CA IOU Codes and Standards Earnings Claims Framework

FINAL REPORT

Three Prototypes
And Summary

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Submitted to:
Pacific Gas & Electric Co.
Pat Eilert
(530) 757-5261

Submitted by:
HESCHONG MAHONE GROUP
11626 Fair Oaks Blvd. #302
Fair Oaks, CA 95628
Phone:(916) 962-7001
Fax: (916) 962-0101
e-mail: info@h-m-g.com
website: www. h-m-g.com

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PREFACE

This report is the result of the efforts of many people and numerous activities. The estimates of electricity, gas and peak demand impacts for Residential Standards measures and the portions of the Appliance Standards specific to residential construction were generated by Ken Nittler of EnerComp and Bruce Wilcox of Berkeley Solar Group. The analysis of the impacts of the Nonresidential Standards revisions and the HVAC and Water heating portions of the Appliance Standards specific to nonresidential construction was performed by Pete Jacobs and David Roberts of Architectural Engineering Corporation. The analysis for Dry Type Transformers was performed by Eley and Associates for PG&E's CASE Program, and referenced here. The HESCHONG MAHONE GROUP was responsible for managing the analysis process, performing the balance of the analysis, and generating this report.

The draft report was initially reviewed within PG&E's Codes and Standards office and later by a wider audience within PG&E's Energy Efficiency division. In July 2001, the Codes and Standards personnel at the other investor owned utilities (IOU) in California reviewed the draft. From each review, the authors received very constructive comments which resulted in improvements to the report, including correction of various minor errors and omissions (e.g., nonresidential exterior lighting was initially omitted, and a slight inaccuracy in Cool Roof reflectivity was corrected).

The analysis that formed the basis of the draft report was also reshaped based on recommendations and observations of the reviewers. For example, we redid the MW impact estimate using a method for calculating peak demand that is more consistent with other utility program evaluation efforts. Additionally, we enhanced the analysis to begin crediting savings for Appliance Standard measures at the point where those standards become effective. The second round of analysis was performed in late August and early September 2001.

1. INTRODUCTION

In the summer of 2000 many parts of California experienced sharply higher prices for electricity, power shortages, or both. The Legislature and Governor reacted by enacting AB970 as an emergency measure. AB970 empowered the California Energy Commission (CEC) to, among other things, adopt new Building and Appliance Standards within an emergency rulemaking – within 120 days. Updated Residential and Nonresidential Building Standards were adopted as emergency standards by the CEC in early January, 2001, and re-adopted through the full process in April.

The first of two sets of Appliance Standards resulting from AB970 were adopted in February, 2001. The Energy Commission has an open rule-making for a second set of Appliance Standards that they are planning to adopt near the end of 2001.

The CEC could not have accomplished much of the work needed for development and adoption of these standards without the help and analysis of interested third parties. Of these, the state's investor owned utilities (IOUs) were the most active and provided the greatest amount of assistance. The IOUs had begun a project nearly a year before AB970 was enacted, that sought to identify likely targets for standards upgrades. In early 2000, the Codes and Standards Enhancement Project (CASE) singled out a list of measures for further study and analysis with an intent of urging the CEC to adopt them in the 2004 code cycle. The 2004 cycle was the target because the Commission had previously announced that they were "skipping" the 2001 triennial code cycle. Then, in August of 2000, the CEC announced that it would be considering "amendments to the [1998] Nonresidential Standards based on provisions of ASHRAE 90.1-1999."[1] The likely changes were all nonresidential and would be in the areas of:

- Cool Roofs
- Fenestration
- HVAC Equipment Efficiency
- Air-side Economizers
- Cooling Towers
- Acceptance Testing and Completion Requirements

Passage of AB970 afforded an opportunity to add more measures (including residential and appliance measures) and possibly to speed up acceptance of some of the code proposals the IOUs' CASE project had been analyzing FOR 2004. Shortly after AB970 was signed by the Governor, the CEC published a

[1] Notice of Staff Workshop: Title 24 Building Energy Efficiency Standards Scope and Analysis Plan for Revisions for 2002. Workshop to be held on Friday, September 8, 2000. Notice issued on August 16, 2000.

request for code change proposals.[2] They requested suggestions in the following categories:

- Residential duct design and sealing
- Residential air conditioning equipment and system efficiency (TXVs, refrigerant charge, right sizing)
- Residential high performance fenestration
- Residential water heating tradeoff rules potentially affecting peak energy
- Residential building envelope
- Residential radiant barriers
- Residential reflective roof coatings
- Nonresidential State building Tier 1 measures
- ASHRAE 90.1-1999 Tier 2 measures
- Nonresidential duct efficiency for roof top units
- Nonresidential HVAC controls
- Nonresidential lighting and lighting controls

PG&E offered those CASE initiatives that appeared to be ready for adoption, and asked its contractors to help identify any others that had not been included in the CASE project. The IOUs provided at least 14 proposals that either ended up in the Building and Appliance Standards or will be included in the later 2001 adoption of the Appliance Standards. Many other code changes, although proposed by others (e.g., CEC staff, NRDC) were strongly supported and improved by efforts made through the IOUs' on-going CEM market transformation programs. Adoption of some measures was arguably only possible because of familiarity with the technology developed through the utilities' new construction and retrofit programs.

The *quality* of the IOU's code enhancement efforts has often been recognized by the CEC. PG&E even received an official letter of appreciation from the Chairman of the Energy Commission in 1992 and another letter of appreciation from the CEC Energy Efficiency Committee in 2001. This report is an attempt to *quantify*, perhaps for the first time, the energy impacts attributable to those efforts. In the analysis leading to this report, we took a conservative approach both to estimating the overall impact of each standards measure, as well as estimating the "credit" that the IOU Codes and Standards (C&S) program should receive. It is likely that the actual impacts are significantly larger.

