliance Saturation Study (RASS, 2004) and energy use index (EUI) and share information from the Commercial End-Use Survey (CEUS) (2006). Table 2-3 lists the per-home residential end-use electricity consumption by utility. The utility specific per-household consumptions numbers, in conjunction with the CEC housing forecasts, are used to extrapolate the residential end-use consumption listed in Table 2-4.

Table 2-3: Residential Per-Household End-Use Consumption by Utility – 2004 (kWh)[4]

End-Use Grouping[5]	PG&E	SCE	SDG&E
HVAC	819	980	429
Water Heating	360	264	251
Lighting	1,627	1,681	1,542
Miscellaneous	3,479	3,201	3,236
Total per Household	6,285	6,127	5,458

Using the per-household UECs, saturation data, and housing forecasts, the estimate of PG&E residential consumption for 2016 is 29,190 GWh. The estimates of residential consumption for SCE and SDG&E are 24,669 and 6,379 GWh, respectively. The estimates of end-use consumption do not incorporate the effects of income growth, energy price changes, or energy efficiency programs initiated during 2004-2016. In addition, the RASS estimates of per-household consumption were derived from billing data from 2002 and 2003, directly following the energy crisis. During this period, individual conservation behaviors may have led to reduced energy consumption relative to non-crisis periods. The estimates listed in Table 2-4 should be viewed as a rough estimate of future consumption.

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4 These data are derived from the RASS CDA utility specific results (2004). Lighting is the sum of outdoor lighting and 80% of the UEC for miscellaneous. Miscellaneous is 20% of the UEC for miscellaneous, refrigeration, dryers, pools and spas, and cooking. Water heating includes conventional and solar water heating, dishwashers, and clothes washers.

5 To align the end-use designations with those used in this study, added several measures were added to water heating and miscellaneous that were estimated separately in the RASS study. Water using appliances are added to water heating. Miscellaneous in this study includes pool pumps, refrigerators, and dryers. The UECs for these measures have been added to miscellaneous in the above table. In the RASS study, it was not possible to directly estimate the UEC for lights. To form a rough estimate of lighting energy usage, we added the UEC for outdoor lighting to 80% of the miscellaneous UEC. This breakout of the miscellaneous UEC was based on professional judgment.

Table 2-4: Estimate of Residential End-Use Consumption by Utility – 2016 (GWh)

End-Use Grouping	PG&E Residential Consumption	PG&E Percent of Consumption	SCE Residential Consumption	SCE Percent of Consumption	SDG&E Residential Consumption	SDG&E Percent of Consumption
HVAC	3,804	13%	3,946	16%	501	8%
Water Heating	1,671	6%	1,065	4%	293	5%
Lighting	7,557	26%	6,770	27%	1,802	28%
Miscellaneous	16,157	55%	12,888	52%	3,783	59%
Utility Total	29,190		24,669		6,379	

Table 2-5 lists the commercial electric intensities per square foot by end-use and utility. Using the per-square foot EUIs, share data, and floor space forecasts, the estimate of PG&E commercial consumption for 2016 is 31,256 GWh. The estimates of commercial consumption for SCE and SDG&E are 38,156 and 8,900 GWh, respectively. The estimates of end-use consumption do not incorporate the effects of economic growth, energy price changes, or energy efficiency programs initiated during 2004-2016. In addition, the CEUS estimates of per-square foot consumption were calibrated to billing data from 2002, directly following an economic down turn and the 2000-2001 energy crisis. The conservation behaviors adopted during the energy crisis may have led to reduced energy consumption relative to non-crisis periods. The estimates listed in Table 2-6 should be viewed as a rough estimate of future consumption.

Table 2-5: Commercial Electric Intensity by End-use and Utility, 2002 (kWh/ft^2)

End-Use Grouping	PG&E	SCE	SDG&E
HVAC	3.44	4.03	4.32
Lighting	4.42	4.82	5.06
Refrigeration	1.92	1.77	1.79
Miscellaneous	3.17	3.07	3.47
Total per Square Foot	12.95	13.69	14.64

These data are derived from the EUI estimates from CEUS (2006). Lighting refers to interior and exterior lighting. HVAC is heating, cooling, and vents. Miscellaneous includes water heating, cooking, office equipment, miscellaneous, air compressors, motors, and process equipment.

Table 2-6: Estimate of Commercial End-Use Consumption by Utility, 2016 (GWh)

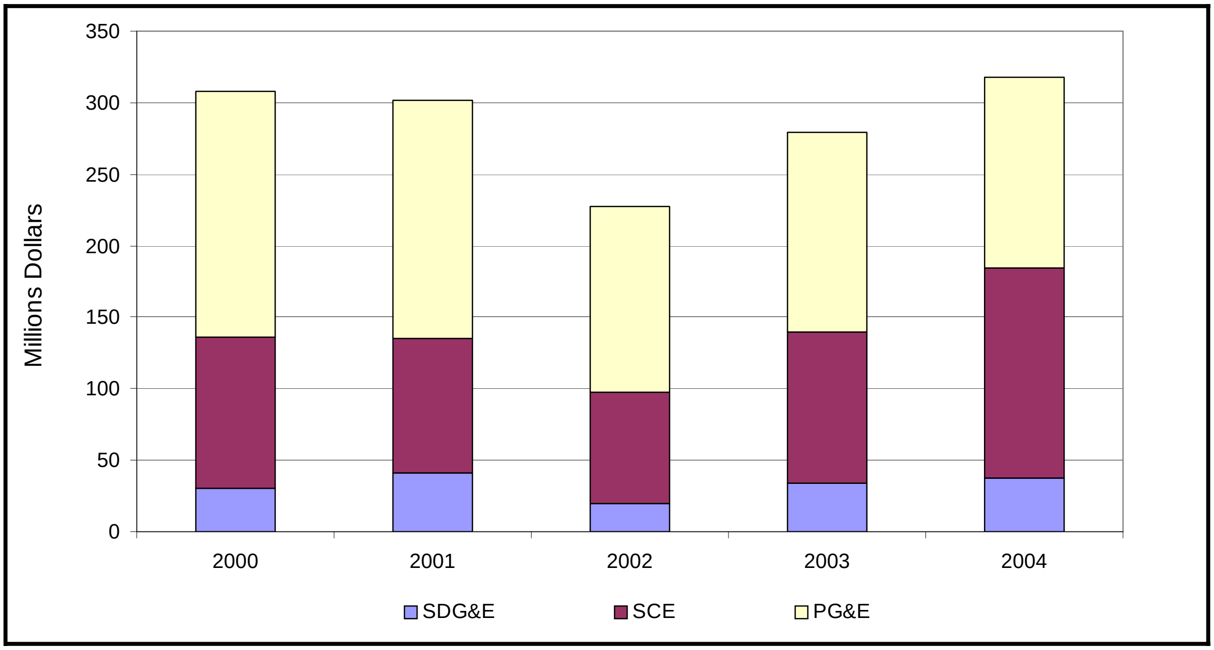
End-Use Grouping	PG&E Commercial Consumption	PG&E Percent of Consumption	SCE Commercial Consumption	SCE Percent of Consumption	SDG&E Commercial Consumption	SDG&E Percent of Consumption
HVAC	8,303	27%	11,232	29%	2,626	30%
Lighting	10,668	34%	13,434	35%	3,076	35%
Refrigeration	4,634	15%	4,933	13%	1,088	12%
Miscellaneous	7,651	24%	8,556	22%	2,110	24%
Utility Total	31,256		38,156		8,900	

These data are derived from the EUI estimates from CEUS (2006) and floorstock forecasts.

2.2 Background on California Energy Efficiency Program Impacts

The 2000-2001 energy crisis led to an escalation of energy prices in California and to an increase in the importance of energy efficiency programs. Annual spending on energy efficiency programs by the major California IOUs for planning years 1995-1999 averaged less than $220 million per year (in 2000 dollars).[6] Energy efficiency expenditures by utilities increased significantly in the 2000-2004 period, as shown in Figure 2-4. Annual spending for energy efficiency programs by PG&E, SCE, and SDG&E exceeded $300 million in planning years 2000, 2001, and 2004, with an average of $286 million spent for planning years 2000-2004 (in program year dollars).[7]

Figure 2-4: Utility Energy Efficiency Program Spending, 2000-2004



Data courtesy of CEC *California Energy Demand 2006-2016 Staff Energy Demand Forecast*, September 2005.

Annual first-year impacts from energy efficiency programs have risen with the increases in funding. Historically, first-year impacts averaged approximately 1,000 GWh, with nonresidential programs representing approximately 80% and residential programs claiming the remaining 20% of the savings.[8] Figure 2-5 and Figure 2-6 illustrate the first-year energy and demand savings claimed by the IOU energy efficiency programs between 2000-2004.

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6 KEMA-Xenergy. Data from the *California Statewide Residential Sector Energy Efficiency Potential Study, Volume 1 of 2*. April 2003.

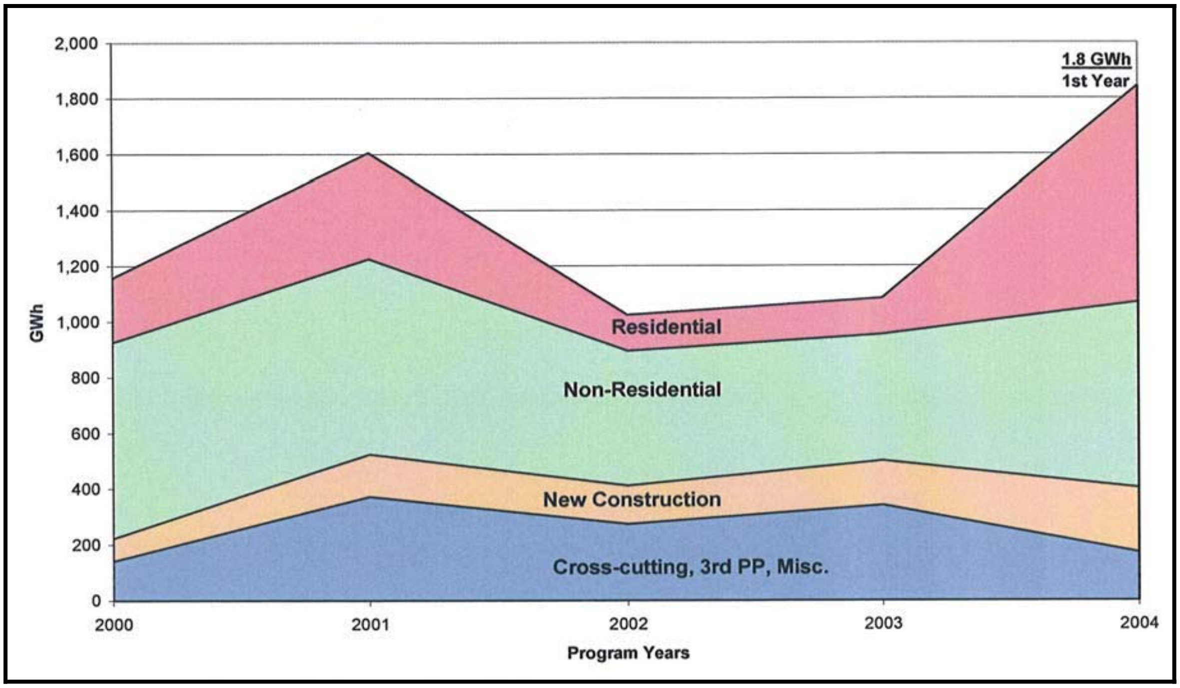
7 Annual funding and savings values from the California Energy Commission Staff Paper titled *Funding and Energy Savings from Investor-Owned Utility Energy Efficiency Programs in California for Program Years 2000 Through 2004*, dated August 2005.

8 KEMA-Xenergy, op. cit. April 2003.

In 2004, the three major utilities claimed first-year electricity savings of 1,834 GWh. In 2004, the greatest claimed savings came from the residential sector. This represented a major change in the focus of California energy efficiency programs from nonresidential programs to residential programs. The large increase in residential claimed savings in 2004 appears to be the result of a significant increase in residential lighting programs.[9]

In 2001, the three California IOUs claimed first-year peak savings of 475 MW, with 377 MW saved in 2004. In 2000 and 2003, nonresidential programs had the greatest megawatt savings while residential programs had the highest peak savings in 2004. The 2004 increase in utility demand savings mirrors the increase in energy savings and the change in the sector in which demand savings are achieved also mirrors the energy savings results.[10]

Figure 2-5: First-Year GWh Savings by Utility for Energy Efficiency Programs

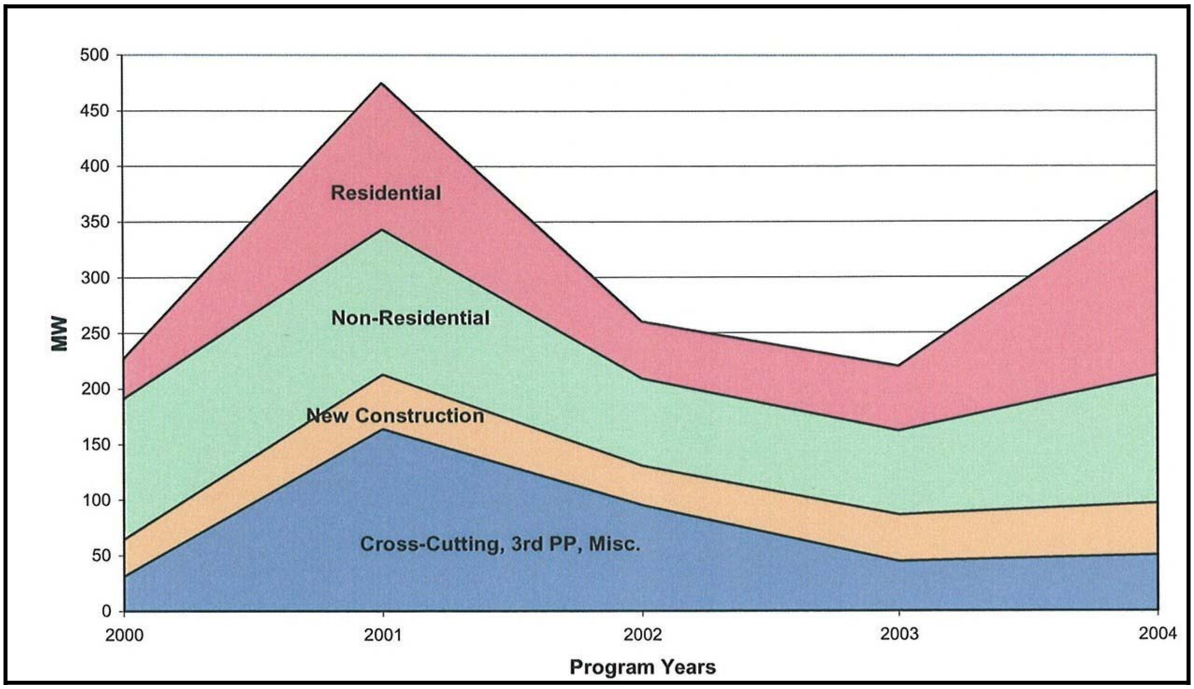


Data courtesy of the CEC: *Funding and Energy Savings from Investor-Owned Utility Energy Efficiency Programs in California for Program Years 2000 Through 2004*, August 2005. Figure 2-5 is a reproduction of Figure 5 in the CEC report.

9 CEC, op. cit, August 2005.

10 The increase in energy efficiency program spending and accomplishments seen in 2004 are likely to continue into the foreseeable future which is one reason for calibrating the analysis to the 2004 program accomplishments.

Figure 2-6: First-Year Peak Savings of Utility Energy Efficiency Programs



Data courtesy of the CEC: *Funding and Energy Savings from Investor-Owned Utility Energy Efficiency Programs in California for Program Years 2000 Through 2004,* August 2005. Figure 2-5 is a reproduction of Figure 6 in the CEC report.

The increase in energy efficiency program funding in 2004 and the energy savings attributable to these programs are expected to continue for the near and foreseeable future. The California Public Utilities Commission (CPUC) has established aggressive goals and authorized commensurate funding increases for the four California IOUs for 2004-2013. The 2004-2008 energy efficiency goals for the IOUs are listed in Table 2-7.[11] Meeting these goals will require the utilities to continue operating their existing energy efficiency programs effectively while expanding these and new programs into technologies and segments not previously the primary focus of the energy efficiency programs.

[11] The IOU savings goals are from the California Energy Commission's report titled *California Energy Demand 2006-2016 Staff Energy Demand Forecast*, revised September 2005.

Table 2-7: First-Year Impacts of 2004-2008 Energy Efficiency Goals

	PG&E			SCE		SCG	SDG&E		
	GWh	MW	MM Therms	GWh	MW	MM Therms	GWh	MW	MM Therms
2004	744	161	10.95	826	179	11.48	268	58	3.88
2005	744	161	12.25	826	170	13.37	268	58	3.72
2006	829	180	14.54	922	200	14.94	281	61	2.08
2007	944	205	16.54	1046	227	19.84	285	62	2.37
2008	1053	229	19.54	1167	253	23.51	284	62	3.00

Data courtesy of CEC. The IOU savings goals are from the *California Energy Demand 2006-2016 Staff Energy Demand Forecast*, September 2005.

The aggressive energy efficiency goals set by the CPUC reinforce the importance of this study. The KEMA 2002/2003 statewide potential study (henceforth to be called the "2000 study") was the foundation for the energy savings goals listed above.[12] The current study was designed to estimate the remaining energy efficiency potential and to help determine where the most efficient energy savings could be found to meet the CPUC goals.

The current study estimates the remaining energy efficiency potential available under current program design and incentive levels. The study calibrates estimates of market potential to the 2004 energy efficiency program accomplishments provided by the four California IOUs. These program accomplishments represent the energy efficiency savings achieved under the first year of CPUC-mandated increase in savings and funding. Calibrating to 2004 accomplishments grounds the study to the current increase in funding and to the relative relationship between the utilities' commercial and residential programs. Because of the use of the 2004 program year for calibration purposes, the current study is referred to below as the "2004 study."

The 2004 study benefited from recent statewide studies in both the residential and commercial sectors. The 2004 analysis used data from the California Statewide Residential Appliance Saturation Survey (RASS) (2004),[13] Commercial End-Use Survey (2006),[14]

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[12] The 2002/2003 KEMA statewide potential study is labeled the 2000 study to clearly indicate that the study is calibrated to the 1996-2000 program year energy efficiency accomplishments. The forecast estimated in the current analysis will be referred to as the "2004 study" to indicate these results are calibrated to the 2004 program year energy efficiency accomplishments.

[13] KEMA-Xenergy, Inc. *California Statewide Residential Appliance Saturation Study*. Prepared for the California Energy Commission. June 2004.

[14] Itron, Inc. *California Commercial Energy Use Survey*. CEC-400-2006-005. Prepared for the California Energy Commission. March 2006.

Database for Energy Efficiency Resources (DEER) (2001, 2005),[15,16] Avoided Costs and Externality Adders (2004), IOU 2004 quarterly filings, and forecasts of the housing stock and commercial building floorspace provided by the CEC. The recent statewide studies provided the latest input data on technology saturations, savings impacts, and avoided costs. Recent information on technology saturations is crucial when analyzing the remaining potential in sectors with mature energy efficiency programs.

This report also presents market potential estimates that increase both the number of measures incentivized and the levels of incentives. Incentive levels analyzed include setting incentives equal to full incremental measure costs (full cost analysis) and to the average of current incentives and full incremental costs (scenario level incentives). The measures added to the full-cost and scenario analyses either existed in the 2004 program accomplishments of other California IOUs or were chosen by the project team after analyzing previous program accomplishments, past potential studies, and the 2001 and 2005 DEER. The measure augmented full incremental cost and scenario results represent an estimate of potential savings associated with programs as they could be designed.

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[15] Xenergy, Inc. *2001 DEER (Database for Energy Efficient Resources) Update Study*. Prepared for the California Energy Commission. August 2001.

[16] Itron, Inc. *2004-2005 Database for Energy Efficiency Resources (DEER) Update Study: Final Report.* Prepared for Southern California Edison. December 2005.

3

Approach and Key Assumptions

This section describes the approach and key assumptions used in the analysis of the existing building residential and commercial sectors. In addition, key issues relevant to the analysis are discussed and comparisons are made between this study (2004 potential study) and the 2000 KEMA-Xenergy potential study. The comparison of key assumptions helps to focus attention on the factors that influenced the two research efforts.

The analyses of the new construction (Appendices O, P, and Q), emerging technologies (Section 11), and industrial (Section 7) sectors were completed separately and differ somewhat from the approach described below for the existing residential and commercial sectors. Descriptions of the approaches used to analyze potential for these other sectors are described in their separate sections of the report.

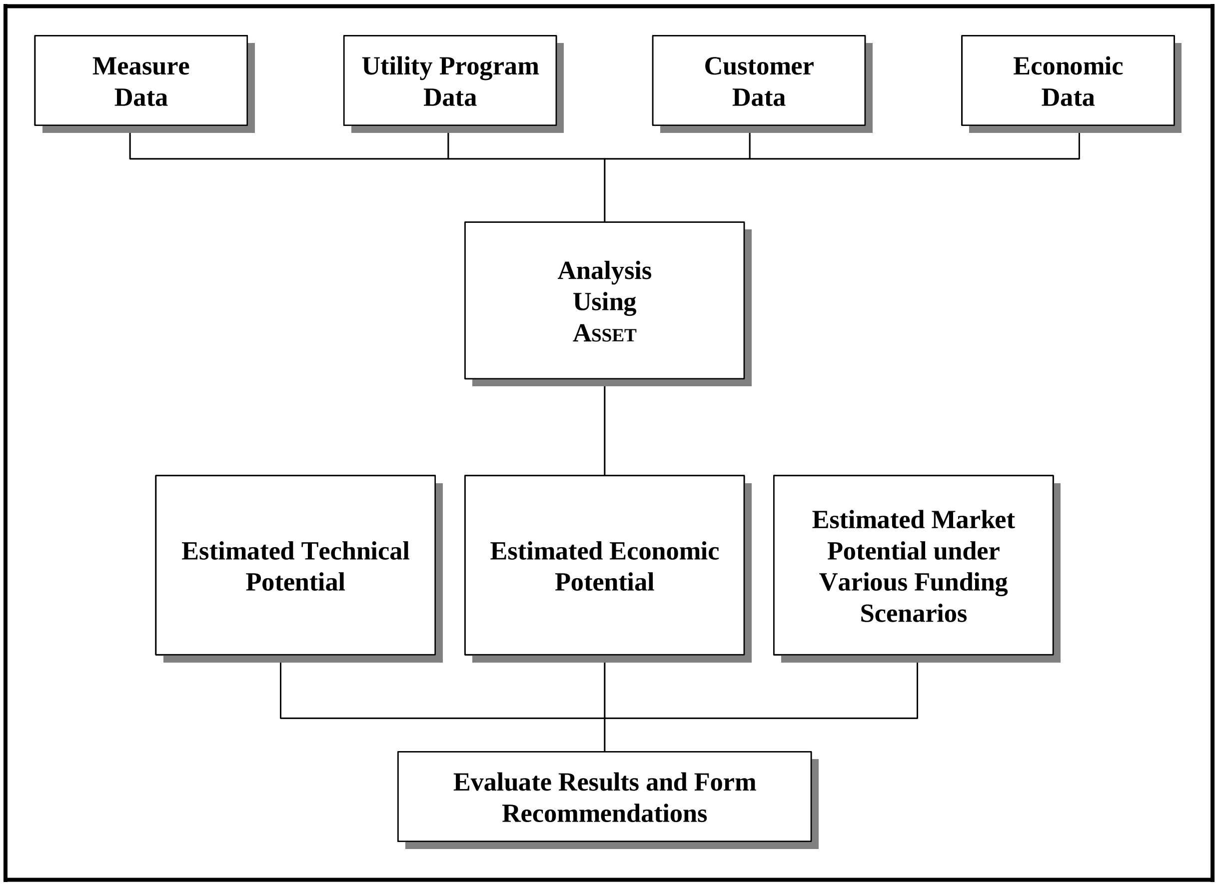
3.1 Overview of Approach

The overall approach involved the following five general steps, each of which is described in more detail below.

- Collect and develop input data for the model,
- Estimate technical potential,
- Estimate economic potential,
- Estimate market potential under different incentive funding scenarios, and
- Evaluate results and develop recommendations.

Figure 3-1 illustrates the relationship of these tasks. While the figure implies that the process flows smoothly from top to bottom, the analysis using ASSET is an iterative process. The simulation of the market potential with current utility programs may take multiple rounds to calibrate. The findings from the market potential may lead to various funding scenario simulations. Once the market potential is forecast, the findings from the market, economic, and/or technical potential forecast may influence which measures the policy makers decide to retain in their programs.

Figure 3-1: Overview of Study Approach



3.2 Estimating Technical Potential

Technical potential is a measure of where installation of an energy-efficient measure is considered applicable and feasible regardless of cost or acceptability to the customer. Applicability limits installation to situations where a qualifying end use or technology is present (e.g., water heater blankets for electric water heaters require an electric water heater to be present). Feasibility limits installation to situations where installation is physically practical (e.g., available space, noise considerations, and lighting level requirements are considered, among other things).

The installation time in this analysis is treated differently for retrofit and conversions versus replace-on-burnout situations. For retrofit and conversion situations, the model specifies the installation during the first year of the simulation. For replace-on-burnout situations, the model specifies the installation as the old measure requires replacement.

Technical potential was calculated as follows:

$$TP_{res} = \sum_i \left(Sav_i \times App_i \times Fes_i \right)$$

where

TP_{res} = technical potential
Sav_i = estimated energy savings for measure i
App_i = applicability factor for measure i
Fes_i = feasibility factor for measure i

3.3 Estimating Economic Potential

Economic potential includes the further consideration of measure costs. Economic potential is the modeling simulation in which the most efficient technology option that is cost effective is selected subject to applicability and feasibility. Avoided costs, measure costs, and program costs were used to conduct a total resource cost (TRC) test from the utility perspective.[1] Technically feasible installations that pass the TRC test are included in economic potential.

The measure cost used is the *full cost* (full incremental cost). For a conversion or retrofit measure, the incremental cost is the full installation cost of the measure including the labor cost to install it. For a replace-on-burnout measure, the incremental cost is the difference in equipment cost from the base measure to the high efficiency measure. Labor installation costs are not included in incremental costs for replace-on-burnout measures.[2] For residential and commercial CFL screw-in lights, a negative maintenance cost associated with longer CFL lifetimes is included in incremental costs.[3]

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[1] Note that the KEMA-Xenergy study measured economic potential using the total resource cost test from a societal perspective. Further, program costs were excluded from their total resource cost test, and they were included in maximum achievable potential estimates. Use of the societal TRC may lead to a slightly larger economic potential than using a TRC that only incorporates avoided costs, measure costs, and program costs. The KEMA-Xenergy study also included environmental avoided costs, however these are very small relative to the generation and transmission and distribution avoided costs. It is unlikely that the environmental avoided costs impact the economic potential of many items.

[2] For replace-on-burnout measures, the labor costs are assumed to be neutral or the same for both the low and the high efficiency technology, leading to no increase in the incremental cost of the high efficiency measure.

[3] The negative maintenance cost for CFLs simplified the calculation of payback for lighting measures with different lifetimes. The maintenance cost represents the yearly cost of incandescent not purchased during the extended life of the CFL.

The TRC test was calculated as follows:

$$TRC = \sum_{1}^{N} \frac{avoided\ cost}{measure\ cost + program\ cost}$$

A measure passed the TRC test if the test exceeded one.

Using the TRC test, economic potential was calculated as follows:

$$EP_{res} = \sum_{i} \left(Sav_i \times App_i \times Fes_i \times B_i \right)$$

where

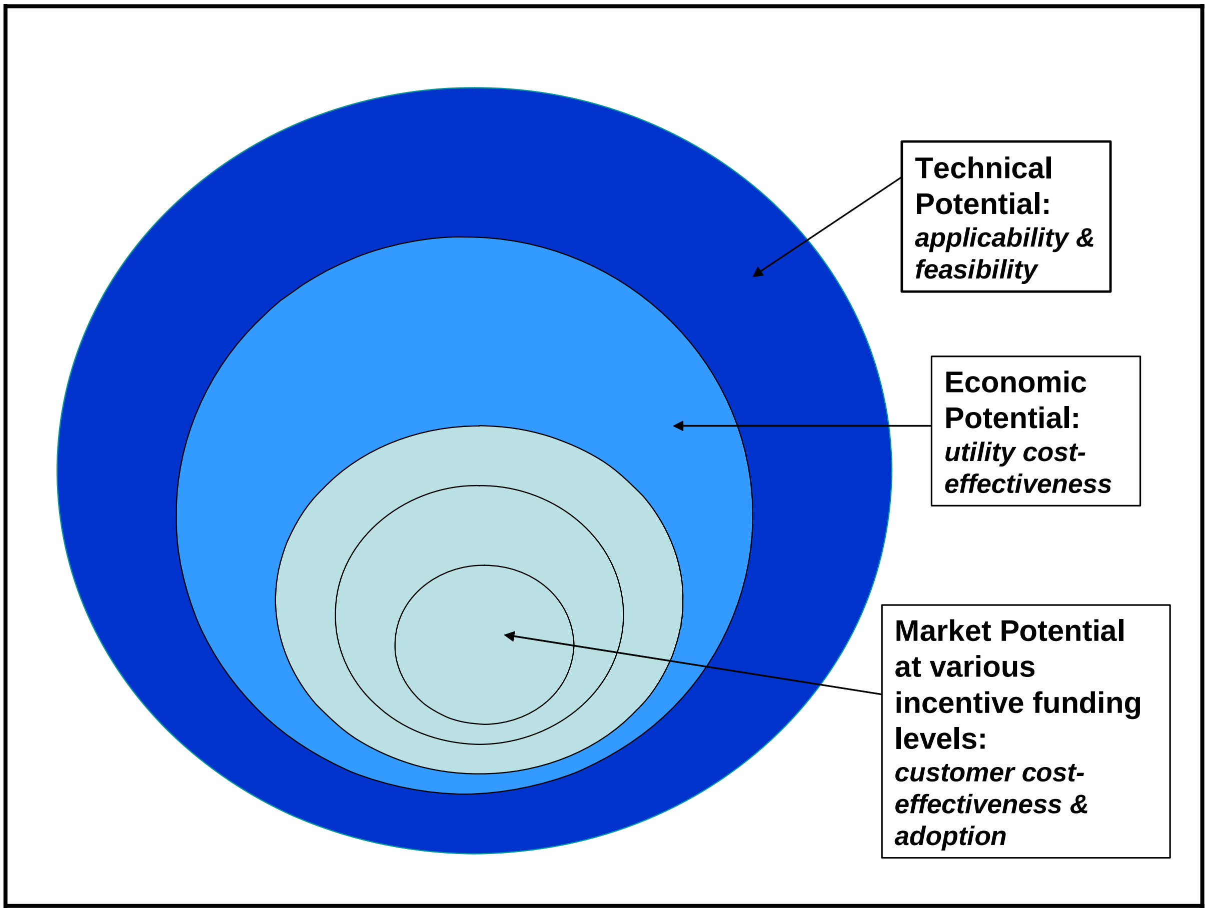
EP_{res} = economic potential
Sav_i = estimated energy savings for measure *i*
App_i = applicability factor for measure *i*
Fes_i = feasibility factor for measure *i*
B_i = binary variable indicating that measure i passed the TRC test

3.4 Estimating Market Potential

Market potential relates to the impacts that can be expected to occur within a specified period and with a specified level of utility program activity. It takes into account a variety of factors such as customer cost-effectiveness, awareness, willingness to adopt (which in turn depends on various market barriers like risk perceptions, split incentives, limited rationality etc.). To estimate market potential, the ASSET model estimates market outcomes under alternative market conditions and program configurations. The model also incorporates barriers to technology adoption due to information costs, technology awareness, and customer perceptions about technology performance.

Figure 3-2 illustrates the relationship between technical, economic, and market potential.

Figure 3-2: Relationship of Technical, Economic, and Market Potential



3.4.1 Modeling Adoption

Models of adoption behavior are used by ASSET to estimate adoption rates over time. These models incorporate estimates of awareness and willingness that change over time. Furthermore, the model includes control shares derived from the percentage of adopters reported for utility programs in 2004.[4]

As part of the forecasting process, the first year's energy savings estimates or adoptions (2004) are calibrated to the reported measure energy savings or adoptions (called control totals in ASSET). In some cases, this calibration process resulted in estimated adoption rates or energy savings that differ sharply from those reported by the IOUs. This occurred either because 1) utility-reported per unit or per measure savings were different across utilities, or

[4] Note that in the KEMA study adoption models were based on a series of screens. First, availability was considered as a function of eligible stock (where adopters are removed) and building decay. Next, awareness was considered as a function of money spent on awareness/information building. Third, adoption was calculated as a function of the participant test.

2) utility-reported savings were different from DEER[5,6] estimated savings. In addition, utilities differed in whether adoptions were due to retrofit or replace-on-burnout. This assumption affected the resulting savings, since retrofit adoptions generally claim higher savings given that the base case is the existing appliance.

To account for these discrepancies, some of the residential control totals were shifted within measure groups to reduce larger differences between those adoption rates reported by the IOUs and those resulting from the ASSET estimation process. In selecting which adjustments to make, priority was given to measures with higher-than-average reported energy savings and/or higher-than-average differences in estimates of savings per unit or measure. Table 3-1 summarizes the adjustments made during the analysis.

Table 3-1: Adjustments to Control Totals

Utility	Measure Group	Changes to Savings Estimates
SDG&E	Electric shell measures	Increase wall insulation; offset with decreases in windows and infiltration
SDG&E	Gas shell measures	Increase wall insulation; offset with decreases in attic insulation and infiltration
SDG&E	Pool pumps	Increase two-speed pool pumps; offset with decreases in one-speed pool pumps.
SDG&E	Cooling measures	Increase evaporative coolers; offset with decrease in whole house fans.
SCE	Pool pumps	Increase two-speed pool pumps; offset with decreases in one-speed pool pumps.
PG&E	Electric shell measures	Increase wall insulation; offset with decreases in attic insulation and infiltration
PG&E	Gas shell measures	Increase wall insulation; offset with decreases in attic insulation and windows.

3.4.2 Funding Scenarios

Three funding scenarios were examined. First, the current level of incentive funding for IOU energy efficiency programs in the 2004 to 2005 program years was considered. Second, a full incremental cost funding level was analyzed in which the full incremental cost of measures was incentivized. Third, an average scenario was analyzed in which the incentive funding level was the average of the current level and the measure's full incremental cost.

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5 Xenergy, Inc. *2001 DEER (Database for Energy Efficient Resources) Update Study*. Prepared for the California Energy Commission. August 2001.

6 Itron, Inc. *2004-2005 Database for Energy Efficiency Resources (DEER) Update Study: Final Report.* Prepared for Southern California Edison. December 2005.

3.5 Modeling Issues and Key Assumptions

Model design, technology inputs, and utility energy efficiency program accomplishments can significantly influence the estimate of the remaining energy efficiency potential. This sub-section briefly discusses the model and assumptions used in this study, comparing the data and assumptions used in this study with those employed in the 2000 study.

3.5.1 Use of ASSET

The forecasts for the 2000 and the 2004 studies used different modeling approaches. The analysis for this study was conducted using a model developed by Itron[7] called ASSET. The -KEMA-Xenergy[8] 2000 study used their DSM ASSYST model. The ASSET model uses a payback-based logit model to characterize customer adoption of energy efficiency measures. DSM ASSYST uses S-shaped implementation curves that relate customer benefit-cost ratios to penetration rates of energy efficiency measures. DSM ASSYST was used to estimate the existing industrial potential. The manual for DSM ASSYST is provided in Appendix N.

Figure 3-3 depicts the overall framework of the ASSET model. As shown, the model requires utility data, information on customer characteristics, and technology data. Utility data include utility program costs, avoided costs of energy and demand, and program features. Customer characteristics encompass size (number of homes, floor stock), load profiles, and various aspects of adoptions-related behavior (awareness, willingness, etc.). Technology features include costs and lifetimes as well as savings associated with applications by specific customer segments. ASSET was developed to estimate DSM measure adoptions and the associated energy and demand savings over a specified forecast period.

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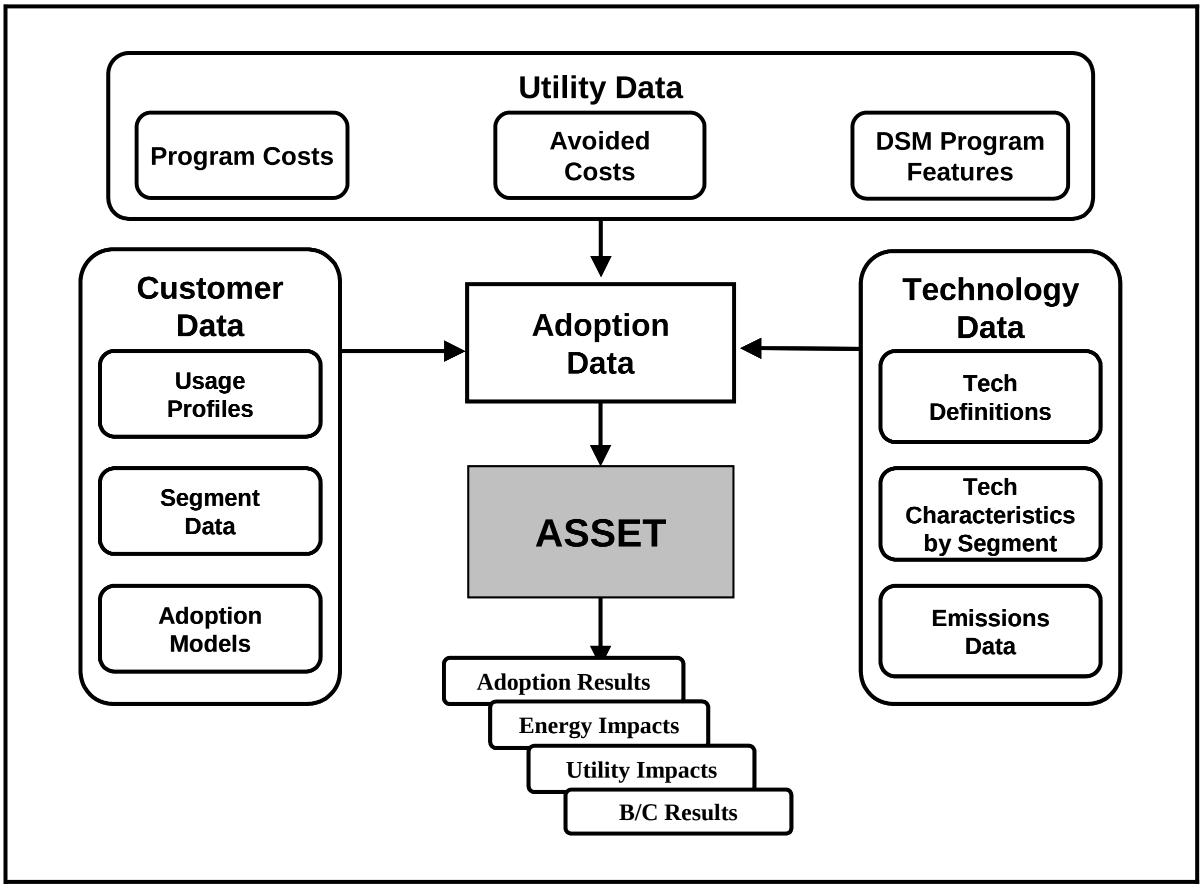
7 The model was developed by Regional Economic Research, Inc. (RER). RER was acquired by Itron in 2003.

8 Similarly, Xenergy was acquired by KEMA in 2003. For this report, they are referred to as KEMA-Xenergy.

Figure 3-3: Overview of ASSET Framework



ASSET is designed to yield adoption forecasts for four distinct types of decision states.

- ***New Construction.*** For new construction decisions, adoption models give the fraction of new construction that adopts an option. The adoption rate is the same as the market penetration in new construction. Average saturation levels in the overall stock change as the new units are included in the overall totals.
- ***Replacement on Burnout.*** For replacement decisions, the total decay of all options in a competition group defines market size. In this case, the adoption models give the share of total group replacements for an option. Average saturation levels are impacted if the shares in replacement differ from the shares of total decay in the group.
- ***Equipment Conversion.*** For equipment conversion decisions, existing saturation levels define the size of the conversion market. In this case, the adoption models give the fraction of customers with a specific type of equipment who convert to an alternative option. Saturation levels change because the stock of the base option declines and the stock of the target option increases.
- ***Device Retrofit.*** For retrofit decisions, saturation levels are modeled relative to the fraction of customers who qualify for the specific device. In this sense,

saturation levels define the fraction of the applicable market that already has a measure installed. The adoption rate is a retrofit rate, giving the fraction of the applicable market that installs a device. Device saturation levels change as a direct result of device acquisition.

These distinctions are related to the difference between event-driven and discretionary decisions. In particular, new construction and replace-on-burnout decisions are analyzed using event-driven models, and equipment conversion and device retrofit actions are analyzed using models that account for the discretionary nature of the decisions.

The following are some features of ASSET that make it particularly suitable for use in this study.

- ASSET incorporates both physical barriers to adoption (technology applicability and feasibility) and market barriers to adoption (customer awareness, customer willingness, and supply-side availability) in order to impose realistic limits on market potential estimates.
- ASSET offers a variety of adoption models to estimate market adoption rates based on technology and customer characteristics. Specific modeling frameworks are provided for four different types of decisions: new construction, replacement at time of burnout, equipment conversions, and retrofit actions. Multiple modeling frameworks for the same technology can be implemented simultaneously.
- ASSET incorporates a fully articulated stock accounting system. This system keeps track of the inventory of all base technologies and DSM measures over time, thereby adjusting the remaining potential for adoptions as well as base technology and measure decay. The stock accounting system allows the base technologies to decay and re-enter the forecast.
- ASSET is capable of modeling both binary and multinomial decisions involving technologies. It does this through the definition of competition groups (groups of competing technologies) and the integration of multinomial adoption models.
- ASSET is designed to recognize changes in codes and standards over time. Technologies and/or efficiency levels prohibited by codes/standards in future periods are made unavailable for the purposes of modeling adoptions.
- ASSET allows the user to specify the rate at which energy efficiency measures are replaced in kind at the end of their lifetimes.
- ASSET offers the ability to do “on-the-fly” measure screening. This means that cost-effectiveness tests can be conducted automatically in each forecast period to determine the measures for which interventions will be conducted. This capability allows the recognition of changes in cost effectiveness stemming from variations in market conditions, alterations in standards, and other factors.

3.5.2 Model Parameters

The ASSET model requires input information on the payback period for the energy efficiency technology and on the influence of payback on the probability of adopting the technology. Itron's payback parameters were derived from a residential and commercial market research study conducted for Northern States Power Company and the resulting conjoint analysis of these data.[9] The conjoint analysis was designed to assess the tradeoffs that customers make in deciding to replace their existing measures with more efficient technologies. The major purpose of the conjoint analysis was to develop the payback parameters so that they could be used in ASSET technology adoption models.

The ASSET program uses the measure payback, the payback parameter and the utility's program accomplishments or quantity of adoptions to calibrate the adoption model for the first year of the program forecast. The payback parameter determines the influence of the economic variable, payback, on achieving the quantity of adoptions. To calibrate the model to the utility's achievements, the ASSET program calculates the impact of non-economic technology attributes that influence the probability of technology adoption, the calibration factor. The non-economic attributes captured by the calibration factor could include the quality of light for a CFL relative to an incandescent, the noise level of a high efficiency appliance relative to existing technology, and the perception of quality for the high efficiency measure relative to existing measures. The non-economic factors captured by the calibration factor are assumed to be constant over the forecast period.

Forecasts of the alternative market scenario are accomplished by changing a measure's payback, leaving the payback parameter and the calibration factor constant. For example, increases in rebate levels will reduce the payback period and increase the probability of adoption. Increases in rebate levels do not change the payback parameter, instead increases in rebates reduce the length of the payback period. Increases in rebates do not change the non-economic attributes of the technology, nor do they change the calibration factor.

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9 These data come from *Northern States Power Company Customer Survey Final Report* prepared by Regional Economic Research, Inc. and Opinion Dynamics Corporation, March 1995. While the parameter estimates from the conjoint analysis are dated, to the best of our knowledge, this research has not been replicated more recently in California or elsewhere. Increases in energy prices have reduced payback lengths, middle-eastern conflicts have introduced concerns about the supply of energy, and global warming may have increased concerns about the environment and energy usage, all of these changes may have led to changes in the payback parameter in unexpected and conflicting ways. A new conjoint or double bounded analysis of the influence of rebate levels on consumer choices would help to reduce the level of uncertainty surrounding these parameters. Alternatively, a time-series analysis of energy efficiency measure adoptions, rebate levels and measure costs would add to our understanding of the influence of economic variables on energy efficiency measure adoptions.

3.5.3 Study Scope

The 2000 study focused on the electric and natural gas energy efficiency potential in the existing residential and commercial sectors. The 2004 study expands the previous focus to include both existing and the new construction markets for the residential, commercial, and industrial sectors and for emerging technologies. Both the 2000 study and the 2004 analysis use retrofit and replace-on-burnout models to estimate the remaining potential associated with installation of energy efficiency measures in existing construction. Neither study addresses the potential associated with customer behavioral changes.

The 2000 study analyzed the potential over a 10-year period (2003-2012). The 2004 study assesses the energy efficiency potential over a 13-year period (2004-2016).

The 2000 study restricted energy efficiency measures and practices to those that were commercially available in 2002. The 2004 study of current market potential in the existing and new construction sectors restricted the forecast to measures and practices included in the accomplishments reported in the utilities' 2004 quarterly filings. The forecast of market potential under rebates exceeding current rebate levels includes additional commercially available measures. The 2004 forecasts of residential, commercial, and industrial technical and economic potential are restricted to currently available measures.

The emerging technology forecast of the 2004 study restricted measures to two groups. The first included measures that are not yet commercially available but likely to become available soon. This group of measures is further restricted to those measures that will be cost-effective for a significant proportion of end users. The second group of measures are currently commercially available but have not been adopted by more than 2% of the end-uses. Measures with only long-term potential, as well as energy efficiency practices, were excluded from the emerging technology forecast. The 2000 study did not include an emerging technology potential forecast.

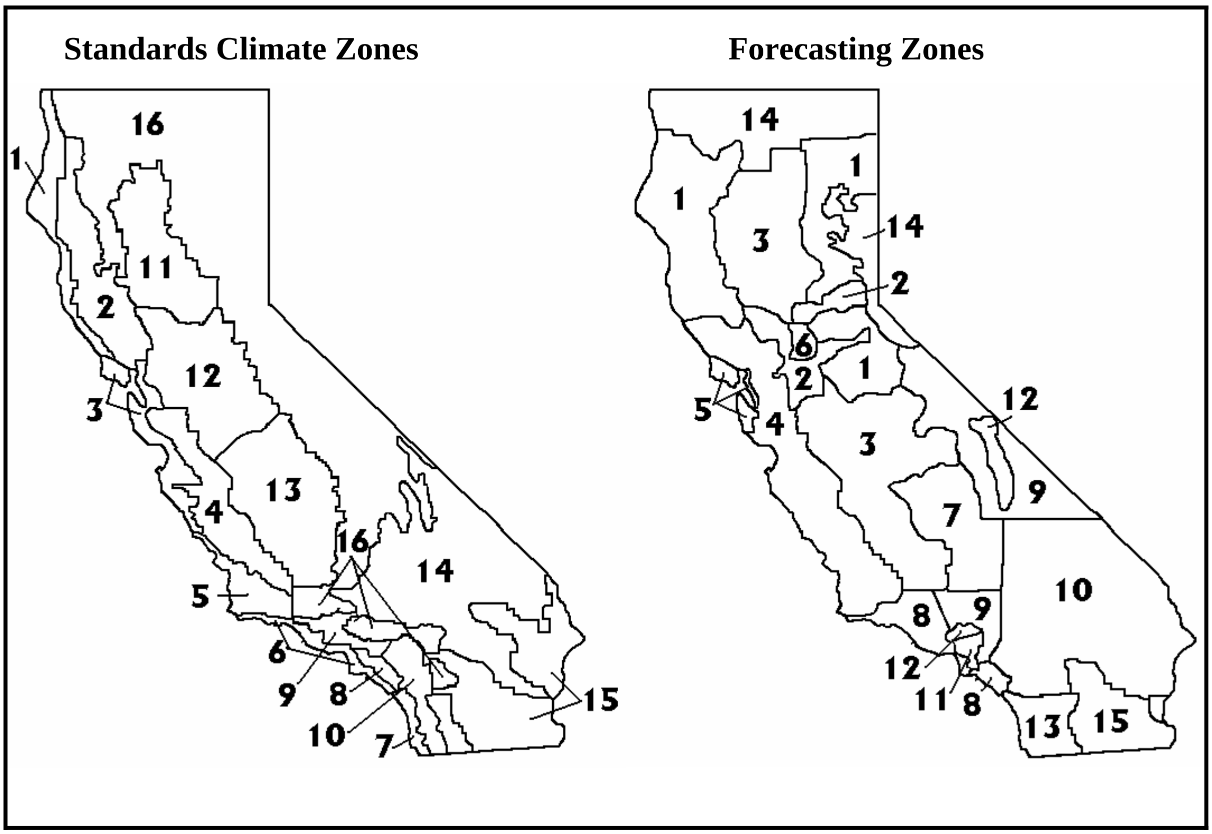
3.5.4 Geographic Scope

While this study is designed to support decision making with respect to statewide energy efficiency programs, it is by necessity limited partially to the service areas of four IOUs: PG&E, SCE, SoCalGas, and SDG&E.

The 2000 study presented results by the CEC forecasting weather zones. These are very different from the CEC Title 24 Standards weather zones. These two sets of CEC climate zones are designed to serve two separate purposes, with the Title 24 Standards climate zones providing greater breadth of climate diversity. The forecasting climate zones serve the purpose of disaggregating utility service territory into zones while the building standards climate zones are blind to utility service boundaries. Figure 3-4 illustrates the geographic representations of the two sets of CEC zones.

For this study, the analysis was conducted using CEC Title 24 Standards climate zones. The choice of climate zones was driven by two factors: the availability of other input values[10] and the desire to produce weather-sensitive forecasts intended to assist the program planning process. The disaggregated, weather-sensitive nature of the Standards climate zones provides greater diversity for the impacts of weather-sensitive measures.

Figure 3-4: Comparing Climate Zones



The analysis requires that results be aggregated to the utility service area even though the CEC Title 24 Standards climate zones are not uniquely associated with utility service areas. Therefore, separate utility-specific analyses were conducted as necessary within a climate zone. In addition to performing analyses by unique climate zone and utility service area, PG&E Climate Zone 3 was split in order to separate PG&E congestion zones. Table 3-2

[10] The avoided cost forecasts approved for this study were derived by the standards climate zones. See Energy and Environmental Economics, Inc. *A Forecast of Cost-Effectiveness Avoided Costs and Externality Adders.* Prepared for the California Public Utilities Commission, Energy Division. January 2004.

contains a listing of climate zone to utility service area/congestion zone used for this analysis.

Table 3-2: Title 24 Standards Climate Zone by Utility

	PG&E	SCE	SCG	SDG&E
Climate Zones	CZ1 CZ2 CZ3A CZ3B CZ4 CZ5 CZ11 CZ12 CZ13 CZ16	CZ6 CZ8 CZ9 CZ10 CZ13 CZ14 CZ15 CZ16	CZ4 CZ5 CZ6 CZ8 CZ9 CZ10 CZ13 CZ14 CZ15 CZ16	CZ7 CZ10 CZ14

3.5.5 Development of Scenarios

The 2000 study analyzed market scenarios with alternative rates and funding levels. The 2004 study assumed rates were constant at the 2004 level, focusing on three alternative funding levels.

The 2000 forecast analyzed a low, base, and high energy cost scenario. The influence of energy prices on the remaining potential forecast was of particular interest during and immediately following the 2001 energy crisis. The 2000 low energy cost scenario analyzed potential if rates were below their 2001 crisis levels, the base case started with the 2001 rates, allowing rates to decline to their pre-crisis level by 2006. The high cost scenario assumed energy prices remained at their 2001 level through out the forecast period.

The funding levels analyzed in the 2000 study used a base of the average energy efficiency program funding between 1996-2000, the pre-crisis period. The choice of the base funding level for the 2000 study was predicated on the hypothesis that the high level of funding and conservation behavior during the 2001 crisis was not likely to continue during the post-crisis period. The three additional funding levels analyzed assumed that funding increased 50%, 100%, and a maximum achievable funding level.

The 2004 study analyzed three incentive scenarios. The first entailed running the inputs with the level of incentives and costs relative to the 2004-2005 energy efficiency programs. This "current" level of funding scenario included all energy efficiency measures that the utilities had rebated and claimed program accomplishments for in the 2004-2005 program years. The "current" funding scenario captures the first year of high level of funding and program activity associated with the new, higher CEC energy savings goals. A second scenario considered full incremental cost incentives. This "full cost" scenario included all the energy efficiency measures analyzed in this study, including some that were not rebated during the 2004-2005 program year.[11] The third scenario was designed to consider incentive funding levels in-between these two extremes. This average scenario looked at incentive levels that were an average of those from the current and full incremental cost scenarios.

3.6 Develop Input Data for the Model

This study required the collection and development of a wide range of information to drive the model. In particular, the following categories of data were developed:

- Energy efficiency measure data,
- Utility program data,
- Customer data, and
- Economic data.

Each category is described briefly below. Appendix B provides a more detailed description of the model inputs.

3.6.1 Energy Efficiency Measure Data

Selecting Measures for the Analysis

One important determinant of the project's general scope is the set of energy efficiency measures to be included in the analysis. On one hand, it is critical for the list to be reasonably comprehensive so that the estimates of energy efficiency potential are meaningful. On the other hand, depending on the specificity of measure definitions, one could identify thousands of distinct measures, many of which would have insignificant potential. Another issue is that the ways of characterizing measures differ across programs, thus making it difficult to develop common definitions and lists.

Fortunately, choosing measures does not need to occur in a vacuum. To some extent, the utilities have already dealt with this issue in other contexts. For instance, the DEER Advisory Committee has approved a common set of significant measures for developing the DEER database. Moreover, various advisory committees have approved measure lists for the previous 2000 KEMA–Xenergy study designed to estimate the potential for energy efficiency measures in the residential, commercial, and industrial sectors. While these

[11] The list of energy efficiency measures included in the analysis was determined by the project advisory committee, in consultation with Itron. This list is largely made up of measures included in the 2004 IOU energy efficiency programs. Not all utilities, however, include all of the measures offered in the programs of the other utilities. In addition, the project advisory committee selected a handful of measure to be included that were not in the 2004 programs. The listed of measured added to the technical, economic, full incremental cost, and average cost scenarios are listed in chapters 4 and 5.

measure lists are based on somewhat different objectives, they are reasonably consistent with respect to their total coverage. This should not be surprising. The choice of measures for the 2000 energy efficiency potential study were partly based on a review of the old DEER database, and the design of the current DEER database was based partly on a review of the 2000 potential study. However, it should be noted that the specific measures included in the DEER and 2000 study differ with respect to the specificity of measure definitions. Most importantly, the measures included in the energy efficiency studies tend to be defined more generally than those contained in DEER. In general, these studies generalized some measures, ignored others, and added measures not included within DEER based upon utility filings.

To finalize the set of DSM measures to include in this statewide assessment of energy efficiency potential, the measures currently included within DEER (which has been modified since the 2000 study) were reviewed and compared to other sources. The first comparison was with the measures included in the 2000 study. As expected, it was found that DEER contains many of the measures included within the potential studies, but not all measures. The second comparison was through a review of the fourth quarter utility filings of their programs results. These filings contain much of the programmatic detail needed by the ASSET model, such as incentives provided, impacts achieved, and administrative costs incurred. These filings also list all measures included within their respective programs.

Only energy efficiency measures and practices that provide long-term energy savings were considered for this study. In addition, only installable measures and practices (as opposed to energy conservation behaviors) were included in the analysis.

Table 3-3 presents the end uses included in the analysis. Appendix A provides more detail about the individual measures. The study analyzed 47 electric residential measures, 18 natural gas residential measures and 82 commercial measures.

Table 3-3: End Uses included in Analysis

End Use	Description
Residential Electric	
HVAC	High efficiency central and room air conditioners, heat pumps, whole house evaporative coolers, and whole house fans
Lighting	Compact fluorescent lamps and hardwired fixtures, LED exit signs, occupancy sensors, photocells, and torchieres
Refrigeration	High efficiency refrigerators and refrigerator and freezer recycling
Water Heating	Water heaters, low-flow showerheads, faucet aerators, and pipe wrap
Miscellaneous	High efficiency clothes washers, one and two speed pool pumps, clothes dryers, dishwashers, windows, infiltration control, attic and wall insulation, HVAC diagnostics, and duct repair
Residential Gas	
HVAC	High efficiency gas furnace
Water Heating	Water heaters, low-flow showerheads, faucet aerators, pipe wrap, and boiler controllers
Miscellaneous	Clothes washers, clothes dryers, dishwashers, attic and window insulation, infiltration control, and duct repair
Commercial Electric	
HVAC	High efficiency air conditioning, chillers, chiller tune-up, and DX tune-up
Lighting	Compact and efficient linear fluorescent lamps and hardwired fixtures, HIDs and metal halides, LED exist signs, time clocks, occupancy sensors, and photocells
Refrigeration	Controls, infiltration barriers, compressors, fan motors, and night covers
Miscellaneous	Holding cabinet, steamer, copy machine
Commercial Gas	
HVAC	Boilers
Miscellaneous	Cooking equipment, clothes washers, and water heaters

Measure Characteristics

The model uses a number of other measure characteristics. The primary inputs, their sources, and a brief comparison to the 2000 study is provided below. Details of the measure characteristics used in the 2004 study are provided in Appendix C for residential measures and Appendix D for commercial measures.

Technology Definitions. A set of technology definitions, in terms of various measure characteristics, was constructed. This included volumes (e.g., R-values), efficiencies (e.g., SEERs), sizes (e.g., lamp lengths), and other factors. Technologies were assigned to end uses for the purpose of summarization.

Measure Impacts and Costs. The DEER was the primary source of information for efficiency measure impacts and costs for both the 2000 and the 2004 statewide studies. This information was supplemented by other sources, such as utility submittals, where necessary.

The non-weather-sensitive portion of the DEER was updated after the 2000 potential study. The DEER update[12] included identification of the most currently available information on measure impacts and costs. The measure impacts for residential lighting significantly changed between the 2001 and the 2005 DEER. Changes to residential lighting include a reduction in the assumed run hours and a change in the incandescent to CFL wattage specifications.[13]

Itron used the updated information where possible and obtained the IOUs' 2005 EE annual reports that described the utility DSM programs, measures, and assumptions. These utility filings were the primary source of measure impact and cost information after the DEER.

Measure Lifetimes. Measure lifetimes include the minimum lifetime, maximum lifetime, and the minimum conversion time[14] for each measure. The PUC Policy Manual was the primary source of measure lifetime information used in both the 2004 and the 2000 studies. Several estimates of measure life have changed since the 2000 study based on measurement and evaluation studies sponsored by the California Measurement Advisory Council (CALMAC). When found, these updated measure life estimates were used for the 2004 study. For other measures (e.g., emerging technologies), lifetimes were based on reviews of the technical literature.

Technical Feasibility. The technical feasibility of a measure refers to the percentage of households, or commercial floorstock, that could transform to a high efficiency technology. For residential lighting measures, the 2004 study used values taken from the recent California Residential New Construction study.[15] For other measures, the values were derived from professional judgment of the evaluators.

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[12] Itron, Inc. *2004-2005 DEER,* op. cit.

[13] Ibid. Section 2.1.

[14] The minimum conversion time represents the minimum time before a customer who had just purchased a lower efficiency technology would consider purchasing a higher efficiency technology for the same measure.

[15] Values for screw-in CFLs were taken from the California Residential New Construction Study. Values for hardwired CFLs were derived as a percentage of the values for screw-in CFLs. See Itron, Inc. *Residential New Construction Baseline Study of Building Characteristics - Homes Built After 2001 Codes.* Prepared for Pacific Gas and Electric. August 2004.

Applicability. For non-retrofit measures, this binary variable indicates whether a particular measure is applicable for a particular housing or building type (for example, exit signs are not applicable for a single family home). The model often dictates the value of applicability. For example, for replace-on-burnout measures, the applicability must be "1" if all measures are to be replaced with either a low or a high efficiency measure on burnout. For retrofit measures, this variable limits the size of the market to the percentage of homes or businesses with the qualifying equipment or configuration. Usually this fraction depends on technology and/or fuel type shares. Most of the applicability values for residential retrofit measures were derived from the RASS data while the commercial retrofit applicability values were derived from the CEUS data.

Availability. Both market and legal availability were specified for all measures.

The 2000 statewide potential study and the 2004 study used information on the latest availability and standards. The 2004 analysis incorporated several changes in standards that occurred between these reports. Changes in federal and state standards, which mandate improvements in the energy efficiency level of commercially available technologies, lead to reductions in the remaining market, economic, and technical energy efficiency potential.

Changes in federal standards incorporated in the 2004 study include an increase in the base efficiency level for residential central air conditioners and heat pumps. SEER 10 measures are assumed to be commercially available until 2006, when the base technology changes from SEER 10 to SEER 13. New federal National Appliance Energy Conservation Act Standards (NAECA) for refrigerators increased the base efficiency by approximately 30% and reduced the savings per clothes washer by approximately 50%. Federal standards also increased the base efficiency for residential and commercial gas and electric water heaters. The Energy Policy Act also increased the base efficiency for commercial motors, leading to a cut in claimed savings of approximately 50%.[16]

Emerging technology measures have limited availability due to their nature. Emerging technologies were divided into two groups: ones that were commercially available, but uncommon and those that were not immediately commercially available.

While it is likely that codes and standards will change over the life of the forecast, no assumptions were made about future codes and standards that have not yet been defined.

[16] Information on changes in standards and energy savings are from Itron *2004-2005 Database for Energy Efficiency Resources (DEER) Update Study: Final Report.* Prepared for Southern California Edison. December 2005.

Base Shares. This variable represents the percentage of households that have the particular technology. The 2004 base share data benefited from the recent RASS and CEUS studies.

For the 2004 study, residential lighting measures base share values were obtained from the California Residential Market Share Tracking study (RMST).[17] For non-lighting measures, base share values were taken from the RASS study (2004)[18] where available. For some measures, the RASS data are not a good source for base shares of high efficiency technology. In these cases, the values were amended with the evaluators' professional judgment.

For commercial measures, base share values were obtained from the CEUS study (2006). The commercial lighting measure base share information available from the CEUS study was a significant improvement from the 2000 study where the existing saturation of high efficiency lighting was a matter of relative uncertainty.[19]

The 2000 study used the most recent, available data to determine base share values. Their data sources included the 1997 California Baseline Lighting Efficiency Technology Report, the Statewide Survey of Multifamily Common Area Buildings (2000), utility-specific commercial end-use surveys for 1992 to 1998, DEER (2001),[20] and IOU quarterly filings from 1996–2000, and CEC forecasts of saturations.[21]

Intensities. For retrofit measures, the intensity is the energy savings associated with retrofitting the house or commercial building. For replace-on-burnout and conversion measures, the values were derived as the difference between the usage of low and high efficiency measures. In most cases, the 2000 and 2004 studies used savings values taken from DEER.[22]

Technology Density. The 2000 and the 2004 forecasts employed the most recent data on technology density. Technology density represents the number of installed units per household for residential measures. For commercial measures, this variable usually represents the number of units per thousand square feet of conditioned space.

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[17] Itron, Inc. *California Lamp Report 2004.* Prepared for Southern California Edison. June 15, 2005.

[18] KEMA-Xenergy, Inc. *California Statewide Residential Appliance Saturation Study.* Prepared for the California Energy Commission. June 2004.

[19] Xenergy, Inc. *California Statewide Commercial Energy Efficiency Potential Study.* July 2002. See page A-15.

[20] Xenergy, Inc. *2001 DEER (Database for Energy Efficient Resources) Update Study.* Prepared for the California Energy Commission. August 2001.

[21] Xenergy, op. cit., July 2002 and KEMA-Xenergy, op. cit., April 2003.

[22] For residential measures, except for central air conditioning, DEER data were taken from version 1.0 of the database. For commercial measures, the 2004 DEER database values were used.

The 2000 forecast used data from multiple sources included the 1997 California Baseline Lighting Efficiency Technology Report, the Statewide Survey of Multifamily Common Area Buildings (2000), utility-specific commercial end-use surveys for 1992 to 1998.

For the 2004 commercial sector study, estimates of technology densities were extracted from the recent CEC-sponsored California Statewide CEUS database. This database provided the 2004 study with recent statewide data gathered from an in-depth on-site survey of commercial building equipment and characteristics. For the residential sector, the 2004 study developed values of saturations and technology densities largely from the 2004 Residential Appliance Saturation Survey (RASS) database.

Automatic Replacement Fractions. ASSET allows for the use of assumptions with respect to the automatic replacement of technologies in kind. Assumptions concerning automatic replacement-in-kind fractions were based on the professional judgment of the evaluators.

Residential New Construction. For the residential sector, new construction values of saturations and technology densities were developed from the Residential New Construction Survey database.

Market Barriers. These barriers are characterized in terms of two key inputs: awareness and willingness. Willingness essentially summarizes all non-awareness barriers. Where possible, Itron identified baseline estimates of willingness and awareness at the technology level from existing sources such as recent market assessment and process and impact evaluations. Where information was not available, Itron used professional judgment. For the 2004 analysis, the values of awareness and willingness typically start at a relatively high level (60 to 100%) and were assumed to grow at 2% per year. The willingness and awareness values for the 2004 analysis grow at 2% for all market scenario analysis.

The 2000 study used an awareness variable within the DSM ASSYST model with the baseline value based on judgment. The awareness variable used in the 2000 study is not directly comparable to the awareness and willingness variables used in the 2004 analysis. The ASSYST value of awareness applies only to the fraction of the population that does not currently own the high efficiency measure, while the ASSET awareness and willingness variables apply to all of the population. The baseline value used in the 2000 study was 25%, regardless of efficiency measure, fuel type, or sector. The growth of awareness over time was dependent on the utility administrative and advertising budget. In the 2000 study, increases in rebate levels are associated with increases in advertising and administrative budgets, leading to faster growth in awareness as rebate levels increase.

While the baseline awareness values used in DSM ASSYST are generally much lower than those used in ASSET, the populations these values are applied to differ dramatically. If a measure has an initial high efficiency measure saturation of 50% and the 2002 study assumes that awareness is 25%, they are assuming that 62.5% of the total population is aware. This is the same as the 2004 study assuming that the original level of awareness and willingness was 62.5%. Given the differing definitions of awareness, it is not clear how the initial values for this variable, or the differing growth assumptions, influence the differences in the 2002/2003 study and the current analysis.

3.6.2 Utility Program Data

Avoided Costs

When energy efficiency measures save energy, the utilities avoid having to provide power they would otherwise have had to deliver. This "avoided cost" reflects the hourly marginal costs for utility generation. For this study, avoided costs were derived from the Avoided Cost Model developed by E3 for the CPUC.[23] The E3 model includes both the energy costs and the T&D costs for each hour for the years 2004 through 2023. Line losses are directly reflected in the E3 avoided cost modeling through the model's inclusion of loss factors in its T&D avoided cost modeling. Reliability and environmental costs are also included in these estimates.

The 2000 study used a variety of statewide averages of avoided costs based on the authorized CPUC avoided costs for major IOUs.[24] The earlier study did not have access to reliability and price elasticity adders, these adders were developed by E3 at the request of the CPUC. On average, the CPUC statewide averages of avoided costs were higher than the avoided costs used for the 2004 study.[25]

Avoided costs were obtained by geographic area and by hour for use in the analysis. Location-specific values were used to assess cost-effectiveness in the geographic zones employed in the study. Hourly values were mapped into time-of-use (TOU) period averages for use in the ASSET analysis.

A standard set of TOU periods was used to represent the specific periods used by the individual utilities. The schedule of TOU periods is a derivative of PG&E's Hour Ending TOU Schedule and is the same schedule used by the 2000 study. The schedule is presented in Table 3-4. The avoided costs by climate zone, TOU period, and year are listed in Appendix B.

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[23] Energy and Environmental Economics, Inc. January 2004. op cit.

[24] California Public Utilities Commission. *Ruling on Cost-Effectiveness Issues.* A.00-09-049. ALJ Linda R. Bytoff. October 25, 2000.

[25] If the avoided costs used in the 2000 study were higher than those used in the 2004 study, this could contribute to the 2000 study's high economic potential relative to the 2004 study.

Table 3-4: Time-of-Use Periods Used in the Analysis

Peak Status	Summer (May 1 thru Oct 31)	Winter (all other months)
Peak	1 PM to 6:59 PM Weekdays	(none)
Partial-Peak	9 AM – 12:59 PM Weekdays 7 PM – 9:59 PM Weekdays	9 AM – 9:59 PM Weekdays
Off-Peak	10 PM – 8:59 AM Weekdays All Weekends and Holidays	10 PM to 8:59 AM Weekdays All Weekends and Holidays

Retail Rates

The 2004 forecast obtained commercial and residential electric and gas rate data from the four IOUs. After carefully comparing current rates with the 2002 forecast of rates from the CEC, Itron determined that the retail rates for 2004 differed substantially from the CEC forecast rates for 2004. Given these differences, the 2004 study was implemented using current rates and a model that assumed constant real prices.

The 2000 study considered uncertainty in electricity and gas retail rates and in avoided costs by producing estimates for a base case, a high case, and a low case. The 2004 study does not include scenarios representing various levels of energy costs.

For the residential analysis, general service rates for single family detached homes were obtained from each utility's rate department. Rates were current as of November 2004. Data from the recently completed RASS study were used in an analysis of average electrical usage for single family detached homes by climate zone. Results from this analysis showed that most incremental usage would be at the top tier rate. Therefore, top tier rates for summer and winter usage were used. Table 3-5 presents the residential electric and gas rates used in the study.

Table 3-5: Residential Retail Rates Used in Analysis

Utility	Summer Electric Rate (per kWh)		Winter Electric Rate (per kWh)		Gas Rate (per Therm)
	Single Family	Multifamily	Single Family	Multifamily	
PG&E	$0.2107	$0.1432	$0.2107	$0.1432	$1.1563
SCE	$0.1712	$0.1375	$0.1683	$0.1347	n/a
SoCalGas	n/a	n/a	n/a	n/a	$1.0942
SDG&E	$0.1713	$0.1439	$0.1630	$0.1439	$1.0942

Table 3-6 and Table 3-7 present a summary of the commercial electric retail rates used in the study (energy and demand, respectively). Table 3-8 presents a summary of commercial gas retail rates used in the study. Appendix B presents a more detailed table that breaks the rates down by commercial building type.

Table 3-6: Commercial Electric Energy Retail Rates Used in Analysis

Utility, Size of Commercial Bldg.	Summer (per kWh)			Winter (per kWh)		
	Peak	Partial Peak	Off Peak	Peak	Partial Peak	Off Peak
PG&E, Small	$0.1646	$0.1257	$0.1187	n/a	$0.0992	$0.0921
PG&E, Large	$0.1504	$0.0902	$0.0767	n/a	$0.0955	$0.0765
SCE, Small	$0.1297	$0.0930	$0.0826	n/a	$0.0983	$0.0826
SCE, Large	$0.1222	$0.0735	$0.0619	n/a	$0.0806	$0.0625
SDG&E	$0.1762	$0.1487	$0.1370	n/a	$0.1473	$0.1373

Table 3-7: Commercial Demand Retail Rates Used in Analysis

Utility, Size of Commercial Bldg.	Summer (per kW)			Winter (per kW)		
	Peak	Partial Peak	Off Peak	Peak	Partial Peak	Off Peak
PG&E, Small	$5.90	n/a	n/a	n/a	$1.42	n/a
PG&E, Large	$11.93	$3.30	n/a	n/a	$3.26	n/a
SCE, Small	$15.12	n/a	n/a	n/a	$6.21	n/a
SCE, Large	$24.95	$9.90	n/a	n/a	$7.32	n/a
SDG&E	$16.28	n/a	n/a	n/a	$16.11	n/a

Table 3-8: Commercial Gas Retail Rates Used in Analysis

Utility, Size of Commercial Bldg.	Summer (per therm)			Winter (per therm)		
	Peak	Partial Peak	Off Peak	Peak	Partial Peak	Off Peak
PG&E, Sm.	$1.0579	$1.0579	$1.0579	n/a	$1.1233	$1.1233
PG&E, Lg.	$0.9498	$0.9498	$0.9498	n/a	$0.9900	$0.9900
SCE, Sm.	$1.0464	$1.0464	$1.0464	n/a	$1.0464	$1.0464
SCE, Lg.	$0.8536	$0.8536	$0.8536	n/a	$0.8536	$0.8536
SDG&E, Sm.	$1.0729	$1.0729	$1.0729	n/a	$1.1542	$1.1542
SDG&E, Lg.	$0.9213	$0.9213	$0.9213	n/a	$0.9257	$0.9257

Program Designs and Achievements

The ASSET modeling framework requires very specific information at the measure level on each utilities' program offerings and achievements to date. Elements of information include the following:

- Administrative information, including program start date, end date or changes in codes (if applicable), segment-level availability, and program administrative costs,
- Measure-level incentive data, and
- Program accomplishments data, comprised of annual estimates of measure adoptions and/or measure-level first year energy savings.

These data were collected directly from the participating utilities. To the extent possible, publicly available utility filings like the utilities' quarterly and annual energy efficiency plans and reports were used. In addition, detailed program-level results and impact studies were tapped as necessary to develop relevant information on program accomplishments. Insofar as the primary focus of this study is on the comprehensive set of programs offered in the utilities' service areas, it was also necessary to access filings and reports relating to third-party programs.

The 2000 study used general information regarding IOU conservation programs from 1996 to 2000 in order to identify specific conservation measures for inclusion within the studies as well as to identify levels of achieved program accomplishments. While the analysis for the 2000 study was primarily undertaken in 2001, the study authors and the advisory committee felt that the IOU energy efficiency program accomplishments in 2001 represent a period of "unprecedented changes in energy consumptions and behavior among consumers and businesses in California in response to the energy crisis."[26] The 2000 study's use of a four-year general accomplishment level may have led to the inclusion of measures that may have been absent from a single program year accomplishment, helping to insure completeness. The use of the generalized 1996-2000 program year accomplishments, however, eliminates the impact of the high level of energy conservation achieved in 2001. The decision to use a four-year program average, eliminating the 2001 energy crisis, was based on the well founded conclusion that the energy conservation and implementation of energy efficiency measures associated with the energy crisis would not continue into the future. The energy efficiency program accomplishments achieved in 2002 and 2003, show that their conclusion was well founded. In 2004, the CPUC increased energy efficiency program funding, and energy efficiency program savings goals, leading to an increase in program accomplishments.

The 2004 study uses results from the IOU quarterly filings from 2004 to set current levels of program accomplishments and to determine which measures are included in the forecast of current potential. Restricting the energy efficiency measures to those with reported savings in a single year of program accomplishments limits the list of measures included in the current market forecast. Using program accomplishments from the first year in a cycle of aggressive funding and energy savings goals allows the study to incorporate recent increases in accomplishments, which are explicitly mandated by the CPUC to continue into the foreseeable future.

The level of program accomplishment in 2004 is the model's calibration point. The initial calibration of the model can significantly impact the forecast of market potential. In 2000, the three California IOUs reported energy efficiency program accomplishments of approximately 1,200 GWh of savings. The commercial and industrial sector programs accounted for nearly 70% of the savings, while the residential programs represented most of the remaining 30%.[27] The 2004 study was calibrated to program accomplishments from 2004. In 2004, the three California IOUs claimed approximately 1,800 GWh of energy efficiency savings, with residential programs representing more claimed savings than the commercial and industrial sectors.

The results presented in Sections 4 and 5 indicate that the 2004 study has a higher forecast of current residential market potential and a lower forecast of current commercial market potential than the 2000 study. The higher residential market forecast for the 2004 analysis is substantially influenced by the significant increase in residential program accomplishments reported in 2004. The small reduction seen in the commercial market forecast from the 2004

26 Xenergy, op. cit. July 2002.

27 KEMA-Xenergy, op. cit., April 2003.

study, relative to the 2000 analysis, is influenced by program accomplishments and the long-standing nature of the utilities' commercial energy efficiency programs.

The adoption modeling framework within ASSET allows for a variety of modeling approaches, such as payback requirement curves, diffusion models, and probability share models tempered within a framework of stock accounting. Utility and third-party program accomplishments were used to develop the baseline calibrating estimates of impact by measure. For residential lighting and appliance measures, these estimates were cross-checked against the results of the RMST System.

3.6.3 Customer Data

Customer data include TOU usage profiles, information on segment sizes, and adoption model parameters.

Usage Profiles. Usage profiles were defined for end uses and technologies and are currently characterized in ASSET in terms of energy fractions, peak factors, and coincidence factors for six TOU periods. Usage profiles were developed for the commercial sector using the results of building simulations conducted by Itron for the CEUS project. Residential shapes were obtained from Itron's library of residential end-use profiles. These latter profiles were developed using Itron's proprietary SitePro software system, which uses DOE-2 as an engine.

The 2000 study used energy and peak factors by major IOUs to develop estimates of energy and demand impacts for different time-of-use periods. Data sources for the commercial sector energy and peak factors varied by IOU service territory. For the SDG&E service territory, these factors were developed from a SDG&E EUI study performed by Regional Economic Research, Inc. (RER) in 2000. For PG&E, KEMA used data from PG&E's 1998 Commercial Building Survey. For SCE, a combination of SDG&E and PG&E data was used. For the residential sector, KEMA used information from the CEC forecasting database for non-weather-sensitive measures and interim DOE-2 model-based datasets developed for the 2001 DEER update study, which was performed by KEMA.

Segment Data. Segment data include forecasts of key drivers, such as numbers of residential customers, commercial floorstock, and industrial employment, or value of shipments. Base share estimates of commercial measures were derived from the CEUS study. Commercial floorspace by CEC building type information was obtained from the CEC by year and by forecasting climate zone for both total floorspace and new construction. For the residential sector, housing stock estimates by forecasting climate zone and housing type (single family, multi family, and mobile home) were obtained from the CEC by year for total units and new construction units.

3.6.4 Economic Data

Economic data used in the analysis include discount and inflation rates. The following rates were used in the analysis.

- Discount rate 5%
- Inflation rate 3%

4

Energy Efficiency Potential in Existing Residential Buildings

This section presents the estimates of residential energy efficiency potential in existing homes. Estimated technical, economic, and market potential are presented for the period 2004 through 2016. Market potential was estimated for three scenarios: 1) the current (2004 to 2005) utility program incentive level, 2) program incentives covering full incremental costs, and 3) an "average" scenario with incentives calculated as the average of current program incentives and full incremental costs. The savings potential estimated from the full incremental cost and the average scenarios are presented for two high efficiency measure lists; the smaller measure list includes only measures from the 2004 utility programs and an expanded measure listed which was used to calculate the economic and technical potential. All results are presented as gross total savings associated with cumulative adoptions over the estimation period.[1]

4.1 Overview

Fifty-one electric and 14 gas high efficiency measures and practices were analyzed for the residential analysis. These measures are all commercially available. In the presentation of results below, measures are aggregated into four electric end uses and three gas end uses. Table 4-1 lists the individual measures that correspond to each end use and fuel type in the analysis. All the measures listed in Table 4-1 were analyzed in the technical, economic, full incremental cost market and the average market forecasts. A few of the measures listed in the table were not included in the current market forecast which is dependent on measure savings from the IOU specific energy efficiency programs.[2] Measures are organized around base case technologies.[3] For measures modeled as replace-on-burnout, the base case is the

1 The energy savings potential presented in this forecast are gross savings. They do not contain a baseline or naturally occurring estimate as was done in the 2002/2003 KEMA forecasts. The savings presented in this analysis also have not been reduced by a net-to-gross ratio.

2 Residential programmable thermostats were not included in the residential analysis even though there are reported program accomplishments for 2006. Due to uncertain measure savings, this measure was eliminated from the residential energy efficiency program in 2006.

3 A full listing of residential measures with their base technologies is available in Appendix A.

minimum energy efficiency standard. For measures modeled as retrofit, the base case is the existing technologies found in California homes.

Table 4-1: Residential Measure Descriptions

End Use	Measure Description	Fuel Type
HVAC	Attic Insulation - Add R19 to R38 - Gas Space Heat, CAC	Both
HVAC	Duct Repair - Gas Space Heat, CAC	Both
HVAC	Infiltration Control - Gas Space Heat, CAC	Both
HVAC	Wall Insulation Add R11(blow-in) - Gas Space Heat, CAC	Both
HVAC	Attic Insulation - Add R19 to R38 - Electric Space Heat, CAC	Electric
HVAC	CAC Split/Packaged Tier 1 - SEER 13	Electric
HVAC	CAC Split/Packaged Tier 2 - SEER 14	Electric
HVAC	CAC Split/Packaged Tier 2 - SEER 14 (Low Income CAC)	Electric
HVAC	CAC Split/Packaged Tier 3 - SEER 15	Electric
HVAC	Dual Pane w/U factor less than 0.4	Electric
HVAC	Duct Repair - Electric Space Heat, CAC	Electric
HVAC	HP Split/Packaged Tier 1 - SEER 13	Electric
HVAC	HP Split/Packaged Tier 2 - SEER 14	Electric
HVAC	HVAC Diagnostics	Electric
HVAC	Infiltration Control – Electric Space Heat, CAC	Electric
HVAC	Room A/C SEER=10.3	Electric
HVAC	Room A/C SEER=10.3 (Low Income RAC)	Electric
HVAC	Wall Insulation Add R11(blow-in) – Electric Space Heat, CAC	Electric
HVAC	Whole House Evaporative Cooler	Electric
HVAC	Whole House Fan with CAC	Electric
HVAC	Gas Furnace - 90 AFUE	Gas
HVAC	Gas Furnace - 90 AFUE (Low Income Furnace)	Gas
HVAC	Gas Furnace - 94 AFUE	Gas
Lighting	9-12W CFL Screw-in	Electric
Lighting	13-17W CFL Screw-in	Electric
Lighting	18-22W CFL Hard-wire	Electric
Lighting	18-22W CFL Screw-in	Electric
Lighting	23-26W CFL Hard-wire	Electric
Lighting	23-26W CFL Screw-in	Electric
Lighting	26-50W CFL Hard-wire	Electric
Lighting	26-50W CFL Screw-in	Electric
Lighting	CFL Torchiere replacing a Halogen	Electric
Lighting	CFL Torchiere replacing an Incandescent	Electric
Lighting	Exit Sign - LED Retrofit	Electric
Lighting	Occupancy Sensor	Electric
Lighting	Photocell	Electric

Table 4-1 (cont'd.): Residential Measure Descriptions

End Use	Measure Description	Fuel Type
Lighting	R30 CFL R30 Reflector	Electric
Lighting	R40 CFL R40 Reflector	Electric
Miscellaneous	Efficient Clothes Dryer, 416 Cycles	Electric
Miscellaneous	Efficient One-Speed Pool Pump	Electric
Miscellaneous	Efficient Two-Speed Pool Pump	Electric
Miscellaneous	Efficient Clothes Dryer, 416 cycles	Gas
Miscellaneous	Freezer Recycling	Electric
Miscellaneous	Refrigerator Recycling	Electric
Miscellaneous	Refrigerator, ENERGY STAR 18 cf Side-Mount Freezer	Electric
Miscellaneous	Refrigerator, ENERGY STAR 18 cf Side-Mount Freezer (Low Income REF)	Electric
Water heating	Clothes Washer Electric Water Heater, 2.65 Capacity MEF=1.42	Electric
Water heating	Clothes Washer Electric Water Heater, 2.65 Capacity MEF=1.60	Electric
Water Heating	Dishwasher - Electric Water Heater, 215 wash cycles EF=0.58	Electric
Water Heating	Electric Water Heater EF=0.93	Electric
Water Heating	Point-of-Use Water Heater	Electric
Water Heating	Faucet Aerator	Electric
Water Heating	Low Flow Showerhead	Electric
Water Heating	Pipe Wrap	Electric
Water Heating	Water Heater Wrap	Electric
Water Heating	Clothes Washer - Gas Water Heater & Dry, 2.65 Capacity MEF=1.42	Gas
Water Heating	Clothes Washer - Gas Water Heater & Dry, 2.65 Capacity MEF=1.60	Gas
Water Heating	Dishwasher - Gas Water Heater, 215 wash cycles EF=0.58	Gas
Water Heating	Faucet Aerator	Gas
Water Heating	Gas Water Heater EF=0.63	Gas
Water Heating	Point-of-Use Water Heater	Gas
Water Heating	Low Flow Showerhead	Gas
Water Heating	Pipe Wrap	Gas
Water Heating	Water Heater Wrap	Gas
Water Heating	Water Heater/Boiler Controllers	Gas

The analysis was conducted for three housing types (single family, multifamily and mobile homes), 21 electric climate zones, and 23 natural gas climate zones (16 CEC Title 24 zones further divided into unique utility service areas). In addition, the analysis of market potential considered three incentive scenarios and two permutations of high efficiency measure lists. In the presentation of results below, these scenarios are referred to as current, full incremental measure cost, and average.

4.2 Electric Efficiency Potential in Existing Residential Buildings

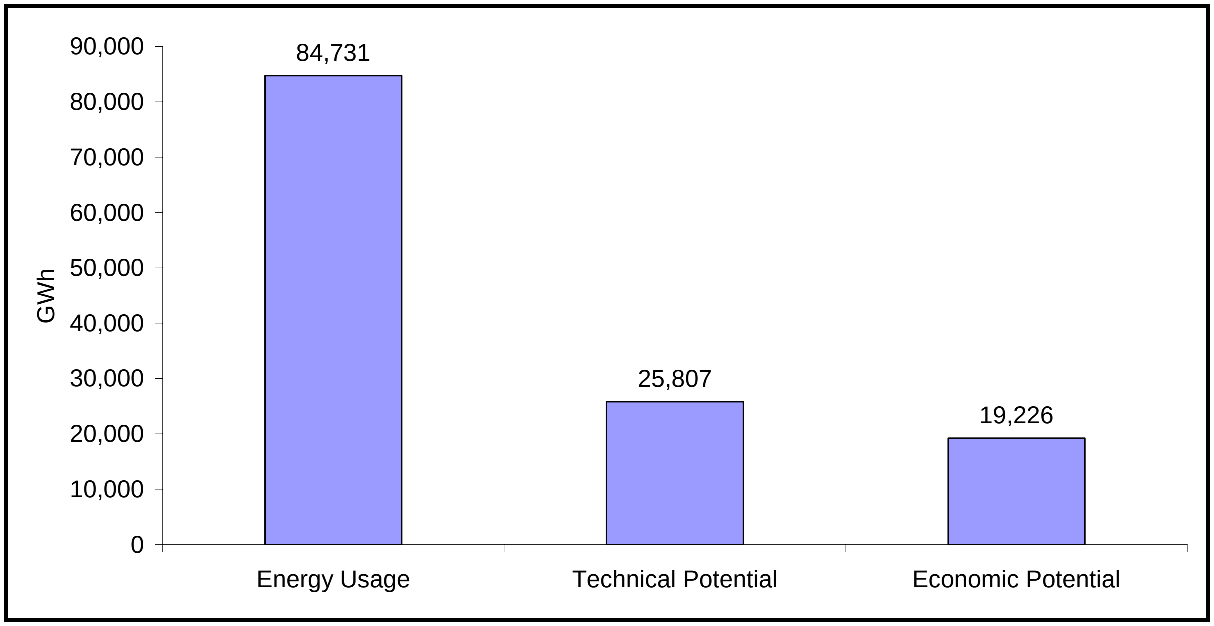
4.2.1 Residential Technical and Economic Potential

Total Residential IOU Technical and Economic Potential

Figure 4-1 and Figure 4-2 present the total estimated electric energy and demand savings potential resulting from the analysis for the three state investor-owned electric utilities: Pacific Gas & Electric (PG&E), Southern California Edison (SCE), and San Diego Gas & Electric (SDG&E). Also shown in these figures is the forecasted electricity use and demand for these utilities, as estimated by the California Energy Commission (CEC).[4] The values are provided for 2016, the last year of the analysis.

As shown in Figure 4-1, total estimated electric technical potential for energy savings is 25,807 GWh, and total estimated electric economic potential is 19,226 GWh. Figure 4-2 shows total estimated technical potential for demand reduction to be 5,365 MW, and total estimated economic potential for demand reduction to be 2,729 MW. The technical potential is about 30% of the expected energy sales and about 25% of the expected demand in 2016. Economic potential is about 23% of the expected energy sales and about 12% of the expected demand in 2016.

Figure 4-1: Forecasted Electricity Use and Total IOU Gross Energy Savings – Technical and Economic Potential for Existing Residential Buildings – 2004-2016



[4] California Energy Commission. *California Energy Demand 2006-2016: Staff Energy Demand Forecast.* June 2005.

Figure 4-2: Forecasted Electricity Demand and Total IOU Gross Demand Savings – Technical and Economic Potential for Existing Residential Buildings – 2004-2016

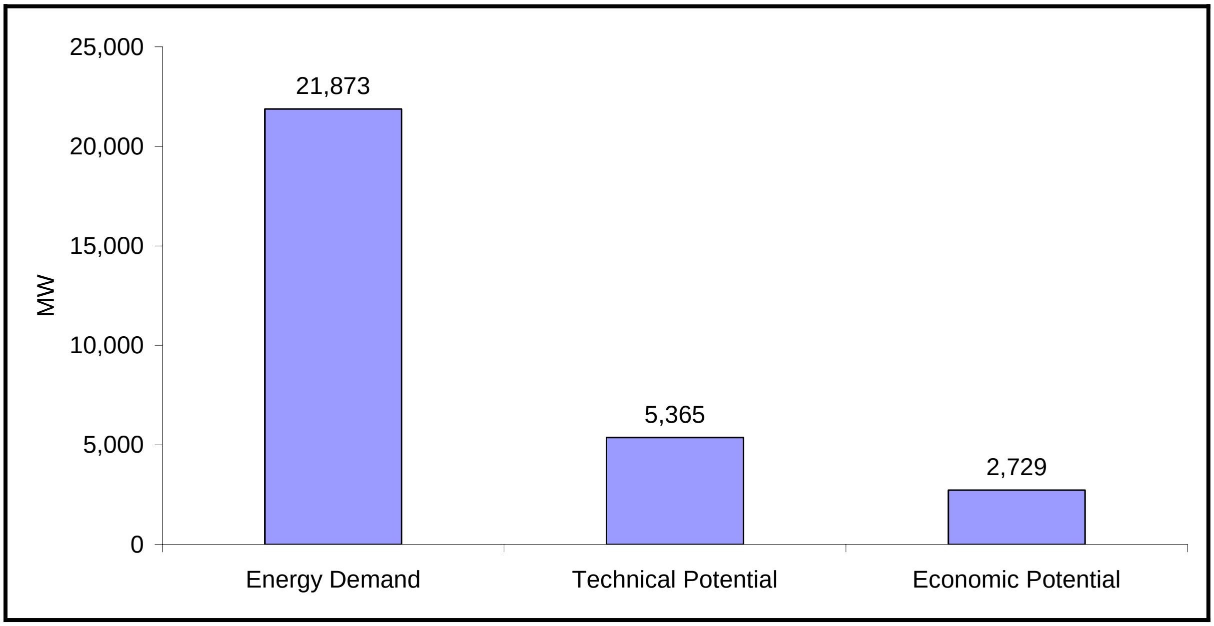


Table 4-2 summarizes the CEC energy and demand forecasts for 2016 by utility service area.[5]

Table 4-2: California Energy Commission's Electricity Forecast – 2004-2016

PG&E		SCE		SDG&E		Total	
GWh	MW	GWh	MW	GWh	MW	GWh	MW
40,428	9,994	35,837	10,240	8,466	1,639	84,731	21,873

Electric energy and demand savings potentials, disaggregated by utility service area, are presented in Figure 4-3 and Figure 4-4 along with the CEC energy and demand forecasts for 2016. These figures illustrate that technical and economic potential is highest for the PG&E service area, although results for the SCE utility area are a close second. In terms of percent of forecasted energy use, the largest percentage of both technical and economic potential to forecasted energy usage is in the SDG&E service territory, followed closely by SCE and PG&E, respectively. The SDG&E service territory also had the largest shares of potential demand savings with technical demand savings potential at 35% of forecasted usage and economic demand savings potential at 17% of forecasted usage. PG&E and SCE had lower shares of potential demand savings to forecasted demand.

5 Ibid. Forms 1.1 and 1.3.

Figure 4-3: Forecast Electricity Use and Estimated Gross Technical and Economic Energy Potential by Utility for Existing Residential Buildings – 2004-2016

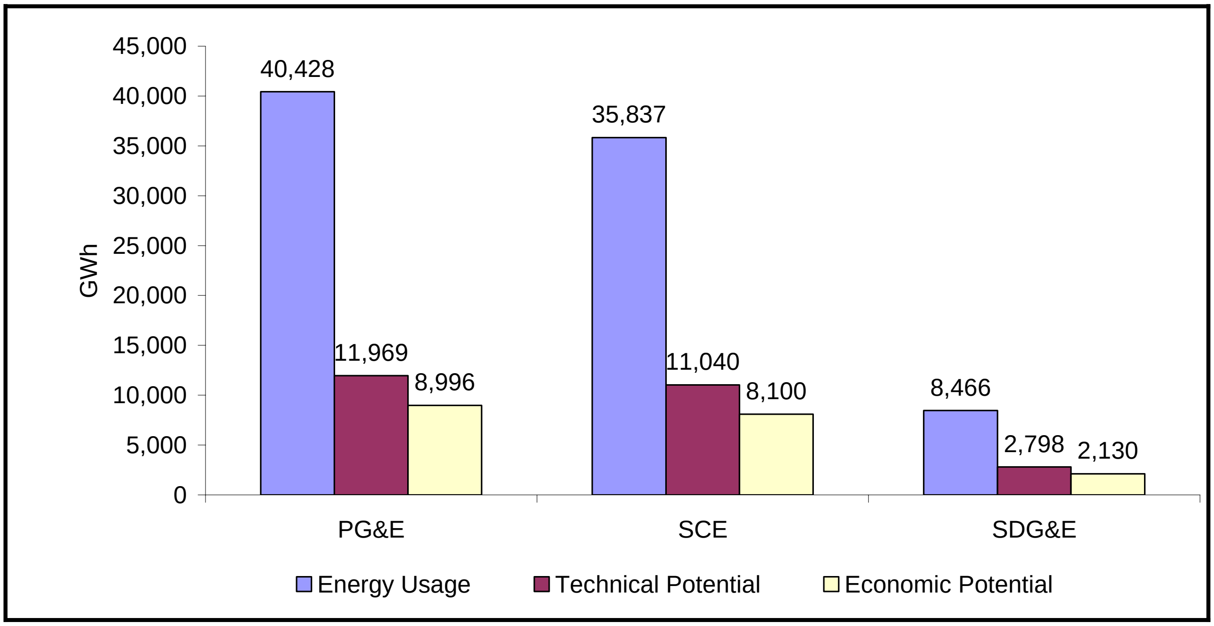
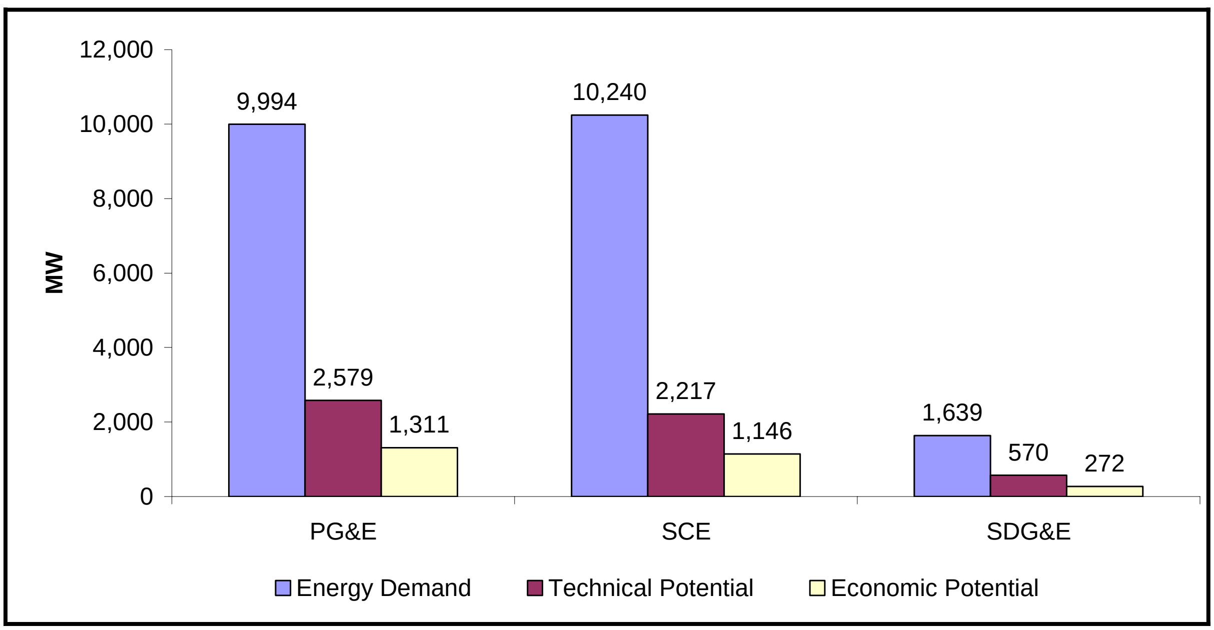


Figure 4-4: Forecast Electricity Demand and Estimated Gross Technical and Economic Demand Potential by Utility for Existing Residential Buildings – 2004-2016



Technical and Economic Potential for Existing Residential Buildings by End Use

Table 4-3 summarizes the technical potential results for 2016 by end use and by utility. The end use "miscellaneous" includes high efficiency refrigeration, freezer and refrigerator recycling, dryers, and pool pumps. As shown, the largest contributor to energy savings is high efficiency lighting, followed by miscellaneous and HVAC measures. For demand savings, the largest contributor is HVAC measures followed distantly by lighting and miscellaneous measures.

Table 4-3: Technical Gross Potential by End Use and Utility for Existing Residential Buildings – 2004-2016

End Use	PG&E		SCE		SDG&E		Total	
	GWh	MW	GWh	MW	GWh	MW	GWh	MW
HVAC	2,128	1,516	2,419	1,269	443	312	4,990	3,096
Lighting	5,825	552	5,072	481	1,433	136	12,330	1,169
Miscellaneous	3,663	475	3,350	447	867	117	7,880	1,039
Water Heating	352	36	199	20	55	5	606	62
Total	**11,969**	**2,579**	**11,040**	**2,217**	**2,798**	**570**	**25,807**	**5,365**

Table 4-4 summarizes the economic potential results by end use and by utility. As shown, the largest contributor to economic energy savings is lighting measures, followed by miscellaneous. For demand savings, the largest contributor is lighting measures followed closely by HVAC and miscellaneous measures.