1.1 Program Portfolio

It is inevitable that comparisons will be made between these impact estimates and those for other types of programs (incentive or information programs). It is worth saying up front that we believe this analysis shows the Codes and Standards program to be a necessary, but not sufficient, part of a *portfolio* of

[2] Notice of Workshop: AB970 Building Energy Efficiency Standards Updates for 2001. Workshop to be held on Monday, September 25, 2000. Notice issued September 13, 2000.

programs. Code adoption is like the pot of gold at the end of the rainbow; but without the rainbow it's hard to find. It is clear that many of the measures adopted during this current code cycle would not have been ready for inclusion in the codes without the design assistance, incentives and market transformation efforts that preceded. Early on, there are the energy efficiency programs that seek out and promote new efficiency technologies and practices. Then the Codes and Standards effort helps to move these innovations into the code as quickly as possible. We believe the link between these two types of programs is so strong that this new analysis could help to make a case for claiming even greater savings than are currently claimed for those new construction and retrofit programs that foster measures which eventually end up in code. In other words, this study argues for even greater earnings claims for the new construction and retrofit programs that increase the likelihood of measure adoption in codes through their market transformation effects; specifically increasing builders' comfort with the measure.

One of the primary differences between codes and standards programs and other energy efficiency programs is which portions of the relevant markets are most affected. A "normal" market penetration curve (see Figure 1) for energy efficiency technologies typically tops out before the technology has reached 100% of the potential market. Codes and standards lift that final segment and speed adoption for the preceding fraction. Those who benefit most from this change are often those in smaller businesses, less expensive housing or other underserved customers. When a measure becomes part of the standards, the benefit accrues to all who might later purchase the equipment or service.

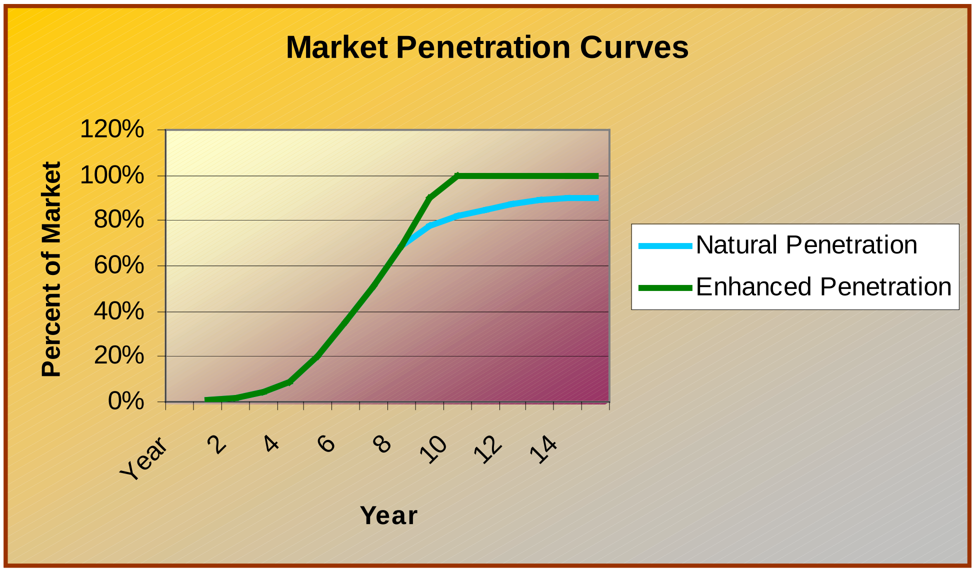

Figure 1: Market Penetration Curves

1.2 Methodology

In preparing this analysis we maintained consistency with the CEC assumptions and estimating methods as much as possible. The Residential Building Standards measures were analyzed by Ken Nittler and Bruce Wilcox, the same team that provided the residential background analysis for the CEC. The Nonresidential Building Standards measures were analyzed by AEC, part of the team that did the nonresidential background analysis for the CEC.

Where possible, we simply report out the results of the Appliance Standards measures analysis that are part of the CEC's record. In many cases the original analysis did not provide energy impacts (gWh/yr, MW, and Mtherm). We had to complete that analysis. In other cases, some of the assumptions lacked the conservatism that we felt was appropriate to an analysis for earnings claims.[3]

There are a number of ways one could develop an earnings claim for codes and standards programs. One way to approach the question might be to assign milestones so that C&S Programs receive ***X*** amount of earnings if the code change proposal is presented at a CEC hearing, ***Y*** amount of earnings if it makes it into the 45-day language and ***Z*** amount of earnings if it is actually adopted. This set of criteria would need to be agreed to in advance, and so, does not apply to the efforts of this past year – the focus of this study.[4]

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[3] For example, the original analysis for torchiere lamps assumed that the standard would drive a very ambitious transformation in the sales mix of technologies, and assumed an hours-of-operation more than double what could be justified by research with which we are familiar. We lowered both assumptions.

[4] Since Codes and Standards are generally triennial processes, this mechanism for earnings would have to be adjusted to match up the activities and milestones to the one or two year earnings claims proceedings.

Another option might be to stipulate that any measure proposed by an IOU that is adopted into code should garner the IOU earnings at the same rate of earnings per expenditures as the IOU receives from other programs. However, because the savings for codes and standards changes are quite large compared to the amount of effort invested, this approach would seriously undervalue the energy efficiency benefits.

A third way, the one used in this analysis, is to calculate an estimated energy impact from the IOUs' C&S program efforts so that they can request earnings based on a cents/kWh (or MW, or Therm) basis. After determining an estimate of the statewide energy impacts of the code changes, we determine how much of the credit for the electricity, peak, and gas savings justifiably can be attributed to the IOUs' C&S programs. The process of determining the factor, or fraction of credit to assign to the IOUs, must to some degree be subjective. In this analysis we have attempted to limit the amount of subjectivity in our approach by listing the level of the IOUs' involvement (e.g., none, contributor, or major actor) in each of ten steps in the code development process. This makes the factor assigned both explicit and defensible, if not entirely objective.

1.3 Duration of Impacts

Program impacts are reported within this report for four time periods: one year, three years, five years and ten years. The following is a discussion of why these periods were chosen, and how results for the various impact periods could be used.

1.3.1 One Year

This is the simplest and most defensible period of impact for making an earnings claim for IOU Codes and Standards programs. The first year impacts are fairly straightforward and can be estimated from the most basic, and therefore least contentious, assumptions. In many appliance cases the calculation can be a first order multiplication of direct energy savings for the widget times the number of widgets that are expected to be installed in the first year. The calculation is more complex for each of many Building Standards measures, but still relatively simple. One problem with the first year savings estimate is that the first year is not the same year for all measures, so a total impact has to either, eliminate those measures that do not obtain the first year (say 2002), or overestimate the savings by including items that are not effective until 2004, 2005 or later. We took the former, more conservative approach.

Most of the Building Standards measures became effective June 1, 2001. However, the nonresidential HVAC measures mostly take effect October 29, 2001 and the implementation of the Residential Standards for subdivisions with home designs approved by the permitting authority before June 1, 2001 is delayed until January 1, 2002. Therefore, this analysis assumes 2002 as the "first year."

1.3.2 Three Year

The Energy Commission has made a pledge to the building community to adopt changes to the Standards on a schedule consistent with the Building Standards Commission's triennial code cycle. Since 1992, they have reliably stuck to that schedule. Consequently, there is an uncertainty about what might change in the Standards three years after these go into effect. Arguably then, only the first three years impact of these standards should count. We provide the three year estimate for those who subscribe to this argument.

On the other hand, it is just as valid to argue that part of the benefit, part of the impacts of the next round of standards rightly should be accredited to this round. If the next round of standards is able to "move the bar up a notch," it is in no small way owing to the fact that this round effectively familiarized the industry with what will be the next round's "base case." Additionally, since the IOU new construction and retrofit programs use the state standards as the baseline for their incremental programs, when new standards take effect, it allows the IOUs to focus on the measures and efficiency levels at the next plateau. These eventually become the "standard" in one of the next standards rounds – and the process continues.

Three, five and ten year impact estimates in this report are built-up of savings as they are phased in. For example, we assume the first year of the Building Standards to be 2002, much of the Appliance Standards is expected to become effective late in 2002, and other efficiency levels and even measures are staged in during 2004, 2005 and 2007.[5] The three year impacts include those items for which the code effective date is anytime between June 1, 2001 and December 31, 2004.

Energy impacts are cumulative. In other words, all the savings (kWh and Therms) from the first year are included in the reported impacts of the second and successive years. The second year includes the 2002 and 2003 savings from the buildings built in 2002, plus the 2003 savings from the buildings built in 2003. The third year savings includes the 2002, 2003 and 2004 savings from the buildings built in 2002, plus the 2003 and 2004 savings from the buildings built in 2003, plus the 2004 savings from the buildings built in 2004.

Peak impacts however are not cumulative in the same way. That is, the kW impact of the second year is simply the 2003 impact of the buildings built in 2002 and 2003. The 2004 (third year) kW impacts are the peak reduction in 2004 from the buildings built in 2002, 2003 and 2004. For cases where we had enough data (e.g., reliable estimates of market penetration, sales projections and construction activity), we developed specific estimates of the cumulative impacts.

[5] In order to clarify some of the staging issues and the dates by which the measures are expected to be effective, we have included two tables in the Appendices. One table shows the effective dates and efficiency levels for air conditioning and heat pump equipment. Another provides the effective dates and efficiency levels for water heating equipment.

For other measures where that level of detail was not available, we used the cumulative impact multipliers shown in Figure 11.

1.3.3 Five Years

In addition to the measures included in the one and three year impact analyses, the five years savings analysis accounts for various water heating and HVAC measures phasing in during 2004, 2005 and 2006. Some of these items are subject to DOE granting a waiver from preemption, but for this analysis we assume that they will be implemented. The five year impacts include all measures for which the effective date of the code is before January 1, 2007.

To simplify the analysis and to make the results easier to compare with other studies, we assumed all the Title 24 energy and peak impacts from HVAC and water heating measures accrue from new buildings. The impacts of the HVAC and water heating portions of the Appliance Standards (Title 20) accrue from remodeling, renovations, additions and equipment replacements. For other appliance measures, and other building measures, we attempted to capture the both the new construction and remodeling impacts together.

1.3.4 Ten Years

The ten year estimate of savings and peak impacts accounts for the impacts of code measures implemented during the first five years, with ten year construction estimates. No new measures are assumed to be added into the implementation mix after 2007.

1.4 Reviewer Concerns

A number of concerns with the basic methodology and even general concept of earnings claims for Codes and Standards Enhancement programs were raised during reviews of earlier drafts of this report. We will address here all those concerns that cannot be more readily addressed elsewhere in the report.