Comparing the technical energy potential with the economic energy savings potential shows that 98% of lighting technical energy savings potential is economic and 72% of the technical energy savings from miscellaneous measures is economic. For HVAC measures, only 24% of technical energy savings and 26% of technical demand savings passes an economic test. Recent increases in federal energy efficiency standards for central air conditioners and heat pumps have led to lower HVAC economic potential energy savings. The replacement of a 10 SEER central air conditioner that burns out with a 13 SEER unit, passes an economic test in some climate zones, but the replacement of a base 13 SEER unit with a 14 SEER unit does not pass at current measure costs and avoided cost benefits. If avoided costs rise and the cost of higher efficiency units decline, the economic performance of central air conditioners will improve.

Table 4-4: Economic Gross Potential by End Use and Utility for Existing Residential Buildings – 2004-2016

End Use	PG&E		SCE		SDG&E		Total	
	GWh	MW	GWh	MW	GWh	MW	GWh	MW
HVAC	465	408	677	345	72	52	1,215	805
Lighting	5,728	543	4,902	465	1,426	135	12,056	1,143
Miscellaneous	2,629	346	2,422	328	602	82	5,654	757
Water Heating	174	14	99	8	29	2	302	24
Total	**8,996**	**1,311**	**8,100**	**1,146**	**2,130**	**272**	**19,226**	**2,729**

Figure 4-5 and Figure 4-6 illustrate the above results.

Figure 4-5: Total IOU Technical and Economic Gross Energy Potential by End Use for Existing Residential Buildings – 2004-2016

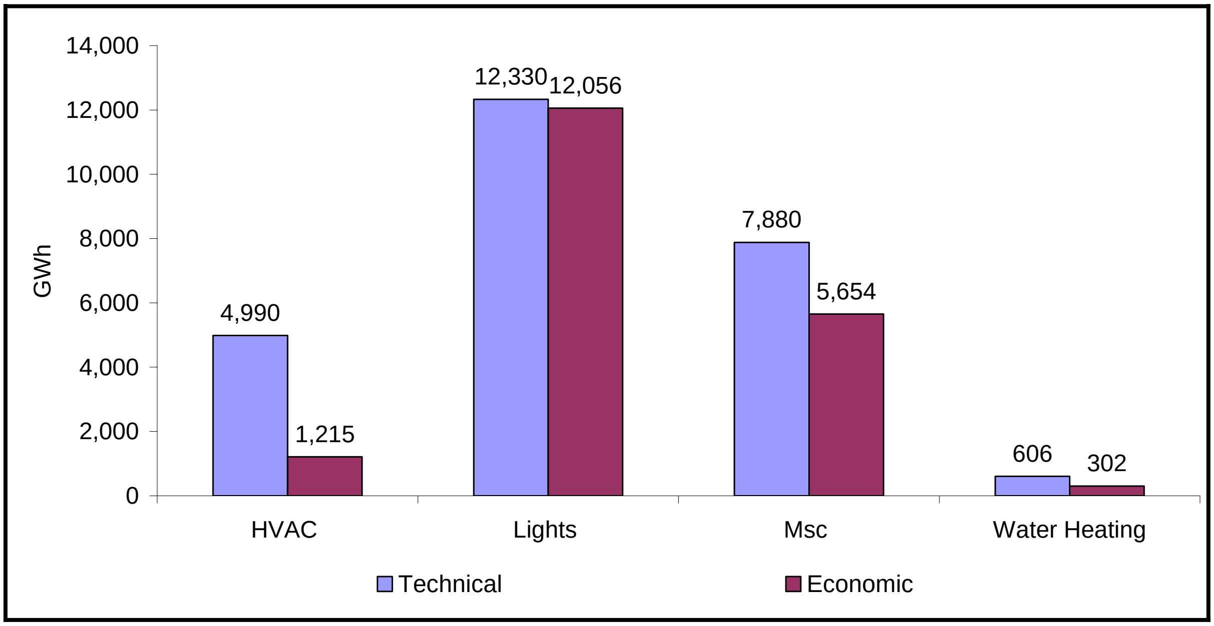


Figure 4-6: Total IOU Technical and Economic Gross Demand Potential by End Use for Existing Residential Buildings – 2004-2016

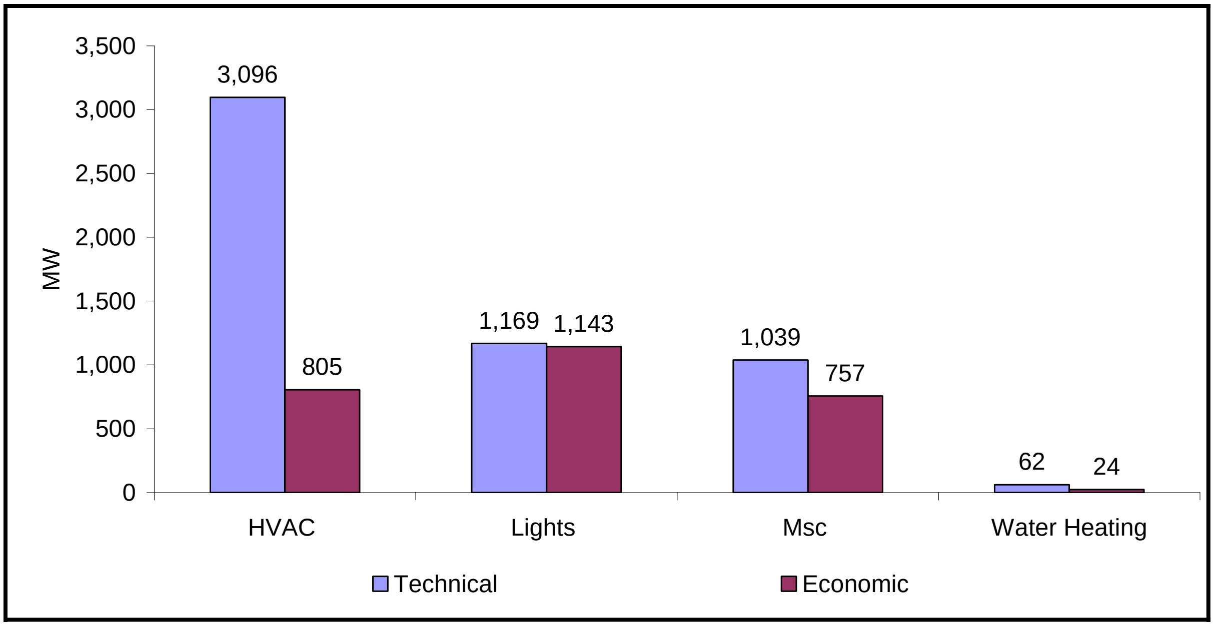


Figure 4-7 and Figure 4-8 present estimates of technical potential at the grouped measure level and in order of descending potential for energy and demand savings, respectively. As shown in Figure 4-7, grouping all screw-in CFLs into one measure group results in CFLs contributing more than twice the technical energy savings contributed by the next highest measure group (refrigerator recycling). After these two highest contributors, measure groups contributing the next largest amount of energy savings (in decreasing order) include hard-wired CFLs, high efficiency refrigerators, high efficiency pool pumps, and central air conditioners.

For demand savings, Figure 4-8 shows that central air conditioners contribute slightly more energy savings than CFLs or windows. After these three highest contributors, measure groups contributing the next largest amount of energy savings (in decreasing order) include HVAC diagnostics and refrigerator recycling.

Figure 4-7: Total Technical Gross Energy Savings by Measure for Existing Residential Buildings – 2004-2016

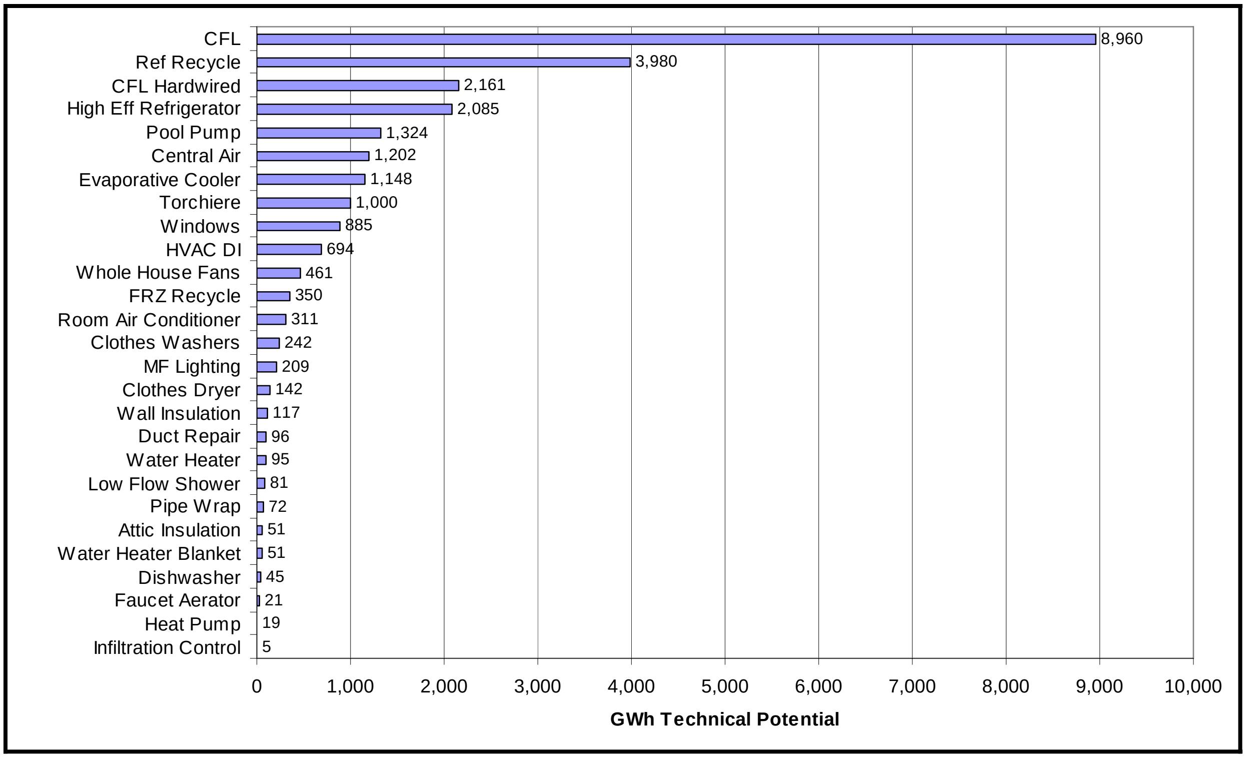
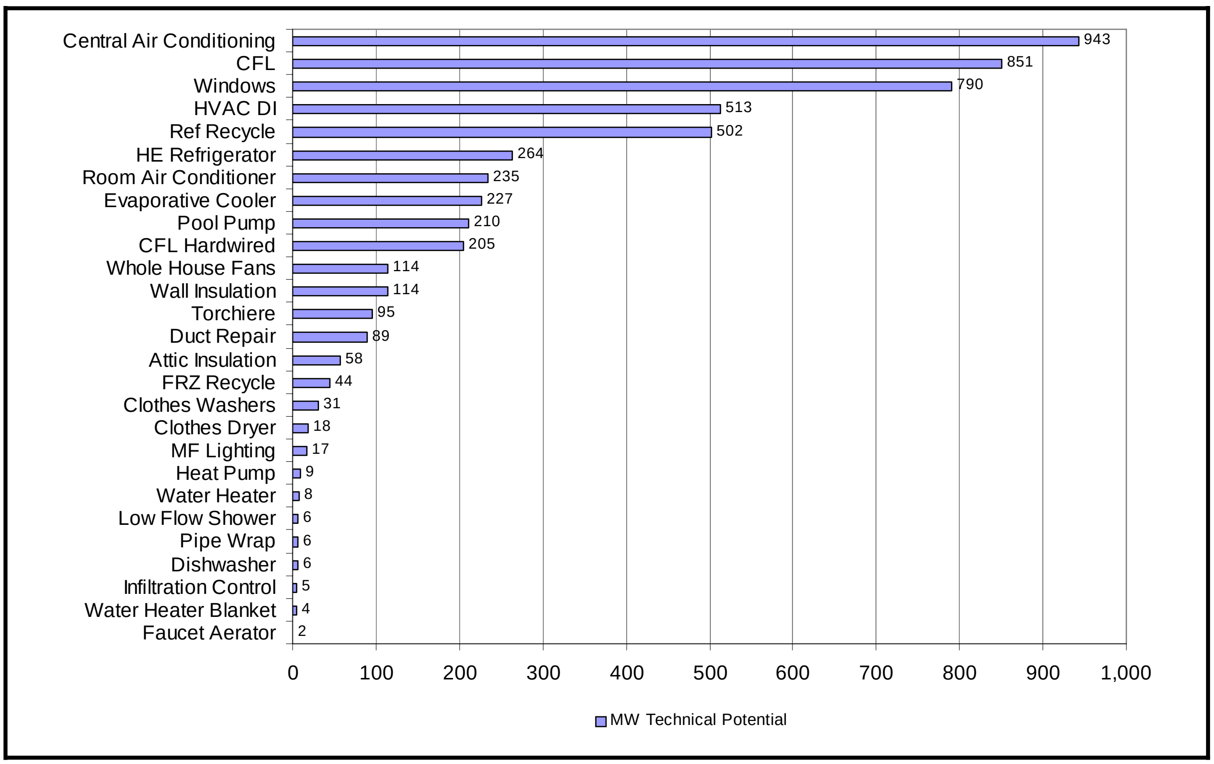


Figure 4-8: Total Technical Gross Demand Savings by Measure for Existing Residential Buildings – 2004-2016



4.2.2 Residential Market Potential for Energy Efficiency

In this subsection, the results for residential existing homes electric potential are further analyzed under three program incentive scenarios and two measure lists. Results were derived for the current 2004-2005 energy efficiency program incentive funding level, for a full incremental cost incentive funding level, and for an average incentive scenario representing the average between current and full incremental cost incentives. Results for the current funding level are restricted to measures included in the 2004 IOU specific energy efficiency programs. Potential savings estimates for the full incremental cost and the average scenario are presented for the full measure list and for the measure list restricted to measures included in the 2004 IOU specific energy efficiency programs. Table 4-5 describes the residential market scenarios for existing homes. Table 4-6 lists the measures not analyzed in the current, average-2004 measures, and full-2004 measure, but added to the full and average scenario estimates.

Table 4-5: Market Scenario Descriptions for Existing Residential Buildings

Market Scenario Name	Description
Current	2004 incentive level, restricted to IOU specific measures incentivized in 2004. For measures experiencing standards changes in 2006, the rebate level changes in 2006. For low income measures, the current rebate is full incremental measure cost.
Average - 2004 Measures	Average between current and full incremental cost incentive levels with the measure list restricted to those incentivized in 2004.
Average	The average between current and full incremental cost incentive levels with all the measures analyzed in the technical and the economic scenarios.
Full-2004 Measures	Full incremental measure cost with the high efficiency measure list restricted to those incentivized in 2004.
Full	Full incremental measure cost incentive levels with all the measures analyzed in the technical and the economic scenarios. For retrofit and conversion measures a working measure is replaced, therefore the full incremental measure cost is the cost of the measure. For replace on burn out measures the full incremental measures cost is the incremental cost between the low and high efficiency measure.

The estimate of the market potential under current funding levels includes all high efficiency measures with IOU-specific program accomplishments in 2004. The estimate of savings potential is calibrated to the IOU measure-specific accomplishments of 2004. The forecast of the current market energy savings potential is an estimate based on the assumption that the IOU programs continue to rebate the current list of measures at the current incentive levels.

Table 4-6: Measures Added for the Average and Full Incremental Cost Incentive Level Forecasts by Utility for Existing Residential Homes[6]

Measure	PG&E	SCE	SDG&E
Occupancy Sensors	Added	Added	Existing
Photo Cells	Added	Existing	Existing
ENERGY STAR Refrigerators	Added	Existing	Existing
Clothes Washers	Existing	Added	Existing
Dish Washers	Existing	Added	Existing
Dryer	Added	Added	Added
HVAC Diagnostics	Added	Added	Added
Instantaneous Water Heater	Added	Added	Added

Estimates of market potential for the full-2004 measures and the average-2004 measures restrict the measures analyzed to those included in the 2004 IOU-specific programs. These analyses are calibrated to the 2004 measure specific adoptions. These analyses estimate the remaining market potential for measures incentivized in 2004, if incentive levels are increased in 2006.

Estimates of market potential under full and the average scenario incentive levels include all of the residential measures analyzed in the economic and technical potential. Measures added to the 2004 IOU specific accomplishments include measures with program accomplishments for one or two of the three California IOUs and high efficiency measures chosen through a consultation of Itron and the project advisory committee (PAC).[7] This consultation led to the addition of three high efficiency residential measures, which were not included in the IOU residential 2004 program accomplishments: high efficiency electric dryers, HVAC diagnostics, and instantaneous water heaters. Table 4-6 lists the measures included in the economic, technical, full, and average incentive level analyses that were not incentivized in 2004. The full and average incentive estimates of market potential represent the forecast of the remaining energy efficiency potential associated with higher funding levels due to higher rebates and a larger list of measures.

The current, full-2004 measures, and average-2004 measures analyses are calibrated to the measure-specific program accomplishments of 2004. For the added measures in full

6 Measures with "Existing" were present in the utility 2004 residential energy efficiency program accomplishments, while measures "Added" were not present in the utility 2004 programs. Measures that were existing were calibrated to actual program accomplishments. Measures that were added were calibrated using professional judgment.

7 Itron, Inc. *WP#1: California Statewide Energy Efficiency Summary Study: Review of Existing Forecasts and Data Inputs Working Paper.* Prepared for Pacific Gas & Electric and the Energy Efficiency Project Advisory Group. August 2004.

incremental cost and average incentive level analysis, starting points or calibration targets were derived by analyzing the calibration level of the same measure at another IOU or by comparing similar measures within the utility. The full increment cost or average scenario-level rebates are implemented in 2006.

As shown in Table 4-7, total IOU market potential under the current funding scenario is 8,445 GWh energy savings and 1,161 MW demand savings. Energy savings under the average-2004 measure scenario increased to 9,649 GWh. If program incentives are increased to cover full incremental costs, energy savings increased another 14% over the restricted average level to 11,036 GWh.

Increasing the measure list and setting the incentive equal to the average of current and full incremental cost led to 10,309 GWh of estimated energy savings potential. The estimate of average scenario potential represents a 22.1% increase over the current estimate of market potential. Comparing the average scenario results with the full incentive forecast shows that increasing the level of rebates led to an additional 14% increase in potential energy savings to 11,757 GWh.

Increasing incentives from their current levels to the average-2004 measures scenario, increased demand savings 24% to 1,434 MW. Increasing incentives from the current levels to the average level and augmenting the list of measures increased demand savings by 57% to 1,827 MW. When program incentives are further increased to cover full incremental costs, additional demand savings of 26% are forecast under the 2004 list of measures and 22% under the augmented list of measures.

Augmenting the measures list added significantly to estimates of energy and demand savings. Among the added measures, HVAC diagnostics was the largest contributor to energy and demand potential savings.

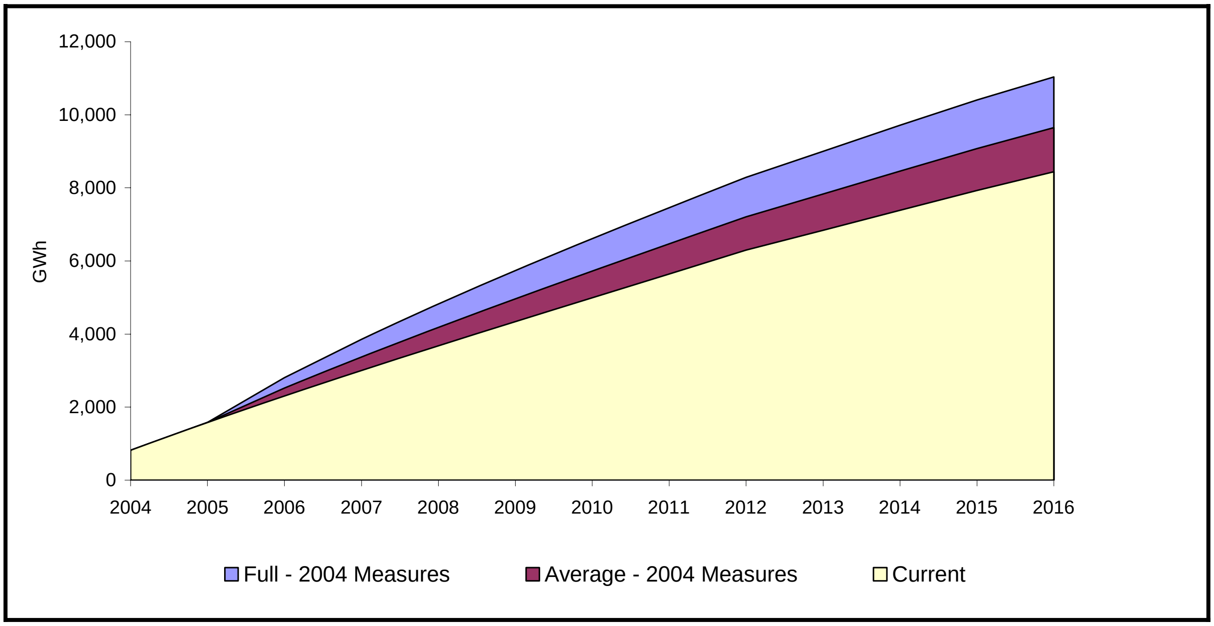
Table 4-7: Estimated Gross Market Potential by Funding Level for Existing Residential Buildings – 2004-2016

Funding Level	Energy (GWh)	Demand (MW)
Current	8,445	1,161
Average-2004 Measures	9,649	1,434
Average	10,309	1,827
Full-2004 Measures	11,036	1,805
Full	11,757	2,233

* Refer to Table 4-5 for a description of the market funding scenarios.

The results for the current measures, average 2004 measures, and full 2004 measures scenarios are illustrated in Figure 4-9 and Figure 4-10. These graphs illustrate the yearly estimate of market potential from cumulative adoptions, assuming that the mix of measures is consistent with the 2004 IOU quarterly filings.[8] Adding the additional measures listed in Table 4-6 leads to the non-restricted results presented in Table 4-7.

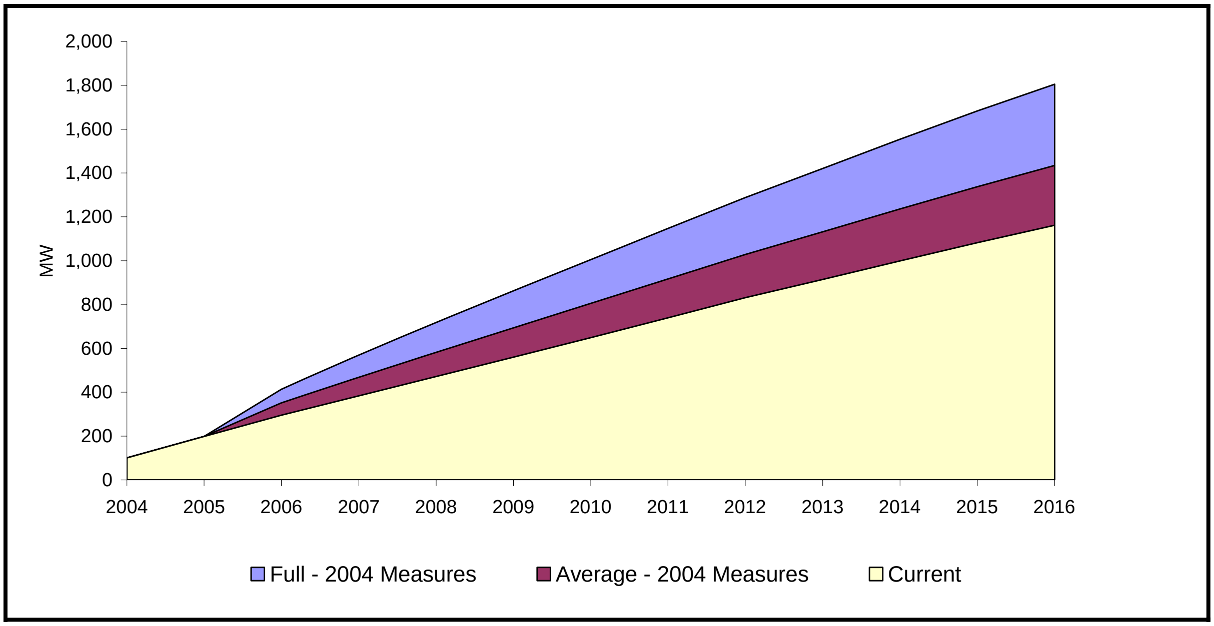
Figure 4-9: Estimated Gross Energy Market Potential by Funding Level for Existing Residential Buildings – 2004-2016



* Refer to Table 4-5 for a description of the market funding scenarios.

8 The results presented in this section are gross program savings estimates. The savings estimates have not been reduced by a net-to-gross ratio and there is no baseline estimate of savings forecast.

Figure 4-10: Estimated Gross Demand Market Potential by Funding Level for Existing Residential Buildings – 2004-2016



* Refer to Table 4-5 for a description of the market funding scenarios.

Market Potential by End Use for Existing Residential Buildings

Table 4-8 summarizes the energy market potential estimates by funding level and end use. For comparison, technical and economic estimates are also included. Table 4-9 presents similar results for peak demand reduction. Increasing funding for HVAC, miscellaneous, and water heater measures from current funding levels to full incremental cost, while maintaining the 2004 measure list, increases energy savings by 150%, 36%, and 58%, respectively. Adding the additional measures listed in Table 4-6 would further increase energy savings for HVAC by 542 GWh, miscellaneous by 144 GWh, and water heating by 31 GWh.

Increasing funding for lighting measures in existing residential homes from current funding levels to full incremental measure cost increases energy savings by only 15%. At current rebate levels, the payback period for residential CFLs is less than a year. Given the short payback period associated with the current rebate level, it is not surprising that increasing funding to full incremental costs, does not lead to a substantial increase in energy savings.

Table 4-8: Estimated Gross Market Energy Potential by Funding Level and End Use for Existing Residential Buildings – 2004-2016 (GWh)

	Technical (GWh)	Economic (GWh)	Current (GWh)	Average 2004 Measures (GWh)	Average GWh	Full 2004 Measures (GWh)	Full (GWh)
HVAC	4,990	1,215	512	822	1,325	1,279	1,821
Lighting	12,330	12,056	5,008	5,355	5,358	5,770	5,774
Misc.	7,880	5,654	2,855	3,377	3,512	3,875	4,019
Water Ht.	606	302	71	94	114	112	143
Total	**25,807**	**19,226**	**8,445**	**9,649**	**10,309**	**11,036**	**11,758**

* Refer to Table 4-5 for a description of the market funding scenarios.

Table 4-9: Estimated Gross Market Demand Potential by Funding Level and End Use for Existing Residential Buildings – 2004-2016 (MW)

	Technical (MW)	Economic (MW)	Current (MW)	Average 2004 Measures Potential (MW)	Average (MW)	Full 2004 Measures (MW)	Full (MW)
HVAC	3,096	805	312	483	856	750	1,156
Lighting	1,169	1,143	476	509	509	548	548
Misc.	1,039	757	366	432	449	494	512
Water Ht.	62	24	8	11	13	13	17
Total	**5,365**	**2,729**	**1,161**	**1,434**	**1,827**	**1,805**	**2,233**

* Refer to Table 4-5 for a description of the market funding scenarios.

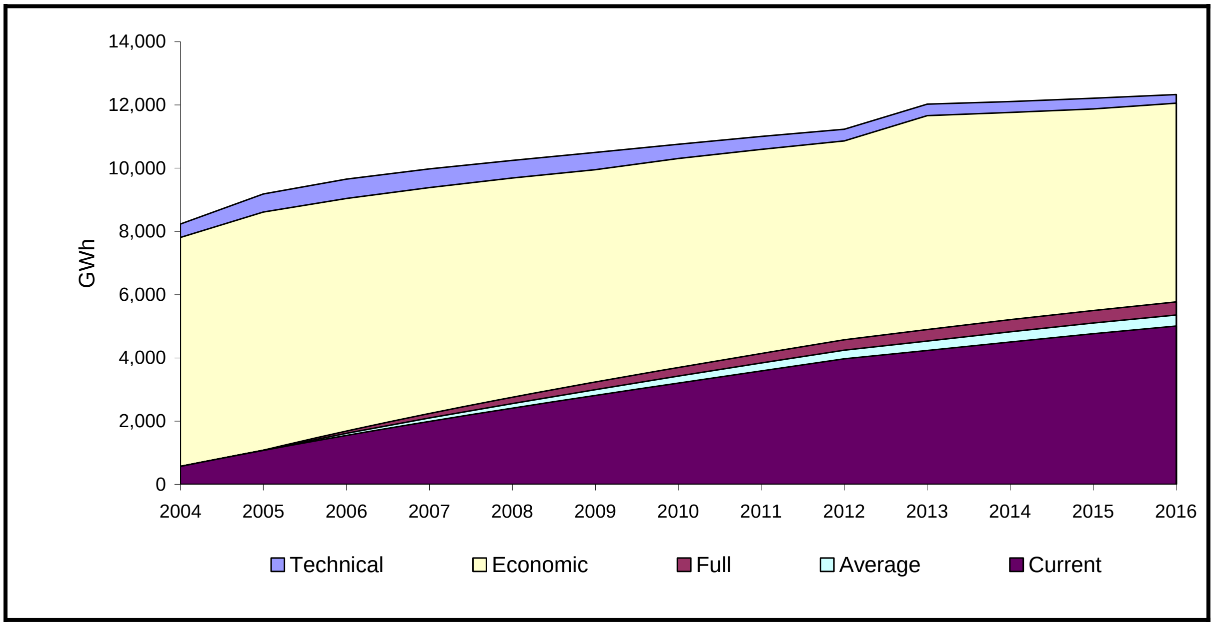
4.2.3 Existing Residential Lighting

This subsection provides a more detailed look at the results for lighting measures. There are unique characteristics of residential CFLs and the existing residential homes lighting programs that have led Itron to provide additional detail on the modeling process and the estimated market potential. Existing residential home lighting measures provided a significant contribution to current IOU residential program accomplishments and to estimated energy efficiency potential.

The short lifetimes of CFL bulbs relative to the forecast period, the importance of the market for residential CFLs at the beginning of the forecast period, and the payment of rebates for replacement CFLs required a customized modeling strategy for this end use. Three models were used to forecast energy efficiency potential: a conversion model, a replace-on-burnout model, and a new construction model.[9] Since CFL bulbs have lifetimes shorter than the forecast period, bulbs adopted prior to and during the early years of the forecast period needed to be replaced during the forecast period. The replace-on-burnout model explicitly models these replacements assuming a high percentage of replacement in-kind. The energy savings resulting from this type of model are similar to estimates from models that assume exceptionally long lifetimes or automatic readoption for CFLs (e.g., in the 2002/2003 KEMA studies measures with lifetimes less than 20 years were automatically readopted). The added benefit of using the replace-on-burnout model, however, is that the model allows for the replacement of CFLs that burn out before the end of the forecast period, resulting in a more realistic forecast of CFL adoptions, measure costs, and the incentives required to achieve the forecasted adoptions.

Figure 4-11 illustrates the aggregate statewide residential lighting potential under alternative funding levels for 2004 through 2016. The figure shows that increasing incentives from the current level to the average (average of the current incentive and a full incremental cost incentive) results in only a slight increase (7%) in energy savings over the forecast period. Similarly, ramping up to the full incentive level increases energy savings only by another 8% from savings resulting from the average incentives. Even at a full incremental cost incentive level, the market potential falls far short of the economic or technical potential forecast.

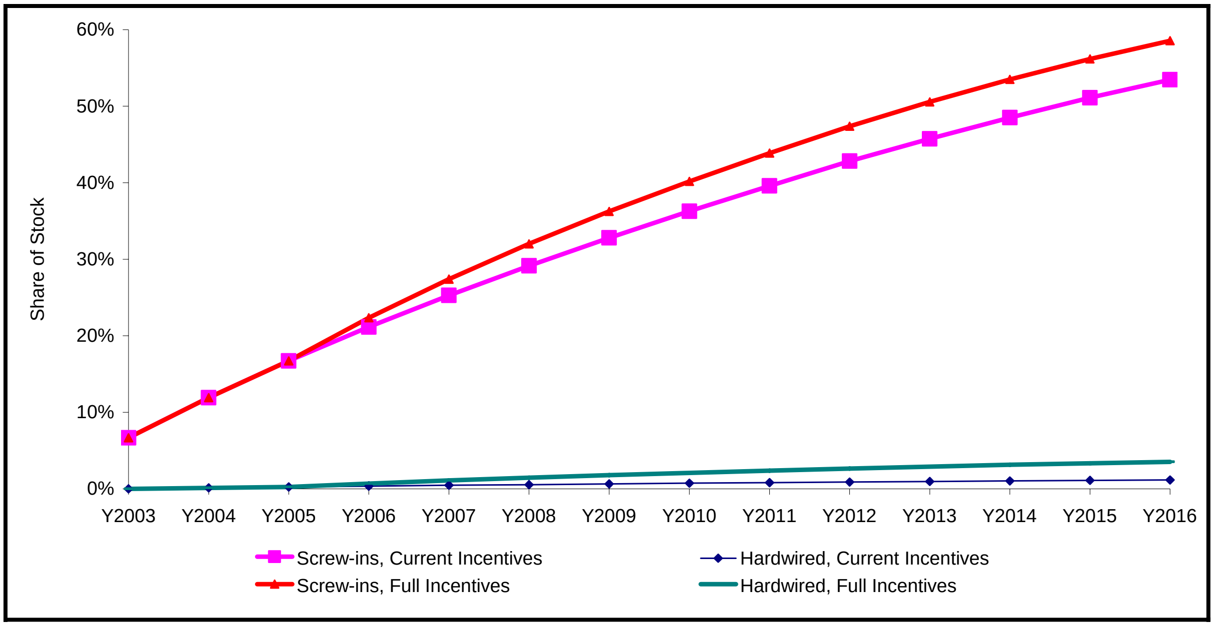
Figure 4-11: Estimated Residential Lighting Energy Potential by Funding Level



9 The forecast for residential torchieres used only a conversion model while the forecast for multifamily exit signs, multifamily photocells, and multifamily occupancy sensors were modeled only as retrofit measures. Potential for all other lighting measures was estimated using all three models.

The aggregate lighting results presented in Figure 4-11 mask some interesting lighting findings. For example, consider the lighting group that contains 18- to 22-watt CFL screw-ins and 18- to 22-watt CFL hard-wired fixtures, which compete with 75-watt incandescents. Figure 4-12 illustrates the distribution of the lighting stock between the two high efficiency measures for this group under the current and full incremental cost funding levels.

Figure 4-12: Estimated Percentage Stock for 18- to 22-Watt CFL Screw-Ins and Hard-Wired Fixtures in Existing Residential Homes



In 2003, the assumed base share for the 18- to 22-watt screw-in CFLs was 7%, with the remaining 93% of stock for this competition group consisting of 75-watt incandescent bulbs. Assuming the utilities continue with current incentive levels, the share of the CFL screw-ins is estimated to grow to 54% of the stock for this competition group by the year 2016, while hard-wired fixtures grew to 1%, adding to a total efficiency share of the stock of 55%. Assuming utilities increase incentives to full incremental measure costs, the statewide share of CFL screw-ins is estimated to grow to 59% of the stock of bulbs for this competition group while hard-wired fixtures grow to 3%, adding to a total efficiency share of the competition group stock of 62%. The estimate of 18- to 22-watt CFL penetration differed significantly by utility area. Under full incremental cost incentives, the potential for this lighting group ranged from 56% to 84% of the stock of bulbs for this competition group, depending on utility area. Thus, the estimate of the share of the stock of bulbs in this competition group that will be CFL by 2016 is as high as 84%, although statewide that average drops to 62%.

For the remaining lighting competition groups, Table 4-10 presents the percentages of the lighting stock, by competition group, that contain high efficiency lighting measures in 2004 and the estimates for 2016. The results are listed by lighting competition groups in 2004 and in 2016 under alternative funding levels. These results show that the smallest CFL competition group is forecast to have only 5% of the stock in 2016, while 40-watt incandescents maintain 95% of the stock of bulbs in this competition group. This result is in marked contrast to the results for the two largest CFL competition groups. The larger CFL competition groups are estimated to capture more than 70% of the lighting stock in their competition group under current incentives, increasing to more than 75% under full incentives.

Table 4-10: Estimated High Efficiency Stock Share by Competition Group and Funding Level for Existing Residential Buildings

Competition Group	High Efficiency Lighting Stock Share 2004	High Efficiency Lighting Stock Share 2016 Current Incentives	High Efficiency Lighting Stock Share 2016 Full Incentives
40-watt incandescent 9- to 12-watt CFL bulbs	7%	5%	6%
60-watt incandescent 13- to 17-watt CFL bulbs	9%	30%	36%
100-watt incandescent 23- to 26-watt CFL bulbs	18%	69%	70%
100-watt incandescent 23- to 26-watt CFL Hardwired fixture	0%	2%	4%
Total 23- to 26-watt CFL Penetration	19%	71%	74%
150-watt incandescent 26- to 50-watt CFL bulbs	15%	51%	51%
150-watt incandescent 26- to 50-watt CFL Hardwired fixture	3%	20%	26%
Total 26- to 50-watt CFL Penetration	18%	71%	77%

The results presented in Table 4-10 show that there is a significant distribution of achievement within the lighting group. Under current incentives, the larger wattage CFLs are forecast to capture over 70% of the stock of lighting within their competition group, while the 9- to 12-watt CFL group is estimated to represent only 5% of its competition group's lighting stock.

The lighting results are impacted by the short payback period and the IOU wattage-specific program accomplishments from 2004. The utility accomplishments were used to calibrate the model. Utility 2004 quarterly filings showed that current program design, coupled with current technologies, have led households to adopt larger wattage CFLs more rapidly than lower wattage CFLs. The model results indicate that the continuation of current incentive levels will cause larger wattage CFLs to dominate their incandescent competition by 2016, while lower wattage CFLs will remain a niche market. Increasing measure rebates to full incremental cost marginally increases the percentage of the market dominated by larger wattage CFLs but it does not significantly change the market penetration of lower wattage CFLs.[10]

4.2.4 Electric Cost and Benefit Results for Existing Residential Buildings

Table 4-11 presents a summary of the costs, savings, and benefit-to-cost ratios for three of the market potential funding scenarios.

Table 4-11: Summary of the Electric Market Potential Results for Existing Residential Buildings – 2004-2016

Item	Current	Average	Full
Gross Program Costs	$101,593,868	$125,481,099	$149,350,098
Net Measure Costs	$1,871,876,432	$3,128,023,800	$4,473,299,926
Gross Incentives	$1,471,506,688	$2,704,205,291	$5,239,323,202
Net Avoided Cost Benefit	$3,726,813,980	$4,891,134,045	$5,760,643,295
Program TRC	1.89	1.50	1.25

* Refer to Table 4-5 for a description of the market funding scenarios.

The results show that all three funding levels result in cost-effective programs based on the TRC test, with benefit-cost ratios ranging from 1.25 to 1.89.[11] Utility-specific TRC test results are presented below.

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[10] The lighting results are calibrated to the 2004 IOU-specific residential program accomplishments. The utility accomplishments for 2004 show substantial adoptions of high wattage CFLs and few adoptions for low wattage CFLS. As the high wattage market becomes saturated with CFLs, the low wattage bulbs may become increasingly important in the utility programs. The forecast of continued low penetration for low wattage CFLs is based on current program results. Changes in the design of utility programs to encourage consumer acceptance of low wattage CFLs may lead to a higher penetration than is currently forecast.

[11] For the full cost forecast, incentives exceed measures costs because the incentives are gross while the measure costs are net and incentives are paid to recycle refrigerators and freezers, which have no measure costs.

4.2.5 Residential Utility-Level Potential, Benefits, and Costs

In this subsection, the technical, economic, and market potential are presented over time at the utility level. The utility-specific costs, savings, and TRC test results are listed below.

Figure 4-13, Figure 4-14, and Figure 4-15 and Table 4-12, Table 4-13, and Table 4-14 illustrate and list the potential energy savings for the current, average, full incremental cost, economic, and technical forecasts for PG&E, SCE, and SDG&E, respectively. Figure 4-16, Figure 4-17, and Figure 4-18 and Table 4-15, Table 4-16, and Table 4-17 illustrate the potential demand savings for PG&E, SCE, and SDG&E, respectively. These figures illustrate the energy efficiency potential achieved by each utility in 2004 and the potential for future growth in energy efficiency under alternative augmented market scenarios. The tables provide the energy and demand savings from cumulative adoptions in 2016 by end use.

The yearly illustration of technical and economic potential needs to be analyzed carefully. For retrofit and conversion models, the technical potential assumes an instantaneous installation of energy efficiency measures wherever applicable and feasible. For replace-on-burnout models, the technical potential is phased in as the previous measures burn out. Economic potential is similar to technical, with the further consideration of costs.

Given the definitions of economic and technical potential, the technical potential illustrated for each utility in 2004 does not depict the level of technical potential each utility achieved. The technical potential illustrates what the utility could achieve if they could force all households that could adopt the measure to adopt the measure. Increases in technical potential over time are due to population growth and the burnout of existing measures.

<u>PG&E Potential Energy Savings Forecasts for Existing Residential Buildings</u>

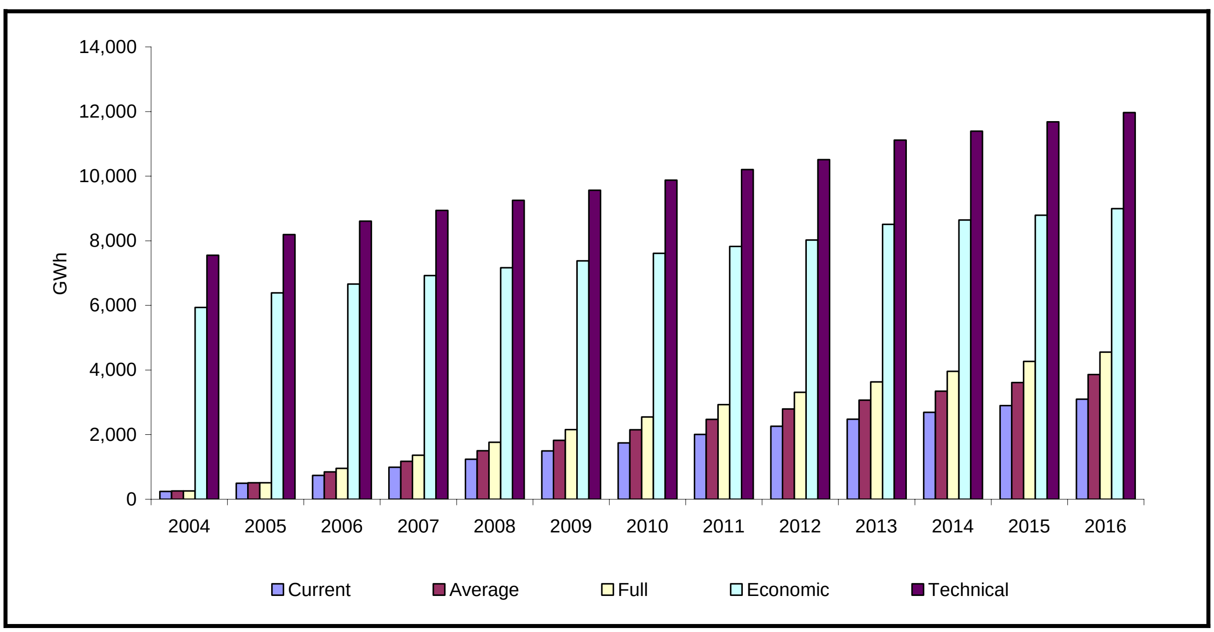
The results in Table 4-12 list the end-use energy savings from existing homes in PG&E's service territory. Estimated savings potential under current incentives are 3,102 GWh, with nearly two-thirds of these savings derived from the residential lighting program. Increasing incentives to the average between current incentives and full incremental measure costs, while augmenting the measure list, increases forecast savings to 3,861 GWh. Increasing incentives from current to average has the largest percentage increase on HVAC measures, due in part to the addition of HVAC diagnostic savings. HVAC diagnostic was not included in the current incentive analysis due to the lack of program accomplishments for 2004. Increasing incentives to full incremental measure cost increases potential savings to 4,555 GWh. HVAC measures have the largest percentage increase in potential savings between the average and full incremental cost analysis. HVAC measures have large increases in savings when incentive are increased due to their relatively high incremental costs and longer payback periods under current and average incentives.

Table 4-12: PG&E Estimated Gross Market Energy Potential by Funding Level and End Use for Existing Residential Buildings – 2004-2016 (GWh)

Total	Technical	Economic	Full	Average	Current
2004	7,550	5,937	256	256	245
2005	8,192	6,391	514	514	491
2006	8,612	6,665	953	850	740
2007	8,943	6,923	1,361	1,177	989
2008	9,255	7,170	1,763	1,502	1,240
2009	9,565	7,380	2,158	1,826	1,492
2010	9,881	7,612	2,545	2,149	1,747
2011	10,201	7,824	2,928	2,472	2,004
2012	10,513	8,020	3,307	2,795	2,262
2013	11,115	8,512	3,636	3,071	2,476
2014	11,398	8,648	3,959	3,346	2,689
2015	11,683	8,788	4,266	3,609	2,899
2016	11,969	8,996	4,555	3,861	3,102

The results in Figure 4-13 show the timeline of potential savings under the three market scenarios and economic and technical potential. The results are consistent with the total energy saving numbers presented in the end use in Table 4-12.

Figure 4-13: PG&E Estimated Gross Technical, Economic, and Market Energy Potential for Existing Residential Buildings – 2004-2016



* Refer to Table 4-5 for a description of the market funding scenarios.

SCE Potential Energy Savings Forecasts for Existing Residential Buildings

The results in Table 4-13 list the end use energy savings from existing homes in SCE's service territory. Estimated savings potential under current incentives are 4,231 GWh, with 54% of these savings derived from the residential lighting program and 39% a result of the miscellaneous end use. For SCE, the miscellaneous end use savings are largely due to high efficiency refrigerators and refrigerator and freezer recycling.

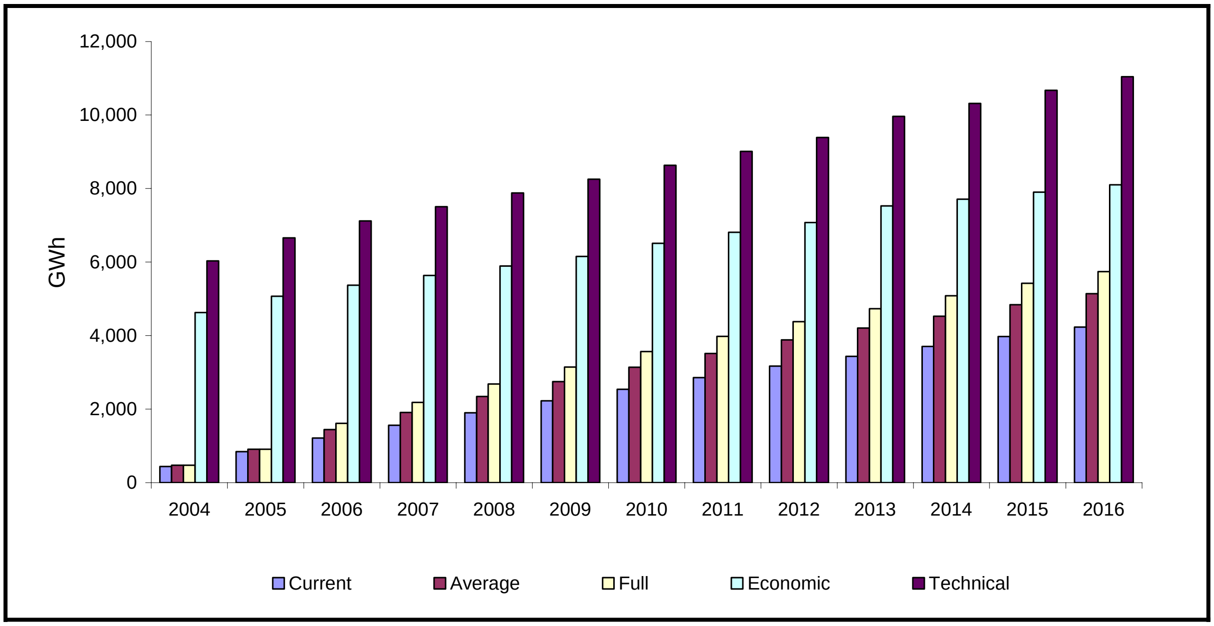
Increasing incentives to the average between current incentives and full incremental measure costs, while augmenting the measure list, increases forecast savings to 5,136 GWh, a 21% increase over the current incentive forecast. Increasing incentives from current to average has the largest percentage potential energy savings increase on water heating, followed closely by HVAC measures. Under the 2004 SCE residential energy efficiency programs, clothes washers, dishwashers and HVAC diagnostics were not incentivized. Adding these measures to the average scenario dramatically increased the savings for these end uses. Increasing incentives to full incremental measure cost increases potential savings to 5,740 GWh.

Table 4-13: SCE Estimated Gross Market Energy Potential by Funding Level and End Use for Existing Residential Buildings – 2004-2016 (GWh)

Total	Technical	Economic	Full	Average	Current
2004	6,029	4,627	477	477	440
2005	6,656	5,070	911	911	840
2006	7,118	5,373	1,614	1,445	1,214
2007	7,504	5,636	2,182	1,910	1,562
2008	7,879	5,893	2,686	2,343	1,898
2009	8,253	6,153	3,142	2,749	2,223
2010	8,631	6,512	3,569	3,137	2,541
2011	9,012	6,811	3,979	3,514	2,856
2012	9,387	7,078	4,378	3,881	3,166
2013	9,966	7,526	4,730	4,202	3,433
2014	10,316	7,710	5,082	4,524	3,704
2015	10,676	7,903	5,424	4,840	3,974
2016	11,040	8,100	5,740	5,136	4,231

Figure 4-14 shows that SCE's energy efficiency potential under the three market scenarios and their economic and technical forecasts. The energy savings represented in Figure 4-14 are consistent with the total forecasts presented above.

Figure 4-14: SCE Estimated Gross Technical, Economic, and Market Energy Potential for Existing Residential Buildings – 2004-2016



* Refer to Table 4-5 for a description of the market funding scenarios.

SDG&E Potential Energy Savings Forecasts for Existing Residential Buildings

The results listed in Table 4-14 present the end use energy savings from existing homes in SDG&E's service territory. Estimated savings potential under current incentives are 1,112 GWh. Nearly two-thirds of the forecast potential savings under 2004 rebate levels are derived from the residential lighting program and approximately 29% of the forecast savings are from miscellaneous. For SDG&E, miscellaneous is a combination of high efficiency refrigerator, recycled refrigerators and freezers, and high efficiency pool pumps.

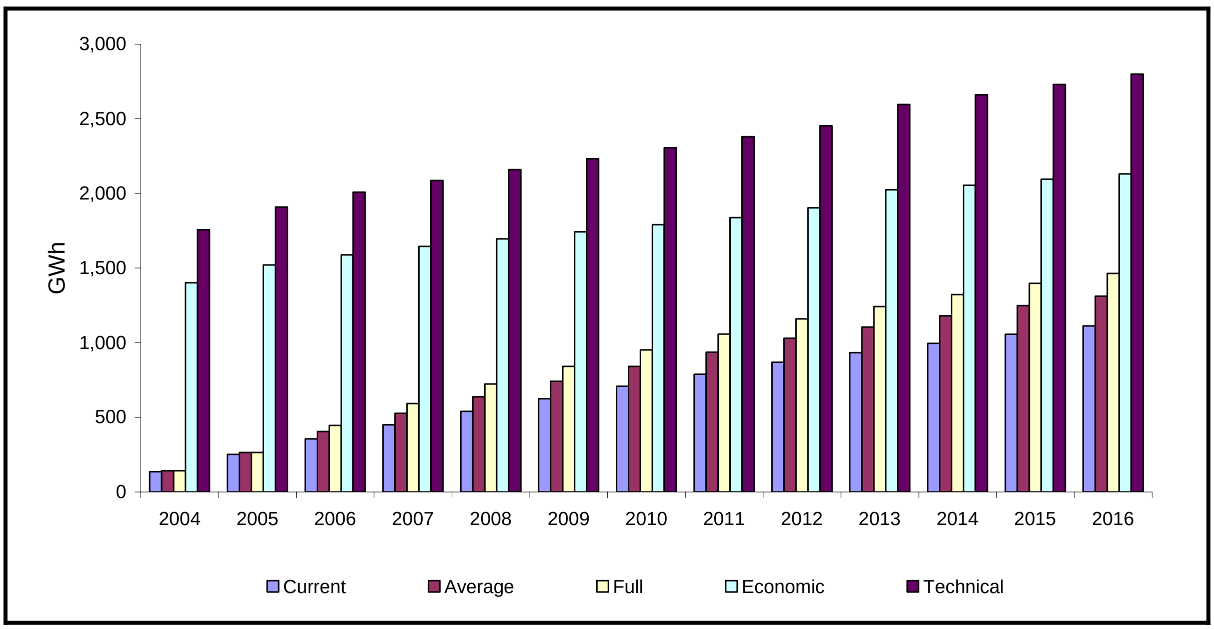
Increasing incentives to the average between current incentives and full incremental measure costs, while augmenting the measure list, increases forecast potential savings to 1,311 GWh, an 18% increase in savings. Increasing incentives from current to average has the largest percentage increase on HVAC measures, due in part to the addition of HVAC diagnostic savings. HVAC diagnostic was not included in the current incentive analysis due to the lack of program accomplishments for 2004. Increasing incentives to full incremental measure cost increases potential savings to 1,464 GWh.

Table 4-14: SDG&E Estimated Gross Market Energy Potential by Funding Level and End Use for Existing Residential Buildings – 2004-2016 (GWh)

Total	Technical	Economic	Full	Average	Current
2004	1,757	1,402	142	142	135
2005	1,909	1,520	264	264	251
2006	2,008	1,588	446	405	355
2007	2,086	1,644	592	526	450
2008	2,159	1,694	723	638	539
2009	2,232	1,742	842	742	625
2010	2,306	1,790	952	841	707
2011	2,380	1,838	1,058	936	789
2012	2,453	1,904	1,159	1,030	869
2013	2,595	2,024	1,242	1,105	933
2014	2,661	2,055	1,323	1,179	996
2015	2,729	2,094	1,397	1,248	1,056
2016	2,798	2,130	1,464	1,311	1,112

Figure 4-15 illustrates SDG&E's energy efficiency potential under all three market scenarios and the economic and technical forecast.

Figure 4-15: SDG&E Estimated Gross Technical, Economic, and Market Energy Potential for Existing Residential Buildings – 2004-2016



* Refer to Table 4-5 for a description of the market funding scenarios.

PG&E Potential Demand Savings Forecasts for Existing Residential Buildings

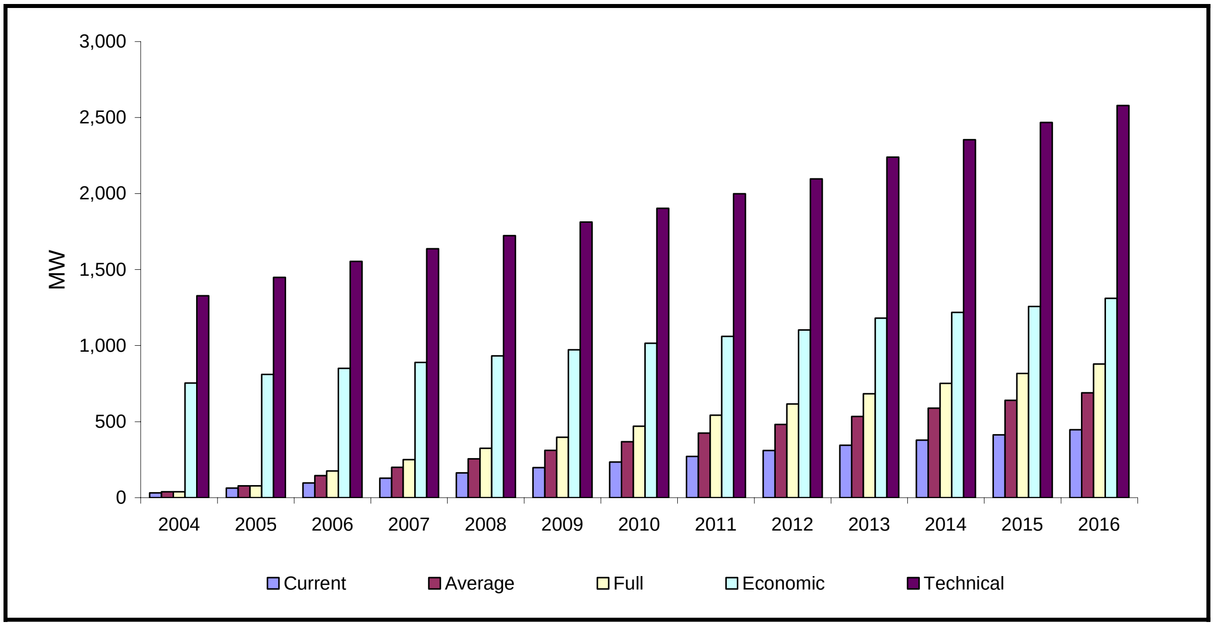
The results in Table 4-15 list the end-use peak demand savings from existing homes in PG&E's service territory. The estimated demand savings potential under current incentives is 447 MW. Increasing incentives to the average between current incentives and full incremental measure costs, while augmenting the measure list, increases forecast savings to 689 MW. Increasing incentives from 2004 levels to the average level leads to the largest increase in HVAC savings due to the addition of HVAC diagnostics, 47% of demand savings under the average scenario are due to HVAC measures. Increasing incentives to full incremental measure cost increases demand potential savings to 879 MW, a 28% increase over the average incentive level estimate.

Table 4-15: PG&E Estimated Gross Market Demand Potential by Funding Level and End Use for Existing Residential Buildings – 2004-2016 (MW)

Total	Technical	Economic	Full	Average	Current
2004	1,328	754	38	38	31
2005	1,448	810	78	78	63
2006	1,554	850	176	144	96
2007	1,637	890	250	200	129
2008	1,723	932	324	256	163
2009	1,812	972	397	311	198
2010	1,903	1,016	470	367	234
2011	1,999	1,061	542	424	271
2012	2,096	1,103	615	481	309
2013	2,238	1,181	684	534	344
2014	2,354	1,219	752	588	379
2015	2,468	1,257	817	640	414
2016	2,579	1,311	879	689	447

Figure 4-16 illustrates PG&E's potential demand savings under the three alternative incentive levels and their economic and technical potential.

Figure 4-16: PG&E Estimated Gross Technical, Economic and Market Demand Potential for Existing Residential Buildings – 2004-2016



* Refer to Table 4-5 for a description of the market funding scenarios.

SCE Potential Demand Savings Forecasts for Existing Residential Buildings

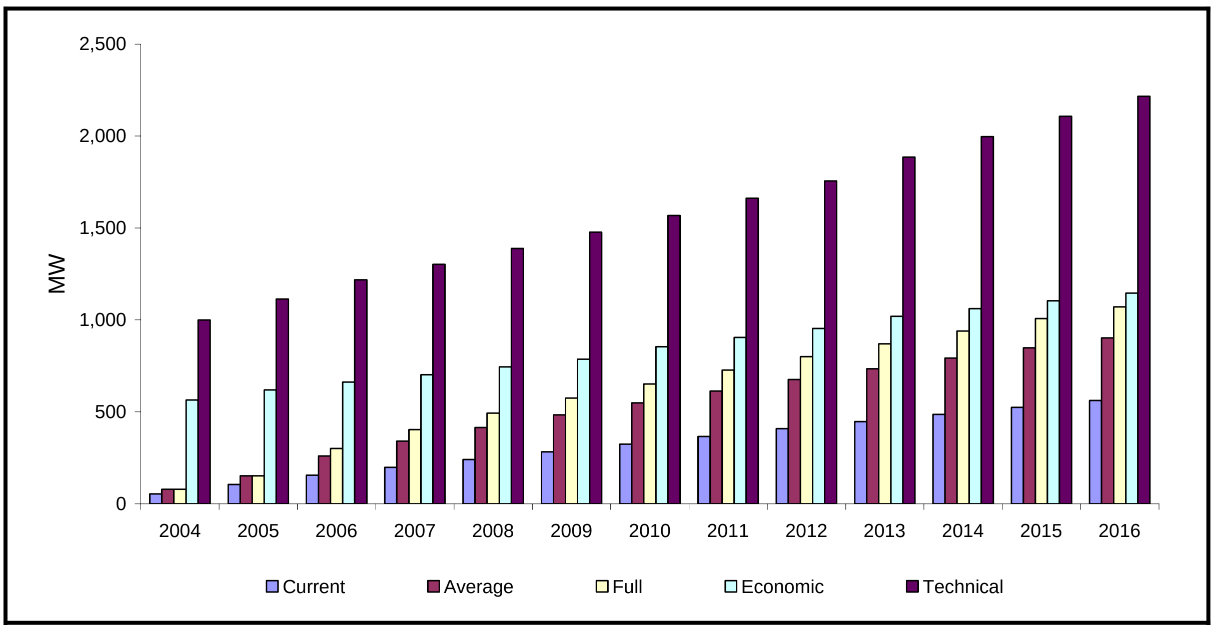
The results in Table 4-15 list the end-use peak demand savings from existing homes in SCE's service territory. The estimated demand savings potential under current incentives is 562 MW. Residential lighting, followed closely by miscellaneous, is the largest contributor to potential peak demand savings under the current incentives scenario. Increasing incentives to the average between current incentives and full incremental measure costs, while augmenting the measure list, increases forecast savings to 903 MW. Increasing incentives from 2004 levels to the average level leads to the largest increase in HVAC peak demand savings, 47% of demand savings under the average scenario are due to HVAC measures. Increasing incentives to full incremental measure cost increases demand potential savings to 1,071 MW, a 19% increase over the average incentive level estimate.

Table 4-16: SCE Estimated Gross Market Demand Potential by Funding Level and End Use for Existing Residential Homes – 2004-2016 (MW)

Total	Technical	Economic	Full	Average	Current
2004	999	564	79	79	54
2005	1,114	619	152	152	105
2006	1,218	662	301	260	156
2007	1,302	703	403	341	199
2008	1,389	744	493	415	241
2009	1,477	787	574	484	283
2010	1,568	855	651	549	325
2011	1,661	905	726	613	366
2012	1,756	953	800	676	408
2013	1,886	1,019	870	734	447
2014	1,997	1,061	939	792	486
2015	2,107	1,104	1,007	849	525
2016	2,217	1,146	1,071	903	562

Figure 4-17 presents the potential demand savings for the three market scenarios and the economic and technical potential estimates for SCE.

Figure 4-17: SCE Estimated Gross Technical, Economic, and Market Demand Potential for Existing Residential Homes – 2004-2016



* Refer to Table 4-5 for a description of the market funding scenarios.

SDG&E Potential Demand Savings Forecasts for Existing Residential Buildings

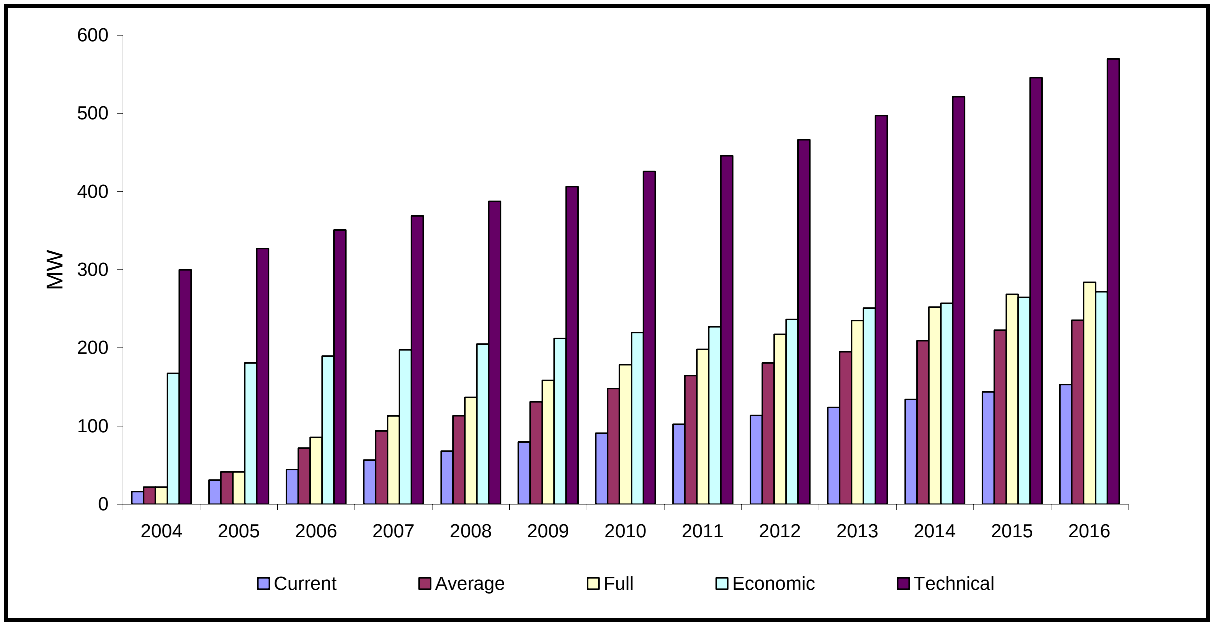
The results in Table 4-17 list the end-use peak demand savings from existing homes in SDG&E's service territory. The estimated demand savings potential under current incentives is 153 MW. In the current incentive forecast, HVAC and miscellaneous measures each account for approximately 26% of peak demands savings, with lighting capturing 45% of potential demand savings. Increasing incentives to the average between current incentives and full incremental measure costs, while augmenting the measure list, increases forecast savings to 235 MW. Increasing incentives from 2004 levels to the average level leads to the largest increase in HVAC savings due to the addition of HVAC diagnostics, 46% of demand savings under the average scenario are due to HVAC measures. Increasing incentives to full incremental measure cost increases demand potential savings to 284 MW, a 21% increase over the average incentive level estimate.

Table 4-17: SDG&E Estimated Gross Market Demand Potential by Funding Level and End Use for Existing Residential Buildings – 2004-2016 (MW)

Total	Technical	Economic	Full	Average	Current
2004	300	167	22	22	16
2005	327	181	41	41	31
2006	351	190	86	72	44
2007	369	197	113	94	56
2008	387	205	137	113	68
2009	406	212	158	131	79
2010	426	220	178	148	91
2011	446	227	198	164	102
2012	466	236	217	181	114
2013	497	251	235	195	124
2014	522	257	252	209	134
2015	546	265	269	223	144
2016	570	272	284	235	153

Figure 4-18 illustrates SDG&E's potential demand savings associated with technical, economic and the three market forecasts.

Figure 4-18: SDG&E Estimated Gross Technical, Economic, and Market Demand Potential for Existing Residential Buildings – 2004-2016



* Refer to Table 4-5 for a description of the market funding scenarios.

Utility-Specific Cost and Benefits for Existing Residential Buildings

The utility-specific costs and benefits are presented in Table 4-18, Table 4-19, and Table 4-20. The forecast shows that all three utilities offer cost-effective programs and that their programs would be cost effective at both the average and full incremental cost funding levels. SCE's energy efficiency programs, at the current funding level, have the highest TRC value, with a benefit-to-cost ratio of 2.16. The TRCs for SDG&E and PG&E at the current funding levels are both 1.67.[12]

[12] The cost, benefit, and TRC data for SDG&E and PG&E include the four dual fuel measures: attic insulation, wall insulation, duct repair, and infiltration control. These measures are analyzed in the electric model for homes with electric heat and CAC and for homes with gas heat and CAC. For SCE, these measures were analyzed in all electric homes. Including the dual fuel measure from gas-heated homes for SDG&E and PG&E reduces the cost effectiveness of their programs.

Table 4-18: Summary of PG&E Electric Market Potential Costs and Benefits for Existing Residential Buildings – 2004-2016

Item	Current	Average	Full
Gross Program Costs	$50,491,153	$64,860,000	$80,819,294
Net Measure Costs	$738,776,563	$1,309,909,280	$1,881,395,995
Gross Incentives	$573,515,634	$1,140,105,834	$2,255,815,145
Net Avoided Cost Benefit	$1,320,635,406	$1,754,637,280	$2,168,419,246
Program TRC	1.67	1.28	1.11

* Refer to Table 4-5 for a description of the market funding scenarios.

Table 4-19: Summary of SCE Electric Market Potential Cost and Benefits for Existing Residential Buildings – 2004-2016

Item	Current	Average	Full
Gross Program Costs	$27,748,540	$32,435,957	$35,697,260
Net Measure Costs	$846,954,342	$1,388,494,371	$2,017,660,878
Gross Incentives	$655,762,992	$1,179,518,283	$2,321,216,648
Net Avoided Cost Benefit	$1,888,110,050	$2,472,079,712	$2,823,674,268
Program TRC	2.16	1.74	1.38

* Refer to Table 4-5 for a description of the market funding scenarios.

Table 4-20: Summary of SDG&E Electric Market Potential Cost and Benefits for Existing Residential Buildings – 2004-2016

Item	Current	Average	Full
Gross Program Costs	$23,354,174	$28,185,142	$32,833,544
Net Measure Costs	$286,145,526	$429,620,150	$574,243,053
Gross Incentives	$242,228,061	$384,581,174	$662,291,409
Net Avoided Cost Benefit	$518,068,523	$664,417,053	$768,549,780
Program TRC	1.67	1.45	1.27

* Refer to Table 4-5 for a description of the market funding scenarios.

4.3 Gas Efficiency Potential in Existing Residential Buildings

In the presentation of results below, measures are aggregated into three end uses: HVAC, water heating, and miscellaneous. For gas measures, miscellaneous is gas dryers.

4.3.1 Technical and Economic Gas Potential in Existing Residential Buildings

Total IOU Residential Technical and Economic Potential

Figure 4-19 presents the total estimated gas potential resulting from the analysis for the state investor-owned gas utilities of PG&E, SDG&E, and Southern California Gas (SoCalGas). Also shown is the forecasted gas use for these three utilities as estimated by the CEC.[13] The values are provided for the last year of the analysis, 2016.

As shown, total estimated technical potential is 972 million therms. Total estimated economic potential is 303 million therms. As a percentage of total forecasted 2016 gas sales, technical potential represents about 17% and economic potential about 5% of anticipated sales.

Figure 4-19: Estimated Gas Gross Technical and Economic Potential for Existing Residential Buildings – 2004-2016

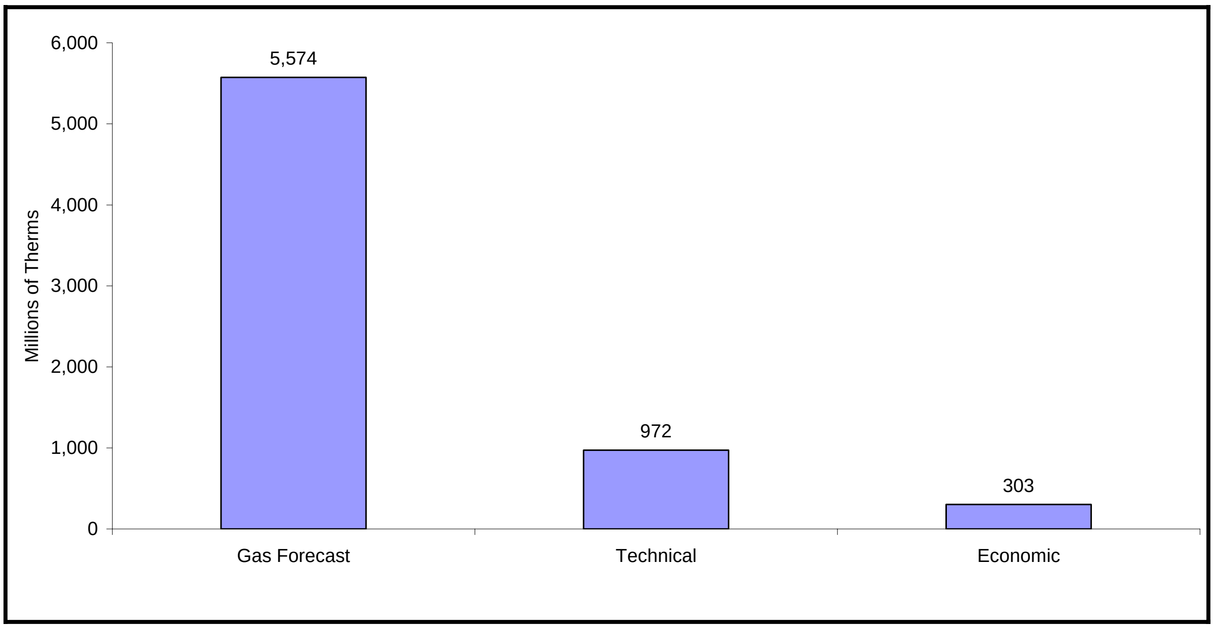


Table 4-21 summarizes the CEC forecast of expected gas sales in 2016 by utility service area.[14]

13 CEC June 2005 op. cit., Tables 10-5, 10-6, 10-7.

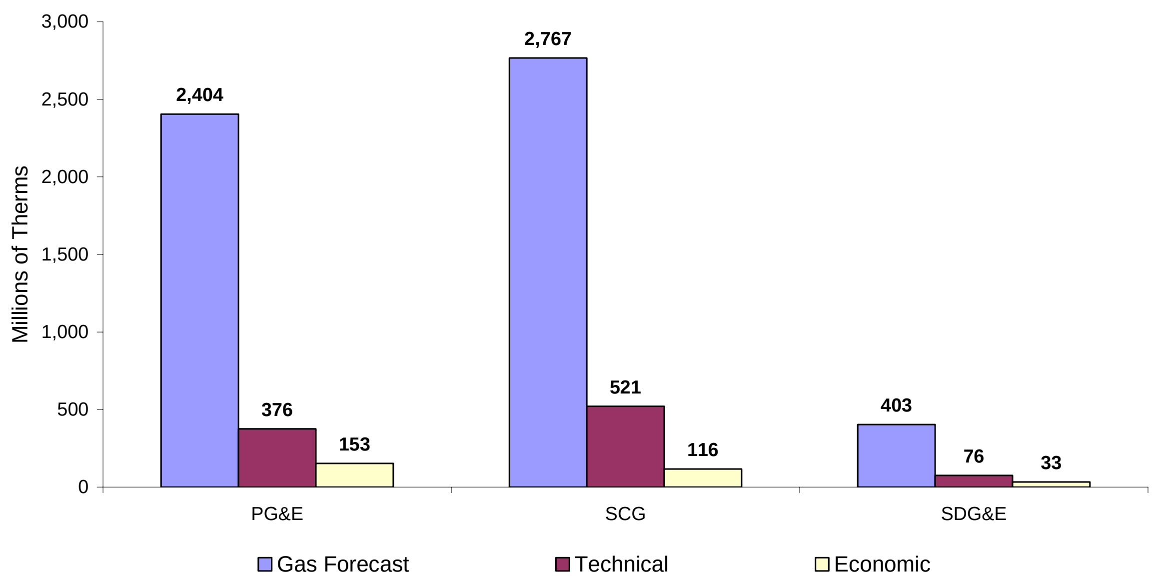
14 CEC June 2005 op. cit., Tables 10-5, 10-6, 10-7.

Table 4-21: California Energy Commission's Residential Gas Forecast – 2004-2016 (millions of therms)

PG&E	SoCalGas	SDG&E	Total
2,404	2,767	403	5,574

These forecasts are presented in Figure 4-20, along with the technical and economic potential estimates by utility service area. This figure illustrates that technical potential is highest for the SoCalGas service area at 521 million therms and the economic potential is highest for PG&E at 153 million therms. As a percentage of anticipated gas sales, the technical savings estimate is 19% of sales for SoCalGas and SDG&E and 16% for PG&E. Economic savings potential estimates are 8% of sales for SDG&E, 6% of sales for PG&E, and 4% of sales for SoCalGas.

Figure 4-20: Estimated Gas Gross Technical and Economic Potential by Utility for Existing Residential Buildings – 2004-2016



Technical Potential by End Use for Existing Residential Buildings

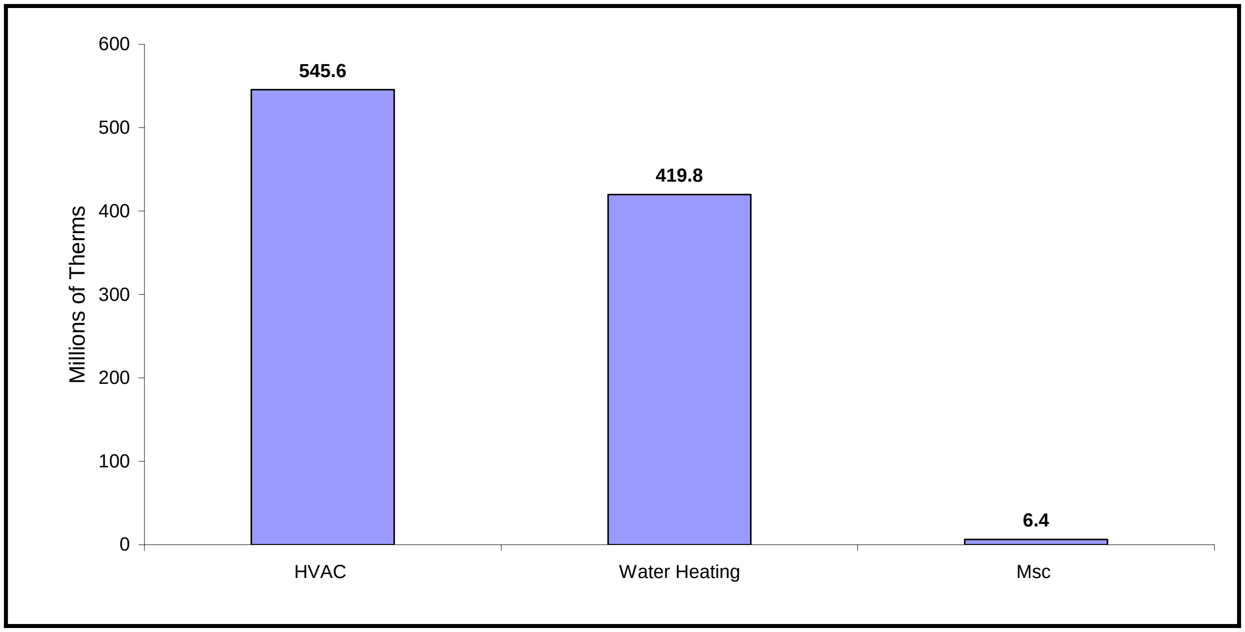
Table 4-22 summarizes the technical potential results by end use and utility. As shown, the largest contributor to gas savings is HVAC, followed closely by water heating measures.

Table 4-22: Gross Technical Potential by End Use and Utility for Existing Residential Buildings – 2004-2016 (millions of therms)

End Use	PG&E	SoCalGas	SDG&E	Total
HVAC	217	303	25	546
Water Heating	157	213	49	420
Miscellaneous	1	4	1	6
Total	**376**	**521**	**76**	**972**

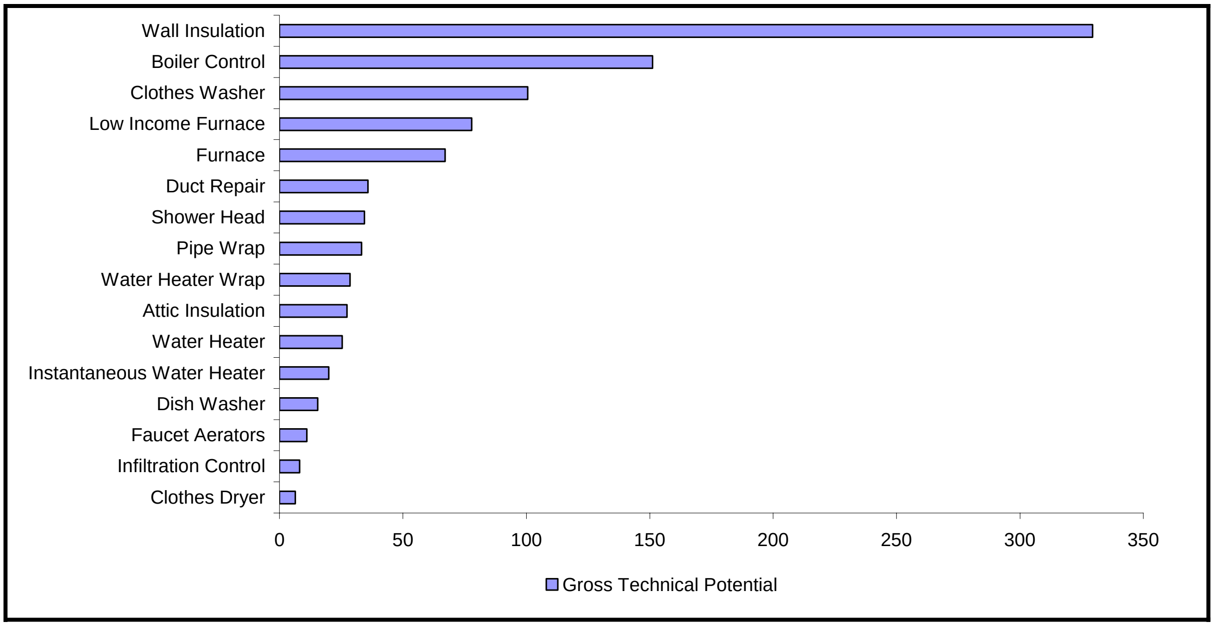
Estimates of total gross technical gas energy savings by end use are illustrated in Figure 4-21.

Figure 4-21: Estimated Gas Gross Technical Potential by End Use for Existing Residential Buildings – 2004-2016



Technical potential estimates are presented at the measure level and in order of descending potential in Figure 4-22. As shown, wall insulation contributes the most to technical potential, followed by boiler controls and clothes washers.

Figure 4-22: Estimated Gas Gross Technical Potential by Measure for Existing Residential Buildings – 2004-2016



Economic Potential by End Use for Existing Residential Buildings

Table 4-23 summarizes the economic potential results by end use and utility. As shown, only water heating and HVAC measures are cost-effective and contribute to economic potential. The only gas miscellaneous measures are dryers. The utility service area with the greatest economic potential is PG&E.

Table 4-23: Gross Economic Potential by End Use and Utility for Existing Residential Buildings – 2004-2016 (millions of therms)

End Use	PG&E	SoCalGas	SDG&E	Total
HVAC	75	0	3	77
Miscellaneous	0	0	0	0
Water Heating	78	116	31	225
Total	**153**	**116**	**33**	**303**

For PG&E and SDG&E, one HVAC measure contributes to their economic potential—wall insulation.[15] For PG&E and SDG&E, wall insulation is one of four dual fuel measures estimated in the electric model. These four measures (wall insulation, attic insulation, infiltration control, and duct repair) contribute both gas and electric savings. The savings for the dual fuel measures are scaled to account for the percent of gas-heated homes by climate zone. For SoCalGas, these measures are estimated in a gas model, without electric avoided cost savings. For each of the three IOUs, gas models were completed at a utility-wide level, without the climate zone specific breakdowns used for the electric model.

The HVAC economic potential reported in Table 4-26 for PG&E and SDG&E, and the lack of potential for SoCalGas, is a result of two features of the gas model. Dual fuel utilities can claim both the gas and electric savings for wall insulation. SoCalGas was modeled as a gas utility, claiming only gas savings. Modeling SoCalGas this way reduces the relative likelihood that wall insulation will pass the economic test. Secondly, savings for the dual fuel measures in the PG&E and SDG&E areas are estimated at a climate zone level, while savings in the SoCalGas territory are estimated at the utility level. This difference allowed wall insulation to be cost effective for specific climate zones in the PG&E and SDG&E territories, while it is not cost effective at the utility level in the SoCalGas territory.

For all three gas IOUs, the cost-effective water heater measures are boiler controls, faucet aerators, low flow showerheads, and water heater wrap.[16]

4.3.2 Market Potential for Gas Energy Efficiency in Existing Residential Buildings

In this subsection, the above results for the remaining gas potential savings are analyzed under three program incentive scenarios. As described below (see Table 4-24), results were derived for the current 2004-2005 energy efficiency program incentive funding level, a full incentive funding level and an average funding scenario with incentives set to the average between current and full incremental cost incentives. The full and the average scenarios are presented with all measures analyzed in the technical and economic forecasts. For comparison purposes, limited results are also presented for the full-2004 Measure and the average-2004 Measure scenarios with the analyzed measures limited to those incentivized in

15 Measures can have high technical and/or economic potential while having a low market penetration. Technical potential takes into account feasibility, applicability, and availability. Economic potential takes into account costs along with feasibility, applicability, and availability. Market potential accounts for consumers' behavior. A measure may have substantial technical and economic potential for energy savings while possessing features that make the measure unpopular with consumers.

16 The analysis of economic potential was completed with the 2004 rates and avoided costs. In the interim, gas costs have risen substantially. These increases may contribute to a larger gas economic potential in future analyses.

the 2004 IOU programs. For the residential gas technical, economic, full and average analyses, dryers and instantaneous water heaters were added to the list of measures incentivized in 2004.

Table 4-24: Market Scenario Descriptions for Existing Residential Buildings

Market Scenario Name	Description
Current	2004 incentive level, restricted to IOU specific measures incentivized in 2004. For measures experiencing standards changes in 2006, the rebate level changes in 2006. For low income measures, the current rebate is full incremental measure cost.
Average-2004 Measures	Average between current and full incremental cost incentive levels with the measure list restricted to those incentivized in 2004.
Average	The average between current and full incremental cost incentive levels with all the measures analyzed in the technical and the economic scenarios.
Full-2004 Measures	Full incremental measure cost with the high efficiency measure list restricted to those incentivized in 2004.
Full	Full incremental measure cost incentive levels with all the measures analyzed in the technical and the economic scenarios. For retrofit and conversion measures a working measure is replaced, therefore the full incremental measure cost is the cost of the measure. For replace on burn out measures the full incremental measures cost is the incremental cost between the low and high efficiency measure.

As discussed above, the current, full-2004 measures and the average-2004 measures market scenarios only include measures with IOU program accomplishments in 2004. The full and the average market scenarios also include instantaneous water heaters and gas dryers, two measures not incentivized in 2004.

As shown in Table 4-25, total IOU market potential under the current funding scenario is 88 million therms. Under the average funding scenario, restricted to 2004 measures, savings increase by 93% to 170 million therms. Increasing funding levels to the restricted full level increases savings to 213 million therms, a 25% increase. The results for the current, restricted average and the restricted full incremental cost forecasts are illustrated in Figure 4-23.

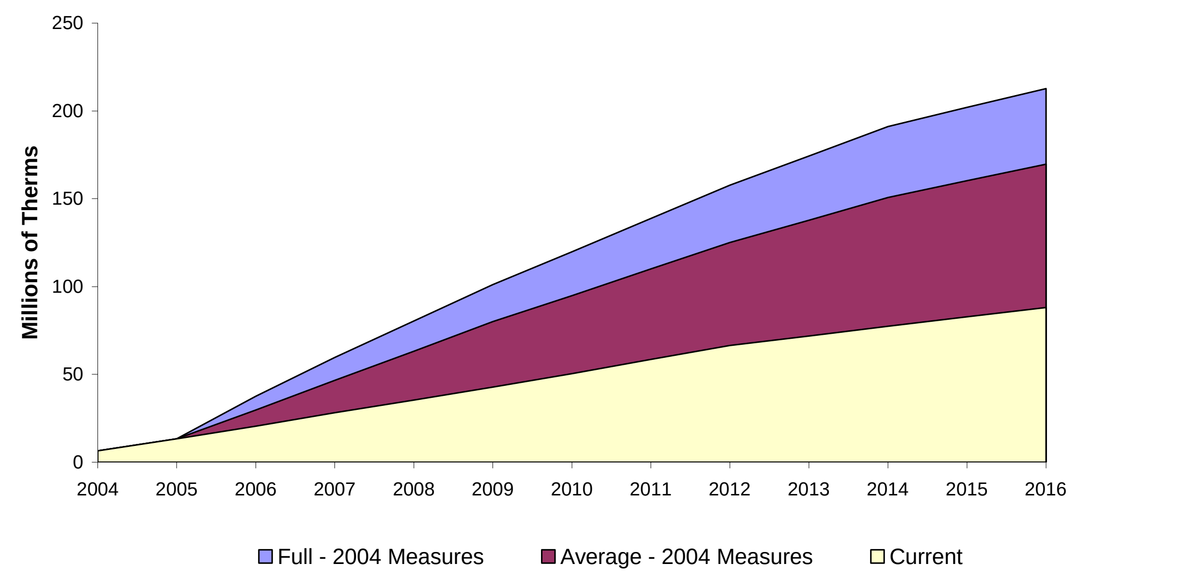
If incentivized measures include dryers and instantaneous gas water heaters, the average funding level leads to savings of 178 million therms, an increase of 103% over current program funding. Increasing funding to cover full incremental costs, the savings further increase 30% to 231 million therms.

Table 4-25: Estimated Gross Market Potential by Funding Level for Existing Residential Buildings – 2004-2016

Funding Level	Millions of Therms
Current	88
Average-2004 Measures	170
Average	178
Full-2004 Measures	213
Full	231

* Refer to Table 4-24 for a description of the market funding scenarios.

Figure 4-23: Estimated Gas Market Potential by Funding Level for Existing Residential Buildings – 2004-2016



* Refer to Table 4-24 for a description of the market funding scenarios.

Gas Market Potential by End Use for Existing Residential Buildings

Table 4-26 summarizes the three market potential estimates, and the estimates restricted to the 2004 measure list, by end use. For comparison, technical and economic estimates are also included. As shown, water heating has the largest economic potential and is the largest contributor to gas savings for each of the three market forecasts. Water heating measures, including dishwashers and clothes washers, dominated the 2004 residential gas program accomplishments for PG&E and SoCalGas. The forecasts of market potential are calibrated to the 2004 accomplishments, making the water heating end use the largest contributor to the market forecasts.

As illustrated in Figure 4-22, a substantial part of the existing homes residential technical potential for HVAC is in wall insulation. The market forecasts for wall insulation indicate that while it is technically feasible to save more energy by installing this measure, few households are forecast to take advantage of this option. The forecasts are calibrated to the current (2004) utility programs. The 2004 residential gas program accomplishments indicate that all three of the gas IOUs offer rebates for wall insulation in gas-heated homes, but the 2004 program accomplishments are small relative to the water heating measure and other HVAC measures.[17]

Table 4-26: Estimated Gas Gross Market Potential by Funding Level and End Use for Existing Residential Buildings – 2004-2016 (millions of therms)

End Use	Technical	Economic	Current	Average 2004 Measures	Average	Full 2004 Measures	Full
HVAC	546	77	32	70	70	88	88
Miscellaneous	6	0	0	0	2	0	5
Water Heating	420	226	56	99	106	124	138
Total	**972**	**303**	**88**	**170**	**178**	**203**	**231**

* Refer to Table 4-24 for a description of the market funding scenarios.

4.3.3 Gas Cost and Benefit Results for Existing Residential Buildings

Table 4-27 presents a final summary of the residential gas market potential estimates for three of the market funding levels with costs, benefits, and TRC ratios included for reference.

Table 4-27: Summary of Gas Market Potential Results for Existing Residential Buildings – 2004-2016

Item	Current	Average	Full
Program Costs	$27,262,306	$55,122,158	$69,446,476
Net Measure Costs	$1,564,800,255	$4,105,185,958	$4,990,005,002
Gross Incentives	$785,192,150	$3,289,974,300	$6,033,430,652
Net Avoided Cost Benefit	$264,879,468	$514,353,572	$647,561,596
Program TRC	0.17	0.12	0.13

* Refer to Table 4-24 for a description of the market funding scenarios.

[17] A large technical or economic potential does not directly imply a large market potential. Given customers' current perception of wall insulation and the current program design, consumers are not choosing to adopt this measure.

As shown at the statewide level, the portfolio of gas programs is not cost effective based on the results of the TRC test, which range from 0.12 to 0.17. At a measure level, boiler controllers, faucet aerators, low flow showerheads, and water heater wrap are cost effective based on the results of the TRC test.[18]

The results in Table 4-27 do not include the costs and benefits for the dual fuel measures for SDG&E and PG&E. These measures were estimated in the electric model and the costs and benefits are represented in the summary of electric market potential results.

Many high efficiency gas measures have relatively high incremental measure costs. The high incremental measure costs reduce the likelihood the measure will pass the TRC test.[19]

4.3.4 Utility-Level Residential Gas Potential, Benefits and Costs

In this subsection, the natural gas technical, economic, and market potential are presented for 2004-2016 at the utility level. The utility-specific costs, savings, and TRC test results are listed below.

Figure 4-24, Figure 4-25, and Figure 4-26 and Table 4-28, Table 4-29, and Table 4-30 present the potential natural gas savings for PG&E, SoCalGas, and SDG&E, respectively. These figures and tables help to illustrate the natural gas energy efficiency potential achieved by each utility in 2004 and the potential for future growth in energy efficiency savings under the alternative market scenarios.

PG&E Potential Gas Savings Forecasts for Existing Residential Buildings

Table 4-28 lists the natural gas potential savings for PG&E's existing residential sector by end use and scenario. The current forecast of 48 million therms is dominated by water heating savings. In addition to water heaters, the water heating end use includes appliances using gas heated water, boiler controllers, faucet aerators, and low flow showerheads. Increasing incentives to the average between current incentives and full incremental measure costs, and adding dryers and instantaneous water heaters, increases the potential forecast to 83 million therms, an increase of 73%. Further increasing incentives to full incremental measure costs increases the savings to 101 million therms, a 22% increase.

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[18] KEMA's portfolio level gas test result was 1.03. Their analysis included at least two gas measures which passed the TRC test but are no longer included in the utility energy efficiency programs: programmable thermostats and ceiling insulation from R0-R19. Most of the remaining gas measures which passed a TRC test in the previous forecast also pass the TRC test under Itron's forecast.

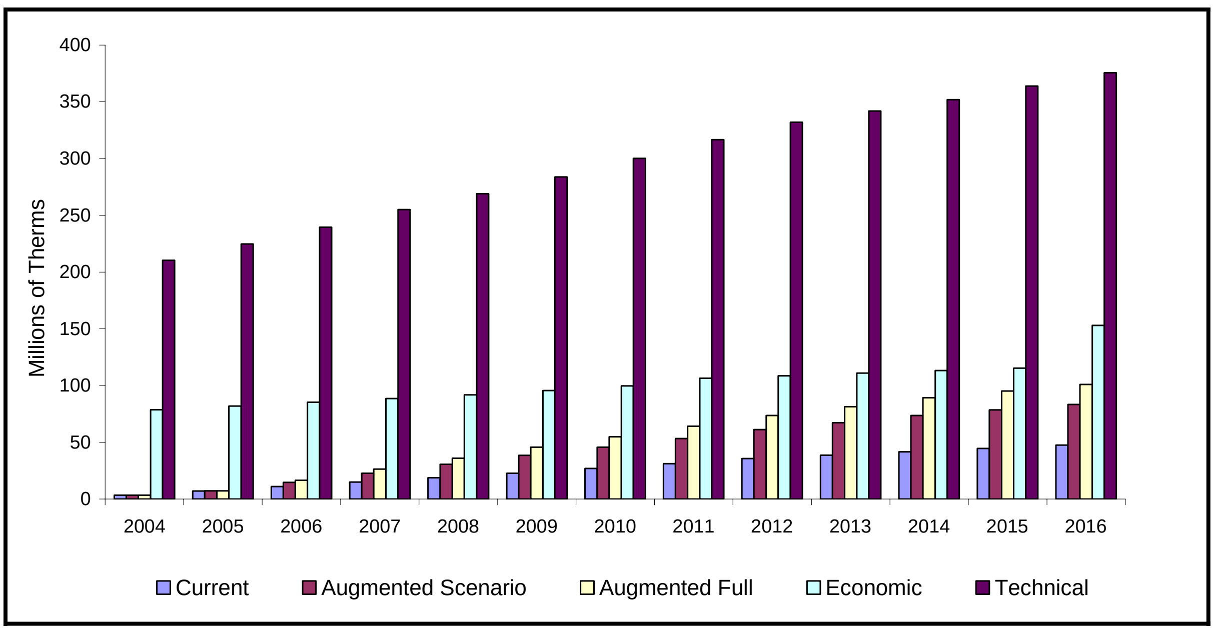
[19] The gas rate data and gas avoided costs used in this analysis are from 2004. Gas prices have increased substantially during the analysis period. The TRC test is sensitive to increases in gas avoided costs. Future analyses using higher avoided costs may find more measure cost effective.

Table 4-28: PG&E Estimated Gross Market Gas Potential by Funding Level and End Use for Existing Residential Buildings – 2004-2016 (millions of therms)

Total	Technical	Economic	Full	Average	Current
2004	210	79	4	4	4
2005	2245	82	7	7	7
2006	240	85	17	15	11
2007	255	89	26	23	15
2008	269	92	36	31	19
2009	284	96	46	39	23
2010	300	100	55	46	27
2011	317	107	64	53	31
2012	332	109	73	61	36
2013	342	111	81	67	39
2014	352	113	89	74	42
2015	364	116	95	79	45
2016	376	153	101	83	48

Figure 4-24 illustrates PG&E's technical, economic, and market potential for natural gas measures.

Figure 4-24: Estimated PG&E Gross Technical, Economic, and Market Gas Potential for Existing Residential Buildings – 2004-2016



* Refer to Table 4-24 for a description of the market funding scenarios.

SoCalGas Potential Gas Savings Forecasts for Existing Residential Buildings

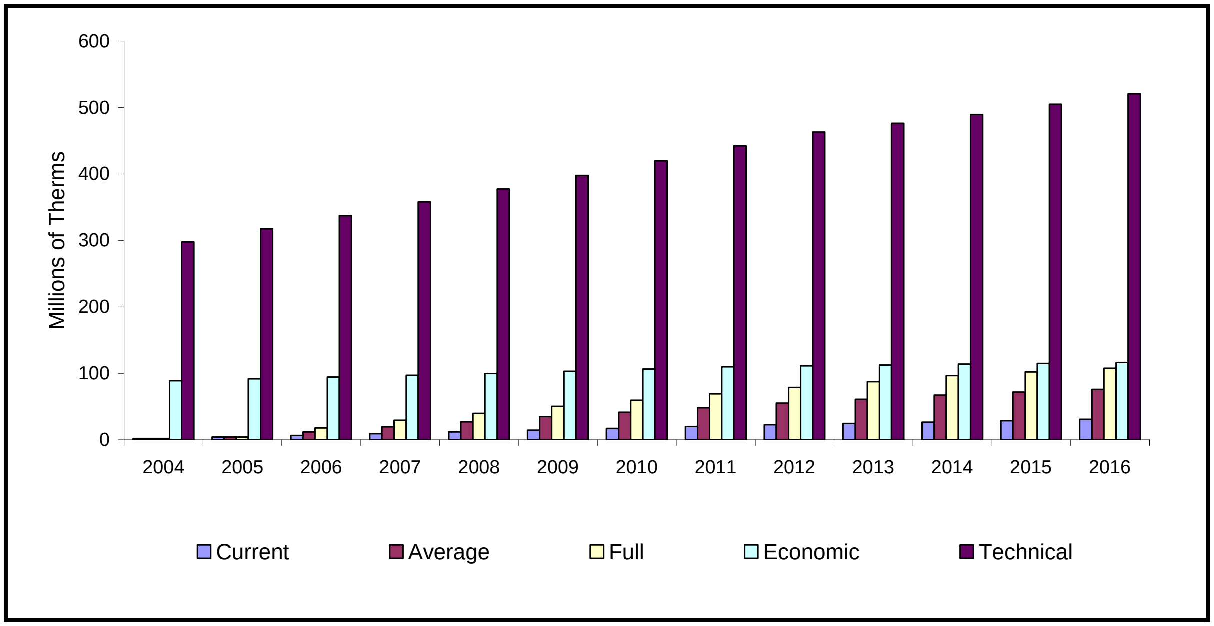
Table 4-29 lists the natural gas potential savings for the SoCalGas existing residential sector by end use and scenario. A continuation of current incentive levels is forecast to lead to a savings of 31 million therms in 2016. Increasing incentives to the average between current incentives and incremental cost, and adding dryers and instantaneous water heaters, is forecast to increase savings to 76 million therms, a 145% increase. Further increasing incentives to full incremental costs will increase potential savings to 108 million therms.