1.4.1 Why should the IOUs get ANY credit for Codes and Standards revisions?

This question was generally stated as, “Money for the C&S efforts came from rate-payers, and money for enforcement comes from taxpayers and building permit applicants; so why should IOUs be paid for C&S efforts?” The simple answer is that adoption of the measures under consideration here would not have been adopted but for the IOU programs. We do not claim 100% credit for any of the measures. Clearly, there was some effort on the part of the CEC even for those measures the CEC was not previously considering, and for which the IOUs provided a completed analysis and draft code language. Because of this, the maximum percentage of the credit ascribed to the utilities for any measure is 95%.

To allay one's concerns that the utilities are getting credit for something they shouldn't, one need only read the Scoping and Rulemaking orders of the CEC (showing what they WERE considering before IOU intervention) and some of the reports that were generated under PG&E's Codes and Standards Enhancement program. Some changes were arguably only possible for the CEC to make because of earlier analysis performed under the IOU's C&S programs, even if the CEC might have considered the change. Putting aside those changes for which the IOUs cannot be definitively credited with the proposal and background analysis (in other words, proposals to which they only *contributed*), and examining only those code changes that were unambiguously the result of IOU efforts, the energy savings and peak impacts are still sizeable. The table in Figure 2 shows the impacts from just six Nonresidential and four Appliance Standards changes that were specifically proposed and prepared by PG&E's CASE program. These ten changes alone account for over ¼ of the gWh saved in three years.

Three Year Impacts		
gWh	MW	M therms
521	90.3	1.3
26%	10%	7%

Figure 2 : Impacts of IOU Sole Proposals

In the next section of this report, we present the aggregate impacts of all the AB970 (2001) Title 24 and Title 20 changes taken together. This includes those that the IOUs were not significantly involved in, those that they supported, and those for which they were the primary sponsors. Section 1 describes some of the other major findings of the analysis work, and provides a recommended framework for how this analysis can be used to support earnings claims for code changes resulting in part from IOU C&S programs.

As to the question of the taxpayers' and building permit applicants' money paying for enforcement, there are two responses. First, the building departments' costs (including the portion covered from jurisdictions' general funds) are no greater enforcing one level of efficiency than another. These changes to the standards add essentially no cost to the enforcement of the building codes. Second, the utilities provide significant assistance to the enforcement community by offering classes, helping with specific projects and providing other aids (fact sheets, web sites, etc.). Indeed, IOU C&S and other program efforts ease the burden of the enforcement community by educating other actors in the construction stream (e.g., window manufacturers, architects, and builders). Many IOU programs that provide, as one of the services, a complete energy plan review, have demonstrated that enforcement without the IOU back-up, is often very spotty.

1.4.2 Why shouldn't the CEC get this credit; or at least a share of it?

The simple answer is that by using the percentage responsible approach, the CEC does get credit as part of the "remainder" group once the IOUs' credit is netted out. If the CEC had a purpose for claiming shared credit, e.g., an earnings claims procedure of their own, then they could use this same methodology to determine how large that credit should be. For this study, we did not need to separate the CEC from all others. We only estimated the portion of credit that should flow to the IOUs.

1.4.3 Earnings Claims are for "hard savings" like installed CFLs, and are not appropriate for "soft savings" like building standards efforts.

The simplest response to this concern is that building and appliance standards savings and impacts might be "harder" than some program impacts. There is always a concern about how persistent a market shift (toward a more efficient measure) is when the program that caused the change ceases to offer incentives for inclusion in projects. Once a measure is adopted in code, this common concern evaporates. All new construction has to comply with the building standards, and all equipment sales have to comply with the appliance standards.

There is always a question, in any prospective estimate of impacts, "what would have been?" And there is always the question of how much of the apparent savings actually would have occurred anyway. We believe that we have addressed those questions adequately for this earnings claim by (a) taking a conservative approach to each variable, and (b) by thorough research into what those in the know in each market segment estimate "would have been." We believe that these estimates and the savings they represent are at least as solid as most ex-ante or even ex-post estimates of savings and peak impacts.

1.4.4 Why should the utilities get credit for C&S efforts when they are already getting credit for new construction (NC) programs and retrofit programs on many of the same measures?

The first answer is that they shouldn't for the same time periods and same buildings. In general, when a measure is included in the codes, the IOU incentive programs cease focusing on that widget or the code level of efficiency. C&S programs, as has been asserted above, are only a part of a large portfolio of programs, from research and development, through market transformation, to codes and standards.

Second, the standards typically act on a different segment of the market. It takes efforts at each stage to move most efficiency improvements into the full market; and each effort acts on a different segment of the population. Using LED exit signs for an example, the R&D efforts to develop these devices was supported by the IOUs; sometimes directly, sometimes through EPRI, sometimes through other research centers. Results of these first efforts gave the "early adopters" something to move up to from "standard" exit signs.

The transformation of the market occurred largely a result of IOU incentive programs for both new and replacement LED exit signs. Those builders, developers or building maintenance people who were not bold enough to adopt the new exit signs on their own without greater proof of performance, were often enticed by the IOUs' incentives. This increase in demand helped to bring the costs down and quality up, resulting in even more increases in demand.

The standards revision effort was almost entirely as a result of California IOUs. They supported research and analysis of the energy and cost savings potential. One detail to come out of this analysis was that market penetration of high efficiency exit signs was already near 75%. The portion of the market this change affects is the fairly small late-adopter segment. Consequently, the energy and peak impacts being claimed for C&S exit sign efforts are only in that area, in Figure 1, that is between the two curves (natural market penetration and enhanced market penetration) as they near 100%.