Table 4-29: SoCalGas Estimated Gross Market Gas Potential by Funding Level and End Use for Existing Residential Buildings – 2004-2016 (millions of therms)

Total	Technical	Economic	Full	Average	Current
2004	298	89	2	2	2
2005	317	92	4	4	4
2006	337	94	18	12	7
2007	358	97	29	20	9
2008	377	100	40	27	12
2009	398	103	50	35	14
2010	420	107	60	42	17
2011	442	110	69	48	20
2012	463	111	79	55	23
2013	476	112	88	61	25
2014	490	114	97	67	27
2015	505	115	102	72	29
2016	521	116	108	76	31

Figure 4-25 presents the natural gas potential for SoCalGas for the technical, economic, and three market scenarios for the years 2004-2016.

Figure 4-25: Estimated SoCalGas Gross Technical, Economic, and Market Gas Potential for Existing Residential Buildings – 2004-2016



* Refer to Table 4-24 for a description of the market funding scenarios.

SDG&E Potential Gas Savings Forecasts for Existing Residential Buildings

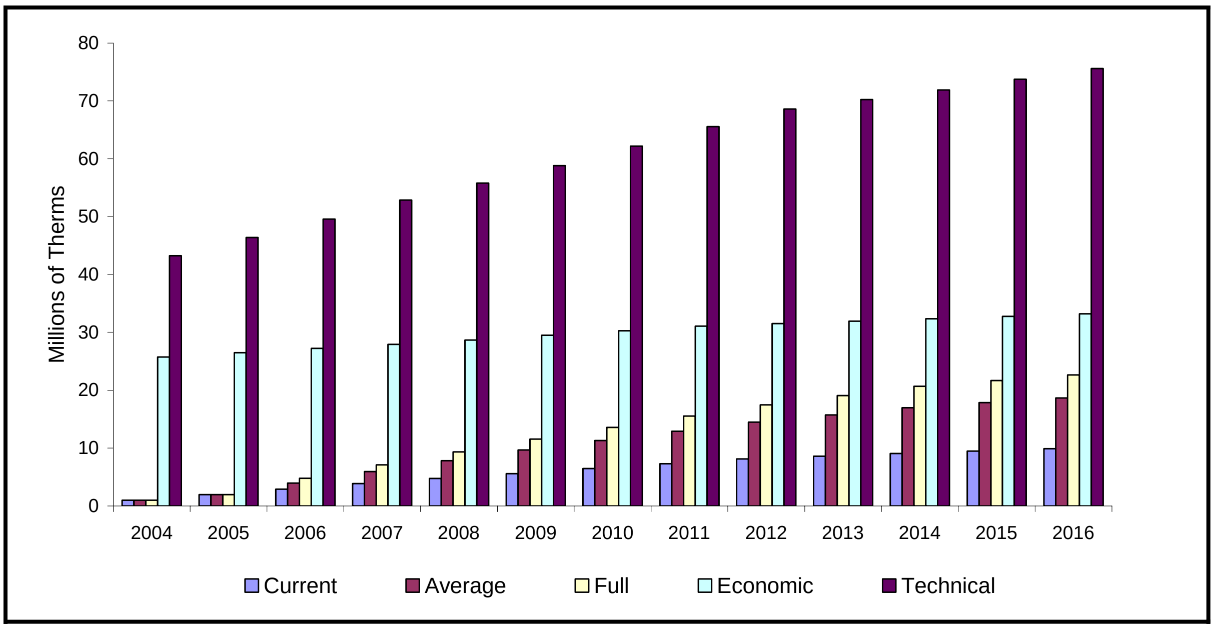
Table 4-30 lists the natural gas potential savings for SDG&E's existing residential sector by end use and scenario. At 2004 incentive levels, the natural gas potential savings is 10 million therms. Increasing incentives to the average between the 2004 level and full incremental measure cost, and augmenting the measures to include dryers and instantaneous water heaters, is forecast to increase natural gas savings to 19 million therms, an increase of 90%. Further increasing incentives to full incremental costs is forecast to increase potential natural gas savings in SDG&E's service territory to 23 million therms, a further increase of 21%.

Table 4-30: SDG&E Estimated Gross Market Gas Potential by Funding Level and End Use for Existing Residential Buildings – 2004-2016 (millions of therms)

Total	Technical	Economic	Full	Average	Current
2004	43	26	1	1	1
2005	46	26	2	2	2
2006	50	27	5	4	3
2007	53	28	7	6	4
2008	56	29	9	8	5
2009	59	29	12	10	6
2010	62	30	14	11	6
2011	66	31	16	13	7
2012	69	32	17	14	8
2013	70	32	19	16	9
2014	72	32	21	17	9
2015	74	33	22	18	9
2016	76	33	23	19	10

Figure 4-26 illustrates the technical, economic, and market forecasts of natural gas savings potential for SDG&E's existing residential sector for the years 2004-2016.

Figure 4-26: Estimated SDG&E Gross Technical, Economic, and Market Gas Potential for Existing Residential Buildings – 2004-2016



* Refer to Table 4-24 for a description of the market funding scenarios.

Natural Gas Utility-Specific Cost and Benefits for Existing Residential Buildings

Table 4-31, Table 4-32, and Table 4-33 present the costs and benefits associated with the alternative funding levels for each utility. These tables show that the forecast of the total resource cost is less than one for all utilities under all funding levels. The highest benefit-to-cost ratio is for SDG&E's natural gas program at 0.24. The benefit-to-cost ratio for SCG and PG&E are similar at 0.17 and 0.15, respectively.

Table 4-31: Summary of PG&E Gas Market Potential Costs and Benefits for Existing Residential Buildings – 2004-2016

	Current	Average	Full
Gross Program Costs	$14,610,330	$25,373,992	$29,184,337
Net Measure Costs	$820,042,461	$1,706,789,865	$1,909,001,120
Gross Incentives	$308,363,203	$1,309,667,082	$2,281,131,597
Net Avoided Cost Benefit	$128,183,552	$220,399,528	$253,522,139
TRC	0.15	0.13	0.13

* Refer to Table 4-24 for a description of the market funding scenarios.

Table 4-32: Summary of SCG Gas Market Potential Costs and Benefits for Existing Residential Buildings – 2004-2016

	Current	Average	Full
Net Program Costs	$9,705,876	$24,585,954	$34,178,324
Net Measure Costs	$614,734,244	$1,998,389,892	$2,624,622,204
Gross Incentives	$420,240,305	$1,668,498,123	$3,197,358,339
Net Avoided Cost Benefit	$105,156,222	$241,432,440	$333,254,119
TRC	0.17	0.12	0.13

* Refer to Table 4-24 for a description of the market funding scenarios.

Table 4-33: Summary of SDG&E Gas Market Potential Costs and Benefits for Existing Residential Buildings – 2004-2016

	Current	Average	Full
Gross Program Costs	$2,946,100	$5,162,212	$6,083,815
Net Measure Costs	$130,023,549	$400,009,201	$456,381,678
Gross Incentives	$56,588,642	$311,809,095	$554,940,716
Net Avoided Cost Benefit	$31,539,694	$52,521,604	$60,785,338
TRC	0.24	0.13	0.13

* Refer to Table 4-24 for a description of the market funding scenarios.

4.4 Key Residential Results and Future Research Recommendations

4.4.1 Summary of Key Results for Existing Residential Buildings

The gross statewide market potential for electric energy efficiency at the currently funded level is 8,445 GWh over a 13-year period. The current energy savings market potential is 33% of estimated technical potential and 44% of estimated economic potential. Increasing incentives to a level equal to the average between current incentives and full incremental costs, while restricting analysis to those measures incentivized in 2004 (average-2004 measures), is estimated to lead to energy savings of 9,649 GWh, a 14% increase. Further ramping up incentives to cover full incremental measure costs (full-2004 measures) added 1,387 GWh (total 11,036 GWh) to estimated potential savings. The market scenario full-2004 measures, leads to a market forecast that is 43% of estimated technical potential and 57% of estimated economic potential.

The estimates of technical and economic potential include high efficiency measures with no program accomplishments for 2004. Increasing the list of measures analyzed in the gross statewide market potential to include the augmented list of high efficiency measures, and increasing incentives to a level equal to the average between current and full costs (the average scenario), resulted in a gross savings estimate of 10,309 GWh over the 13-year period. The average scenario energy potential forecast is 40% of estimated technical potential and 54% of estimated economic potential. Further increasing incentives to full incremental measure costs, with the augmented measure list, is estimated to add 1,448 GWh to market potential, resulting in a total forecast of remain gross energy potential of 11,757 GWh. The estimate of full augmented market energy potential is 46% of estimated technical potential and 61% of estimated economic potential.

The gross market potential for demand reduction at the currently funded level was 1,161 MW over a 13-year period, which is 22% of estimated technical potential and 43% of estimated economic potential. Ramping up incentives to cover full incremental costs and augmenting the measure list added 1,072 MW (total 2,233 MW) to the estimated demand potential. The full market scenario estimate of demand potential is 42% of estimated technical potential and 82% of estimated economic potential. Setting incentives equal to the average between current and full costs, and augmenting the measure list, led to a savings estimate of 1,827 MW over the 13-year period. The average market scenario estimate of demand potential represents 34% of estimated technical potential and 67% of estimated economic potential.

The market potential for gross gas efficiency at the currently funded level was 88 million therms over a 13-year period, which is 9% of estimated technical potential and 30% of estimated economic potential. Ramping up incentives to cover full incremental costs and augmenting the measure list to include high efficiency gas dryers and instantaneous water heaters increased the estimates of savings by 143 million therms (total 231 million therms). The full market scenario estimate of potential is 24% of estimated technical potential and 77% of estimated economic potential. Setting incentives equal to the average between current and full costs, and augmenting the measure list, resulted in a savings of 178 million therms over the 13-year period. The average market scenario estimate of potential is 19% of estimated technical potential and 59% of estimated economic potential.

TRC results for electric programs under the current, average, and full market scenarios showed that each of these incentive levels is cost effective. Specifically, the current incentive program resulted in a statewide benefit-cost ratio of 1.89, while the statewide full incremental cost incentive program scored 1.25 and the statewide average scenario-level incentive program scored 1.50.

TRC results for gas programs under the three funding scenarios showed that none of the considered incentive scenarios was cost effective. Specifically, continuing with the current incentive program resulted in a statewide benefit-cost ratio of 0.17, while the augmented full-cost incentive program scored 0.13 and the average scenario-level incentive program scored 0.12. Several low-cost gas water heating measures are cost effective, but the current IOU programs include many residential gas HVAC and appliance measures that are not cost effective. The 2004 program accomplishments showed that the current utility natural gas energy efficiency program relies on savings from many measures that are not cost effective, significantly reducing the benefit-cost ratio for the market forecasts. The TRC values reported in this report use the 2004 rates and avoided costs. Subsequent, and future, increases in the natural gas avoided costs will increase the benefits of natural gas energy efficiency measures relative to their benefits in 2004.

4.4.2 Key Assumptions and Areas Needing Research

The input data for residential measure technology density and base shares are largely derived from the Residential Appliance Saturation Survey of 2004.[20] This survey was a mail survey with over 20,000 respondents. The survey responses provide recent data on the saturation and the fuel type of appliances in homes by utility and climate zone. These data ensure that the fuel type and technology density assumptions used in the model accurately represent the distribution in California homes in 2004. Relying on these data, however, has drawbacks. Respondents to mail surveys are likely to know if their home has a clothes washer or dryer, but they are less likely to know if their home is insulated. Mail surveys are also poor sources of data for many high efficiency measures. Base share data on the fraction of homes with high efficiency gas heaters, dishwashers, air conditioners, refrigerators and water heaters

[20] KEMA-Xenergy, Inc. *California Statewide Residential Appliance Saturation Study*. Prepared for the California Energy Commission. June 2004.

were based on professional judgment. Future potential analyses would benefit from residential on-site data on the fraction of applicable homes with high efficiency measures, improved information on residential insulation, and the need for duct sealing, HVAC diagnostics, and infiltration control.

Potential analyses are dependent on a full understanding of high efficiency measure impacts. The ASSET model uses information from DEER to determine the energy savings of high efficiency technologies. Given the timing of these analyses, and the release of the 2005 DEER database,[21] the residential analysis of the energy savings potential in existing homes relied on savings data from the 2001 DEER.[22] Updating these assumptions to be consistent with new information from the 2005 DEER would improve the accuracy of the forecasts. Additional research on the energy savings of programmable thermostats, duct sealing, HVAC diagnostics, and HVAC refrigerant recharging would also help to reduce the level of uncertainty surrounding the energy savings associated with these measures.[23]

The model results are also highly dependent on assumptions concerning the influence of increased rebates on consumer behavior. The ASSET model relies on payback parameters estimated from previous research in the Midwest.[24,25] These parameters were established from a conjoint analysis of consumers' responses concerning their likelihood of purchasing

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[21] Itron, Inc. 2004-2005 Database for Energy Efficiency Resources (DEER) Update Study: Final Report. Prepared for Southern California Edison. December 2005.

[22] Xenergy, Inc. *2001 DEER (Database for Energy Efficient Resources) Update Study*. Prepared for the California Energy Commission. August 2001.

[23] Programmable thermostats and HVAC refrigerant recharging were not included in the current analysis. HVAC recharging was not a rebated measure in 2004 and programmable thermostats were eliminated from utility programs in 2006. These measures were not included or were eliminated in part due to uncertainty surrounding their savings.

[24] These data come from *Northern States Power Company Customer Survey Final Report* prepared by Regional Economic Research, Inc. and Opinion Dynamics Corporation, March 1995. While the parameter estimates from the conjoint analysis are dated, to the best of our knowledge, this research has not been replicated more recently in California or elsewhere. Increases in energy prices have reduced payback lengths, middle-eastern conflicts have introduced concerns about the supply of energy, and global warming may have increased concerns about the environment and energy usage, all of these changes may have led to changes in the payback parameter in unexpected and conflicting ways. A new conjoint or double bounded analysis of the influence of rebate levels on consumer choices would help to reduce the level of uncertainty surrounding these parameters. Alternatively, a time-series analysis of energy efficiency measure adoptions, rebate levels and measure costs would add to our understanding of the influence of economic variables on energy efficiency measure adoptions.

[25] The results from the 2002/2003 KEMA study are also sensitive to their assumptions concerning the influence of increased rebates on consumer behavior. Their sensitivity parameters were derived from expert professional judgment derived from years of study. Their sensitivity parameters were not derived from analytical research on the influence of alternative rebates on consumer behavior.

high efficiency technology under different rebate levels. This research was conducted prior to an increase in consumer awareness of high efficiency measures, the California energy crisis the recent wars in the Middle East, and our improved understanding of global warming. These changes in society may have had significant impacts on these sensitivity parameters. Further analysis of the impact of rebates on consumers' choices would improve our understanding in this area.

5

Energy Efficiency Potential in Existing Commercial Buildings

This section presents the estimates of commercial energy efficiency potential in existing buildings resulting from the analysis. Estimated technical, economic, and market potential are presented for 2004 through 2016. Market potential is estimated for three program funding scenarios: 1) the current (2004 to 2005) utility program incentive level for high efficiency measures with 2004 accomplishments specific to investor-owned utility (IOU), 2) program incentives that cover full incremental costs, and 3) incentives set to the average between current and full incremental costs. Two high efficiency measure lists were used for the analysis. The savings potential estimated from the current, full 2004 measures, and average 2004 measures market scenarios are presented for analyses limited to high efficiency measures with accomplishments in the IOU-specific 2004 utility programs. The technical, economic, full, and average market scenarios are also presented using an expanded measure listed that was chosen following consultations with existing data sources and the program advisory committee. All results are presented as total gross savings associated with cumulative adoptions over the 2004 through 2016 period.

5.1 Overview

Eighty-two individual high efficiency measures were analyzed for the commercial energy efficiency analysis. These measures were all commercially available at the time of the analysis and most of the measures have IOU-specific accomplishments for the 2004 program year. In the presentation of results below, measures are aggregated into four electric end uses and two gas end uses.

Table 5-1 lists the individual measures that correspond to each end use in the analysis.

Table 5-1: Commercial Measure Descriptions

End Use	Measure Description	Fuel Type
Lighting	9-12W CFL	Electric
Lighting	9-12W Pin-Based Hardwired CFL Fixture	Electric
Lighting	13-17W CFL	Electric
Lighting	13-17W Pin-Based Hardwired CFL Fixture	Electric
Lighting	18-26W CFL	Electric
Lighting	18-26W Pin-Based Hardwired CFL Fixture	Electric
Lighting	27-50W CFL	Electric
Lighting	27-50W Pin-Based Hardwired CFL Fixture	Electric
Lighting	13-17W CFL Reflector	Electric
Lighting	Exterior Pulse Start MH 0-100W (incandescent base case)	Electric
Lighting	Exterior Pulse Start MH 0-100W (mercury vapor base case)	Electric
Lighting	Exterior Pulse Start MH 100-175W (incandescent base case)	Electric
Lighting	Exterior Pulse Start MH 100-175W (mercury vapor base case)	Electric
Lighting	Exterior Pulse Start MH 175W> (incandescent base case)	Electric
Lighting	Exterior Pulse Start MH 175W> (mercury vapor base case)	Electric
Lighting	Interior HID Fixture 101-175 W (incandescent base case)	Electric
Lighting	Interior HID Fixture 101-175 W (mercury vapor base case)	Electric
Lighting	Interior HID Fixture 176-250 W (incandescent base case)	Electric
Lighting	Interior HID Fixture 176-250 W (mercury vapor base case)	Electric
Lighting	Interior HID Fixture 36-70 W (incandescent base case)	Electric
Lighting	Interior HID Fixture 36-70 W (mercury vapor base case)	Electric
Lighting	Interior HID Fixture 71-100 W (incandescent base case)	Electric
Lighting	Interior HID Fixture 71-100 W (mercury vapor base case)	Electric
Lighting	Interior Metal Halide (Pulse Start) Fixture	Electric
Lighting	HO T5 4-Lamp Hi-Bay Fixture	Electric
Lighting	Occupancy Sensor - Plug Load	Electric
Lighting	Photocell Control	Electric
Lighting	Time Clock Control	Electric
Lighting	Photocell/Time Clock Control	Electric
Lighting	T5 or T8 Fixtures, Electric Ballast (4Ft) Fixture Change-Out	Electric
Lighting	T8 Lamps, Electric Ballast (8Ft) Second Generation Fixture Change-Out	Electric
Lighting	LED Exit Signs	Electric
Lighting	Electronic Ballast, Dimming with Daylighting	Electric
Lighting	Reflectors with Delamping (4Ft)	Electric
Lighting	Reflectors with Delamping (8Ft)	Electric
Miscellaneous	Insulated Holding Cabinet	Electric
Miscellaneous	Pressureless Steamer	Electric
Miscellaneous	Small ENERGY STAR Copy Machine	Electric
Miscellaneous	Vending Machine Control – Nonrefrigerated	Electric
Miscellaneous	Vending Machine Control – Refrigerated	Electric

Table 5-1 (cont'd.): Commercial Measure Descriptions

End Use	Measure Description	Fuel Type
Miscellaneous	Catalytic Infrared Gas Fryer	Gas
Miscellaneous	Commercial Horizontal Axis Clothes Washer with Gas Water Heat	Gas
Miscellaneous	Convection Gas Oven	Gas
Miscellaneous	Efficient Griddle - Gas	Gas
Miscellaneous	High Efficiency Gas Water Heater	Gas
Miscellaneous	Instantaneous Gas Water Heater	Gas
Miscellaneous	Hot Water Circulation Pump Time Clock	Gas
Miscellaneous	Power Burner Conveyor Belt Oven - Gas	Gas
HVAC	High Efficiency Centrifugal Chiller	Electric
HVAC	High Efficiency Reciprocating Chiller	Electric
HVAC	Chiller Tune-Up	Electric
HVAC	DX Tune-Up	Electric
HVAC	High Efficiency Package A/C (<65 kBtu/hr) 13 SEER	Electric
HVAC	High Efficiency Package A/C (<65 kBtu/hr) 14 SEER	Electric
HVAC	High Efficiency Package A/C (>65 kBtu/hr) 13 SEER	Electric
HVAC	High Efficiency Package A/C (>65 kBtu/hr) 14 SEER	Electric
HVAC	High Efficiency Package Terminal A/C Tier 2 (< 65 kBtu/hr)	Electric
HVAC	High Efficiency Package Terminal A/C Tier 2 (> 65 and < 135 kBtu/hr)	Electric
HVAC	Reflective Window Film	Electric
HVAC	Cool Roof	Electric
HVAC	HVAC Fan Motor	Electric
HVAC	Cooling Circulation Pump VSD	Electric
HVAC	Thermostat Controls – Electric Heat and A/C	Electric
HVAC	Thermostat Controls – A/C and Gas Heat	Both
HVAC	Gas Boiler Tune-Up	Gas
HVAC	High Efficiency Space Heating Boiler	Gas
HVAC	Boiler Pipe Insulation	Gas
Refrigeration	Night Covers for Horizontal Display Case	Electric
Refrigeration	Night Covers for Vertical Display Case	Electric
Refrigeration	Low Temp Vertical Open Case to New Reach-In	Electric
Refrigeration	Medium Temp Vertical Open Case to New Reach-In	Electric
Refrigeration	Anti-Sweat Heater Controls	Electric
Refrigeration	Infiltration Barriers for Walk-ins	Electric
Refrigeration	Permanent-Split Capacitor (PSC) Evaporator Fan Motor	Electric
Refrigeration	Electric Commercial (ECM) Evaporator Fan Motor	Electric
Refrigeration	Electric Commercial (ECM) Evaporator Fan Motor for Walk-Ins	Electric
Refrigeration	Evaporator Fan Controller for Walk-In Coolers	Electric
Refrigeration	Conventional Single-Line to Multiplex Compressor System	Electric
Refrigeration	Add Floating Head Pressure Control to Multiplex System	Electric
Refrigeration	Multiplex System with Efficient (oversized) Condenser	Electric
Refrigeration	High Efficiency Low-Temperature Compressor	Electric

The analysis was conducted for 12 building types: colleges, grocery stores, health-related buildings, lodging, large office buildings, refrigerated buildings, retail, restaurants, schools, small office buildings, warehouses, and miscellaneous. In addition, forecasts are divided into the same 21 electric climate zones used in the residential analysis.[1]

5.2 Electric Efficiency Potential

Technical and Economic Potential

Total Commercial IOU Technical and Economic Potential

Figure 5-1 and Figure 5-2 present the total estimated electric energy and demand savings potential resulting from the analysis for the three state investor owned utilities (Pacific Gas & Electric (PG&E), Southern California Edison (SCE), and San Diego Gas & Electric (SDG&E). Also shown in these figures is the forecasted electricity use and demand for these three utility service areas as estimated by the California Energy Commission (CEC).[2] The values are provided for the last year of the analysis, 2016.

As shown in Figure 5-1, total estimated electric technical potential for energy savings is 13,932 GWh, and total estimated electric economic potential is 11,290 GWh. Figure 5-2 shows total estimated technical potential for demand reduction to be 3,096 MW and total estimated economic potential for demand reduction to be 1,996 MW. The technical potential is about 15% of the expected energy sales and about 10% of the expected demand in 2016. Economic potential is about 12% of the expected energy sales and about 7% of the expected demand in 2016.

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1 Please see Table 3-2 for a list of Climate Zones, by IOU, used in the analysis.

2 California Energy Commission. *California Energy Demand 2006-2016: Staff Energy Demand Forecast.* June 2005.

Figure 5-1: Forecast Electricity Use and Total IOU Gross Energy Savings – Technical and Economic Potential in Existing Commercial Buildings – 2004-2016

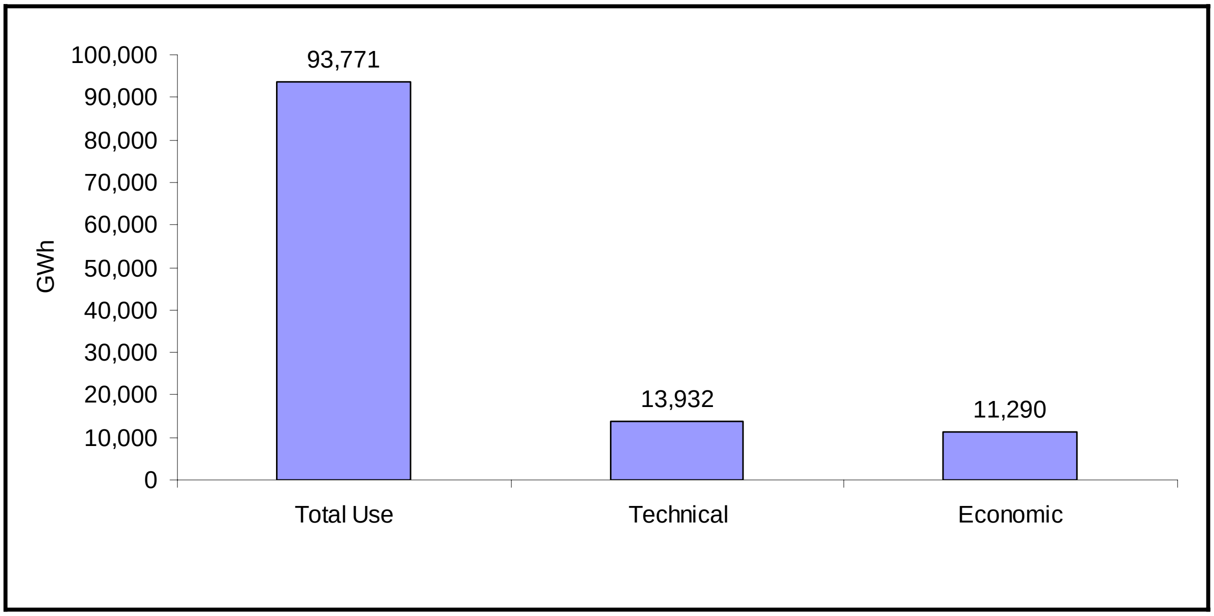


Figure 5-2: Forecast Electricity Demand and Total IOU Gross Demand Savings – Technical and Economic Potential in Existing Commercial Buildings – 2004-2016

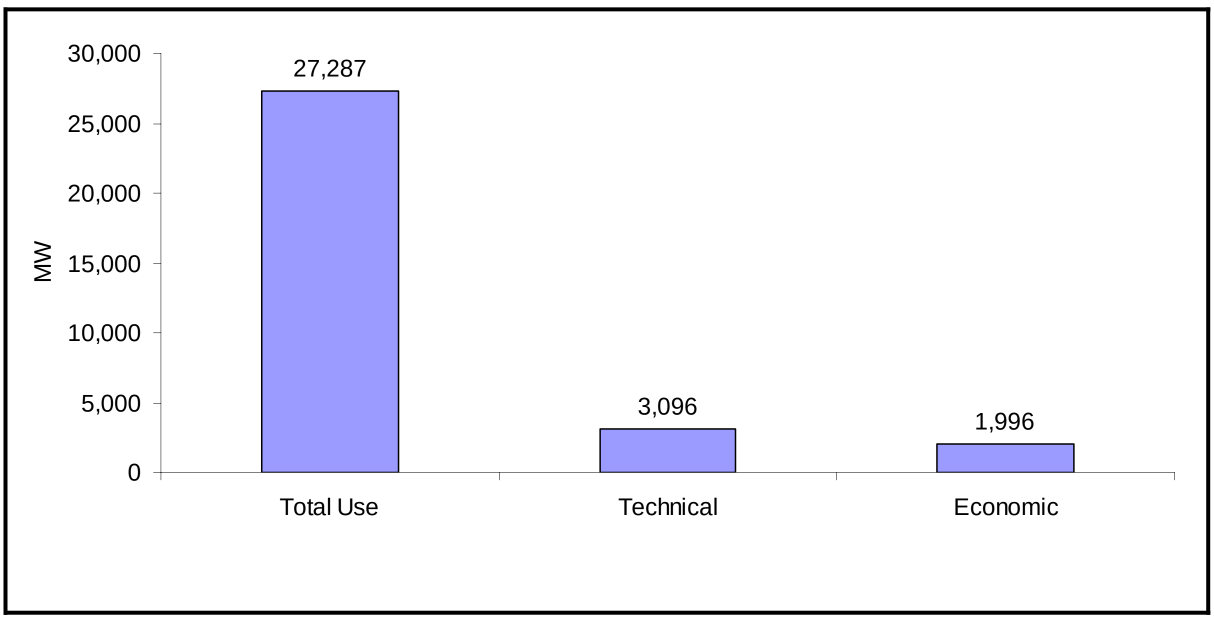


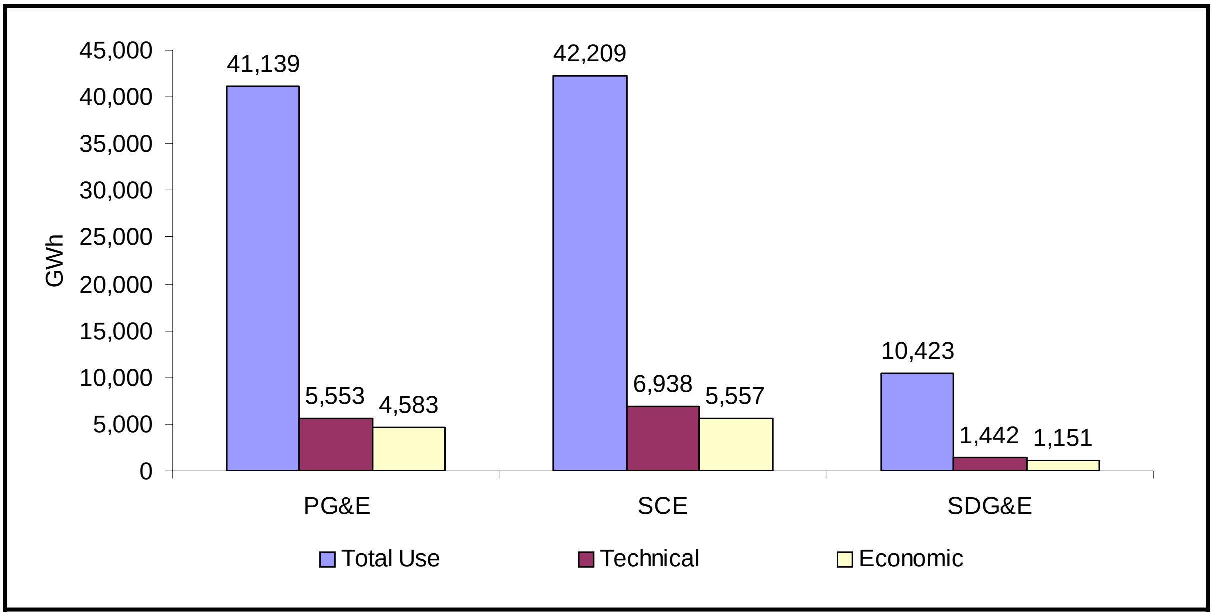
Table 5-2 summarizes the CEC energy and demand forecasts for 2016 by utility area.[3]

Table 5-2: California Energy Commission's Commercial Electricity Forecast – 2004-2016

PG&E		SCE		SDG&E		Total	
GWh	MW	GWh	MW	GWh	MW	GWh	MW
41,139	8,082	42,209	8,782	10,423	2,126	93,771	27,287

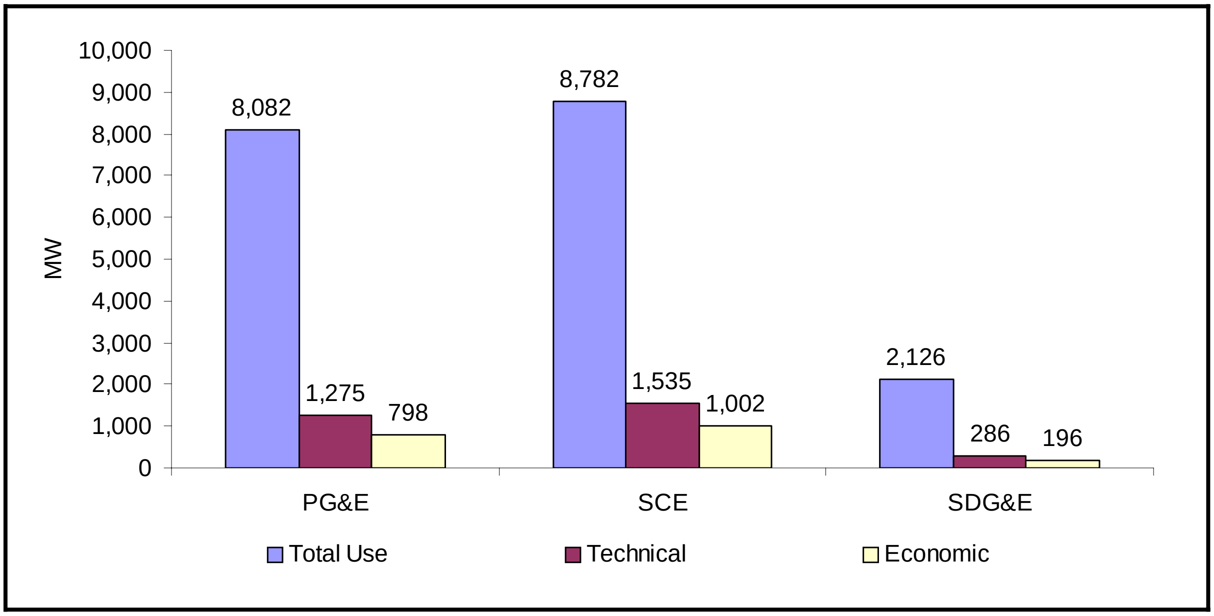
Figure 5-3 and Figure 5-4 present energy and demand savings potentials along with the CEC energy and demand forecasts for 2016 disaggregated by utility service area. These figures illustrate that technical and economic potential are highest for the SCE service area, although results for the PG&E utility area are a close second. In terms of percent of forecasted energy use and electricity demand, the biggest share of both technical and economic potential is in the SCE service territory, followed closely by SDG&E and PG&E, respectively.

Figure 5-3: Forecast Electricity Use and Estimated Gross Technical and Economic Energy Potential by Utility in Existing Commercial Buildings – 2004-2016



3 CEC, op. cit., Forms 1.1 and 1.3.

Figure 5-4: Forecast Electricity Demand and Estimated Gross Technical and Economic Demand Potential by Utility in Existing Commercial Buildings – 2004-2016



Technical and Economic Potential by End Use

Table 5-3 summarizes the gross economic potential results by end use and by utility. Miscellaneous measures include cooking, water heating, office equipment, and vending machines. Lighting measures exhibit the greatest electric energy savings potential at 5,738 GWh, followed by refrigeration measures at 3,064 GWh. Lighting measures also contribute the highest peak demand potential savings at 866 MW, followed by HVAC and refrigeration measures at 641 and 437 MW, respectively.

Table 5-3: Gross Economic Potential by End Use and Utility in Existing Commercial Buildings – 2004-2016

End Use	PG&E		SCE		SDG&E		Total	
	GWh	MW	GWh	MW	GWh	MW	GWh	MW
Lighting	2,376	351	2,754	422	608	93	5,738	866
HVAC	724	232	1,164	349	226	60	2,115	641
Refrigeration	1,330	195	1,459	205	275	37	3,064	437
Miscellaneous	152	21	180	26	42	6	373	53
Total	4,583	798	5,557	1,002	1,151	196	11,290	1,996

Figure 5-5 presents estimates of electric energy savings by end use for all IOUs. This figure shows that the technical potential for lighting, refrigeration, and miscellaneous closely mirrors their economic potential. The economic potential for energy savings for HVAC measures is approximately half the technical potential for energy savings. Figure 5-6 presents estimates of electric demand savings by end use for all IOUs. Again, economic potential nearly equals technical demand potential for all end uses other than HVAC. The remaining economic demand potential for HVAC high-efficiency measures is approximately 40% of the technical potential. These results indicate that nearly all non-HVAC commercial measures are cost effective, while many HVAC measures do not pass an economic test.

Figure 5-5: Total IOU Gross Technical and Economic Energy Potential by End Use in Existing Commercial Buildings – 2004-2016

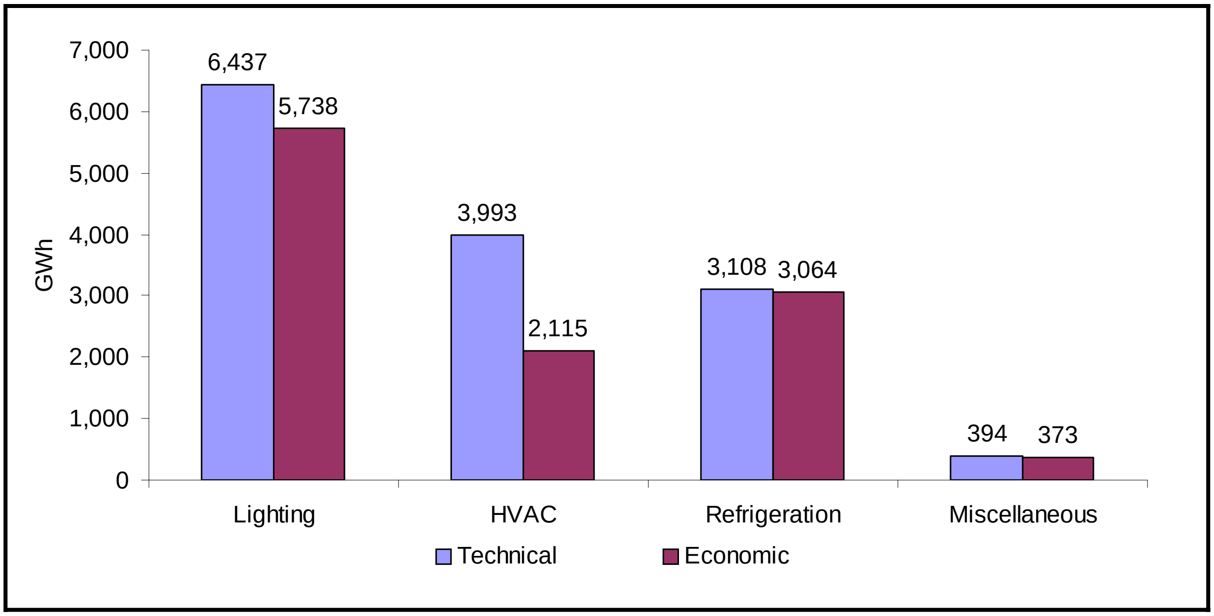


Figure 5-6: Total IOU Gross Technical and Economic Demand Potential by End Use in Existing Commercial Buildings – 2004-2016

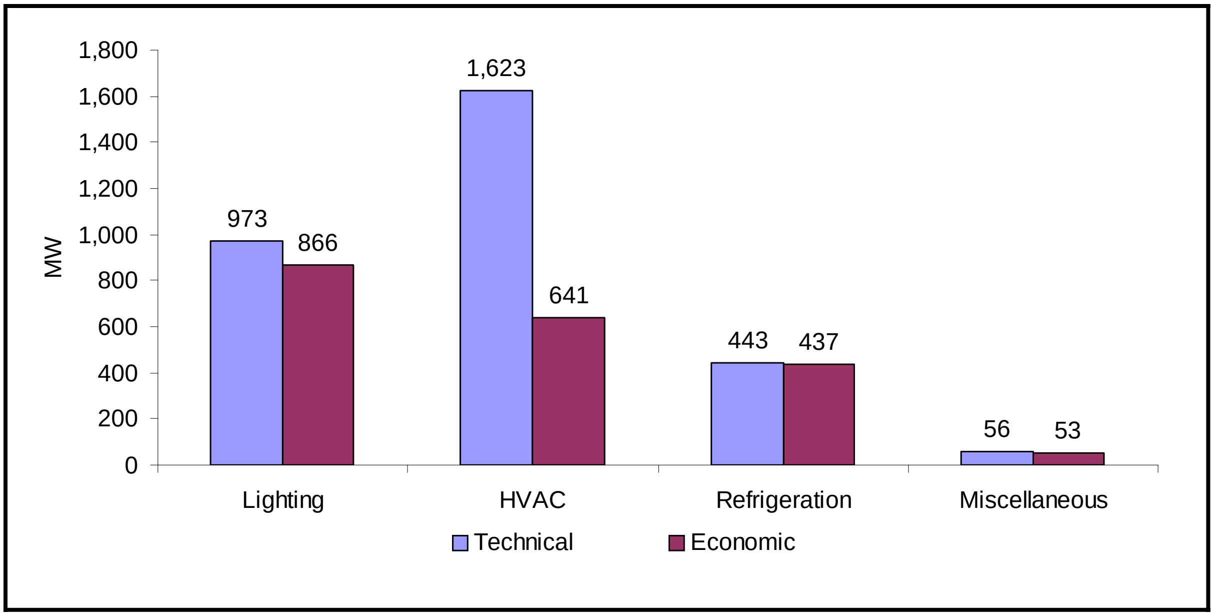


Figure 5-7 and Figure 5-8 present estimates of technical potential at the measure group level (group of similar measures), in order of descending potential for energy and demand savings, respectively. As shown in Figure 5-7, screw-in CFLs and hardwired CFL fixtures are the largest contributor to technical energy savings (2,278 GWh). After CFLs, measure groups contributing the next largest amount of energy savings (in decreasing order) are refrigeration motors, cooling tune-ups, and occupancy sensors.

The demand technical potential results presented in Figure 5-8 show that cooling tune-ups contribute the largest peak demand reduction (851 MW). After cooling tune-ups, measure groups contributing large peak demand reductions include (in decreasing order) HE DX, CFLs, HE DX, refrigeration motors, and occupancy sensors.

Figure 5-7: Electric Gross Energy Savings by Measure Groupings in Existing Commercial Buildings (Technical Potential) – 2004-2016

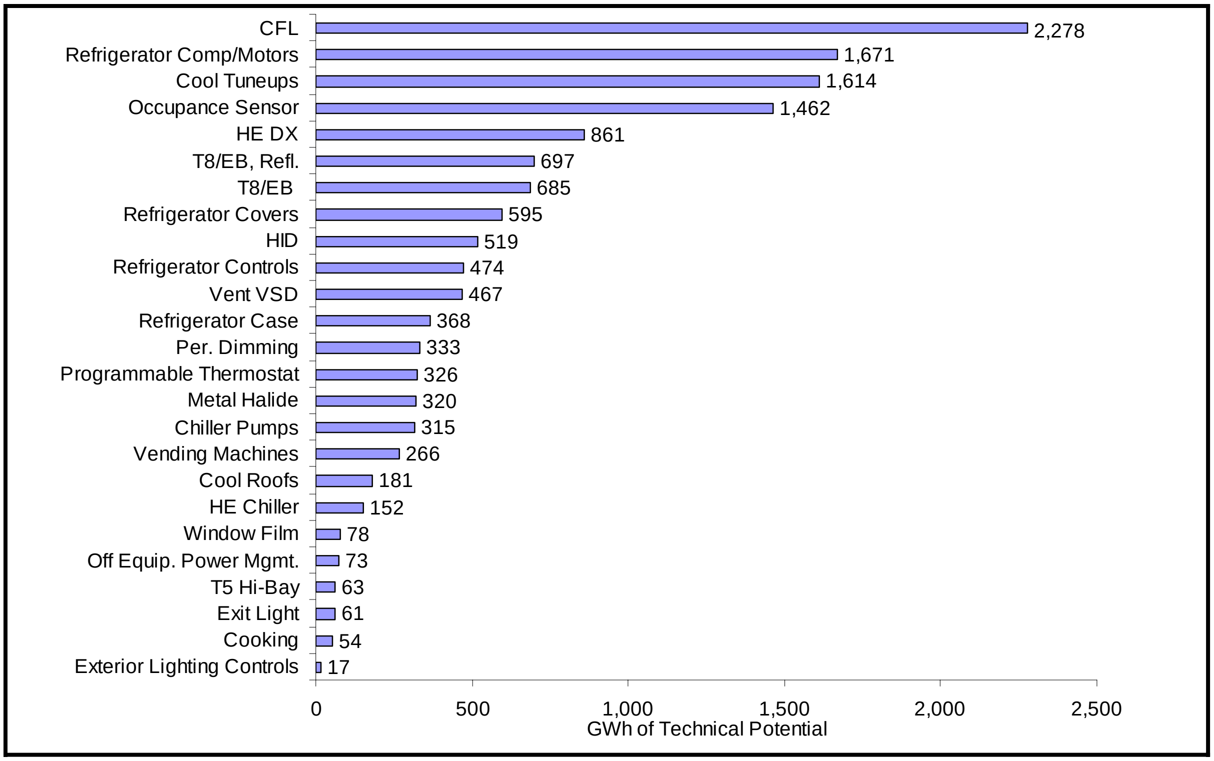
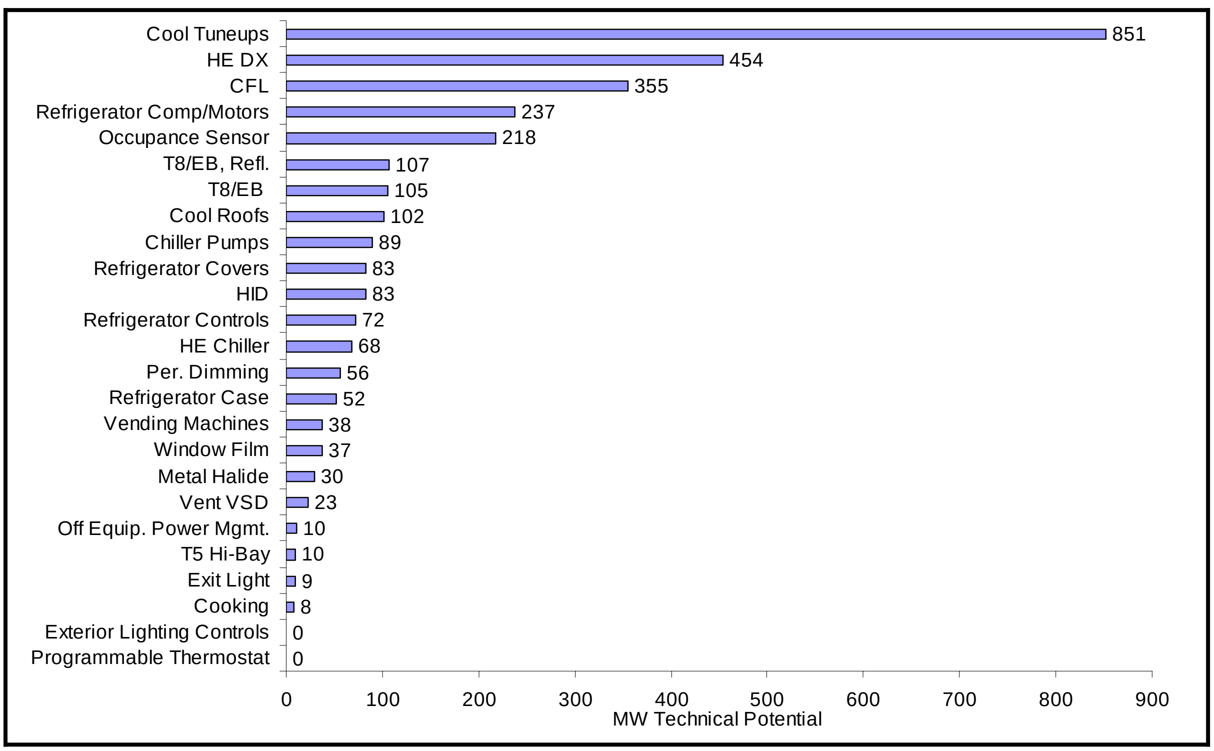


Figure 5-8: Electric Gross Demand Savings by Measure Groupings in Existing Commercial Buildings (Technical Potential) – 2004-2016



Market Potential for Energy Efficiency

This subsection presents the estimates of the remaining market potential for the three program funding scenarios and two measure lists. Results were derived for the current 2004-2005 energy efficiency program incentive level (current), a full incremental cost incentive, and an average between the current and full incremental cost level. Table 5-4 describes the commercial market scenarios for existing buildings.

The current analysis is limited to IOU specific measures incentivized in 2004. Limited results are presented for the full 2004 measures and average 2004 measures market scenarios, which increase incentive levels while restricting the measure analyzed to those incentivized in 2004. The full and average market scenarios are analyzed for all measures included in the economic and technical analysis. The list of measures added in the technical, economic, full, and average scenarios are listed in Table 5-5.

Table 5-4: Market Scenario Descriptions for Existing Commercial Buildings

Market Scenario Name	Description
Current	2004 incentive level, restricted to IOU specific measures incentivized in 2004. For measures experiencing standards changes in 2006, the rebate level changes in 2006.
Average – 2004 Measures	Average between current and full incremental cost incentive levels with the measure list restricted to those incentivized in 2004.
Average	The average between current and full incremental cost incentive levels with all the measures analyzed in the technical and the economic scenarios.
Full – 2004 Measures	Full incremental measure cost with the high efficiency measure list restricted to those incentivized in 2004.
Full	Full incremental measure cost incentive levels with all the measures analyzed in the technical and the economic scenarios. For retrofit and conversion measures a working measure is replaced, therefore the full incremental measure cost is the cost of the measure. For replace on burn out measures the full incremental measures cost is the incremental cost between the low and high efficiency measure.

The market forecast for the full incremental cost and the average market scenario analyses increase both the incentive levels and the number of high efficiency measures. Table 5-5 lists the IOU-specific high efficiency measures added for the full and average scenarios. The measures added either existed in the 2004 program accomplishments of other California

IOUs or were chosen by the project team following an analysis of previous program accomplishment, past potential studies, and the 2001 and 2005 DEER.[4,5]

Table 5-5 illustrates that several high efficiency HVAC, lighting, and miscellaneous measures were added to the electric full and average market scenario analyses. For the market analyses, more measures were added to SDG&E (16 additional measures) than to either SCE (10 measures) or PG&E (10 measures).

Table 5-5: IOU-Specific Measures Added to the Full and Average Market Analyses

End Use	Measures	SDG&E	SCE	PG&E
HVAC	High Efficiency Package Terminal A/C Tier 2 (<65 kBtu/hr)	Existed	Existed	Added
HVAC	High Efficiency Package Terminal A/C Tier 2 (+> 65 and <135 kBtu/hr)	Added	Added	Added
HVAC	Chiller Tune-Up	Added	Added	Added
HVAC	DX Tune-Up	Added	Added	Added
HVAC	High-Efficiency Reciprocating Chiller (0.51 kW per ton)	Added	Added	Added
HVAC	Thermostat Controls on A/C Units - Single Zone	Added		
HVAC	Cooling Circulation Pump VSD	Added	Added	Added
HVAC	High Efficiency Package A/C (>65 kBtu/hr) SEER 13	Added		
HVAC	High Efficiency Package A/C (>65 kBtu/hr) SEER 14		Added	Added
Lights	Electronic Ballast, Dimming (with daylighting)	Added	Existed	Existed
Lights	Exterior Pulse Start MH 0-100W (incandescent base case)	Added	Existed	Existed
Lights	Interior HID Fixture 36-70 W (mercury vapor base case)	Existed	Added	Existed
Lights	Interior HID Fixture 176-250 W (mercury vapor base case)	Added	Existed	Existed
Lights	Occupancy Sensor - Plug Load	Added	Existed	Existed
Miscellaneous	Insulated Holding Cabinet	Added	Existed	Existed
Miscellaneous	Pressureless Steamer	Added	Existed	Existed
Miscellaneous	Small ENERGY STAR Copy Machine – 0-20 copies/minute	Added	Added	Added
Miscellaneous	Vending Machine Control – Nonrefrigerated	Added	Added	Added
Refrigeration	Electric Commercial (ECM) Evaporator Fan Motor for Walk-Ins	Added	Added	Added

4 Xenergy, Inc. *2001 DEER (Database for Energy Efficient Resources) Update Study*. Prepared for the California Energy Commission. August 2001.

5 Itron, Inc. 2004-2005 Database for Energy Efficiency Resources (DEER) Update Study: Final Report. Prepared for Southern California Edison. December 2005.

Table 5-6 presents the energy and demand savings through 2016 under the three incentive levels and the two measure lists. As shown, the current program incentive funding level would result in energy savings of 3,000 GWh and demand savings of 461 MW. Increasing incentives to the average between current incentive levels and the full incremental costs, while maintaining the 2004 measures list, raises the estimate of energy savings to 3,579 GWh (an increase of 19%) and demand savings to 568 MW (a 23% increase). Further increasing incentives to full incremental costs, with the restricted measure list, adds 328 GWh of energy savings, a 9% increase. Full incremental cost incentive levels with the 2004 measures list are also estimated to add 47 MW (for a total of 615 MW) to demand savings, an 8% increase over the estimate of average 2004 measures market scenario demand savings.

Market forecasts that increase both the high efficiency measure list (see Table 5-5) and the incentive levels lead to a forecast of potential savings associated with a more expanded commercial energy efficiency program. The average scenario forecast is estimated to produce savings of 4,104 GWh and 787 MW. Comparing the current forecast with the average market forecast, the energy forecast increased 37% and the demand forecast of potential savings increased 71%. If the average market scenario is compared to the average 2004 measures scenario, expanding the measure list increases savings by 525 GWh and 219 MW. The full incremental cost scenario increases incentives to cover full incremental costs and includes all of the additional high efficiency measures listed in Table 5-5. The full incremental cost estimate of remaining energy and demand potential are 4,720 GWh and 982 MW, respectively. Increasing incentives from the average scenario levels to the full incremental costs added 13% to energy savings and 25% to demand reduction.

Table 5-6: Estimated Market Potential in Existing Commercial Buildings by Funding Level – 2004-2016

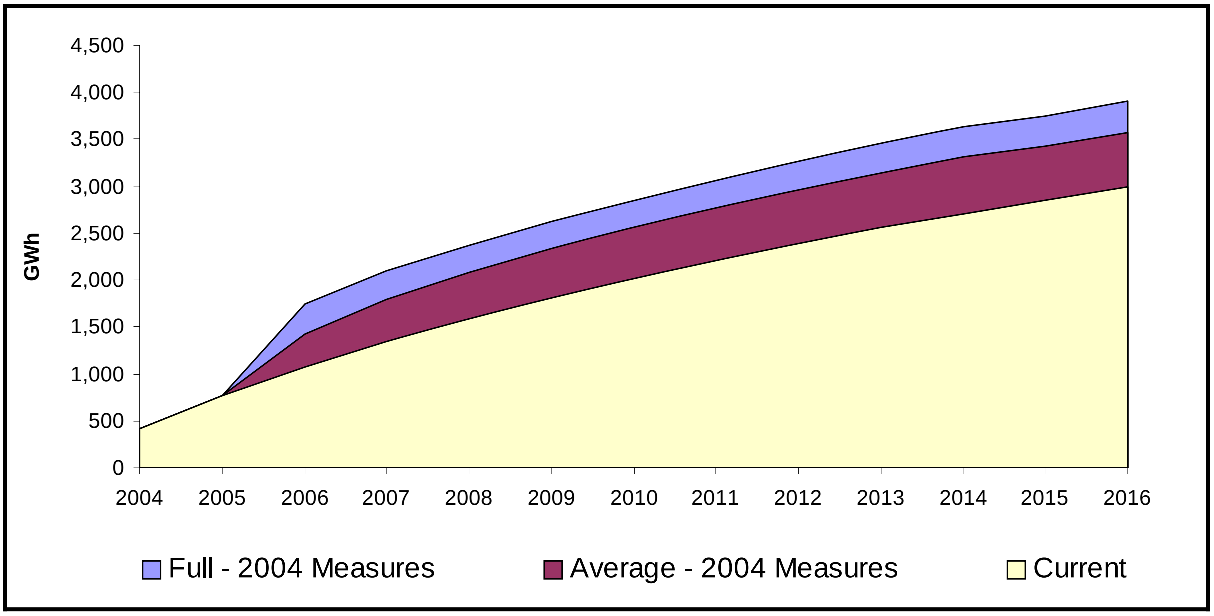
Funding Level	Energy (GWh)	Demand (MW)
Current	3,000	461
Average – 2004 Measures	3,579	568
Average	4,104	787
Full – 2004 Measures	3,907	615
Full	4,720	982

* Refer to Table 5-4 for descriptions of the market scenario funding levels.

The current, average 2004 measures, and full 2004 measures market scenario results for year 2004 through 2016 are illustrated in Figure 5-9 and Figure 5-10. In these figures, all three analyses have the same potential savings for 2004 and 2005, with higher incentives for the full 2004 measures and average 2004 measures analyses beginning in 2006. An illustration of the average and the full market scenarios would have a shape similar to those shown in

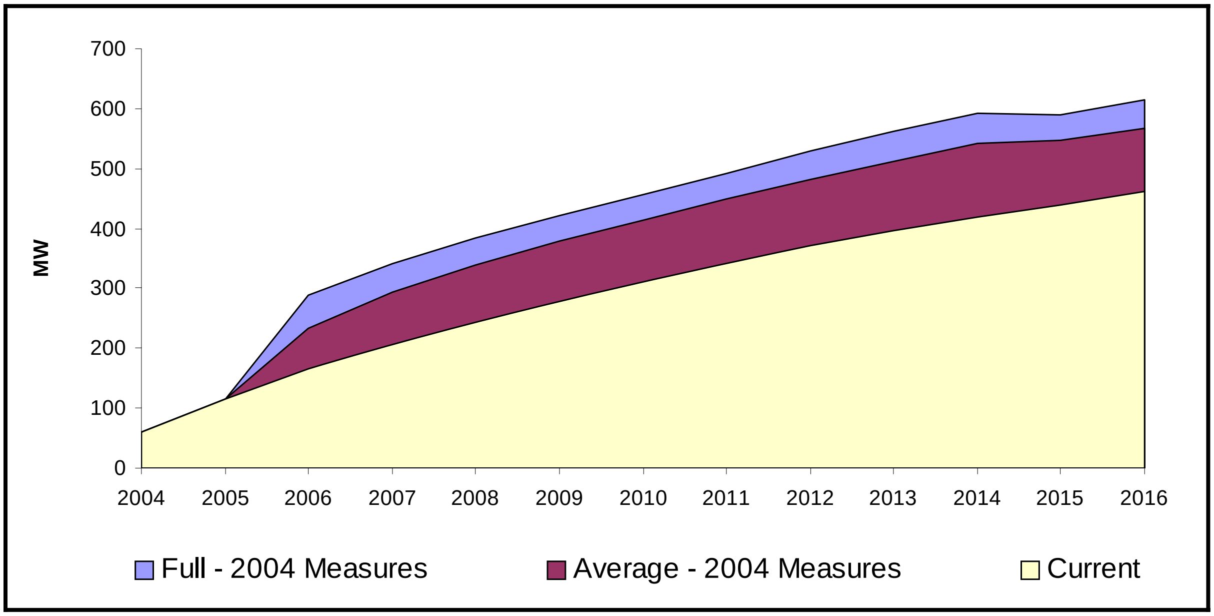
Figure 5-9 and Figure 5-10, with a higher level of potential savings beginning in 2004 due to the augmented measure list.

Figure 5-9: Estimated Gross Energy Market Potential in Existing Commercial Buildings by Funding Level – 2004-2016



* Refer to Table 5-4 for descriptions of the market scenario funding levels.

Figure 5-10: Estimated Gross Demand Market Potential in Existing Commercial Buildings by Funding Level – 2004-2016



* Refer to Table 5-4 for descriptions of the market scenario funding levels.

Market Potential by End Use

Table 5-7 summarizes the energy market potential estimates by funding level and end use. For comparison, technical and economic estimates are also included. Note that lighting measures contribute most of the energy savings for each of the five market potential funding levels.

The second largest contributor to energy savings is the HVAC measure category. The estimated energy savings associated with HVAC measures jumps considerably when the high efficiency measure list is augmented to include the measures in Table 5-5. Increasing incentives for HVAC measures from the current levels to the average level while maintaining the 2004 measures list increases energy savings 22%. Increasing incentives from current levels to the average between current and full incremental cost and augmenting the measure list, increases potential energy savings by 101%.

Table 5-7: Estimated Gross Energy Market Potential by Funding Level and End Use in Existing Commercial Buildings – 2004-2016 (GWh)

End Use	Technical	Economic	Current	Average – 2004 Measures	Average	Full – 2004 Measures	Full
Lighting	6,437	5,738	1,780	2,192	2,194	2,420	2,424
HVAC	3,993	2,115	655	802	1,315	879	1,676
Refrig.	3,108	3,064	528	546	550	564	570
Misc.	394	373	37	40	45	44	51
Total	**13,932**	**11,290**	**3,000**	**3,580**	**4,104**	**3,907**	**4,720**

* Refer to Table 5-4 for descriptions of the market scenario funding levels.

Table 5-8 summarizes the market potential estimates for peak demand reduction by funding level and end use. For comparison, technical and economic estimates are also included.

The current, average – 2004 measures, and the full – 2004 measures market forecasts of lighting peak demand potential is larger than the peak demand potential of HVAC, refrigeration, and miscellaneous measures. For market scenarios with the expanded measure list, HVAC measures are estimated to have the highest remaining demand reduction potential.

Table 5-8: Estimated Gross Demand Market Potential by Funding Level and End Use in Existing Commercial Buildings – 2004-2016 (MW)

End Use	Technical	Economic	Current	Average – 2004 Measures	Average	Full – 2004 Measures	Full
Lighting	973	866	273	336	336	370	371
HVAC	1,623	641	108	150	367	159	524
Refrig.	443	437	74	76	77	79	80
Misc.	56	53	5	6	6	6	7
Total	**3,096**	**1,996**	**461**	**568**	**787**	**614**	**982**

* Refer to Table 5-4 for descriptions of the market scenario funding levels.

Cost and Benefit Results

Table 5-9 presents a summary of the costs, savings, and ratios for the three market scenarios.

Table 5-9: Summary of Commercial Electric Market Potential Results – 2004-2016

Item	Current	Average	Full
Gross Program Costs	$29,069,379	$44,335,358	$54,985,758
Net Measure Costs	$773,740,351	$1,656,789,933	$2,150,178,594
Gross Incentives	$231,615,979	$1,020,263,075	$2,253,065,121
Avoided Cost Benefit	$2,031,445,156	$2,780,609,268	$3,171,958,939
Program TRC	2.53	1.63	1.44

* Refer to Table 5-4 for descriptions of the market scenario funding levels.

As shown, at the statewide commercial electric portfolio level, the portfolio of electric programs is cost-effective based on the results of the TRC test.[6]

Utility-Level Potential, Benefits, and Costs

In this subsection the technical, economic, and market potential are presented over time at the utility level. The utility specific costs, savings, and TRC test results are listed below.

6 For this analysis, the avoided cost was derived from *A Forecast of Cost-Effectiveness Avoided Costs and Externality Adders* by Energy and Environmental Economics, Inc., January 2004. If the avoided costs have increased significantly since the costs were determined, more commercial HVAC measures in existing buildings might be cost effective at alternative market funding levels.

Figure 5-11, Figure 5-12, and Figure 5-13 illustrate the estimated current, average, full, economic, and technical potential for PG&E, SCE, and SDG&E. Table 5-10, Table 5-11, and Table 5-12 list the market, economic, and technical potential by utility and end-use. These figures and tables help illustrate the IOU-specific energy efficiency savings potential from their commercial programs for existing commercial buildings.

PG&E Potential Electric Energy Savings Forecasts

The results presented in Table 5-10 list PG&E's market, economic, and technical energy savings potential. If PG&E continues with its current incentive levels, it is estimated to save 1,109 GWh from its existing commercial energy efficiency program in 2016. Increasing incentives to the average between current and full incentives, and augmenting the current measure list, is forecast to increase energy savings to 1,557 GWh, a 40% increase. Further increasing incentives to full incremental costs is estimated to increase savings to 1,818, an additional 17% increase.

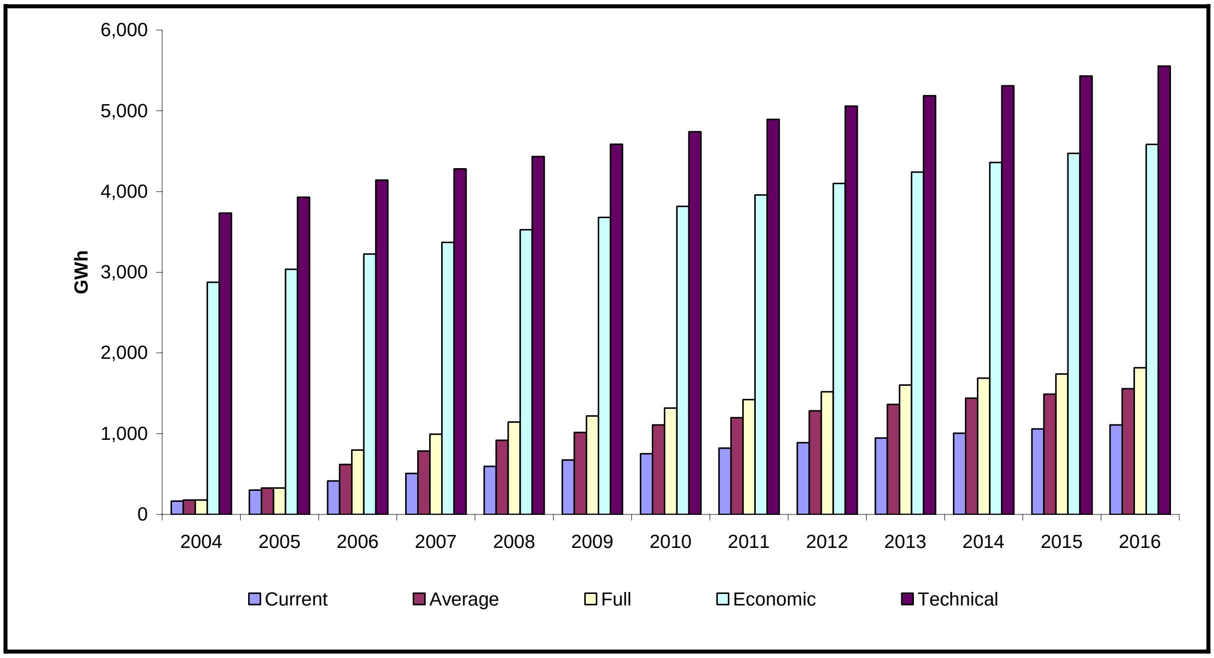
Increasing incentives from 2004 levels (current) to the average between current and full leads to a 92% increase in HVAC potential savings. The large increase is due in part to the increase in the number of HVAC measures analyzed in the average and full market scenarios (see Table 5-5). Increasing HVAC incentives from average to full increases estimated energy savings by an additional 20%.

Table 5-10: Estimated PG&E Gross Energy Market Potential by Funding Level and End Use in Existing Commercial Buildings – 2004-2016 (GWh)

Total	Technical	Economic	Full	Average	Current
2004	3,731	2,876	178	178	165
2005	3,930	3,036	329	329	301
2006	4,141	3,223	799	618	413
2007	4,280	3,368	992	786	508
2008	4,431	3,528	1,145	920	595
2009	4,586	3,679	1,218	1,018	676
2010	4,739	3,817	1,317	1,110	750
2011	4,892	3,957	1,421	1,198	821
2012	5,057	4,099	1,519	1,285	889
2013	5,185	4,241	1,602	1,364	948
2014	5,309	4,359	1,688	1,440	1,004
2015	5,429	4,472	1,740	1,489	1,057
2016	5,553	4,583	1,818	1,557	1,109

Figure 5-11 presents the estimate of PG&E's remaining energy efficiency potential in existing commercial buildings under current, average, and full market scenarios. The economic and technical potential forecasts are also illustrated.

Figure 5-11: Estimated PG&E Gross Technical, Economic, and Market Energy Savings in Existing Commercial Buildings – 2004-2016



* Refer to Table 5-4 for descriptions of the market scenario funding levels.

SCE Potential Electric Energy Savings Forecasts

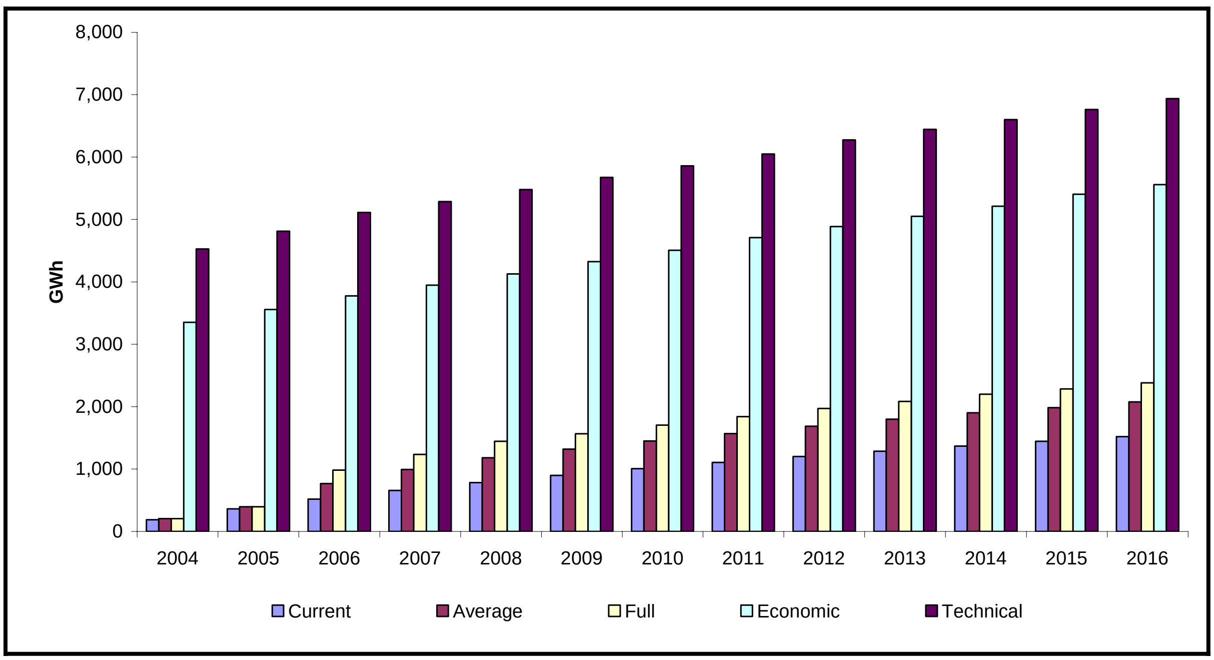
Table 5-11 lists SCE's market, economic, and technical electric energy potential by end use. If SCE continues with its 2004 incentive levels, it is forecast to save 1,518 GWh from its commercial energy efficiency program in 2016. Increasing SCE's list of high efficiency measures and increasing incentives to the average level increases potential savings to 2,076 GWh, an increase of 37% over current energy savings. The end use with the largest increase in savings, when incentives are increased from the current level to the average between current and full, is HVAC. HVAC savings increase 136%. The large increase is due to the addition of several HVAC measures to the average market forecast that were not included in the current forecast (see Table 5-5). Further increasing incentives to full incremental measure costs is estimated to increase savings to 2,381 GWh, a 15% increase.

Table 5-11: Estimated SCE Gross Energy Market Potential by Funding Level and End Use in Existing Commercial Buildings – 2004-2016 (GWh)

Total	Technical	Economic	Full	Average	Current
2004	4,525	3,350	204	204	188
2005	4,812	3,557	396	396	362
2006	5,113	3,777	983	766	518
2007	5,286	3,948	1,236	994	655
2008	5,480	4,124	1,444	1,179	782
2009	5,673	4,323	1,565	1,319	898
2010	5,859	4,507	1,704	1,448	1,006
2011	6,049	4,709	1,841	1,570	1,106
2012	6,274	4,885	1,968	1,687	1,201
2013	6,442	5,051	2,084	1,796	1,287
2014	6,601	5,213	2,199	1,900	1,368
2015	6,763	5,405	2,282	1,985	1,445
2016	6,938	5,557	2,381	2,076	1,518

Figure 5-12 illustrates SCE's market, economic, and technical potential from cumulative adoptions through 2016.

Figure 5-12: Estimated SCE Gross Technical, Economic, and Market Energy Savings Existing Commercial Buildings – 2004-2016



* Refer to Table 5-4 for descriptions of the market scenario funding levels.

<u>SDG&E Potential Electric Energy Savings Forecasts</u>

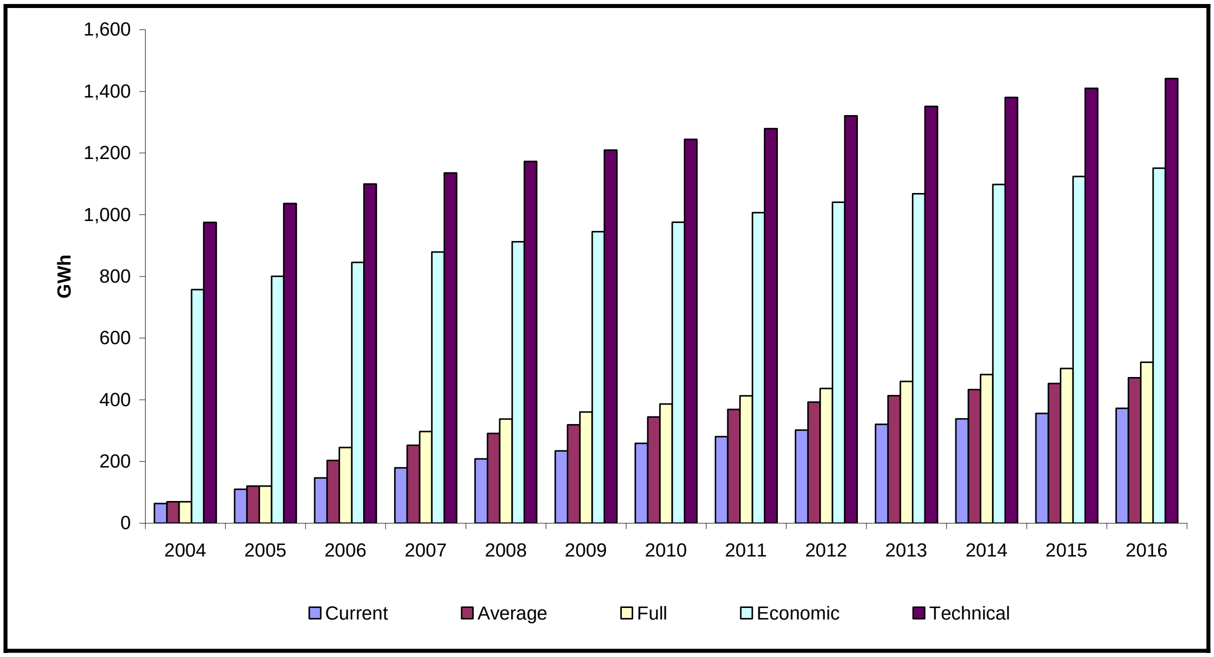
Table 5-12 lists SDG&E's market, economic, and technical forecast by end use for the year 2016. Under current incentive levels, SDG&E's forecast commercial energy efficiency savings is 373 GWh. Augmenting SDG&E's commercial high efficiency measure list and increasing its incentives to the average between current and full incremental cost will increase savings to 472 GWh, a 27% increase. Increasing incentives to the average between current and full substantially increases the potential forecast for HVAC measures due to an increase in the number of HVAC measures analyzed (see Table 5-5). Further increasing incentives to full incremental costs increases the estimate of savings to 522 GWh, or an additional savings of 11%.

Table 5-12: Estimated SDG&E Gross Energy Market Potential by Funding Level and End Use in Existing Commercial Buildings – 2004-2016 (GWh)

Total	Technical	Economic	Full	Average	Current
2004	975	757	69	69	64
2005	1,036	800	121	121	110
2006	1,100	845	245	203	146
2007	1,135	879	297	253	179
2008	1,173	912	337	291	209
2009	1,210	945	360	319	235
2010	1,244	976	387	345	258
2011	1,280	1,006	413	369	281
2012	1,320	1,041	437	392	302
2013	1,351	1,068	459	413	320
2014	1,380	1,098	482	434	339
2015	1,410	1,124	501	453	356
2016	1,442	1,151	522	472	373

Figure 5-13 illustrates SDG&E's market, economic, and technical potential from cumulative adoptions through 2016.

Figure 5-13: Estimated SDG&E Gross Technical, Economic, and Market Energy Savings Existing Commercial Buildings – 2004-2016



* Refer to Table 5-4 for descriptions of the market scenario funding levels.

PG&E Potential Demand Savings Forecasts

Table 5-13 lists the estimate of PG&E's end-use market, economic, and technical demand savings from cumulative adoptions through 2016. Under a continuation of the current program design, PG&E's commercial program is estimated to save 170 MW in 2016. Increasing incentives to the average between current and full incremental measure costs, and increasing the number of high efficiency measures incentivized, would add 153 MW (323 MW), a 90% increase over the demand savings from the current incentive levels. Increasing incentives to full incremental measure costs is estimated to further increase demand savings to 421 MW, an additional savings of 30%.

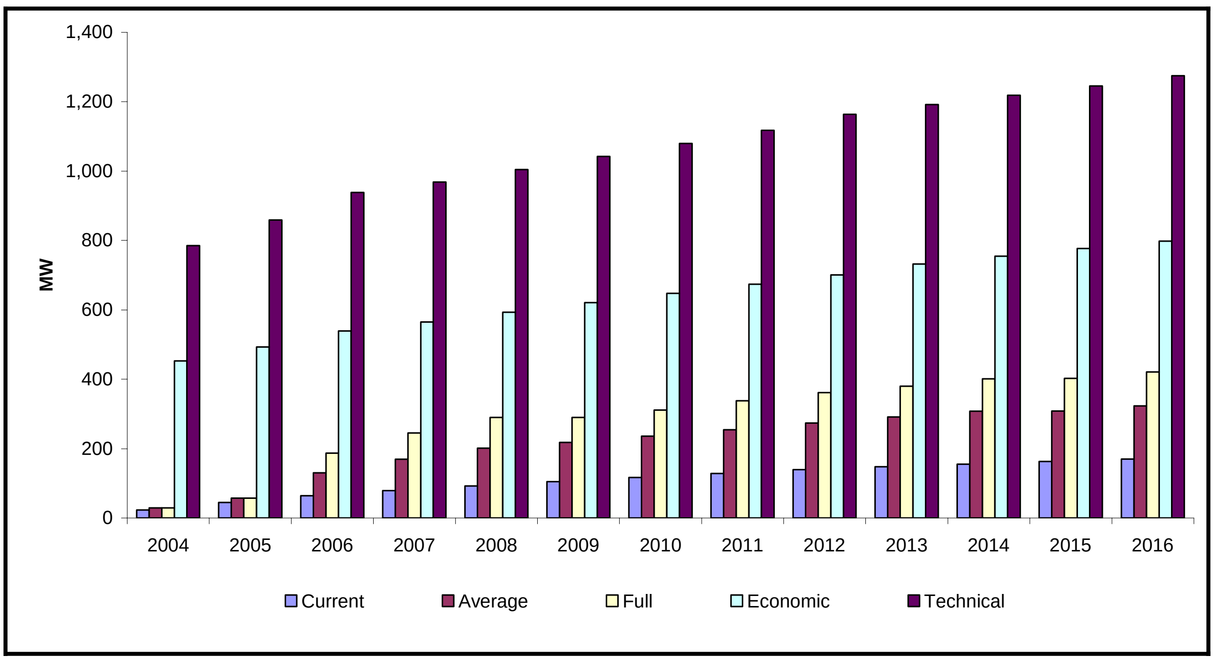
The substantial increase in demand savings associated with increasing incentives from the current level to the scenario level is due to both the increase in incentives and an increase in the number of measures receiving an incentive. Many high efficiency HVAC measures included in this forecast did not receive incentives under the 2004 commercial program. The augmented scenario and the augmented full-cost potential estimates include energy and demand savings potential for measures included in the 2004 program accomplishments and for measures included in Table 5-5.

Table 5-13: Estimated PG&E Gross Demand Market Potential by Funding Level and End Use in Existing Commercial Buildings – 2004-2016 (MW)

Total	Technical	Economic	Full	Average	Current
2004	785	453	29	29	23
2005	859	493	58	58	45
2006	938	539	188	131	65
2007	968	565	245	170	79
2008	1,004	593	290	202	92
2009	1,042	621	290	218	105
2010	1,080	647	311	236	117
2011	1,117	674	338	254	128
2012	1,163	700	362	274	140
2013	1,191	732	380	291	148
2014	1,219	755	401	308	155
2015	1,245	777	403	309	163
2016	1,275	798	421	323	170

Figure 5-14 illustrates the estimate of PG&E's market, economic, and technical demand savings from cumulative adoptions through 2016.

Figure 5-14: Estimated PG&E Gross Technical, Economic, and Market Demand Savings in Existing Commercial Buildings – 2004-2016



* Refer to Table 5-4 for descriptions of the market scenario funding levels.

SCE Potential Demand Savings Forecasts

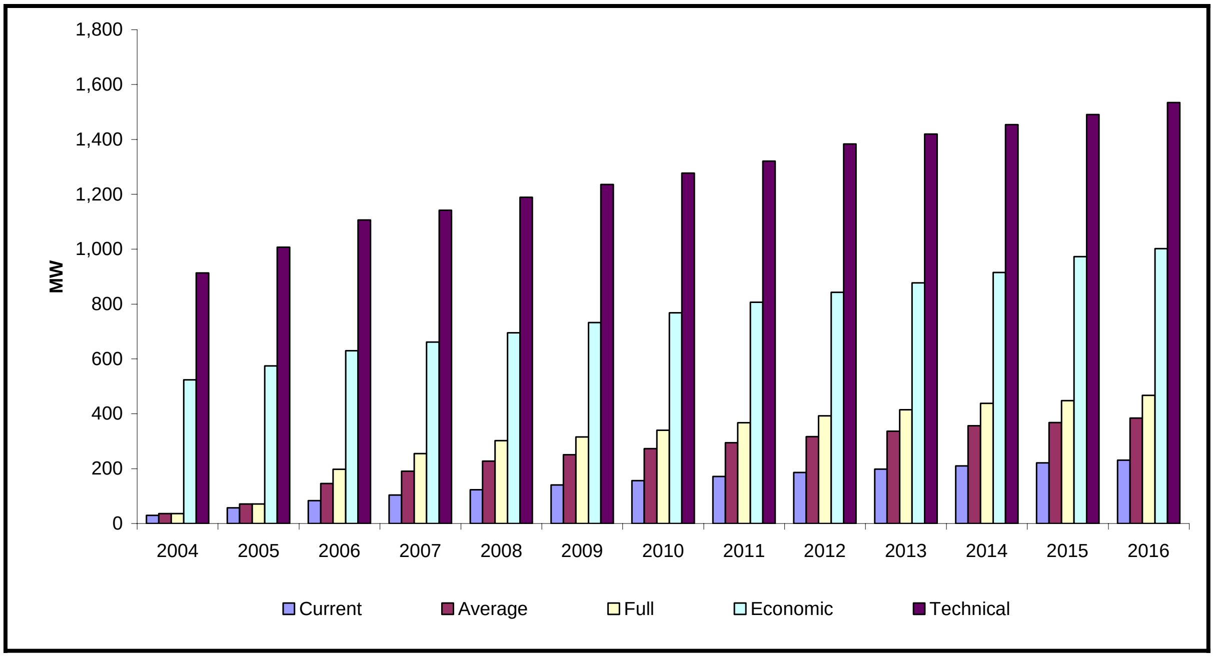
Table 5-14 lists SCE's end-use market, economic, and technical forecast demand potential from cumulative adoptions in 2016. Under current market incentives, SCE is forecast to save 232 MW. Increasing incentives to the average between current and full incremental costs, and incentivizing measures with no accomplishments in SCE's 2004 commercial program (see Table 5-5), is estimated to increase demand savings to 384 MW, a 66% increase. Further increasing incentives to full incremental cost is forecast to increase savings to 467 MW, a 22% increase in demand savings over the average market scenario.

Table 5-14: Estimated SCE Gross Demand Market Potential by Funding Level and End Use in Existing Commercial Buildings – 2004-2016 (MW)

Total	Technical	Economic	Full	Average	Current
2004	913	524	36	36	30
2005	1,007	575	71	71	58
2006	1,106	630	198	146	83
2007	1,142	662	255	191	104
2008	1,189	695	302	228	123
2009	1,235	733	316	251	141
2010	1,277	768	340	273	157
2011	1,321	807	368	295	172
2012	1,383	843	393	317	186
2013	1,420	877	415	337	198
2014	1,454	915	438	357	210
2015	1,491	973	448	368	221
2016	1,535	1,002	467	384	232

Figure 5-15 presents SCE's commercial market, economic, and technical demand savings potential from cumulative adoptions through 2016.

Figure 5-15: Estimated SCE Gross Technical, Economic, and Market Demand Savings in Existing Commercial Buildings – 2004-2016



* Refer to Table 5-4 for descriptions of the market scenario funding levels.

SDG&E Potential Demand Savings Forecasts

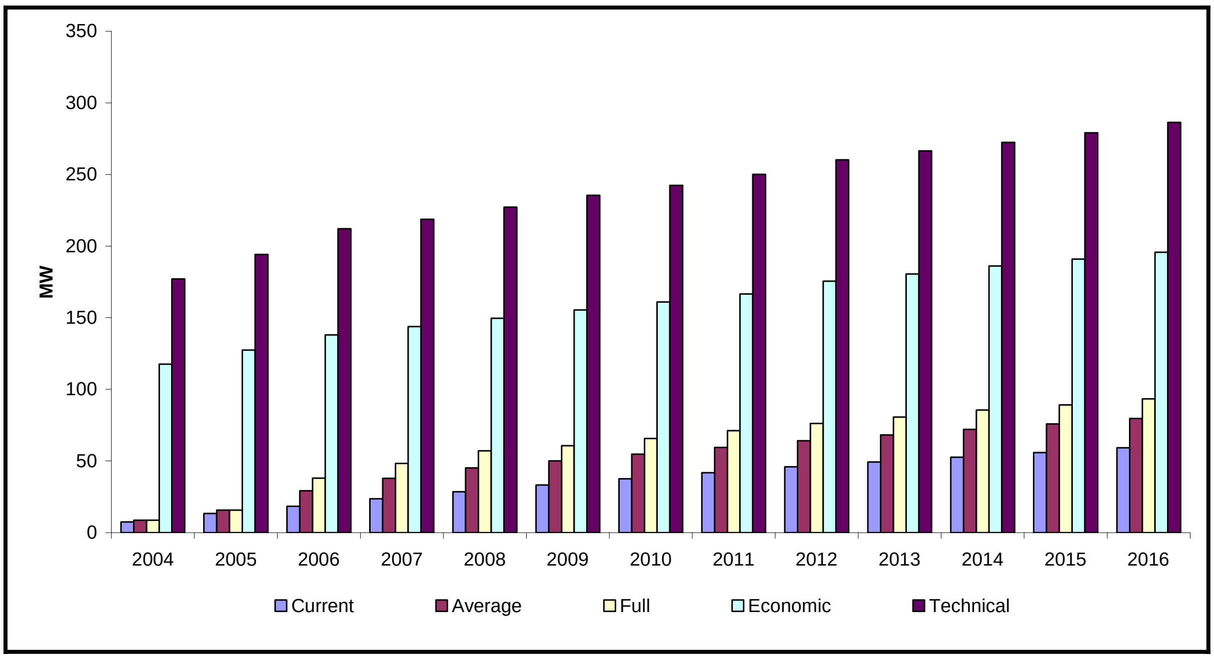
Table 5-15 lists SDG&E end-use market, economic, and technical demand potential. Under a continuation of the current program design, SDG&E is forecast to save 59 MW. Increasing incentives to the average between current and full, and incentivizing measures not currently included in SDG&E commercial program (see Table 5-5), is estimated to increase its demand savings to 80 MW, a 36% increase. Further increasing incentives to full incremental measure costs is estimated to increase demand savings to 93 MW, a 13% increase over the average scenario.

Table 5-15: Estimated SDG&E Gross Demand Market Potential by Funding Level and End Use in Existing Commercial Buildings – 2004-2016 (MW)

Total	Technical	Economic	Full	Average	Current
2004	177	118	9	9	7
2005	194	127	16	16	13
2006	212	138	38	29	18
2007	219	144	48	38	24
2008	227	150	57	45	29
2009	235	155	61	50	33
2010	242	161	66	55	38
2011	250	167	71	59	42
2012	260	176	76	64	46
2013	267	181	81	68	49
2014	272	186	85	72	53
2015	279	191	89	76	56
2016	286	196	93	80	59

Figure 5-16 illustrates SDG&E's forecast demand savings from its commercial energy efficiency program.

Figure 5-16: Estimated SDG&E Gross Technical, Economic, and Market Demand Savings in Existing Commercial Buildings – 2004-2016



* Refer to Table 5-4 for descriptions of the market scenario funding levels.

Utility Specific Electric Costs and Benefits

Table 5-16, Table 5-17, and Table 5-18 list the costs, benefits, and benefit-to-cost ratios for the market forecasts of the IOU commercial energy efficiency programs. As presented in these tables, all three utilities' commercial programs are cost-effective at the current, average, and full incremental cost incentive levels. SCE's commercial programs have the highest benefit-to-cost ratios at 2.65, followed by SDG&E and PG&E. Increasing funding reduces the TRC test results. If incentives were set equal to full incremental measure costs, SDG&E's TRC test would be the highest at 1.55, followed by SCE and PG&E at 1.54 and 1.30, respectively.

Table 5-16: PG&E Commercial Electric Market Costs and Benefits in Existing Commercial Buildings – 2004-2016

Item	Current	Average	Full
Gross Program Costs	$8,916,986	$14,252,337	$18,189,067
Net Measure Costs	$299,159,822	$707,262,692	$943,044,205
Gross Incentives	$94,911,995	$437,664,116	$992,964,250
Net Avoided Cost Benefit	$769,319,990	$1,085,592,443	$1,252,823,655
Program TRC	2.50	1.50	1.30

* Refer to Table 5-4 for descriptions of the market scenario funding levels.

Table 5-17: SCE Commercial Electric Market Costs and Benefits in Existing Commercial Buildings – 2004-2016

Item	Current	Average	Full
Gross Program Costs	$15,762,067	$24,087,402	$29,679,296
Net Measure Costs	$359,197,092	$770,832,135	$979,449,044
Gross Incentives	$99,328,120	$467,008,027	$1,022,030,083
Net Avoided Cost Benefit	$997,114,098	$1,363,438,068	$1,554,777,010
Program TRC	2.65	1.71	1.54

* Refer to Table 5-4 for descriptions of the market scenario funding levels.

Table 5-18: SDG&E Commercial Electric Market Costs and Benefits in Existing Commercial Buildings – 2004-2016

Item	Current	Average	Full
Gross Program Costs	$4,390,326	$5,995,619	$7,117,394
Net Measure Costs	$115,383,448	$178,695,106	$227,685,346
Gross Incentives	$37,375,867	$115,590,932	$238,070,787
Net Avoided Cost Benefit	$265,011,069	$331,578,756	$364,358,273
Program TRC	2.21	1.80	1.55

* Refer to Table 5-4 for descriptions of the market scenario funding levels.

5.3 Gas Efficiency Potential

Technical and Economic Gas Potential

Total IOU Technical and Economic Potential

Figure 5-17 presents the total estimated gas potential resulting from the analysis for the state investor-owned gas utilities of PG&E, SDG&E, and Southern California Gas (SoCalGas). Also shown is the forecasted gas use for these three same utilities as estimated by the CEC.[7] The values are provided for the last year of the analysis, 2016.

As shown, total estimated technical potential is 109 million therms. Total estimated economic potential is 38 million therms. As a percentage of total forecasted 2016 gas sales, technical potential represents about 5% and economic potential about 2% of anticipated sales.

[7] CEC, op. cit., Tables 10-5, 10-6, 10-7.

Figure 5-17: Forecast Gas Use and Estimated Gross Gas Technical and Economic Potential in Existing Commercial Buildings – 2004-2016

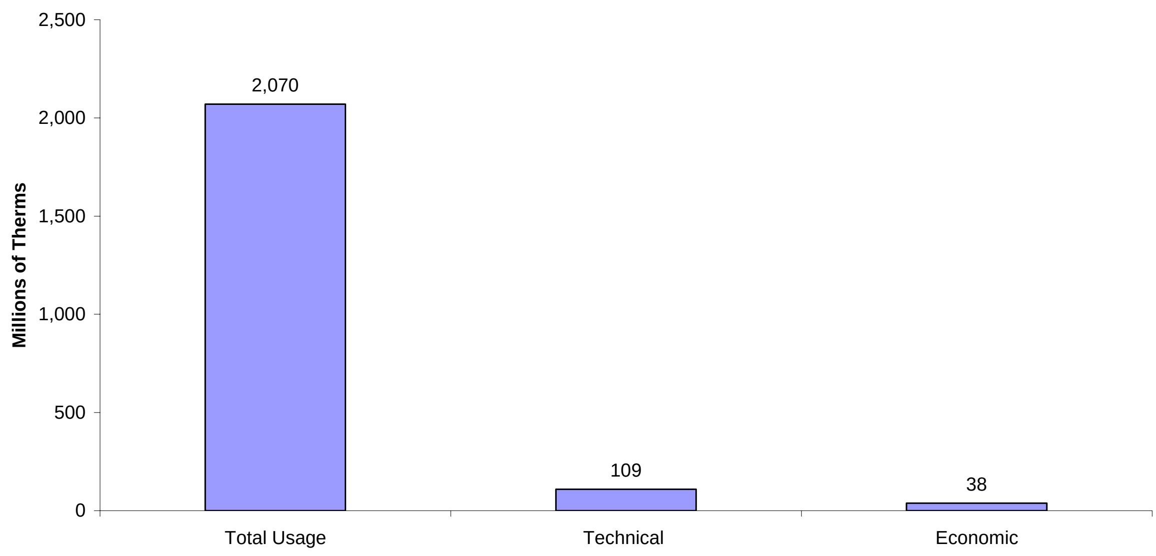


Table 5-19 summarizes the CEC forecast of expected gas sales in 2016 by utility service area.[8]

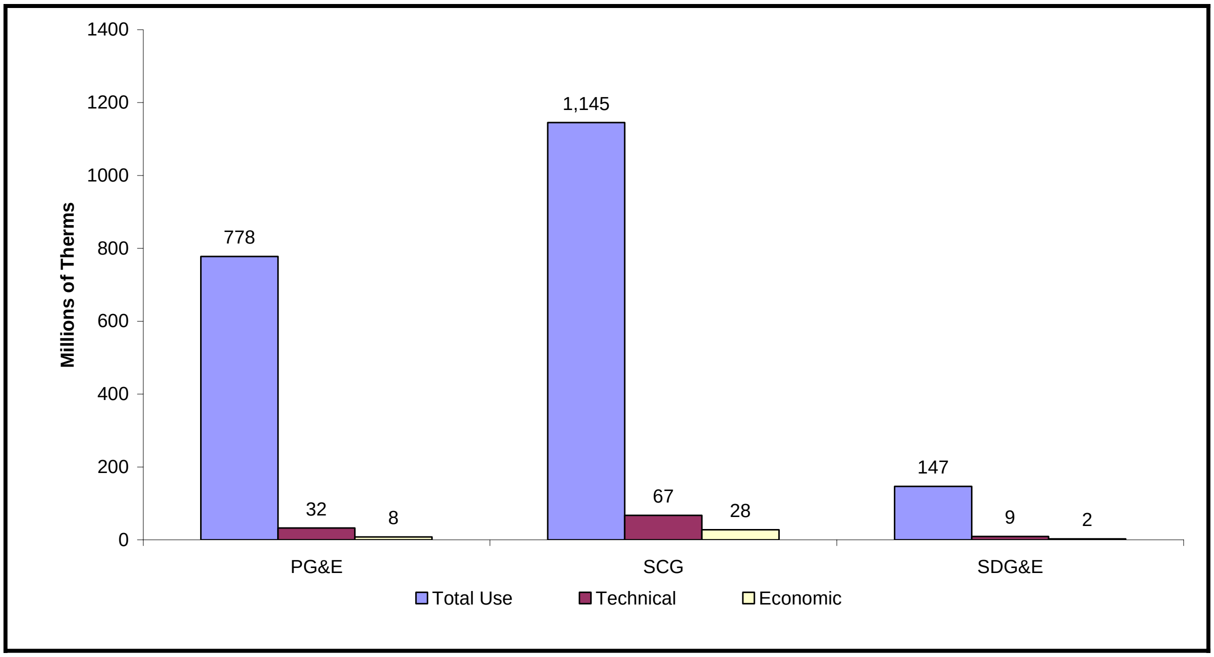
Table 5-19: CEC's Gas Forecast – 2004-2016 (millions of therms)

PG&E	SoCalGas	SDG&E	Total
778	1,145	147	2,070

These results are presented in Figure 5-18, along with the forecasts of technical and economic potential by utility service area. This figure illustrates that technical potential is highest for the SoCalGas service area at 67 million therms. Economic potential is also highest for the SoCalGas service area at 33 million therms. As a percentage of anticipated gas sales, SoCalGas had the highest percentage with 6% of technical potential and 2.5% of economic potential. SDG&E's technical potential is 6% of anticipated usage while economic potential is only 2% of forecast usage.

[8] CEC, op. cit., Tables 10-5, 10-6, 10-7.

Figure 5-18: Forecasted Gas Use and Estimated Gross Gas Technical and Economic Potential by Utility in Existing Commercial Buildings – 2004-2016



Technical Potential by End-Use Grouping

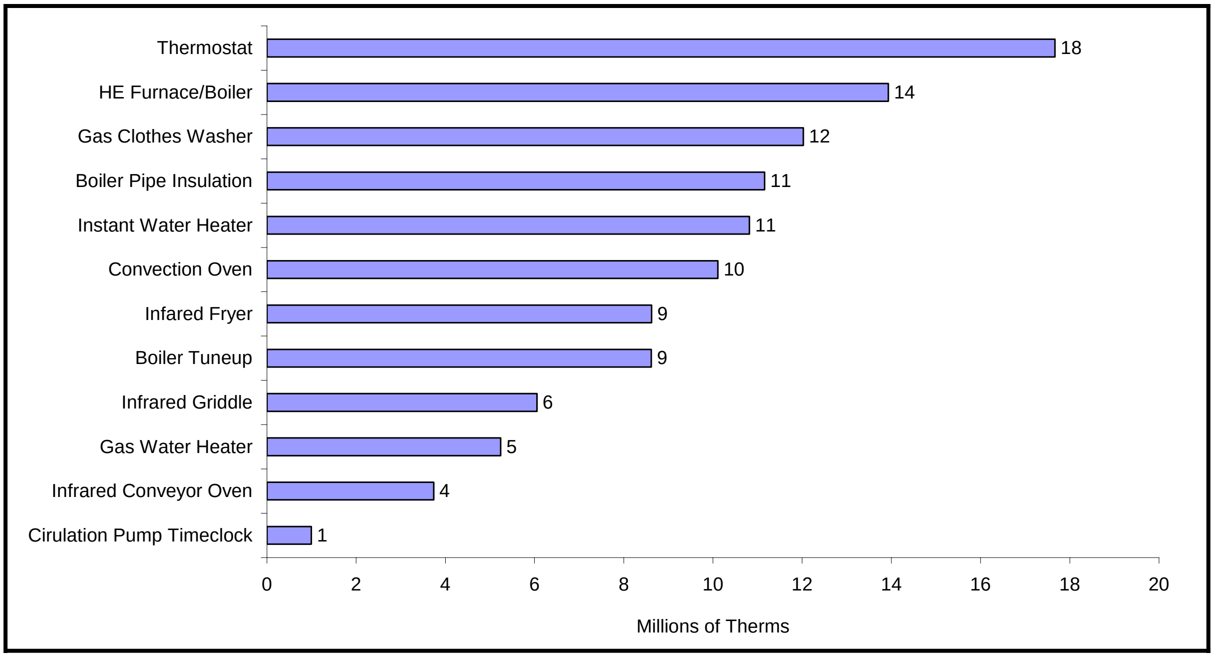
Table 5-20 summarizes the technical potential results by end-use grouping and utility. As shown, miscellaneous non-HVAC measures contribute the most to potential savings.

Table 5-20: Gross Technical Potential by End-Use Grouping and Utility in Existing Commercial Buildings – 2004-2016 (millions of therms)

End Use	PG&E	SoCalGas	SDG&E	Total
HVAC	15	33	3	51
Non-HVAC	17	35	6	58
Total	**32**	**68**	**9**	**109**

Figure 5-19 breaks down the technical potential estimates at the measure (or group of similar measures) level and in order of descending potential. As shown, thermostats contribute the most (18 million therms) towards gas savings. The measure groups contributing the next largest amount towards gas savings include (in decreasing order) furnaces and boilers, gas clothes washers, pipe insulation, and instant water heaters.

Figure 5-19: Estimated Gross Gas Technical Potential by Measure in Existing Commercial Buildings – 2004-2016



Economic Potential by End-Use Grouping

Table 5-21 summarizes the economic potential results by end-use grouping and utility. As shown, HVAC measures result in the majority of savings for each of the IOU service areas. The economic potential savings of installing high efficiency gas HVAC measures is 26 million therms through the year 2016. The economic potential for gas non-HVAC measures is 12 million therms.

Table 5-21: Gross Economic Potential by End Use and Utility in Existing Commercial Buildings – 2004-2016 (millions of therms)

End Use	PG&E	SoCalGas	SDG&E	Total
HVAC	4	21	1	26
Miscellaneous	4	7	1	12
Total	**8**	**28**	**32**	**38**

Market Potential for Gas Energy Efficiency

This subsection further presents the gas market potential under three program incentive levels and two measure lists. As described above, results were derived for the current 2004-2005 energy efficiency program incentive funding level, a full incremental cost incentive funding level, and an incentive level set to the average between current and full incremental measure costs. The current incentive market scenario's measure list is limited to measures with IOU-specific program accomplishments in 2004. The average 2004 measures and full 2004 measures market scenarios increase incentive levels while continuing to limit the high efficiency measures to those analyzed in the current scenario. Limited results are presented for the average 2004 measures and full 2004 measures scenarios. The average and full market scenarios analyze the full set of high efficiency measures analyzed in the economic and technical scenario. Table 5-22 lists the measures added to the average, full, economic, and technical scenario that were not analyzed in the current, average 2004 measures, and full 2004 measures scenarios. Table 5-23 list a full description of the market scenarios for existing commercial buildings.

Table 5-22: Gas Measures Added to the IOU Programs for the Scenario and Full Incremental Cost Market Analysis in Existing Commercial Buildings

Measure	PG&E	SoCalGas	SDG&E
Gas Boiler Tune-Up	Added	Added	Added
Boiler Pipe Insulation	Existing	Existing	Added
Gas Heat Thermostat	Existing	Existing	Added
High Efficiency Boiler	Added	Existing	Added
Gas Fryer	Added	Existing	Added
Gas Conveyor Oven	Added	Existing	Added
Gas Convection Oven	Added	Existing	Added
Gas Griddle	Added	Existing	Added
Gas Water Heater	Existing	Existing	Added
Gas Instantaneous Water Heater	Existing	Existing	Added
Hot Water Circ. Pump Timer	Added	Added	Added

Table 5-23: Market Scenario Descriptions for Existing Commercial Buildings

Market Scenario Name	Description
Current	2004 incentive level, restricted to IOU specific measures incentivized in 2004. For measures experiencing standards changes in 2006, the rebate level changes in 2006.
Average – 2004 Measures	Average between current and full incremental cost incentive levels with the measure list restricted to those incentivized in 2004.
Average	The average between current and full incremental cost incentive levels with all the measures analyzed in the technical and the economic scenarios.
Full – 2004 Measures	Full incremental measure cost with the high efficiency measure list restricted to those incentivized in 2004.
Full	Full incremental measure cost incentive levels with all the measures analyzed in the technical and the economic scenarios. For retrofit and conversion measures a working measure is replaced, therefore the full incremental measure cost is the cost of the measure. For replace on burn out measures the full incremental measures cost is the incremental cost between the low and high efficiency measure.

As shown in Table 5-24, total IOU market potential under the current funding scenario is 27 million therms. Increasing incentive to the average between the current level and full incremental measure cost, while keeping the high efficiency measure list limited to those with program accomplishments in 2004, increases potential savings to 36 million therms, an increase of 33%. Further increasing funding to the full 2004 measures scenario level, increases the potential savings to 44 million therms.

If incentives are increased to the average between current and full incremental cost, and the measure list is expanded to include those measure listed in Table 5-22, estimated potential savings are 44 million therms. The savings from the average market scenario analysis represent a 63% increase over the forecast savings from the current market potential analysis. If program incentives were further increased to cover full incremental costs, savings are forecast to increase to 56 million therms, a 28% increase over the average market scenario.

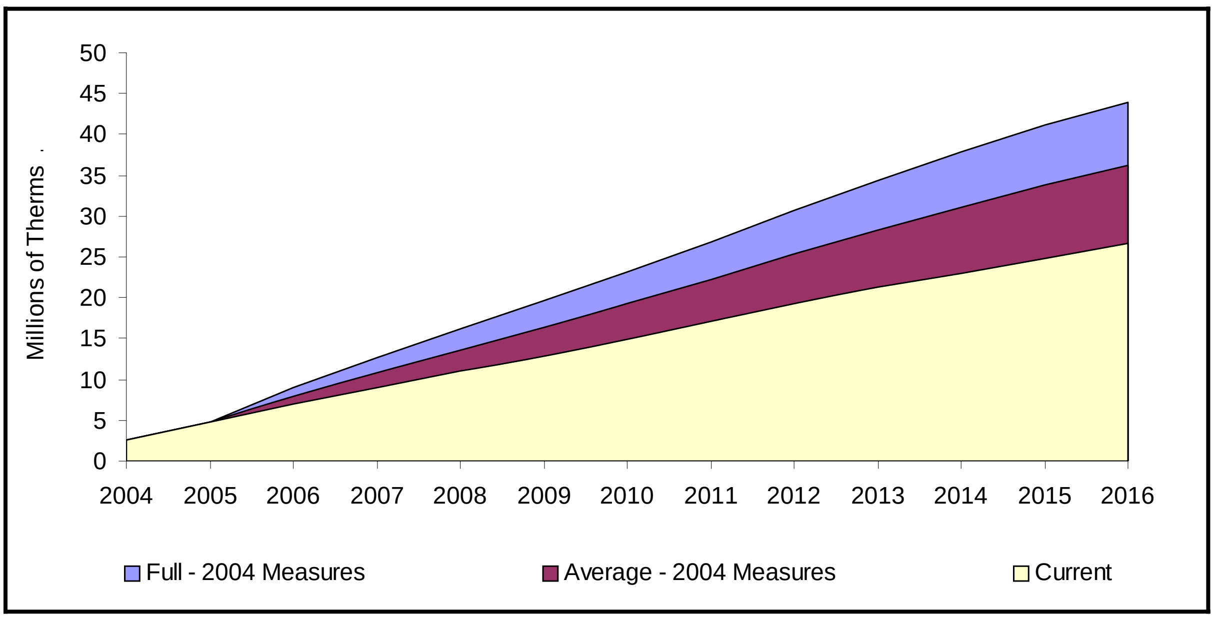
Table 5-24: Estimated Gross Market Potential by Funding Level in Existing Commercial Buildings – 2004-2016

Funding Level	Millions of Therms
Current	27
Average 2004 Measures	36
Average	44
Full 2004 Measures	44
Full	56

* Refer to Table 5-23 for a description of the market funding scenarios.

The results for the current, average 2004 measures, and full 2004 measures market forecasts are illustrated in Figure 5-20. The high efficiency measures analyzed for all three funding levels were limited to those with accomplishments in 2004. The higher incentive levels for the average 2004 measures and the full 2004 measures take effect in 2006. An illustration of the average and the full market scenarios would look very similar to those represented below, with a higher level of potential for through the forecast period.

Figure 5-20: Estimated Gross Gas Market Potential by Funding Level in Existing Commercial Buildings – 2004-2016



* Refer to Table 5-23 for a description of the market funding scenarios.

Market Potential by End-Use Grouping

Table 5-25 summarizes the market potential estimates by funding level and end use grouping. For comparison, technical and economic estimates are also included. For the current, average 2004 measures and the average market scenarios, HVAC measures account for more than half the potential savings. For the full 2004 measures and the full market scenarios, miscellaneous measures result in approximately half the savings potential.

Table 5-25: Estimated Gross Gas Market Potential by Funding Level and End Use Grouping in Existing Commercial Buildings – 2004-2016 (millions of therms)

End Use	Technical	Economic	Current	Average 2004 Measures	Average	Full 2004 Measures	Full
HVAC	51	27	16	19	24	22	28
Miscellaneous	58	12	11	17	20	22	28
Total	**109**	**39**	**27**	**36**	**44**	**44**	**56**

* Refer to Table 5-23 for a description of the market funding scenarios.

Cost and Benefit Results

Table 5-26 presents a final summary of the commercial gas market potential estimates for the current, average, and the full incremental cost funding levels with costs, benefits, and TRC ratio.

Table 5-26: Summary of Commercial Gas Market Potential Results in Existing Commercial Buildings – 2004-2016

Item	Current	Average	Full
Gross Program Costs	$21,876,929	$31,667,968	$38,766,114
Net Measure Costs	$89,426,180	$196,284,482	$276,641,547
Gross Incentives	$19,461,300	$110,101,772	$262,951,827
Net Avoided Cost Benefit	$84,223,141	$141,877,389	$178,556,321
Program TRC	0.76	0.62	0.57

* Refer to Table 5-23 for a description of the market funding scenarios.

At the statewide level, the commercial gas portfolio programs for existing buildings are not cost-effective based on the results of the TRC test.[9] Increases in funding leads to a slight decline in the TRC test.[10]

Utility-Level Savings, Costs, and Benefits

This subsection presents estimates of IOU-specific gross technical, economic and market gas savings, and discusses program benefit-to-cost ratios.

PG&E Potential Gas Savings Forecasts

Table 5-27 lists PG&E's market, economic, and technical gas potential forecasts for existing commercial buildings. In 2016, the estimate of PG&E's current market potential is 3 million therms. Increasing incentives to the average between current and full incremental costs, and adding measures not incentivized in 2004, increases the estimate of market potential to 8 million therms, a 100% increase. Further increasing incentives to full incremental measure cost increases the market potential estimate of savings to 12 therms, a further 50% increase.

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9 The net measure costs exceed the gross incentives in the full incentive forecast due to the inclusion of the results from years 2004 and 2005. For year 2004 and 2005, incentives are equal to current incentives, reducing the gross incentives below the net measure costs. This impact is accentuated by the fact that the statewide net to gross ratio for cooking measures is one. Refer to Appendix B, Table B-3 for a further discussion on the net to gross ratio used in this study.

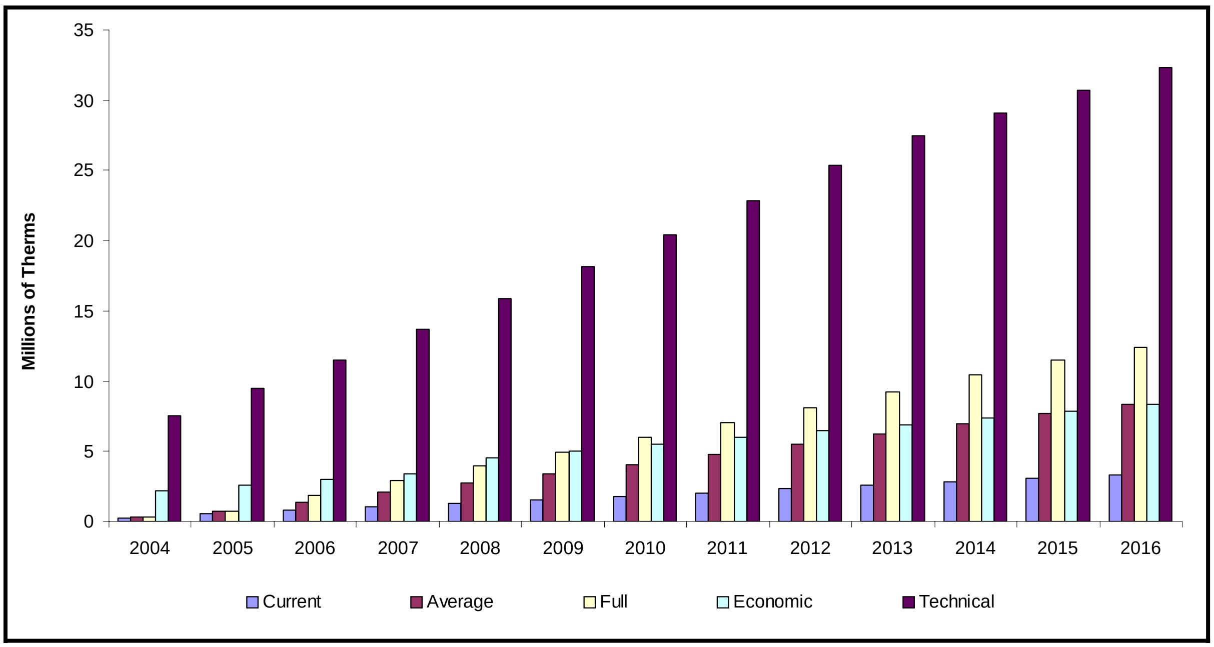
10 For this analysis, the avoided cost was derived from *A Forecast of Cost-Effectiveness Avoided Costs and Externality Adders* by Energy and Environmental Economics, Inc., January 2004. If the avoided costs have increased significantly since the costs were determined, the commercial gas portfolio for existing building might be cost effective at the average and full market funding level.

Table 5-27: Estimated PG&E Gross Gas Market Potential by Funding Level and End Use in Existing Commercial Buildings – 2004-2016 (millions of therms)

Total	Technical	Economic	Full	Average	Current
2004	8	2	0	0	0
2005	9	3	1	1	1
2006	12	3	2	1	1
2007	14	3	3	2	1
2008	16	5	4	3	1
2009	18	5	5	3	2
2010	20	5	6	4	2
2011	23	6	7	5	2
2012	25	6	8	6	2
2013	27	7	9	6	3
2014	29	7	10	7	3
2015	31	8	12	8	3
2016	32	8	12	8	3

Figure 5-21 illustrates PG&E's market, economic, and technical potential in existing commercial buildings for 2004-2016.

Figure 5-21: PG&E Gross Gas Market, Economic, and Technical Potential in Existing Commercial Buildings – 2004-2016



* Refer to Table 5-23 for a description of the market funding scenarios.

SoCalGas Potential Gas Savings Forecasts

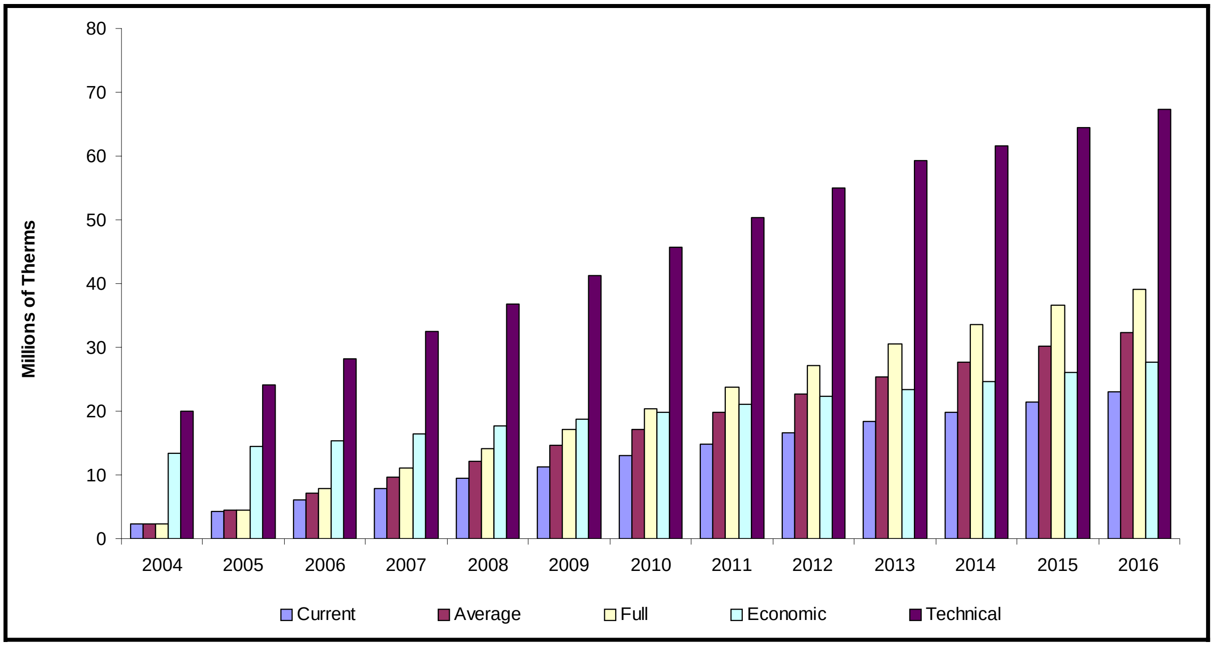
Table 5-28 lists the market, economic, and technical natural gas potential estimates for the SoCalGas commercial energy efficiency programs. The estimate of gross market savings potential under current incentives is 23 million therms. Increasing incentives to the average between current and full incremental measure costs, and adding gas boiler tune-ups and hot water heater time clocks, increases the estimate of market potential to 32 million therms, a 42% increase. Further increasing incentives to full incremental costs increases the estimate of potential savings to 39 million therms, an additional 21% increase.

Table 5-28: Estimated SoCalGas Gross Gas Market Potential by Funding Level and End Use in Existing Commercial Buildings – 2004-2016 (millions of therms)

Total	Technical	Economic	Full	Average	Current
2004	20	13	2	2	2
2005	24	14	4	4	4
2006	28	15	8	7	6
2007	32	16	11	10	8
2008	37	18	14	12	10
2009	41	19	17	15	11
2010	46	20	20	17	13
2011	50	21	24	20	15
2012	55	22	27	23	17
2013	59	23	30	25	18
2014	62	25	34	28	20
2015	64	26	37	30	21
2016	67	28	39	32	23

Figure 5-22 illustrates the market, economic, and technical potential from cumulative adoptions for SoCalGas commercial energy efficiency program in existing buildings.

Figure 5-22: SoCalGas Gross Gas Market, Economic, and Technical Potential in Existing Commercial Buildings – 2004-2016



* Refer to Table 5-23 for a description of the market funding scenarios.

SDG&E Potential Gas Savings Forecasts

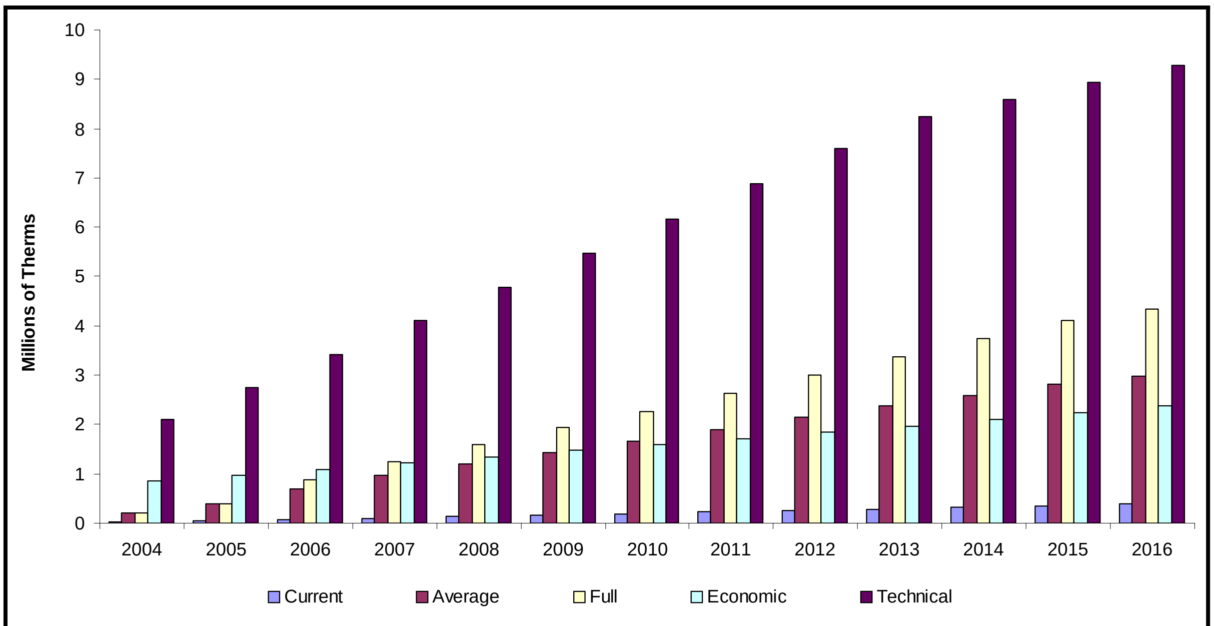
Table 5-29 lists SDG&E's market, economic, and technical gas potential estimates for existing commercial buildings. The current market savings potential estimate is less than half a million therms. Increasing incentives to the average between current and full incremental measure costs, and adding the 11 measures not included in SDG&E's 2004 program (see Table 5-22), increases the estimate of savings to 3 million therms, a 682% increase. Further increasing incentives to full incremental measure costs raises the estimate of market savings to 4 million therms, an additional increase of 46%.

Table 5-29: Estimated SDG&E Gross Gas Market Potential by Funding Level and End Use in Existing Commercial Buildings – 2004-2016 (millions of therms)

Total	Technical	Economic	Full	Average	Current
2004	2	1	0	0	0
2005	3	1	0	0	0
2006	3	1	1	1	0
2007	4	1	1	1	0
2008	5	1	2	1	0
2009	5	1	2	1	0
2010	6	2	2	2	0
2011	7	2	3	2	0
2012	8	2	3	2	0
2013	8	2	3	2	0
2014	9	2	4	3	0
2015	9	2	4	3	0
2016	9	2	4	3	0

Figure 5-23 illustrates SDG&E's market, economic, and technical gas potential from cumulative adoptions through 2016.

Figure 5-23 : SDG&E Gross Gas Market, Economic, and Technical Potential in Existing Commercial Buildings – 2004-2016



* Refer to Table 5-23 for a description of the market funding scenarios.

Utility Specific Electric Costs and Benefits

Table 5-30, Table 5-31, and Table 5-32 list the IOU costs and benefits from their commercial gas energy efficiency programs under current, average, and full incremental cost funding levels. As presented in Table 5-30, PG&E's commercial gas program is cost effective under the current funding level and nearly cost effective under the average funding level. The SoCalGas and SDG&E commercial gas programs are not cost effective at any funding level.

The PG&E current commercial gas program is cost-effective due to the measures included in their program. Their current program focuses on cost effective HVAC and water heating measures. The SoCalGas program is broader, including many of the miscellaneous measures that are not cost effective.

Table 5-30: PG&E Commercial Gas Costs and Benefits in Existing Commercial Buildings – 2004-2016

Item	Current	Average	Full
Gross Program Costs	$979,470	$2,186,797	$3,164,872
Net Measure Costs	$10,185,168	$40,517,561	$65,788,334
Gross Incentives	$3,103,634	$24,663,011	$66,605,422
Net Avoided Costs Benefit	$23,811,043	$41,277,931	$55,661,344
TRC	2.13	0.97	0.81

* Refer to Table 5-23 for a description of the market funding scenarios.

Table 5-31: SoCalGas Commercial Gas Costs and Benefits in Existing Commercial Buildings – 2004-2016

Item	Current	Average	Full
Gross Program Costs	$20,762,195	$28,407,439	$34,116,225
Net Measure Costs	$77,933,034	$139,719,757	$185,109,182
Gross Incentives	$16,007,937	$76,627,361	$172,042,370
Net Avoided Costs Benefit	$59,531,077	$85,113,582	$103,539,730
TRC	0.60	0.51	0.47

* Refer to Table 5-23 for a description of the market funding scenarios.

Table 5-32: SDG&E Commercial Gas Costs and Benefits in Existing Commercial Buildings – 2004-2016

Item	Current	Average	Full
Gross Program Costs	$135,263	$1,073,733	$1,485,017
Net Measure Costs	$1,307,978	$16,047,164	$25,744,030
Gross Incentives	$349,728	$8,811,400	$24,304,035
Net Avoided Costs Benefit	$882,019	$15,485876	$19,355,247
TRC	0.61	0.90	0.71

* Refer to Table 5-23 for a description of the market funding scenarios.

5.4 Key Commercial Results and Future Research Recommendations

Summary of Key Results for Existing Commercial Buildings

The gross commercial market potential for electric energy efficiency measures at the currently funded level (2004 incentive levels) is estimated to be 3,000 GWh. The market potential under current incentives is 22% of the estimated energy technical potential and 27% of estimated economic energy potential. Increasing incentives to equal the average between current incentives and full incremental costs, and maintaining a high efficiency measure list consistent with the 2004 IOU commercial program accomplishments (average 2004 measures), resulted in additional savings of 580 GWh (total 3,580 GWh), which is 26% of estimated technical potential and 33% of estimated economic potential. Increasing incentives to a level equal to full incremental costs resulted in a savings of 3,907 GWh for the full 2004 measures market scenario. This result represents 28% of estimated technical potential and 35% of estimated economic potential.

Estimates of technical and economic potential (13,932 GWh and 11,290 GWh) are based on the remaining energy efficiency potential associated with 82 high efficiency measures listed in Table 5-1. The current, average 2004 measures, and the full 2004 measures market scenarios presented above are limited to measures included in the 2004 IOU measure-specific program accomplishments. In the average and the full incremental cost funding scenarios, incentives were increased and measure lists were expanded to include all 82 high efficiency measures.

Augmenting the measure list and setting incentives equal to the average between current incentive levels and full incremental costs increased the estimate of energy potential to 4,104 GWh. The average market scenario estimates of potential energy savings are 29% of estimated technical potential and 36% of estimated economic potential. Increasing incentives to a level equal to full incremental costs, while maintaining the augmented measure list, increased the estimate of potential energy savings to 4,720 GWh. The full incremental cost savings potential represents 34% of estimated technical potential and 42% of estimated economic potential.

The market potential for demand reduction at the currently funded level was 461 MW over a 13-year period, or 15% of estimated technical potential and 23% of estimated economic potential. Demand savings for the average 2004 measures market scenario were 568 MW over the 13-year period. This represents 18% of estimated technical potential and 28% of estimated economic potential. Ramping up incentives to the full 2004 measures scenario increases the estimate of remaining demand saving to 614 MW or 20% of estimated technical potential and 31% of estimated economic potential.

Increasing the number of measures analyzed during the market forecast to the same measures analyzed in the technical and economic forecasts and setting incentives to the average between current and full incremental cost resulted in estimated demand savings of 787 MW or 25% of estimated technical potential and 39% of estimated economic potential. Further increasing incentive levels to full incremental measure costs, while analyzing the full list of measures, led to an estimate of 982 MW of demand savings, or 32% of estimated technical potential and 49% of estimated economic potential

The market potential for gas efficiency at the currently funded level was 27 million therms or 25% of estimated technical potential and 69% of estimated economic potential. Increasing incentives to the average 2004 measures market scenario increased the estimate of potential savings to 36 million therms. Further increasing incentives to full 2004 measures scenario increased the estimate to 44 million therms or 40% of estimated technical potential or 113% of estimated economic potential.

Increasing the number of measures analyzed and setting the incentives at the average between current and full incremental measure cost resulted in estimated savings of 44 million therms, or 40% of estimated technical potential and 113% of estimated economic potential. Further increasing incentives to full incremental measure costs, while analyzing the expanded measure list, resulted in estimated savings potential of 56 million therms, which is 51% of estimated technical potential and 144% of estimated economic potential.

Key Assumptions and Areas Needing Research

The input data for commercial measure technology density and base share are derived from an early sample of the Commercial End-Use Survey (CEUS). CEUS is an extensive on-site survey of California commercial buildings. The on-site surveys began in 2002 and ended in 2005. The use of these data ensures that the input data on the technology density and fuel saturations represent current distributions. The information on the base share of standard and high efficiency measures represents the most recent and best data available. On-site surveys of high efficiency measures, however, can be limited by the surveyor's ability to gather efficiency data.

On-site survey data on the share of standard and high efficiency lighting is assumed to closely resemble the distribution of actual lighting distributions. Given standard survey techniques, the efficiency levels of lighting are relatively easy to ascertain. For example, data from the CEUS database indicate that in southern California lodging, 40% of 40-watt incandescent light fixtures have been converted to CFLs (14%) or hardwired CFL fixtures (26%). While it is relatively easy to identify the efficiency of lighting, it can be difficult to identify the efficiency level of HVAC equipment. The efficiency information may not be listed on the nameplate, the equipment may be in an inaccessible location, or the nameplate data may be illegible. For example, packaged air conditioning units often do not list the efficiency level on the nameplate.

In addition, the savings assumption for some commercial high efficiency measures has a high degree of uncertainty. The savings from programmable thermostats are highly uncertain. The current level of uncertainty in their savings assumptions, in combination with the very low peak impacts has led some utilities to drop programmable thermostats from their commercial programs. Other measures analyzed in this study with highly uncertain savings assumptions include daylighting, variable frequency drives, and HVAC fan motors. Future potential studies would benefit from further research on the savings impacts of these measures.

6

Comparison of Potential in Existing Residential and Commercial to the 2002/2003 KEMA-Xenergy Study

Since the mid-1970s, California has invested publicly funded energy efficiency programs designed to encourage the replacement of existing technologies with high efficiency technologies. These efforts have been quite successful, resulting in savings of about 9 GW, 34,000 GWh and 2 billion Therms between 1976 and 2000.[1] While these programs have been very successful, substantial potential for energy savings is believed to remain. In 2002 and 2003, a comprehensive analysis of California's remaining energy efficiency potential in the existing residential and commercial sectors was undertaken by KEMA-Xenergy.[2]

Given the increased role and funding assigned to energy efficiency in the future development of California's energy sector, a result of the California energy crisis of 2000-2001, an update to these previous potential studies was deemed necessary. This new study's objective is to provide detailed results to aid the design and implementation of the significantly expanded California energy efficiency effort.

In this report, Itron re-examined California's remaining energy efficiency potential in the existing residential and commercial sectors and KEMA expanded the analysis to the existing industrial sector. Itron also expanded the analysis to examine the energy efficiency potential in the residential, commercial, and industrial new construction sectors, and to emerging technologies. Henceforth, the KEMA 2002/2003 studies will be referred to as the 2000 study and this study will be referred to as the 2004 study.[3]

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1 KEMA-Xenergy, Inc. *California Statewide Residential Sector Energy Efficiency Potential Study* (April 2003). www.calmac.org.

2 Xenergy, Inc. *California Statewide Commercial Sector Energy Efficiency Potential Study* (July 2002) and KEMA-Xenergy, Inc. *California Statewide Residential Sector Energy Efficiency Potential Study* (April 2003). www.calmac.org.

3 The results for this study will be referred to as the 2004 study because the models are calibrated to the 2004 IOU program results and the base incentive levels are those in the 2004 energy efficiency programs. The 2002/2003 KEMA-Xenergy studies will be referred to as the 2000 study because these modes are calibrated to the 1996-2000 program year IOU program results.

Focusing on the remaining energy efficiency potential in existing residential homes and existing commercial buildings, this section will briefly discuss some of the similarities and differences between the 2000 statewide potential studies and this study. The section will touch on the data sources used as inputs for the analyses and how these data impact the potential forecasts. The primary focus will be to illustrate the two forecasts of California's remaining energy efficiency potential in existing residential and commercial buildings, highlighting their similarities and differences, and to provide a brief explanation for their different forecasts of the remaining energy efficiency potential.[4]

6.1 Background

The scope of the 2000 and 2004 studies differed, as did the questions driving the analysis. The 2000 studies was charged with determining the remaining energy efficiency potential in California to ascertain whether publicly funded efforts to promote energy efficiency were adequately funded. This was the first comprehensive study of energy efficiency potential in California since the mid-1990s. Changes in technologies, utility programs, and other important variables warranted that the state undertake an analysis of the remaining energy efficiency potential. These studies were undertaken as the California energy crisis began to unfold, making their results very timely for public policy discussions. The results from the 2000 studies were used by the California Public Utilities Commission (CPUC) to establish new, aggressive goals for electricity and natural gas savings for the state's investor-owned utilities (IOUs) energy efficiency promoting efforts for 2004-2013.[5]

The 2004 study re-examines the remaining potential in the existing residential and commercial sectors and expanded the analysis into additional sectors and new technologies. The study was charged with determining the remaining energy efficiency potential in California in the wake of the significantly larger savings obtained in 2000-2001 and the increased public support for and financing of energy efficiency programs. With the previous set of studies having answered the issue of appropriate public funding, the question still remaining was how to optimize program offerings across utilities, market segments, and end uses. The findings from this study will be used by program planners to guide their program's offerings and their customer targeting. The findings will be used to help the utilities meet the aggressive goals set by the CPUC.

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[4] This section compares the results for the remaining energy efficiency potential in existing residential and commercial buildings. The 2000 study did not analyze new construction, emerging technologies, or the existing industrial sectors.

[5] See the California Energy Commission's report *California Energy Demand 2006-2016 Staff Energy Demand Forecast*, September 2005, for the IOU savings goals.

The different context under which these studies were carried out limit the direct comparability of the results. The rest of this chapter addresses key differences between these two efforts that affect comparison of their results.

6.2 Data Issues and Results

Energy efficiency potential forecasts have complex and extensive data needs. In general, a more accurate characterization of the current state of residential and commercial energy efficiency equipment saturations, impacts, costs, and IOU program accomplishments will lead to more accurate forecasts of the remaining technical, economic, and market potentials. Collecting these data is the first and most time-consuming step in any potential analysis.

The 2000 forecast and the 2004 forecast faced significant data requirements associated with collecting the input datasets. First, a list of energy efficiency technologies is developed. The 2000 and the 2004 forecast turned to the Database of Energy Efficient Resources (DEER),[6,7] the energy efficiency program filings of the major IOUs, and discussions with utility Program Advisory Committees to help determine the high efficiency technologies to be included in each study.[8] The 2000 study analyzed 69 commercial measures and 41 residential measures, while the 2004 analysis looked at 82 commercial measures and 65 residential measures.[9] Once the list of measures was determined, data had to be collected on measure saturations, technology densities, incremental energy savings and costs, utility program accomplishments and costs, and forecasts of future housing stocks,[10] commercial building floor space,[11] utility rates, and avoided costs.[12]

The 2000 and the 2004 forecasts employed the most recent data on technology densities, technology saturations, impacts and costs. The 2000 forecast used data from multiple sources including, but not limited to, the 1999 California Baseline Lighting Efficiency

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6 Xenergy, Inc. *2001 DEER (Database for Energy Efficient Resources) Update Study.* Prepared for the California Energy Commission. August 2001.

7 Itron, Inc. *2004-2005 Database for Energy Efficiency Resources (DEER) Update Study: Final Report.* Prepared for Southern California Edison. December 2005.

8 The discussion of the measures list for the 2004 study is found in "*WP #1: California Statewide Energy Efficiency Summary Study: Review of Existing Forecasts and Data Inputs*" by Itron, Inc, August 2004.

9 For the list of commercial and residential measures for the 2000 study see volume 2, appendix A in KEMA July 2002 and April 2003. For the list of commercial and residential measures for the 2004 study, see chapters 3 and 4 of this report. The increase in number of measures is largely due to finer distinctions in the residential and commercial lighting analyses for this report.

10 Data courtesy of Glen Sharp, California Energy Commission, in March 2004.

11 Data courtesy of Mohsen Abrishami, California Energy Commission, in March 2004.

12 For this analysis, the avoided cost was derived from *A Forecast of Cost-Effectiveness Avoided Costs and Externality Adders* by Energy and Environmental Economics, Inc., January 2004.

Technology Report,[13] the Statewide Survey of Multifamily Common Area Buildings,[14] utility-specific commercial end-use surveys for 1992 to 1998, the 2001 DEER (2001),[15] IOU quarterly filings from 1996-2000, and California Energy Commission (CEC) forecasts of saturations, floor space, electric and natural gas customer rates, and avoided costs.[16]

The 2004 analysis benefited from recent statewide studies in both the residential and commercial sectors. The 2004 analysis used data from the California Statewide Residential Appliance Saturation Study (RASS),[17] the 2006 Commercial End-Use Survey (CEUS),[18] the 2001 and 2005 DEER,[19,20] 2004 Avoided Costs and Externality Adders,[21] 2004 IOU quarterly filings, and forecasts of the housing stock and commercial building floor space provided by the CEC.

These data allowed the 2004 forecast to estimate the remaining potential with more recent information on technology density and the saturation of high efficiency measures. These data also enabled the study to analyze the remaining potential savings with increased measure and climate zone disaggregation. The increase in the number of climate zones analyzed allowed for climate zone-specific avoided costs and climate zone-specific impact data for weather-sensitive measures. The increased measure disaggregation was largely used in the description of residential and commercial lighting measures. Improvements in the understanding of lighting impacts allowed the study to use finer wattage disaggregation and the detailed program accomplishment data from the IOU program reports.[22] The increased climate zone and measure disaggregation apparent in the 2004 study was one of the

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13 Heschong Mahone Group. *Lighting Efficiency Technology Report, Volume III: Market Barriers Report.* Prepared for the California Energy Commission. http://www.energy.ea.gov/efficiency/lighting/lighting_reports.html. 1999.

14 ADM Associates, Inc. and TekMRKT Works, LLC. *Final Report: Statewide Survey of Multi-Family Common Area Building Owners Market: Volume 1: Apartment Complexes.* Prepared for Southern California Edison. June 2000.

15 Xenergy, Inc. *2001 DEER (Database for Energy Efficient Resources) Update Study.* Prepared for the California Energy Commission. August 2001.

16 KEMA July 2002 and April 2003 op. cit.

17 KEMA-Xenergy, Inc. *California Statewide Residential Appliance Saturation Study.* Prepared for the California Energy Commission. June 2004.

18 Itron, Inc. *California Commercial Energy Use Survey.* CEC-400-2006-005. Prepared for the California Energy Commission. March 2006.

19 Xenergy 2001 DEER, op. cit.

20 Itron 2004-2005 DEER, op. cit.

21 Energy and Environmental Economics, Inc. *A Forecast of Cost-Effectiveness Avoided Costs and Externality Adders.* Prepared for the California Public Utilities Commission, Energy Division. January 2004.

22 For lighting impact data, the 2004 study used data from the KEMA-Xenergy, Inc. lighting logger study *CFL Metering Study*, prepared for Pacific Gas & Electric Company, San Diego Gas & Electric Company, and Southern California Edison, February 25, 2005

objectives of the analysis. The increase in disaggregation helps program planners to focus their efforts to specific climate zones and measures with substantial remaining potential savings.

The increase in the disaggregation of the 2004 results, relative to the 2000 results, does not come without costs. The 2004 effort required more highly disaggregated data, leading to higher complexity, costs and a longer completion time. In the end, both the 2000 and 2004 models use utility-level accomplishments to calibrate their estimates. The increased disaggregation of the 2004 forecast cuts the estimates into more measure and climate zone groupings, but both models are calibrated by program accomplishments that are not climate zone or building type specific.

The key differences in the data used are detailed in the sections that follow. When possible, a discussion on how they may have affected the results and the differences with the previous studies' results is also provided.

Residential Data and Results

The 2004 residential forecast benefited from new residential data, updated impact information, and its use of the 2004 IOU quarterly filings. The IOU quarterly filings for 2004 present the savings for the first program year of the CPUC's new aggressive energy efficiency program funding and energy savings goals. Using the IOU's 2004 program accomplishments allowed Itron to incorporate recent changes in utility residential programs undertaken to help achieve the CPUC energy savings goals.[23]

Electric Residential Potential

Figure 6-4 and Figure 6-5 illustrate the IOU energy efficiency program accomplishments for 2000-2004. In 2004, the utility programs placed a new emphasis on residential programs. In large part, the increase in the residential program accomplishments was due to a substantial increase in energy savings from the residential lighting program. In 2004, the IOUs changed their residential lighting program, implementing a program of upstream residential lighting rebates. The upstream rebate, in combination with a decline in manufacturing costs, significantly reduced the price paid by consumers. The new program design contributed to

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23 Much of the increase in the 2004 residential energy efficiency program accomplishments are due to an increase in CFL savings. During the 2000-2001 energy crisis there was a substantial increase in consumer awareness about CFLs. The recent declines in CFL prices have also contributed to their increased usage. The implementation of upstream incentives in 2004 also reduced the price that consumers pay for CFLs and the hassle in applying for a rebate. All of these effects contribute to the significant increases seen in this measure's contribution to portfolio results in 2004. This increase in 2004 residential results and calibration to 2004 program accomplishment, could affect this study's results for 2004-2016; contributing to higher residential forecasts of the remaining energy efficiency potential.

the increase in the residential lighting program accomplishments; approximately 70% of the energy savings from the residential energy efficiency programs was due to residential lighting programs.

The 2004 analysis disaggregated CFL lighting measures into conventional incandescent-to-CFL wattage competition groups. In contrast, the 2000 analysis focused on an incandescent-to-CFL composite group. The disaggregation of residential lighting into specific competition groups allowed the 2004 forecast to take advantage of the disaggregated utility program filings results and to more accurately estimate the energy savings associated with each CFL-to-incandescent competition group.

The 2004 IOU filings showed that current program design, coupled with current technologies, has led households to adopt larger wattage CFLs more rapidly than lower wattage CFLs. The 2004 forecast indicates that the continuation of current incentive levels will lead larger wattage CFLs to dominate their incandescent competition by 2016, while lower wattage CFLs will remain a niche market. In this study, increasing measure rebates to full incremental cost marginally increases the percentage of the market dominated by larger wattage CFLs, but it does not significantly change the market penetration of lower wattage CFLs.

Disaggregating the CFL and incandescent lighting measures into wattage-specific competition groups allowed the 2004 forecast to take advantage of the existing data and to produce a measure-specific forecast providing information on adoptions, incentives, and energy savings. The measure-specific forecast dramatically illustrates successful measures and measures where the current program design is not contributing significant energy savings. This level of disaggregation increases the complexity and cost of the forecast, but provides program designers with data helpful in gauging the success of current program designs and areas needing improvement.

Figure 6-1: Residential Sector Remaining Energy Savings Forecast for the 2000 and the 2004 Potential Analysis

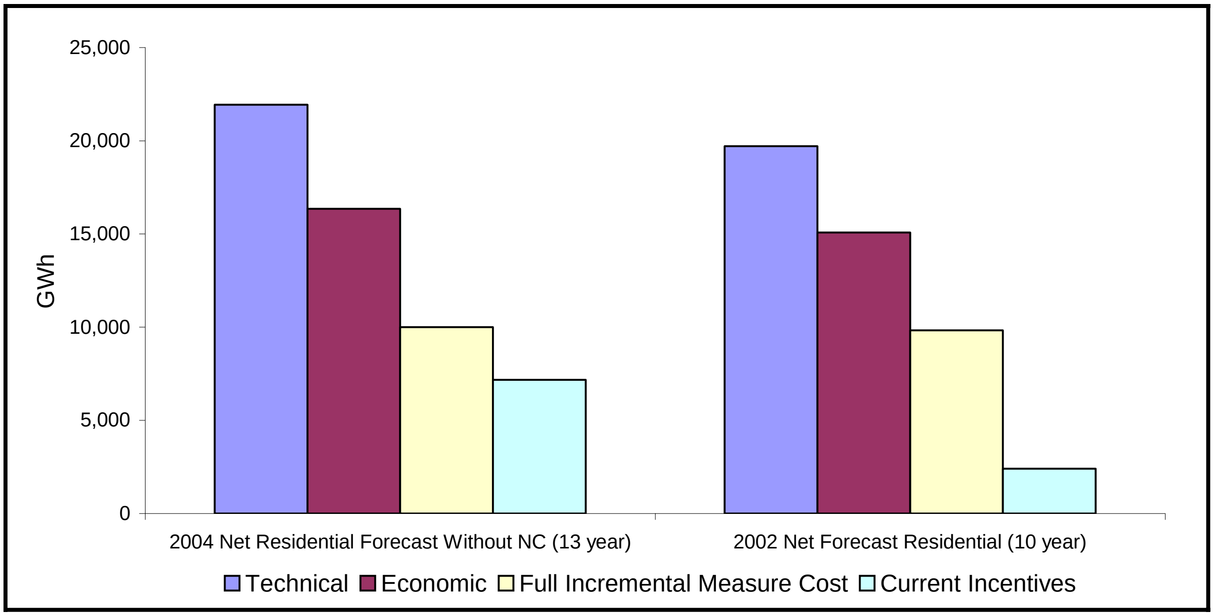
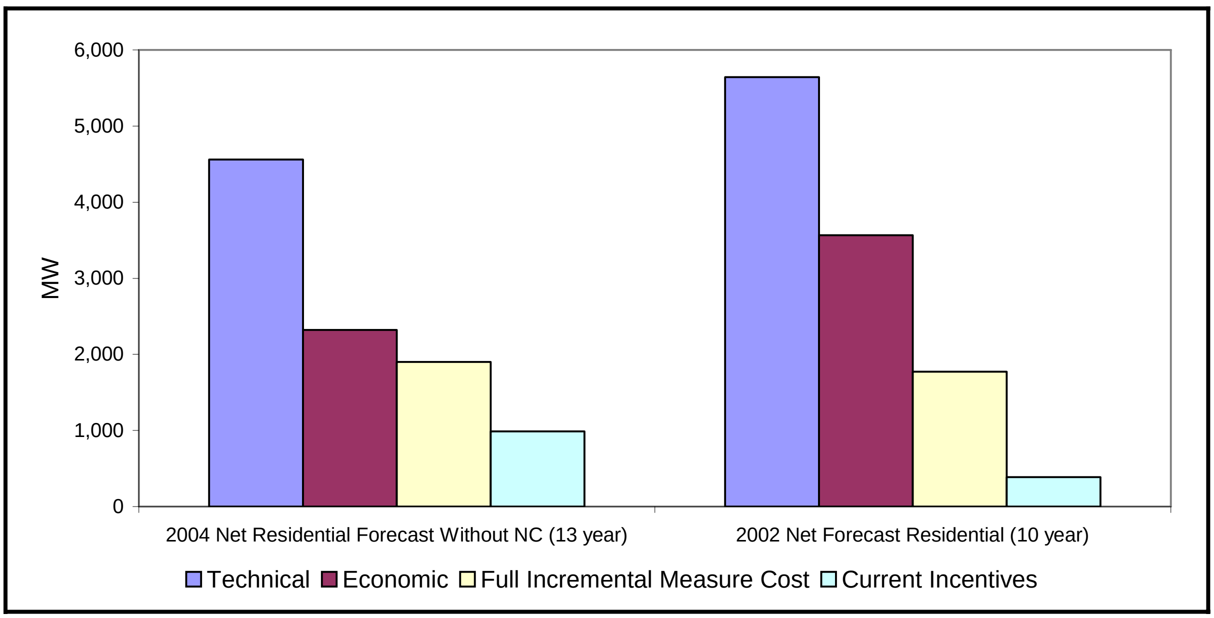


Figure 6-2: Residential Sector Remaining Demand Savings Forecast for the 2000 and the 2004 Potential Forecast



The larger residential program accomplishments, the emphasis on lighting, and the disaggregation of lighting measures are represented in the 2004 forecast. Figure 6-1 and Figure 6-2 illustrate the remaining residential market, economic, and technical energy and demand potential as forecast in the 2000 and 2004 studies.[24] The current market energy and demand forecasts for the 2004 study are clearly larger than those of the 2000 study. The technical and economic energy savings potential from the 2004 study are slightly larger than those from the 2000 study, while the technical and economic demand savings potential from the 2000 study are higher than the estimates of remaining demand savings from the 2004 study.

The increases in the current market energy and demand forecasts are largely due to increases in lighting potential. Changes in the emphasis and structure of the IOU residential lighting program were incorporated in the 2004 study. Calibration of the current incentive forecast to program accomplishments, and the significant increase in program accomplishments in 2004, lead to the large increase in the current incentives forecast for 2004 relative to 2000. The 2000 study's forecast could not be designed to account for unknown changes in the design of the residential lighting program. Forecasts of the remaining energy efficiency potential can model changes in rebate levels and administrative and advertising costs, but they do not model some other changes in program design, such as the implementation of upstream lighting rebates and do not currently model ongoing reduction in unit measure prices, that can also significantly increase adoption per dollar of effort.

The forecast of the technical and economic demand potential is lower in the 2004 forecast than the 2000 forecast. Much of this decline is due to changes in federal SEER standards for central air conditioners and heat pumps and the elimination of some HVAC measures from the 2004 analysis. Federal SEER standards for central air conditioners and heat pumps require manufacturers to stop the production of all units below a 13 SEER in 2006. To accommodate these changes, the base measure for high efficiency air conditioning and heat pumps changes from 10 SEER to 13 SEER in 2007. This change in the base measure's energy savings and costs significantly reduces both the remaining technical and the economic potential demand savings.

[24] The 2000 forecast is a net forecast. To facilitate comparison, gross results from the 2004 forecast have been multiplied by a net-to-gross ratio of 0.85 to approximate the net energy savings. This ratio was chosen strictly to facilitate a comparison between the studies. Several factors prohibit a true comparison from taking place including: the years included in the analysis are different, the 2004 study takes into account changes in Standards and it would be a time intensive exercise to apply net-to-gross ratios to each measure in the 2000 study.

The 2000 residential potential forecast included many HVAC measures not included in the 2004 analysis. HVAC measures in the 2000 analysis, but not in 2004, include programmable thermostats, R0-R19 ceiling insulation, ceiling fans, attic venting, cool roofs, and floor insulation. Many of these measures were eliminated from the 2004 analysis due to new analyses that significantly reduced the savings impacts associated with the measure.

The elimination of several HVAC measures and the change in the federal baseline SEER for residential air conditioning led to sizable a reduction in the forecast of economic and technical energy savings and to a significant reduction in the forecast of demand savings when comparing the 2000 residential results to the 2004 findings.

Natural Gas Residential Potential

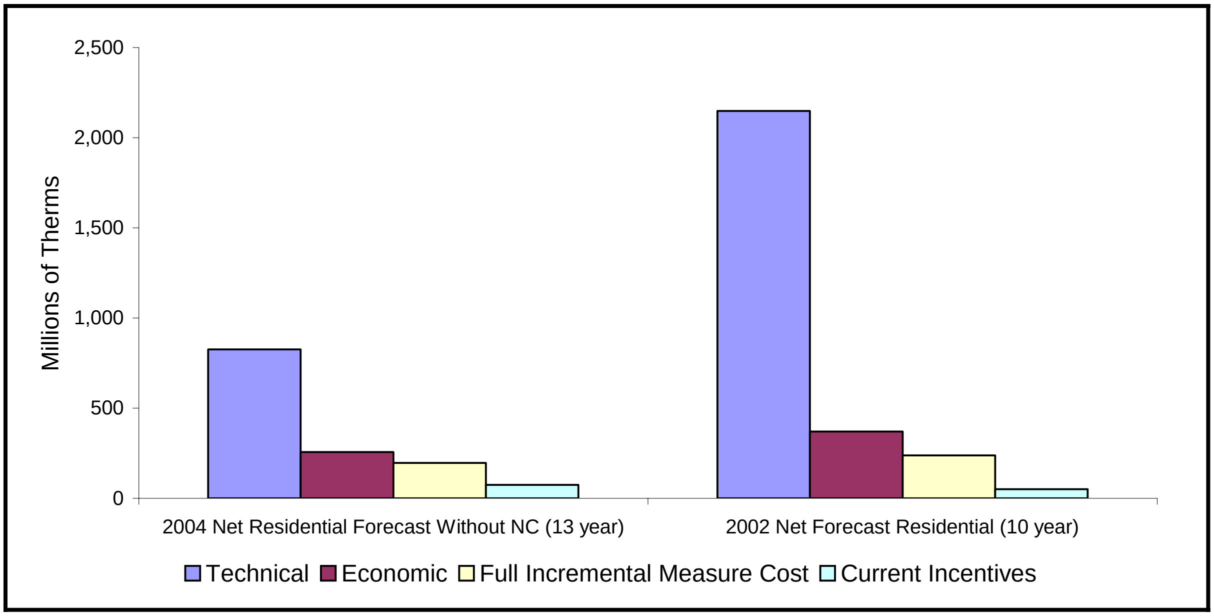
Figure 6-3 illustrates the estimated natural gas savings potential for the 2000 and 2004 residential analyses.[25] As with the commercial natural gas potential savings, the technical and economic potential estimates from the 2000 analysis are higher than those from this analysis. The differences in the technical and economic potential estimates are largely due to the high efficiency measures analyzed, changes in federal and state energy efficiency standards, and changes in high efficiency measure savings.

The 2000 residential sector potential analysis estimated the potential remaining from solar water heaters. The 2000 analysis forecast that solar water heater had over 800 million therms of remaining technical potential. The 2004 analysis chose not to include solar water heaters in the high efficiency measure list. In 2004, no California IOU was offering residential rebates for solar hot water heaters.

The 2000 analysis also included several smaller measures not analyzed in the 2004 study. These measures include programmable thermostats, floor insulation, and HVAC testing and repair. The 2004 analysis did not analyze programmable thermostats because all of the California IOUs have chosen to eliminate this measure from their residential energy efficiency program offering. The 2004 analysis included HVAC testing in the electric model of energy efficiency potential but chose not to include it in the gas model due to potential savings overlap with duct repair. Examination of the HVAC testing and repair measure in the 2001 residential DEER indicated that this measure could be broken into two measures, limiting the HVAC testing to an electric measure and duct repair to an electric and gas measure. Breaking the HVAC testing and repair measure into two distinct measures eliminated the possibility of double counting the duct repair associated with HVAC testing and repair.

[25] The 2004 analysis produced gross estimates of the remaining potential. To facilitate comparison to the 2000 analysis, the 2004 gross potential results have been multiplied by a net-to-gross ratio of 0.85.

Figure 6-3: Residential Sector Natural Gas Savings Potential for the 2000 and the 2004 Potential Study



The 2000 analysis estimates show that the technical potential for high efficiency gas clothes washers exceeds 300 million therms, while the 2004 analysis estimated the remaining technical potential at approximately 100 million therms. The disparity in these two estimates of technical potential stem from several differences imbedded in the analyses.

The 2000 analysis of clothes washers was undertaken before the recent changes in the federal rating standards. Prior to January 1, 2004 clothes washers were rated based on an energy factor (EF). The new federal standard is based on a modified energy factor (MEF). The 2002 analysis used the EF rating system while the 2004 analysis used the MEF. The federal standards in place in 2000 required an EF = 1.18. An EF = 1.18 is approximately equal to a MEF of 0.817.[26] The federal standards applicable in 2004 is an MEF = 1.04. The increase in the federal minimum standards works to reduce the remaining technical potential for gas clothes washers.

The 2000 analysis of clothes washers also estimates the technical potential associated with clothes washers in multifamily common area laundry settings. The 2004 analysis of clothes washers limited the estimate of potential to clothes washers in multifamily units, but did not analyze the potential of units in common areas.

[26] Consortium for Energy Efficiency. *Residential Clothes Washer Initiative Program Description*, 1996. Revised 2002.

The estimate of technical potential associated with wall insulation exceeded 325 million therms in the 2004 analysis and was estimated to be approximately 175 million therms in the 2000 analysis. Much of the difference in the estimate of technical potential for this measure stems from different assumptions underlying the technical saturation of wall insulation. This measure only applies to older homes built before Title 24 building standards. The 2000 study assumed that approximately 25% of homes built before 1979 had an insufficient level of wall insulation. The 2004 study used data from the 2004 RASS database to determine the percentage of older homes without insulation. These data indicate that the percentage of uninsulated pre-1979 homes exceeds 25%, and these data substantially explain the difference between the 2000 and 2004 estimates of wall insulation technical potential.[27] Given the nature of the RASS data, more research may be needed to reliably determine the percent of under insulated older homes in California.

Changes in the measure list and the new RASS saturation data help to explain major differences in the 2000 and the 2004 estimate of the remaining natural gas potential. Additional in-depth research is needed to help eliminate remaining uncertainties about the saturation of measures in residential housing.

Commercial Data and Results

The 2006 CEUS database provided the 2004 study with recent statewide data gathered from an in-depth on-site survey of commercial building equipment and characteristics. Prior to the completion of this database, data on commercial measure saturation were utility-specific and limited to data collected for utility-specific commercial end-use surveys from 1992 through 1998.

Electric Commercial Potential

Detailed data on the current saturation of high efficiency measures are particularly important in the California commercial sector. California has been rebating high efficiency measures in the commercial sector for over 30 years. In recent history, energy savings for nonresidential energy efficiency programs has typically represented 70 to 80% of energy savings from all of the California IOU energy efficiency programs.[28] Figure 6-4 and Figure 6-5 illustrate recent energy efficiency program accomplishment data for the four California IOUs.

[27] The RASS study was a mail survey that inquired about several features of the home and appliances in the home. Many individuals living in older homes may not know if their walls are insulated.

[28] KEMA July 2002 op. cit.

Figure 6-4: First-Year GWh Savings from 2000-2004 for Energy Efficiency Programs

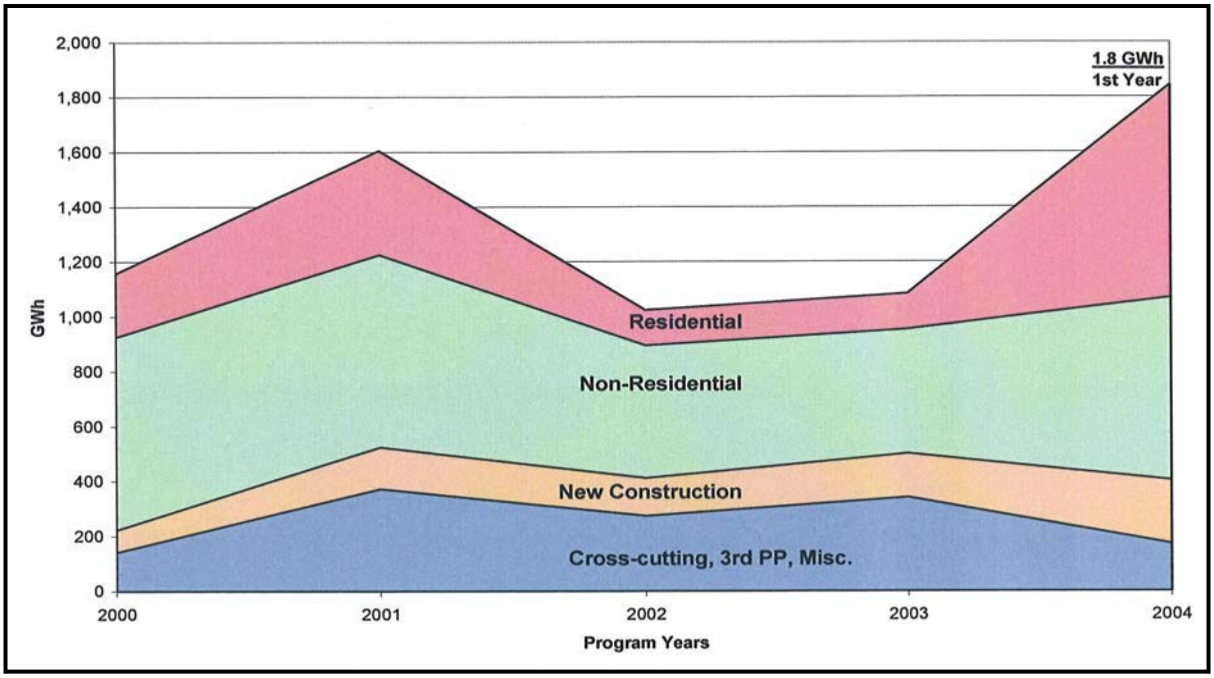
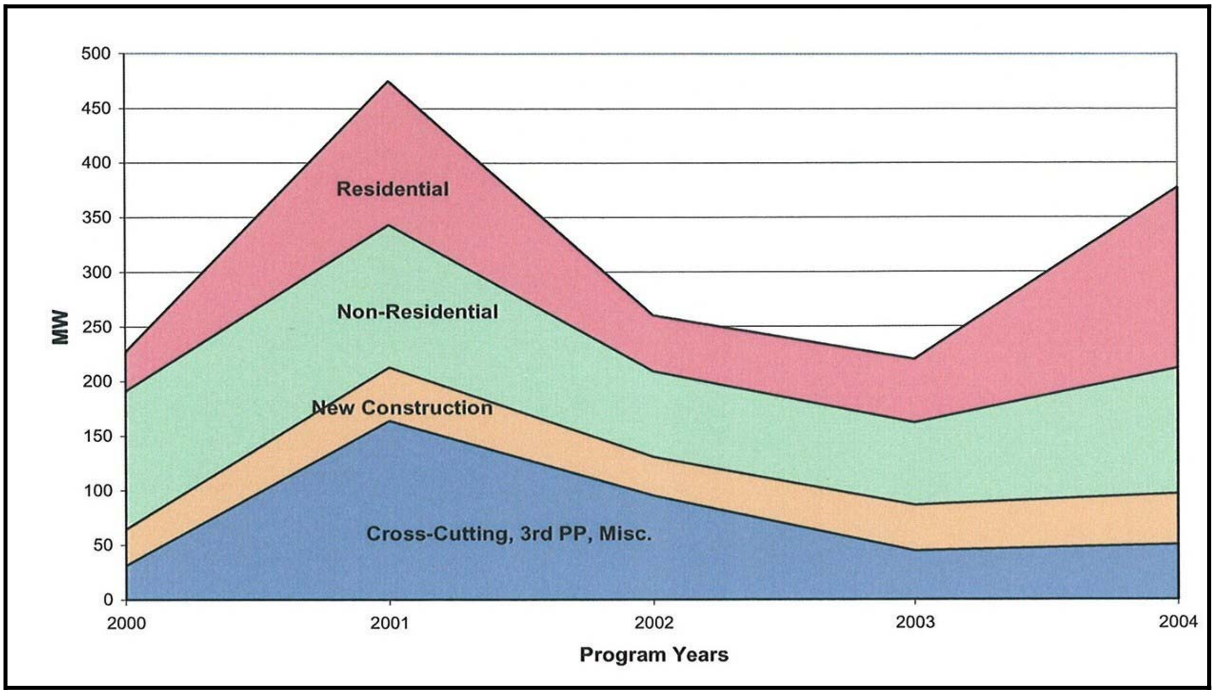


Table courtesy of the CEC. *Funding and Energy Savings from Investor-Owned Utility Energy Efficiency Programs in California for Program Years 2000 Through 2004.* Cynthia Rogers, Mike Messenger, and Sylvia Bender. August 2005

Figure 6-5: First-Year MW Savings from 2000-2004 for Energy Efficiency Programs

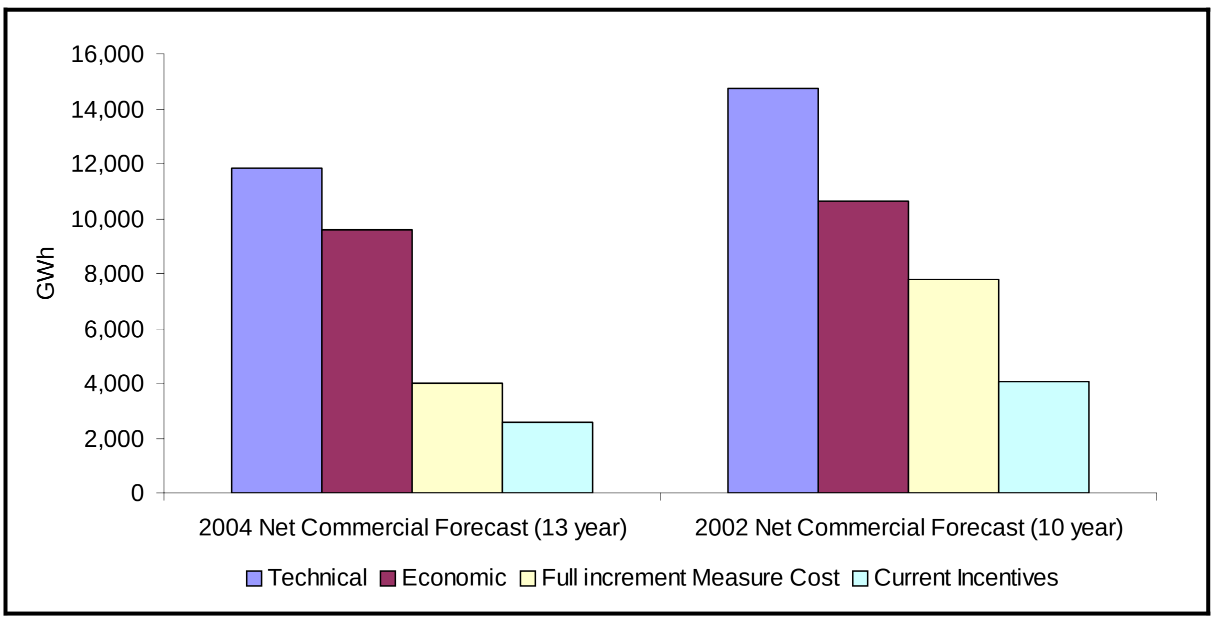


Data courtesy of the CEC: *Funding and Energy Savings from Investor-Owned Utility Energy Efficiency Programs in California for Program Years 2000 Through 2004*, August 2005. This figure is a reproduction of Figure 6 in the CEC report.

California's continued emphasis on nonresidential energy efficiency programs has resulted in significant energy savings and a substantial increase in the saturation of high efficiency measures in the nonresidential sector. For example, the 2000 analysis stated the "current saturation levels for T8 lamp/electronic ballast and compact fluorescent lamps are high but are uncertain." The average saturation of T8s in the 2000 study ranged from 55% for four-foot T8s in large commercial establishments to 11% for eight-foot T8s in small commercial establishments.[29] The saturation of four-foot T8 lamps in this study is derived from the recent 2005 CEUS and ranged from 91% to 19%, with a mean of 62%. The significant penetration of high efficiency T8 lamps helps illustrate the success of past commercial energy efficiency program and limits the remaining energy savings potential of future programs in the area of commercial lighting.

The recent CEUS data enabled the 2004 forecast to measure the saturation of high efficiency commercial lighting, and other commercial measures, with less uncertainty than the 2000 forecast. These types of recent data on measure saturation are necessary for an accurate forecast of the remaining energy efficiency potential, and the importance of these data increases in sectors with long-standing mature programs.

Figure 6-6: Commercial Sector Energy Forecasts from the 2000 and the 2004 Potential Studies



[29] Ibid. The uncertainty surrounding the saturation of lamps and other equipment in the 2002 commercial analysis stemmed, at least in part, from the age of the commercial saturation data, in combination with the long-standing and successful nature of California's commercial energy efficiency programs.

Figure 6-6 and Figure 6-7 illustrate the commercial energy and demand savings potential forecast from the 2000 and 2004 studies.[30] The 2000 study results are a forecast of energy savings over a 10-year period, while the 2004 results are a forecast over a 13-year period. The decline in the remaining market, economic, and technical energy efficiency potential is clearly illustrated in these figures.

Additional evidence of the forecast decline in the remaining commercial energy efficiency potential is found in comparisons of technical and economic potential to expected energy sales. In the 2000 analysis, the estimate of technical and economic energy potential was about 18% and 13% of total commercial energy usage, respectively. The 2000 study estimated that technical demand potential was 22% and economic demand potential was14% of commercial demand usage. In this study, Itron estimated that technical potential was 15% of expected commercial energy usage and economic energy potential was 12% of expected usage. The 2004 analysis also found that technical demand potential had fallen to 10% of expected demand and that economic demand potential had declined to 7% of expected demand.[31]

The decline in the forecast of energy efficiency potential is due to many factors, including a reduction in the commercial program accomplishments in 2004 relative to 2000 (see Figure 6-4), a slightly different measure mix, new measure impacts, changes in federal and California's energy efficiency standards, and the new technology saturation data from CEUS.

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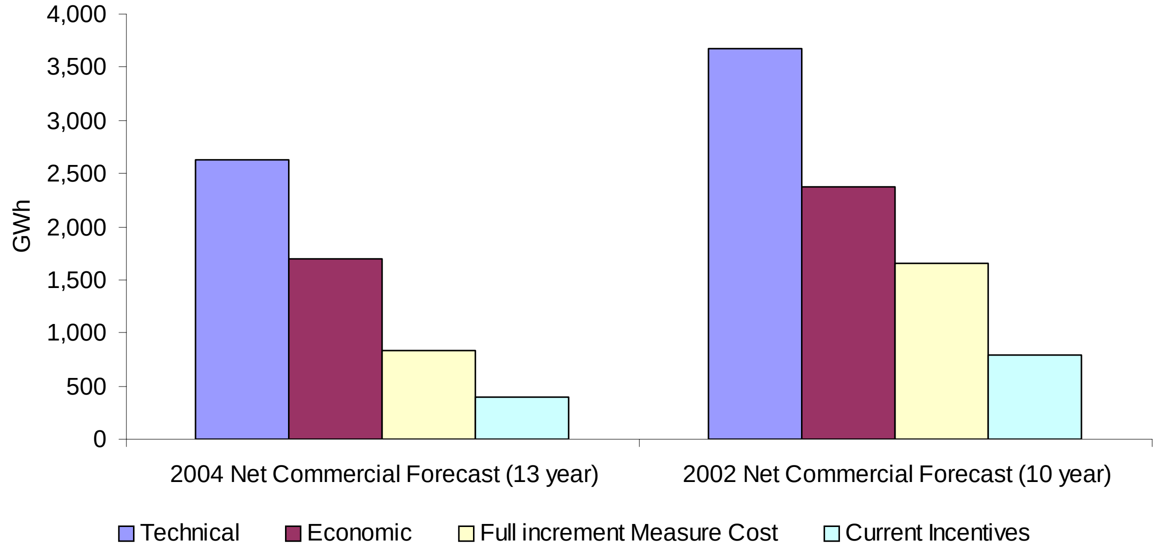
[30] The 2004 study did not calculate a net forecast of the remaining potential. To facilitate comparison to the 2000 study results, the numbers presented in Figure 6-2 have assumed a net-to-gross ratio of 0.85. (Refer to Footnote 15 for a discussion of using a net-to-gross ratio of 0.85.)

[31] The effectiveness of past programs works to decrease the forecast of electricity usage. Past success works to reduce the appearance of current program success – yesterday's spillover is incorporated into the baselines used to judge the current programs.

Figure 6-7: Commercial Sector Demand Forecasts from the 2000 and the 2004 Potential Studies



The 2000 study analyzed 69 commercial high efficiency measures while this study analyzed 82 measures (see Table 5-1).[32] The increased number of measures analyzed in the 2004 study is largely a result of an increase in the number of CFL lighting measures analyzed.

While the increased number of lighting measures, relative to the 2000 study, might lead to an increase in the estimate of potential savings, many factors in the 2004 analysis restrain the forecast of the remaining lighting potential. These factors include the currently higher saturation of efficient lighting, a reduction between 2001 and 2005 in the DEER hours of lighting operation, which decreases the impacts for lighting in 2005 relative to 2001, and the implementation of new federal standards for commercial lighting.

The recent CEUS database helps to eliminate many of the uncertainties that were present in the 2000 potential study concerning the saturation and technology density of lighting in commercial buildings. The saturation data from the 2005 CEUS database shows that many commercial buildings have converted their T8 and T12 lighting measures to high efficiency measures, lending supporting data to the effectiveness of previous commercial energy efficiency programs while limiting the remaining potential available with existing high efficiency lighting measures. The combination of changes in DEER hours of operation and improved information on the technology saturation of high efficiency lighting works to reduce the estimate of the remaining potential associated with T8s from approximately 3500 GWh and 700 MW in the 2000 analysis to 1380 GWh and 250 MW in the 2004 analysis.

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32 The high efficiency commercial measure list for the 2002 study is Table A8 in Xenergy July 2002 op. cit.

In the 2000 commercial potential forecast, the perimeter lighting dimming measures contributed approximately 1700 GWh and 775 MW to technical potential. For this analysis, perimeter dimming only added 333 GWh and 63 MW to technical potential. The primary source of the difference in these estimates appears to be a result of significant differences in the applicability assigned by the two studies. The 2000 analysis assumed that perimeter dimming was applicable to the perimeter and to areas with skylights. The 2004 analysis assumed that the measure was applicable to the perimeter where window glass constitutes 20% of the wall area. This restriction eliminates several building types from the analysis, including grocery stores, lodging, retail, restaurants, and schools.

The CEUS database also helps to eliminate some of the uncertainties associated with the technology saturations and the portion of floorspace using high efficiency chillers for cooling. The 2000 analysis used data on the portion of floorspace cooled by chillers from 1992-1996 CEUS databases and professional judgment.[33] In this analysis, the portion of floorspace cooled by chillers is determined by the current CEUS database. The CEUS data indicates that the 2000 analysis generally assumed that too much floorspace was cooled by chillers and too little floorspace was cooled by direct expansion units (DX). These findings help to explain why the 2000 study forecasts that high efficiency chillers have a remaining demand potential of approximately 300 MW while the 2004 study estimates the remaining demand potential at 47 MW.

Recent changes in federal standards also restrict manufacturers from producing 10 SEER packaged air conditioning units after 2005, increasing the base efficiency level for packaged units to 13 SEER. The 2000 study assumed that a 10 SEER unit was the base unit, enabling this study to forecast the remaining potential associated with the implementation of a 12 SEER air conditioner. In the 2004 analysis, the forecast eliminates the 10 SEER base after 2006 and estimates the potential associated with replacing a 13 SEER air conditioner with a 14 or a 15 SEER unit. The improved energy efficiency of the base air conditioning unit reduces demand and usage savings for the higher efficiency 14 and 15 SEER air conditioners, significantly increasing the measure payback period. Changing the base efficiency for packaged air conditioners works to reduce the remaining market and economic demand potential in the 2004 forecast relative to the 2002 forecast.[34]

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33 KEMA July 2002, op. cit. See Appendix A.

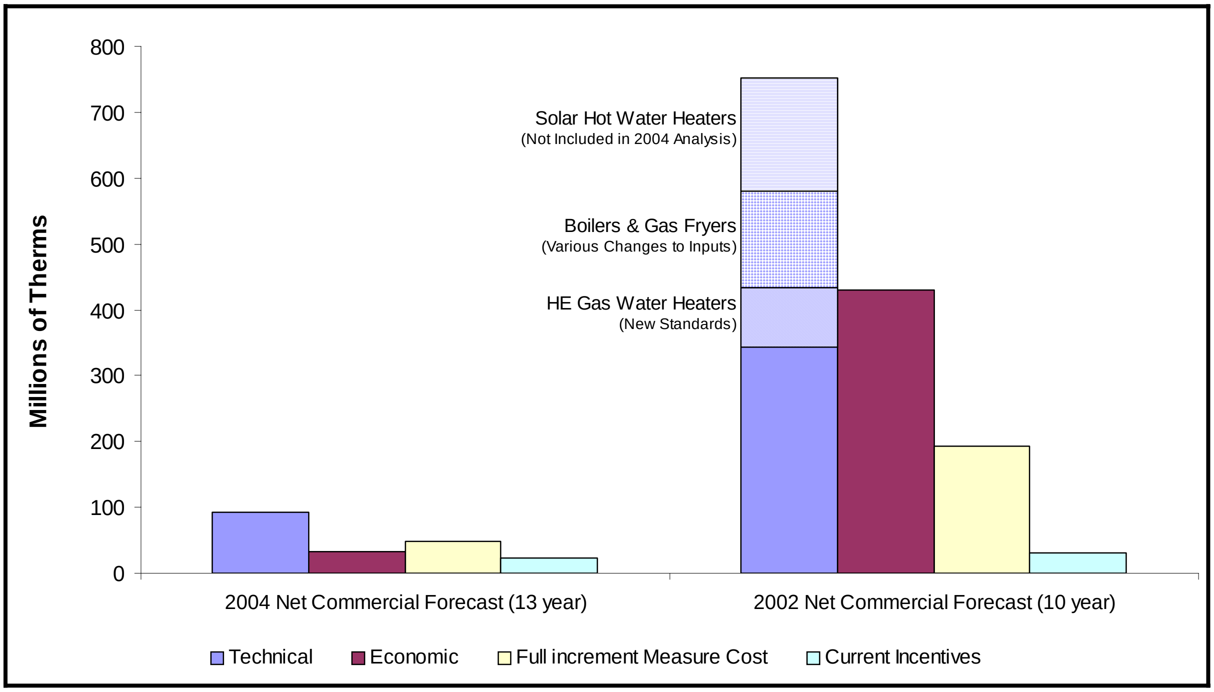
34 Using colleges in climate zone 10 as an example, replacing a 10 SEER unit with a 13 SEER unit saves 2,578 kWh per thousand square feet. Replacing a 13 SEER unit with a 14 SEER unit saves only 463 kWh per thousand square feet. Changing the base dramatically reduces the incremental savings associated with high efficiency air conditioning measures.

The recent on-site building data provided by the CEUS database, in combination with changing federal standards and long-standing commercial energy efficiency programs, have worked to reduce the forecast of remaining potential relative to the 2000 forecast.

Natural Gas Commercial Potential

Figure 6-8 illustrates the remaining potential for natural gas savings as forecast by the 2000 and 2004 analysis.[35] Clearly, the technical, economic, and full incremental measure cost forecasts are significantly larger for the 2000 analysis than for this study. Much of the difference in the technical and economic natural gas commercial potential savings is due to the high efficiency measures analyzed, federal standards, and the new measure saturations and technology densities implemented in the 2004 analysis.

Figure 6-8: Commercial Sector Therms Forecast for the 2000 and the 2004 Potential Studies



The 2000 analysis included commercial solar hot water heaters. These measures were forecast to have a technical potential of 184 million therms. This measure was not included in the 2004 analysis. None of the three gas IOUs currently incentivizes commercial solar water heaters. When the high efficiency measure list was chosen for this analysis, none of the IOUs expressed an interest in estimating technical or economic potential.

35 The 2004 analysis produced gross estimates of the remaining potential. For comparison purposes, the 2004 gross estimates of potential savings have been adjusted using a net-to-gross ratio of 0.85.

There is a large difference in the technical potential savings estimated between both efforts for high-efficiency space-heating boilers. In the 2000 analysis, the forecast of potential technical savings for a condensing high-efficiency space-heating boiler with 95% efficiency was 103 million therms. In the 2004 analysis, Itron estimated the remaining technical potential savings for a high efficiency space-heating boiler with 85% efficiency.[36] The estimated technical potential from the 2004 analysis was 14 million therms.

There are several differences in the 2000 and the 2004 analysis of potential savings from space heating boilers. First, the 2000 analysis assumed a substantially higher level of efficiency for their highest efficiency space heating boiler. The high level of efficiency gave the 2000 study an energy savings of 18%. The 2000 analysis also employed technology saturation data from the 1992-1996 CEUS databases.

The 2004 analysis attempted to use the engineering estimates of savings from the 2004-2005 DEER database. The DEER database analyzed a high efficiency space heating boiler with an 85% efficiency, leading to 5% to 6% energy savings over the base measure. Unfortunately, the 2005 DEER database's estimates for high efficiency boilers are in units not consistent with the necessary units for the ASSET model. Due to this inconsistency, Itron turned to the claimed per-unit savings of the three major IOUs. All three IOUs list high efficiency gas space heating boilers in the program offerings with a claimed savings equivalent to approximately 5% to 6% of energy usage. The 2004 analysis used the per-unit energy savings from the IOUs and the new technology density and saturation data from CEUS.[37] These data led to the significantly lower estimate of technical potential than was estimated in the 2002 analysis.

Several other gas high efficiency measures from the 2000 study had substantially less estimated technical and economic potential in the 2004 analysis. The decline in savings potential may be due to reductions in savings impacts, different measure descriptions, or changes in technology saturations and densities. For example, the 2000 analysis determined that infrared gas fryers had a technical potential of 61 million therms while the 2004 analysis estimated the remaining technical potential at 8.6 million therms.

Changes in California appliance standards between the 2000 analysis and the 2004 study reduced the remaining energy efficiency potential for high efficiency gas water heaters. The 2000 study assumed that high efficiency gas water heaters have an energy savings fraction of 25%. The implementation of the new California appliance standards changed the base efficiency for a gas hot water heater from an energy factor (EF) = .54 to EF = .6. Changes in

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36 The high efficiency boiler analyzed in the 2005 DEER database has an efficiency of 85%.

37 The SoCalGas claimed savings are 64.2 kBtu per unit. This level of savings is consistent with 5% to 6% savings on an 85% efficient boiler operating 1000 to 1200 hours.

the minimum or base energy efficiency factor have reduced the energy savings fraction used in the 2005 DEER, and for this study, to 5%.[38] The decline in energy savings associated with high efficiency hot water heaters and the new CEUS technology density and saturation data have contributed to a dramatic decline in the technical potential for hot water heaters from 97 million therms to 5.2 million therms.

Changes in the high efficiency measure list, including the elimination of high efficiency solar hot water heaters and the highest efficiency choices for space heating boilers, combined with changes in standards and technology densities and saturations, help explain the significant decline in commercial natural gas technical potential.

6.3 Additional Data Issues

The 2004 forecast of California's energy efficiency potential benefited from the DEER, CEUS and RASS data collection efforts. These data provided the 2004 study with current data on saving impacts associated with high efficiency measures and the saturation and technology densities of residential and commercial measures. These data, however, did not eliminate all of the data and modeling uncertainties. Remaining issues include, but are not limited to, the saturation of many high efficiency measures in residential housing, customers' attitudes toward high efficiency measures, factors that influence customers' decisions to purchase high efficiency measures, and the appropriate net-to-gross ratio for upstream and mature energy efficiency measures.

Both the 2000 and 2004 California energy efficiency potential studies were forced to rely on professional judgment when available databases did not contain reliable values of necessary input variables. The use of professional judgment is most evident in both studies when determining customers' attitudes toward high efficiency measures. The 2000 study reasoned that significant increases in funding would lead to increases in customer willingness to adopt energy efficiency measures. The 2004 study assumed that a larger share of households and businesses were currently aware and willing to implement commercially available measures.

The 2000 study links the rate of growth in awareness and willingness to the level of energy efficiency funding. In the 2000 study, the level of awareness and willingness is higher for the full-cost analysis than for the current funding analysis as it assumes that part of the program funding increases go to increased awareness, education, and outreach efforts. In the 2004 study, the level of awareness and willingness is generally high and not influenced by the level of program funding. Currently, little information is available to support assumed

[38] Data from Itron 2004-2005 DEER, op. cit.

levels of awareness and willingness. Additional studies are needed to clarify the key issue of customer attitudes toward high efficiency measures.

Forecasting models require information on the factors that impact consumer buying decisions. For example, are the purchases of energy efficiency measures highly sensitive to changes in rebates levels, rates, and the period of payback? Alternatively, do consumers make their purchasing decision based on other, non-economic, factors? Additional research is needed in this area to clarify the relationship between rebates or payback length, and other social decision making factors affecting the probability of adoptions.

6.4 Conclusion

Incorporating the changes in the IOUs' baseline accomplishments, changes in federal and state standards, and new input data are the most important difference between the 2000 and 2004 studies. The 2000 study was calibrated to a general average of four years' (1996-2000) worth of utility program accomplishments. This enabled the 2000 study to capture measures that may be missing from a single program year and averages out short-term fluctuations in funding. The 2004 analysis is calibrated to the 2004 program accomplishments. This enabled the 2004 study to capture recent increases in the residential program and reductions in the commercial program. If the increases in the residential program are due to long-run increases in funding, and the reduction in the commercial program are a result of maturity and high saturations of efficient measures, this approach will more accurately capture the future of these programs. The differences in the market forecasts from the 2000 and the 2004 studies help to emphasize the importance of updating forecasts following contextual changes.

The calibration of the 2004 study to the 2004 IOU program year accomplishments contributes to the current market residential forecast exceeding the current market commercial forecast for existing buildings. Traditionally the existing nonresidential energy efficiency programs have claimed higher saving than the existing residential energy efficiency programs. In 2004, the residential energy-efficiency program savings exceeded the nonresidential energy-efficiency program savings. The increase in claimed residential program savings is largely due to an increase in savings from residential lighting measures. The ability of residential lighting programs to continue these high levels of accomplishments is yet to be determined.

The two studies analyzed different lists of high efficiency measures. The 2000 analysis included some measures eliminated from the 2004 analysis due to changes in federal and state energy efficiency standards. Changes in federal and state standards improve the efficiency of base measure choices, reducing the remaining energy efficiency potential. The 2000 study did not attempt to incorporate the 2005 changes in codes and standards. The

2004 analysis results are estimates net of the 2005 changes in codes and standards, whereas the results from the 2000 study do not net out these effects. It is well accepted that codes and standards have made a significant contribution to the adoption and savings from high-efficiency measures.

The 2000 analysis also included some very high efficiency measures not analyzed in the 2004 study. These measures include, but are not limited to, solar hot water heaters and very high efficiency gas boilers. Including these measures in the 2000 analysis works to increase the technical and full incremental cost market forecast relative to the 2004 estimates.

The two analyses differ in the savings impact, technology density, and saturation data used in the models. The newly released RASS (2004), DEER (2005), and CEUS (2006) allowed the 2004 study to update technology saturations, eliminating many uncertainties from the 2000 study. The 2004 analysis uses technology saturation data, which include the tremendous increase in energy efficiency measures following the 2000-2001 energy crisis. The increase in high efficiency measure saturations following the energy crisis works to reduce the remaining energy efficiency potential in the 2004 study relative the 2000 study.

7

California Industrial Energy Efficiency Potential

Under separate contract, KEMA-Xenergy (KEMA) developed the estimates of industrial energy efficiency potential. KEMA has developed a separate report to present their methodology and results.[1] Presented here is a summary of their findings. This section presents KEMA's estimates of electric and natural gas technical, economic, and achievable energy efficiency potential for the industrial sector of the major investor-owned utility (IOU) service territories in California.

7.1 Overview

Included in the industrial analyses were 127 electric and 36 gas measures. The complete set of measures was pre-screened to include only those measures presently commercially available to provide a realistic assessment of potential. Thus, few emerging technologies were included in the analysis. The measure analysis was segmented into the three electric and three gas IOU service territories and further into 16 industrial categories based on standard industrial code (SIC) classifications. (The more recent North American Industrial Classification System, NAICS, was not used because most utility databases were still using the SIC system at the time of the analysis.)[2]

The technical, economic, and achievable potential results are presented in several formats:

- In aggregate for each utility,
- By end use and measure, and
- By industry segment.

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1 KEMA-Xenergy, Inc., Lawrence Berkeley National Laboratory, and Quantum Consulting. *California Industrial Sector Energy Efficiency Potential Study*. Prepared for Pacific Gas and Electric Company. April 2006.

2 For a mapping of SIC codes to NAICS codes, see: Xenergy, Inc. *California Industrial Energy Efficiency Market Characterization Study*. Prepared for Pacific Gas and Electric Company. December 2001. http://www.calmac.org/publications/California%20Ind%20EE%20Mkt%20Characterization.pdf or visit the U.S. Census Bureau website at http://www.census.gov/epcd/www/naics.html.

KEMA provided estimates of savings potential in both absolute and percentage terms. Total base energy use, from which percentages are calculated, was developed from utility billing data collected in the 2003-2004 period. For electric consumption, the total base electric use in the major IOU service territories is roughly 33,000 GWh. It is estimated that the peak demand associated with total industrial energy for the three utilities is approximately 4,700 MW. For gas consumption, the total base gas use in the major IOU service territories is roughly 3,600 million therms. Table 7-1 lists the electric measures and Table 7-2 the gas measures. Technical potential estimates for each measure are provided in the tables.

Table 7-1: Industrial Electric Efficiency Measures and Technical Savings Potential – 2005

Measure	GWh Savings	MW Savings
O&M-Extruders/Injection Molding	38	0.9
Pumps – ASD (6-100 hp)	100	1.3
Comp Air - ASD (6-100 hp)	58	0.8
Compressed Air-Sizing	109	14.7
Pumps – O&M	208	26.6
Fans – O&M	26	3.4
Bakery – Process (Mixing) – O&M	11	1.4
Air Conveying Systems	19	0.6
Efficient Refrigeration – Operations	34	4.4
High Consistency Forming	4	0.5
Gap Forming Paper Machine	4	0.5
Efficient Practices Printing Press	14	1.8
Compressed Air – O&M	356	48.1
Near Net Shape Casting	2	0.2
Bakery – Process	54	7.1
Heating – Optimize Process (M&T)	15	2.2
Drives – Optimize Process (M&T)	30	4.2
Pumps – Controls	602	77.1
Compressed Air - System Opt	261	35.3
Fans – Improve Components	27	3.5
Process Control	7	0.9
Rep V-Belts – Drives	10	1.3
Top-Heating (glass)	4	0.5
New Transformers Welding	32	4.6
Efficient Processes (welding, etc.)	27	3.9
Efficient Drives – Rolling	7	0.9
Centrifugal Chiller, 0.51 kW/ton	92	17.9
Efficient Drives	3	0.3
Drives – EE Motor	22	2.8
Machinery	16	2.3
Efficient Machinery	0	0.0
Compressed Air – Controls	69	9.3

Table 7-1 (cont'd): Industrial Electric Efficiency Measures and Technical Savings Potential – 2005

Measure	GWh Savings	MW Savings
Refinery Controls	15	1.9
Programmable Thermostat - DX	46	2.4
O&M/Drives – Spinning Machines	7	4.7
Fans – ASD (6-100 hp)	13	0.7
Efficient Desalter	0	0.0
Pumps – System Optimization	516	66.0
Efficient Electric Melting	6	0.7
ENERGY STAR Transformers	45	6.5
Heating – Scheduling	3	0.1
Drives – Scheduling	11	0.3
Pumps – ASD (100+ hp)	121	1.5
Comp Air – ASD (100+ hp)	69	0.9
Drives – Process Control	6	0.7
Heating – Process Control	6	0.7
Fans – Motor Practices (6-100 HP)	22	2.8
Extruders/Injection Molding – Multi-Pump	54	6.7
Fans – ASD (100+ hp)	59	1.1
Membranes for Wastewater	0	0.0
Optimize Drying Process	11	1.4
Optimization Refrigeration	58	7.6
Clean Room – Controls	20	2.8
Efficient Curing Ovens	48	6.9
Optimization Control PM	12	1.6
Fans – Controls	237	30.5
Efficient Printing Press	12	1.5
Injection Molding – Impulse Cooling	20	2.4
Drying (UV/IR)	2	0.1
Process Optimization	5	0.6
Other Process Controls (batch and site)	8	1.0
Fans – System Optimization	80	5.2
Window Film – DX	34	6.6
RET 2L4' Premium T8, 1EB	705	131.7
CFL Hardwired, Modular 36W	191	35.0
Pumps – Motor Practices (100+ HP)	30	3.8
Pumps – Motor Practices (6-100 HP)	29	3.7
Rep V-Belts – Other	0	0.0
Comp Air-Motor Practices (100+ HP)	17	2.3
Comp Air-Motor Practices (6-100 HP)	17	2.2
Process Drives – ASD	2	0.2
Direct Drive Extruders	28	3.5
Clean Room – New Designs	11	1.3
Fans – Motor Practices (1-5 HP)	5	0.6
Injection Molding – Direct Drive	17	2.1

Table 7-1 (cont'd): Industrial Electric Efficiency Measures and Technical Savings Potential – 2005

Measure	GWh Savings	MW Savings
Power Recovery	3	0.3
Heat Pumps – Drying	3	0.4
Pumps – Motor Practices (1-5 HP)	8	1.0
Comp Air-Motor Practices (1-5 HP)	4	0.6
Fans – Rep 100+ HP Motor	15	2.0
Occupancy Sensor, 4L4' Fluorescent Fixture	56	13.9
Drives – Process Control (batch and site)	29	3.6
Window Film - Chiller	27	5.3
DX Packaged System, EER=10.9	71	13.9
Pumps –- Rep 100+ HP Motor	23	3.0
Comp Air – Rep 100+ HP Motor	14	1.8
Efficient Grinding	35	4.1
Light Cylinders	5	0.7
Intelligent Extruder (DOE)	0	0.0
Fans – Rep 1-5 HP Motor	5	0.7
Fans – Motor Practices (100+ HP)	6	2.4
Pumps – Sizing	21	17.3
EMS – Chiller	42	8.2
Cool Roof – DX	38	7.3
Pumps – Rep 1-5 HP Motor	8	1.0
Comp Air – Rep 1-5 HP Motor	5	0.6
Fans – ASD (1-5 hp)	6	0.1
Pumps – Rep 6-100 HP Motor	25	3.3
Comp Air – Rep 6-100 HP Motor	15	2.0
Cooling Circ. Pumps – VSD	21	4.0
Fans – Rep 6-100 HP Motor	12	2.1
Pumps – ASD (1-5 hp)	9	0.1
Comp Air – ASD (1-5 hp)	5	0.1
Cool Roof – Chiller	17	3.3
DX Tune Up/Advanced Diagnostics	47	9.2
Metal Halide, 50W	25	4.4
Evaporative Pre-Cooler	27	5.3
Chiller Tune-Up/Diagnostics	1	1.1

Table 7-2: Industrial Gas Efficiency Measures and Technical Savings Potential – 2005

Measure	Millions of Therms
Maintain Boilers	21.9
Load Control	42.9
Improved Process Control	18.2
Automatic Steam Trap Monitoring	25.3
Preventative Maintenance	1.5
Improved Insulation	78.8
Condensate Return	1.8
Process Controls & Management	46.7
Duct Insulation	0.6
Flare Gas Controls And Recovery	7.5
Water Treatment	9.0
Fouling Control	12.3
High Efficiency (95%) Condensing Furnace/Boiler	5.7
Combustion Controls	2.3
Batch Cullet Preheating	2.8
Optimize Furnace Operations	1.8
EMS Optimization	0.3
Efficient Furnaces	4.0
Upgrade Burner Efficiency	4.5
Leak Repair	4.3
Improved Separation Processes	1.4
Efficient Burners	26.7
Flue Gas Heat Recovery/Economizer	8.9
Thermal Oxidizers	1.7
Steam Trap Maintenance	54.9
Oxy-fuel	8.3
Heat Recovery	15.6
EMS Install	3.1
Improve Ceiling Insulation	7.3
Process Integration	37.2
Stack Heat Exchanger	0.1
Blowdown Steam Heat Recovery	4.4
Efficient Drying	4.6
Extended Nip Press	2.4
Insulation/Reduce Heat Losses	0.2
Closed Hood	0.7

7.2 Potential for Industrial Electric Energy Efficiency

Technical and Economic Potential by Utility

In Figure 7-1, KEMA presents their estimates of total electric technical and economic potential for energy and peak demand. Overall, technical energy savings potential is estimated to be roughly 5,500 GWh, about 17% of total industrial electric usage (i.e., 5,485 GWh Savings ÷ 32,847 GWh of base consumption). Economic potential is estimated to be about 5,000 GWh, about 15% of total base usage (for year 2004). Technical demand savings potential is estimated to be over 750 MW, about 16% of total peak demand. Economic potential is estimated to be approximately 660 MW, about 14% of total base 2004 demand.