2. SUMMARY OF FINDINGS

There are a few important findings that need to be highlighted - findings that do not necessarily surface in the prototypical analyses of individual measures provided in Sections 2 - 4.

2.1 Aggregate Statewide Savings

In this analysis we covered all the significant changes to the Residential and Nonresidential Building Standards that were adopted by emergency process in January and finalized through the "regular" process in April 2001. We also covered all of the Appliance Standards that were anticipated in the California Energy Commission's 15-Day Language for Title 20 Appliance Standards issued in November 2000. The CEC adopted standards for water heaters and some HVAC equipment in February 2001. They added a small number of measures (and dropped some) when they issued the revised 15-Day Language on March 30, 2001. These changes were not included in the first (draft) analysis that was already underway at the time, but are included in this final version[6].

The following table shows the total estimated energy impacts from all the measures in both the building standards and the appliance standards. It is worth noting that, if you consider the average power plant being built these days to be just under 300MW, then these code enhancements will deliver about one new power plant every year for the next ten years.

	1st Year Impacts			Three Year Impacts			Five Year Impacts			Ten Year Impacts		
	gWh	MW	M therms	gWh	MW	M therms	gWh	MW	M therms	gWh	MW	M therms
Residential Standards	**131**	**199**	**1**	**789**	**597**	**4**	**1964**	**1000**	**9**	**7200**	**1994**	**34**
Nonresidential Standards	**81**	**32**	**0**	**415**	**83**	**2**	**1081**	**138**	**7**	**3964**	**279**	**25**
Appliance Standards	**144**	**55**	**0**	**518**	**216**	**12**	**1271**	**442**	**46**	**7047**	**1378**	**425**
TOTAL	**356**	**286**	**1**	**1721**	**896**	**18**	**4317**	**1579**	**62**	**18210**	**3651**	**484**

Figure 3: One, Three, Five and Ten-Year Aggregate Statewide Impacts

These results vary somewhat from those published as part of the AB970 proceedings. A full explanation appears below in Section 2.3, but it is relevant to point out here that the results shown in Figure 3 are based on a conservative analysis, that the first year is assumed to be 2002, and that first year impacts

[6] Since new 15-day language, after the March 2001 version, has not yet been published by the Commission, measures, efficiency levels and other details of the pending Appliance Standards are subject to change. The specific efficiency measures included here represent our best estimate of what the final language will contain – based on the published 15-day language and extensive discussions with Commission Staff.

from requirements that do not become effective until later years are not counted until the effective year.[7]

Peak Impacts	1 yr		3 Yr		5 Yr		10 yr	
Residential Standards	**199**	69%	**597**	67%	**1000**	64%	**1994**	55%
Nonresidential Standards	**32**	11%	**83**	9%	**138**	9%	**279**	8%
Appliance Standards	**55**	19%	**211**	24%	**432**	28%	**1378**	38%

Figure 4: Distribution of the Peak Savings

Another interesting result of this analysis is a picture of the relative size of the peak impacts derived from changes to the three pieces of the Standards. It is commonly thought that most of what we do to affect residential energy use, does not impact the peak demand very much compared to nonresidential efficiency improvements. In this round of standards revisions, most of the changes were nonresidential changes, and yet the residential standards account for about two thirds of the total peak impact.

The primary residential improvements included upgrades in fenestration SHGC (leading to significantly lower cooling loads), and cooling system improvements (resulting in lower energy usage to meet the cooling load). Inclusion of thermal expansion valves (TXVs) and a requirement for tightened ducts ($\leq$ 6% leakage) comprise the main system improvements.

Perhaps more significantly, this analysis for the first time includes multifamily buildings. The CEC's analysis did not include multifamily construction impacts. This increases the *apparent* size of the residential efficiency gains in our analysis relative to the CEC's. While the CEC has been achieving efficiency gains in multifamily buildings each time it made an improvement to the residential standards, it has never counted those energy savings or demand impacts.

[7] An alternate way to calculate "first year" impacts, as the CEC did for appliances, is to add up the impacts from each measure's first year of effectiveness, even though they are different calendar years.

2.2 Aggregate IOU C&S Energy Impacts

After examining the aggregate impacts of all the changes to the standards, the next step in developing an earnings claim is to estimate the total effect that can be ascribed to the utilities' C&S programs. Due to where the IOUs put their efforts, the ratio of impacts, between Residential, Nonresidential and Appliance Standards, looks different from the ratios in the total statewide impacts. As will be seen from the discussions in the following sections, we used conservative assumptions to derive these estimates, and yet it still appears that the utilities are at least one quarter responsible for the 286 MW peak reduction; an equivalent of providing 60 MW of peak reduction in the first year of the standards.[8] By itself that is nearly 1/10th of the CEC's total statewide projected annual load growth.

CA IOU C&S Program Energy Impacts	1st Year Impacts			Three Year Impacts			Five Year Impacts			Ten Year Impacts		
	gWh	MW	M therms	gWh	MW	M therms	gWh	MW	M therms	gWh	MW	M therms
Residential Standards	21	29	0.11	125.33	87.39	0.77	311.41	146.46	1.63	1142	292	6.0
Nonresidential Standards	34	15	0.04	147.98	32.86	0.87	391.69	54.84	2.88	1441	113	10.3
Appliance Standards	59	16	0.00	183.95	60.15	3.60	398.08	118.96	13.13	1920	365	126.4
Totals	113	60	0.14	457	180	5	1101	320	18	4502	769	143

Figure 5: IOU C&S Aggregate Energy Impacts

Another interesting way to view the changes to the standards is to compare the gas savings to the electricity savings. It was common to hear during the Standards proceedings that we weren't getting any gas savings to speak of – it was all electricity and peak savings. After all, the effort was sparked by an electricity crisis. However, Figure 6 shows that the gas savings expected from this set of changes to the standards will be significant, roughly one third of the MBtu equivalent of the electricity savings. The IOUs' C&S programs deserve credit for nearly one third of that.