Figure 7-1: Estimated Electric Technical and Economic Savings Potential (Industrial Sector Existing Construction, PG&E/SCE/SDG&E) – 2005

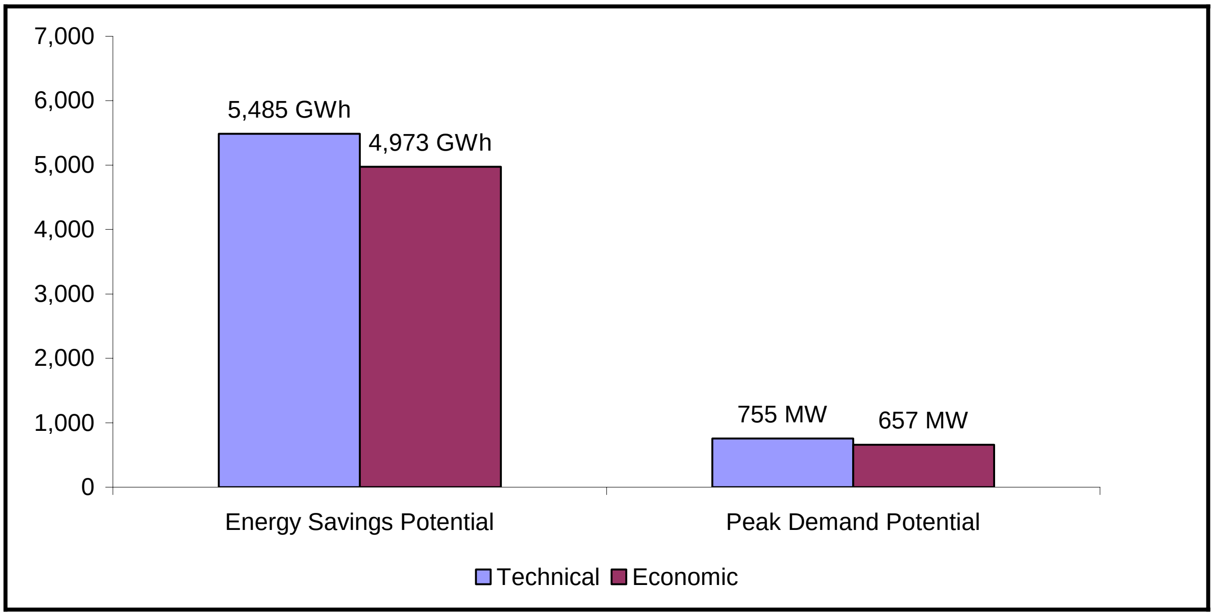
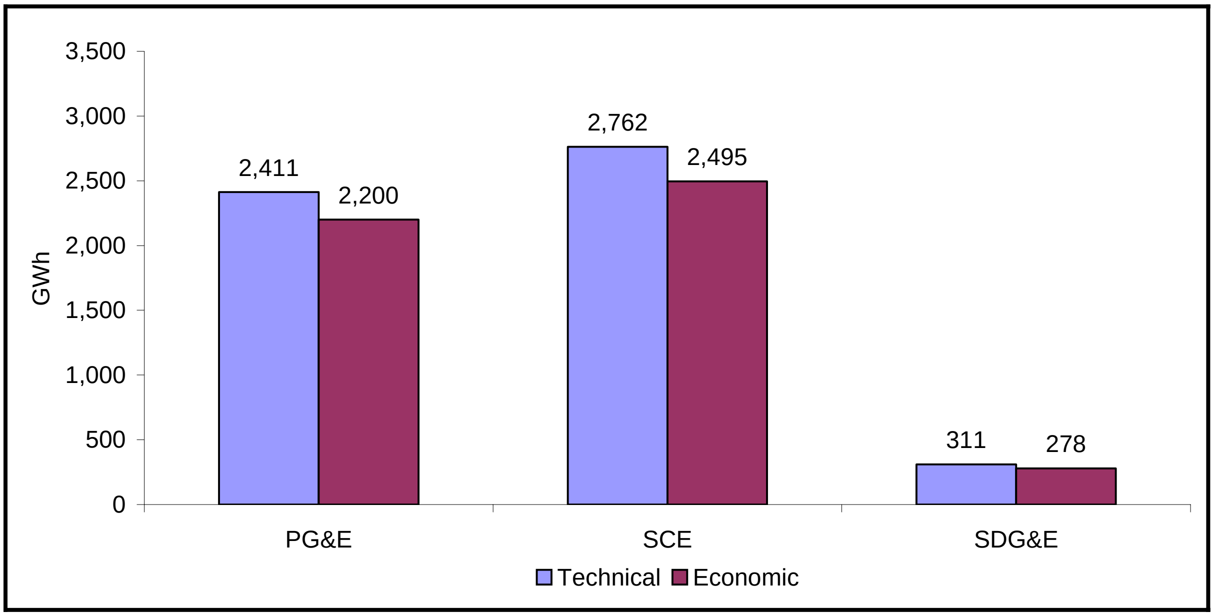


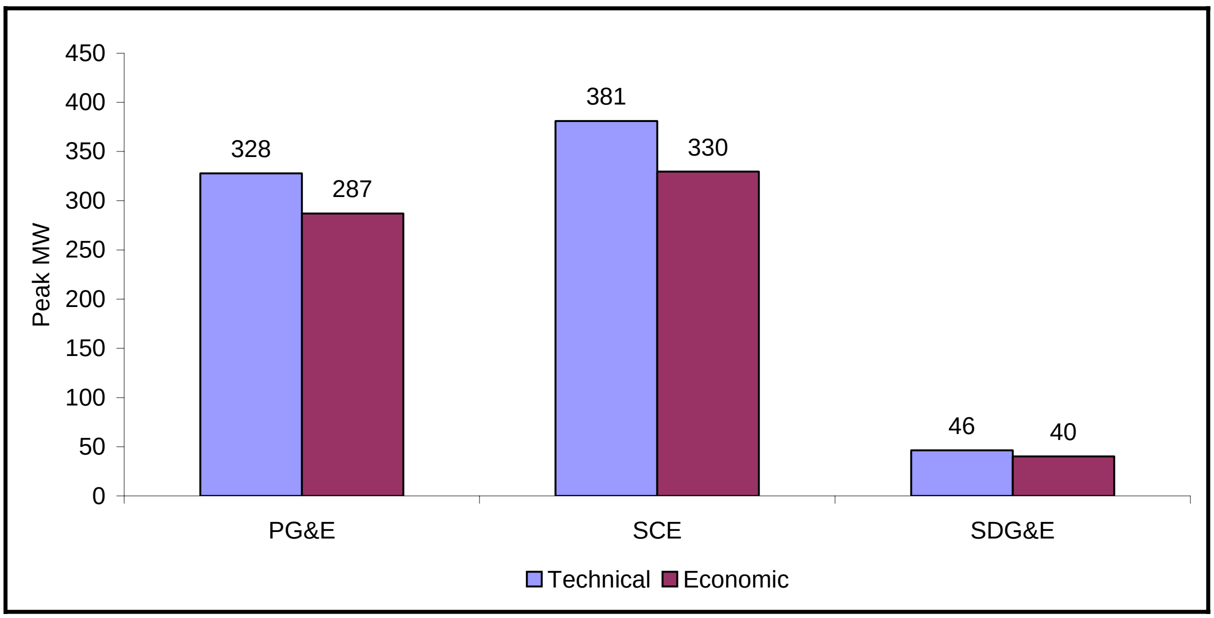
Figure 7-2 and Figure 7-3 show technical and economic potential by utility. The potentials in the Pacific Gas and Electric (PG&E) and Southern California Edison (SCE) territories are similar in size. SCE has slightly higher economic savings potential at about 2,500 GWh, followed closely by PG&E's potential of approximately 2,200 GWh. As a percent of base consumption, the economic energy savings potentials are 16% for PG&E, 15% for SCE, and 14% for San Diego Gas & Electric (SDG&E). Differences are mainly due to the types of industries and the avoided costs in each service territory.

Figure 7-2: Industrial Electric Savings Potential by Utility – 2005



KEMA estimated technical peak demand savings potential of around 350 MW for both PG&E and SCE and just under 50 MW for SDG&E. PG&E and SCE each have economic peak demand savings potential of approximately 300 MW, while the estimate for SDG&E is approximately 40 MW. It is estimated that PG&E and SCE economic demand savings potential are about 14% each and SDG&E's is about 13%.

Figure 7-3: Industrial Electric Demand Savings Potential by Utility – 2005



Industrial Electric Technical and Economic Savings Potential by End Use and Measure

Estimates of energy and peak demand savings potential are provided by end use in Figure 7-4 and Figure 7-5. The first set of figures provides savings in absolute terms; the second, in terms of the percentage of base case end-use energy or peak demand. Pumping represents the largest end-use savings potential, followed by compressed air and lighting.

Figure 7-4: Industrial Electric Savings Potential by End Use – 2005

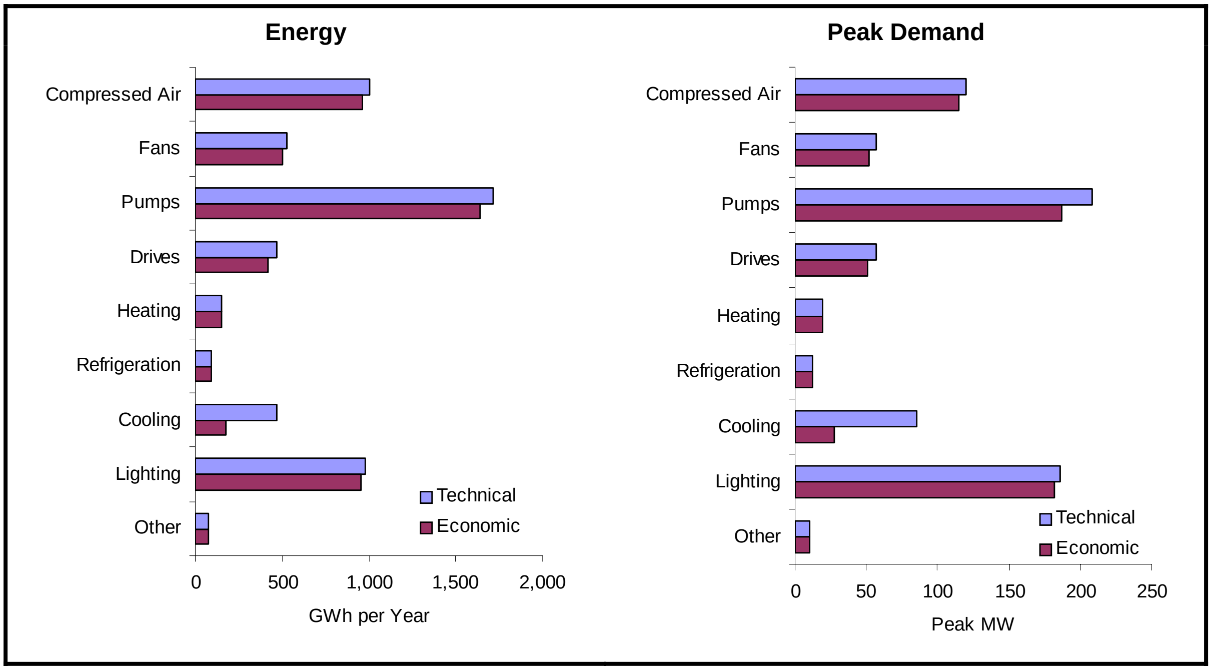
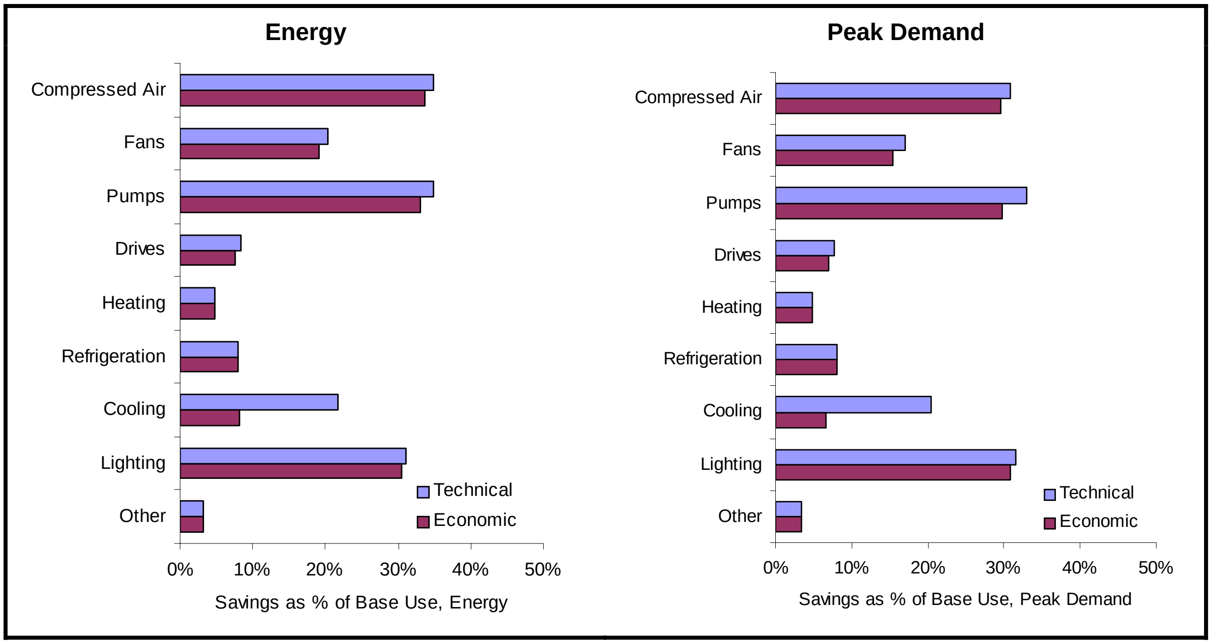


Figure 7-5: Industrial Electric Savings Potential as Percent of Base End-Use Consumption – 2005



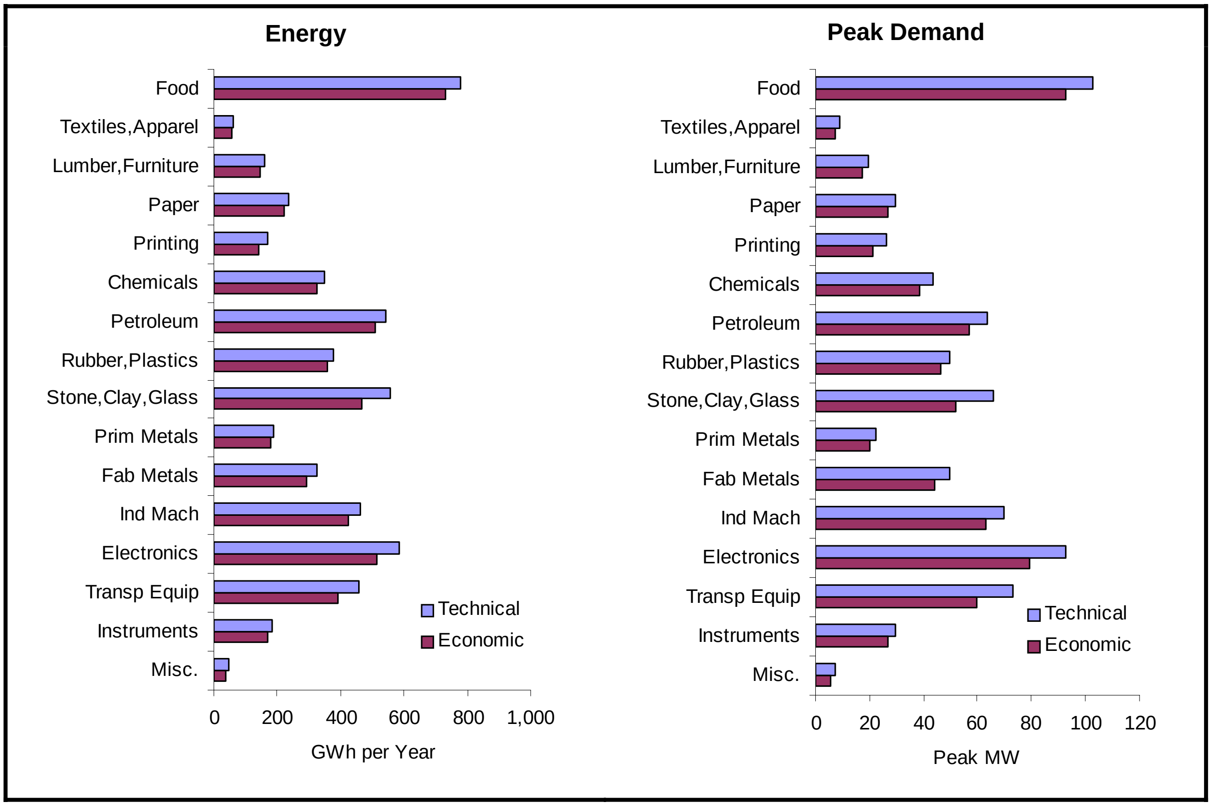
Economic savings potential values are summarized by end use and utility in Table 7-3.

Table 7-3: Industrial Electric Economic Potential by End Use and Utility – 2005

	PG&E		SCE		SDG&E		Total	
End Use	**GWh**	**MW**	**GWh**	**MW**	**GWh**	**MW**	**GWh**	**MW**
Compressed Air	446	53	458	55	62	8	966	115
Fans	220	23	260	27	21	2	500	52
Pumps	774	88	794	90	69	9	1,637	187
Drives	148	18	251	31	22	3	421	51
Heating	69	9	73	10	7	1	149	20
Refrigeration	60	8	33	4	1	0.1	94	12
Cooling	67	11	94	15	15	2	175	28
Lighting	393	75	491	93	74	14	958	182
Other	23	3	41	6	8	1	72	10
Total Economic Potential	2,200	287	2,495	330	278	40	4,973	657
Total Electricity Use	14,171	2,002	16,639	2,365	2,037	308	32,847	4,675

Figure 7-6 presents estimates of technical and economic potential by industrial category. Key industrial segments include food; petroleum refining; stone, clay and glass; and industries associated with "high tech" (industrial machinery, electronics, and transportation equipment).

Figure 7-6: Industrial Electric Savings Potential by Industrial Category – 2005



7.3 Achievable Electric Potential

In contrast to technical and economic potential estimates, achievable potential estimates take into account market and other factors that affect adoption of efficiency measures. KEMA's method of estimating measure adoption takes into account market barriers and reflects actual consumer- and business-implicit discount rates.

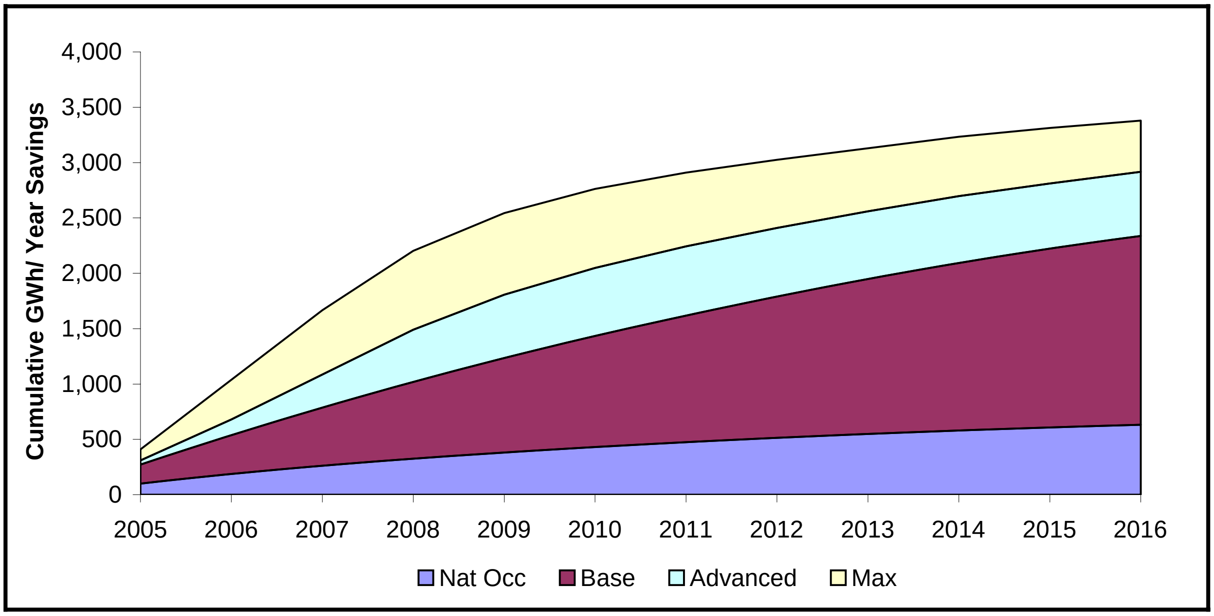
Achievable potential refers to the amount of savings that would occur in response to one or more specific program interventions. Net savings associated with program potential are savings that are projected beyond those that would occur naturally in the absence of any market intervention. Because achievable potential depends on the type and degree of intervention applied, potential estimates were developed under alternative funding scenarios: base achievable, advanced achievable, and maximum achievable.

The base achievable funding scenario reflects funding levels similar to 2004-2005 program budgets. The maximum achievable scenario reflects large increases in marketing/information budgets and an increase in rebate levels to 100% of incremental measure costs. The advanced achievable scenario represents funding levels that are in between the base and maximum achievable scenarios.[3] Program energy and peak-demand savings were forecasted under each scenario for 2005-2016.

Figure 7-7 and Figure 7-8 show estimates of achievable potential savings for electric energy and peak demand, respectively. These figures also show naturally occurring savings estimates. By 2016, the naturally occurring component of savings is estimated to be about 630 GWh and 70 MW.

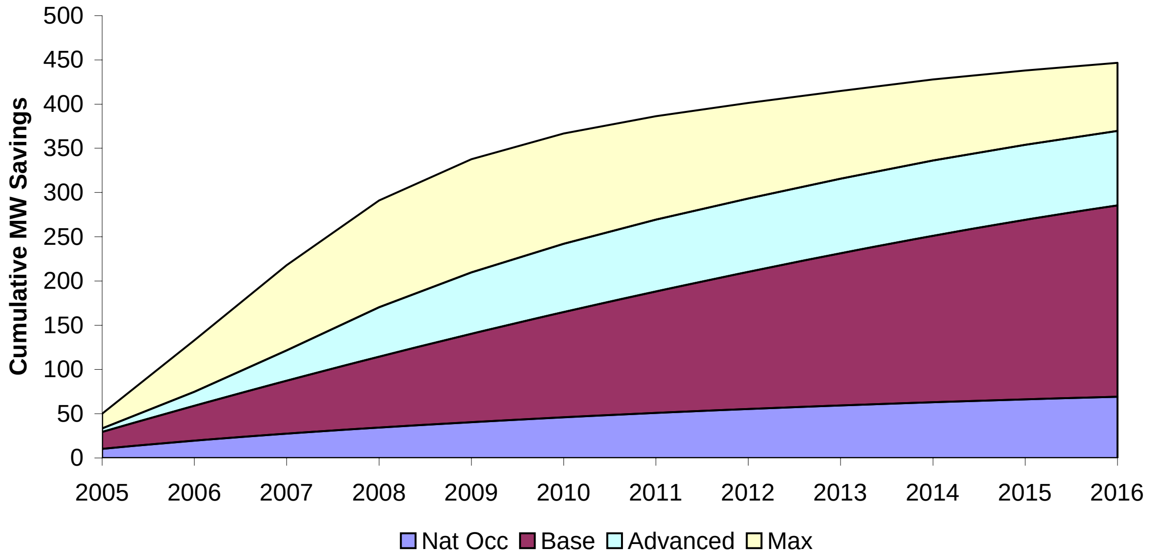
As shown in Figure 7-7, by 2016 net energy savings are projected to be roughly 1,700 GWh under base achievable, 2,300 MW under advanced achievable, and 2,750 under maximum achievable. Figure 7-8 depicts projected net peak demand savings of about 220 MW under base achievable, 300 MW under advanced achievable, and 380 MW under maximum achievable.

Figure 7-7: Achievable Energy Savings Potential by Program Funding Scenario – 2005-2016



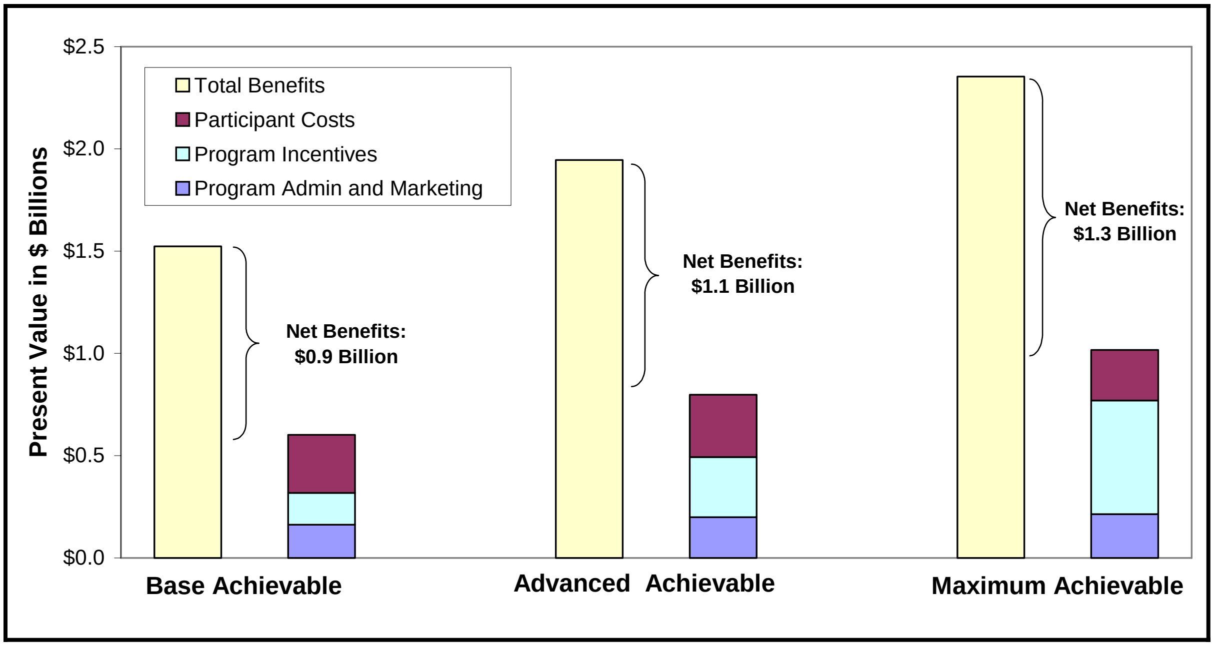
[3] The base, advanced, and maximum achievable scenarios in the Industrial analysis are essentially equivalent to the current, average, and full incentives scenarios developed for the Residential and Commercial sectors.

Figure 7-8: Achievable Peak Demand Savings Potential by Program Funding Scenario – 2005-2016



The costs and benefits associated with the industrial efficiency funding scenarios over the 2005-2016 forecast period are shown in Figure 7-10. Total program and participant costs vary from $0.6 billion under the base achievable scenario to $1.0 billion under the maximum achievable scenario. Total avoided-cost benefits range from $1.5 billion under base achievable to $2.4 billion under maximum achievable. Net avoided-cost benefits (the difference between total avoided-cost benefits and total resource costs, which include participants' costs) range from $0.9 billion to $1.3 billion. All funding scenarios are cost-effective based on the TRC test, which is the principal test used in California to determine program cost effectiveness.

Figure 7-9: Costs and Benefits of Industrial Electric Efficiency Savings – 2005-2016



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

TRC test and other results are summarized in Table 7-4 for all scenario runs. The results shown indicate that all the scenarios are cost effective based on the TRC. TRC values range from a high of 2.5 under the base achievable scenario to a low of 2.3 under the maximum achievable scenario.

The TRC values remain relatively flat across funding levels due to offsetting factors. First TRC values tend to decrease somewhat as funding levels increase because savings are acquired from measures with decreasing cost-effectiveness. That is, under the higher funding levels, energy efficiency opportunities are being purchased from higher and higher on the energy efficiency supply curve. Countering this trend is the fact that the proportion of net savings increases under the more aggressive scenarios. This is because naturally occurring savings are static across funding levels (since they are by definition unaffected by market interventions) while gross program savings increase substantially; thus, the ratio of net-to-gross savings increases across the more aggressive funding levels.

Table 7-4: Summary of Industrial Electric 12-Year Net Program Potential Results* – 2005-2016

Result	Base Achievable	Advanced Achievable	Maximum Achievable
Program Costs (Mil.)	$317	$493	$770
Participant Costs (Mil.)	$285	$305	$247
Avoided Cost Benefits (Mil.)	$1,523	$1,946	$2,353
Net Benefits (Mil.)	$921	$1,149	$1,336
Gross Savings	2,338 GWh/Yr 285 MW	2,916 GWh/Yr 370 MW	3,380 GWh/Yr 447 MW
Net Savings	1,706 GWh/Yr 216 MW	2,284 GWh/Yr 301 MW	2,748 GWh/Yr 378 MW
Program TRC Ratio	2.5	2.4	2.3

* All costs and energy and demand savings are cumulative amounts through year 2016. Program TRC is for the entire 2005-2016 forecast period. Present value of benefits and costs over 20-year normalized measure lives for 12 program years (2005-2016), nominal discount rate = 8%, inflation rate = 3%.

Breakdown of Achievable Potential

Figure 7-10 shows achievable potential estimates by utility. The results show gross cumulative savings estimates through 2016. SCE shows the highest potentials, followed closely by PG&E.

Figure 7-10: Industrial Gross Achievable Electric Savings Potential by Utility – Cumulative – 2005-2016

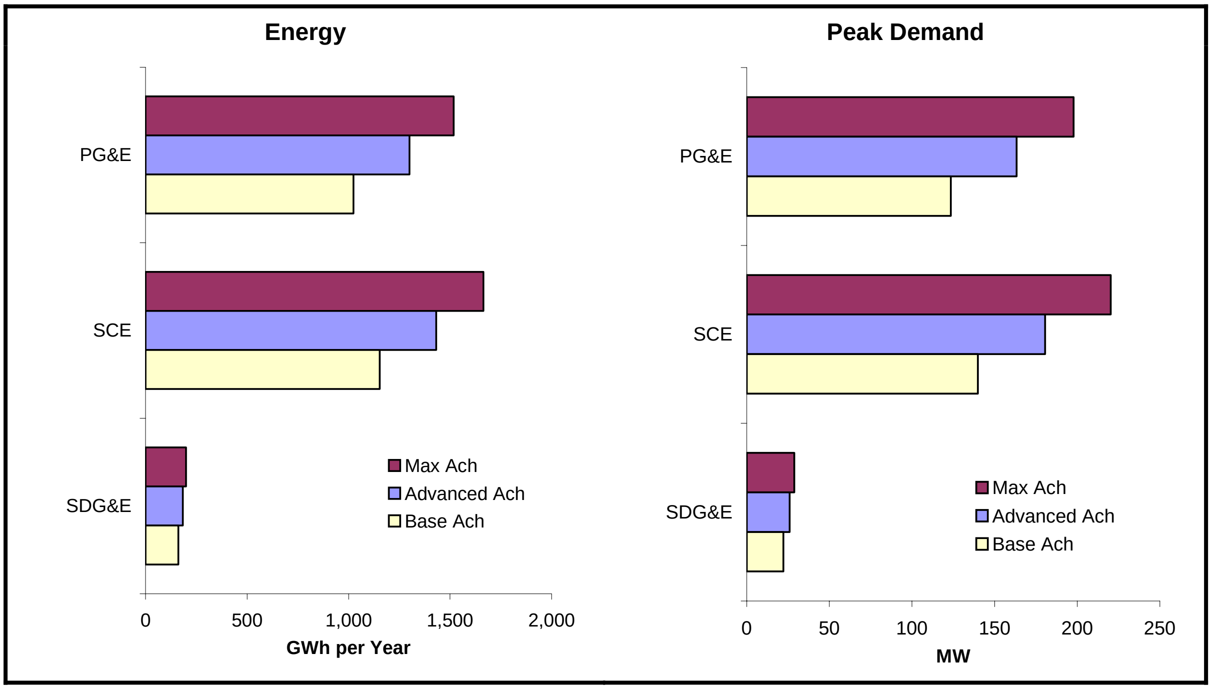
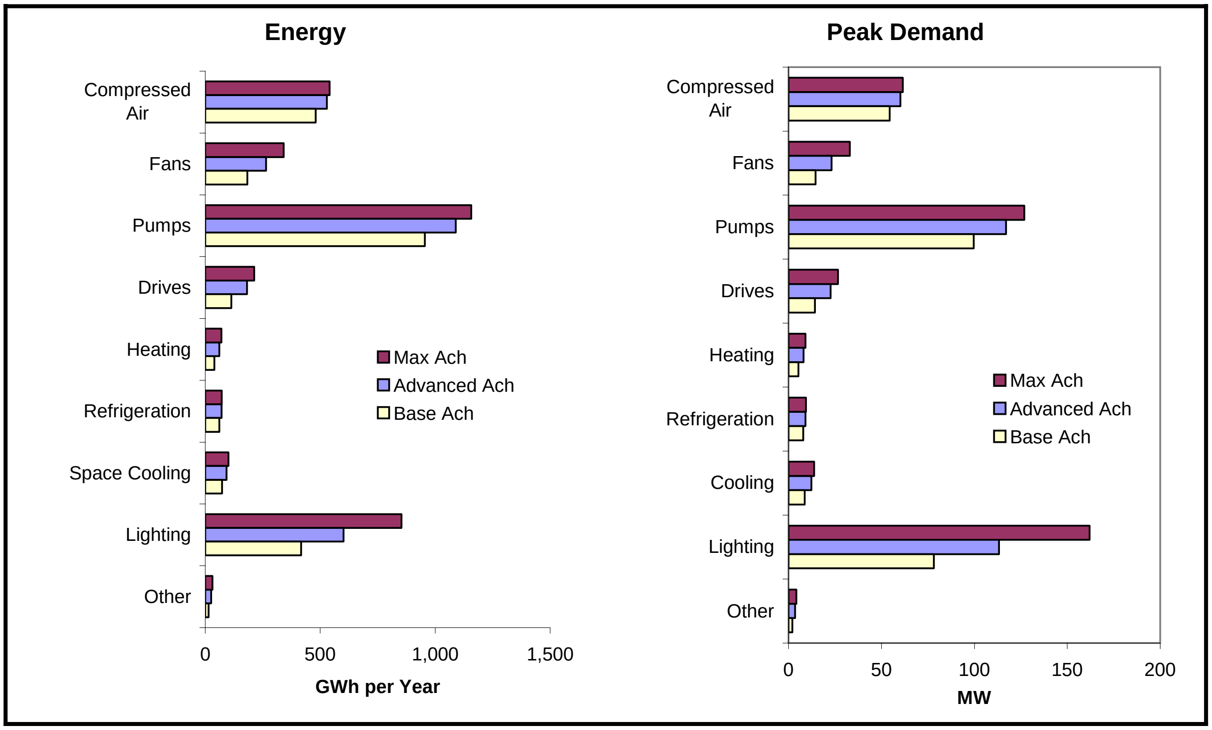


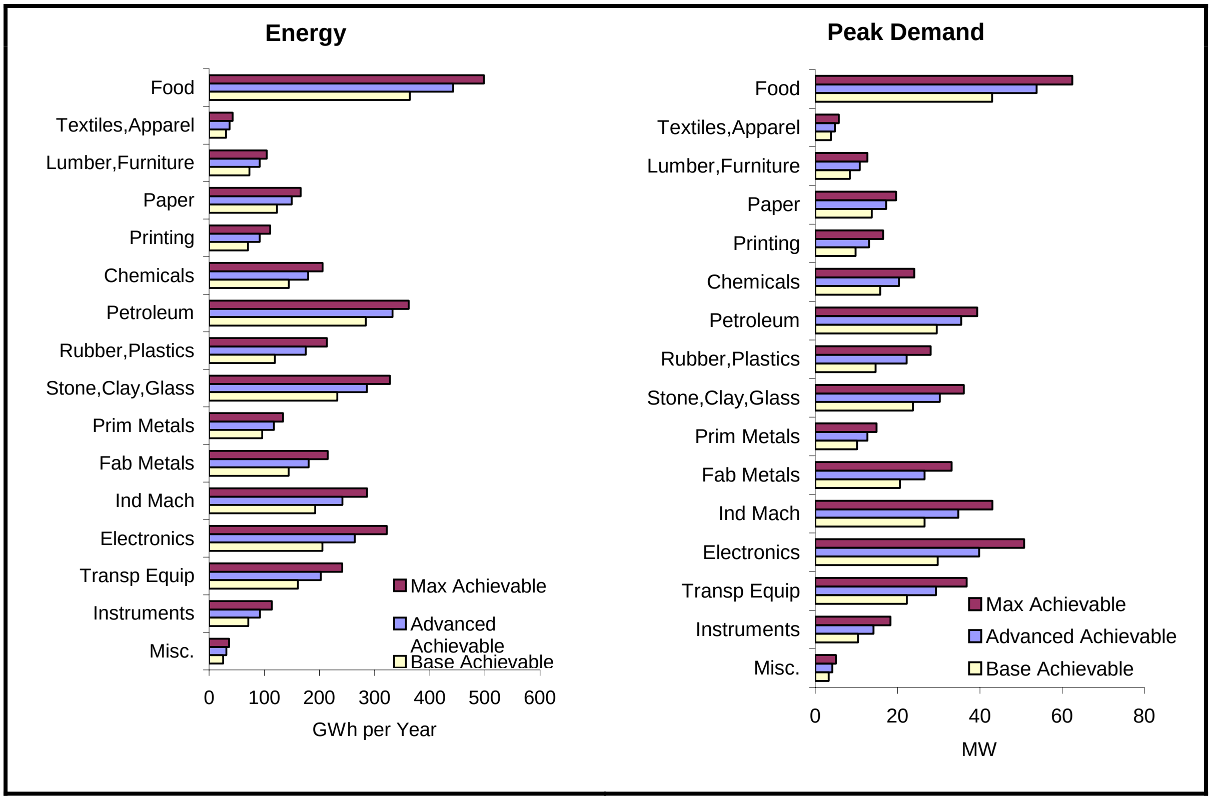
Figure 7-11 shows achievable potential estimates by end use. Pumping and lighting show the highest potential levels, followed by compressed air and fan systems.

Figure 7-11: Industrial Gross Achievable Electric Savings Potential by End Use – Cumulative – 2005-2016



Achievable potentials by industry type are shown in Figure 7-12. Food, petroleum, stone, clay and glass, and electronics show some of the higher energy saving potentials. For peak demand, food, petroleum, electronics, transportation equipment, industrial machinery, and stone, clay, and glass show the highest savings potential.

Figure 7-12: Industrial Gross Achievable Electric Savings Potential by Industry – Cumulative – 2005-2016



Summary of Electric Potentials

The industrial energy efficiency potential discussed above is summarized in the following tables. Table 7-5 and Table 7-6 present energy and peak demand potentials by utility. Table 7-7 and Table 7-8 present potentials by end use. Table 7-9 and Table 7-10 present potentials by industry. Finally, Table 7-11 through Table 7-16 present potentials by utility and industry.

Table 7-5: Summary of Industrial Electric Energy Potentials by Utility – Cumulative – 2005-2016

Utility	Total GWh	GWh Potentials					
		Technical	Economic	Maximum Achievable	Advanced Achievable	Base Achievable	Naturally Occurring
PG&E	14,171	2,411	2,200	1,517	1,300	1,024	330
SCE	16,639	2,762	2,495	1,664	1,432	1,152	257
SDG&E	2,037	311	278	199	183	161	45
Total	32,847	5,485	4,973	3,380	2,915	2,338	632

Note: Naturally occurring savings are included in the achievable potential estimates.

Table 7-6: Summary of Industrial Peak Demand Potentials by Utility – Cumulative – 2005-2016

Utility	Total MW	MW Potentials					
		Technical	Economic	Maximum Achievable	Advanced Achievable	Base Achievable	Naturally Occurring
PG&E	2,002	328	287	198	163	123	36
SCE	2,365	381	330	220	181	140	27
SDG&E	308	46	40	29	26	22	6
Total	4,673	755	657	447	370	285	69

Note: Naturally occurring savings are included in the achievable potential estimates.

Table 7-7: Summary of Industrial Electric Energy Potentials by End Use – Cumulative – 2005-2016

End Use	Total GWh	GWh Potentials					
		Technical	Economic	Maximum Achievable	Advanced Achievable	Base Achievable	Naturally Occurring
Compressed Air	2,874	1,004	966	541	529	480	184
Fans	2,655	529	500	341	264	184	29
Pumps	5,117	1,719	1,637	1,157	1,089	955	261
Drives	6,574	468	421	213	181	113	39
Heating	3,527	149	149	70	62	40	14
Refrigeration	2,722	94	94	72	71	61	12
Space Cooling	3,768	466	175	101	93	73	16
Lighting	3,212	982	958	854	601	417	74
Other	2,397	72	72	31	26	15	2
Total	32,847	5,485	4,973	3,380	2,915	2,338	632

Note: Naturally occurring savings are included in the achievable potential estimates.

Table 7-8: Summary of Industrial Peak Demand Potentials by End Use – Cumulative – 2005-2016

End Use	Total MW	MW Potentials					
		Technical	Economic	Maximum Achievable	Advanced Achievable	Base Achievable	Naturally Occurring
Compressed Air	385	120	115	62	60	54	22
Fans	339	57	52	33	23	15	2
Pumps	647	208	187	127	117	100	21
Drives	849	57	51	27	23	14	5
Heating	458	20	20	9	8	5	2
Refrigeration	353	12	12	9	9	8	2
Cooling	728	85	28	14	12	9	1
Lighting	594	186	182	162	113	78	14
Other	319	10	10	4	4	2	0
Total	4,673	755	657	447	370	285	69

Note: Naturally occurring savings are included in the achievable potential estimates.

Table 7-9: Summary of Industrial Gross Electric Energy Potentials by Industry – Cumulative – 2005-2016

Industry	Total GWh	GWh Potentials					
		Technical	Economic	Maximum Achievable	Advanced Achievable	Base Achievable	Naturally Occurring
Food	4,495	779	729	498	442	364	100
Textiles, Apparel	462	63	55	43	37	31	7
Lumber, Furniture	987	159	147	104	92	73	19
Paper	1,361	238	224	166	150	123	30
Printing	843	171	142	111	91	71	22
Chemicals	2,987	350	328	206	180	145	37
Petroleum	2,086	541	510	362	333	284	85
Rubber, Plastics	2,232	377	361	213	175	119	25
Stone, Clay, Glass	3,545	557	467	328	286	233	60
Prim Metals	1,186	191	179	134	117	96	23
Fabricating Metals	1,798	324	292	215	180	144	38
Ind. Machines	2,779	461	424	286	241	192	65
Electronics	4,011	585	516	322	264	205	53
Transp. Equip.	2,383	460	392	241	203	161	42
Instruments	1,393	183	168	114	92	71	19
Misc.	298	47	39	36	31	25	6
Total	32,847	5,485	4,973	3,380	2,915	2,338	632

Note: Naturally occurring savings are included in the achievable potential estimates.

Table 7-10: Summary of Industrial Gross Peak Demand Potentials by Industry – Cumulative – 2005-2006

Industry	Total MW	MW Potentials					
		Technical	Economic	Maximum Achievable	Advanced Achievable	Base Achievable	Naturally Occurring
Food	611	103	92	62	54	43	11
Textiles, Apparel	67	9	7	6	5	4	1
Lumber, Furniture	136	19	17	13	11	8	2
Paper	180	30	27	20	17	14	3
Printing	127	26	21	16	13	10	3
Chemicals	390	44	39	24	20	16	3
Petroleum	263	64	57	39	35	29	8
Rubber, Plastics	295	50	47	28	22	15	3
Stone, Clay, Glass	432	66	52	36	30	24	5
Prim Metals	144	22	20	15	13	10	2
Fabricating Metals	280	50	44	33	27	21	5
Ind. Machines	441	70	63	43	35	27	8
Electronics	649	93	79	51	40	30	7
Transp. Equip.	383	73	60	37	29	22	5
Instruments	231	30	27	18	14	10	3
Misc.	44	7	6	5	4	3	1
Total	4,673	755	657	447	370	285	69

Note: Naturally occurring savings are included in the achievable potential estimates.

Table 7-11: Summary of Industrial Electric Energy Potentials by Industry – Cumulative – 2005-2006 – PG&E

Industry	Total GWh	GWh Potentials					
		Technical	Economic	Maximum Achievable	Advanced Achievable	Base Achievable	Naturally Occurring
Food	2,861	496	464	317	278	225	69
Textiles, Apparel	65	9	8	5	4	3	1
Lumber, Furniture	580	93	87	57	49	38	12
Paper	430	75	71	49	43	34	10
Printing	291	59	49	37	30	22	8
Chemicals	1,018	119	112	78	67	52	16
Petroleum	1,359	352	332	232	211	177	59
Rubber, Plastics	606	102	98	58	47	31	8
Stone, Clay, Glass	1,616	254	213	149	128	101	31
Prim Metals	224	36	34	22	19	14	4
Fabricating Metals	353	63	57	40	33	25	9
Ind. Machines	2,056	341	314	220	185	145	53
Electronics	1,518	221	195	133	108	81	26
Transp. Equip.	512	99	84	58	49	37	13
Instruments	646	85	78	57	46	34	11
Misc.	39	6	5	4	3	2	1
Total	14,171	2,411	2,200	1,517	1,300	1,024	330

Note: Naturally occurring savings are included in the achievable potential estimates.

Table 7-12: Summary of Industrial Electric Energy Potentials by Industry – Cumulative – 2005-2006 – SCE

Industry	Total GWh	GWh Potentials					
		Technical	Economic	Maximum Achievable	Advanced Achievable	Base Achievable	Naturally Occurring
Food	1,580	274	256	171	155	131	28
Textiles, Apparel	383	52	45	27	23	18	4
Lumber, Furniture	380	61	57	37	33	27	6
Paper	919	161	151	102	93	77	16
Printing	460	93	78	58	47	36	10
Chemicals	1,522	179	167	115	100	81	17
Petroleum	725	188	177	120	113	99	24
Rubber, Plastics	1,562	264	252	147	121	82	15
Stone, Clay, Glass	1,902	299	251	171	151	125	27
Prim Metals	949	153	143	92	79	64	13
Fabricating Metals	1,366	246	222	152	126	101	26
Ind. Machines	585	97	89	61	51	42	11
Electronics	1,955	285	252	167	136	107	23
Transp. Equip.	1,582	305	260	177	148	119	28
Instruments	580	76	70	50	40	31	7
Misc.	187	30	25	17	14	11	2
Total	16,639	2,762	2,495	1,664	1,432	1,152	257

Note: Naturally occurring savings are included in the achievable potential estimates.

Table 7-13: Summary of Industrial Electric Energy Potentials by Industry – Cumulative – 2005-2006 – SDG&E

Industry	Total GWh	GWh Potentials					
		Technical	Economic	Maximum Achievable	Advanced Achievable	Base Achievable	Naturally Occurring
Food	55	9	9	10	9	8	3
Textiles, Apparel	14	2	2	11	11	10	3
Lumber, Furniture	27	4	4	10	9	8	2
Paper	12	2	2	15	13	12	3
Printing	91	18	15	15	14	12	4
Chemicals	446	52	49	13	12	11	5
Petroleum	2	1	1	10	9	8	3
Rubber, Plastics	64	11	10	8	7	6	2
Stone, Clay, Glass	27	4	4	8	7	7	2
Prim Metals	13	2	2	20	19	19	5
Fabricating Metals	80	14	13	23	21	17	3
Ind. Machines	138	23	21	6	5	5	2
Electronics	538	78	69	22	20	17	4
Transp. Equip.	289	56	48	6	6	5	2
Instruments	168	22	20	6	6	5	1
Misc.	72	11	10	15	14	12	3
Total	2,037	311	278	199	183	161	45

Note: Naturally occurring savings are included in the achievable potential estimates.

Table 7-14: Summary of Industrial Peak Demand Potentials by Industry – Cumulative – 2005-2006 – PG&E

Industry	Total MW	MW Potentials					
		Technical	Economic	Maximum Achievable	Advanced Achievable	Base Achievable	Naturally Occurring
Food	388	65	59	40	34	27	8
Textiles, Apparel	9	1	1	1	1	0	0
Lumber, Furniture	79	11	10	7	6	4	1
Paper	57	9	8	6	5	4	1
Printing	43	9	7	6	4	3	1
Chemicals	132	15	13	9	7	6	1
Petroleum	171	42	37	25	22	18	5
Rubber, Plastics	80	14	13	8	6	4	1
Stone, Clay, Glass	196	30	24	16	14	10	3
Prim Metals	27	4	4	2	2	1	0
Fabricating Metals	54	10	9	6	5	4	1
Ind. Machines	326	52	47	33	27	20	7
Electronics	245	35	30	21	16	12	3
Transp. Equip.	82	16	13	9	7	5	2
Instruments	107	14	12	9	7	5	2
Misc.	6	1	1	1	0	0	0
Total	2,002	328	287	198	163	123	36

Note: Naturally occurring savings are included in the achievable potential estimates.

Table 7-15: Summary of Industrial Peak Demand Potentials by Industry – Cumulative – 2005-2006 – SCE

Industry	Total MW	MW Potentials					
		Technical	Economic	Maximum Achievable	Advanced Achievable	Base Achievable	Naturally Occurring
Food	216	36	32	21	19	15	3
Textiles, Apparel	55	8	6	4	3	2	0
Lumber, Furniture	53	7	7	4	4	3	1
Paper	122	20	18	12	10	8	1
Printing	69	14	12	9	7	5	1
Chemicals	199	22	20	13	11	9	1
Petroleum	92	22	20	13	12	10	2
Rubber, Plastics	207	35	33	19	15	10	2
Stone, Clay, Glass	233	35	28	19	16	13	2
Prim Metals	116	18	16	10	8	6	1
Fabricating Metals	213	38	33	23	18	14	3
Ind. Machines	93	15	13	9	7	6	1
Electronics	318	45	39	26	20	15	3
Transp. Equip.	255	49	40	27	22	17	4
Instruments	97	12	11	8	6	5	1
Misc.	28	4	4	3	2	1	0
Total	2,365	381	330	220	181	140	27

Note: Naturally occurring savings are included in the achievable potential estimates.

Table 7-16: Summary of Industrial Peak Demand Potentials by Industry – Cumulative – 2005-2006 – SDG&E

Industry	Total MW	MW Potentials					
		Technical	Economic	Maximum Achievable	Advanced Achievable	Base Achievable	Naturally Occurring
Food	7.4	1.2	1.2	1.2	1.1	0.9	0.3
Textiles, Apparel	2.1	0.3	0.2	1.4	1.4	1.3	0.3
Lumber, Furniture	3.7	0.5	0.5	1.6	1.4	1.2	0.2
Paper	1.6	0.3	0.2	2.2	2.0	1.6	0.3
Printing	13.7	2.8	2.3	2.2	2.1	1.8	0.5
Chemicals	58.1	6.5	6.0	1.7	1.6	1.5	0.6
Petroleum	0.3	0.1	0.1	1.4	1.2	1.0	0.3
Rubber, Plastics	8.4	1.4	1.4	1.0	0.9	0.8	0.2
Stone, Clay, Glass	3.3	0.5	0.4	1.0	0.9	0.8	0.3
Prim Metals	1.5	0.2	0.2	2.5	2.4	2.3	0.7
Fabricating Metals	12.4	2.2	2.0	4.0	3.5	2.8	0.5
Ind. Machines	21.9	3.5	3.1	0.8	0.7	0.6	0.1
Electronics	86.9	12.5	10.6	3.9	3.4	2.9	0.6
Transp. Equip.	46.3	8.9	7.2	0.8	0.7	0.5	0.1
Instruments	27.9	3.6	3.2	0.8	0.7	0.7	0.1
Misc.	10.5	1.7	1.4	1.9	1.8	1.5	0.4
Total	306.0	46.2	40.1	28.6	25.9	22.2	5.6

Note: Naturally occurring savings are included in the achievable potential estimates.

7.4 Potential for Gas Energy Efficiency

Technical and Economic Potential by Utility

Figure 7-13 presents KEMA's estimates of total natural gas technical and economic potential. Note that technical and economic potential are nearly the same, due to a measure list that focused on reasonably cost-effective measures. Overall, technical savings potential is estimated to be roughly 470 Mth, about 13% of total industrial natural gas usage, excluding gas used as feedstocks (i.e., 470 Mth Savings ÷ 32,847 Mth of base consumption). Economic potential is also estimated to be about 470 Mth.

Figure 7-13: Estimated Natural Gas Technical and Economic Potential (Industrial Sector Existing Construction, PG&E/SCG/SDG&E) – 2005

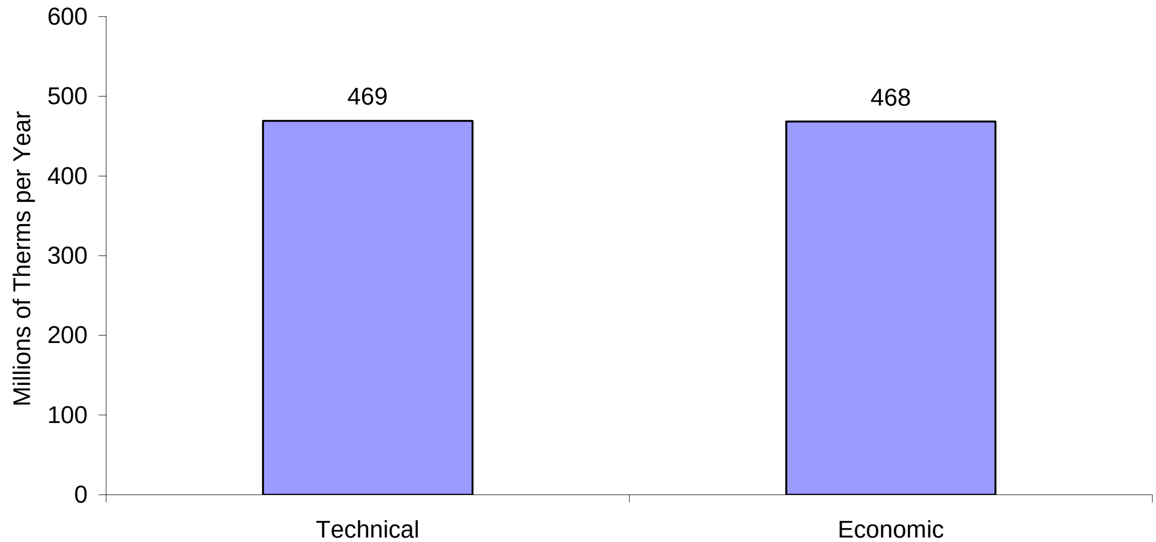
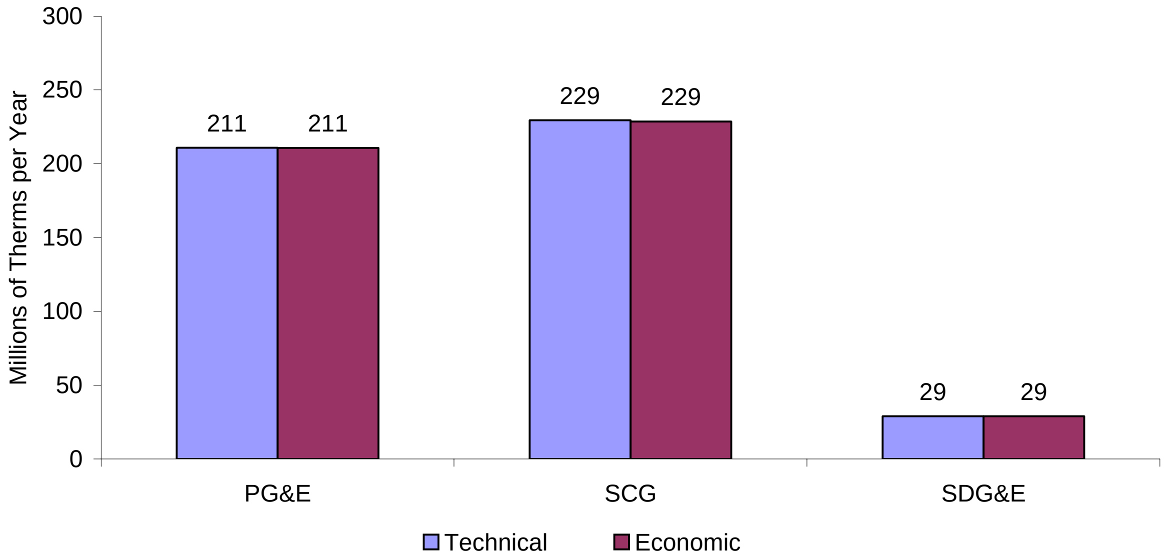


Figure 7-14 shows technical and economic potential by utility. The potentials in the PG&E and Southern California Gas (SCG) territories are similar in size. SCG has slightly higher economic savings potential at about 230 Mth, followed closely by PG&E's potential of approximately 210 Mth. As a percent of base consumption, the economic energy savings potentials are 14% for SDG&E and about 13% for PG&E and SCG. Differences are mainly due to the types of industries and the avoided costs in each service territory.

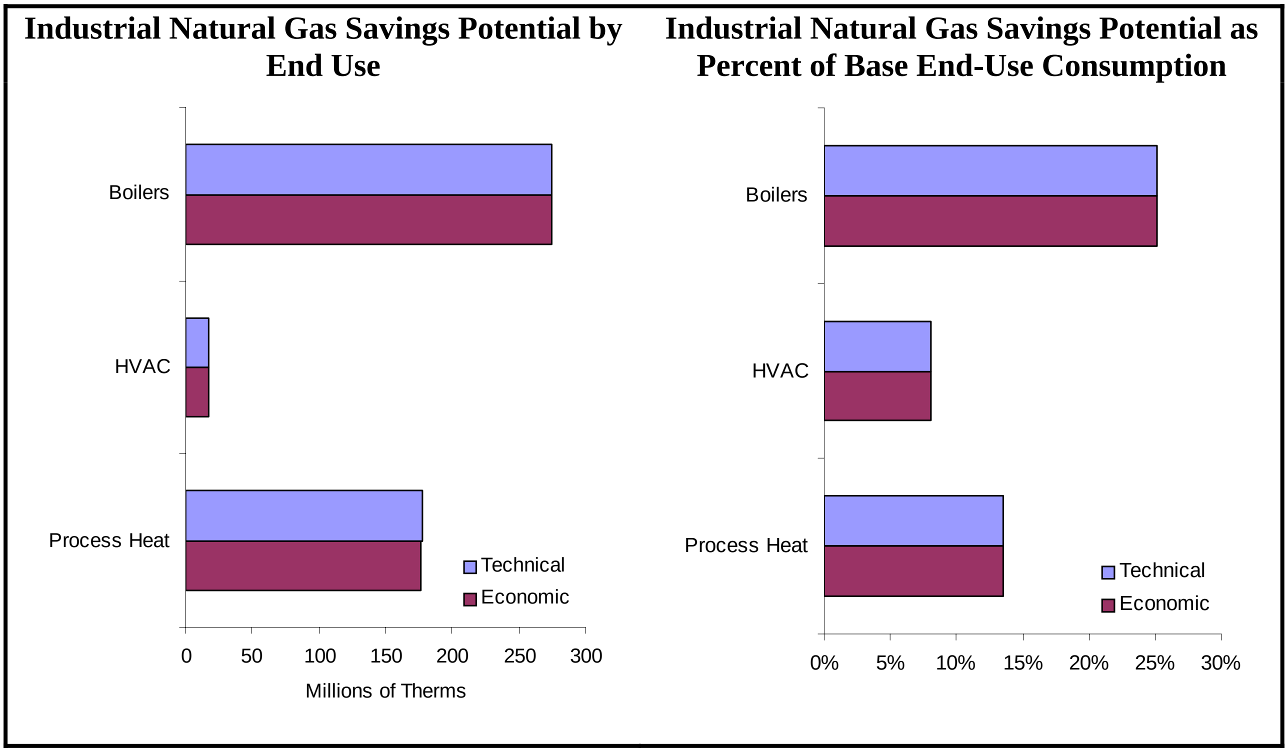
Figure 7-14: Industrial Natural Gas Savings Potential by Utility – 2005



Natural Gas Technical and Economic Savings Potential by End Use and Measure

Estimates of natural gas savings potential are provided by end use in Figure 7-15. The first figure provides savings in absolute terms and the second figure is in terms of the percentage of base case end-use natural gas consumption. Boilers represent the largest source of savings potential, followed by process heating.

Figure 7-15: Industrial Natural Gas Savings Potential – 2005



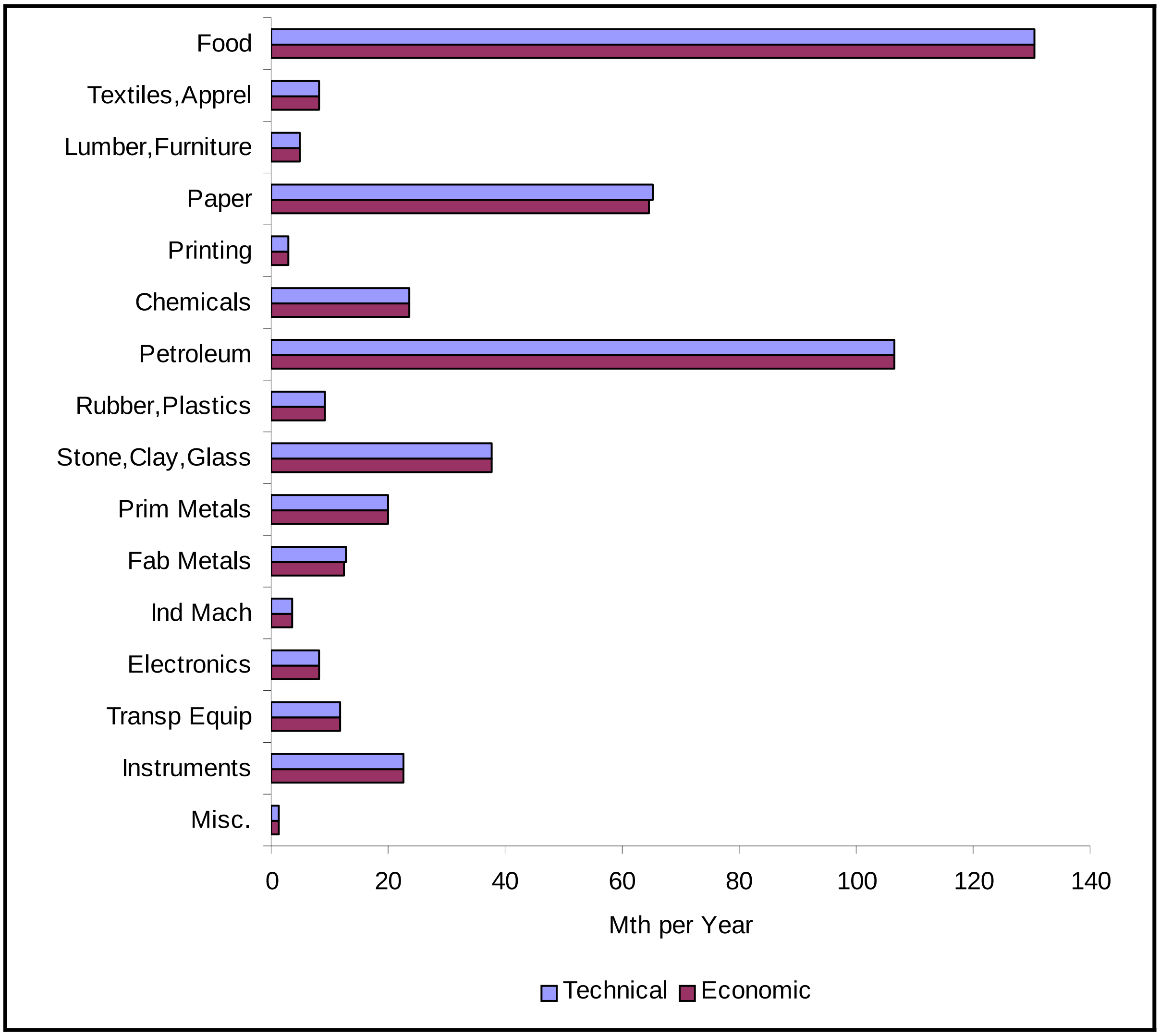
Economic savings potential values are summarized by end use and utility in Table 7-17.

Table 7-17: Industrial Natural Gas Economic Savings Potential by End Use and Utility – 2005

End Use	PG&E	SCG	SDG&E
Boilers	119	138	18
HVAC	5	7	4
Process Heat	87	83	7
Total Economic Potential	**211**	**229**	**29**
Total Natural Gas Use	1,664	1,718	209

Figure 7-16 presents estimates of technical and economic potential by industrial category. Key industrial segments include food, paper, and petroleum refining.

Figure 7-16: Industrial Natural Gas Savings Potential by Industrial Category – 2005

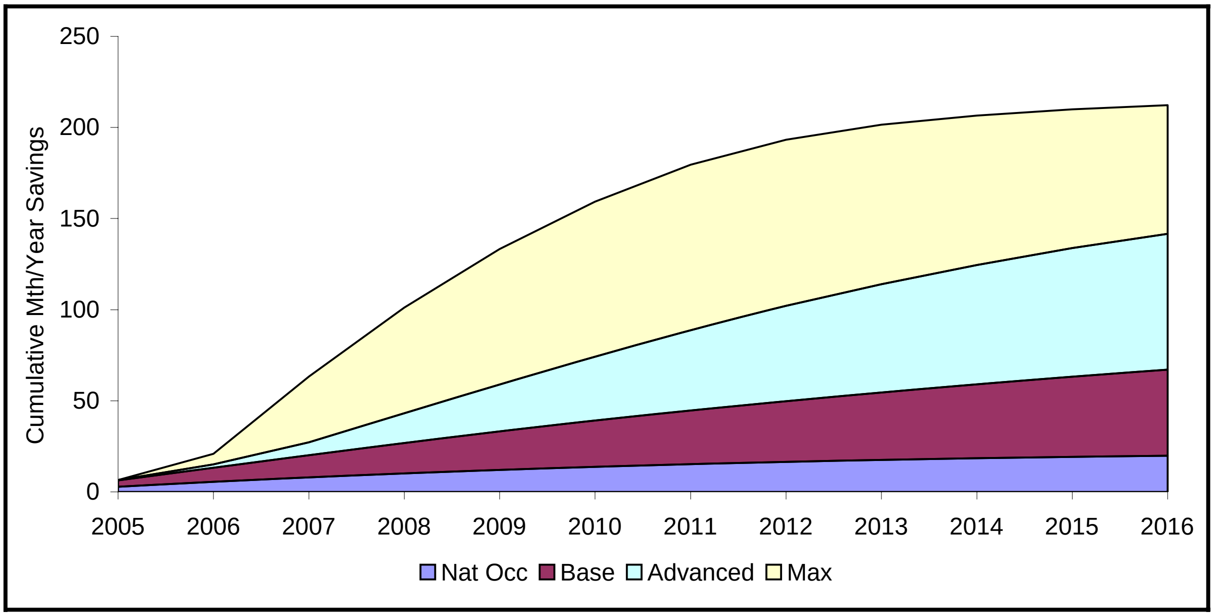


7.5 Achievable Natural Gas Potential

The base achievable funding scenario reflects funding levels similar to 2004-2005 program budgets. The maximum achievable scenario reflects large increases in marketing/information budgets and an increase in rebates levels to 100% of incremental measure costs. The advanced achievable scenario represents funding levels that are in between the base and maximum achievable scenarios. Program energy and peak-demand savings were forecasted under each scenario for 2005-2016.

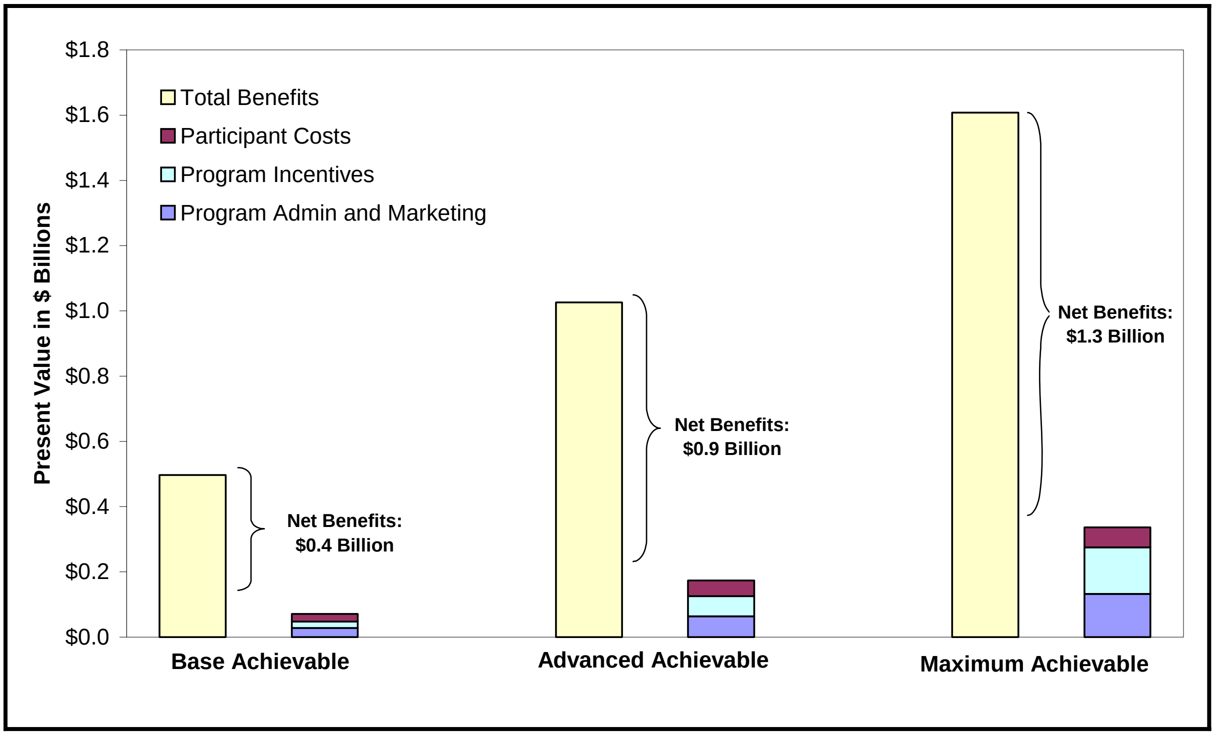
Figure 7-17 shows estimates of achievable potential savings for natural gas. Net energy savings are projected to be roughly 50 Mth under base achievable, 120 Mth under advanced achievable, and 190 Mth under maximum achievable.

Figure 7-17: Achievable Natural Gas Savings Potential by Program Funding Scenario – 2005-2006



The costs and benefits associated with the industrial efficiency funding scenarios over the 2005-2016 forecast period are shown in Figure 7-18. Total program and participant costs vary from $0.07 billion under the base achievable scenario to $0.3 billion under maximum achievable scenario. Total avoided-cost benefits range from $0.5 billion under base achievable to $1.6 billion under maximum achievable. Net avoided-cost benefits (which are the difference between total avoided-cost benefits and total resource costs, which include participants' costs) range from $0.4 billion to $1.3 billion. 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.

Figure 7-18: Costs and Benefits of Industrial Natural Gas Efficiency Savings – 2005-2006



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

TRC test and other results are summarized in Table 7-18 for all scenario runs. The results shown indicate that all the scenarios are cost effective based on the TRC. TRC values range from a high of 7.0 under the base achievable scenario to a low of 4.8 under the maximum achievable scenario. TRC values tend to decrease somewhat as funding levels increase because savings are acquired from measures with decreasing cost effectiveness.

Table 7-18: Summary of Industrial Natural Gas 12-Year Net Program Potential Results* – 2005-2006

Result	Base Achievable	Advanced Achievable	Maximum Achievable
Program Costs (Mil.)	$48	$126	$275
Participant Costs (Mil.)	$24	$48	$61
Avoided Cost Benefits (Mil.)	$497	$1,027	$1,608
Net Benefits (Mil.)	$426	$853	$1,271
Gross Savings	67 Mth/Yr	142 Mth/Yr	212 Mth/Yr
Net Savings	47 Mth/Yr	122 Mth/Yr	192 Mth/Yr
Program TRC Ratio	7.0	5.9	4.8

* All costs, energy and demand savings are cumulative amounts through year 2016. Program TRC is for the entire 2005-2016 forecast period. Present value of benefits and costs over 20-year normalized measure lives for 12 program years (2005-2016), nominal discount rate = 8%, inflation rate = 3%.

Breakdown of Achievable Potential

Figure 7-19 shows achievable potential estimates by utility. The results show gross cumulative savings estimates through 2016. The figure also shows PG&E with the highest base achievable and advanced achievable savings potential, while SCG is somewhat higher in the maximum achievable scenario. This result reflects the fact that PG&E's current programs show somewhat higher impacts than SCG's.

Figure 7-19: Industrial Gross Achievable Natural Gas Savings Potential by Utility – Cumulative – 2005-2006

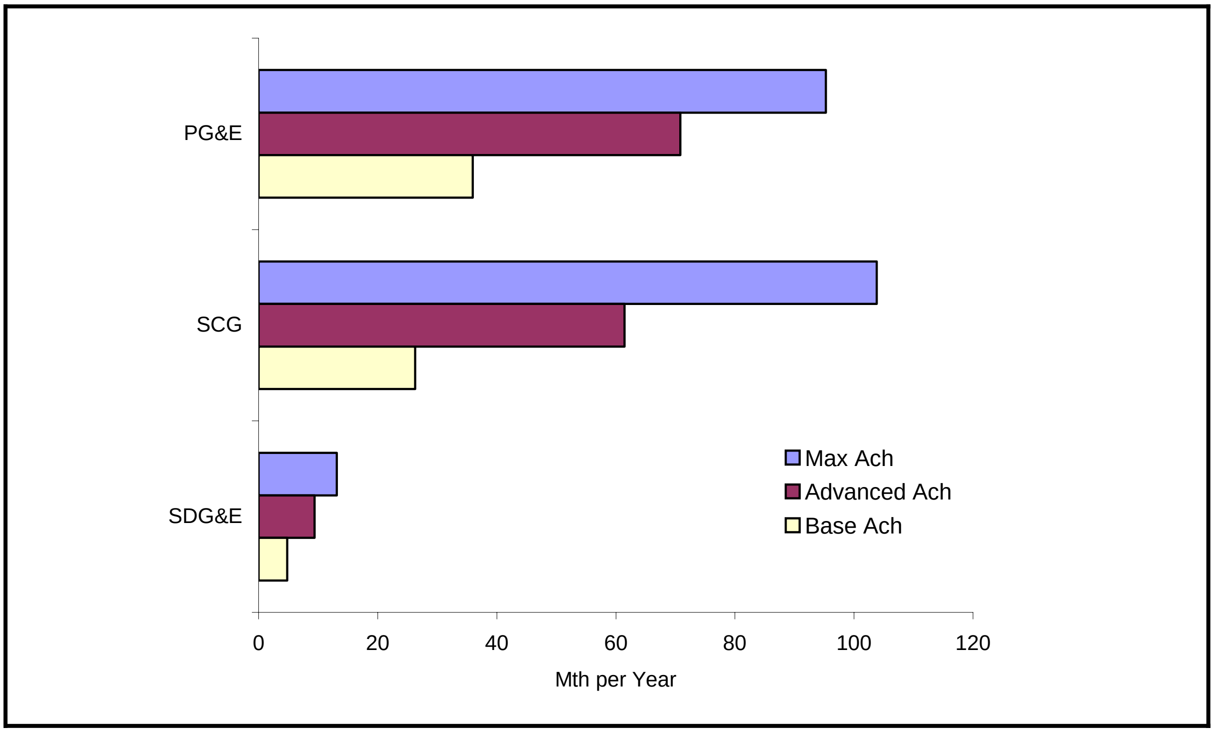
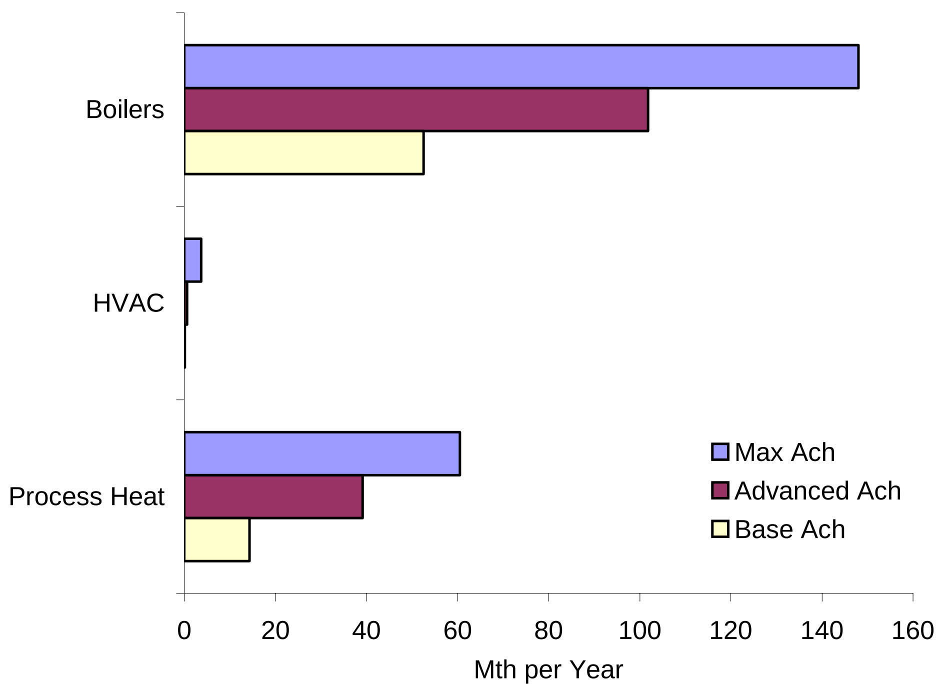


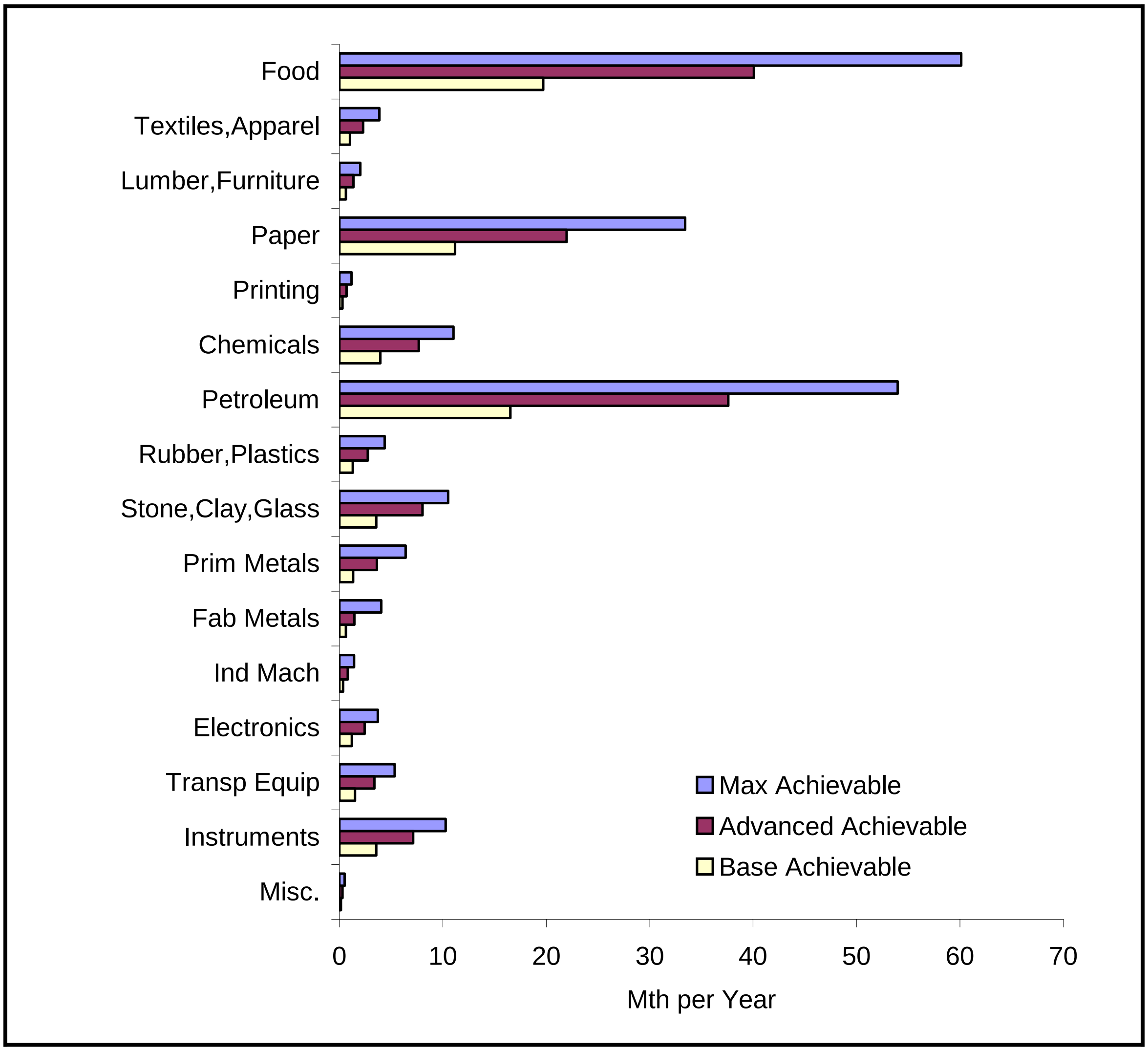
Figure 7-20 shows achievable potential estimates by end use. Boiler systems show the highest potentials at about twice the level of process heating systems. Boiler systems often include extensive steam and hot water piping networks that can be targeted for savings, while process heating systems do not.

Figure 7-20: Industrial Gross Achievable Natural Savings Potential by End Use – Cumulative – 2005-2006



Achievable potentials by industry type are shown in Figure 7-21. Food, petroleum, and paper provide the largest sources of potential under all three achievable scenarios.

Figure 7-21: Industrial Gross Achievable Natural Gas Savings Potential by Industry – Cumulative – 2005-2006



Summary of Potentials

The industrial energy efficiency potential discussed above is summarized in the following tables. Table 7-19 presents natural gas potentials by utility, Table 7-20 presents potentials by end use, and Table 7-21 presents potentials by industry. Finally, Tables 7-21 through 7-23 present potentials by utility and industry.

Table 7-19: Summary of Industrial Natural Gas Potentials by Utility – Cumulative – 2005-2006

		Mth Potentials					
Utility	Total Mth	Technical	Economic	Maximum Achievable	Advanced Achievable	Base Achievable	Naturally Occurring
PG&E	1,664	211	211	95	71	36	9
SCG	1,718	229	229	104	61	26	10
SDG&E	209	29	29	13	9	5	1
Total	3,591	469	468	212	142	67	20

Note: Naturally occurring savings are included in the achievable potential estimates.

Table 7-20: Summary of Industrial Natural Gas Potentials by End Use – Cumulative – 2005-2006

		Mth Potentials					
End Use	Total Mth	Technical	Economic	Maximum Achievable	Advanced Achievable	Base Achievable	Naturally Occurring
Boilers	1,135	275	275	148	102	53	19
Process Heat	1,293	177	176	60	39	14	1
Other Process Use	61	0	0	0	0	0	0
HVAC	187	17	17	4	1	0	0
Feedstocks	784	0	0	0	0	0	0
Other	131	0	0	0	0	0	0
Total	3,591	469	468	212	142	67	20

Note: Naturally occurring savings are included in the achievable potential estimates.

Table 7-21: Summary of Industrial Natural Gas Potentials by Industry – Cumulative – 2005-2006

Industry	Total Mth	Mth Potentials					
		Technical	Economic	Maximum Achievable	Advanced Achievable	Base Achievable	Naturally Occurring
Food	629	130	130	60	40	20	7
Textiles, Apparel	43	8	8	4	2	1	0
Lumber, Furniture	34	5	5	2	1	1	0
Paper	329	65	65	33	22	11	4
Printing	27	3	3	1	1	0	0
Chemicals	197	24	24	11	8	4	1
Petroleum	1,437	107	107	54	38	17	4
Rubber, Plastics	54	9	9	4	3	1	0
Stone, Clay, Glass	260	38	38	11	8	4	0
Prime Metals	144	20	20	6	4	1	0
Fab. Metals	99	13	13	4	1	1	0
Ind. Machines	33	4	4	1	1	0	0
Electronics	55	8	8	4	2	1	0
Transp. Equip.	84	12	12	5	3	2	0
Instruments	159	23	23	10	7	4	1
Misc.	8	1	1	1	0	0	0
Total	3,591	469	468	212	142	67	20

Note: Naturally occurring savings are included in the achievable potential estimates.

Table 7-22: Summary of Industrial Natural Gas Potentials by Industry – Cumulative – 2005-2006 – PG&E

Industry	Total Mth	Mth Potentials					
		Technical	Economic	Maximum Achievable	Advanced Achievable	Base Achievable	Naturally Occurring
Food	361.2	74.9	74.9	34.7	25.1	13.0	3.8
Textiles, Apparel	1.4	0.3	0.3	0.1	0.1	0.0	0.0
Lumber, Furniture	28.8	4.4	4.4	1.8	1.3	0.6	0.2
Paper	90.1	17.9	17.7	9.2	6.9	3.9	1.1
Printing	7.1	0.8	0.8	0.3	0.2	0.1	0.0
Chemicals	89.3	10.7	10.7	5.0	3.7	2.0	0.6
Petroleum	774.5	57.5	57.5	29.2	22.5	10.9	1.9
Rubber, Plastics	17.3	2.9	2.9	1.4	1.0	0.5	0.2
Stone, Clay, Glass	175.9	25.6	25.6	7.1	5.8	2.8	0.2
Prime Metals	23.8	3.3	3.3	1.1	0.8	0.3	0.1
Fab. Metals	19.5	2.5	2.5	0.8	0.4	0.2	0.0
Ind. Machines	19.4	2.2	2.2	0.8	0.5	0.2	0.1
Electronics	27.7	4.1	4.1	1.9	1.3	0.7	0.2
Transp. Equip.	19.2	2.7	2.7	1.2	0.9	0.4	0.1
Instruments	7.4	1.0	1.0	0.5	0.3	0.2	0.0
Misc.	1.6	0.2	0.2	0.1	0.1	0.0	0.0
Total	1,664.1	211.0	210.7	95.3	70.8	35.9	8.5

Note: Naturally occurring savings are included in the achievable potential estimates.

Table 7-23: Summary of Industrial Natural Gas Potentials by Industry – Cumulative – 2005-2006 – SCG

Industry	Total Mth	Mth Potentials					
		Technical	Economic	Maximum Achievable	Advanced Achievable	Base Achievable	Naturally Occurring
Food	265.9	55.1	55.1	25.3	14.8	6.6	2.8
Textiles, Apparel	40.8	7.8	7.8	3.7	2.2	1.0	0.4
Lumber, Furniture	4.9	0.5	0.5	0.2	0.1	0.0	0.0
Paper	238.8	47.4	46.9	24.2	15.1	7.3	3.1
Printing	16.6	1.9	1.9	0.7	0.4	0.2	0.1
Chemicals	77.3	9.3	9.3	4.3	2.6	1.2	0.5
Petroleum	659.8	48.9	48.9	24.7	15.1	5.6	1.7
Rubber, Plastics	36.6	6.2	6.2	2.9	1.7	0.8	0.3
Stone, Clay, Glass	82.6	12.0	12.0	3.3	2.2	0.7	0.1
Prime Metals	119.5	16.7	16.7	5.3	2.9	1.0	0.3
Fab. Metals	77.4	9.9	9.8	3.1	1.1	0.4	0.2
Ind. Machines	12.2	1.4	1.4	0.5	0.3	0.1	0.0
Electronics	19.2	2.8	2.8	1.3	0.7	0.3	0.1
Transp. Equip.	52.7	7.4	7.4	3.3	1.9	0.8	0.3
Instruments	8.4	1.2	1.2	0.5	0.3	0.1	0.1
Misc.	5.3	0.7	0.7	0.3	0.2	0.1	0.0
Total	1,718.0	229.4	228.7	103.8	61.4	26.3	10.1

Note: Naturally occurring savings are included in the achievable potential estimates.

Table 7-24: Summary of Industrial Natural Gas Potentials by Industry – Cumulative – 2005-2006 – SDG&E

Industry	Total Mth	Mth Potentials					
		Technical	Economic	Maximum Achievable	Advanced Achievable	Base Achievable	Naturally Occurring
Food	1.98	0.41	0.41	0.19	0.14	0.08	0.02
Textiles, Apparel	0.38	0.07	0.07	0.03	0.02	0.01	0.00
Lumber, Furniture	0.08	0.01	0.01	0.00	0.00	0.00	0.00
Paper	0.17	0.03	0.03	0.02	0.01	0.01	0.00
Printing	2.80	0.31	0.31	0.13	0.09	0.04	0.01
Chemicals	30.61	3.67	3.67	1.73	1.32	0.73	0.20
Petroleum	2.55	0.19	0.19	0.10	0.08	0.04	0.01
Rubber, Plastics	0.49	0.08	0.08	0.04	0.03	0.02	0.00
Stone, Clay, Glass	1.29	0.19	0.19	0.05	0.04	0.02	0.00
Prime Metals	0.41	0.06	0.06	0.02	0.01	0.01	0.00
Fab. Metals	2.23	0.29	0.28	0.10	0.04	0.02	0.01
Ind. Machines	1.57	0.18	0.18	0.07	0.04	0.02	0.01
Electronics	8.12	1.19	1.19	0.55	0.40	0.21	0.06
Transp. Equip.	11.69	1.64	1.64	0.76	0.56	0.28	0.07
Instruments	143.07	20.36	20.36	9.27	6.51	3.28	0.87
Misc.	1.38	0.19	0.19	0.09	0.06	0.03	0.01
Total	208.83	28.87	28.87	13.13	9.37	4.79	1.27

Note: Naturally occurring savings are included in the achievable potential estimates.

7.6 Conclusions

Achievable energy savings in the industrial sector range from 5% to 8% of base usage for electricity and from 1% to 5% of base usage for natural gas (for the base, advanced, and maximum achievable program scenarios, respectively). The achievable program estimates fall below economic potential estimates because it is unlikely that programs will be able to capture all the available savings due to factors such as naturally occurring savings, limited equipment turnover during the forecast period, and the fact that some customers will not install cost-effective measures due to various market barriers (such as capital limitations, lack of information about measures, limited installation opportunities due to production schedules, and hassle). All forecast program scenarios have projected TRC ratios greater that 1.0, reflecting KEMA's estimates that program benefits will exceed costs.

For electricity, the cumulative energy savings for the maximum achievable forecast are about 60% higher that the base forecast (that reflects current program efforts) by 2016. For natural gas, the maximum achievable forecast is about 300% above the base forecast. The differences between electricity and natural gas projections reflect the fact that California has pursued electricity efficiency options more rigorously that it has pursued natural gas options. There is also more uncertainty in the maximum achievable forecasts, since they reflect program efforts that are considerably beyond historical experience. This is especially true for the natural gas efficiency projections.

For both electricity and natural gas, improved process controls, system optimization, and O&M measures are key components of potential savings. These measures are likely to be more difficult to implement than strict equipment efficiency improvements, as they will require more customer education to effect improvements. A key component of forecast uncertainty is related to customer adoption of the control and optimization measures.

8

California Residential New Construction Energy Efficiency Potential

Under separate contract, Itron developed the estimates of commercial new construction energy efficiency potential. Itron's methodology can be found in Appendix O. This section presents the estimates of residential new construction energy efficiency potential resulting from the analysis. Estimated technical, economic, and market potential are presented for the period 2003 through 2016. Market potential was estimated for two program incentive funding levels: 1) the current utility program incentive level and 2) program incentives covering full incremental costs. All results reflect the current year's savings from cumulative adoptions over the period through 2016. Incremental savings can be found in the detailed results spreadsheets in Appendix I.

8.1 Overview

Itron estimated energy efficiency potential for residential new construction by building type and climate zone. The approach used was similar to the one used to estimate potential in existing residential buildings (the Potential Study) with several important differences. The differences include using packages of measures versus individual measures, the development of incremental costs, the development of energy savings, the number of building types, the number of scenarios, and the calibration year. Each is described in further detail below.

Appendix O includes a summary of the methodology on how the prototypes and the costs and savings were developed.

Packages of Measures

The objectives of the New Construction Potential Study included finding the savings potential for residential buildings that would approximate the building of ENERGY STAR® homes under the existing Standards (reaching 15 and 25% above the 2001 codes) and under the new Standards (reaching 10 and 15% above the 2005 codes) by Title 24 climate zone. Instead of estimating potential for the individual measures, it was necessary to develop packages of measures that could be added to the baseline home/building to allow it to reach the efficiency levels listed in Table 8-1.

Table 8-1: Measure Bundle Efficiency Levels

Scenario	Description	2003-2005 Level of Efficiency	2006-2013 Level of Efficiency
1	Code Level	2001 Code	2005 Code
2	Base Activity Level	2001 Code + 15%	2005 Code + 10%
3	High Activity Level	2001 Code + 25%	2005 Code + 15%

Incremental Costs

While the incremental measure costs used in the Potential Study were obtained from the Database for Energy Efficient Resources (DEER),[1,2] they were inappropriate for the New Construction Potential Study. Over 90% of new homes in California are built by medium to large builders[3] who might receive discounts on equipment/products, unlike the average residential consumer in the Potential Study who would be purchasing high efficiency equipment themselves. Therefore, the incremental measure costs for high efficiency measures were developed by interviewing builders and contractors.[4] These individual measure costs were then aggregated to develop the package costs.

Energy Savings

The incremental measure savings used in the Potential Study were also obtained from DEER. However, since individual measure savings are not additive and the measure savings may not be equivalent when added to a new home as opposed to an existing home, the savings for the packages of measures were developed using MICROPAS.[5] (Note the following caveat. To Itron's knowledge, there has not been a recent billing analysis conducted on MICROPAS.)

Building Types

The Potential Study developed inputs and estimated potential for three building types: single family detached homes, multifamily buildings, and mobile homes. For the New Construction Potential Study, however, it was necessary to develop cost and savings estimates and

1 Xenergy, Inc. *2001 DEER (Database for Energy Efficient Resources) Update Study*. Prepared for the California Energy Commission. August 2001.

2 Itron, Inc. 2004-2005 Database for Energy Efficiency Resources (DEER) Update Study: Final Report. Prepared for Southern California Edison. December 2005.

3 Itron, Inc. *Residential New Construction Baseline Study of Building Characteristics - Homes Built After 2001 Codes*. Prepared for Pacific Gas and Electric. August 2004.

4 Itron, Inc. *Incremental Costs Study*. Prepared for Pacific Gas and Electric. September 2003.

5 MICROPAS was chosen as the compliance tool because it is the tool of choice among energy consultants for performing low-rise residential compliance analysis. Interviews with MICROPAS developers indicate that more than 75% of energy professionals use their product. Further, two subsequent studies by Itron indicate that more than 90% of energy compliance documentation was completed using MICROPAS.

estimate potential for five building types due to differences in building shells (single family homes) and equipment types (multifamily buildings). The five building type groups include one-story single family detached homes, two-story single family detached homes, two-story single family attached homes (row houses), two-story multifamily buildings (apartments), and three-story multifamily buildings (apartments).

Scenarios

The Potential Study used three scenarios (current, scenario, and full) while the New Construction Potential Study used only two scenarios (current and full). Further, the incentive used in the full-cost scenario run does not equal the Incremental Measure Cost. Instead, the weighted average of the incremental costs (by IOU, Inland vs. Coastal, and building type) was used as the full incentive.[6] During 2003-2005, the incentives used in the analysis match those given by the IOUs. Beginning in 2006, the current scenario run uses rebates agreed upon by the New Construction Advisory Group and the full scenario run uses the average incremental cost discussed above.

Calibration Year

While the Potential Study used the 2004 IOU accomplishments, the most recent accomplishments available for the California ENERGY STAR New Homes Program were for 2003.

8.2 Potential for Residential New Construction Electric Energy Efficiency

Technical and Economic Potential

Total Residential New Construction Technical and Economic Potential

Figure 8-1 and Figure 8-2 present the total estimated energy and demand savings potential for new construction resulting from the analysis for the three state investor-owned electric utilities: Pacific Gas & Electric (PG&E), Southern California Edison (SCE), and San Diego Gas & Electric (SDG&E).

[6] The New Construction Potential Advisory Group wanted to limit the number of different incentives to be paid. They were developed by building type (SFD, SFA, MF), by performance level (15% above 2001 Standards, 25% above 2001 Standards, 10% above 2005 Standards and 15% above 2005 Standards.), and by region (North Coastal (CEC Climate Zones 1-5), South Coastal (CEC Climate Zones 6-7), Warm Inland (CEC Climate Zones 8-10 and 16), and Hot Inland (CEC Climate Zones 11-15). Therefore, the full incentive does not equal the Incremental Measure Cost. The weighted average of the incremental costs was used as the full incentive.

As shown in Figure 8-1, total estimated electric technical potential for energy savings is 1,049 GWh, and total estimated electric economic potential is 635 GWh. Figure 8-2 shows total estimated technical potential for demand reduction to be 948 MW, and total estimated economic potential for demand reduction to be 533 MW.

Figure 8-1: Total IOU Residential New Construction Energy Savings – Technical and Economic Potential – 2003-2016

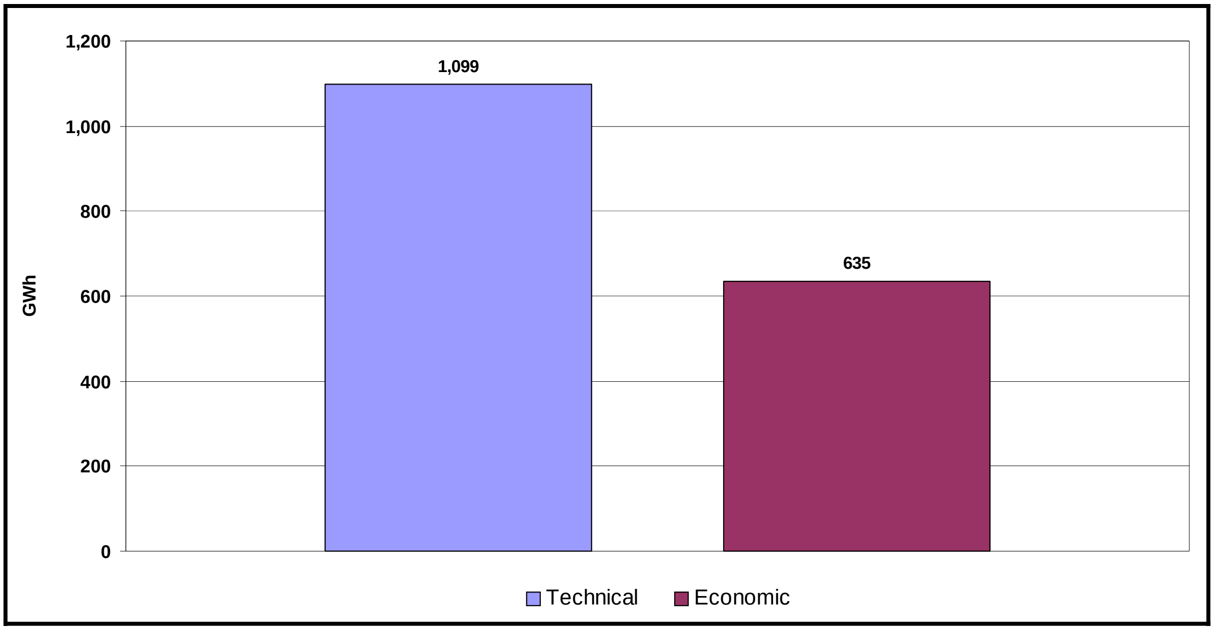
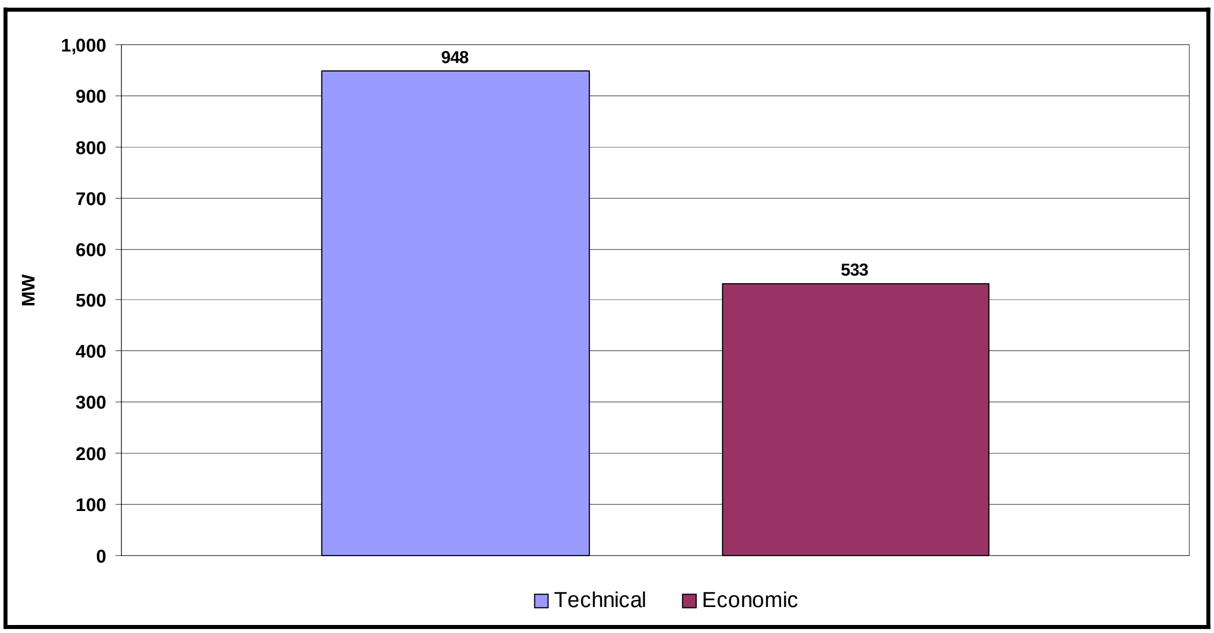


Figure 8-2: Total IOU Residential New Construction Demand Savings – Technical and Economic Potential – 2003-2016



The energy and demand savings potential results, disaggregated by utility service area, are presented in Figure 8-3 and Figure 8-4. These figures illustrate that both technical and economic energy potential are highest in the SCE service area, while technical and economic demand potential are highest for the PG&E service area.

Figure 8-3: Estimated Residential New Construction Technical and Economic Energy Potential by Utility – 2003-2016

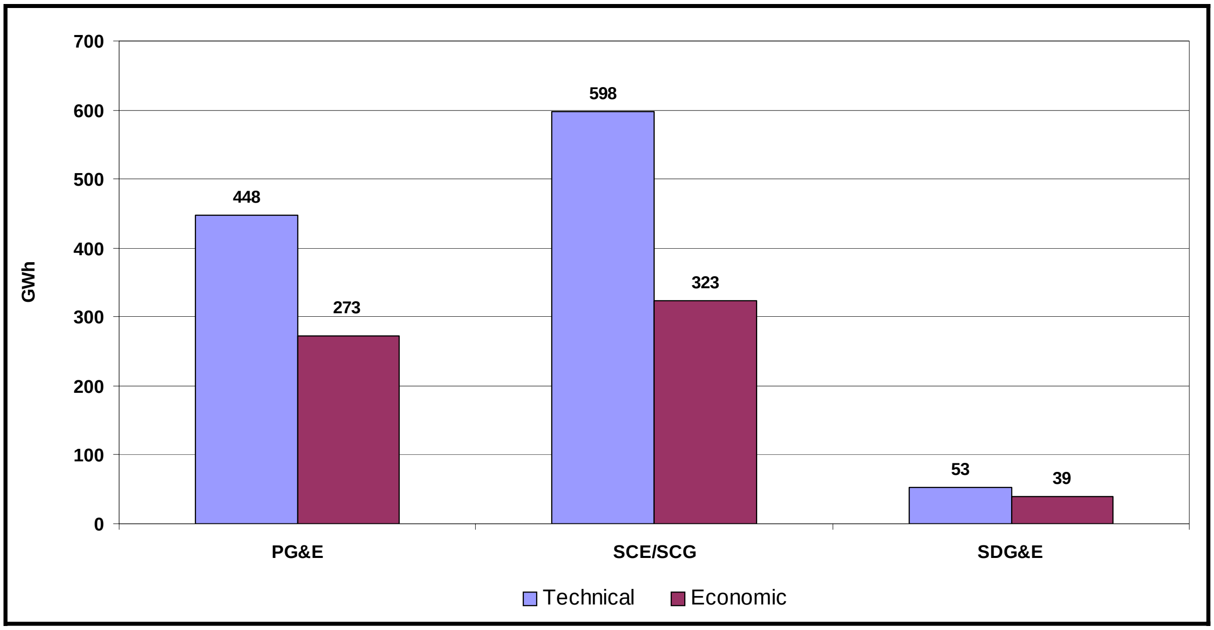
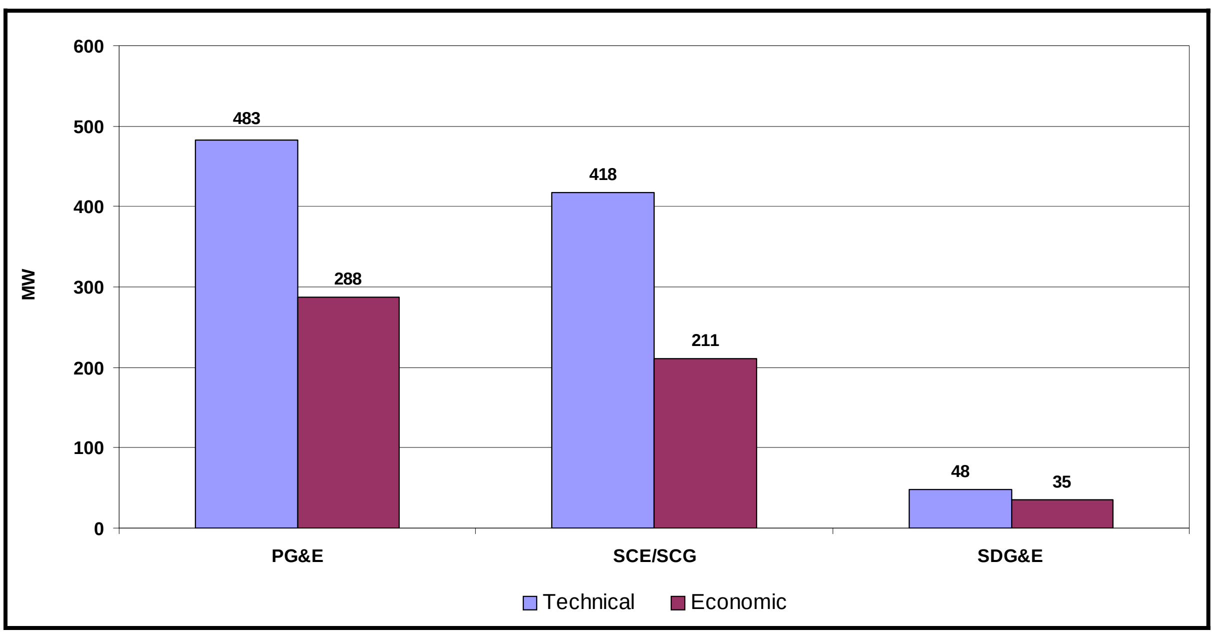


Figure 8-4: Estimated Residential New Construction Technical and Economic Demand Potential by Utility – 2003-2016



Residential New Construction Technical and Economic Potential by Building Type

Table 8-2 summarizes for each utility the technical potential results for 2016 by building type: single family, multifamily (which includes single family attached buildings). As shown, the largest contributors to energy and demand savings are single family residences. Table 8-3 summarizes the economic potential results by building type and utility. In this case, the largest contributors to energy and demand savings are also single family units. Figure 8-5 and Figure 8-6 illustrate the results shown in the tables.

Table 8-2: Residential New Construction Technical Potential by Building Type and Utility – 2003-2016

Building Type	PG&E		SCE		SDG&E		Total	
	GWh	MW	GWh	MW	GWh	MW	GWh	MW
Single Family	389	429	547	377	34	30	971	836
Multifamily	59	53	51	41	19	17	129	111
Total	**448**	**483**	**598**	**418**	**53**	**48**	**1,099**	**948**

Table 8-3: Residential New Construction Economic Potential by Building Type and Utility – 2003-2016

End Use	PG&E		SCE		SDG&E		Total	
	GWh	MW	GWh	MW	GWh	MW	GWh	MW
Single Family	234	252	303	195	30	27	567	474
Multifamily	39	35	20	16	9	8	68	59
Total	273	288	323	211	39	35	635	533

Figure 8-5: Total IOU Residential New Construction Technical and Economic Energy Potential by Building Type – 2003-2016

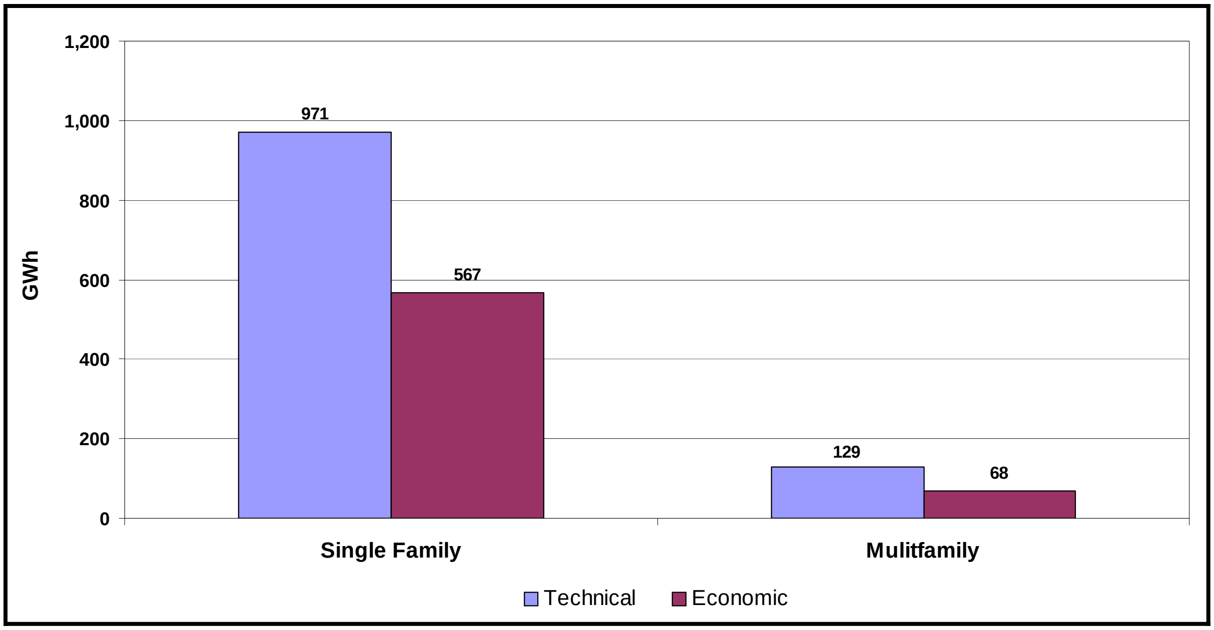
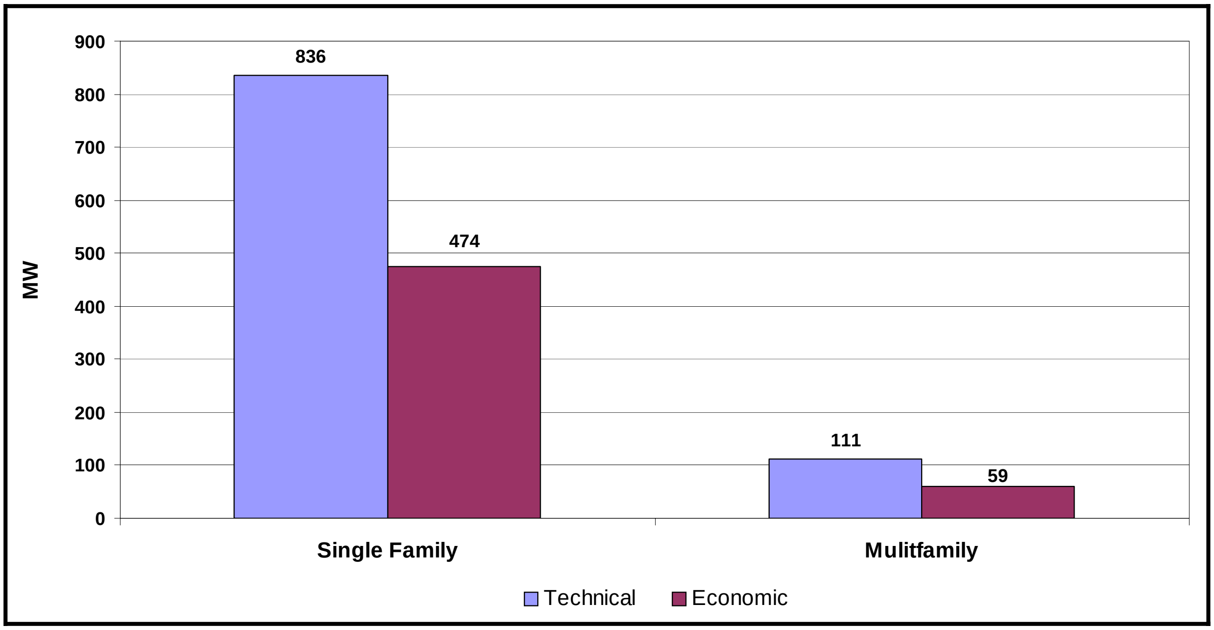


Figure 8-6: Total IOU Residential New Construction Technical and Economic Demand Potential by Building Type – 2003-2016



Residential New Construction Market Potential for Energy Efficiency

In this subsection, the results for residential new homes electric potential are further analyzed under two program incentive scenarios. Results were derived for the current 2004-2005 energy efficiency program incentive funding level and for a full incremental cost incentive funding level. Table 8-4 describes the residential market scenarios for new homes.

Table 8-4: Market Scenario Descriptions for Existing Residential Buildings

Market Scenario Name	Description
Current	2004 incentive level. Due to changes to the Title 24 Standards changes in 2006, the rebate level changes in 2006.
Full	The full incentive does not equal the Incremental Measure Cost. Instead, the weighted average of the incremental costs was used as the full incentive.[7]

Total Residential New Construction Market Potential

In this subsection, the above results for electric technical and economic potential are further analyzed under two program incentive scenarios. Results were derived for the current 2004-2005 California ENERGY STAR New Homes Program incentive funding level, and for a full incremental cost incentive funding level. As mentioned above, the full-cost scenario run does not equal the Incremental Measure Cost. Instead, the weighted average of the incremental costs (by IOU, Inland vs. Coastal, and building type) was used as the full incentive. Also, note that the full-cost scenario is not implemented until 2006, which coincides with both the new Title 24 Standards and the new California residential new construction programs.

As shown in Table 8-5, total IOU market potential under the current funding scenario is 147 GWh energy savings and 142 MW demand savings. When program incentives are further increased to cover full incremental costs, energy savings increased 73% to 255 GWh, while demand savings increased 79% to 254 MW. These results are illustrated in Figure 8-7 and Figure 8-8. By design, the market potential energy savings for the full incentive scenario equal those of the current incentive scenario until 2006 as can be seen in these figures.

The difference in 2005 and 2006 between the results for current and full funding levels exists because in some climate zones, the current rebate level is higher than the incremental cost of the high efficiency building packages.

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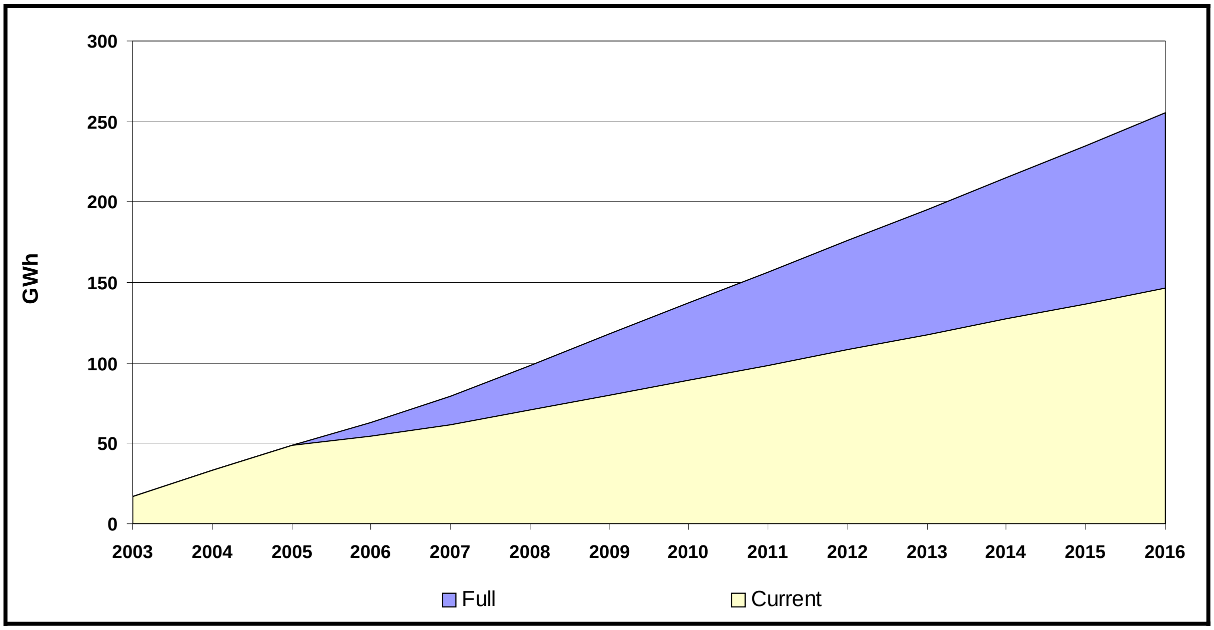
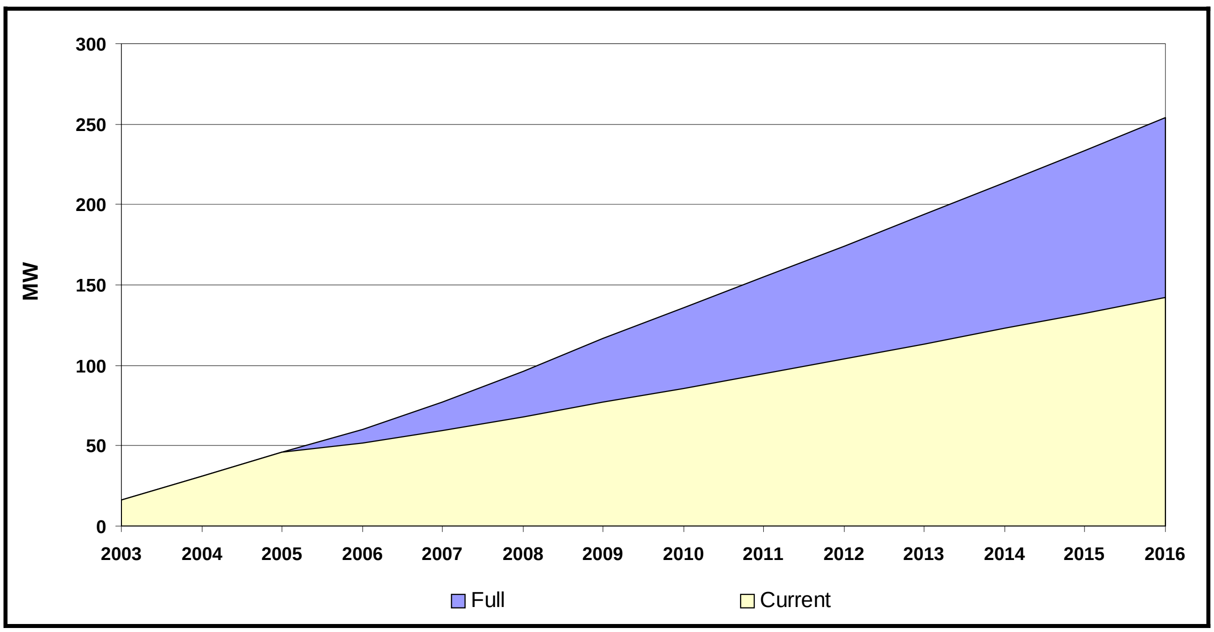
[7] The New Construction Potential Advisory Group wanted to limit the number of different incentives to be paid. They were developed by building type (SFD, SFA, MF), by performance level (15% above 2001 Standards, 25% above 2001 Standards, 10% above 2005 Standards and 15% above 2005 Standards.), and by region (North Coastal (CEC Climate Zones 1-5), South Coastal (CEC Climate Zones 6-7), Warm Inland (CEC Climate Zones 8-10 and 16), and Hot Inland (CEC Climate Zones 11-15).

Figure 8-7: Estimated Residential New Construction Energy Market Potential by Funding Level



* Refer to Table 8-4 for a description of the market funding scenarios.

Figure 8-8: Estimated Residential New Construction Demand Market Potential by Funding Level



* Refer to Table 8-4 for a description of the market funding scenarios.

Table 8-5: Estimated Residential New Construction Market Potential by Funding Level – 2003-2016

Funding Level	Energy (GWh)	Demand (MW)
Current	147	142
Full	255	254

* Refer to Table 8-4 for a description of the market funding scenarios.

Residential New Construction Market Potential by Building Type

Table 8-6 summarizes the new construction energy market potential estimates by funding level and building type. For comparison, technical and economic estimates are also included. Table 8-7 presents similar results for peak demand reduction.

Table 8-6: Estimated Residential New Construction Energy Market Potential by Funding Level and Building Type – 2003-2016

Building Type	Technical Potential (GWh)	Economic Potential (GWh)	Current		Full	
			GWh	% of Econ. Pot.	GWh	% of Econ. Pot.
Single Family	971	567	120	21%	204	36%
Multifamily	129	68	27	39%	51	75%
Total	**1,099**	**635**	**147**	**23%**	**255**	**40%**

* Refer to Table 8-4 for a description of the market funding scenarios.

Table 8-7: Estimated Residential New Construction Demand Market Potential by Funding Level and Building Type – 2003-2016

Building Type	Technical Potential (MW)	Economic Potential (MW)	Current		Full	
			MW	% of Econ. Pot.	MW	% of Econ. Pot.
Single Family	836	474	117	25%	208	44%
Multifamily	111	59	25	42%	46	77%
Total	948	533	142	27%	254	48%

* Refer to Table 8-4 for a description of the market funding scenarios.

Utility-Level Residential New Construction Potential

This subsection presents the technical, economic, and market potential of new construction over time at the utility level.

Table 8-8, Table 8-10, and Table 8-12 provide the potential new construction energy savings for PG&E, SCE, and SDG&E, respectively, and Figure 8-9, Figure 8-11, and Figure 8-13 illustrate these data in graphical form. The potential new construction demand savings for these utilities are presented in Table 8-9, Table 8-11, and Table 8-13, while Figure 8-10, Figure 8-12, and Figure 8-14 present graphs of these data. These tables and figures help illustrate the new construction energy efficiency potential for future growth in new construction energy efficiency savings under alternative market scenarios.

Given the definitions of economic and technical potential, the technical potential illustrated for each utility in 2003 does not illustrate the level of technical potential each utility achieved. The technical potential illustrates what the utility could achieve if they had the ability to force all builders who could adopt the measure to do so. Increases in technical potential over time arise from continued new construction.

Table 8-8 shows that PG&E's new construction energy efficiency market potential, in 2016, is 71 GWh under the current incentive levels. Increasing incentives to the full level raises potential savings to 125 GWh, a 76% increase.

Table 8-9 provides PG&E's potential new construction demand savings under the two alternative incentive levels. PG&E's forecasted demand savings in 2016, under current incentive levels is 80 MW. Raising incentives to full incremental measure costs further increases the demand savings to 146 MW, an increase of 82% over the current results.

Table 8-8: Estimated PG&E Residential New Construction Gross Technical, Economic, and Market Energy Potential – 2003-2016 (GWh)

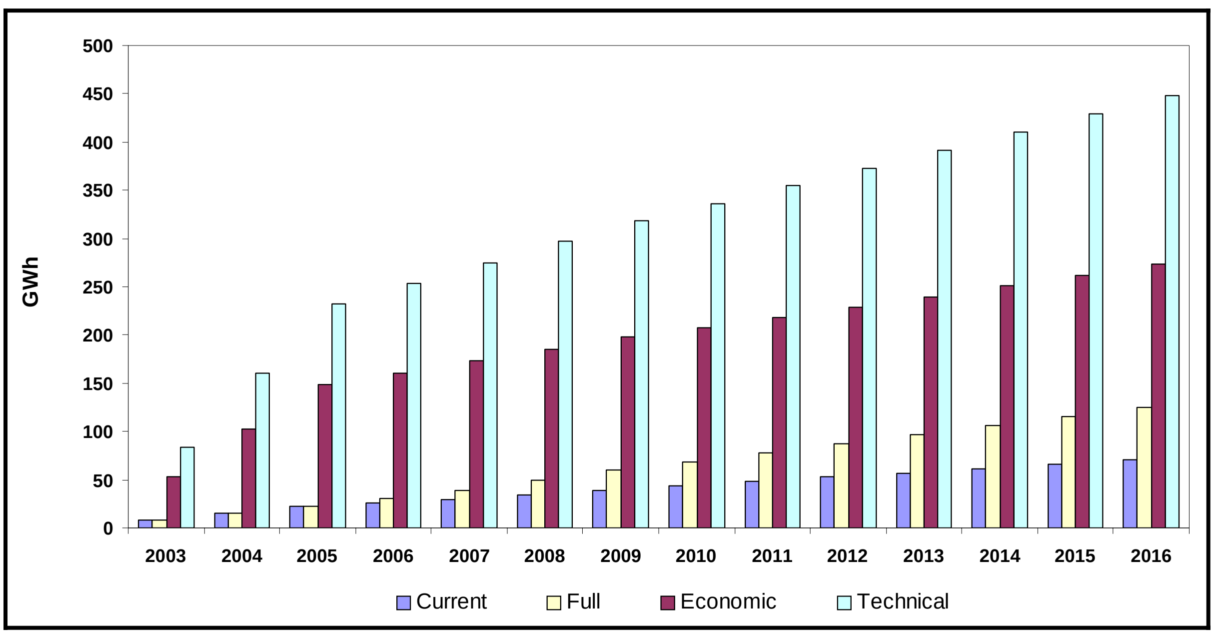
Total	Technical	Economic	Full	Current
2003	83	54	8	8
2004	160	103	16	16
2005	233	149	23	23
2006	254	161	30	26
2007	275	173	39	29
2008	297	185	49	34
2009	318	198	60	39
2010	336	208	69	43
2011	354	219	78	48
2012	373	229	87	53
2013	391	240	96	57
2014	410	251	106	62
2015	429	262	115	66
2016	448	273	125	71

Table 8-9: Estimated PG&E Residential New Construction Gross Technical, Economic, and Market Demand Potential – 2003-2016 (MW)

Total	Technical	Economic	Full	Current
2003	88	49	9	9
2004	169	95	18	18
2005	246	137	26	26
2006	269	152	35	29
2007	292	166	45	33
2008	316	181	56	38
2009	340	196	68	44
2010	359	209	79	49
2011	379	221	90	54
2012	400	234	101	59
2013	420	247	112	64
2014	441	261	123	69
2015	461	274	134	75
2016	483	288	146	80

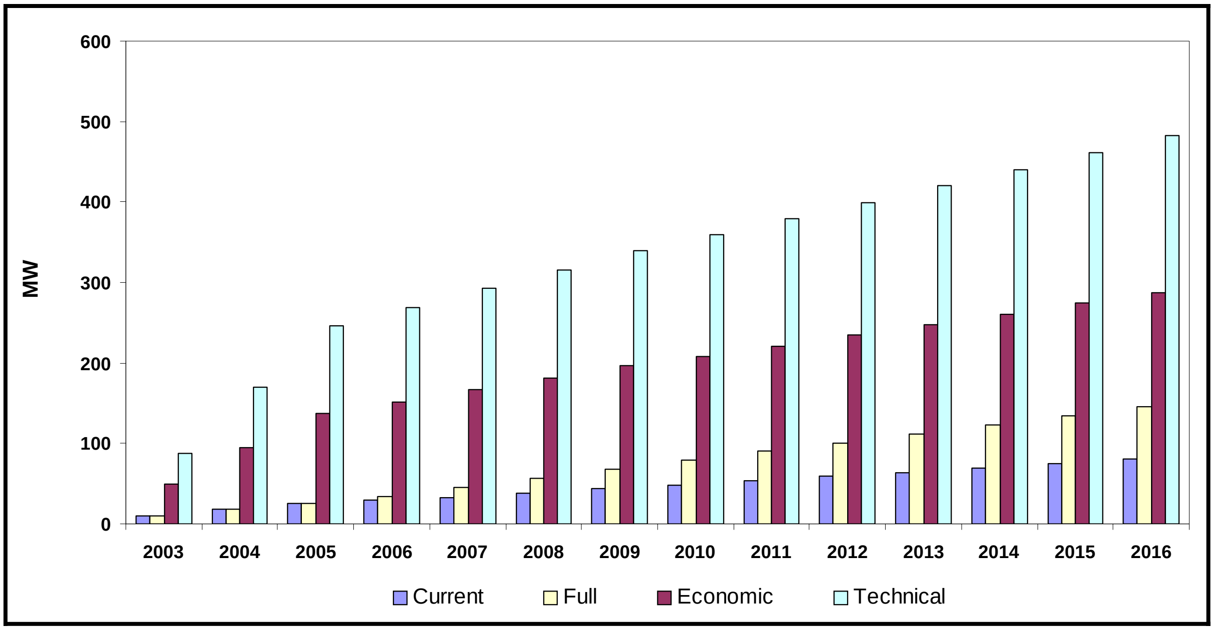
Figure 8-9 and Figure 8-10 illustrate the data in Table 8-8 and Table 8-9.

Figure 8-9: Estimated PG&E Residential New Construction Gross Technical, Economic, and Market Energy Potential



* Refer to Table 8-4 for a description of the market funding scenarios.

Figure 8-10: Estimated PG&E Residential New Construction Gross Technical, Economic, and Market Demand Potential



* Refer to Table 8-4 for a description of the market funding scenarios.

Table 8-10 shows that SCE's new construction energy efficiency technical potential forecast is larger than the forecast for either PG&E or SDG&E. However, the economic potential forecast for SCE levels off beginning in 2006, increasing only slightly over the 11-year period from 226 to 323 GWh. In general, building an ENERGY STAR home in most climate zones for most building types in SCE's territory prior to 2006 is cost-effective (the economic potential as a percentage of the technical potential in 2005 is 94%). However, beginning in 2006, the incremental economic potential as a percentage of the incremental technical potential is 27%. This means that it is cost-effective for only a few of the 40 prototypes to be built at either 10% or 15% above the 2005 Title 24 Standards.

Table 8-11 presents the potential new construction demand savings for SCE. Under current incentives, SCE's new construction potential demand savings in 2016 are 46 MW. Increasing incentives to the full level increases the forecast of demand savings to 85 MW, an 84% increase. Similar to the graph of energy savings, the economic potential for demand savings also level off after 2005 increasing only 67 MW from 144 to 211 MW in an 11-year period.

Table 8-10: Estimated SCE Residential New Construction Gross Technical, Economic, and Market Energy Potential – 2003-2016 (GWh)

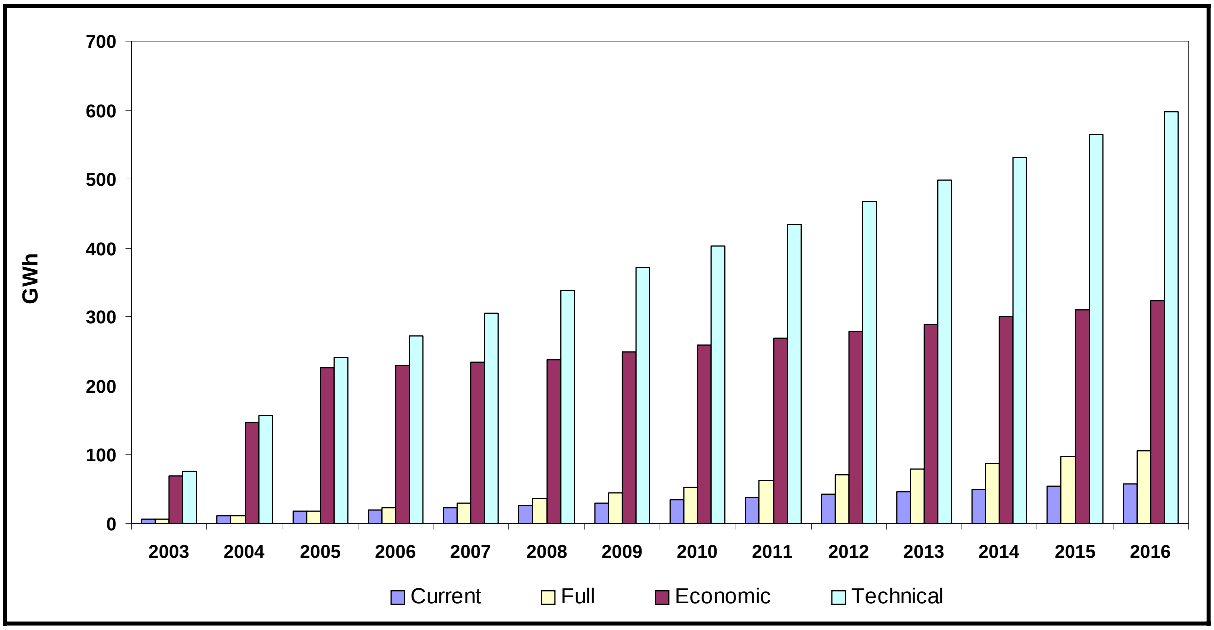
Total	Technical	Economic	Full	Current
2003	75	70	6	6
2004	157	147	12	12
2005	241	226	18	18
2006	273	230	23	21
2007	305	234	29	23
2008	338	238	37	27
2009	372	249	45	30
2010	403	259	53	34
2011	435	268	62	38
2012	467	279	71	42
2013	499	289	79	46
2014	532	300	88	50
2015	565	310	97	54
2016	598	323	106	58

Table 8-11: Estimated SCE Residential New Construction Gross Technical, Economic, and Market Demand Potential – 2003-2016 (MW)

Total	Technical	Economic	Full	Current
2003	51	45	4	4
2004	105	93	9	9
2005	162	144	14	14
2006	184	146	17	15
2007	207	149	22	18
2008	231	151	29	20
2009	256	159	36	23
2010	278	165	42	27
2011	301	172	49	30
2012	324	179	56	33
2013	347	187	63	36
2014	370	194	70	40
2015	394	202	78	43
2016	418	211	85	46

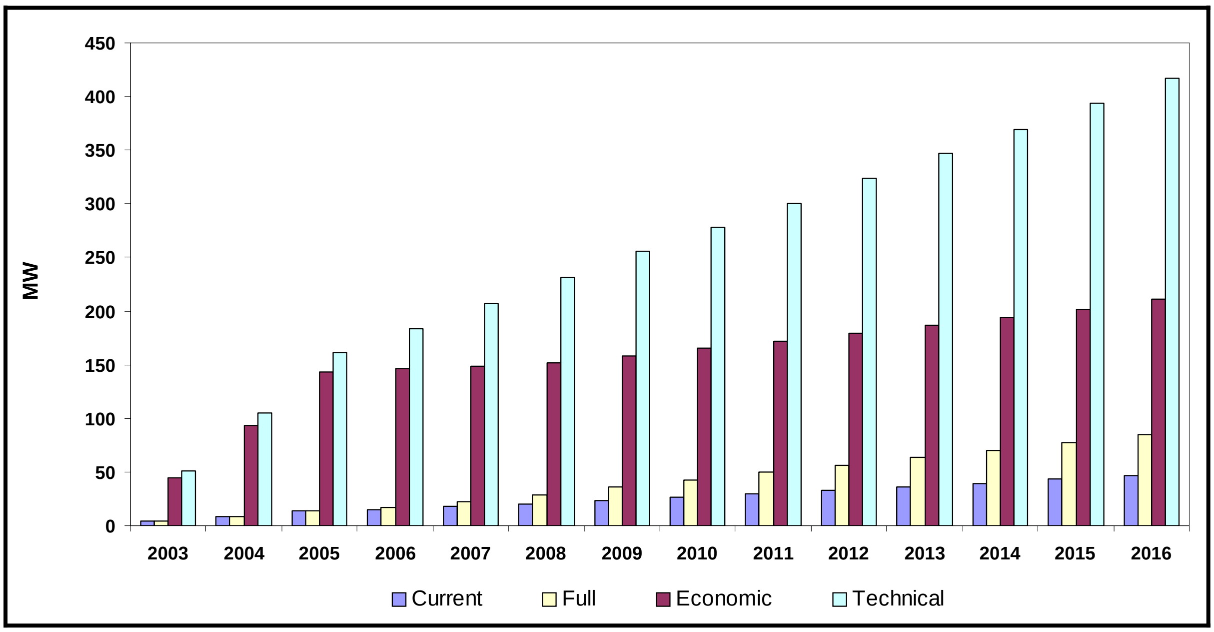
Figure 8-11 and Figure 8-12 illustrate the data from Table 8-10 and Table 8-11.

Figure 8-11: Estimated SCE Residential New Construction Gross Technical, Economic, and Market Energy Potential



* Refer to Table 8-4 for a description of the market funding scenarios.

Figure 8-12: Estimated SCE Residential New Construction Gross Technical, Economic, and Market Demand Potential



* Refer to Table 8-4 for a description of the market funding scenarios.

Table 8-12 and Table 8-13 provide SDG&E's potential new construction energy and demand savings under both market forecasts. SDG&E's new construction market potential at current incentive levels is 17 GWh and 15 MW. Increasing incentives to the full level increases potential savings to 24 GWh, a 42% increase. Raising incentives to full incremental measure costs increases the forecast of demand savings to 23 MW, an increase of 48% over the scenario forecast of demand savings.

SDG&E's economic potential forecast as a percentage of its technical potential forecast is higher than PG&E and SCE/SoCalGas at 73% versus 61% and 54%, respectively. This means that a larger portion of the technical potential is cost-effective in SDG&E's territory than in the other utilities'. This result may seem surprising, but it is because it is more cost-effective to build high efficiency new homes in the inland regions of SDG&E (CEC Climate Zones 10 and 14) than in some other climate zones. (See Section 8.5 for a discussion of the TRC results.)

Table 8-12: Estimated SDG&E Residential New Construction Gross Technical, Economic, and Market Energy Potential – 2003-2016 (GWh)

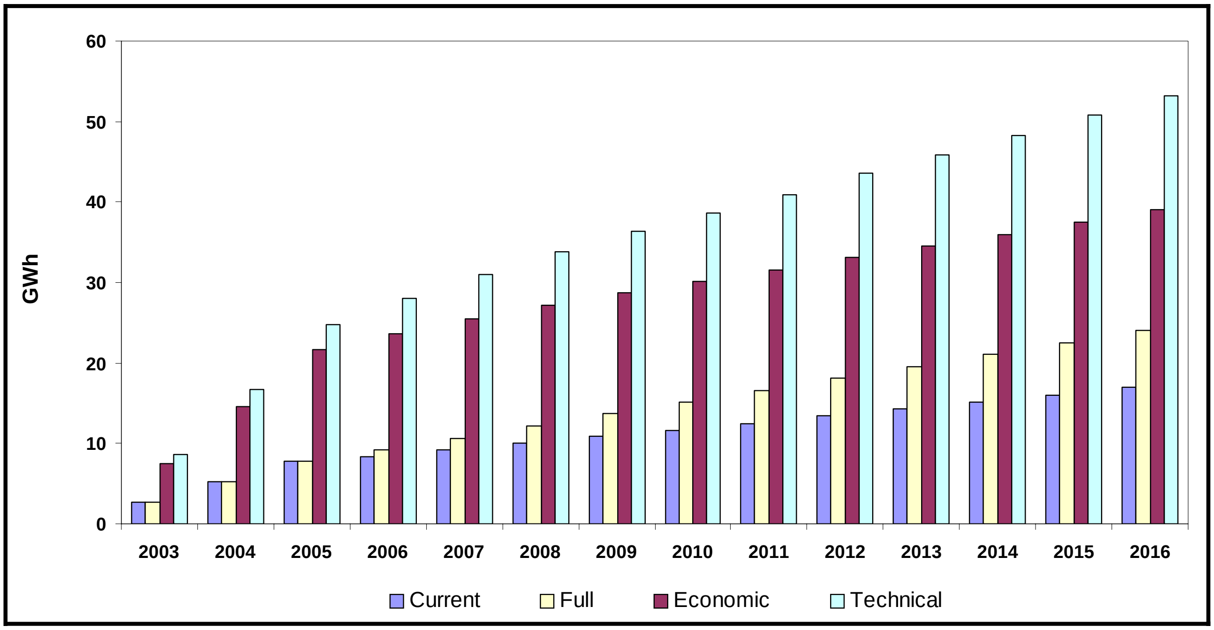
Total	Technical	Economic	Full	Current
2003	9	8	3	3
2004	17	15	5	5
2005	25	22	8	8
2006	28	24	9	8
2007	31	25	11	9
2008	34	27	12	10
2009	36	29	14	11
2010	39	30	15	12
2011	41	32	17	12
2012	44	33	18	13
2013	46	35	20	14
2014	48	36	21	15
2015	51	37	23	16
2016	53	39	24	17

Table 8-13: Estimated SDG&E Residential New Construction Gross Technical, Economic, and Market Demand Potential – 2003-2016 (MW)

Total	Technical	Economic	Full	Current
2003	8	6	2	2
2004	15	12	5	5
2005	23	18	7	7
2006	26	20	8	8
2007	28	21	10	8
2008	31	23	11	9
2009	33	25	13	10
2010	35	26	14	11
2011	37	27	16	11
2012	39	29	17	12
2013	41	30	18	13
2014	43	32	20	14
2015	45	33	21	15
2016	48	35	23	15

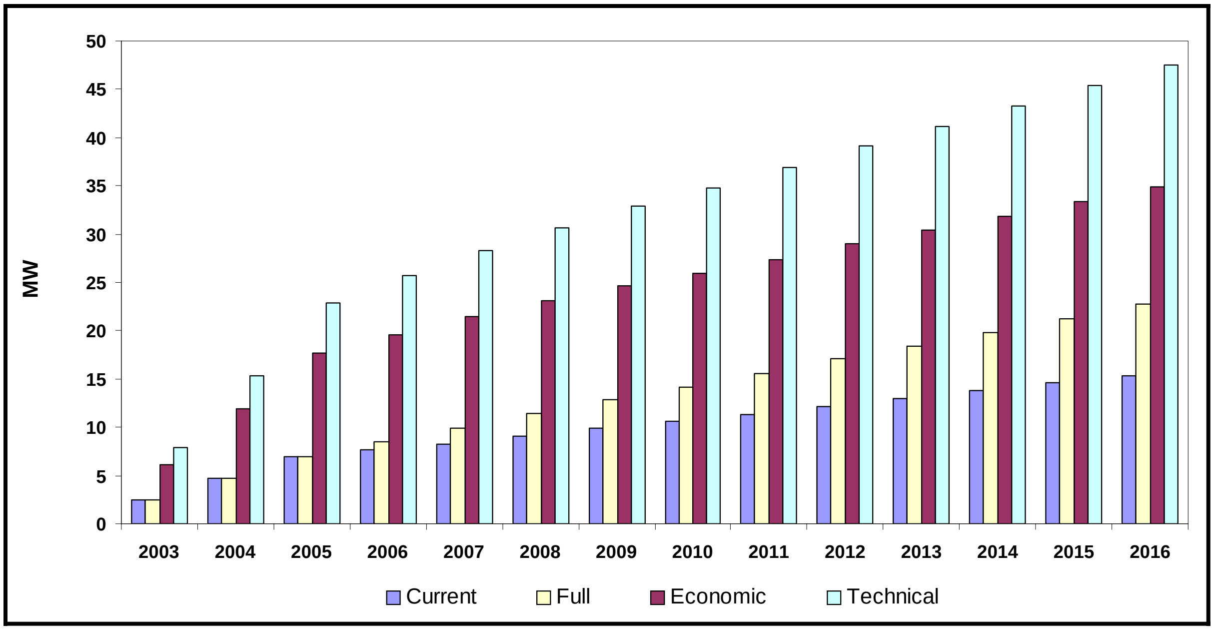
Figure 8-13 and Figure 8-14 illustrate the data in Table 8-12 and Table 8-13.

Figure 8-13: Estimated SDG&E Residential New Construction Gross Technical, Economic, and Market Energy Potential



* Refer to Table 8-4 for a description of the market funding scenarios.

Figure 8-14: Estimated SDG&E Gross Residential New Construction Technical, Economic, and Market Demand Potential



* Refer to Table 8-4 for a description of the market funding scenarios.

8.3 Residential New Construction Potential for Gas Energy Efficiency

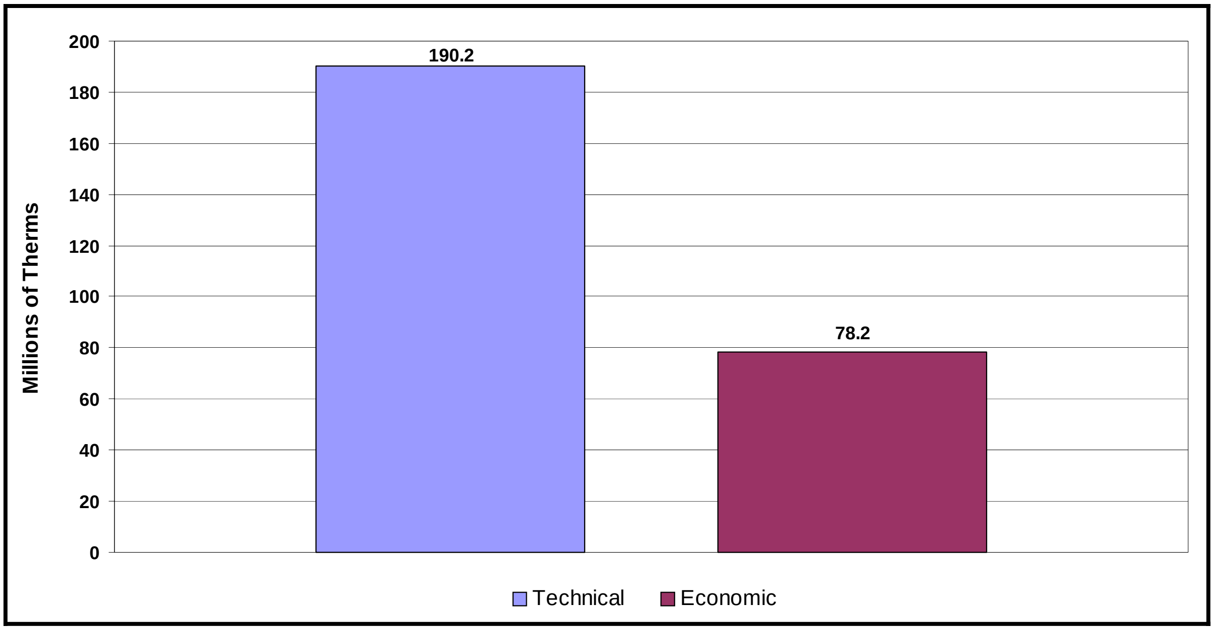
Technical and Economic Gas Potential

Total Residential New Construction Technical and Economic Potential

Figure 8-15 presents the total estimated new construction gas potential resulting from the analysis for the three state investor-owned gas utilities of PG&E, SDG&E, and Southern California Gas (SoCalGas). The values are provided for 2016, the last year of the analysis.

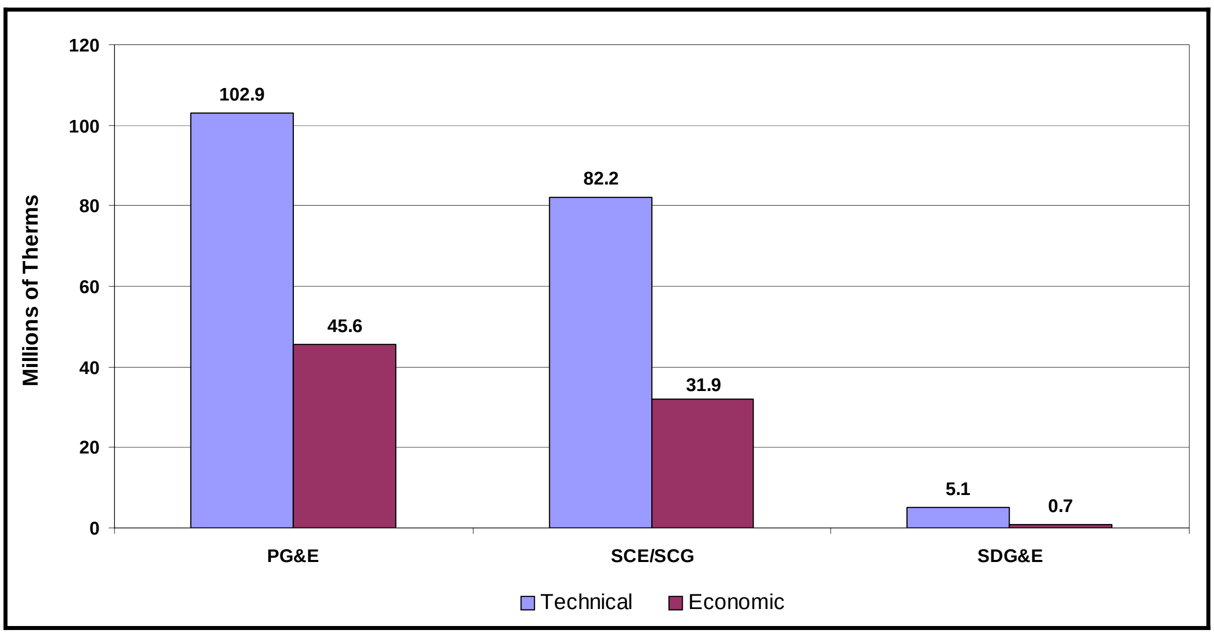
As shown, total estimated technical potential is 190.2 million therms. Total estimated economic potential is 78.2 million therms.

Figure 8-15: Estimated Residential New Construction Gas Technical and Economic Potential – 2003-2016



Presented in Figure 8-16 are the technical and economic potential forecasts by utility service area. This figure illustrates that technical potential is highest for the PG&E service area at 102.9 million therms and that economic potential is highest for PG&E at 45.5 million therms.

Figure 8-16: Estimated Residential New Construction Gas Technical and Economic Potential by Utility – 2003-2016



Residential New Construction Technical and Economic Potential by Building Type

Table 8-14 summarizes the technical potential results by building type and utility. As shown, the largest contributors to new construction gas savings in all IOU service areas are single family residences.

Table 8-14: Technical Residential New Construction Potential by Building Type and Utility – 2003-2016 (millions of therms)

Building Type	PG&E	SoCalGas	SDG&E	Total
Single Family	95.06	78.20	3.85	177.11
Multifamily	7.85	3.99	1.26	13.10
Total	**102.90**	**82.19**	**5.11**	**190.20**

Estimates of new construction gas energy savings for all IOUs are presented by building type in Figure 8-17. As shown, the technical gas potential for new single family homes is much higher than for multifamily buildings (177 and 13 million therms, respectively). This is because 1) the ratio of new single family to multifamily residences in 2005 was approximately 3-to-1 with an average of 5-to-2 over the last 10 years, and 2) each of the single family prototypes have gas space heating whereas the multifamily prototypes have a mix of gas and electric space heating.

Figure 8-17: Estimated Residential New Construction Gas Potential by Building Type – 2003-2016

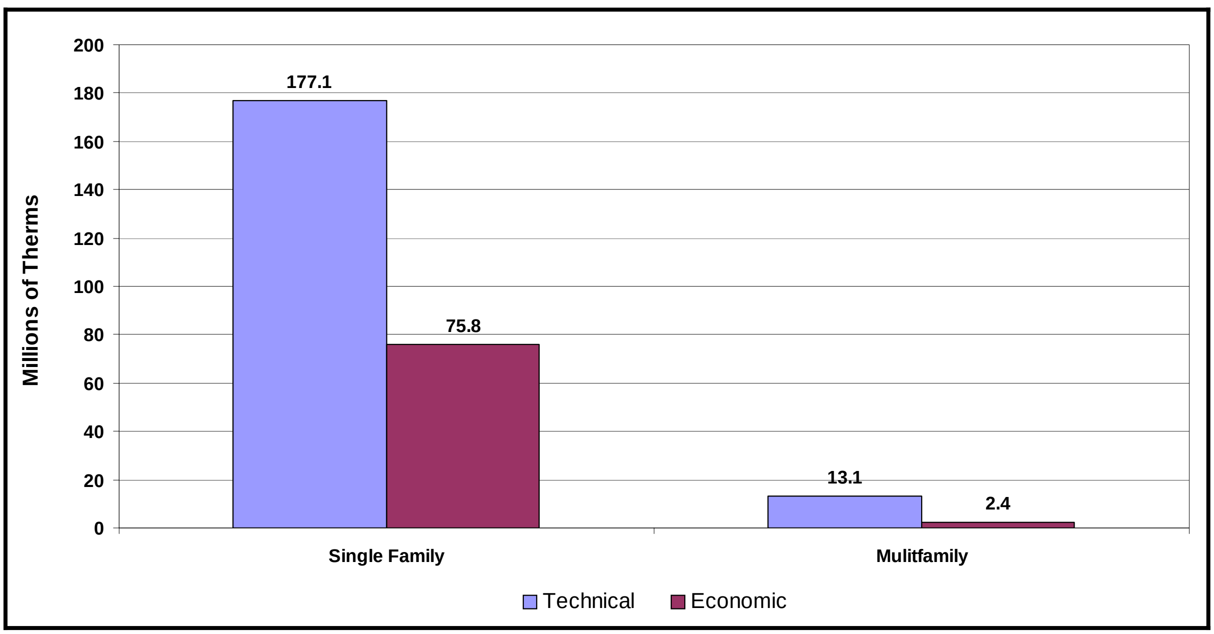


Table 8-15 summarizes the economic potential results by building type and by utility. As shown, the utility service area with the greatest economic potential is PG&E. The SDG&E service area is unique in that the multifamily economic potential is greater than the single family economic potential. The ratio of single family homes to multifamily units in SDG&E's service territory is just over 1-to-1. In SDG&E's territory, nearly half of the new multifamily units being built are attached single family homes, which also have gas space heating and gas water heating, compared to approximately 30%-40% in the SCE, SoCalGas, and PG&E service territories.

Table 8-15: Residential New Construction Economic Potential by Building Type and Utility – 2003-2016 (millions of therms)

Building Type	PG&E	SoCalGas	SDG&E	Total
Single Family	44.19	31.39	0.26	75.84
Multifamily	1.39	0.52	0.45	2.37
Total	**45.59**	**31.91**	**0.71**	**78.21**

Residential New Construction Market Potential for Gas Energy Efficiency

Total Residential New Construction Market Potential

This subsection further analyzes the above results for new construction gas technical and economic potential under two program incentive scenarios.

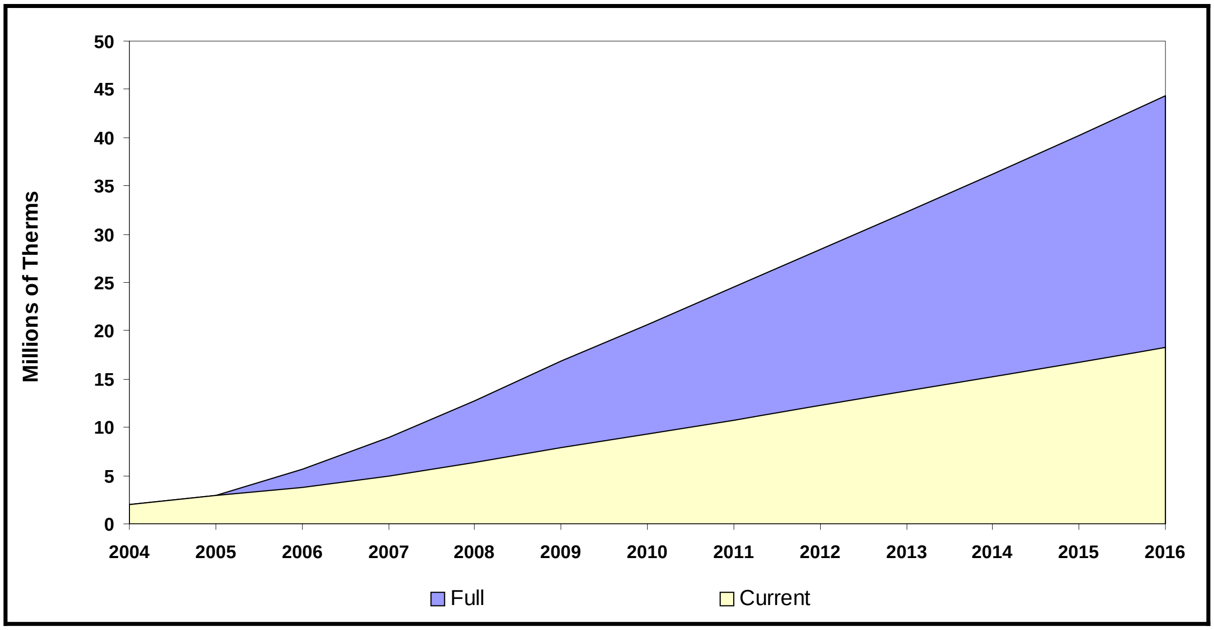
Table 8-16 shows that total IOU market potential under the current funding scenario is 18.3 million therms. When program incentives are increased to cover full incremental costs, the savings further increase 142% to 44.3 million therms. Figure 8-18 illustrates these results.

Table 8-16: Estimated Residential New Construction Market Potential by Funding Level – 2003-2016

Funding Level	Millions of Therms
Current	18.33
Full	44.29

* Refer to Table 8-4 for a description of the market funding scenarios.

Figure 8-18: Estimated Residential New Construction Gas Market Potential by Funding Level



* Refer to Table 8-4 for a description of the market funding scenarios.

<u>Residential New Construction Market Potential by Building Type</u>

Table 8-17 summarizes the market potential estimates by funding level and building type. For comparison, technical and economic estimates are also included.

Table 8-17: Estimated Residential New Construction Gas Market Potential by Funding Level and Building Type – 2003-2016

Building Type	Technical	Economic	Current	Full
Single Family	177.1	75.8	17.0	38.8
Multifamily	13.1	2.4	1.4	5.4
Total	**190.2**	**78.2**	**18.3**	**44.3**

* Refer to Table 8-4 for a description of the market funding scenarios.

Utility-Level Residential New Construction Gas Potential

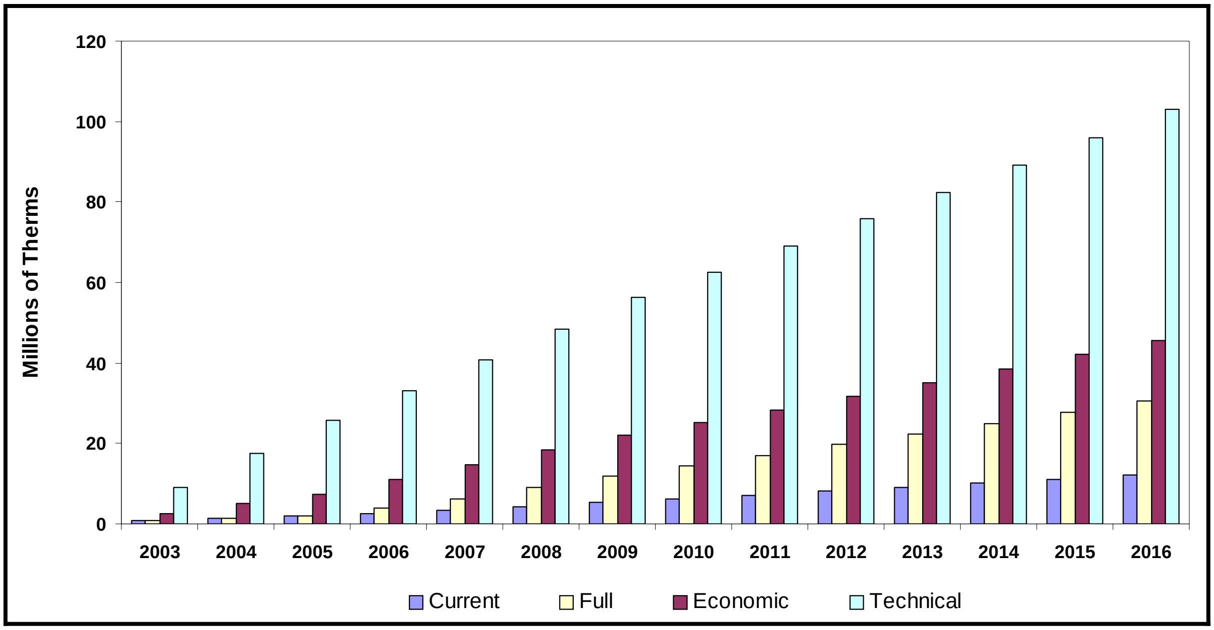
This subsection presents the natural gas new construction technical, economic, and market potential for the years 2003-2016 at the utility level. Table 8-18, Table 8-19, and Table 8-20 present the potential natural gas savings for PG&E, SoCalGas, and SDG&E, respectively. The data provided in these tables are displayed in graphical form in Figure 8-19, Figure 8-20, and Figure 8-21. These tables and figures help to illustrate the new construction natural gas energy efficiency potential achieved by each utility in 2003 and the potential for future growth in energy efficiency savings under the alternative market scenario.

Table 8-18 illustrates PG&E's technical, economic, and market potential for new construction natural gas savings. The new construction market potential under current incentives in the final analysis year is 12 million therms. Increasing incentives to full incremental measure costs increases the savings to 30 million therms, an increase of 152%.

Table 8-18: Estimated PG&E Gross Residential New Construction Technical, Economic, and Market Gas Potential – 2003-2016 (millions of therms)

Total	Technical	Economic	Full	Current
2003	9	3	1	1
2004	18	5	1	1
2005	26	7	2	2
2006	33	11	4	3
2007	41	15	6	3
2008	48	18	9	4
2009	56	22	12	5
2010	63	25	14	6
2011	69	28	17	7
2012	76	32	20	8
2013	82	35	22	9
2014	89	39	25	10
2015	96	42	28	11
2016	103	46	30	12

Figure 8-19: Estimated PG&E Gross Residential New Construction Technical, Economic, and Market Gas Potential



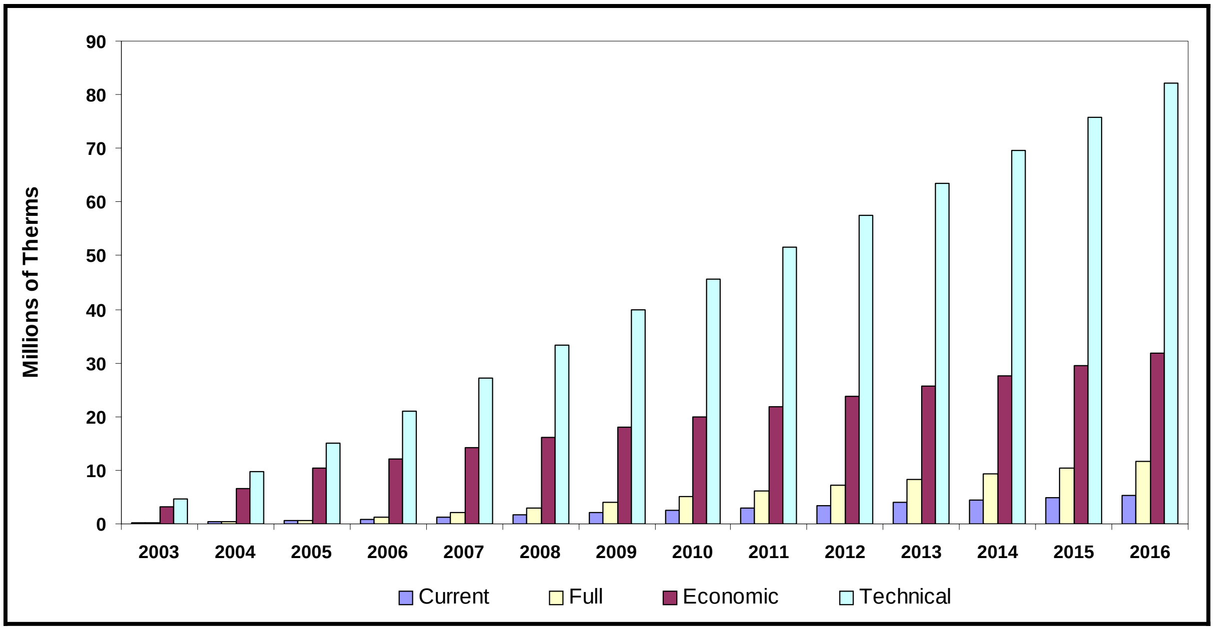
* Refer to Table 8-4 for a description of the market funding scenarios.

Table 8-19 presents SoCalGas new construction natural gas potential. Continuing current incentive levels leads to expected savings of 5.4 million therms in 2016. Increasing incentives to full incremental costs is forecast to increase potential natural gas savings in SoCalGas' service territory to 11.6 million therms, an increase of 116%.

Table 8-19: Estimated SoCalGas Gross Residential New Construction Technical, Economic, and Market Gas Potential – 2003-2016 (millions of therms)

Total	Technical	Economic	Full	Current
2003	5	3	0	0
2004	10	7	0	0
2005	15	10	1	1
2006	21	12	1	1
2007	27	14	2	1
2008	33	16	3	2
2009	40	18	4	2
2010	46	20	5	3
2011	51	22	6	3
2012	58	24	7	3
2013	64	26	8	4
2014	70	28	9	4
2015	76	30	11	5
2016	82	32	12	5

Figure 8-20: Estimated SoCalGas Gross Residential New Construction Technical, Economic, and Market Gas Potential



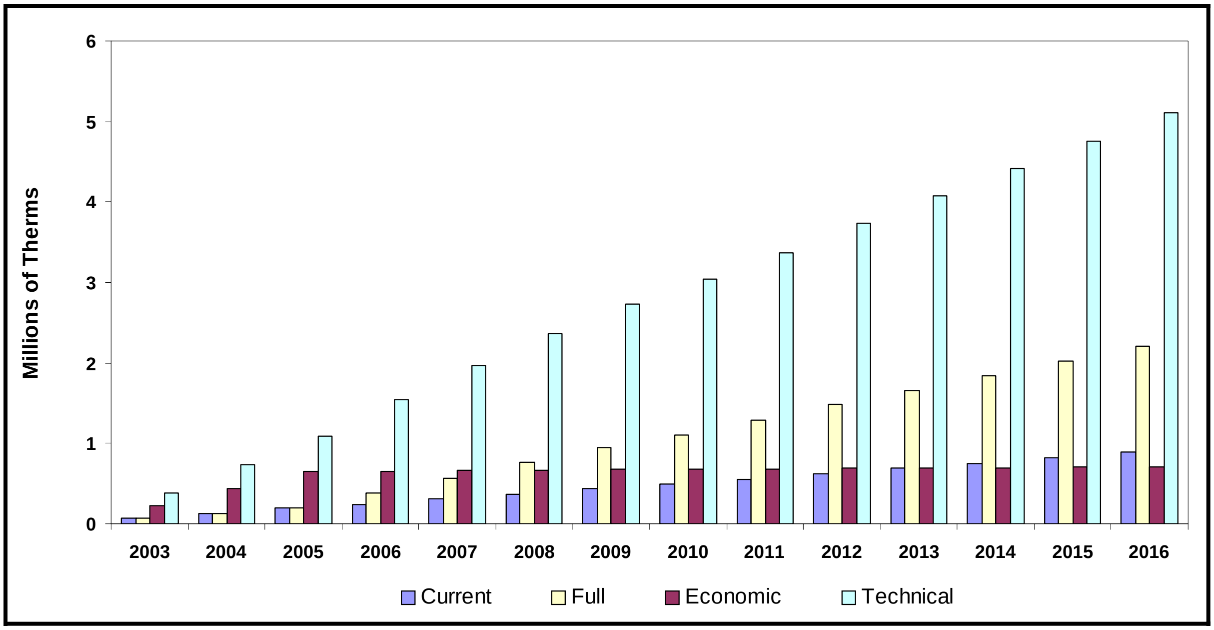
* Refer to Table 8-4 for a description of the market funding scenarios.

Table 8-20 illustrates the forecast new construction natural gas savings for SDG&E. At current incentive levels, the forecast of natural gas savings is 0.9 million therms. Increasing incentives to full incremental costs is forecast to increase potential natural gas savings in SDG&E's service territory to 2.2 million therms, an increase of 144%.

Table 8-20: Estimated SDG&E Gross Residential New Construction Technical, Economic, and Market Gas Potential – 2003-2016 (millions of therms)

Total	Technical	Economic	Full	Current
2003	0	0	0	0
2004	1	0	0	0
2005	1	1	0	0
2006	2	1	0	0
2007	2	1	1	0
2008	2	1	1	0
2009	3	1	1	0
2010	3	1	1	0
2011	3	1	1	1
2012	4	1	1	1
2013	4	1	2	1
2014	4	1	2	1
2015	5	1	2	1
2016	5	1	2	1

Figure 8-21: Estimated SDG&E Gross Residential New Construction Technical, Economic, and Market Gas Potential



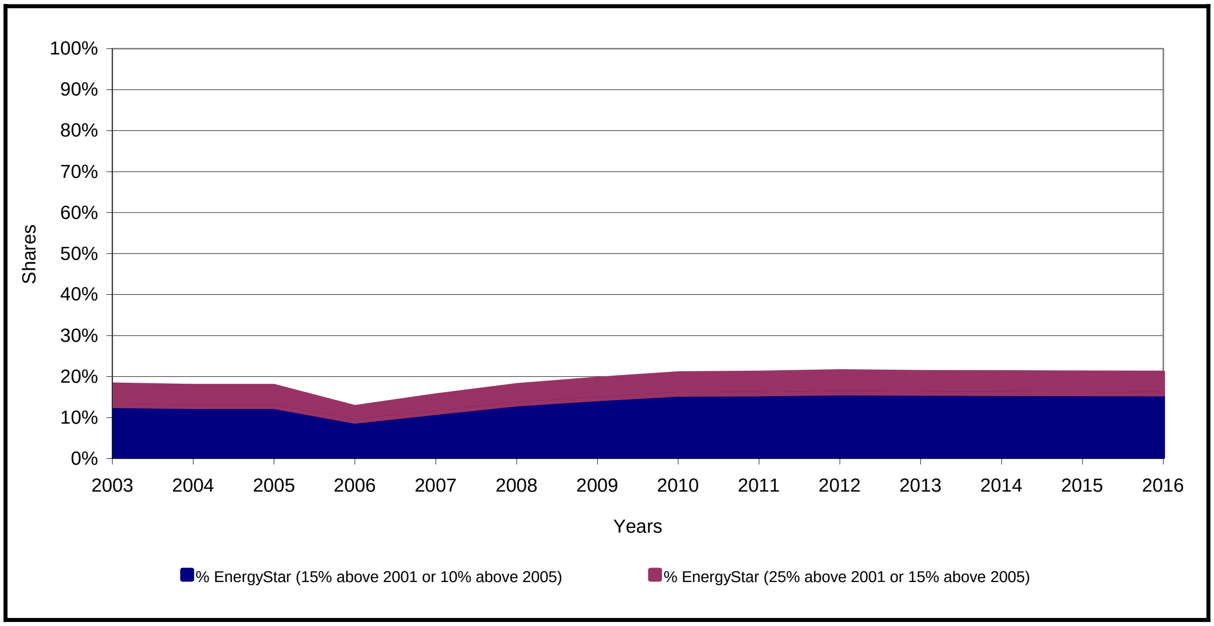
* Refer to Table 8-4 for a description of the market funding scenarios.

8.4 Shares

Figure 8-22 and Figure 8-23 illustrate the estimated shares of high efficiency homes in California using current funding levels and full cost incentives,[8] respectively. As previously mentioned, the Potential Study used the 2004 IOU accomplishments whereas the most recent accomplishments available for the California ENERGY STAR New Homes Program were for 2003. As can be seen, the share of high efficiency homes is higher under the full incremental cost scenario than the current rebate levels. Figure 8-24 and Figure 8-25 present the estimated shares of high efficiency single family and multifamily homes, respectively.

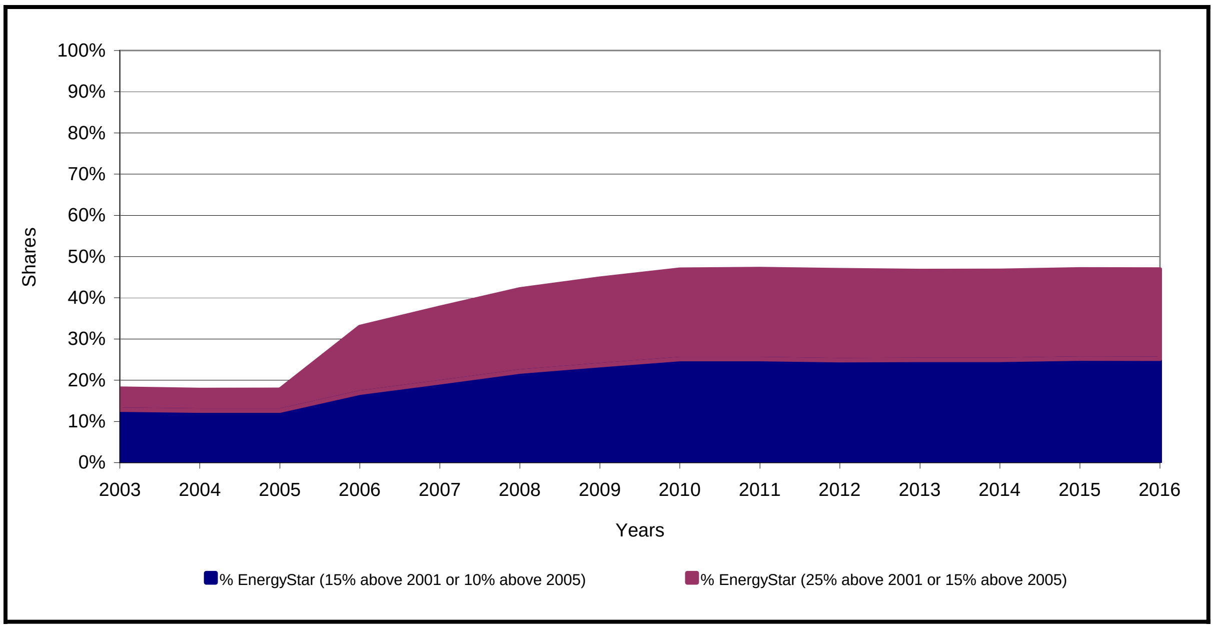
8 The incentives used in the full-cost scenario run do not equal the Incremental Measure Cost. Instead, the weighted average of the incremental costs (by IOU, Inland vs. Coastal, and building type) were used as the full incentive.

Figure 8-22: Statewide Shares – Current Funding Level



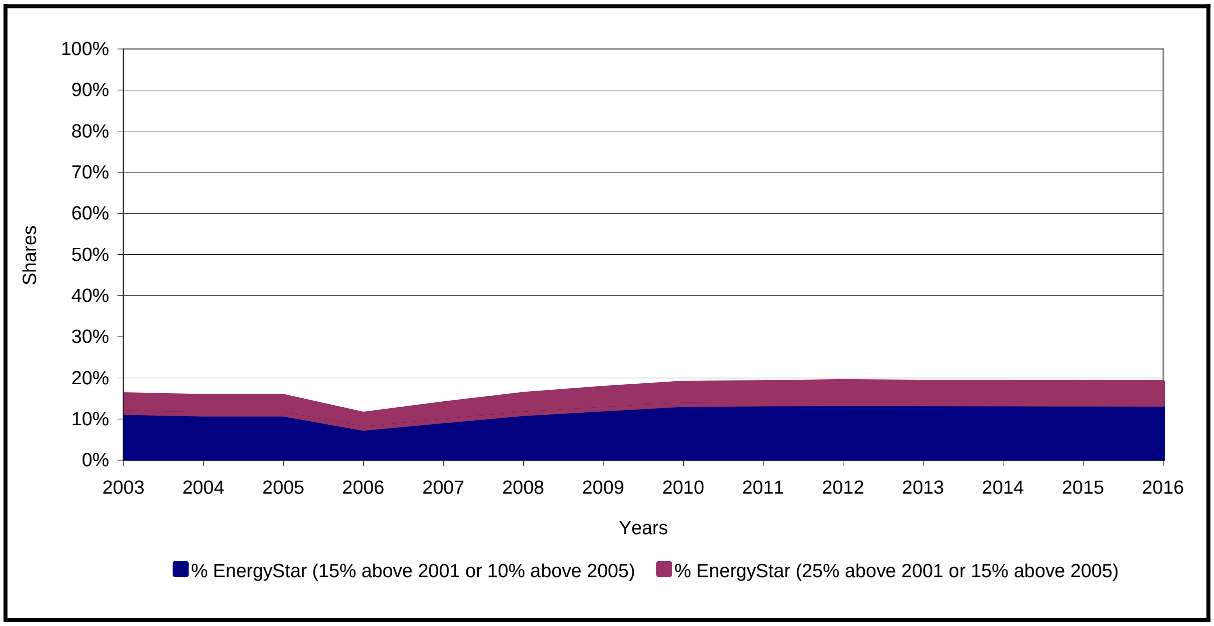
* Refer to Table 8-4 for a description of the market funding scenarios.

Figure 8-23: Statewide Shares – Full-Cost Incentives



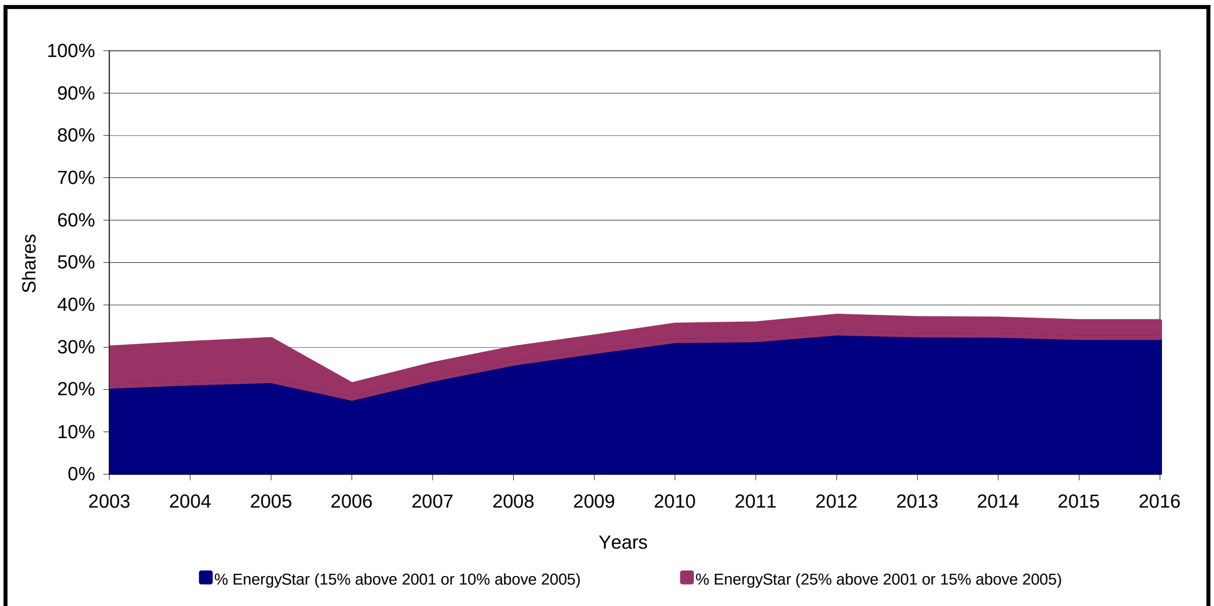
* Refer to Table 8-4 for a description of the market funding scenarios.

Figure 8-24: Statewide Single Family Shares – Current Funding Level



* Refer to Table 8-4 for a description of the market funding scenarios.

Figure 8-25: Statewide Multifamily Shares – Current Funding Level



* Refer to Table 8-4 for a description of the market funding scenarios.

8.5 Residential New Construction Cost and Benefit Results

Table 8-21 presents the statewide specific new construction costs and benefits. Neither funding level results in cost-effective programs based on the TRC test, with benefit-cost ratios of 0.87 and 0.72.[9] However, residential new construction programs are likely to have a high degree of spillover. The residential new construction programs have educated builders about energy efficiency in general and have introduced them to a wide variety of new and upcoming energy efficiency measures. The increased demand for these high efficiency measures has sometimes helped market transformation and has helped to drive new Title 24 Standards.

Table 8-21: Summary of Residential New Construction Market Potential Costs and Benefits – 2003-2016

Item	Current	Full
Gross Program Costs	$35,617,315	$68,309,977
Net Measure Costs	$154,233,963	$387,349,983
Gross Incentives	$157,157,772	$614,041,014
Net Avoided cost benefit	$165,773,055	$330,151,204
Program TRC	**0.87**	**0.72**

* Refer to Table 8-4 for a description of the market funding scenarios.

Residential New Construction Cost and Benefit Results by Building Type

Table 8-22 presents the costs, savings, and TRC ratios for each of the two market potential funding scenarios disaggregated by building type. As shown, the TRC results are higher for single family homes than for multifamily buildings. This is primarily because, on average, the baseline multifamily buildings are even more efficient relative to the Standards than single family homes.[10]

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9 For this analysis, the avoided cost was derived from *A Forecast of Cost-Effectiveness Avoided Costs and Externality Adders* by Energy and Environmental Economics, Inc., January 2004. If the avoided costs have increased significantly since the costs were determined, the residential new construction program might be cost effective at the current and full market funding level.

10 The average $ compliance margin for single family homes is 14% (2003 Baseline Study) and 22% for multifamily buildings (2001 Baseline Study). See Itron, Inc. *Residential New Construction Baseline Study – 2001*. Prepared for Pacific Gas and Electric. September 2002.

Table 8-22: Summary of Residential New Construction Market Potential Results by Building Type – 2003-2016

Item	SF - Current	SF - Full	MF - Current	MF - Full
Program Costs	$26,756,820	$49,833,247	$8,860,496	$18,476,731
Net Measure Costs	$132,549,582	$299,649,419	$21,684,380	$87,700,564
Gross Incentives	$132,396,597	$460,647,520	$24,761,174	$153,393,494
Avoided cost benefit	$143,572,071	$279,128,789	$22,200,984	$51,022,416
Program TRC	**0.90**	**0.80**	**0.73**	**0.48**

* Refer to Table 8-4 for a description of the market funding scenarios.

Cost and Benefit Results by IOU

Cost and benefit results by IOU and region (coastal versus inland) are presented in Table 8-23, Table 8-24, and Figure 8-15. As shown, in southern California (SDG&E, SCE, and SoCalGas), the TRC results for the coastal region are relatively poor—0.68 and 0.63, respectively. There are two reasons for these low TRC results. First, nonparticipant homes built along the south coast (CEC Climate Zones 6-7) are already energy efficient (the average compliance margin under the 2001 Standards is 16%, which means, on average, they meet the threshold required to be a California ENERGY STAR New Home). Second, the 2005 Standards did not affect the south coast as much as the more extreme climates of California.

Table 8-23: Summary of PG&E Residential New Construction Market Potential Costs and Benefits – 2003-2016

Item	Coastal - Current	Coastal - Full	Inland - Current	Inland - Full
Gross Program Costs	$2,294,155	$5,190,707	$16,190,591	$33,612,568
Net Measure Costs	$5,143,711	$19,752,076	$83,802,369	$207,917,560
Gross Incentives	$5,380,341	$32,602,450	$76,450,448	$318,225,399
Net Avoided cost benefit	$5,065,939	$15,470,620	$92,063,126	$189,342,848
Program TRC	**0.68**	**0.62**	**0.92**	**0.78**

* Refer to Table 8-4 for a description of the market funding scenarios.

Table 8-24: Summary of SCE/SoCalGas Residential New Construction Market Potential Cost and Benefits – 2003-2016

Item	Coastal - Current	Coastal - Full	Inland - Current	Inland - Full
Gross Program Costs	$903,332	$1,389,090	$13,218,838	$23,475,995
Net Measure Costs	$4,486,724	$9,155,125	$42,906,187	$111,014,935
Gross Incentives	$4,772,956	$19,206,218	$50,389,584	$177,396,659
Net Avoided cost benefit	$2,074,255	$3,599,818	$51,247,499	$96,755,082
Program TRC	0.38	0.34	0.91	0.72

* Refer to Table 8-4 for a description of the market funding scenarios.

Table 8-25: Summary of SDG&E Residential New Construction Market Potential Cost and Benefits – 2003-2016

Item	Coastal - Current	Coastal - Full	Inland - Current	Inland - Full
Gross Program Costs	$1,614,348	$2,665,241	$1,396,052	$1,976,376
Net Measure Costs	$10,763,772	$23,122,467	$7,131,200	$16,387,820
Gross Incentives	$12,479,474	$42,989,346	$7,684,968	$23,620,942
Net Avoided cost benefit	$6,492,963	$11,698,542	$8,829,273	$13,284,295
Program TRC	0.52	0.45	1.04	0.72

* Refer to Table 8-4 for a description of the market funding scenarios.

8.6 Summary of Key Results

The technical potential for new construction electric energy efficiency at the current incentive level was found to be 1,099 GWh over a 14-year period and estimated economic potential was found to equal 635 GWh. Of the IOUs, the SCE service area had the highest technical potential, and PG&E had the highest economic potential. The market potential for new construction was estimated to be 147 GWh at the current incentive level, and increasing incentives to cover the full resulted in saving an additional 109 GWh (total 255 GWh).

The technical potential for new construction demand reduction at the current incentive level was found to be 948 MW over a 14-year period, and estimated economic potential was found to equal 533 MW. Of the IOUs, PG&E had both the highest technical and economic potential. The estimated market potential for new construction was 142 MW at the current incentive level, and increasing incentives to cover the full resulted in saving an additional 112 MW (total 254 MW).

The technical potential for new construction gas efficiency at the current incentive level was estimated at 190 million therms over a 14-year period, and the estimated economic potential was equal to 78 million therms. Of the IOUs, PG&E had both the highest technical and economic potential. The market potential for new construction was estimated to be 18 million therms at the current incentive level, and increasing incentives to cover the full resulted in saving an additional 26 million therms (total 44 million therms).

TRC results for the new construction program under the two funding scenarios showed that neither of the incentive scenarios was cost-effective. Specifically, the current incentive program scenario resulted in a benefit-cost ratio of 0.87, while the full-cost incentive program scored 0.72.

9

California Commercial New Construction Energy Efficiency Potential

Under separate contract, Architectural Energy Corporation (AEC) and Itron jointly developed the estimates of commercial new construction energy efficiency potential. AEC developed many of the inputs including incremental costs, energy savings, time-of-use energy usage inputs and calibration shares. Their methodology can be found in Appendix P. This section presents the estimates of commercial new construction energy efficiency potential resulting from the joint analysis. Estimated technical, economic, and market potential are presented for the period 2003 through 2016. Market potential was estimated for two program incentive funding levels: 1) the current utility program incentive level and 2) program incentives covering full incremental costs. All results reflect the current year's savings from cumulative adoptions over the period through 2016. Incremental savings can be found in the detailed results spreadsheets in Appendix J.

9.1 Overview

Energy efficiency potential for commercial new construction was estimated by building type and by climate zone. The approach used was similar to the one used for estimating potential in existing commercial buildings (the Potential Study), however, there are several important differences. The differences include using packages of measures versus individual measures, the development of incremental costs, the development of energy savings, the number of building types, the number of scenarios, and the calibration year. Each of these is described in further detail below.

In addition to these differences, please refer to Appendix P for a summary of the methodology on how the prototypes and the costs and savings were developed.

Packages of Measures

The objectives of the New Construction Potential Study included finding the saving potential for commercial buildings that would approximate the building of energy efficient buildings under the existing Standards (reaching 15 and 25% above the 2001 codes) and under the new Standards (reaching 10 and 15% above the 2005 codes) by Title 24 climate zone. Instead of estimating potential for the individual measures, it was necessary to develop packages of measures that could be added to the baseline building to allow it to reach of the efficiency levels listed in Table 9-1.

Table 9-1: Measure Bundle Efficiency Levels

Scenario	Description	2003-2005 Level of Efficiency	2006-2013 Level of Efficiency
1	Code level	2001 Code	2005 Code
2	Base activity level	2001 Code + 15%	2005 Code + 10%
3	High activity level	2001 Code + 25%	2005 Code + 15%

Incremental Costs

Sources for the incremental measure costs used in the New Construction Potential Study included the 2005 DEER Measure Cost Study,[1] the R.S. Means "Costworks" construction cost estimating database, and construction cost estimates obtained directly from distributors and contractors. These individual measure costs were then aggregated to develop the package costs.

Energy Savings

The incremental measure savings used in the Potential Study were also obtained from DEER. However, since individual measure savings are not additive and the measure savings may not be equivalent when added to a new commercial building as opposed to an existing commercial building, the savings for the packages of measures were developed using DOE-2.1E simulations. In addition to the interactive effects of measures on building energy savings, the effects of the packages of measures on HVAC system size were calculated from the DOE-2.1 simulations.

Building Types

The Commercial New Construction Potential Study developed cost and savings estimates and estimated potential for 11 commercial building types: colleges, grocery stores, health care buildings, lodging, large office buildings, retail, restaurants, schools, small office buildings, warehouses, and miscellaneous commercial buildings.

Scenarios

The Potential Study used three scenarios (current, average scenario, and full).The New Construction Potential Study used only two (current and full). Please note that for cases

[1] Itron, Inc. 2004-2005 Database for Energy Efficiency Resources (DEER) Update Study: Final Report. Prepared for Southern California Edison. December 2005.

where the incremental cost was found to be less than the current incentive, the current incentive was used as the *Full Incentive*.

Calibration Year

While the analysis conducted for existing commercial buildings used the 2004 IOU accomplishments, the most recent accomplishments available for the California Savings by Design Program were for 2003. Please note that all of the graphs and tables in this section differ from the rest of the report.

9.2 Potential for Commercial New Construction Electric Energy Efficiency

Technical and Economic Potential

<u>Total Commercial New Construction Technical and Economic Potential</u>

Figure 9-1 and Figure 9-2 present the total estimated energy and demand savings potential for new construction resulting from the analysis for the three state investor-owned electric utilities: Pacific Gas & Electric (PG&E), Southern California Edison (SCE), and San Diego Gas & Electric (SDG&E). As Figure 9-1 shows, total estimated electric technical potential for energy savings is 4,553 GWh, and total estimated electric economic potential is 4,093 GWh. Figure 9-2 shows total estimated technical potential for demand reduction to be 961 MW, and total estimated economic potential for demand reduction to be 879 MW.

Figure 9-1: Total IOU Commercial New Construction Energy Savings – Technical and Economic Potential – 2003-2016

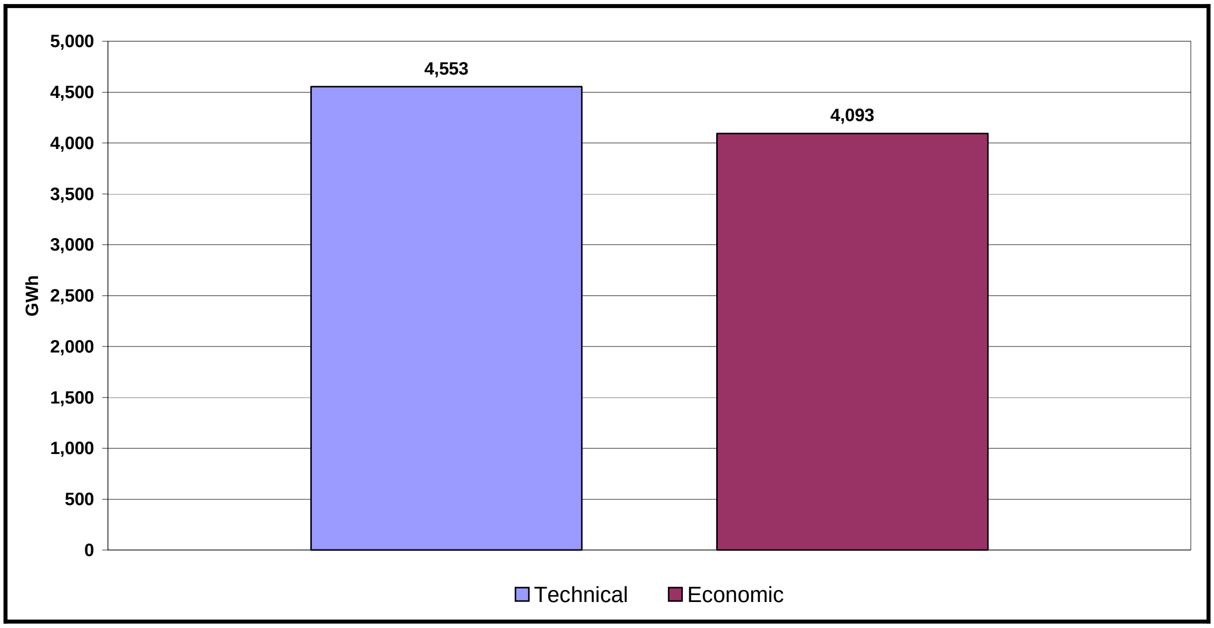
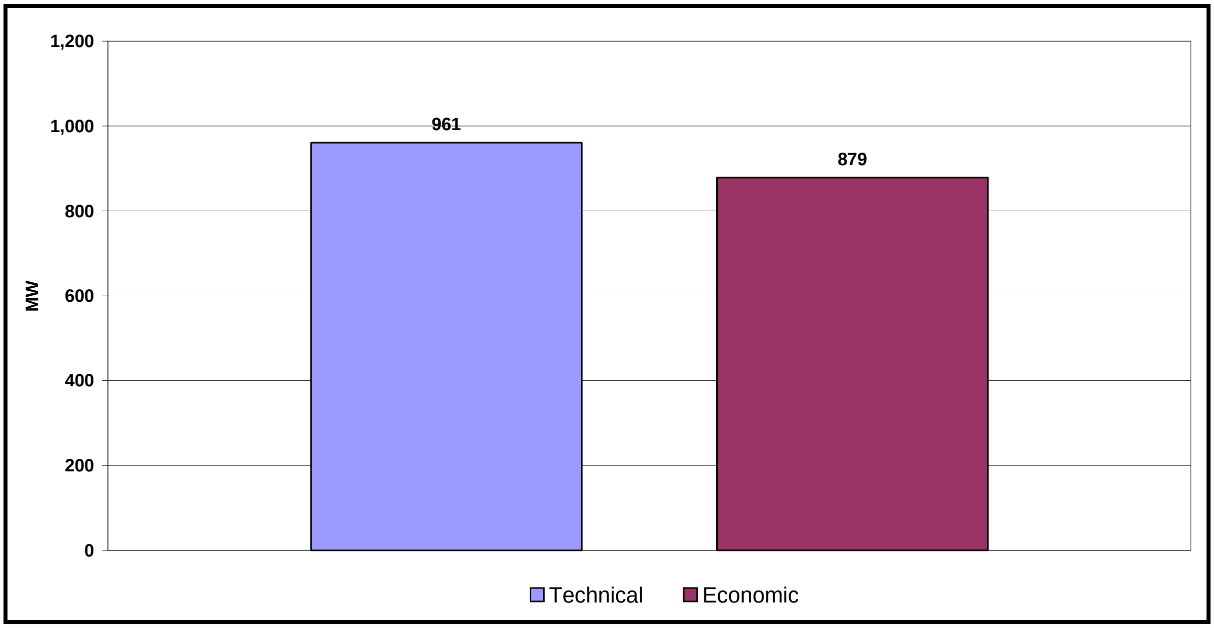


Figure 9-2: Total IOU Commercial New Construction Demand Savings – Technical and Economic Potential – 2003-2016



The energy and demand savings potential results, disaggregated by utility service area, are presented in Figure 9-3 and Figure 9-4.

Figure 9-3: Estimated Commercial New Construction Technical and Economic Energy Potential by Utility – 2003-2016

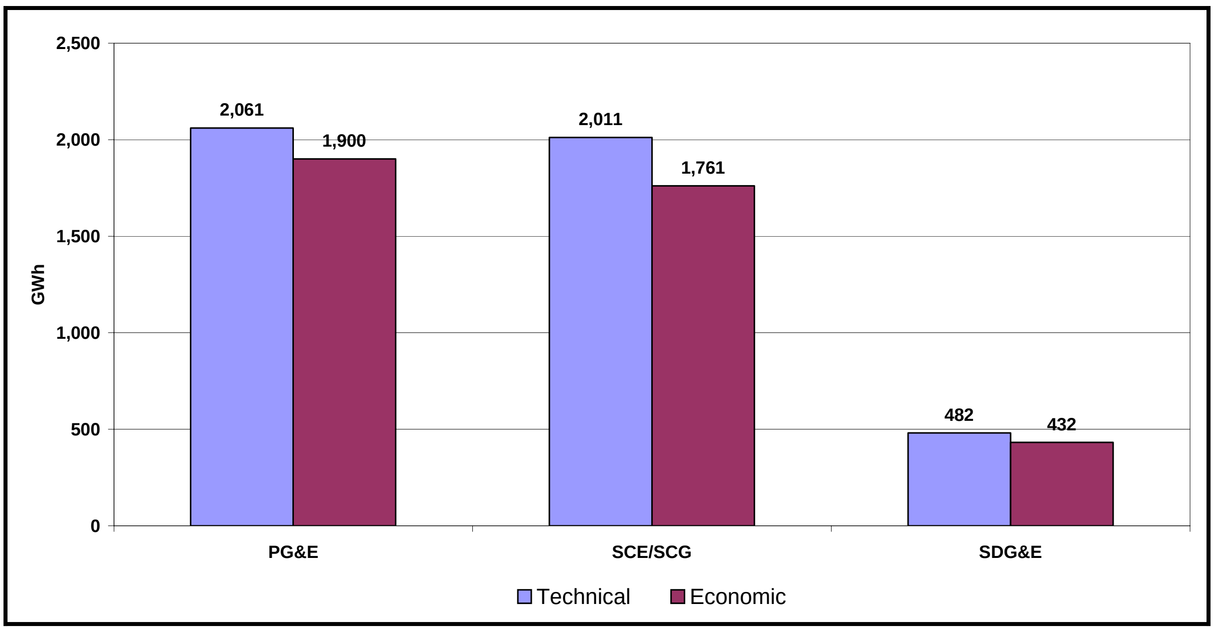
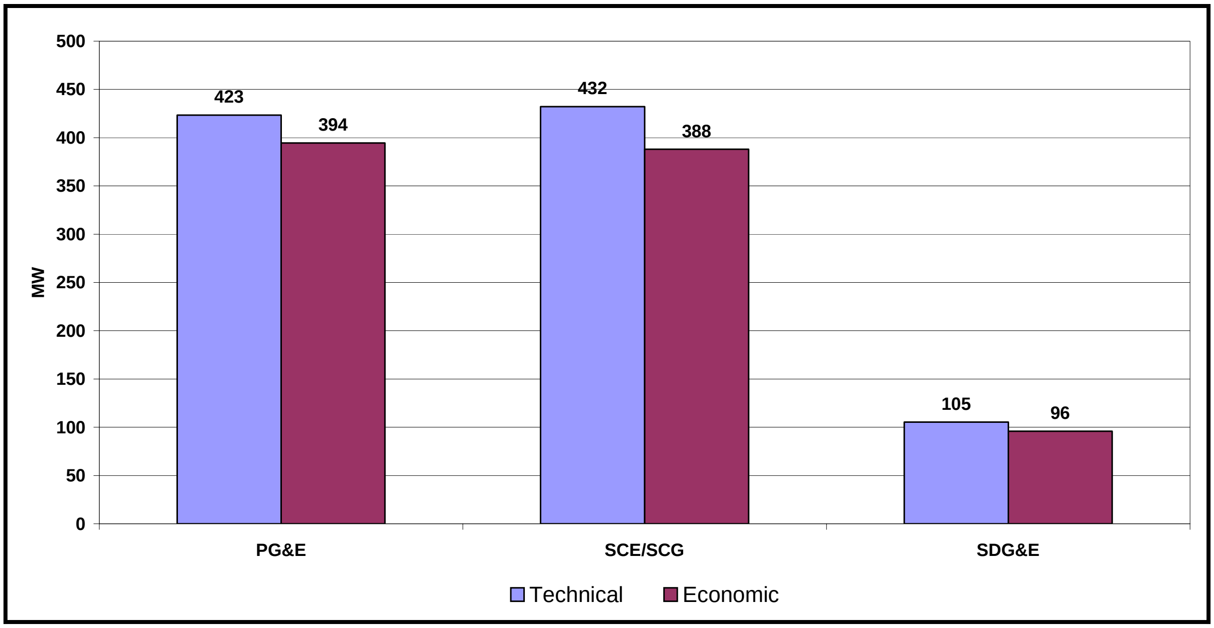


Figure 9-4: Estimated Commercial New Construction Technical and Economic Demand Potential by Utility – 2003-2016



Commercial New Construction Technical and Economic Potential by Building Type

Table 9-2 summarizes the technical potential results for 2016 by building type and by utility. As shown, the largest contributors to energy and demand savings are grocery stores.