[8] We assume only 65% of the nonresidential impact the CEC did due to differences in projected NR new construction square footage. If the CEC's nonresidential new construction projections prove to be more accurate, then the peak impacts from the IOU's codes and standards program efforts will be 8, 18, and 30 MW higher than shown in Figure 5, in the one, three and five year periods, respectively.

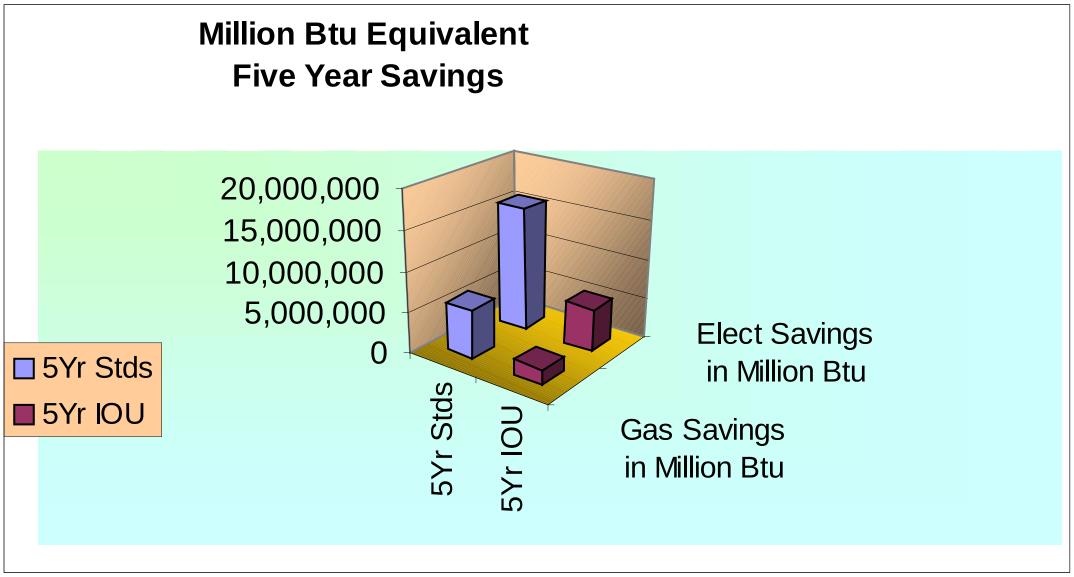

Figure 6: Five-Year Impacts - Gas vs. Electricity

By the tenth year, the gas savings are more than ¾ the size of the electricity savings (48 million million Btu vs. 62 million million Btu).

2.3 Aggregate Savings Estimates vs. Combined Package

One of the goals under which this analysis proceeded was to find out the sum of what each effort, if taken alone, produced in energy impacts. This contrasts with the way the analysis was conducted for the AB970 Building Standards efforts in a very important way. The AB970 Building Standards analysis (though not the Appliance Standards analysis) used the building energy performance modeling tools in such a way that it accounted for interactive effects of the various measures. We isolated each measure so that we could more easily apply a factor relating to the IOUs' share of the credit for adoption of that measure, since the IOUs' participation level was different for each measure.

This one difference could be expected to yield Residential and Nonresidential Building Standards estimates that are higher in our analysis than in the Commission's. And in fact, our first year estimates of Residential and Nonresidential kWh savings (and Residential kW impacts) are slightly higher than the Commission's. However, our Appliance Standards estimates and gas savings estimates for all standards are lower. After five years, our estimates of savings are higher than what we project the CEC's estimate would be[9] only for Residential Standards and (gas savings) for Appliance Standards.

[9] Since the CEC only prepared a first year estimate, we had to extrapolate to make a comparison at the five year point.

However, the primary reason our estimate of Residential Standards is larger than the CEC's has more to do with what we included in our analysis than how we analyzed it. We included multifamily (MF) housing, additions and alterations, whereas the Commission didn't. This alone could easily account for our higher estimates of Residential Standards impacts. We included MF because (a) these amendments impact MF construction perhaps more than any previous set of standards, and (b) in much of California, the MF sector is growing more rapidly than the single family sector. It has not been an issue before because historically MF was a fairly small portion of the residential construction mix. Therefore, it mattered little that MF energy savings were not included in the Commission's estimates. This is less and less the case, as more and more communities find that they need more and more MF dwellings to meet the needs of a growing population within a land-constrained environment.

Another important difference is that we generally used assumptions very near the low (conservative) end of any range we had. This includes ranges reported by the Commission. One of the most conservative adjustments we made was a reduction in impacts of Nonresidential Standards revisions by a factor 0.65 to account for a more conservative projection of nonresidential new construction floor area expected to occur.[10] Given the deepening recession since the analysis began, we have even greater confidence that the project NRNC growth we used is appropriate.

Further, we have assigned to the building standards all of the **new construction** related energy savings from air conditioning changes. The Commission did this too, but it appears to have double counted by taking credit for the same savings on the Appliance Standards accounting.[11] In this study, estimates of savings from air conditioning changes in the Appliance Standards include only impacts from additions, replacements and remodeling; not new construction.