Table 9-2: Commercial New Construction Technical Potential by Building Type and Utility – 2003-2016

Building Type	PG&E		SCE		SDG&E		Total	
	GWh	MW	GWh	MW	GWh	MW	GWh	MW
College	101	28	45	15	17	6	**163**	**49**
Grocery Stores	437	60	424	59	78	11	**939**	**129**
Health Care	62	17	123	31	39	8	**224**	**56**
Lodging	195	28	120	16	40	6	**355**	**50**
Large Office	222	69	297	99	48	16	**567**	**183**
Misc.	332	70	210	40	45	8	**587**	**117**
Retail	308	61	300	58	72	14	**679**	**133**
Restaurant	153	25	229	39	40	7	**421**	**72**
Schools	63	22	71	20	16	4	**150**	**47**
Small Office	96	28	144	46	80	24	**321**	**97**
Warehouse	93	15	48	10	6	1	**146**	**26**
Total	**2,061**	**423**	**2,011**	**432**	**482**	**105**	**4,553**	**961**

Table 9-3 summarizes the economic potential results by building type and by utility. As shown, the largest contributors to energy savings and demand savings are also grocery stores.

Table 9-3: Commercial New Construction Economic Potential by Building Type and Utility – 2003-2016

Building Type	PG&E		SCE		SDG&E		Total	
	GWh	MW	GWh	MW	GWh	MW	GWh	MW
College	101	28	45	15	17	6	163	49
Grocery Stores	437	60	424	59	78	11	939	129
Health Care	62	17	123	31	39	8	224	56
Lodging	195	28	114	15	33	4	342	48
Large Office	222	69	297	99	48	16	567	183
Misc.	332	70	210	40	45	8	587	117
Retail	308	61	300	58	72	14	679	133
Restaurant	17	3	0	0	2	0	19	3
Schools	48	17	69	20	16	4	133	42
Small Office	96	28	144	46	80	24	321	97
Warehouse	83	13	34	6	2	0	119	20
Total	1,900	394	1,761	388	432	96	4,093	879

Figure 9-5 and Figure 9-6 illustrate the above results. As shown, for most building types, economic potential equals technical potential. For these building types, each package of measures that enable the building to reach the various levels above Standards (i.e., 15% and 25% above 2001 Standards and 10% and 15% above 2005 Standards) are cost-effective in every CEC climate zone. On the other hand, this is not the case for restaurants, where economic potential in restaurants makes up less than 5% of the technical potential. As explained in Appendix P, this is because high efficiency electric measures alone did not allow restaurants to reach the designated levels. Therefore, several high efficiency gas measures were needed which are typically less cost-effective.

Figure 9-5: Total IOU Commercial New Construction Technical and Economic Energy Potential by Building Type – 2003-2016

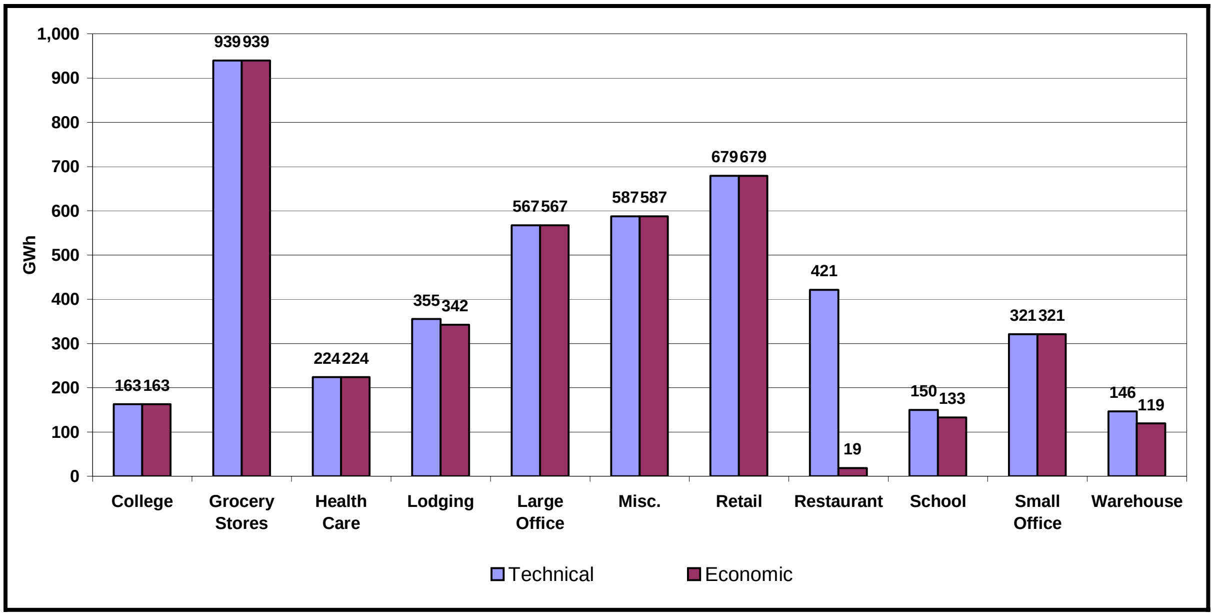
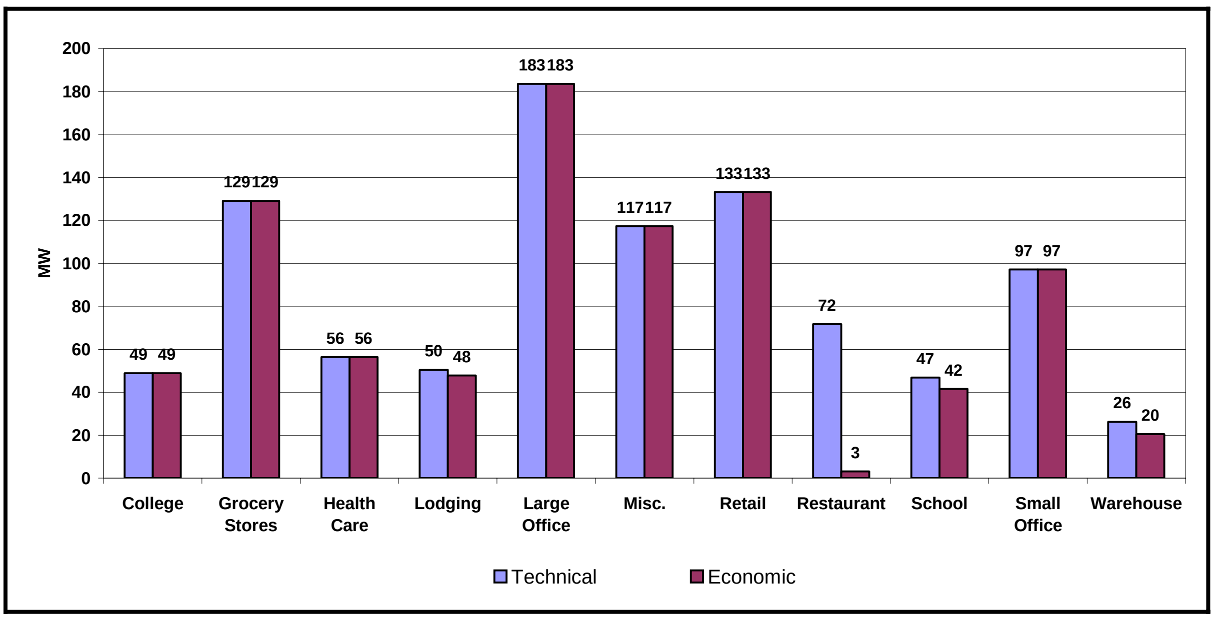


Figure 9-6: Total IOU Commercial New Construction Technical and Economic Demand Potential by Building Type – 2003-2016



Commercial New Construction Market Potential for Energy Efficiency

In this subsection, the results for electric potential in newly constructed commercial buildings are further analyzed under two program incentive scenarios. Results were derived for the current 2004-2005 energy efficiency program incentive funding level and for a full incremental cost incentive funding level. Table 9-4 describes the commercial market scenarios for new buildings.

Table 9-4: Market Scenario Descriptions for Existing Commercial Buildings

Market Scenario Name	Description
Current	2004 incentive level. Due to changes to the Title 24 Standards changes in 2006, the incentive level changes in 2006.
Full	Full incremental measure cost was used as the incentive.

Total Commercial New Construction Market Potential

In this subsection, the above results for electric technical and economic potential are further analyzed under two program incentive scenarios. As previously mentioned, results were derived for the current 2004-2005 California Savings by Design Program incentive funding level, and for a full incremental cost incentive funding level.

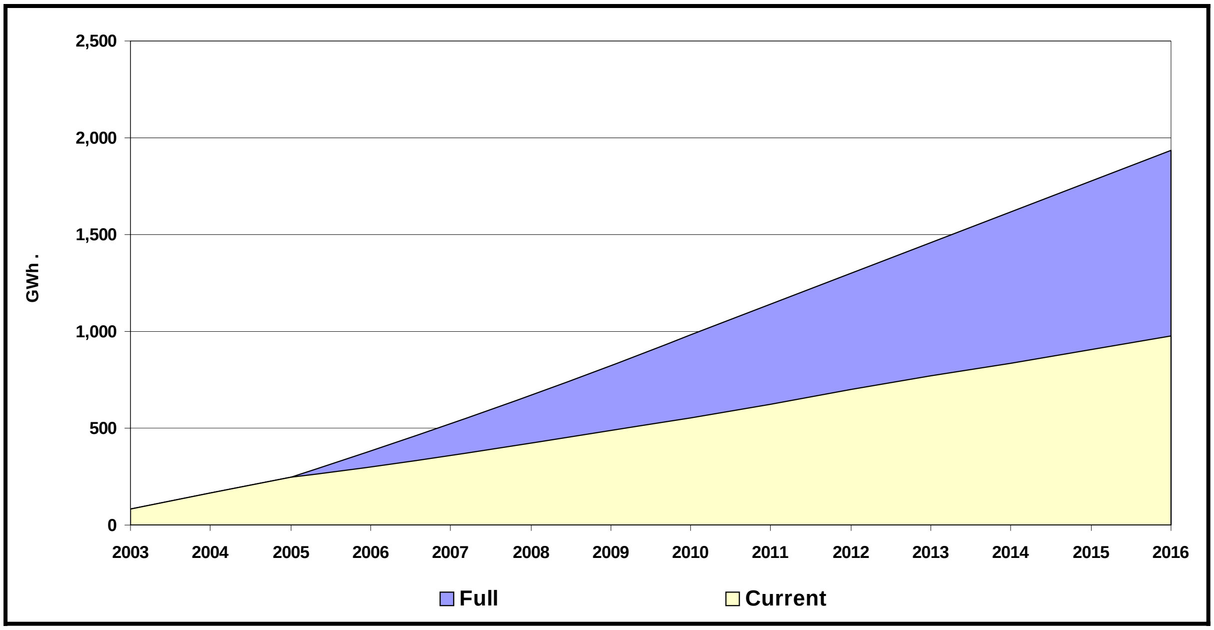
As Table 9-5 shows, total IOU market potential under the current funding scenario is 978 GWh energy savings and 215 MW demand savings. When program incentives are further increased to cover full incremental costs, energy and demand savings more than doubled to 1,938 GWh and 436 MW, respectively. Figure 9-7 and Figure 9-8 illustrate these results.

Table 9-5: Estimated Commercial New Construction Market Potential by Funding Level – 2003-2016

Funding Level	Energy (GWh)	Demand (MW)
Current	978	215
Full Cost	1,938	436

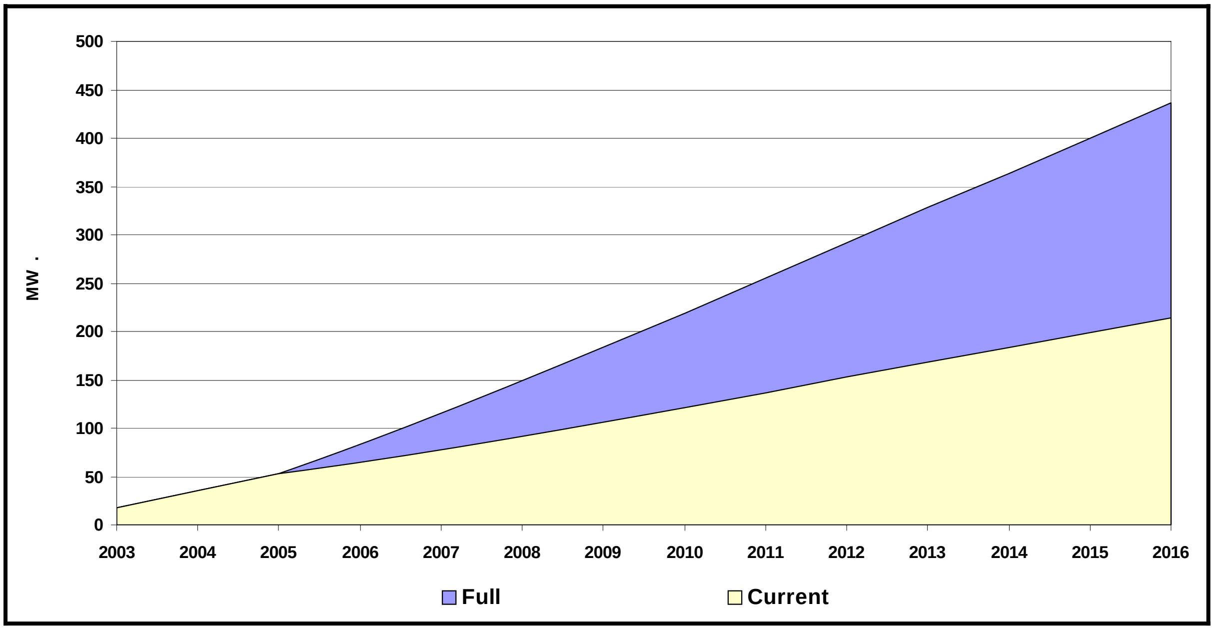
* Refer to Table 9-4 for a description of the market funding scenarios.

Figure 9-7: Estimated Commercial New Construction Energy Market Potential by Funding Level



* Refer to Table 9-4 for a description of the market funding scenarios.

Figure 9-8: Estimated Commercial New Construction Demand Market Potential by Funding Level



* Refer to Table 9-4 for a description of the market funding scenarios.

In these figures, the difference in the 2004 and 2005 results for current and full funding levels is because, in some climate zones, the current rebate level is higher that the incremental cost of the high efficiency measure packages.

Commercial New Construction Market Potential by Building Type

Table 9-6 summarizes the new construction energy market potential estimates by funding level and building type. For comparison, technical and economic estimates are also included. Table 9-7 presents similar results for peak demand reduction. As shown, if the IOUs continue with current incentive levels, they are estimated to save 978 GWh from the commercial new construction program in 2016. Increasing incentives to full incremental costs is estimated to more than double the savings to 1,938 GWh.

As shown, for most building types, potential savings estimated under the current incentives average 24% of economic potential. For restaurants, however, potential savings estimated under the current incentives is over 500% of economic potential. This shows that some restaurants participate in the current program even though it may not be cost-effective to do so. Therefore, it follows that if the incentives were increased to cover the full incremental cost, potential savings would increase even higher over the economic potential; savings under the full cost scenario is nearly 1500% above economic potential.

Table 9-6: Estimated Commercial New Construction Energy Market Potential by Funding Level and Building Type – 2003-2016

Building Type	Technical Potential (GWh)	Economic Potential (GWh)	Current		Full Cost	
			GWh	% of Econ. Pot.	GWh	% of Econ. Pot.
College	163	163	31	19%	52	32%
Grocery Stores	939	939	181	19%	268	29%
Health Care	224	224	44	20%	87	39%
Lodging	355	342	54	16%	79	23%
Large Office	567	567	180	32%	322	57%
Misc.	587	587	118	20%	256	44%
Retail	679	679	157	23%	310	46%
Restaurant	421	19	98	530%	272	1466%
Schools	150	133	19	14%	88	66%
Small Office	321	321	87	27%	178	56%
Warehouse	146	119	9	7%	25	21%
Total	**4,553**	**4,093**	**978**	**24%**	**1,938**	**47%**

* Refer to Table 9-4 for a description of the market funding scenarios.

Table 9-7: Estimated Commercial New Construction Demand Market Potential by Funding Level and Building Type – 2003-2016

Building Type	Technical Potential (MW)	Economic Potential (MW)	Current		Full Cost	
			MW	% of Econ. Pot.	MW	% of Econ. Pot.
College	49	49	9	18%	16	32%
Grocery Stores	129	129	25	19%	37	29%
Health Care	56	56	12	21%	23	41%
Lodging	50	48	8	17%	12	25%
Large Office	183	183	58	32%	104	57%
Misc.	117	117	23	20%	51	43%
Retail	133	133	30	23%	60	45%
Restaurant	72	3	16	514%	46	1465%
Schools	47	42	6	14%	27	65%
Small Office	97	97	26	27%	55	56%
Warehouse	26	20	2	8%	5	25%
Total	961	879	215	24%	436	50%

* Refer to Table 9-4 for a description of the market funding scenarios.

Utility-Level Commercial New Construction Potential

This subsection presents the technical, economic, and market potential of new construction over time at the utility level.

Table 9-8, Figure 9-10 graphically displays SCE's commercial new construction energy savings potential.

Table 9-9, and Table 9-10 present the potential new construction energy savings for PG&E, SCE, and SDG&E, respectively, and Figure 9-9, Figure 9-10 graphically displays SCE's commercial new construction energy savings potential.

Table 9-9, and Figure 9-11 illustrate these data in graphical form. The potential new construction demand savings for the utilities are presented in Table 9-11, Table 9-12, and Table 9-13, with Figure 9-12, Figure 9-13, and Figure 9-14 providing graphical representations of these data. These tables and figures help illustrate the new construction energy efficiency potential achieved by each utility in 2003 and the potential for future growth in new construction energy efficiency savings under an alternative market scenario.

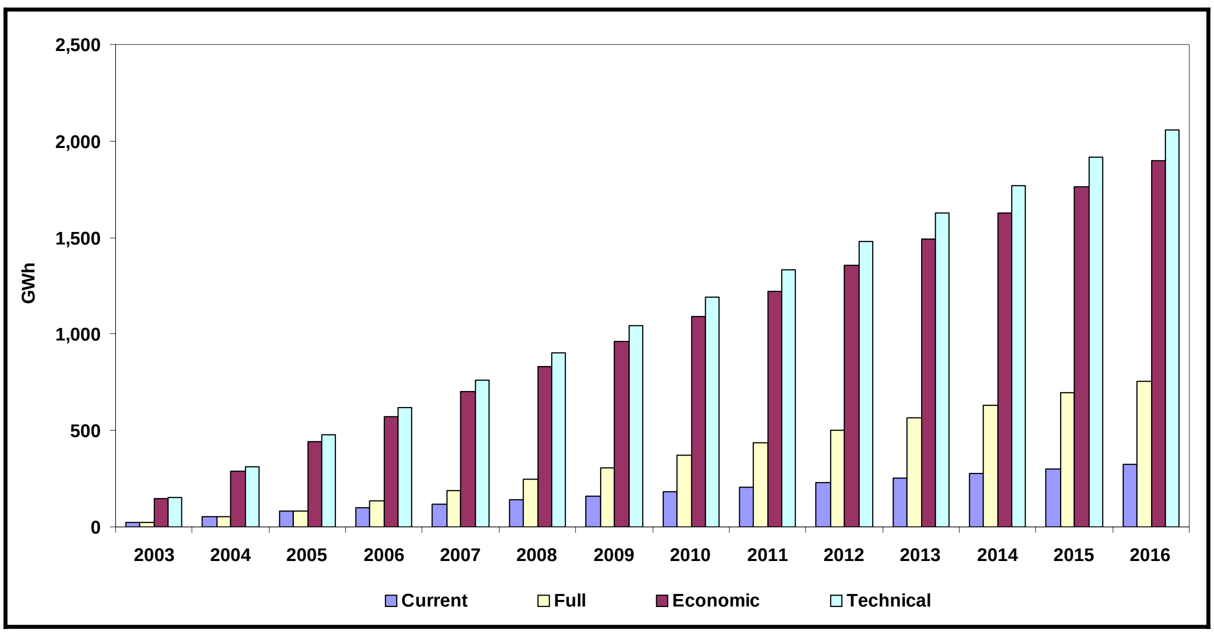
Given the definitions of economic and technical potential, the technical potential illustrated for each utility in 2003 does not illustrate the level of technical potential each utility achieved. The technical potential illustrates what the utility could achieve if they could force all commercial builders who could adopt the measure to adopt the measure.

Table 9-8 shows PG&E's new construction energy efficiency potential under both market forecasts. PG&E's new construction market potential at current incentive levels is approximately 326 GWh. Increasing incentives to the full level increases potential savings to approximately 757 GWh, a 132% increase. Figure 9-9 illustrates this data.

Table 9-8: Estimated PG&E Commercial New Construction Gross Technical, Economic, and Market Energy Potential – 2003-2016 (GWh)

Total	Technical	Economic	Full	Current
2003	155	145	26	26
2004	313	292	53	53
2005	477	444	80	80
2006	617	571	133	99
2007	760	701	190	119
2008	905	832	249	140
2009	1,046	960	309	162
2010	1,189	1,090	372	185
2011	1,333	1,221	436	208
2012	1,479	1,354	501	232
2013	1,627	1,491	566	256
2014	1,771	1,626	630	279
2015	1,916	1,762	693	302
2016	2,061	1,900	757	326

Figure 9-9: Estimated PG&E Commercial New Construction Gross Technical, Economic, and Market Energy Potential – 2003-2016



* Refer to Table 9-4 for a description of the market funding scenarios.

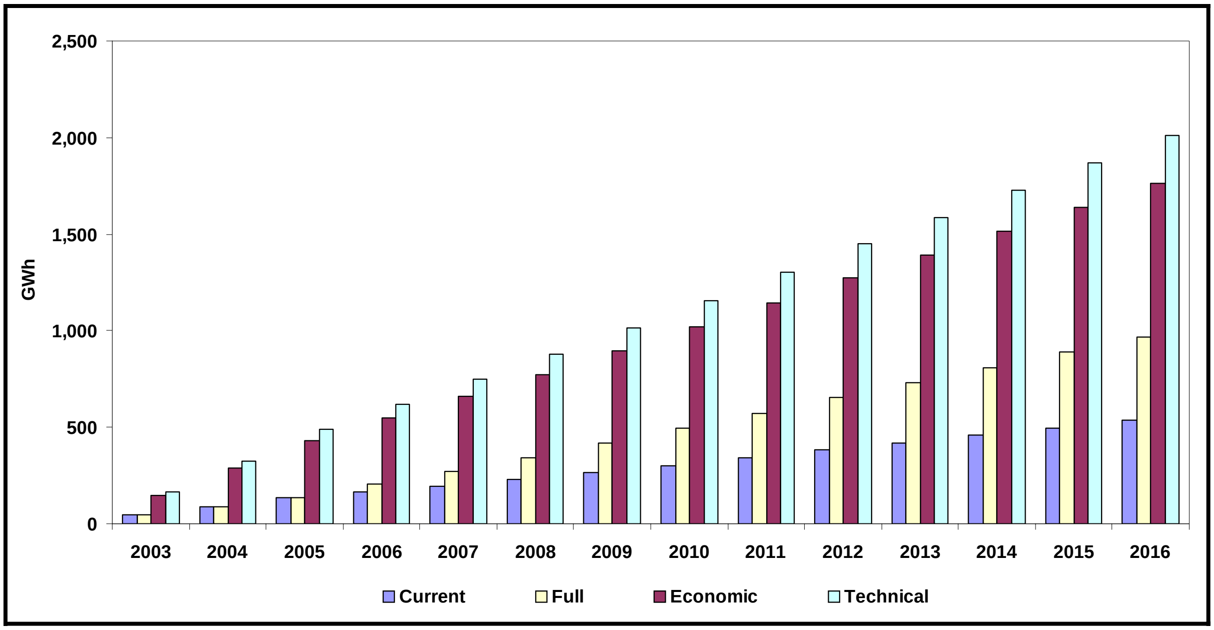
Figure 9-10 graphically displays SCE's commercial new construction energy savings potential.

Table 9-9 shows that SCE's new construction energy efficiency potential under both market forecasts is larger than the forecasts for either PG&E or SDG&E. SCE's new construction market potential, in 2016, is approximately 537 GWh under the current incentive levels. Increasing incentives to the full level raises potential savings to 967 GWh. Figure 9-10 graphically displays SCE's commercial new construction energy savings potential.

Table 9-9: Estimated SCE Commercial New Construction Gross Technical, Economic, and Market Energy Potential – 2003-2016 (GWh)

Total	Technical	Economic	Full	Current
2003	163	145	45	45
2004	324	288	90	90
2005	487	433	136	136
2006	620	549	203	166
2007	748	661	271	196
2008	880	775	342	229
2009	1,017	894	417	265
2010	1,158	1,018	495	303
2011	1,302	1,143	574	343
2012	1,450	1,272	656	383
2013	1,588	1,392	732	421
2014	1,728	1,514	810	459
2015	1,869	1,637	888	498
2016	2,011	1,761	967	537

Figure 9-10: Estimated SCE Commercial New Construction Gross Technical, Economic, and Market Energy Potential – 2003-2016



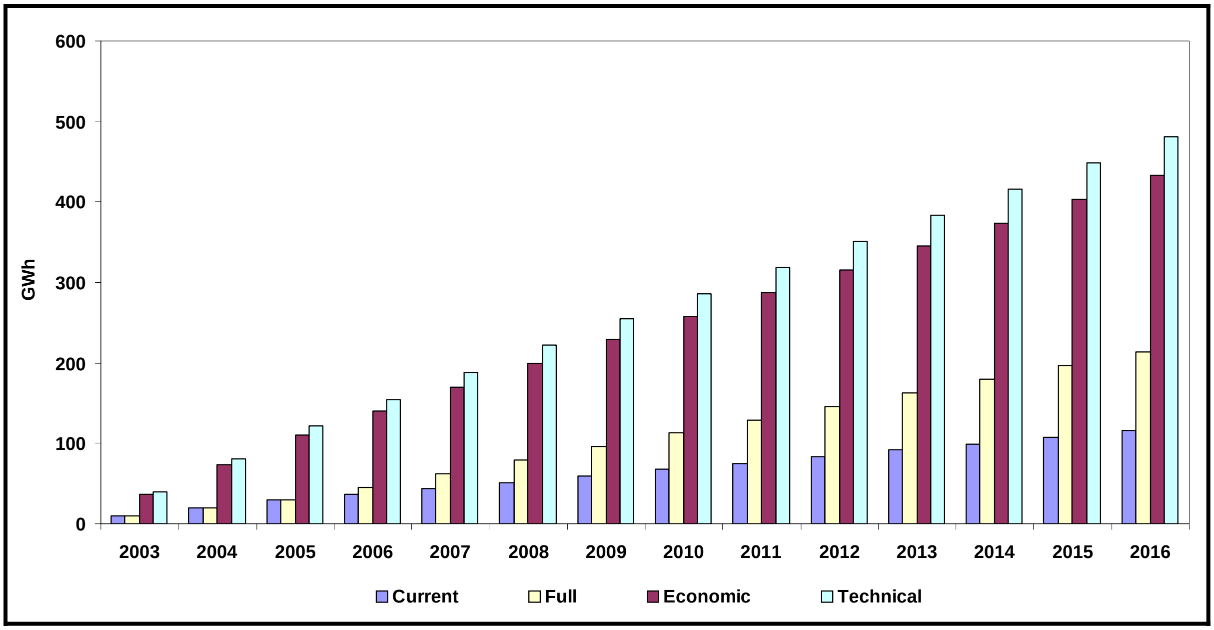
* Refer to Table 9-4 for a description of the market funding scenarios.

Table 9-10 shows SDG&E's new construction energy efficiency potential under both market forecasts. SDG&E's new construction market potential at current incentive levels is 115 GWh. Increasing incentives to the full level increases potential savings to approximately 214 GWh, an 85% increase. Figure 9-11 illustrates these data.

Table 9-10: Estimated SDG&E Commercial New Construction Gross Technical, Economic, and Market Energy Potential – 2003-2016 (GWh)

Total	Technical	Economic	Full	Current
2003	40	36	10	10
2004	81	74	20	20
2005	121	110	30	30
2006	155	140	46	37
2007	188	170	62	44
2008	222	200	79	52
2009	254	229	96	59
2010	286	258	113	67
2011	319	287	129	75
2012	351	316	146	83
2013	384	345	163	91
2014	417	374	180	99
2015	449	403	197	107
2016	482	432	214	115

Figure 9-11: Estimated SDG&E Commercial New Construction Gross Technical, Economic, and Market Energy Potential – 2003-2016



* Refer to Table 9-4 for a description of the market funding scenarios.

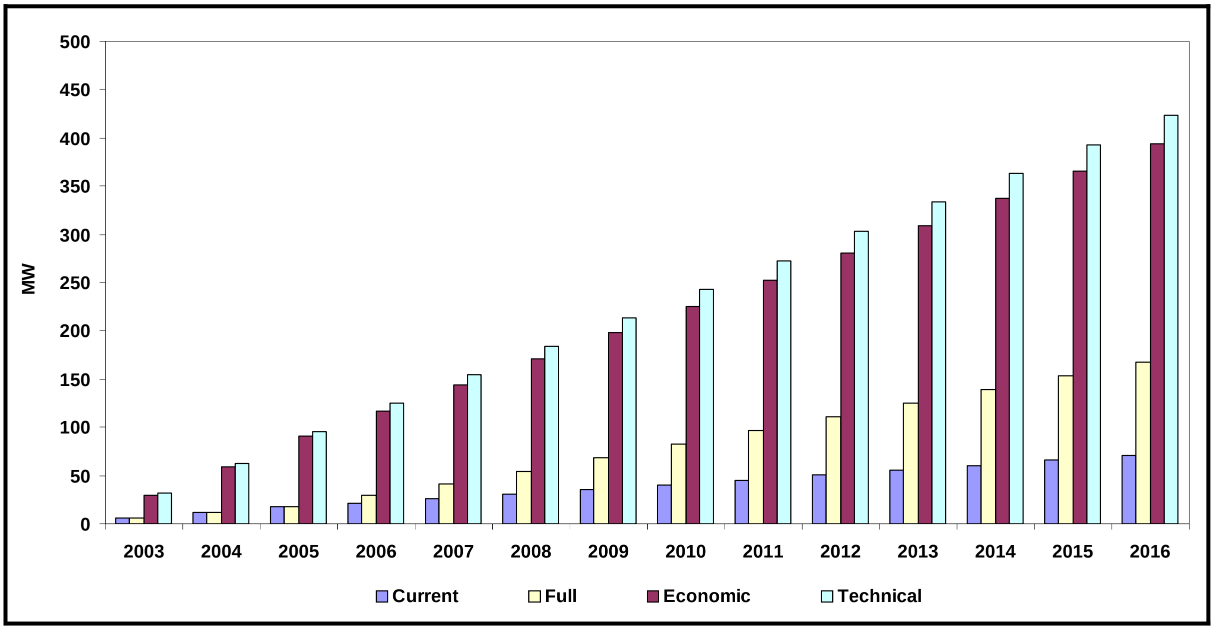
Table 9-11 provides PG&E's potential new construction demand savings under the two incentive levels. PG&E's forecasted demand savings in 2016, under current incentive levels is approximately 71 MW. Raising incentives to full incremental measure costs further increases the demand savings to 167 MW.

Table 9-11: Estimated PG&E Gross Commercial New Construction Technical, Economic, and Market Demand Potential – 2003-2016 (MW)

Total	Technical	Economic	Full	Current
2003	31	30	6	6
2004	63	59	11	11
2005	96	90	17	17
2006	125	117	29	21
2007	154	144	42	26
2008	184	171	55	30
2009	213	198	68	35
2010	243	225	82	40
2011	273	252	96	45
2012	303	280	111	50
2013	333	309	125	55
2014	363	337	139	61
2015	393	366	153	66
2016	423	394	167	71

Figure 9-12 shows a graph of PG&E's estimated commercial energy demand savings presented above in Table 9-11.

Figure 9-12: Estimated PG&E Gross Commercial New Construction Technical, Economic, and Market Demand Potential – 2003-2016



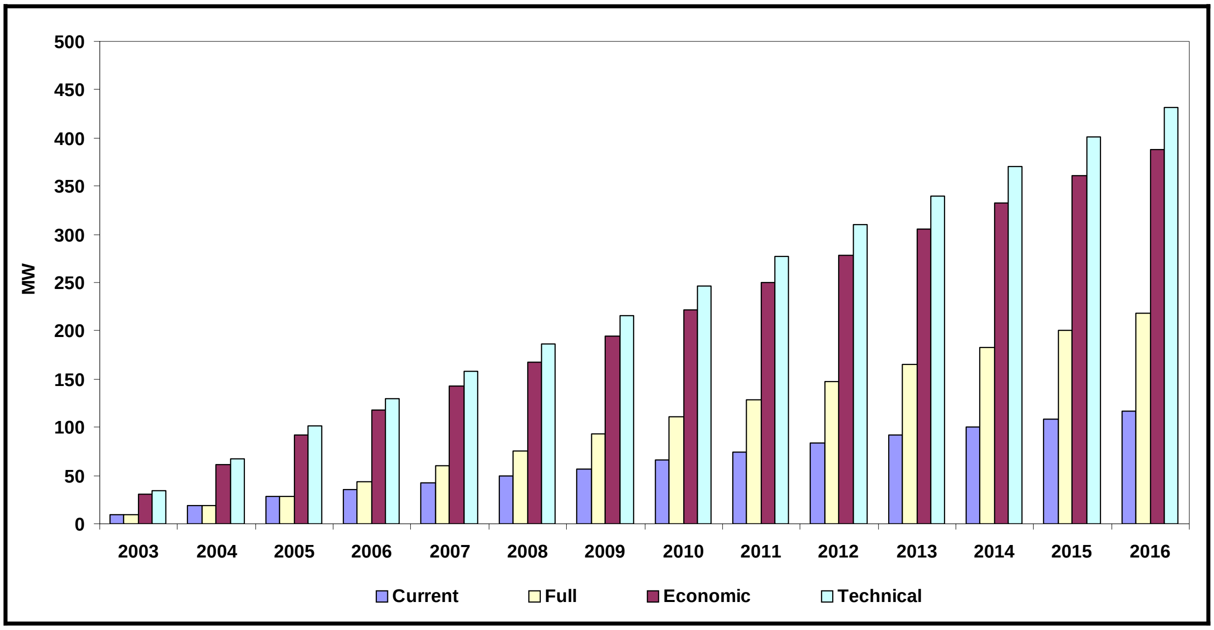
* Refer to Table 9-4 for a description of the market funding scenarios.

Table 9-12 presents the potential new construction demand savings for SCE. Under current incentives, SCE's new construction potential demand savings in 2016 is approximately 117 MW. Increasing incentives to the full level increases the forecast of demand savings to 218 MW. Figure 9-13 depicts these data.

Table 9-12: Estimated SCE Gross Commercial New Construction Technical, Economic, and Market Demand Potential – 2003-2016 (MW)

Total	Technical	Economic	Full	Current
2003	34	31	10	10
2004	68	61	19	19
2005	101	92	29	29
2006	130	118	44	35
2007	158	142	60	42
2008	186	168	76	49
2009	216	194	93	57
2010	247	222	111	66
2011	278	250	129	74
2012	310	278	147	83
2013	340	306	165	92
2014	370	333	183	100
2015	401	360	200	109
2016	432	388	218	117

Figure 9-13: Estimated SCE Gross Commercial New Construction Technical, Economic, and Market Demand Potential – 2003-2016



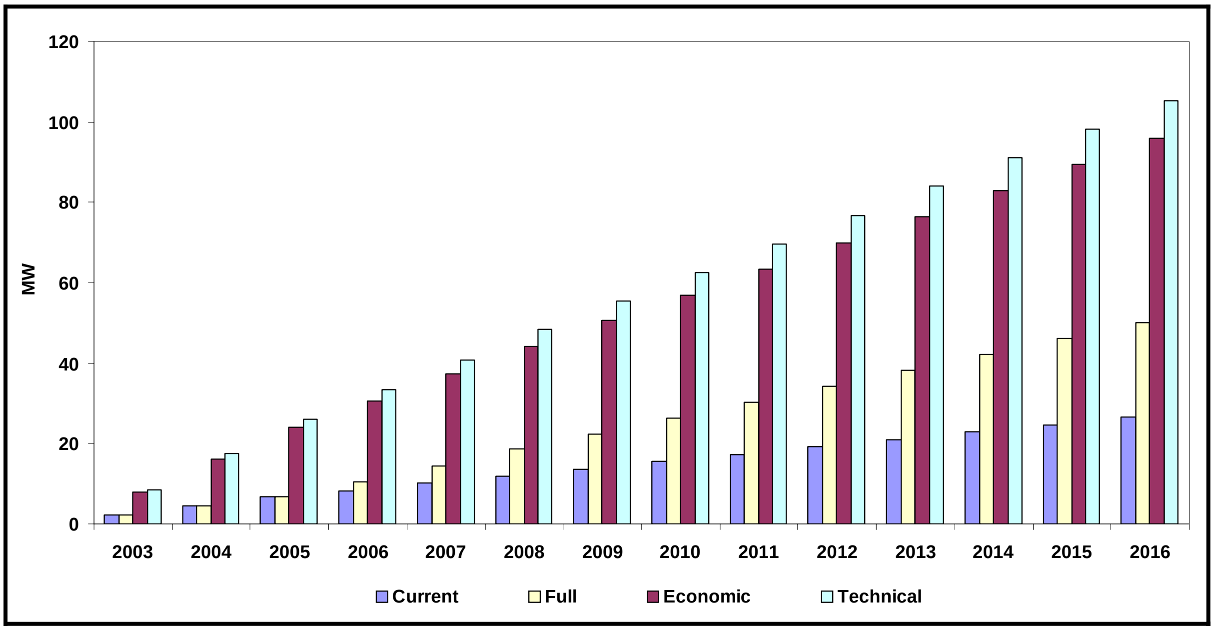
* Refer to Table 9-4 for a description of the market funding scenarios.

Table 9-13 illustrates SDG&E's potential demand savings associated with the two market forecasts. Under current incentive levels, SDG&E is forecast to save 27 MW in 2016. Raising incentives to full incremental measure costs increases the forecast of demand savings to 50 MW. Figure 9-14 graphically displays the data from Table 9-13.

Table 9-13: Estimated SDG&E Gross Commercial New Construction Technical, Economic, and Market Demand Potential (MW)

Total	Technical	Economic	Full	Current
2003	9	8	2	2
2004	17	16	5	5
2005	26	24	7	7
2006	33	31	11	8
2007	41	37	15	10
2008	48	44	19	12
2009	55	51	22	14
2010	63	57	26	15
2011	70	64	30	17
2012	77	70	34	19
2013	84	77	38	21
2014	91	83	42	23
2015	98	90	46	25
2016	105	96	50	27

Figure 9-14: Estimated SDG&E Gross Commercial New Construction Technical, Economic, and Market Demand Potential



* Refer to Table 9-4 for a description of the market funding scenarios.

9.3 Commercial New Construction Potential for Gas Energy Efficiency

This section presents the potential gas savings for commercial new construction. When developing the packages of measures, cost-effective measures were added first and then less cost-effective measures were added by building type and region until each building reached the various levels above the Standards. Since the Standards are fuel neutral and electric measures are generally more cost-effective than gas measures, the packages assembled for many building types did not include many, if any, gas measures.

Technical and Economic Gas Potential

Total Commercial New Construction Technical and Economic Potential

Figure 9-15 presents the total estimated new construction gas potential resulting from the analysis for the three state investor owned gas utilities of PG&E, SDG&E, and Southern California Gas (SoCalGas). The values are provided for 2016, the last year of the analysis.

As shown, total estimated technical potential is 65.7 million therms. Total estimated economic potential is 35.5 million therms.

Figure 9-15: Estimated Commercial New Construction Gas Technical and Economic Potential – 2003-2016

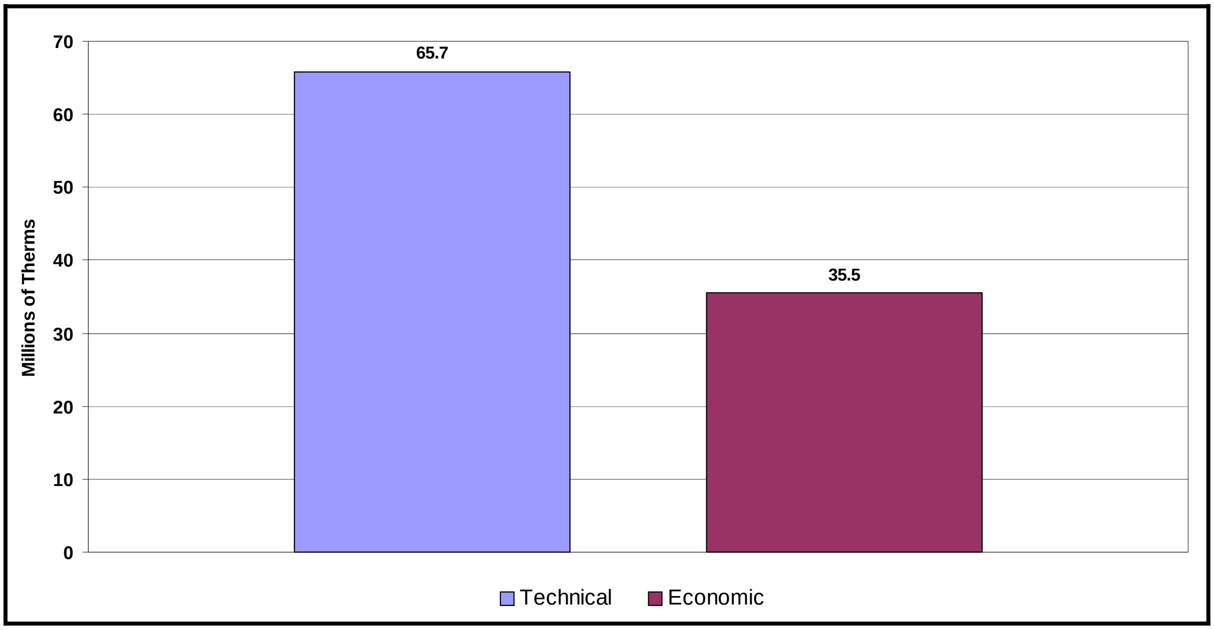
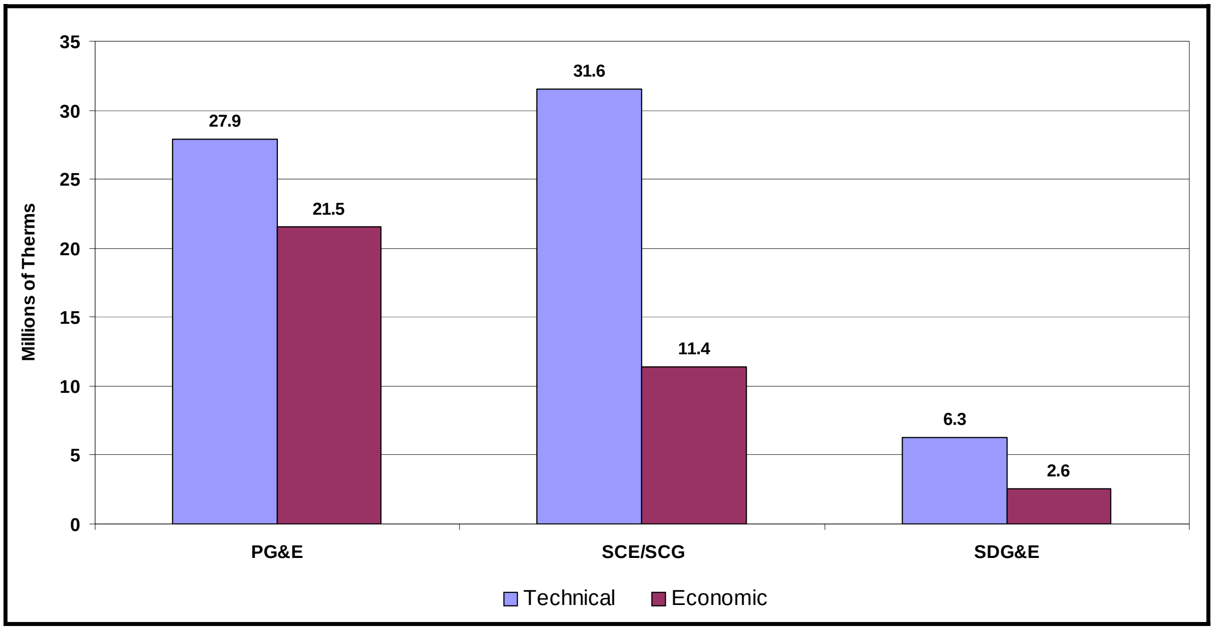


Figure 9-16 presents the technical and economic potential forecasts by utility service area. This figure illustrates that technical potential is highest for the SoCalGas service area at 31.6 million therms and that economic potential is highest for PG&E at 21.5 million therms. For SoCalGas, economic potential is approximately one-third of technical potential, whereas for PG&E it is three-fourths. This is primarily because the technical potential for restaurants in the SoCalGas territory, none of which is economic, makes up approximately two-thirds of its total technical potential. On the other hand, the technical potential for restaurants makes up only one-fourth of its total technical potential.

Figure 9-16: Estimated Commercial New Construction Gas Technical and Economic Potential by Utility – 2003-2016



Commercial New Construction Technical and Economic Potential by Building Type

Table 9-14 summarizes the technical potential results by building type and by utility. As shown, the largest contributors to new construction gas savings in all IOU service areas are restaurants.

Table 9-14: Technical Commercial New Construction Potential by Building Type and Utility (millions of therms) – 2003-2016

Building Type	PG&E	SoCalGas	SDG&E	Total
College	2.1	0.6	0.2	**2.9**
Grocery Stores	-0.1	-0.4	0.0	**-0.5**
Health Care	1.0	0.7	0.2	**2.0**
Lodging	3.9	0.4	0.0	**4.4**
Large Office	3.5	3.6	0.8	**7.9**
Misc.	6.4	4.4	0.8	**11.6**
Retail	1.5	0.9	0.2	**2.7**
Restaurant	6.7	20.1	3.7	**30.6**
Schools	0.3	0.3	0.1	**0.6**
Small Office	1.4	0.5	0.2	**2.0**
Warehouse	1.1	0.4	0.0	**1.5**
Total	**27.9**	**31.6**	**6.3**	**65.7**

Estimates of new construction gas energy savings for all IOUs are presented by building type in Figure 9-17.

Figure 9-17: Estimated Commercial New Construction Gas Potential by Building Type – 2003-2016

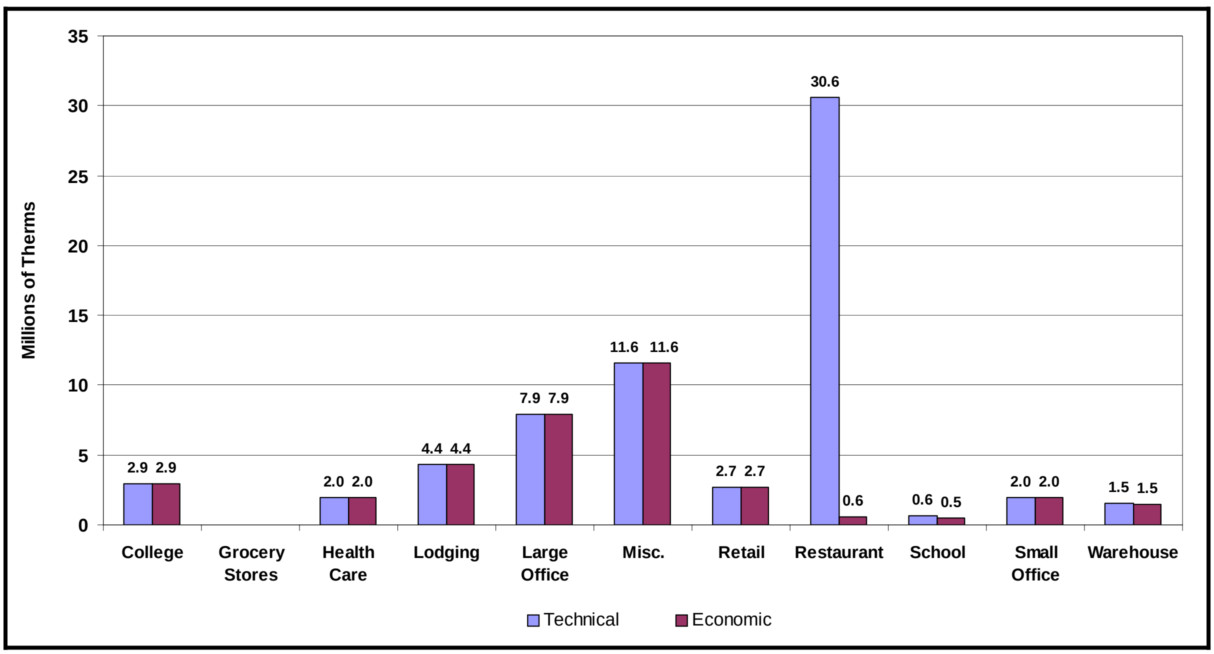


Table 9-15 summarizes the economic potential results by building type and by utility. As shown, the utility service area with the greatest economic potential is PG&E.

Table 9-15: Commercial New Construction Economic Potential by Building Type and Utility – 2003-2016 (millions of therms)

Building Type	PG&E	SoCalGas	SDG&E	Total
College	2.1	0.6	0.2	**2.9**
Grocery Stores	-0.1	-0.4	0.0	**-0.5**
Health Care	1.0	0.7	0.2	**2.0**
Lodging	3.9	0.4	0.0	**4.4**
Large Office	3.5	3.6	0.8	**7.9**
Misc.	6.4	4.4	0.8	**11.6**
Retail	1.5	0.9	0.2	**2.7**
Restaurant	0.5	0.0	0.0	**0.6**
Schools	0.1	0.3	0.1	**0.5**
Small Office	1.4	0.5	0.2	**2.0**
Warehouse	1.1	0.4	0.0	**1.5**
Total	**21.5**	**11.4**	**2.6**	**35.5**

Commercial New Construction Market Potential for Gas Energy Efficiency

Total Commercial New Construction Market Potential

In this subsection, the above results for new construction gas technical and economic potential are further analyzed under two program incentive scenarios.

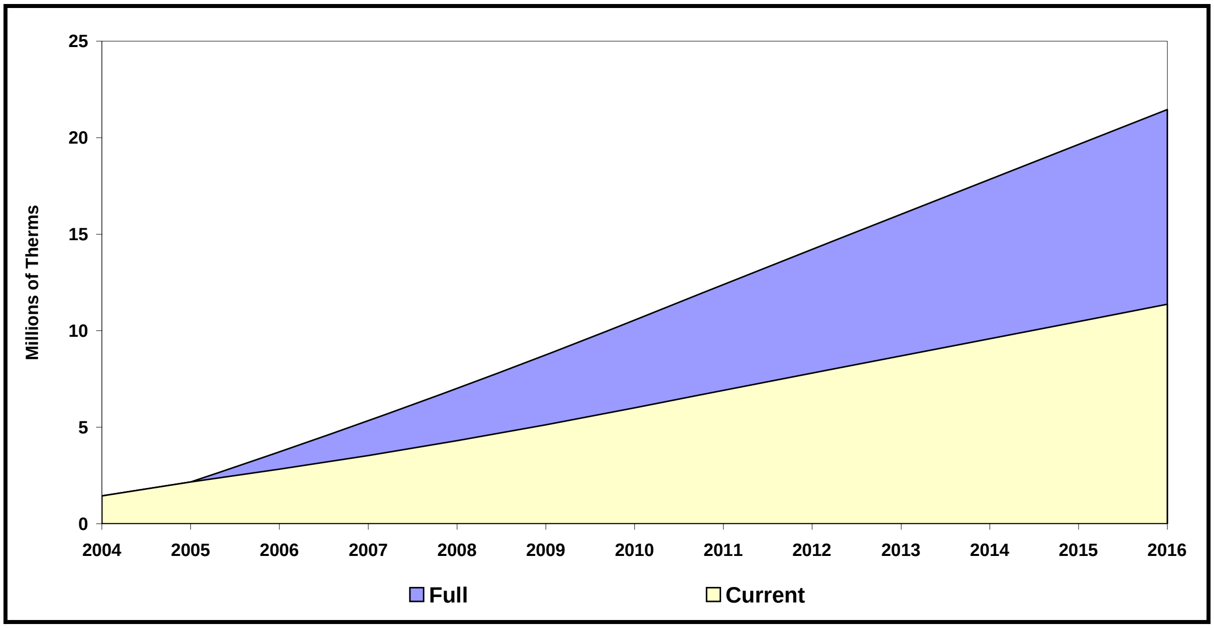
As shown in Table 9-16, total IOU market potential under the current funding scenario is approximately 11 million therms. When program incentives are increased to cover full incremental costs, the savings further increase 85% to approximately 20 million therms. These results are illustrated in Figure 9-18.

Table 9-16: Estimated Commercial New Construction Market Potential by Funding Level – 2003-2016

Funding Level	Millions of Therms
Current	11
Full	20

* Refer to Table 9-4 for a description of the market funding scenarios.

Figure 9-18: Estimated Commercial New Construction Gas Market Potential by Funding Level



* Refer to Table 9-4 for a description of the market funding scenarios.

Commercial New Construction Market Potential by Building Type

Table 9-17 summarizes the market potential estimates by funding level and building type. For comparison, technical and economic estimates are also included.

Table 9-17: Estimated Commercial New Construction Gas Market Potential by Funding Level and Building Type – 2003-2016 (millions of therms)

Building Type	Technical	Economic	Current	Full
College	2.9	2.9	0.6	0.7
Grocery Stores	-0.5	-0.5	-0.6	-1.2
Health Care	2.0	2.0	-0.1	-0.9
Lodging	4.4	4.4	1.1	1.4
Large Office	7.9	7.9	1.0	1.5
Misc.	11.6	11.6	-0.6	-2.6
Retail	2.7	2.7	0.2	-0.6
Restaurant	30.6	0.6	10.1	24.0
Schools	0.6	0.5	-0.1	-0.4
Small Office	2.0	2.0	-0.1	-0.4
Warehouse	1.5	1.5	0.0	-0.1
Total	**65.7**	**35.5**	**11.4**	**21.5**

* Refer to Table 9-4 for a description of the market funding scenarios.

Utility-Level Commercial New Construction Gas Potential

In this subsection, the natural gas new construction technical, economic, and market potential are presented for the years 2003-2016 at the utility level.

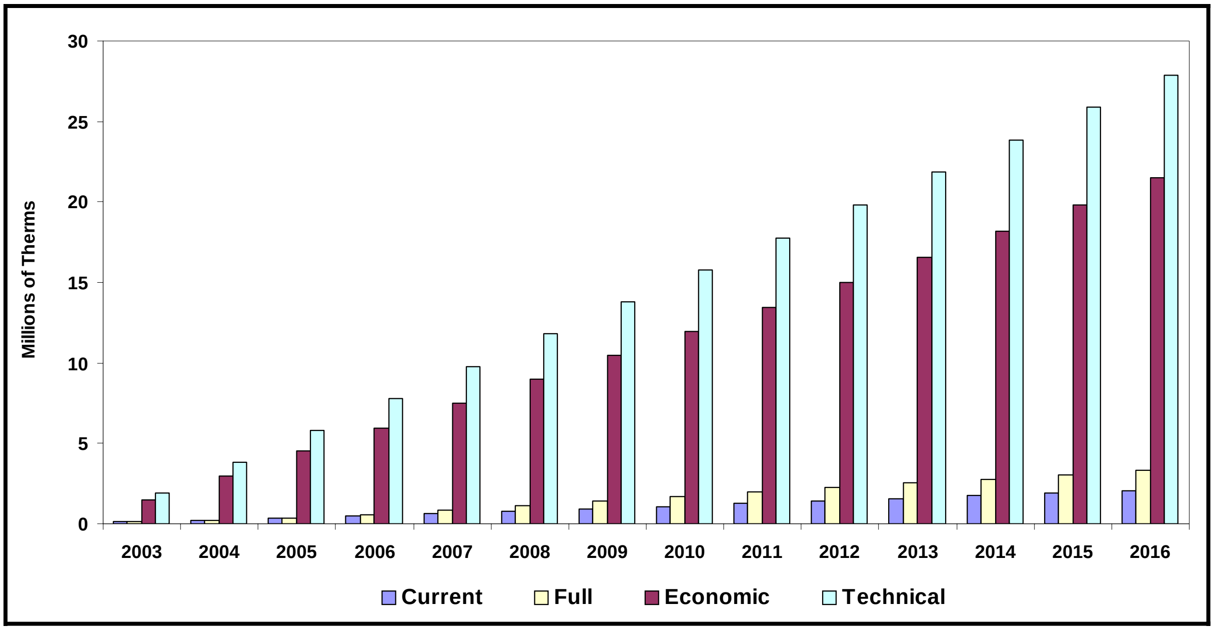
Figure 9-19, Figure 9-20, and Figure 9-21 illustrate the potential natural gas savings for PG&E, SoCalGas, and SDG&E, respectively. These figures help to illustrate the new construction natural gas energy efficiency potential achieved by each utility in 2003 and the potential for future growth in energy efficiency savings under the alternative market scenario.

Table 9-18 illustrates PG&E's technical, economic, and market potential for new construction natural gas savings. The new construction market potential under current incentives is approximately 2.1 million therms. Increasing incentive to full incremental measure costs increases the savings to approximately 3.3 million therms, an increase of 62%. Figure 9-19 presents a graph of the data in Table 9-18.

Table 9-18: Estimated PG&E Gross Commercial New Construction Technical, Economic, and Market Gas Potential – 2003-2016 (millions of therms)

Total	Technical	Economic	Full	Current
2003	2	1	0	0
2004	4	3	0	0
2005	6	4	0	0
2006	8	6	1	0
2007	10	7	1	1
2008	12	9	1	1
2009	14	10	1	1
2010	16	12	2	1
2011	18	13	2	1
2012	20	15	2	1
2013	22	17	3	2
2014	24	18	3	2
2015	26	20	3	2
2016	28	22	3	2

Figure 9-19: Estimated PG&E Gross Commercial New Construction Technical, Economic, and Market Gas Potential



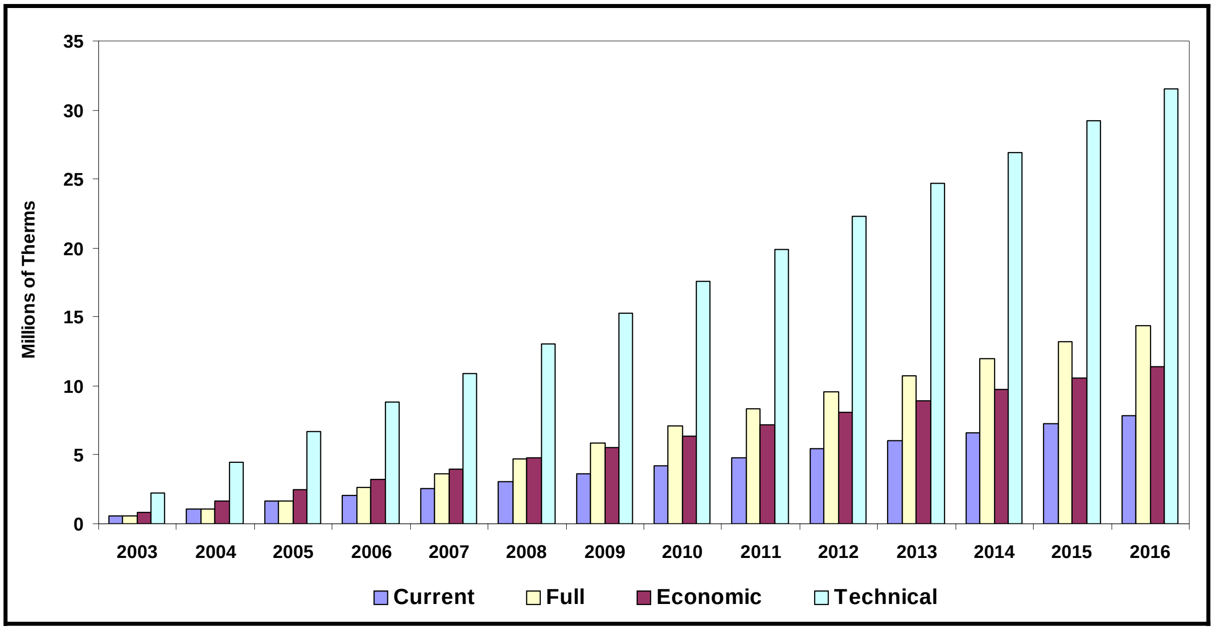
* Refer to Table 9-4 for a description of the market funding scenarios.

Table 9-19 presents the new construction natural gas potential for SoCalGas. A continuation of current incentive levels is expected to lead to a savings of approximately 7.8 million therms in 2016. Increasing incentives to full incremental costs is forecast to increase potential natural gas savings in SoCalGas' service territory to 14.4 million therms. Figure 9-20 displays a graph of SoCalGas' commercial new construction gas savings.

Table 9-19: Estimated SoCalGas Gross Commercial New Construction Technical, Economic, and Market Gas Potential – 2003-2016 (millions of therms)

Total	Technical	Economic	Full	Current
2003	2	1	1	1
2004	4	2	1	1
2005	7	2	2	2
2006	9	3	3	2
2007	11	4	4	3
2008	13	5	5	3
2009	15	6	6	4
2010	18	6	7	4
2011	20	7	8	5
2012	22	8	10	5
2013	25	9	11	6
2014	27	10	12	7
2015	29	11	13	7
2016	32	11	14	8

Figure 9-20: Estimated SoCalGas Gross Commercial New Construction Technical, Economic, and Market Gas Potential



* Refer to Table 9-4 for a description of the market funding scenarios.

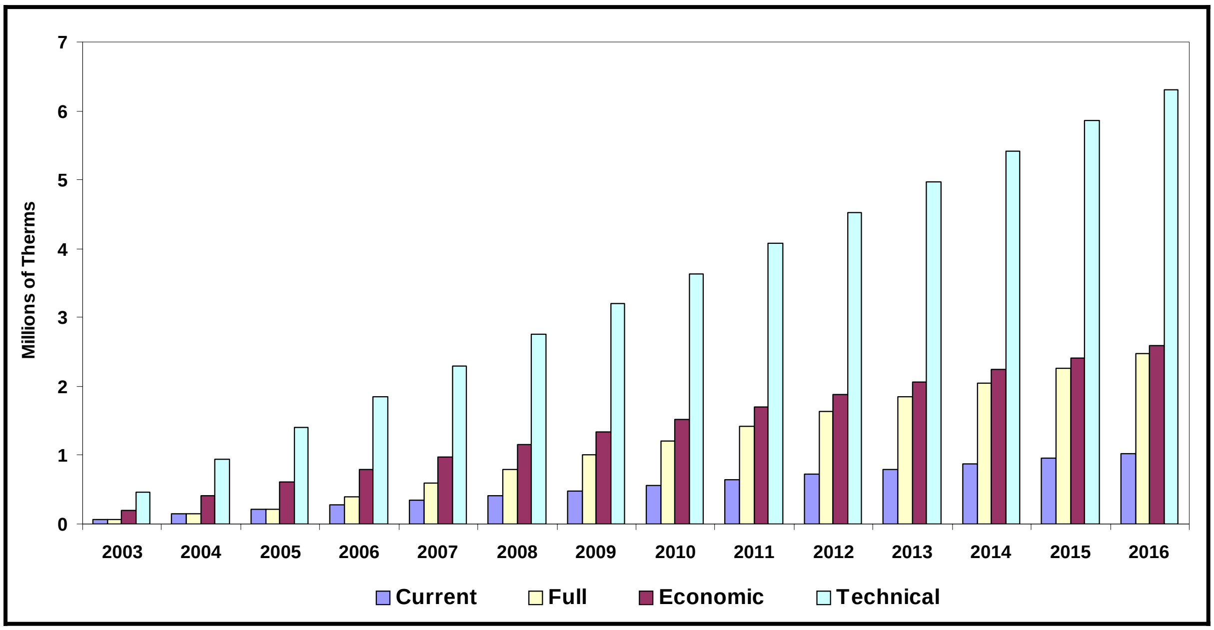
Table 9-20 illustrates the forecast new construction natural gas savings for SDG&E. At current incentive levels, the forecast of natural gas savings is approximately 1 million therms. Increasing incentives to full incremental costs is forecast to increase potential natural gas savings in SDG&E's service territory to 2.5 million therms, an increase of 140%.

Table 9-20: Estimated SDG&E Gross Commercial New Construction Technical, Economic, and Market Gas Potential – 2003-2016 (millions of therms)

Total	Technical	Economic	Full	Current
2003	0	0	0	0
2004	1	0	0	0
2005	1	1	0	0
2006	2	1	0	0
2007	2	1	1	0
2008	3	1	1	0
2009	3	1	1	0
2010	4	2	1	1
2011	4	2	1	1
2012	5	2	2	1
2013	5	2	2	1
2014	5	2	2	1
2015	6	2	2	1
2016	6	3	2	1

A graph of SDG&E's commercial new construction gas potential is provided in Figure 9-21.

Figure 9-21: Estimated SDG&E Gross Commercial New Construction Technical, Economic, and Market Gas Potential

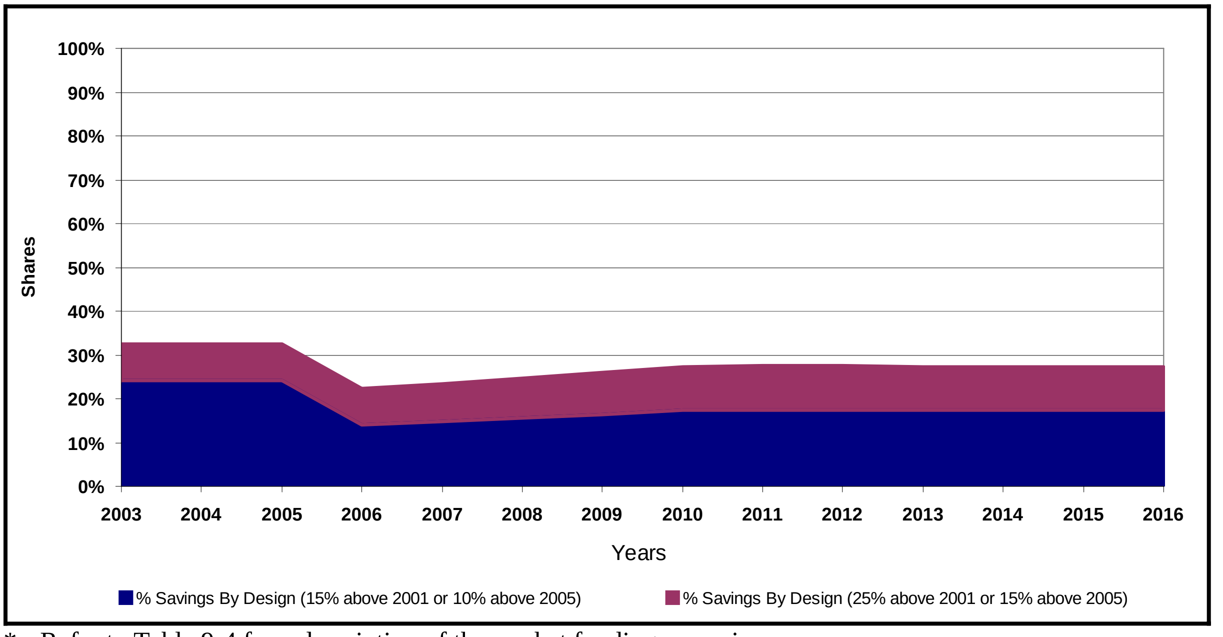


* Refer to Table 9-4 for a description of the market funding scenarios.

9.4 Shares

Figure 9-22 and Figure 9-23 illustrates the estimated shares of high efficiency commercial buildings in California using current funding levels and full cost incentives,[2] respectively.[3] As previously mentioned, the Potential Study used the 2004 IOU accomplishments whereas the most recent accomplishments available for the California Savings by Design Program were for 2003. As can be seen, the shares of high efficiency commercial buildings are higher under the full incremental cost scenario than the current rebate levels. As shown in Figure 9-22, shares are projected to decrease somewhat beginning in 2006 due to the new Standards.

Figure 9-22: Statewide Shares – Current Funding Level

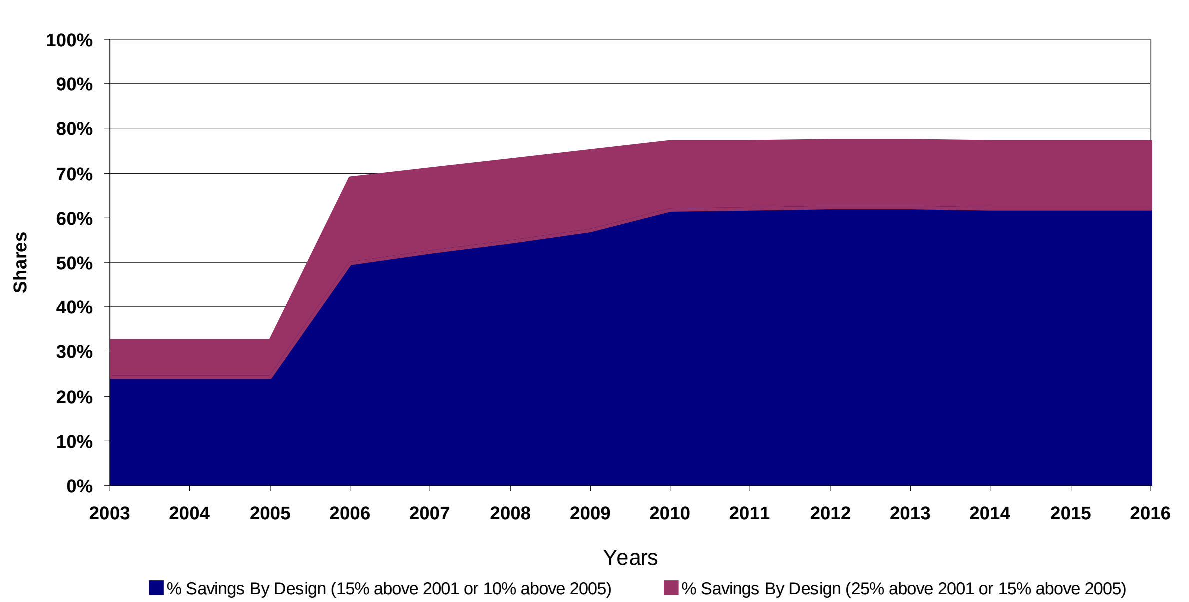


* Refer to Table 9-4 for a description of the market funding scenarios.

2 The incentives used in the full cost scenario run do not equal the Incremental Measure Cost. Instead, the weighted average of the incremental costs (by IOU, Inland vs. Coastal, and building type) were used as the Full Incentive.

3 The shares presented in these graphs are stacked. For example, ASSET estimates that 14% of commercial new construction in 2006 will qualify to participate in the California Savings by Design Program at the 10% level and an additional 8% will qualify at the 15% level. Therefore, in total, 22% of commercial new construction in 2006 will qualify to participate in the California Savings by Design Program.

Figure 9-23: Statewide Shares – Full-Cost Incentives



* Refer to Table 9-4 for a description of the market funding scenarios.

9.5 Commercial New Construction Cost and Benefit Results

Statewide-specific new construction costs and benefits are presented in Table 9-21.

Table 9-21: Summary of Commercial New Construction Market Potential Costs and Benefits – 2003-2016

Item	Current	Full Cost
Gross Program Costs	$22,735,023	$42,103,565
Net Measure Costs	$198,202,027	$581,590,369
Gross Incentives	$81,972,156	$1,011,373,671
Net Avoided cost benefit	$425,327,893	$815,655,507
Program TRC	1.93	1.31

* Refer to Table 9-4 for a description of the market funding scenarios.

The results show that both funding levels result in cost-effective programs based on the TRC test, with benefit-cost ratios of 1.93 and 1.31, respectively.[4]

4 For this analysis, the avoided cost was derived from *A Forecast of Cost-Effectiveness Avoided Costs and Externality Adders* by Energy and Environmental Economics, Inc., January 2004. Any changes in avoided costs would change the cost effectiveness of the program.

Cost and Benefit Results by IOU

The utility-specific costs and benefits are presented in Table 9-22, Table 9-23, and Table 9-24. Programs at current and full-cost incentive levels are cost-effective based on the TRC test in all utility service areas.

Table 9-22: Summary of PG&E Commercial New Construction Market Potential Costs and Benefits – 2003-2016

Item	Current	Full Cost
Gross Program Costs	$10,290,134	$22,356,713
Net Measure Costs	$51,266,901	$203,151,503
Gross Incentives	$25,755,700	$327,279,147
Net Avoided cost benefit	$136,893,088	$302,683,802
Program TRC	2.22	1.34

* Refer to Table 9-4 for a description of the market funding scenarios.

Table 9-23: Summary of SCE/SoCalGas Commercial New Construction Market Potential Cost and Benefits – 2003-2016

Item	Current	Full Cost
Gross Program Costs	$9,786,217	$17,021,806
Net Measure Costs	$129,255,497	$321,705,060
Gross Incentives	$46,576,709	$561,071,100
Net Avoided cost benefit	$234,206,874	$413,499,394
Program TRC	1.68	1.22

* Refer to Table 9-4 for a description of the market funding scenarios.

Table 9-24: Summary of SDG&E Commercial New Construction Market Potential Cost and Benefits – 2003-2016

Item	Current	Full Cost
Gross Program Costs	$2,658,672	$2,725,045
Net Measure Costs	$17,679,629	$56,733,805
Gross Incentives	$9,639,747	$123,023,423
Net Avoided cost benefit	$54,227,931	$99,472,312
Program TRC	2.67	1.67

* Refer to Table 9-4 for a description of the market funding scenarios.

9.6 Summary of Key Results

The technical potential for commercial new construction electric energy efficiency is estimated to be 4,553 GWh over a 14-year period, and estimated economic potential was found to be 4,093 GWh. The market potential for new construction was estimated to be 978 GWh at the current incentive level, and increasing incentives to cover the full resulted in saving an additional 960 GWh (total 1,938 GWh).

The technical potential for commercial new construction demand reduction is 961 MW over a 14-year period, and estimated economic potential was found to be 879 MW. The market potential for new construction was estimated to be 215 MW at the current incentive level, and increasing incentives to cover the full incremental cost resulted in saving an additional 221 MW (total 436 MW).

The technical and economic potential for new construction gas efficiency are estimated to be 66 and 36 million therms over a 14-year period, respectively. Of the IOUs, SoCalGas had the highest technical potential and PG&E had the highest economic potential. The market potential for new construction was estimated to be approximately 11 million therms at the current incentive level, and increasing incentives to cover the full incremental cost resulted in saving an additional 9 million therms (total approximately 20 million therms).

TRC results for the new construction program under the two funding scenarios showed that they were cost-effective. Specifically, the current incentive program scenario resulted in a benefit-cost ratio of 1.9, while the full cost incentive program scored 1.3.

10

California Industrial New Construction Energy Efficiency Potential

Under separate contract, RLW Analytics (RLW) and Itron jointly developed the estimates of industrial new construction energy efficiency potential. RLW developed many of the inputs including incremental costs and energy savings, and calibration shares, while time-of-use energy usage inputs were developed jointly with AEC. RLW's methodology can be found in Appendix Q. This section presents the estimates of industrial new construction energy efficiency potential resulting from the joint analysis. Estimated technical, economic and market potential are presented for the period 2003 through 2016. Market potential was estimated for two program incentive funding levels: 1) the current utility program incentive level and 2) program incentives covering full incremental costs. All results reflect the current year's savings from cumulative adoptions over the period through 2016. Incremental savings can be found in the detailed results spreadsheets in Appendix K.

10.1 Overview

Energy efficiency potential for industrial new construction was estimated by industrial category and by IOU. The industrial portion of the New Construction Potential Study developed cost and savings estimates and estimated potential for three industrial categories, electronics manufacturing, wastewater treatment and refrigerated warehouses. The results shown in this section do not attempt to represent the energy potential for all newly constructed industrial buildings, but rather reflect the potential for only those building types agreed upon by the new construction advisory group.[1]

The approach used was similar to the one used for estimating potential in existing industrial buildings, however, there are several important differences. The differences include the development of incremental costs, the development of energy savings, and the number of industrial categories, the number of scenarios, and the calibration year. Each of these is described in further detail below.

[1] The three NAICs were chosen based on where experts thought most of the new construction in the industrial sector was expected to most likely occur.

In addition to these differences, please refer to Appendix Q for a summary of the methodology on how the prototypes and the costs and savings were developed.

Incremental Costs

Sources for the incremental measure costs used in the New Construction Potential Study included the 2005 DEER Measure Cost Study,[2] the R.S. Means "Costworks" construction cost estimating database, DOE's Motor Master software, utility incentive project documentation and construction cost estimates obtained directly from equipment manufacturers, distributors and contractors.

Energy Savings

Energy savings were calculated via two different methods due to availability of data. For electronics manufacturing, the forecasted load increase was disaggregated by end use. Measure savings were applied to end uses by considering the market applicability of each individual measure.

Wastewater and refrigerated warehouses used a sample of projects similar to the commercial analysis. The market applicability of a given measure was estimated by the saturation of the measure in the sample. The savings percentage of the sample was projected to the sector load increase to determine sector level energy savings.

Calibration Year

While the Potential Study used the 2004 IOU accomplishments, the most recent accomplishments available for the California Savings by Design Program were for 2003. Please note that all of the graphs and tables in this section differ from the rest of the report.

10.2 Potential for Industrial New Construction Electric Energy Efficiency

Technical and Economic Potential

Total Industrial New Construction Technical and Economic Potential

Figure 10-1 and Figure 10-2 present the total estimated energy and demand savings potential for new construction resulting from the analysis for the three state investor-owned electric utilities: Pacific Gas & Electric (PG&E), Southern California Edison (SCE), and San Diego Gas & Electric (SDG&E).

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[2] Itron, Inc. *2004-2005 Database for Energy Efficiency Resources (DEER) Update Study: Final Report.* Prepared for Southern California Edison. December 2005.

As shown in Figure 10-1, total estimated electric technical potential for energy savings is 457 GWh, and total estimated electric economic potential is 452 GWh. Figure 10-2 shows total estimated technical potential for demand reduction to be 70 MW, and total estimated economic potential for demand reduction to be 69 MW.

Figure 10-1: Total IOU Industrial New Construction Energy Savings – Technical and Economic Potential – 2003-2016

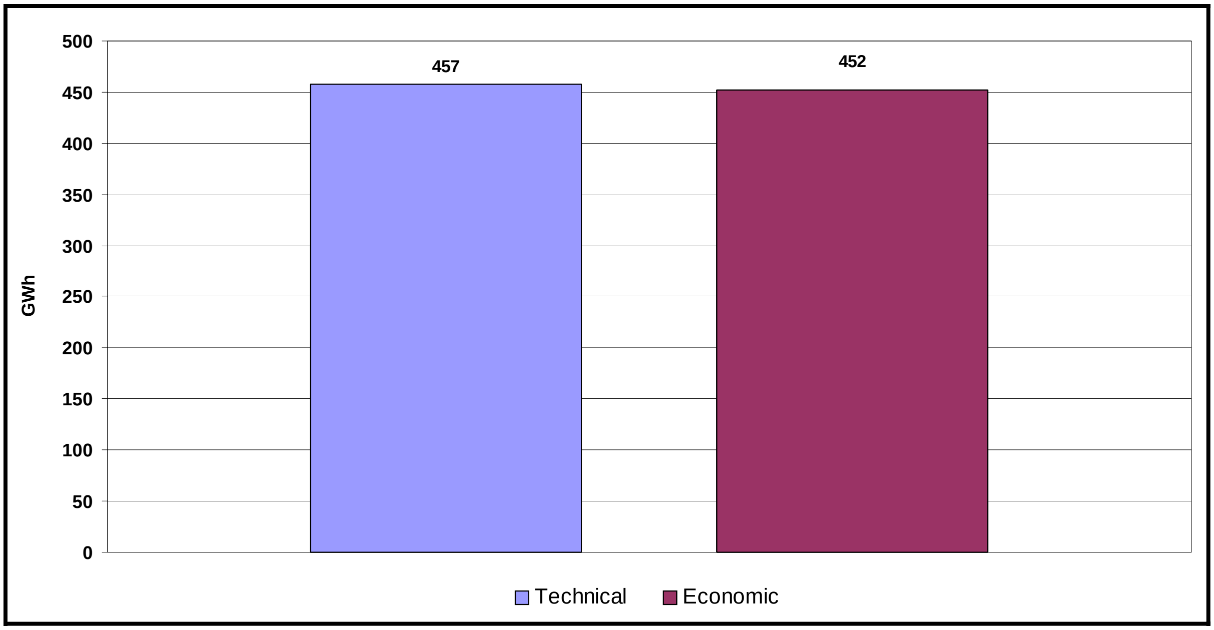
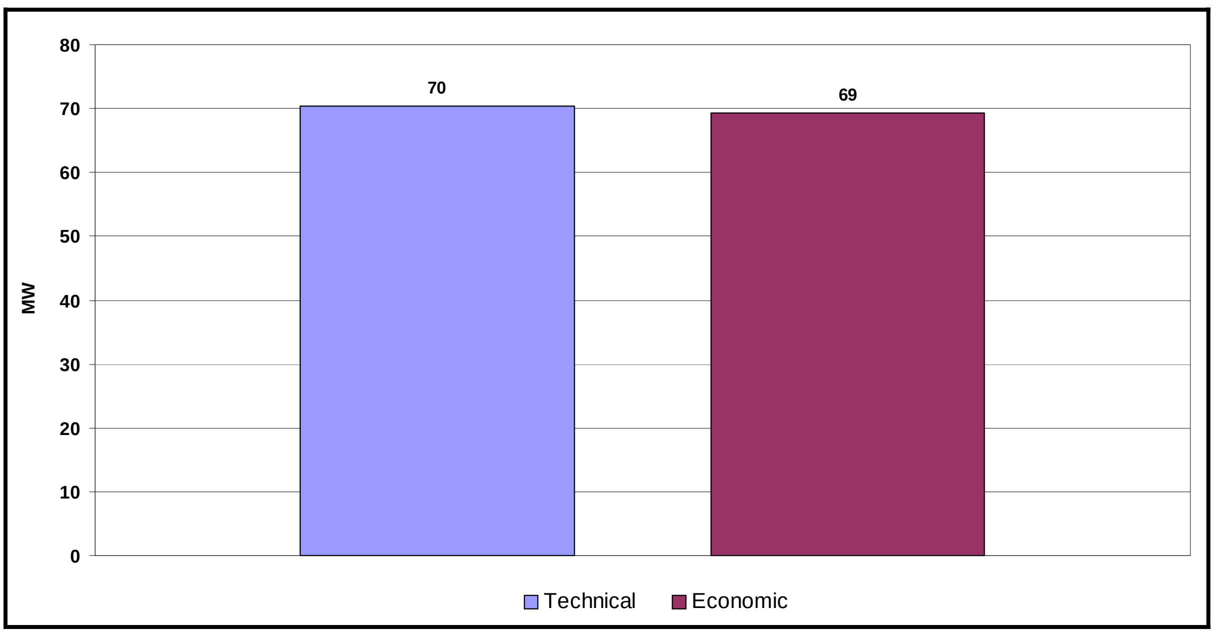


Figure 10-2: Total IOU Industrial New Construction Demand Savings – Technical and Economic Potential – 2003-2016



The energy and demand savings potential results, disaggregated by utility service area, are presented in Figure 10-3 and Figure 10-4.

Figure 10-3: Estimated Industrial New Construction Technical and Economic Energy Potential by Utility – 2003-2016

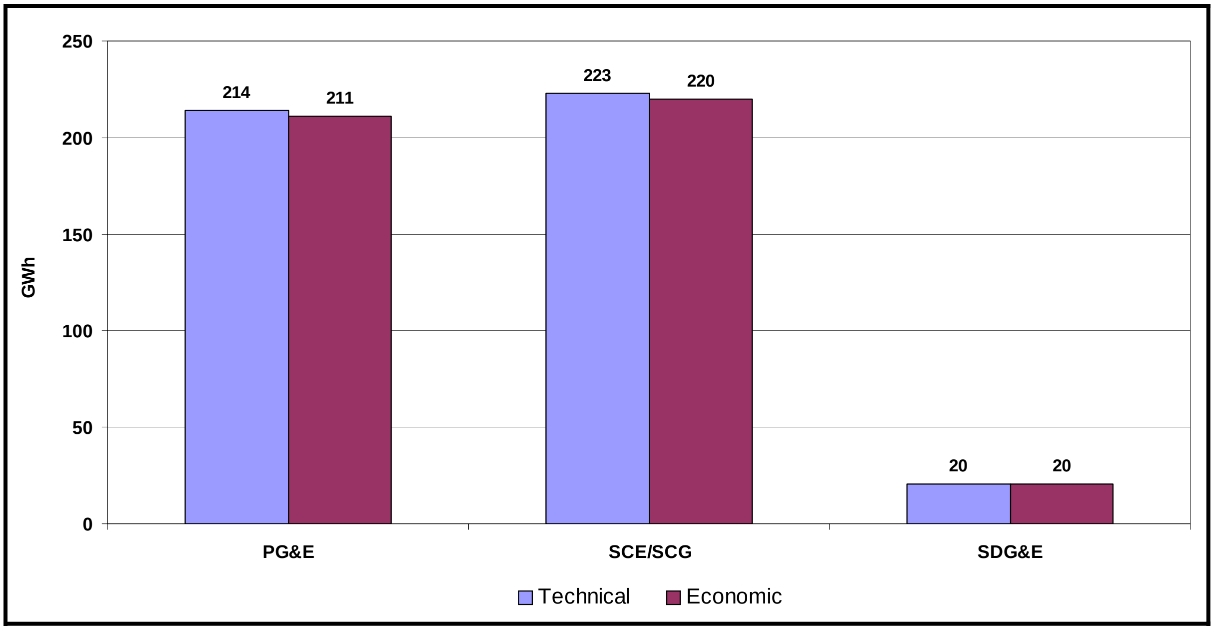
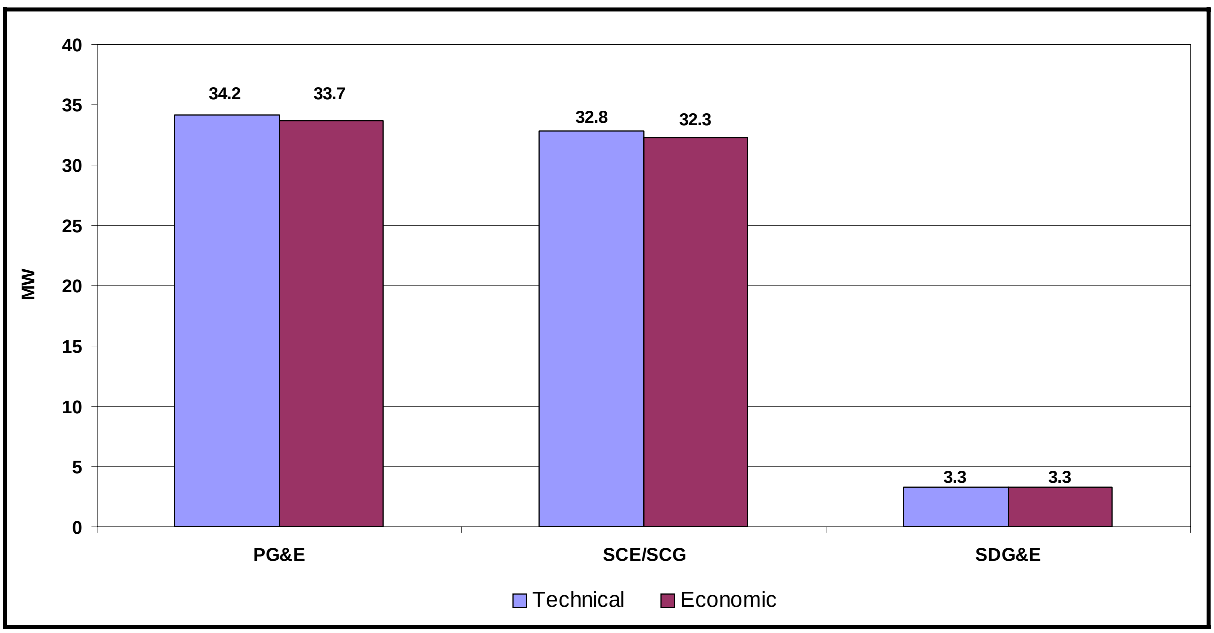


Figure 10-4: Estimated Industrial New Construction Technical and Economic Demand Potential by Utility – 2003-2016



<u>Industrial New Construction Technical and Economic Potential by Industrial Category</u>

Table 10-1 summarizes the technical potential results for 2016 by industrial category and by utility. As shown, the largest contributors to energy and demand savings are clean rooms (SIC 3674).

Table 10-1: Industrial New Construction Technical Potential by Industrial Category and Utility – 2003-2016

Industrial Category	PG&E		SCE		SDG&E		Total	
	GWh	MW	GWh	MW	GWh	MW	GWh	MW
Clean Rooms (3674)	85	11	89	9	7	1	**181**	**21**
Electronics Manufacturing (SIC 36 not 3674)	39	6	29	4	1	0	**69**	**10**
Refrigerated Warehouses	44	9	55	10	9	2	**108**	**20**
Waste Water Treatment Plants	46	9	49	9	3	1	**99**	**19**
Total	**214**	**34**	**223**	**33**	**20**	**3**	**457**	**70**

Table 10-2 summarizes the economic potential results by industrial category and by utility. As shown, the largest contributors to energy savings and demand savings are also clean rooms.

Table 10-2: Industrial New Construction Economic Potential by Industrial Category and Utility – 2003-2016

Industrial Category	PG&E		SCE		SDG&E		Total	
	GWh	MW	GWh	MW	GWh	MW	GWh	MW
Clean Rooms (3674)	85	11	89	9	7	1	**181**	**21**
Electronics Manufacturing (SIC 36 not 3674)	39	6	29	4	1	0	**69**	**10**
Refrigerated Warehouses	44	9	55	10	9	2	**108**	**20**
Waste Water Treatment Plants	44	8	46	9	3	1	**93**	**18**
Total	**211**	**34**	**220**	**32**	**20**	**3**	**452**	**69**

Figure 10-5 and Figure 10-6 illustrate the above results. As shown, for three of the four categories, economic potential equals technical potential. For these industrial categories, each energy efficient measure is cost effective. For the other, most of the measures included in the analysis are cost effective.

Figure 10-5: Total IOU Industrial New Construction Technical and Economic Energy Potential by Industrial Category – 2003-2016

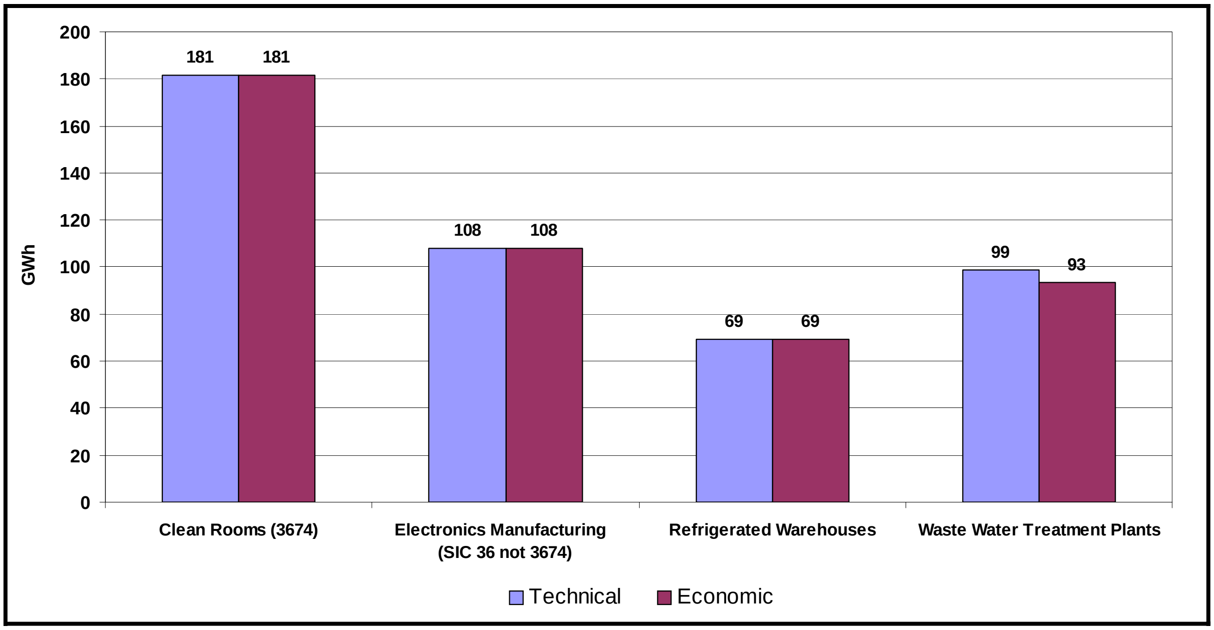
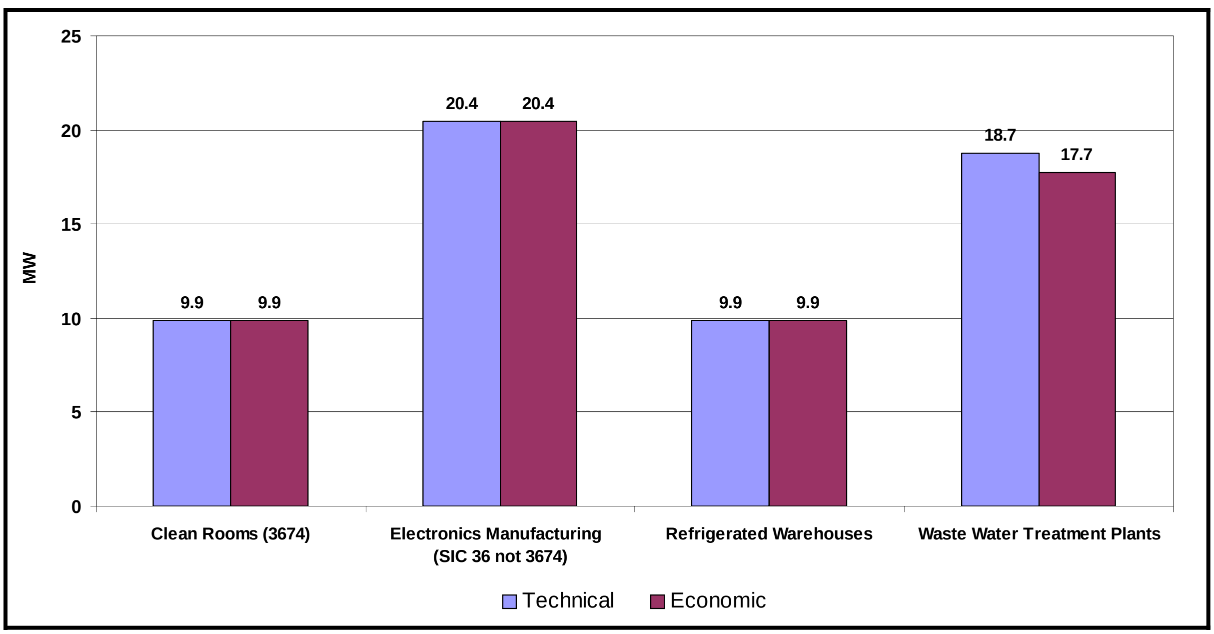


Figure 10-6: Total IOU Industrial New Construction Technical and Economic Demand Potential by Industrial Category – 2003-2016



Industrial New Construction Market Potential for Energy Efficiency

In this subsection, the results for electric potential in newly constructed industrial buildings are further analyzed under two program incentive scenarios. Results were derived for the current 2004-2005 energy efficiency program incentive funding level and for a full incremental cost incentive funding level. Table 10-3 describes the industrial market scenarios for new buildings.

Table 10-3: Market Scenario Descriptions for Existing Industrial Buildings

Market Scenario Name	Description
Current	2004 incentive level. Due to changes to the Title 24 Standards changes in 2006, the incentive level changes in 2006.
Full	Full incremental measure cost was used as the incentive.

Total Industrial New Construction Market Potential

In this subsection, the above results for electric technical and economic potential are further analyzed under two program incentive scenarios. As previously mentioned, results were derived for the current 2004-2005 California Savings by Design Program incentive funding level, and for a full incremental cost incentive funding level.

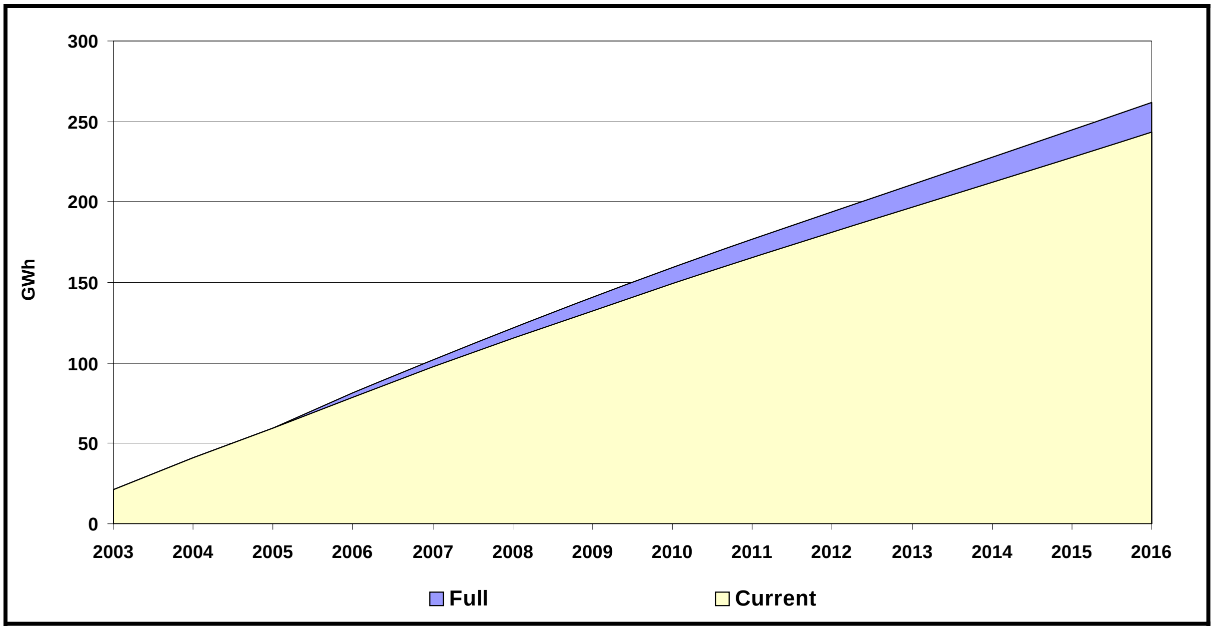
As shown in Table 10-4, total IOU market potential under the current funding scenario is 243 GWh energy savings and 39 MW demand savings. When program incentives are further increased to cover full incremental costs, energy savings increased 8% to 261 GWh, while demand savings increased 6% to 41 MW. These results are illustrated in Figure 10-7 and Figure 10-8.

Table 10-4: Estimated Market Potential by Funding Level – 2003-2016

Funding Level	Energy (GWh)	Demand (MW)
Current	243	39
Full Cost	261	41

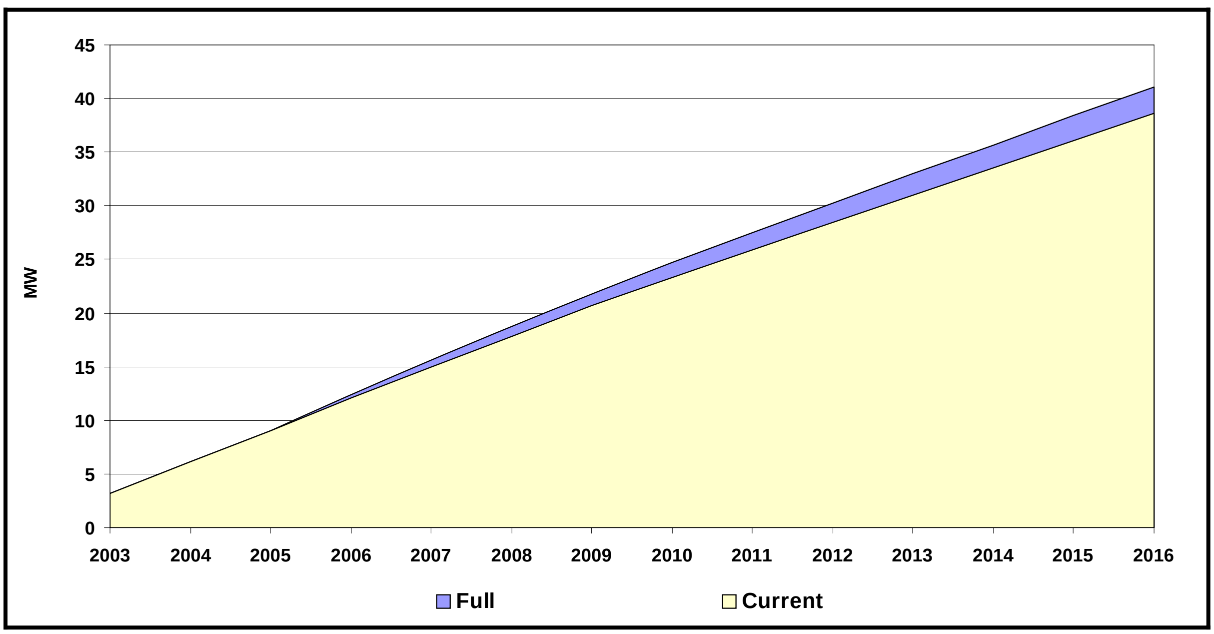
* Refer to Table 10-3 for a description of the market funding scenarios.

Figure 10-7: Estimated Industrial New Construction Energy Market Potential by Funding Level



* Refer to Table 10-3 for a description of the market funding scenarios.

Figure 10-8: Estimated Industrial New Construction Demand Market Potential by Funding Level



* Refer to Table 10-3 for a description of the market funding scenarios.

Industrial New Construction Market Potential by Industrial Category

Table 10-5 summarizes the new construction energy market potential estimates by funding level and industrial category. For comparison, technical and economic estimates are also included. Table 10-6 presents similar results for peak demand reduction. As shown, if the IOUs continue with the current incentive levels, they are estimated to save 243 GWh from the industrial new construction program in 2016. Increasing incentives to full incremental costs is estimated to increase the savings to 261 GWh.

As shown, the average potential savings estimated given current incentives is 54% of economic potential. For wastewater treatment plants, however, potential savings estimated under the current incentives is 99% of economic potential. If incentives were increased to cover the full incremental cost, the potential savings would increase over the economic potential. Overall, potential savings estimated under the full incentive run is 58% of economic potential.

Table 10-5: Estimated Industrial New Construction Energy Market Potential by Funding Level and Industrial Category – 2003-2016

Industrial Category	Technical Potential (GWh)	Economic Potential (GWh)	Current		Full Cost	
			GWh	% of Econ. Pot.	GWh	% of Econ. Pot.
Clean Rooms (3674)	181	181	65	36%	76	42%
Electronics Manufacturing (SIC 36 not 3674)	69	69	64	92%	65	94%
Refrigerated Warehouses	108	108	21	20%	25	24%
Wastewater Treatment Plants	99	93	92	99%	95	102%
Total	**457**	**452**	**243**	**54%**	**261**	**58%**

* Refer to Table 10-3 for a description of the market funding scenarios.

Table 10-6: Estimated Industrial New Construction Demand Market Potential by Funding Level and Industrial Category – 2003-2016

Industrial Category	Technical Potential (MW)	Economic Potential (MW)	Current		Full Cost	
			MW	% of Econ. Pot.	MW	% of Econ. Pot.
Clean Rooms (3674)	21	21	8	36%	9	42%
Electronics Manufacturing (SIC 36 not 3674)	10	10	9	92%	9	94%
Refrigerated Warehouses	20	20	4	21%	5	23%
Wastewater Treatment Plants	19	18	18	99%	18	102%
Total	**70**	**69**	**39**	**56%**	**41**	**59%**

* Refer to Table 10-3 for a description of the market funding scenarios.

Utility-Level Industrial New Construction Potential

In this subsection, the technical, economic, and market potential of new construction are presented over time at the utility level.

Table 10-7, Table 10-8, and Table 10-9 illustrate the potential new construction energy savings for PG&E, SCE, and SDG&E, while Figure 10-9, Figure 10-10, and Figure 10-11 illustrate the data presented in these tables in graphical form. The potential new construction demand savings for the utilities are presented in Table 10-10, Table 10-11, and Table 10-12. Graphs of the demand savings for the utilities are displayed in Figure 10-12, Figure 10-13, and Figure 10-14. These tables and figures help illustrate the new construction energy efficiency potential achieved by each utility in 2003 and the potential for future growth in new construction energy efficiency savings under an alternative market scenario.

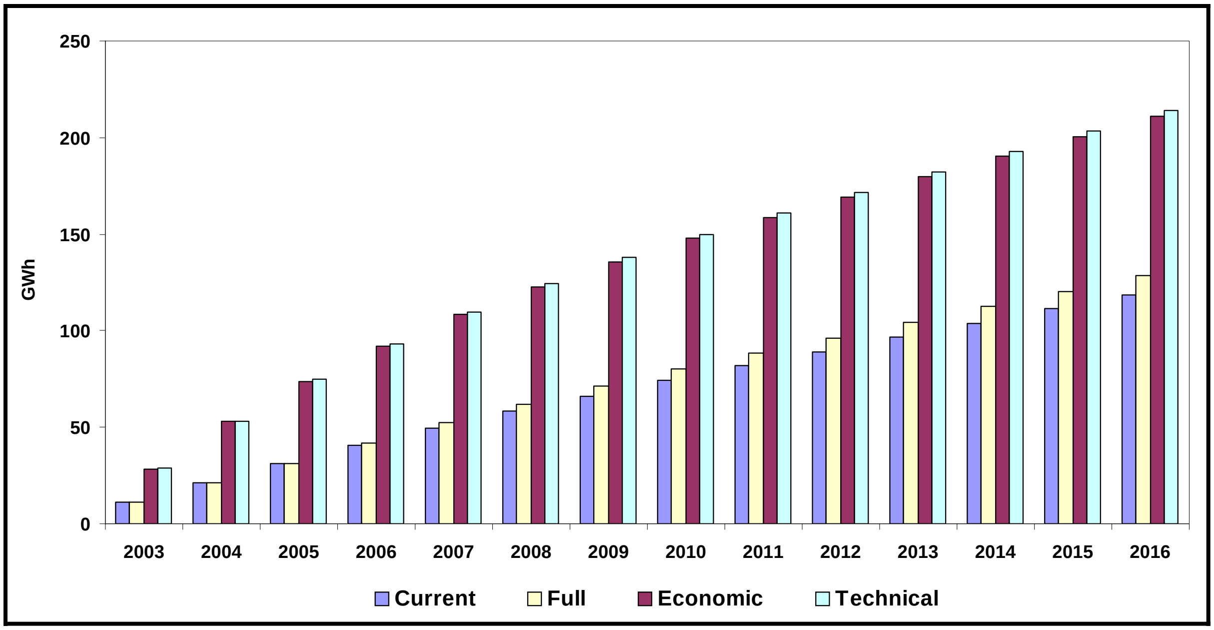
Given the definitions of economic and technical potential, the technical potential illustrated for each utility in 2004 does not illustrate the level of technical potential each utility achieved. The technical potential illustrates what the utility could achieve if they had the ability to force all industrial builders who could adopt the measure, to adopt the measure.

Table 10-7 shows PG&E's new construction energy efficiency potential under both market forecasts. PG&E's new construction market potential at current incentive levels is approximately 119 GWh. Increasing incentives to the full level increases potential savings to about 128 GWh, an 8% increase. Figure 10-9 presents a graph of the data in Table 10-7.

Table 10-7: Estimated PG&E Industrial New Construction Gross Technical, Economic, and Market Energy Potential (GWh)

Total	Technical	Economic	Full	Current
2003	29	28	11	11
2004	53	53	21	21
2005	75	74	31	31
2006	93	92	42	41
2007	110	108	52	50
2008	124	123	62	58
2009	138	136	71	66
2010	150	148	80	74
2011	161	159	88	82
2012	172	169	96	89
2013	182	180	104	97
2014	193	190	112	104
2015	203	201	120	111
2016	214	211	128	119

Figure 10-9: Estimated PG&E Industrial New Construction Gross Technical, Economic, and Market Energy Potential



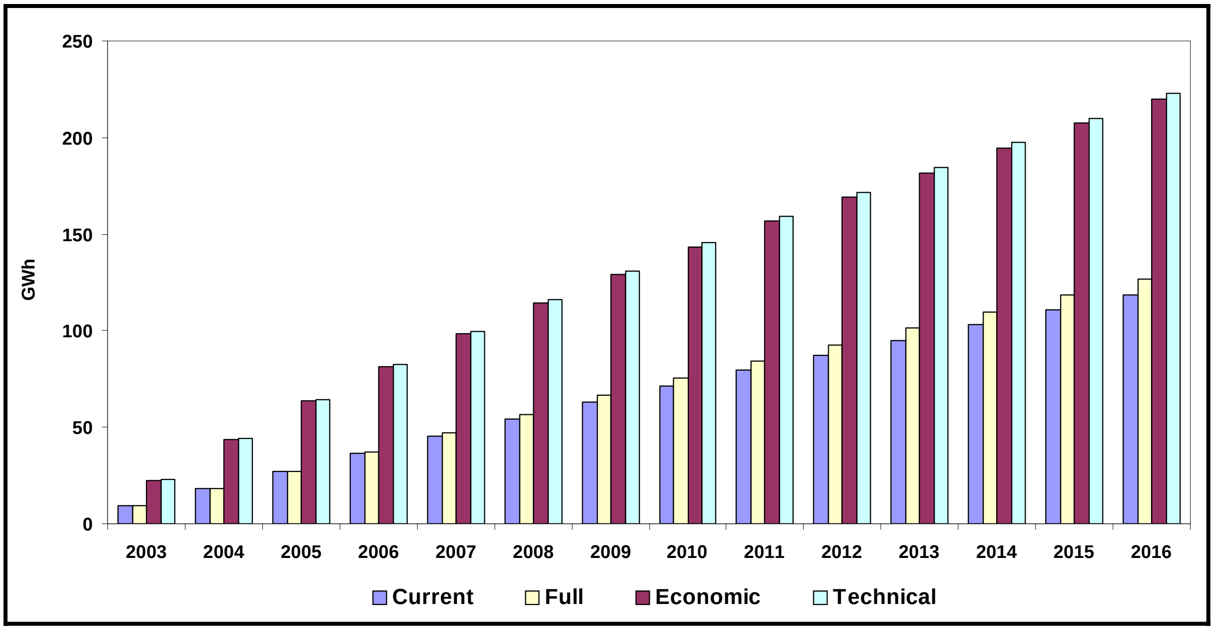
* Refer to Table 10-3 for a description of the market funding scenarios.

Table 10-8 shows that SCE's new construction energy efficiency potential under all market forecasts is similar to the forecasted level for PG&E. SCE's new construction market potential, in 2016, is about 119 GWh under the current incentive levels. Increasing incentives to the full level raises potential savings to about 127 GWh, a 7% increase. Figure 10-10 depicts SCE's industrial new construction potential graphically.

Table 10-8: Estimated SCE Industrial New Construction Gross Technical, Economic, and Market Energy Potential (GWh)

Total	Technical	Economic	Full	Current
2003	23	23	9	9
2004	44	44	18	18
2005	64	63	27	27
2006	83	82	37	36
2007	100	98	47	45
2008	116	114	57	54
2009	131	129	66	63
2010	145	143	76	71
2011	159	157	84	79
2012	172	169	93	87
2013	185	182	101	95
2014	197	195	110	103
2015	210	207	118	111
2016	223	220	127	119

Figure 10-10: Estimated SCE Industrial New Construction Gross Technical, Economic, and Market Energy Potential



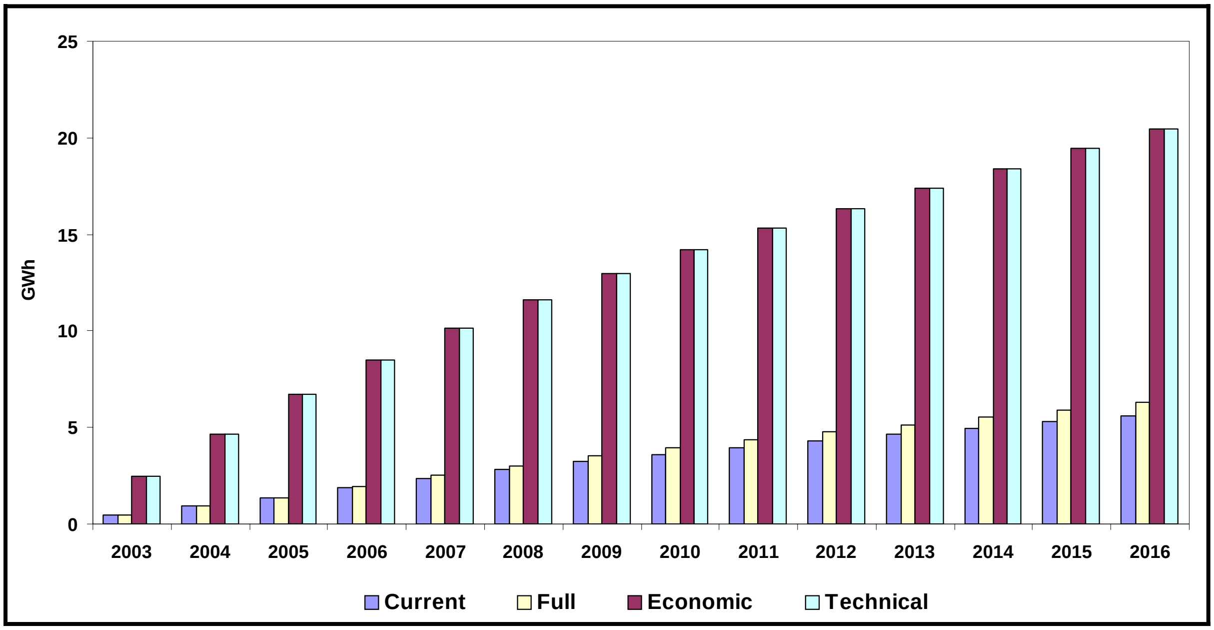
* Refer to Table 10-3 for a description of the market funding scenarios.

Table 10-9 shows SDG&E's new construction energy efficiency potential under all market forecasts. SDG&E's new construction market potential at current incentive levels is about 5.6 GWh. Increasing incentives to the full level increases potential savings to about 6.3 GWh, a 12% increase. Figure 10-11 presents a graph of the data in Table 10-9.

Table 10-9: Estimated SDG&E Industrial New Construction Gross Technical, Economic, and Market Energy Potential (GWh)

Total	Technical	Economic	Full	Current
2003	2	2	0	0
2004	5	5	1	1
2005	7	7	1	1
2006	8	8	2	2
2007	10	10	3	2
2008	12	12	3	3
2009	13	13	4	3
2010	14	14	4	4
2011	15	15	4	4
2012	16	16	5	4
2013	17	17	5	5
2014	18	18	6	5
2015	19	19	6	5
2016	20	20	6	6

Figure 10-11: Estimated SDG&E Industrial New Construction Gross Technical, Economic, and Market Energy Potential



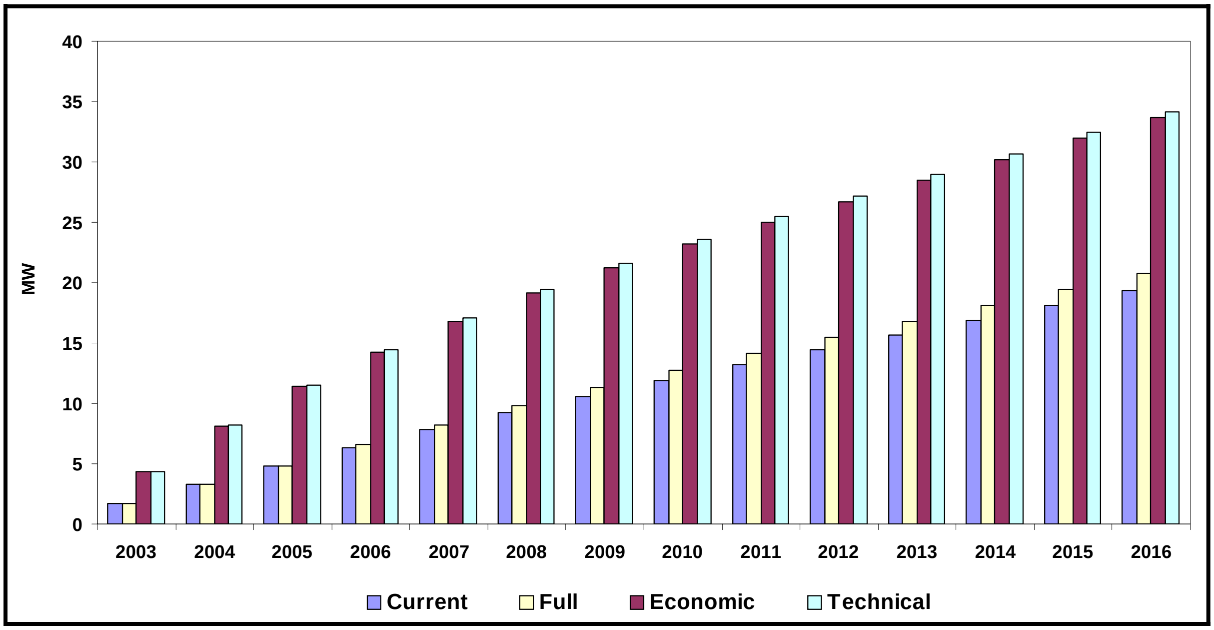
* Refer to Table 10-3 for a description of the market funding scenarios.

Table 10-10 illustrates PG&E's potential new construction demand savings under the two alternative incentive levels. PG&E's forecasted demand savings in 2016, under current incentive levels is about 19 MW. Raising incentives to full incremental measure costs further increases the demand savings to about 21 MW. Figure 10-12 presents PG&E's industrial new construction potential as a graph.

Table 10-10: Estimated PG&E Gross Industrial New Construction Technical, Economic and Market Demand Potential (MW)

Total	Technical	Economic	Full	Current
2003	4	4	2	2
2004	8	8	3	3
2005	12	11	5	5
2006	14	14	7	6
2007	17	17	8	8
2008	19	19	10	9
2009	22	21	11	11
2010	24	23	13	12
2011	25	25	14	13
2012	27	27	15	14
2013	29	28	17	16
2014	31	30	18	17
2015	32	32	19	18
2016	34	34	21	19

Figure 10-12: Estimated PG&E Gross Industrial New Construction Technical, Economic and Market Demand Potential



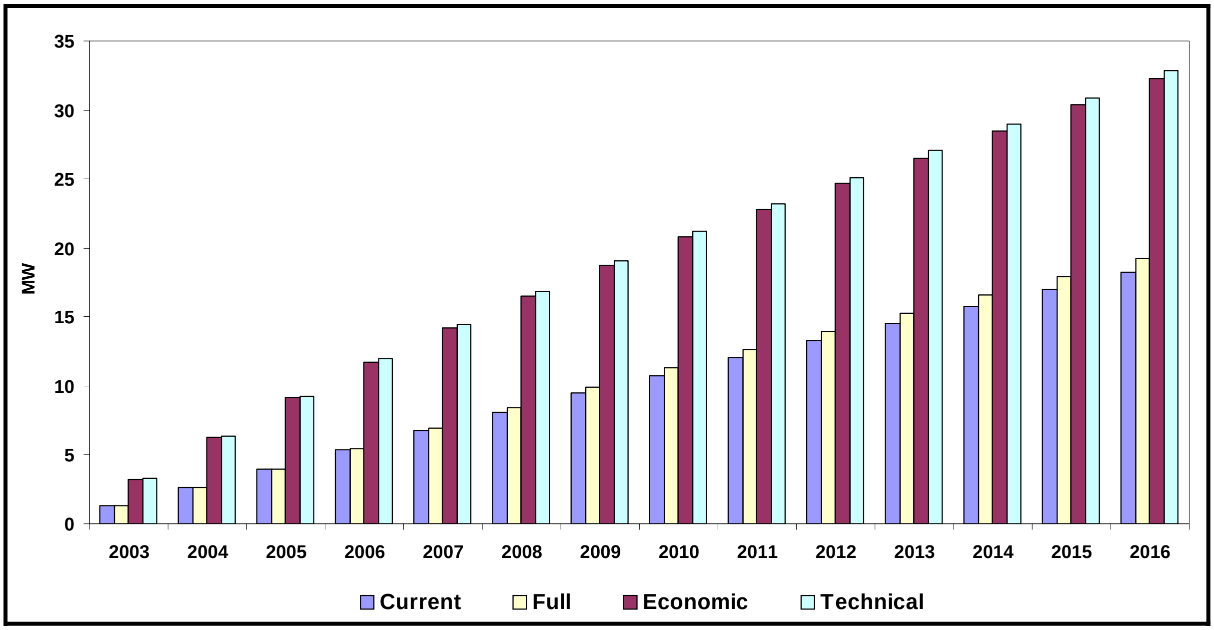
* Refer to Table 10-3 for a description of the market funding scenarios.

Table 10-11 presents the potential new construction demand savings for SCE. Under current incentives, SCE's new construction potential demand savings in 2016 are about 18 MW. Increasing incentives to the full level increases the forecast of demand savings to 19 MW. A graphical representation is shown in Figure 10-13.

Table 10-11: Estimated SCE Gross Industrial New Construction Technical, Economic, and Market Demand Potential (MW)

Total	Technical	Economic	Full	Current
2003	3	3	1	1
2004	6	6	3	3
2005	9	9	4	4
2006	12	12	5	5
2007	14	14	7	7
2008	17	17	8	8
2009	19	19	10	9
2010	21	21	11	11
2011	23	23	13	12
2012	25	25	14	13
2013	27	27	15	15
2014	29	28	17	16
2015	31	30	18	17
2016	33	32	19	18

Figure 10-13: Estimated SCE Gross Industrial New Construction Technical, Economic, and Market Demand Potential



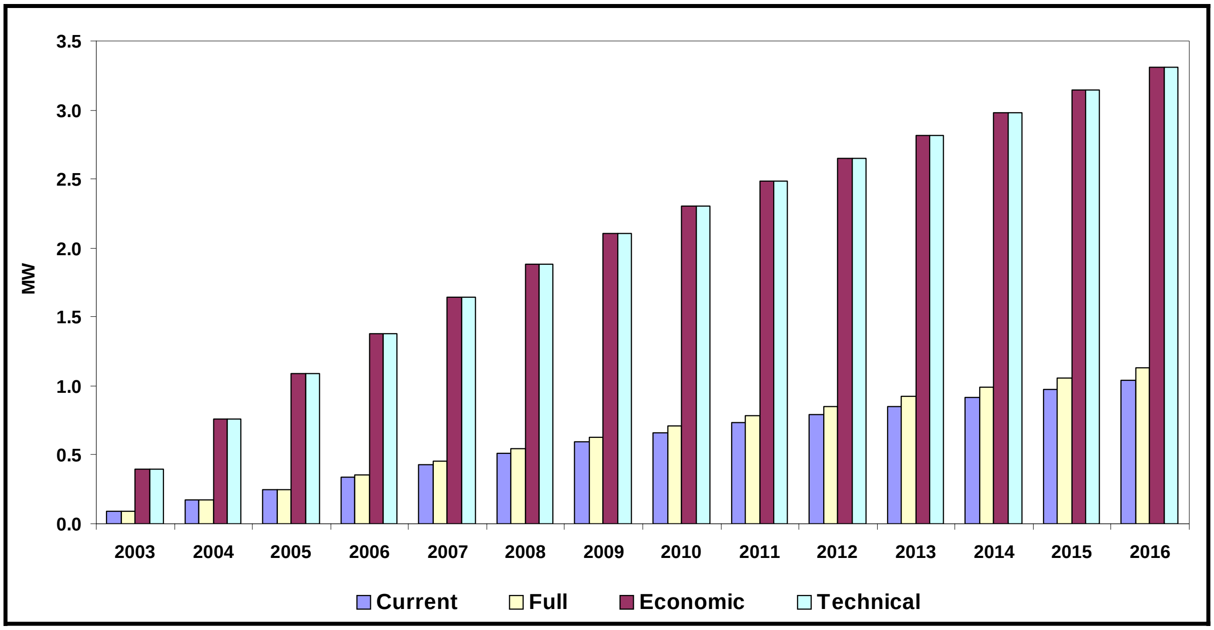
* Refer to Table 10-3 for a description of the market funding scenarios.

Table 10-12 illustrates SDG&E's potential demand savings associated with the three market forecasts. Under current incentive levels, SDG&E is forecast to save 1.0 MW in 2016. Raising incentives to full incremental measure costs increases the forecast of demand savings to 1.1 MW. Figure 10-14 shows SDG&E's industrial new construction potential graphically.

Table 10-12: Estimated SDG&E Gross Industrial New Construction Technical, Economic, and Market Demand Potential (MW)

Total	Technical	Economic	Full	Current
2003	0	0	0	0
2004	1	1	0	0
2005	1	1	0	0
2006	1	1	0	0
2007	2	2	0	0
2008	2	2	1	1
2009	2	2	1	1
2010	2	2	1	1
2011	2	2	1	1
2012	3	3	1	1
2013	3	3	1	1
2014	3	3	1	1
2015	3	3	1	1
2016	3	3	1	1

Figure 10-14: Estimated SDG&E Gross Industrial New Construction Technical, Economic, and Market Demand Potential



* Refer to Table 10-3 for a description of the market funding scenarios.

10.3 Industrial New Construction Cost and Benefit Results

Statewide-specific new construction costs and benefits are presented in Table 10-13. The results show that both funding levels result in cost-effective programs based on the TRC test, with benefit-cost ratios of 2.67 and 2.61 respectively.[3]

Table 10-13: Summary of Industrial New Construction Market Potential Costs and Benefits – 2003-2016

Item	Current	Full Cost
Gross Program Costs	$5,647,484	$6,059,520
Net Measure Costs	$29,801,325	$32,817,078
Gross Incentives	$9,233,838	$32,975,470
Net Avoided cost benefit	$94,816,732	$101,487,129
Program TRC	2.67	2.61

* Refer to Table 10-3 for a description of the market funding scenarios.

[3] For this analysis, the avoided cost was derived from *A Forecast of Cost-Effectiveness Avoided Costs and Externality Adders* by Energy and Environmental Economics, Inc., January 2004. Any changes in avoided costs would change the cost effectiveness of the program.

Cost and Benefit Results by IOU

The utility-specific costs and benefits are presented in Table 10-14, Table 10-15, and Table 10-16. Programs at current and full-cost incentive levels are cost-effective based on the TRC test in all utility service areas.

Table 10-14: Summary of PG&E Industrial New Construction Market Potential Costs and Benefits – 2003-2016

Item	Current	Full Cost
Gross Program Costs	$3,614,256	$3,892,713
Net Measure Costs	$14,687,626	$16,107,032
Gross Incentives	$3,532,351	$15,547,014
Net Avoided cost benefit	$47,072,325	$50,695,286
Program TRC	2.57	2.53

* Refer to Table 10-3 for a description of the market funding scenarios.

Table 10-15: Summary of SCE Industrial New Construction Market Potential Costs and Benefits – 2003-2016

Item	Current	Full Cost
Gross Program Costs	$1,911,881	$2,032,421
Net Measure Costs	$14,324,262	$15,801,325
Gross Incentives	$5,473,666	$16,519,923
Net Avoided cost benefit	$45,248,851	$48,041,373
Program TRC	2.79	2.69

* Refer to Table 10-3 for a description of the market funding scenarios.

Table 10-16: Summary of SDG&E Industrial New Construction Market Potential Costs and Benefits – 2003-2016

Item	Current	Full Cost
Gross Program Costs	$121,347	$134,386
Net Measure Costs	$789,437	$908,721
Gross Incentives	$227,820	$908,533
Net Avoided cost benefit	$2,495,556	$2,750,470
Program TRC	2.74	2.64

* Refer to Table 10-3 for a description of the market funding scenarios.

10.4 Summary of Key Results

The technical potential for industrial new construction electric energy efficiency was 457 GWh over a 14-year period, and estimated economic potential was 452 GWh. The market potential for new construction was estimated to be 243 GWh at the current incentive level, and increasing incentives to cover the full resulted in saving an additional 18 GWh (total 261 GWh).

The technical potential for industrial new construction demand reduction was 70 MW over a 14-year period, and estimated economic potential was 69 MW. The estimated market potential for new construction was 39 MW at the current incentive level, and increasing incentives to cover the full resulted in an additional 2 MW (total 41 MW) savings.

TRC results for the new construction program under the two funding scenarios showed that they were cost-effective. Specifically, the current incentive program scenario resulted in a benefit-cost ratio of 2.67, while the full cost incentive program scored 2.61.

11

Emerging Technology Energy Efficiency Potential

The California Energy Efficiency Potential Study extended the analysis of measures currently or recently offered in programs to include some consideration of emerging technologies. This consideration was restricted to a literature review and a general analysis of potential. The scope of this analysis was focused on a limited set of emerging technologies that were thought to provide some near-term opportunities (by 2016). A significant level of caution is warranted when assessing the savings potential associated with these near-term emerging technologies. By definition, emerging technologies have little or no market acceptance to date; therefore, estimates of the market potential associated with these technologies are by their very nature somewhat speculative. The estimates of technical, economic and market potential developed for this study use preliminary data on measure savings and costs. Projections of market potential are based on judgmental estimates, based on similar currently offered measures, of likely market acceptance. In short, the estimates of market potential for emerging technologies are subject to even more uncertainty than the estimates of potential for measures with which some historical market experience is available. Appendix L describes in detail the emerging measures that were reviewed and the selection criteria used to determine which measures to include in this analysis.

11.1 Overview

A key consideration in this analysis was insuring that the savings associated with selected emerging technologies would be additive to savings associated with high-efficiency measures analyzed in the existing residential and commercial sections of this analysis. This often required the assumption that the emerging technology would replace the most efficient competing technology, and thereby increase the savings available from that technology. For the evaluation of emerging technologies, the team adopted the American Council for an Energy Efficient Economy's (ACEEE's) emerging technology definition. According to ACEEE,[1] an emerging technology is a measure:

[1] Sachs, H., S. Nadel, J. Thorne Amann, M. Tuazon, E. Mendelsohn, L. Rainer, G. Todesco, D. Shipley, and M. Adelaar. *Emerging Energy-Savings Technologies and Practices for the Buildings Sector as of 2004.* American Council for an Energy Efficient Economy. Report #A042, pg. v. October 2004.

> *"…that is either (i) not yet commercialized but likely to be commercialized and cost-effective for a significant proportion of end-users (on a life-cycle cost basis) by 2008; or (ii) commercialized but currently have penetrated no more than 2 percent of the appropriate market. Measures with only long-term potential as well as measures that have already shown significant acceptance in the market are excluded from analysis."*

However, unlike ACEEE, the team excluded from consideration practices such as efficient design, operation, maintenance, and retrocommissioning and focused only on technical (hardware) measures. For this analysis, only technologies applicable to the residential and commercial sectors (not industrial sectors) were included. The reason for the exclusion of industrial measures was that industrial potential was not covered by the scope of this project. The selected residential and commercial measures were then further limited to those whose energy savings can be reasonably quantified at present. Where possible, only technologies judged relevant for California climate conditions were included.

Assessing emerging technologies entailed the following:

- Reviewing literature on emerging technologies, particularly as it may pertain to California,
- Identifying candidate technologies for further review,
- Developing and applying a screening methodology to ascertain the most promising technologies,
- Assembling key assumptions required to evaluate the technical and economic potential of the selected technologies,
- Comparing with assumptions and results from the analysis of more traditional technologies to assure consistency and avoid double counting of savings,
- Estimating technical and economic potential of the emerging technologies, and
- Estimating the market potential based on hypothetical utility programs.

See Appendix L for detail on the measure description and the screening process.

11.2 Review Data Sources

Several recent studies have addressed the availability and potential for emerging technologies, and several such sources were reviewed. Of particular relevance is a 2004 study by ACEEE, which was also extended to specifically evaluate potential savings and opportunities for weather-sensitive applications in California coastal, transition, and inland climate areas.[2]

The reviewed sources are listed in Table 11-1. These sources were used to compile a broad set of candidate technologies to consider for inclusion in the Emerging Statewide Energy Efficiency Potential study.

Table 11-1: Sources Reviewed to Identify Candidate Emerging Technology Measures

Source	Document	Status
ACEEE 2004	Emerging Energy-Saving Technologies and Practices for the Buildings Sector As of 2004	Integrated into data set
SCE 2004	Unpublished list received from SCE	Integrated into data set
ETCC 2004[3]	Summaries and Project Descriptions	Integrated into data set
PIER Program[4]	List of projects on web site	Reviewed
RER 1999[5]	Emerging Technology Efficiency Market Share Needs Assessment, Feasibility, and Market Penetration 12/99	Reviewed

The first three items listed in Table 11-1 were used to develop a master list of emerging technologies. The last two items were useful as background information and were helpful in determining the recommended screening and evaluation methods used for this study. While the last two sources provide promising emerging technologies, they were not used directly in the present study. The RER 1999 report was superseded by ACEEE's 2004 study, which used the methods discussed in RER's study, but built on and updated the earlier work. The PIER Program information described in the California Energy Commission website includes descriptions of work currently funded by the program, but does not contain information of specific technologies that is useful in the present assessment.

11.3 Analysis of Energy Saving Potential

The selected technologies were further analyzed to estimate the potential savings within California and the major investor-owned utility service territories. ACEEE conducted prior analysis of selected weather-sensitive measures as part of its 2004 study.[6] However, that

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2 Ibid. Report #A042. October 2004.

3 Emerging Technology Coordinating Council (ETCC) on-line database at http://www.ca-etcc.com/.

4 Public Interest Energy Research (PIER), www.energy.ca.gov/pier/.

5 Regional Economic Research, Inc. *Emerging Technology Efficiency Market Share Needs Assessment, Feasibility, and Market Penetration Scoping Study.* Prepared for the California Board for Energy Efficiency and Pacific Gas and Electric. December 1999.

6 Ibid, Appendix B.

analysis was by climate region (coastal, transition, inland) and for a specific year (2020), and not directly applicable to the California Energy Efficiency Potential Summary Study. Therefore, supporting calculations and assumptions from the ACEEE study were requested or derived from the report and new estimates were made by year and by utility service area.

Key drivers for the ACEEE study were base-case energy use (e.g., kWh per home, kWh per appliance), percent savings, and percent feasibility. ACEEE used a largely “top-down” approach in which statewide California Energy Commission estimates of end-use energy for 2020 were allocated to climate regions.

To develop annual potential estimates, as well as a point estimate for 2016, the underlying ACEEE assumptions were used in the California Energy Efficiency Potential Summary Study through a “bottom-up” approach. An attempt was made to assure consistency with the 2020 national or state results from the ACEEE study.

Technical issues that needed to be addressed included identifying and correcting for savings reported under more traditional commercial and residential measures covered under the California Energy Efficiency Potential Summary Study, and reviewing measures to identify any potential double (or more) counting of impacts between measures and adjusting for such overlaps.

Residential Adjustments

Examining the residential measures indicated that the clearest overlaps with the traditional measures would occur in fluorescent lamps, central air conditioning (CAC), and refrigerators. Two lighting measures were excluded because their technical potential appeared to be largely or fully captured by traditional measures.

- L13. High-quality residential compact fluorescent portable plug-in fixtures, and
- L16. Airtight compact fluorescent down lights.

If successfully introduced, these measures are likely to increase the acceptance and market potential of fluorescent lighting, but not the technical potential.

CAC baseline estimates of the ACEEE study and the study of traditional measures were compared and the ACEEE estimates were adjusted downward by 9% to be consistent. Since the ACEEE CAC baseline values were based on SEER 12 units, a further downward adjustment brought the baseline values in line with the SEER 15 units included in the technical potential of existing residential units.

Refrigerator baseline values were also compared between the two studies, but no changes were found to be necessary. However, two of the selected residential measures involved refrigerator efficiency. It was decided to retain measure R1 (Solid State Refrigeration) and drop measure A2 (1-kWh/Day Refrigerator) since measure R1 appears to have a slightly higher technical potential.[7]

Six residential measures involved CAC energy savings. As shown in Table 11-2, these measures were evaluated to estimate the combined savings of applying several measures, with separate impacts considered for retrofit installations, new homes, and replace-on-burnout opportunities. As a first step, Measure D2 (Advanced A/C Compressor) was eliminated from the analysis in favor of Measure H7 (Robust A/C), which can provide more savings. Measures H12 (Aerosol-Based Duct Sealing), S1 (High Performance Windows), and S5 (Cool Color Roofing) were combined in a retrofit measure. The technical potential from this combined retrofit measure leads to an overall savings of 25%. Retrofit existing homes could then take advantage of measure H7, the robust air conditioner, at the time the current unit burns out. Assuming the homes have been retrofit with the emerging shell and duct measures, the robust A/C measure leads to technical savings of 13%. Potential CAC savings for new homes combines to 44% with measure H11 (Leak-Proof Duct Fittings) applied rather than H12 (Aerosol-Based Duct Sealing), which is more applicable to retrofits.

Table 11-2: Residential CAC Adjustment

Measure	Feasibility	Savings ACEEE Report	Adj. New Homes	Adjusted ROB	Adjusted Retrofit
H7. Robust A/C	100%	33%	13%	13%	0%
D2. Advanced A/C Compressor	95%	19%	0%	0%	0%
H11. Leak-Proof Duct Fittings	90%	21%	19%	0%	0%
H12. Aerosol-Based Dust Sealing	32%	19%	0%	0%	6%
S1. High Performance Windows	35%	20%	7%	0%	7%
S5. Cool Color Roofing	70%	20%	14%	0%	14%
Combined Savings		72%	44%	13%	25%

To summarize, adding the savings of the individual measures would result in a calculated savings equal to 72% of central air conditioner usage, while a combined analysis results in 44% for new homes and 38% for existing homes: 25% from retrofits and 13% at the time of air conditioner replacement.

PG&E, SCE, and SDG&E were assigned different CAC baseline use and savings estimates based on their distribution of customers in the coastal, transition, and inland areas. The three utilities were also assigned different fan motor baseline energy usage based on 2004 RASS

7 Measure A2 has a greater likelihood of success than R1, so there is a good chance of success of one or both of these technologies.

estimates.[8] RASS results by utility were also used for CAC and electric water heater saturations.

Commercial Adjustments

Analysis of the commercial sector emerging technologies was similar to the residential sector. Further analysis of the commercial measures, indicated that advanced daylighting controls clearly overlapped with occupancy sensors and daylighting measures that were analyzed in the existing statewide efficiency study. Given the overlap with the efficiency study for existing technology, advance daylighting controls were dropped from the emerging technology study.

As shown in Table 11-3, the combined savings was calculated for two measures that related specifically to rooftop packaged air conditioners. As part of this estimate, the baseline efficiency of measure H1a was changed from an EER of 12.2 as used in the ACEEE report to an EER of 13.4 for the highest efficiency traditional measure considered in the California Energy Efficiency Potential Summary Study report. The result is still an impressive 53.6% savings potential, much of which will result from economizer cycles using outside air to cool.

Table 11-3: Commercial Packaged Air Conditioner Adjustment

Measure	Feasibility	Savings ACEEE Report	Adjusted Savings
CA2. Advanced HVAC Controls	22%	49%	49%
H1a. Advanced Rooftop Packaged A/C	38%	23%	9%
Combined Savings			53.6%

It is likely that there are some overlaps in potential savings between the commercial lighting measures in the emerging technologies list and those considered among traditional technologies. Specifically, the inclusion of second generation 8 ft. T8s in the energy efficiency potential study of existing technologies, and lower lighting power densities in California, led to the downward adjustment of the technical potential for "L14. One-Lamp Fluorescent Fixtures with High Performance Lamps by 50%." While there is possible overlap in other lighting measures, sufficient differences between the technologies and their applications suggest that the overlap is small.

[8] KEMA-Xenergy, Inc. *California Statewide Residential Appliance Saturation Study*. Prepared for the California Energy Commission. June 2004.

Estimation of Technical Potential

The adjusted assumptions discussed above were used to calculate the yearly technical potential by energy efficiency measure by utility and year over the period 2004 through 2016. Utility specific residential impacts were based on yearly customer forecasts and RASS estimates of appliance saturations and consumption per appliance (air conditioners, furnace fans, electric water heaters). Utility specific commercial impacts were derived by allocating the 2020 technical potential results of the ACEEE study to the utilities based on the relative size of household forecasts for the utilities and the nation.

The technical savings impacts of retrofit measures were applied immediately in 2006. The technical savings impacts of replace-on-burnout measures were calculated based on the estimated measure lives with assumed equal replacement by year. The annual forecast growth in the number of households was used to estimate the portion of technical potential that can be derived each year from new construction. The technical potential was derived as the yearly sum of measures that may be installed through retrofits, replace-on-burnouts, and new construction.

11.4 Estimate of Technical Potential

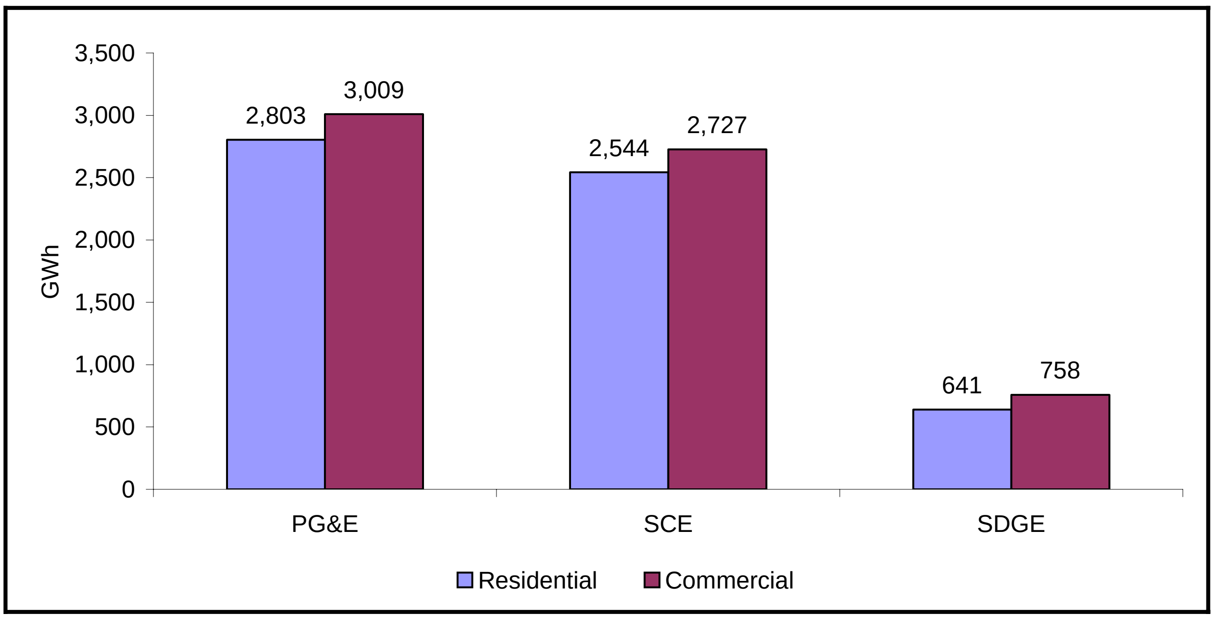
Table 11-4 summarizes the estimated technical potential for electric energy for 2016, by measure and utility. Five residential measures were combined under the “Electric A/C Combined Measures” category and two commercial measures were combined under the “Combined Package A/C” category. The largest technical potential impact in the residential sector was found to be from the “1-Watt Standby Power for Home Appliances” option, while “Networked Computer Power Management” was found to have the greatest technical potential in the commercial sector. Both measures are similar in that they seek to reduce equipment energy use during periods when the equipment is not in active operation.

Table 11-4: Emerging Technologies – GWh Technical Potential – 2006-2016

	PG&E	SCE	SDG&E	Total
Residential				
Electric A/C Combined Measures	532	801	119	1451
D3. Advanced HVAC Blower Motors	205	119	46	370
A1. 1-Watt Standby Power for Home Appliances	1,234	1,079	312	2,625
R1. Solid State Refrigeration	357	337	92	787
W3. Heat Pump Water Heaters	475	207	72	1,053
Total Residential	2803	2544	641	5988
Commercial				
Combined Package A/C	382	428	100	910
H11. Leak-Proof Duct Fittings	157	152	41	349
L14. One-Lamp Linear Fluorescent	284	255	72	611
O1. Networked Computer Power Management	1,008	856	248	2,113
L11b. LED Lighting	614	544	155	1,312
H18. CO_2 Ventilation Control	107	96	27	231
L6. Low Wattage Ceramic MH Lamp	459	395	115	968
Total Commercial	3009	2727	758	6494
Total	**5812**	**5271**	**1399**	**12481**

Figure 11-1 summarizes the 2016 electric energy technical potential by customer class and utility.

Figure 11-1: Emerging Technologies – Electric Energy Technical Potential by Utility – 2006-2016

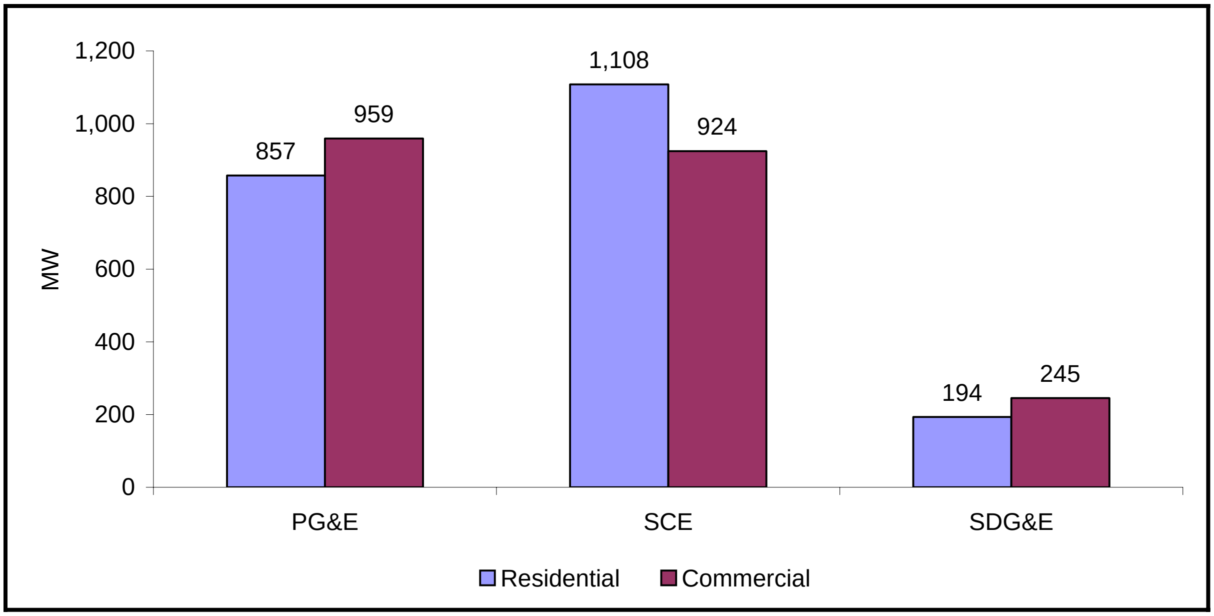


The estimate of the technical electric MW peak demand potential for 2016 is summarized in Table 11-5. Residential and commercial air conditioning systems have the largest impacts due to the coincidence of cooling load and summer system peaks. Figure 11-2 illustrates the technical demand potential. While the highest estimated energy impacts were found at PG&E, the greater use of cooling at SCE is estimated to cause the MW peak demand potential to be highest at SCE.

Table 11-5: Emerging Technologies – MW Technical Potential – 2006-2016

	PG&E	SCE	SDG&E	Total
Residential				
Electric A/C Combined Measures	607	914	136	1657
D3. Advanced HVAC Blower Motors	0	0	0	0
A1. 1-Watt Standby Power for Home Appliances	140	123	35	298
R1. Solid State Refrigeration	45	43	13	101
W3. Heat Pump Water Heaters	65	29	10	104
Total Residential	857	1,108	194	2,159
Commercial				
Combined Package A/C	252	283	66	601
H11. Leak-Proof Duct Fittings	239	232	62	533
L14. One-Lamp Linear Fluorescent	57	51	14	122
O1. Networked Computer Power Management	116	98	29	243
L11b. LED Lighting	139	123	35	297
H18. CO_2 Ventilation Control	43	39	11	92
L6. Low Wattage Ceramic MH Lamp	114	98	29	241
Total Commercial	959	924	245	2129
Total	**1,817**	**2,032**	**439**	**4,288**

Figure 11-2: Emerging Technologies – Electric Demand Technical Potential by Utility – 2006-2016

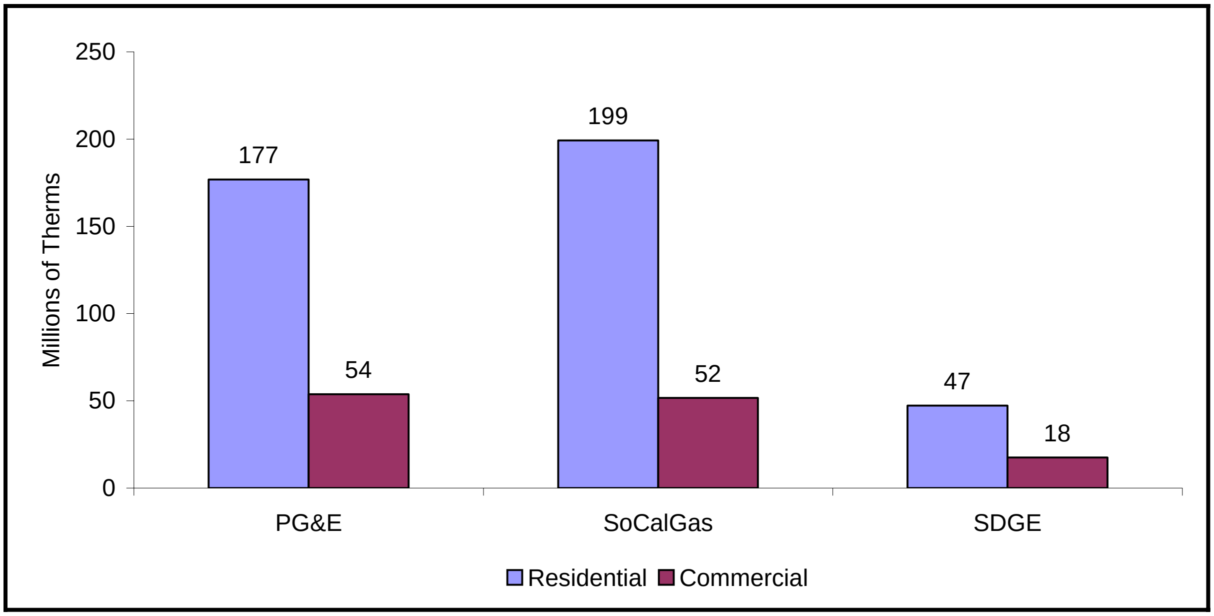


The estimated technical potential for natural gas by measure and utility is shown in Table 11-6. Four residential measures have been combined under the "Gas Heat Combined Measures" category and two of the evaluated commercial technologies had gas savings as well. Figure 11-3 illustrates the potential by utility and customer class.

Table 11-6: Emerging Technologies – Gas Technical Potential – 2006-2016 (millions of therms)

	PG&E	SCG	SDG&E	Total
Residential				
Gas Heat Combined	176.9	199.3	47.2	423.5
Total Residential	176.9	199.3	47.2	423.5
Commercial				
H11. Leak-Proof Duct Fittings	48.0	46.6	12.4	107.0
H18. CO_2 Ventilation Control	5.7	5.2	5.2	16.1
Total Commercial	53.7	51.7	17.6	123.0
Total	**230.7**	**251.0**	**64.8**	**546.5**

Figure 11-3: Emerging Technologies – Gas Technical Potential by Utility – 2006-2016



11.5 Estimated Market Potential

The estimation of the market potential associated with emerging technologies is highly speculative. Currently, there are either no or very limited IOU programs for these measures. Given the lack of current program accomplishments, it is not possible to calibrate the current market potential to actual accomplishments for these measures. Therefore, it was determined that the most appropriate technique to calculate market potential was to use information from the potential forecast for currently available technologies.

The “current incentive” market potential for emerging technologies is calculated using data from the existing residential and commercial sector forecasts for measures currently in the IOU programs. First, the yearly ratio of the forecast of current market potential to technical potential for existing high efficiency measures is calculated. This ratio represents the fraction of existing technical potential that current programs are forecast to save with incentives set equal to 2004 incentive levels. The ratio was calculated separately for residential and commercial retrofit and replace-on-burnout measures. Given that the emerging technology programs are modeled to begin in 2006, the ratio from 2004 was slipped by two years. This process applies the 2004 ratio of market to technical potential for existing technologies to the 2006 forecast of the technical potential for emerging technologies. The 2005 ratio of current market to technical potential is applied to the 2007 emerging forecast, and the process continues through the end of the forecast period.

To calculate the market potential for emerging technologies, it is necessary to choose a level of consumer awareness and willingness to adopt these technologies. Using professional judgment, it was decided that the level of awareness and willingness in 2006 should be set at 10%.[9] The growth in awareness and willingness was set at 5 percentage points a year, resulting is a level of awareness and willingness in 2016 that was only slightly less than the average level for existing technologies in 2004.[10]

The current market potential forecast for emerging technologies was a combination of the adjusted ACEEE technical potential, multiplied by the ratio of market to technical potential from existing technologies and the yearly level of awareness and willingness. All three of the inputs are speculative in nature. The ACEEE estimates of technical potential assume baseline energy usage, savings percentages, and applicability fractions. If any of these assumptions are incorrect, the technical potential presented will be inaccurate. Assuming that emerging technologies will be purchased in a fraction relative to current existing technologies is a "good starting point," but it is not based on statistics associated with emerging technologies.[11] Lastly, the assumed growth in awareness and willingness is substantial, and would require a significant influx of resources.

To calculate the full incremental cost market potential forecast for emerging technologies, the energy saving for existing technologies with incentives equal to full incremental costs was compared to the technical potential for these measures. The ratio of full market savings for existing measures relative to their technical potential was multiplied by awareness and willingness and the technical potential for emerging measures. Given that the full incremental cost incentives were not implemented in the existing technology forecast until 2006, the impact of increased incentives is not apparent in the emerging forecast until 2008.

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9 This level of awareness and willingness may appear overly high to some groups and pessimistically low to others. To those who believe that it is too high, remember that all of the technologies included in this analysis are either currently commercially available or believed to soon be commercialized. To groups that believe that 10% is pessimistic, recall that none of these technologies currently has penetrated more than 2% of the applicable market.

10 To achieve a growth in awareness and willingness of 5 percentage points a year the utilities will need to implement successful advertising programs with customers and trade allies. This growth rate may be overly optimistic, leading to a faster growth in the forecast of market potential from emerging technologies than is possible to achieve in practice. For existing technologies, the growth in awareness and willingness is assumed to be 4% per year.

11 The rate of the acceptance of existing technologies is likely to be different than for emerging technologies. The growth in the ratio of existing technologies relative to a similar ratio for emerging technologies may be slower due to high levels of previous adoptions for existing technologies that lead to market saturation as we approach the end of the forecast period. The level of the existing technology ratio will be high due to current acceptance of the existing technologies among both consumers and trade allies. Applying a low level of awareness and willingness to emerging technologies, and assuming a significant rate of growth, works to reduce the impact of the two concerned listed above.

Table 11-7 lists the estimated technical potential in each year, for cumulative adoptions, with the three market potential incentive alternatives: (1) current incentives, (2) incentives equal to the full incremental cost of the measures, and (3) a scenario with incentives midway between the current and full incentive levels. Recall that the current incentive forecast is not based on actual incentive levels for emerging technologies but on the ratio of the forecast of current market savings for existing technologies to technical potential savings for existing technologies. The full increment cost calculations are based on the ratio of the forecast of full incremental cost market savings for existing technologies to technical potential savings. The average forecast is simply halfway between the current and the full increment cost forecasts.

Table 11-7: Electric Technical and Market Potential by Year

	Electric Energy (GWH)				Electric Demand (MW)			
Year	Technical Potential	Market Current Incentives	Market Average	Market Full Incentives	Technical Potential	Market Current Incentives	Market Average	Market Full Incentives
2004	0	0	0	0	0	0	0	0
2005	0	0	0	0	0	0	0	0
2006	3,836	21	21	21	1,505	6	6	6
2007	4,993	62	62	62	1,839	15	15	15
2008	6,152	121	158	195	2,174	28	37	46
2009	7,311	200	261	323	2,510	47	63	80
2010	8,472	296	386	475	2,846	70	96	122
2011	9,594	410	531	653	3,164	98	135	171
2012	10,527	533	688	842	3,441	129	177	225
2013	11,017	651	837	1,022	3,653	163	223	283
2014	11,506	781	999	1,218	3,865	201	273	346
2015	11,994	923	1,178	1,433	4,077	243	330	417
2016	12,481	1,075	1,369	1,663	4,288	291	392	494

Figure 11-4 illustrates the market potential estimates of electric energy impacts by year for "current incentives," incentives equal to full incremental cost incentives, and a scenario mid-way between the two. As can be seen, the increase in incentives to full incremental costs or to half way between current incentives and full increment costs is assumed to be implemented in 2008. The steep increase in the market forecasts, relative the forecasts of the market potential for existing technologies, is due to the rapid rise in awareness and willingness assumed for emerging technologies. The market for these technologies is likely to grow, and market saturation is not an issue during the forecast period as it is for many existing high efficiency technologies. Table 11-2 illustrates the market potential of peak demand.

Figure 11-4: Electric Energy Market Potential by Year

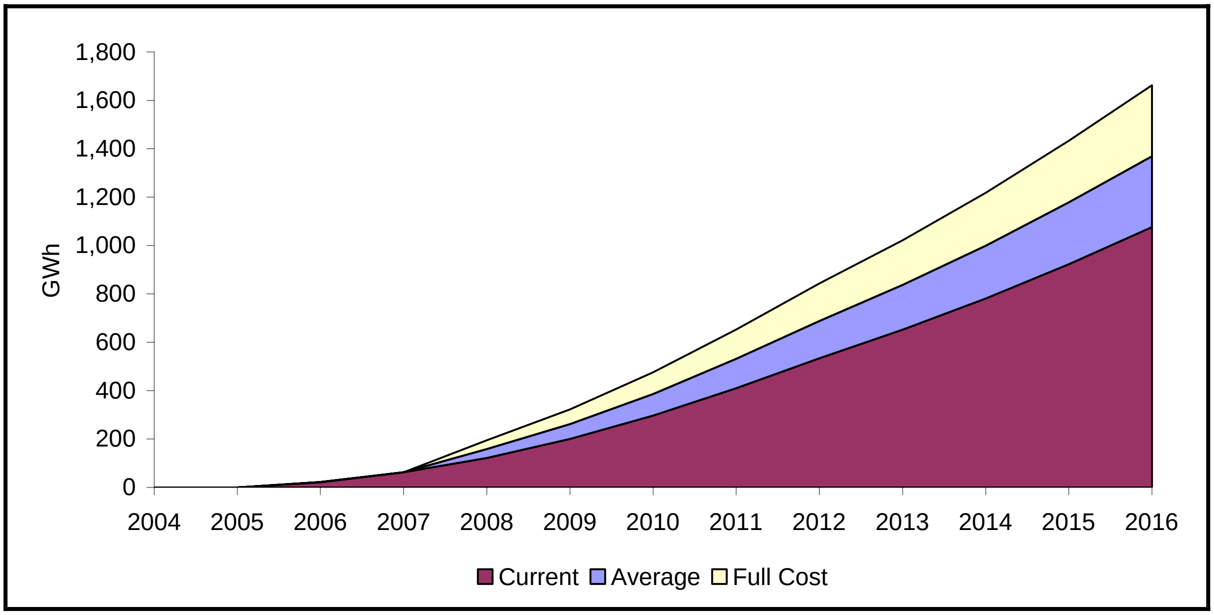


Figure 11-5: Electric Demand Market Potential by Year

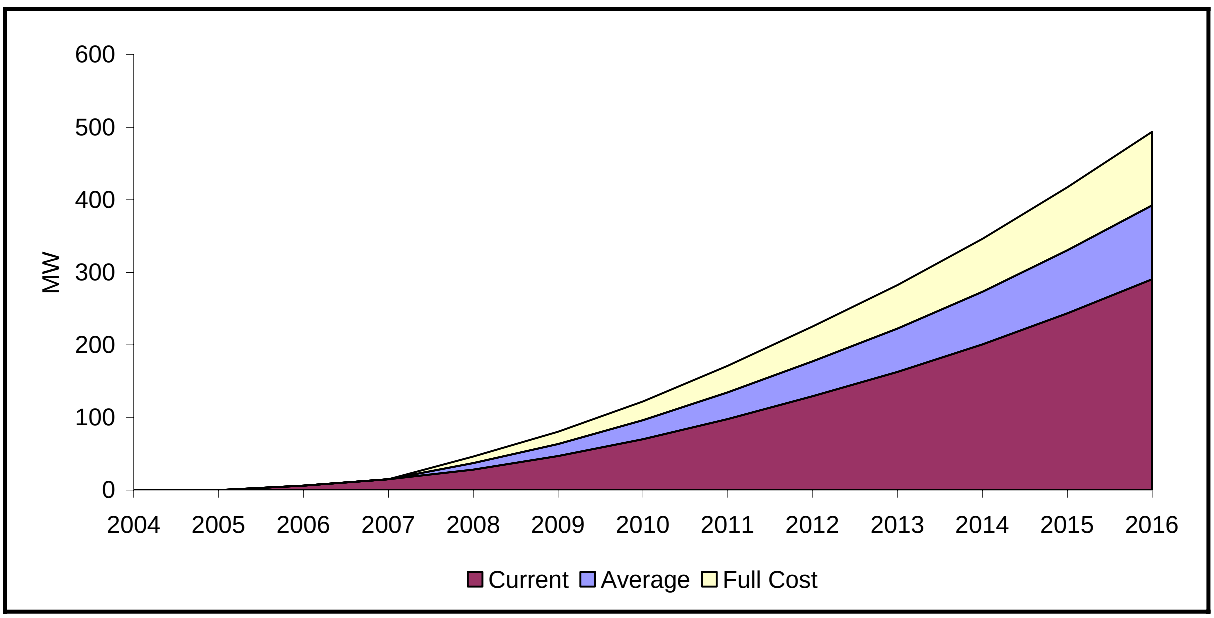
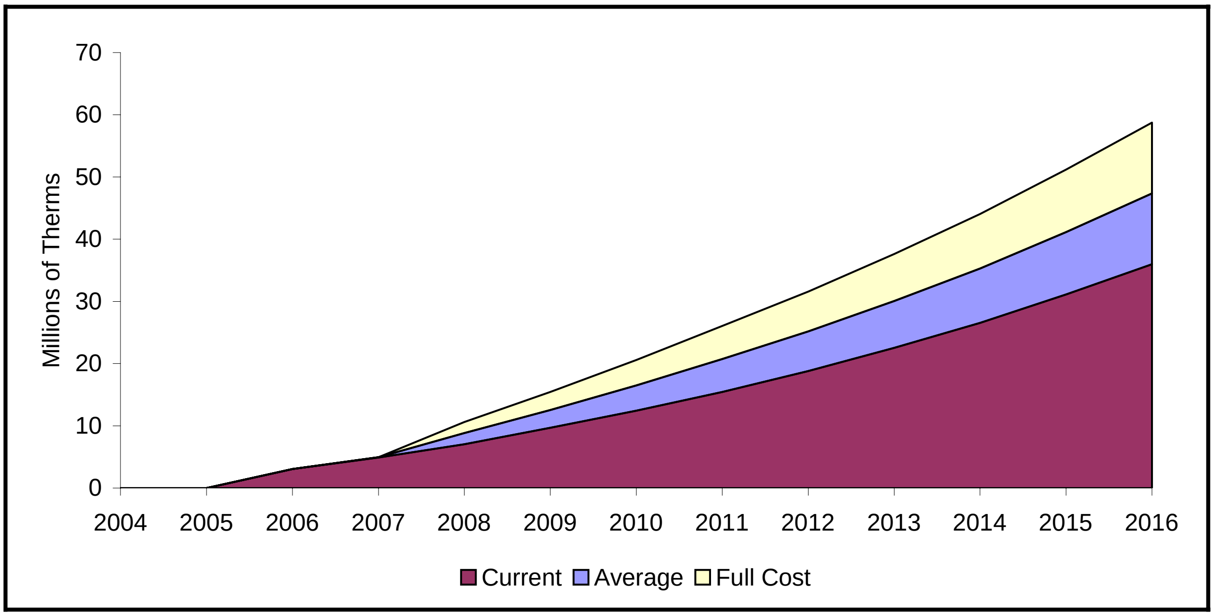


Table 11-8 summarizes the technical and market potential estimates for natural gas. Assumptions for annual acceptance under the three incentive levels were the same as for the electric options. The three market estimates are illustrated in Figure 11-6.

Table 11-8: Gas Technical and Market Potential by Year

Year	Gas (millions of therms)			
	Technical Potential	Market Current Incentives	Market Scenario	Market Full Incentives
2004	0	0	0	0
2005	0	0	0	0
2006	367	3	3	3
2007	384	5	5	5
2008	402	7	9	11
2009	419	10	13	15
2010	436	12	16	21
2011	451	15	21	26
2012	467	19	25	32
2013	483	23	30	38
2014	499	27	35	44
2015	515	31	41	51
2016	530	36	47	59

Figure 11-6: Gas Market Potential by Year



11.6 Summary

A significant level of caution is needed when reviewing estimates of market potential for emerging technologies. Since these technologies have little or no market acceptance to date, their acceptance over the forecast period is uncertain. However, while some technologies will fail to gain acceptance, others not considered and perhaps not yet envisioned will appear and succeed. The history of the energy efficiency market is one in which new options have appeared as older ones have gained widespread acceptance. However, there is a need to develop infrastructure and customer awareness as a prelude to program success with the aid of incentives. The estimates presented above are based on a low level of consumer and trade ally awareness in 2006, but with rapid growth in awareness for the remaining years of the forecast.

The electric efficiency measure found to have the greatest potential was management of computer networks for efficiency, with the primary barrier being lack of acceptance by network administrators. A combination of incremental improvements in the software and successful case studies may result in much of this potential being achieved. The second most important option was 1-Watt standby power in home appliances. A portion of this will be achieved through recent advances and through ENERGY STAR labeling. With increased information and other program support, this option, like network management, may gain widespread acceptance and result in substantial efficiency gains. The third and fourth most important options were in commercial lighting and residential and commercial air conditioning. Given very active research and development in these areas, it appears likely that substantial savings from emerging technologies will occur. Finally, the residential heat pump water heater is an interesting case of a technology with good savings potential; it has been in the market for over 20 years with an uneven history, but may now be poised to gain customer acceptance.

12

Summary and Conclusions

12.1 Focus of Study

This report presents estimates of the technical, economic, and market potential for energy efficiency in the service areas of the four major investor-owned utilities in California. It summarizes the findings of three recent studies of energy efficiency potential in California. The primary focus is on the Energy Efficiency Potential Study, which assessed the potential for electricity and gas savings in existing residential and commercial buildings. However, results from two other studies are also integrated in order to provide a comprehensive view of California energy efficiency potential. The first is an analysis of industrial energy efficiency potential, conducted recently by KEMA, Inc. The second is a study of potential in residential, commercial, and industrial new construction, conducted by Itron, Inc. under a separate contract. The three studies covered by this report, taken together, consider potential energy savings resulting from the installation of high efficiency measures for retrofit, replace-on-burnout, conversions, and new construction situations. Energy savings resulting from changes in behavior, or requiring major redesign of existing systems, were not included in the scope of this work.

12.2 Overview of Study Objectives and Scope

The primary objective of the work underlying this report was to produce estimates of remaining potential energy savings that might be obtainable in the near (2006-2008) and foreseeable (2009-2016) future through publicly funded energy efficiency programs in the existing and new residential, commercial, and industrial sectors. Some of the key questions addressed with this research include the following:

- What is the remaining technical, economic, and market potential for energy efficiency through the year 2016?
- What is the gain in energy efficiency market potential if program funding is increased?
- How does the potential for energy efficiency vary by market sector and climate zone?

The findings from this study will be used by the four California IOUs and their program planners to focus utility program offerings by technologies, sectors, and climate zones. The results will help locate where potential savings remain and which technologies offer the most efficient opportunities for energy savings. The results from this study will help the utilities assess and, to the extent possible, meet the energy saving goals set by the CPUC.

12.3 Methodology

Most of the analysis was conducted using a model called ASSET. The existing industrial forecast used KEMA's DSM ASSYST model. ASSET is a simulation model that yields estimates of technical, economic, and market potential for energy efficiency technologies under a variety of assumptions relating to market conditions, technology features, and customer characteristics.

Inputs used to implement the ASSET analysis for existing residential and commercial buildings were developed from a variety of sources. The Database for Energy Efficiency Resources (DEER) database was the primary source of information for efficiency measure impacts and costs. Due to the timing of this study and the release of the 2005 DEER database,[1] the residential forecast used the 2001 DEER database[2] while the commercial forecast used impacts and costs from the 2005 DEER database. This information was supplemented by other sources, such as utility submittals, where necessary. The *CPUC Policy Manual* was the primary source of measure lifetime information. Technical feasibility was based on professional judgment, supplemented by survey data on specific related end-use characteristics. Indicators of applicability of specific measures were derived from the Residential Appliance Saturation Survey (RASS) and the California Energy Use Survey (CEUS). Legal and market availability of measures were based on a review of codes and standards as well as professional judgment relating to commercialization of new technologies. Base shares and technology densities of measures were estimated based primarily on the California Residential Market Share Tracking Study, RASS, and CEUS.

Inputs used to implement the ASSET analysis for newly constructed residential, commercial, and industrial buildings were developed differently than for existing buildings. As part of the New Construction Potential Study, Itron, AEC, and RLW were charged with running Title 24 compliance software and/or DOE-2 to determine packages of measures that would allow newly constructed buildings to reach various levels above the Title 24 Standards.[3] The team

1 Itron, Inc. *2004-2005 Database for Energy Efficiency Resources (DEER) Update Study: Final Report.* Prepared for Southern California Edison. December 2005.

2 Xenergy, Inc. *2001 DEER (Database for Energy Efficient Resources) Update Study.* Prepared for the California Energy Commission. August 2001.

3 For newly constructed industrial buildings, a combination of packages and individual measures were analyzed.

was also charged with conducting interviews with builders and contractors to estimate the incremental cost of the high efficiency measures used in the packages. Appendices O, P, and Q include the detailed methodology for developing the ASSET inputs.

The housing, commercial floorstock, and industrial load forecasts used in the analysis were developed by the California Energy Commission (CEC) in early 2004. However, the project team did not use the rate forecast that was available when the data were being developed because the first two years of the forecast had already passed and were significantly different than the rates seen during those years.

12.4 Summary of Results

Table 12-1 through Table 12-3 summarize the results of the study. These results are further illustrated in Figure 12-1 through Figure 12-6. All results relate to the annual savings obtained by 2016 from measure adoptions through 2016. The start year for each sector is listed in the table. The analysis for existing buildings is calibrated to the 2004 IOU program accomplishments while the new construction analysis is calibrated to the 2003 IOU program accomplishments. The calibration year is the start year for all analysis other than for existing industrial buildings, where the start year is the calibration year +1 (2005). The emerging technology estimates begin in 2006 to allow the time necessary of emerging technologies to enter the market place. Savings are in gross form, in the sense that they are not adjusted for naturally occurring adoptions. Savings are net of known changes in standards, in the sense that they change the base measure and incremental savings in years when standards change.

Electric Energy Potential

As shown in Table 12-1 and Figure 12-1 the technical potential for annual electric energy savings is estimated to be 63,814 GWh by 2016. Of this, 53,150 GWh is economic, in the sense that the measures it represents pass the total resource cost (TRC) test. The market potential for electric energy savings depends upon the level of incentives offered for the covered measures. Under the current incentive scenario, which assumes that incentives stay at their 2004 levels, market potential amounts to 16,226 GWh by 2016. With incentives that fall half way between 2004 values and full incremental costs (the average scenario), market potential would be 20,065 GWh as of 2016. Under the most aggressive scenario, in which incentives cover full incremental measure costs, market potential is 23,974 GWh. As illustrated in Figure 12-2, 53% of the market potential under the current incentives scenario relates to existing residential buildings. Another 18% is associated with existing commercial buildings, followed by 14% in industrial buildings. Emerging technologies (which are listed separately here) account for another 7%, and new construction accounts for the rest.

Table 12-1: Annual Electric Energy Potential by 2016 (GWh)

	Technical	Economic	Market Current	Market Average	Market Full
Residential Existing Buildings (2004-2016)	25,807	19,226	8,445	10,309	11,757
Commercial Existing Buildings (2004-2016)	13,932	11,290	3,000	4,104	4,720
Industrial Existing Buildings (2005-2016)	5,485	4,973	2,338	2,915	3,380
Residential New Construction* (2003-2016)	1,099	635	147	147	255
Commercial New Construction* (2003-2016)	4,553	4,093	978	978	1,938
Industrial New Construction* (2003-2016)	457	452	243	243	261
Emerging Technologies* (2006-2016)	12,481	12,481	1,075	1,369	1,663
Total	**63,814**	**53,150**	**16,226**	**20,065**	**23,974**

* New construction did not estimate the average market potential, so the current market potential has been used in the market average column. For emerging technologies, all analyzed measures are assumed to be economic.

Figure 12-1: Annual Electric Energy Potential by 2016 (GWh)

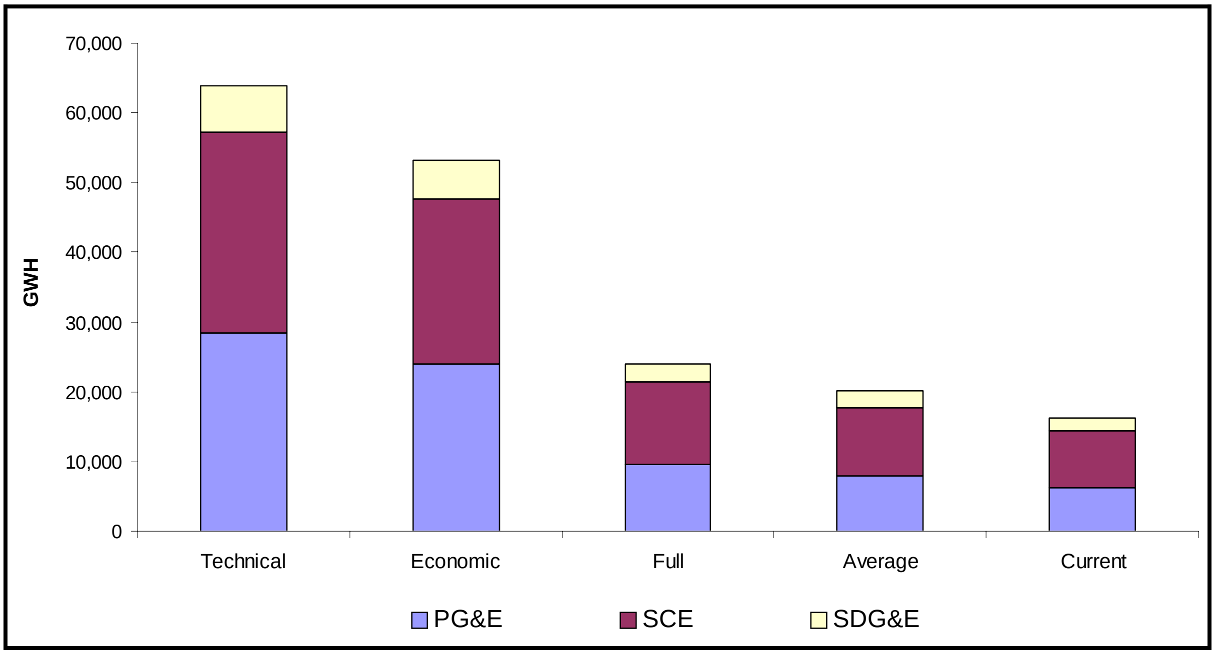
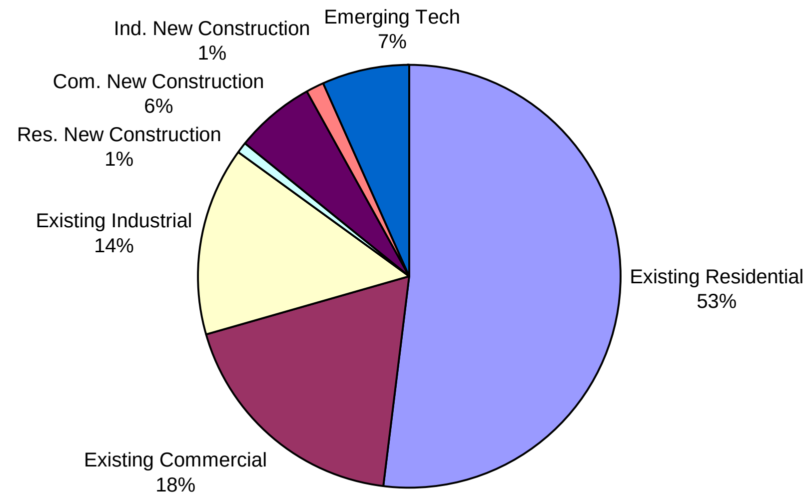


Figure 12-2: Distribution of Electric Energy Market Potential, Current Incentives – 2016



Peak Demand Potential

Table 12-2 and Figure 12-3 indicate the potential for peak demand savings by 2016. As shown there, the total technical potential for peak demand reductions is 15,483 MW in 2016. The corresponding economic potential, based on the application of the TRC test, is 11,151 MW. Market potential ranges from 2,594 to 4,887 MW across the three incentive scenarios. As shown in Figure 12-4, 45% of the market potential for demand savings is associated with residential new construction, with another 18% and 11% relating to the existing commercial and industrial sectors, respectively.

Table 12-2: Annual Electric Peak Demand Potential by 2016 (MW)

	Technical	Economic	Market Current	Market Average	Market Full
Residential Existing Buildings (2004-2016)	5,365	2,729	1,161	1,827	2,233
Commercial Existing Buildings (2004-2016)	3,096	1,996	461	787	982
Industrial Existing Buildings (2005-2016)	755	657	285	370	447
Residential New Construction* (2003-2016)	948	533	142	142	254
Commercial New Construction* (2003-2016)	961	879	215	215	436
Industrial New Construction* (2003-2016)	70	69	39	39	41
Emerging Technologies* (2006-2016)	4,288	4,288	291	392	494
Total	**15,483**	**11,151**	**2,594**	**3,772**	**4,887**

* New construction did not estimate the average market potential, so the current market potential has been used in the market average column. For emerging technologies, all analyzed measures are assumed to be economic.

Figure 12-3: Annual Electric Peak Demand Potential by 2016 (MW)

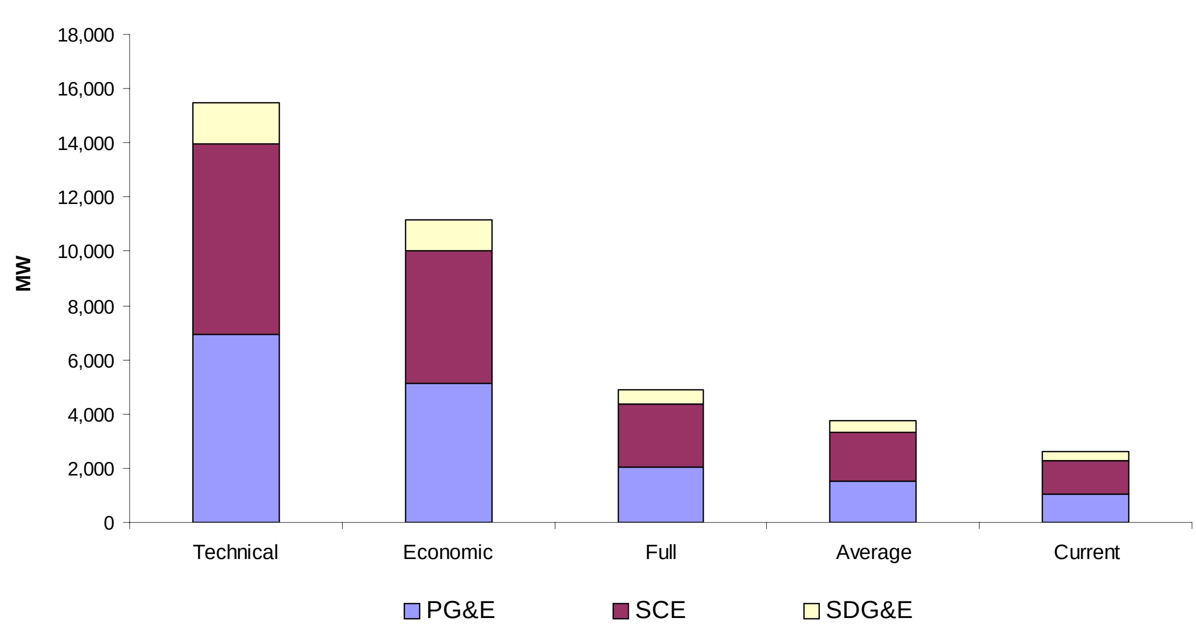
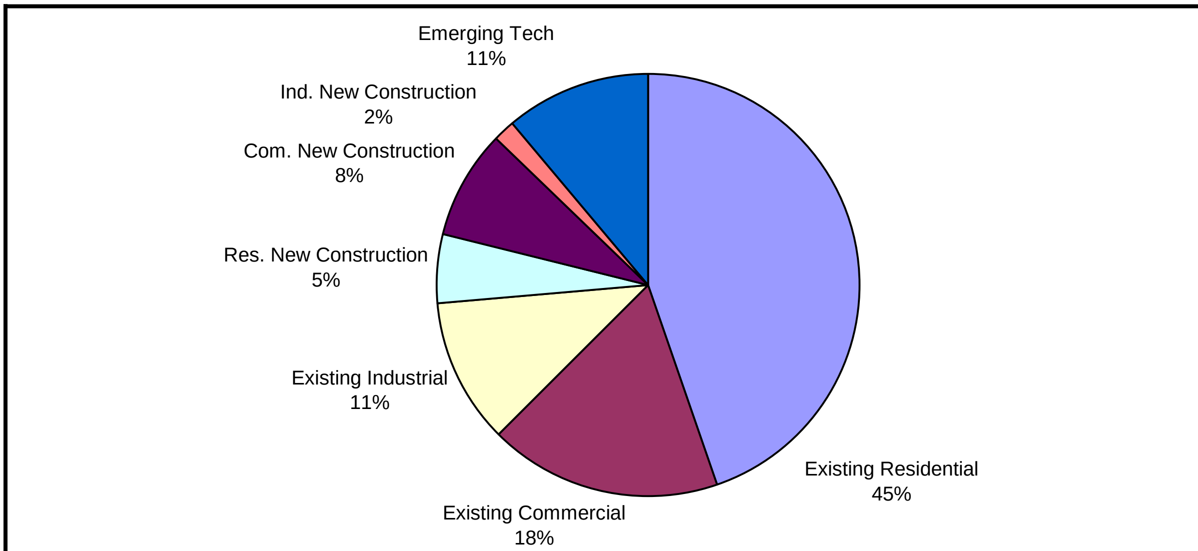


Figure 12-4: Distribution of Electric Peak Demand Market Potential, Current Incentives – 2016



Natural Gas Potential

Table 12-3 and Figure 12-5 depict the potential for natural gas savings by 2016. As shown, the total technical potential for annual gas savings is 2,336 million therms by 2016. Of this, 1,453 million therms of annual savings is economic. The market potential for natural gas savings by 2016 ranges from 247 million therms under the current incentive scenario to 622 million therms under the full incremental cost incentive scenario. As illustrated in Figure

12-6, 36% of the market potential for natural gas savings under the current incentives market scenario comes from existing residential buildings. Share of commercial and industrial existing buildings are 11% and 27% respectively. Emerging technologies account for another 15%, with the rest being attributable to new construction.

Table 12-3: Natural Gas Potential – 2016 (millions of therms)

	Technical	Economic	Market Current	Market Average	Market Full
Residential Existing Buildings (2004-2016)	972	303	88	178	231
Commercial Existing Buildings (2004-2016)	109	38	27	44	56
Industrial Existing Buildings (2005-2016)	469	468	67	142	212
Residential New Construction* (2003-2016)	190	78	18	18	44
Commercial New Construction* (2003-2016)	66	36	11	11	20
Industrial New Construction* (2003-2016)	n/a	n/a	n/a	n/a	n/a
Emerging Technologies* (2006-2016)	530	530	36	47	59
Total	**2,336**	**1,453**	**247**	**440**	**622**

* New construction did not estimate the average market potential, so the current market potential has been used in the market average column. For emerging technologies, all analyzed measures are assumed to be economic. Industrial new construction did not include gas measures.

Figure 12-5: Natural Gas Potential – 2016 (millions of therms)

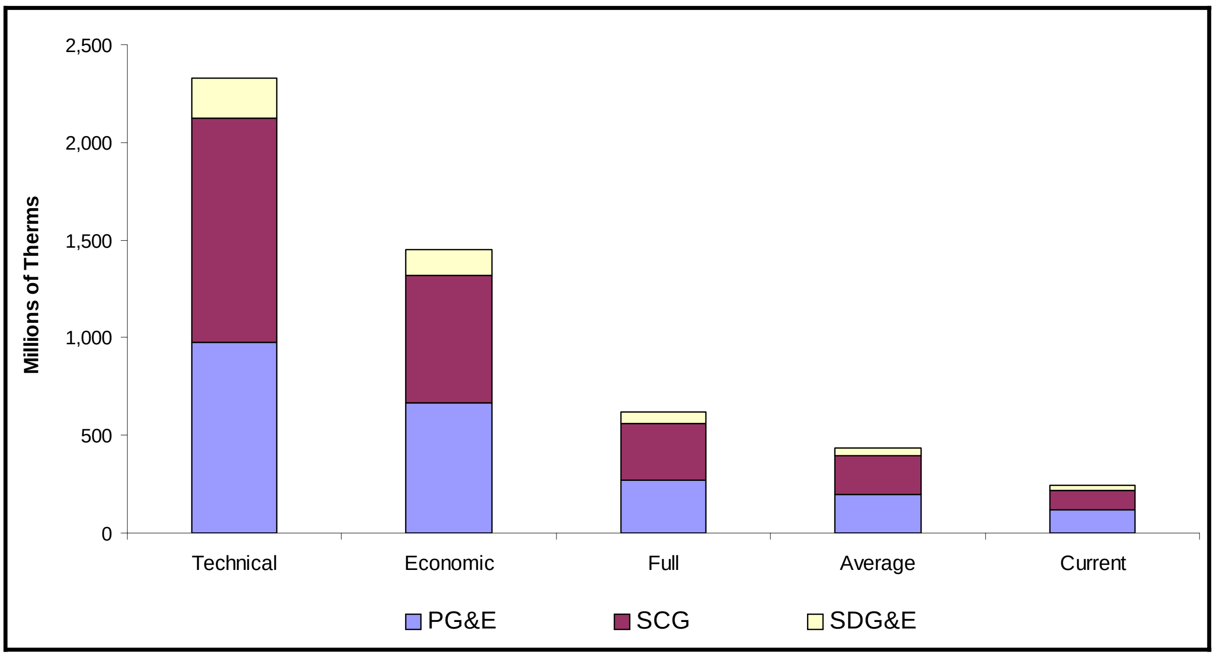
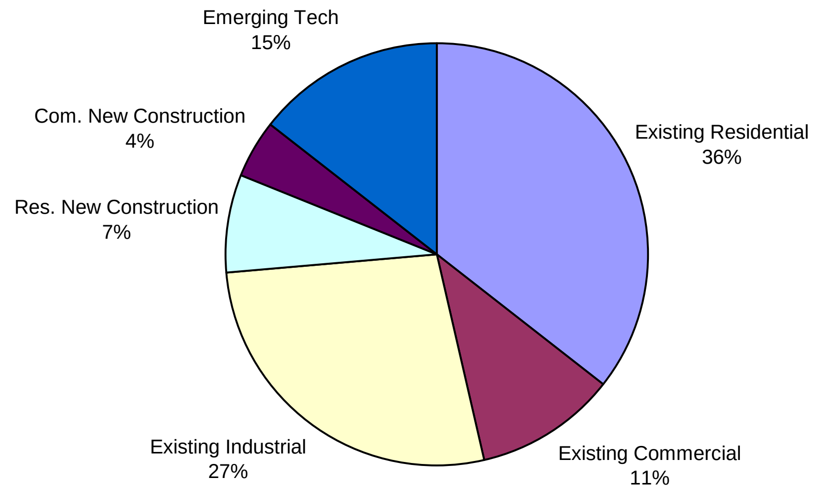


Figure 12-6: Distribution of Natural Gas Market Potential, Current Incentives – 2016



12.5 Caveats

Any study of this sort is subject to a number of caveats. Several important caveats affecting this study are offered below.

Scenario Simulations Rather than Forecasts. Each of the simulations of market potential presented in this report reflects a specific set of assumptions about incentive levels. None of these scenario-specific simulations should be considered a forecast of what is likely to occur over time, since program designs, incentive levels, rates, and rebated measures are constantly evolving and adapting to the existing context. The estimated accomplishments of the scenario models presented here are based on the best available information for key input variables, along with key assumptions concerning program design, floor space growth, and rates, which may not be borne out by reality. In a sense, energy efficiency markets in California can be expected to be a blend of the various scenarios, and energy efficiency accomplishments can be expected to reflect elements of each of the scenario simulations. Given the blending of these various elements, with the major increase in program budgets in the 2006-2008 period, we can probably expect program accomplishments over these years to more closely resemble the simulated results of the average incentives or full incentives scenarios, rather than the current incentives scenario.

Market Saturation and Diminishing Program Accomplishments. One of the primary findings of this study is that the simulated total annual program accomplishments under each of the scenarios tend to diminish over time as the markets for energy efficiency measures mature. For some measures, markets may become relatively saturated, leaving relatively little additional market potential for the measures in question.[4] Program goals—both those set by policy makers as well as those set by program planners and resource planners—should be set with this fact of life in mind. For instance, it should be recognized that running more aggressive programs in one year diminishes that amount of potential left for subsequent years, and may ultimately lead to reduced program accomplishments. At the same time, while this phenomenon has important implications for program planning, it is *partly* an artifact of the primary focus on existing measures. While we have attempted to include some consideration of emerging technologies, even this analysis was focused on currently commercialized technologies. It should be recognized that new measures will also emerge over time, and their promotion through utility and third party programs will provide new sources of program accomplishments. One way to interpret the results of this study in this area is that the maintenance of high levels of annual program accomplishments will necessitate enhancements in the mix of measures offered by these programs over time.

Sensitivity of Simulations to Program Activity. Comparisons of the various market potential scenarios provide indications of the sensitivity of program accomplishments to the level of program activity. As indicated by the titles of the market potential scenarios, the aggressiveness of program designs is represented by the levels of incentives. This aspect of the analysis is subject to two important caveats. First, relatively little empirical work has been done to estimate customer responses to variations in incentive levels, so the results are subject to a significant degree of uncertainty. More research needs to be conducted on this point. Second, program interventions go far beyond financial incentives, and undoubtedly affect awareness of energy efficiency options as well as willingness to purchase those options at a given incentive level. As a result, the differences across these scenarios may understate the impacts of increased program activities. Somewhat mitigating this potential bias, however, it should be recognized that increases in sensitivity to more aggressive programs would be largely timing effects, since the more rapid realization of potential under an aggressive scenario can be expected to diminish the incremental potential for future programs.

General Market Conditions. All of the market potential scenarios depicted in this report assume a given set of future market conditions (other than incentive rates). Obviously, key market conditions like retail rates, avoided costs, and technology costs may follow a very different time path than assumed for the purposes of this study. As these conditions change, simulations will need to be revisited.

[4] To reach some of the remaining markets it may be necessary to change program designs to include integrated solutions. Changes in program designs could lead to synergies that could postpone the onset of diminishing returns. Program design changes, including the implementation of integrated solutions, were not modeled in this analysis.

Comparisons with Previous Studies. It is worth repeating the point made in Section 6 with respect to comparisons of the results of this study with the results of previous studies. As noted there, these comparisons reflect a variety of factors, including different periods (most importantly different starting points), availability of different data on key factors (e.g., current saturations of energy efficiency technologies, or end-use load shapes), different emphases, calibration to different program results, and so on. In general, once we control for these factors, the results of this study are generally consistent with those presented in earlier reports covering California's market for energy efficiency.

12.6 Issues and Areas for Future Study

The completion of an analysis of this size and depth often leads to suggestions for future research.

Economic Conditions. All of the scenarios depicted in this report assume a given set of future market conditions. Obviously, key market conditions like retail rates, avoided costs, technology costs, and floor space may follow a very different path than assumed for the purposes of this study. Future studies may want to rethink the combination of measures, climate zones, and market conditions analyzed. This study analyzed numerous measures and climate zones under one set of economic assumptions.[5] In the future researchers may want to reduce the number of climate zones analyzed for non-weather sensitive measures and implement sensitivity analysis to key economic assumptions.

Recent increases in energy prices have contributed to increases in retail rates and avoided costs. The relative size of these price increases, and the possibility that retail rates and avoided costs may remain at historically high levels for the near term (two to four years), has increased interest in knowing the sensitivity of potential estimates to price changes.

The market scenario chosen for this report may have been driven, in part, by the desire to better understand the incentive levels necessary to reach savings goals. Reducing the number of climate zones (possibilities include north/south and coastal/non-coastal zones) would allow for sensitivity analyses of other economic variables on potential. Reducing the number of climate zones analyzed, however, may reduce the usefulness of the results for program planners who wish to focus their efforts on geographic regions with untapped potential.

We believe that climate zone aggregation is not a sensible option for weather sensitive measures. For weather sensitive measures (air conditioning, shell, and heating measures), savings vary significantly by climate zone. Aggregation of weather sensitive measures

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5 This study used a measure of avoided costs that varied by climate zone and through time. The analysis, however, did not analyze the impact of multiple sets of avoided costs that varied by climate zone and time.

would significantly limit the ability of the model to adequately estimate adoption behavior or savings potential.

Impact of Standards. The estimates of the remaining energy efficiency potential presented in this report are net of the 2006 changes in Federal and California home and appliance standards. Netting out the changes in standards works to reduce the remaining potential when compared to estimates, which do not incorporate standards changes. KEMA-Xenergy's (2002, 2003) estimates of the remaining potential did not incorporate changes in standards during the forecast period.

Changes in standards have contributed substantially to energy and demand savings associated with high efficiency measures. It is possible to use the ASSET model to estimate the energy and demand savings associated with the 2006 change in standards. Using the model to determine the energy and demand savings from changes in standards would provide the utilities and the CPUC with a consistent estimate of these savings. If the future it is also possible to use the ASSET model to estimate the impact of proposed changes in standards.

Integrated Measures. The estimates of the remaining energy efficiency potential were forecast using a measure specific approach. This model assumes that the customer considers that economic and non-economic features of each measure when making their adoption decisions. The model does not estimate the potential associated with integrated measures installed as a package. Types of measures not incorporated in the analysis include building tune-ups and energy savings associated with systems approaches or retrocommissioning. These measures were not included in the analysis because the underlying data needed for the study were not readily available for integrated measures. Information on the applicability, cost, and energy savings for these measures are highly uncertain and require additional study. If these measures become more integral to the IOU energy efficiency programs, they will need to be included in this type of analysis.

Market and Economic Potential. For many of the sectors presented in this report, the full incremental cost market potential is less than the economic potential. This result implies that with current program and measure designs, it would not be possible to encourage all individuals to install all the cost-effective high efficiency measures even if the measures were provided at a cost equal to the standard efficiency measure.

This pattern of results is due to negative measure and/or program non-economic attributes or perceptions for some high efficiency measures. For example, CFLs are almost always cost-effective, yet the full market potential is less than the economic potential. Consumers have chosen to restrict their installation of these measures to less than the cost-effective, feasible applications. Giving these lights away would not lead all households to eliminate all of their applicable incandescent lights.

To encourage more customers to adopt such a cost-effective high efficiency measure, it may be necessary to change more than the measure's incentive. It may be necessary to work to change the program, the measure, or customers' perception of the measure to increase adoption behavior. Utilities may want to examine measures whose full market potential is substantially less than the economic potential to determine if changes in program delivery, implementation, or information may significantly change adoption behavior. Even with program changes, however, there will be cost-effective measures that consumers choose not to adopt due to perceived or actual quality issues.

Payback Parameters. Estimates of market potential depend on the calculated influence of measure cost, incentives, incremental energy savings, and retail rates on adoption behavior. The influence of existing economic variables on adoption behavior can be determined using professional judgment or empirical analysis. When the value of economic variables, including incentives, reaches a level not previously observed, additional assumptions about those variables' influence on behavior are necessary.

The ASSET model employs economic inputs to calculate measure specific payback periods. The influence of payback length on adoption behavior is determined by the model payback parameters. The payback parameters were empirically calculated from analysis performed in the Midwest. Given the importance of these parameters on market forecasts of potential, we feel that additional research should be undertaken to determine the current influence of economic inputs on Californian's market energy efficiency potential.

Payback parameters could be determined using several different types of research. Given the long-standing nature of California's energy efficiency programs, a time-series analysis of adoptions, incentives, measure costs, and retail rates could be used to determine the historic relationship between economic variables and adoption behavior. Alternatively, a conjoint or double-bounded survey of adoption behavior could be undertaken to determine the influence of alternative incentive levels on adoption behavior.