[10] Estimates of expected nonresidential construction volume vary significantly depending upon the source of the estimate. We compared data from the recent MCPAT study on NRNC starts, data from the California Department of Finance, and the estimates contained within the NRNC Study by RLW and AEC (which were the original basis of the CEC estimate).

[11] For example, air conditioning savings from the use of TXVs in new construction were, in our analysis, all attributed to the Residential Building Standards throughout the ten-year analysis period. Assuming that the A/C Appliance Standard becomes effective when planned, February 2, 2004, the credit for TXV savings **should** no longer accrue to the Buildings Standards at that point, but rather to the Appliance Standards. However, to keep the analysis simple, the Building Standards savings estimate includes new construction, and only replacement equipment savings are assigned to the Appliance Standards.

First Year Savings Estimates	Estimates in AB970 Proceeding			Estimates From This Study		
	gWh	MW	M therms	gWh	MW	M therms
Residential Standards	**100**	**155**	**0.85**	**131.1**	**198.7**	**0.60**
Nonresidential Standards	**76**	**63**	**0.70**	**81.1**	**32.3**	**0.36**
Appliance Standards	**5671**	**748**	**0.28**	**143.8**	**55.2**	**0.00**
Total	5847	966	1.83	355.99	286.18	0.96

Figure 7: Comparison of CEC Estimates vs. IOU C&S Estimates - First Year

The comparisons in Figure 7 are somewhat tentative since to our knowledge the Energy Commission Staff have not completed their analysis. The analysis supporting this report also differs somewhat from the initial Draft Report to account for some minor omissions and errors we found on review (e.g., the nonresidential exterior lighting change was not originally accounted for, and erroneous reflectivity assumptions were made for cool roofs). We also recalculated the MW impact estimates using a methodology that is more consistent with other utility program evaluation efforts. Additionally, we credited energy savings for each Appliance Standard measure at the year of its estimated effective date. The Energy Commission's analysis appears to count first year impacts for all appliance measures (regardless of the effective date) as first year Appliance Standards savings. [12]

The next three sections (Sections 3, 4, and 5) present the case for earnings claims for three of the thirty-plus code revisions[13] in which the utilities played a part. Each section describes the revision itself, the process of developing the proposal, the methodology used to estimate the savings, the assumptions underlying the analysis, and the results of the analysis, both on a total statewide basis and on the basis of what can be ascribed to utility C&S Programs. These three case studies are meant to provide examples of how earnings claims for specific measures could be structured.

[12] As stated elsewhere, it appears that the CEC may overestimate **First Year** savings from Appliance Standards by including the first year impacts from each change even though the changes occur in different years. Our analysis phases savings in as various standards provisions phase in.

[13] The careful reader will notice that on Page 2 we said the IOUs proffered 14 proposals. There were at least as many proposals offered by others that were significantly improved or supported by research, analysis or other efforts of the IOUs. We place that figure at 31.

3. DRY TYPE TRANSFORMERS – APPLIANCE STANDARDS

Transformers are used broadly to step down voltage to those used in buildings and industry. Types and sizes of transformers vary according to ownership and purpose. The larger ones are typically utility owned. Smaller, dry type transformers are generally owned by non-utility businesses and serve individual properties. The utilities and their contractors in the Codes and Standards Enhancement Project (CASE) identified an opportunity for increasing energy efficiency through development of a code based upon NEMA adopted voluntary standards for high efficiency transformers.

3.1 Description of the Change

California will be among the first five or six states to recognize the potential for energy and peak savings from regulating dry type transformers. The transformers subject to this Appliance Standard are almost never used by utilities, but large commercial buildings often have two or more. This standard sets an efficiency minimum that is relatively easy and inexpensive to meet, but which results in tremendous energy savings.

3.1.1 Old Standard

There were no existing Appliance Standards in California for commercial type transformers.

Problem (or, Opportunity?)

The efficiency of competing dry type transformers were fairly equivalent until a new technology (amorphous core) came along that reduced core losses fourfold. In 1996, NEMA adopted a voluntary standard (TP-1) that recognizes the superior performance of these transformers.

At the most common operational load, there is a greater difference in efficiency between amorphous core transformers and others, than there is at higher loading. The NEMA voluntary standard for high efficiency dry type transformers (NEMA TP-1, Class 1 Efficiency Levels) requires higher efficiency across the range of loads and results in the greatest savings at partial loads where most non-utility transformers operate.

3.1.2 New Standard

The California Energy Commission is set to adopt a new standard for dry type transformers under 1000kVa, three phase and under 333 kVa, single phase. The new Appliance Standard, Section 1605.3 (t), lists the specific efficiencies from NEMA TP-1, rather than citing the NEMA standard itself. Section 1606 requires reporting and labeling of input, output, efficiency and phase (single or three) of dry type transformers.

3.2 Code Development Process

The Appliance Standard for Dry Type Transformers went through the code adoption process with no opposition. The utilities had the background research and analysis completed before the first AB 970 hearing, and the Commission included it in their proceeding with thanks.

3.2.1 IOU Codes and Standard's Contribution

The IOUs began a process in 1999 through a PG&E contract with the New Buildings Institute to identify targets for enhancements to the California Building and Appliance Standards. Dry type transformers were among the number of measures that the project revealed as being ripe for code. PG&E researched the market share and trends in market penetration of the more efficient transformers. The study, published in September of 2000[14], indicated that depending upon the size of the transformers, market penetration varied significantly. Only about 3% of low voltage, dry type transformers are TP-1 compliant, whereas over 80% of medium voltage, dry type transformers are.

The CASE analysis also provided estimates of energy savings for the switch to the TP-1 standard for that portion of the expected sales of transformers that were not already projected to be TP-1 compliant.

The CEC Staff gave the CASE team a list of issues that needed to be addressed before the Commission could adopt the new appliance standard, and each issue was addressed in the final report from the CASE team.

PG&E's contractors also provided the Commission with draft code language for the Appliance Standards and testified at CEC workshops and hearings on the standard.

3.2.2 Background Efforts

Energy Star has had a listing for dry type transformers that meet the same NEMA standard. Programs in other regions, most specifically the Northeast, have accounted for significant numbers of installations of TP-1 compliant transformers. This sort of effort set the stage for adoption of a code requirement for the higher level, and, in this case, made it easier to establish an incremental cost for upgrading.

[14] "Dry-type Transformer: Codes and Standards Enhancement (CASE) Study." Pacific Gas and Electric Company. September 29, 2000. Prepared by The new Buildings Institute and Eley Associates.

3.3 Energy Impacts

The energy impacts analysis for this measure were prepared by Eley and Associates under a contract with the New Buildings Institute and PG&E to develop code enhancement recommendations originally targeted for the 2004 adoption cycle.

3.3.1 Background

In June of 2000, after winnowing the potential list of code initiatives down to a manageable number, the CASE Initiatives team researched all available data on transformer performance, the size and structure of the transformer market, costs and cost increments for various efficiency levels, and potential energy and peak impacts of a code mandated higher efficiency level. The results of that analysis are what are presented here with no alterations of assumptions or further analysis.

3.3.2 Methodology

The method for calculating the energy impact of the Dry Type Transformer code change is unlike the methodology used for the example Residential Building Standards measure or the Nonresidential Building Standards measure listed in Sections 3 and 4. For certain measures, the analysis within the CEC code adoption process relied on approaches other than modeling with MICROPAS or DOE 2, e.g., dry type transformers. Within the analysis for this report, we also used alternative calculation methods for many of the same measures. Analysis for dry type transformers follows the scheme established within the CASE Initiatives and adopted through the Standards process.

Assumptions

NEMA rates transformers for compliance with TP-1 at 35% loading. The Northeast Energy Efficiency Partnership reported that average loading on low voltage transformers is approximately 16%. The analysis from the CASE study estimated savings at both 16% and 35% loading and provided a range of energy savings. In this report, we conservatively used the lower bound.

The analysis is based on an historical average of about 10,000 low voltage, dry type transformers being installed in California each year, with the potential of cutting the losses about in half on each unit.

3.3.3 Results

The results in

1st Year Impacts			Three Year Impacts			Five Year Impacts			Ten Year Impacts		
gWh	MW	M therms	gWh	MW	M therms	gWh	MW	M therms	gWh	MW	M therms
27	3	0	80.7	9	0	134.5	15	0	269	30	0

Figure 8 show that the standard for dry type transformers is expected to result in a savings of 27 gWh/yr from the first year of installations, 162 gWh/yr by the third year, and about 400 gWh/yr by the tenth year. There is some uncertainty regarding the potential for MW savings since the efficiency improvements from the reference to NEMA TP-1 come at lower partial loads than are typical with at a system peak event. However, the methodology for the reported MW savings here is consistent with that which was in the Energy Commission's Final Statement of Reasons[15] for the expected May 30, 2001 adoption of the Standards (now delayed to the end of 2001). The estimate of 3 MW of peak savings is the low end of the analysis in the report; the high end was 4.9 MW.

1st Year Impacts			Three Year Impacts			Five Year Impacts			Ten Year Impacts		
gWh	MW	M therms	gWh	MW	M therms	gWh	MW	M therms	gWh	MW	M therms
27	3	0	80.7	9	0	134.5	15	0	269	30	0

Figure 8: Statewide Impacts - Dry Type Transformers

Based on the amount of work the IOUs did on development of this new section of the Appliance Standards, we ascribe 90% of the credit for the savings and peak impacts to the IOUs. Therefore, the impacts that should be ascribed to the utilities' Codes and Standards programs is nearly 73 gWh/yr and over 8MW by the third year. The 90% factor was arrived at through the process outlined in the Introduction section, and is justified by the efforts outlined in the discussion of the utility Codes and Standards Contribution in Section 3.2.1.

1st Year Impacts			Three Year Impacts			Five Year Impacts			Ten Year Impacts		
gWh	MW	M therms	gWh	MW	M therms	gWh	MW	M therms	gWh	MW	M therms
24.3	2.7	0.0	72.6	8.1	0.0	121.1	13.5	0.0	242.1	27.0	0.0

Figure 9: IOU C&S Impacts - Dry Type Transformers

[15] When the CEC proposes a standard, they issue an Initial Statement of Reasons (ISOR), which explains why it is proposing to change the regulations. At the time that it adopts the regulation, it issues a Final Statement of Reasons, which contains much of what was in the ISOR, but which also addresses issues and concerns that were raised in the proceeding. The standard to which this section of the report refers is now slated to be adopted toward the end of 2001 or early in 2002. At the time of the initial analysis, it was expected to be adopted in April 2001.

4. TIGHT DUCTS - RESIDENTIAL BUILDING STANDARDS

Leaky ducts are a major source of wasteful use of energy in the residential sector. Studies in California have shown that leakage in "standard" AC and heating duct installations in subdivisions as well as custom homes could run as much as 50%, and often was between 25% and 30%.

In the previous (1998) iteration of the Residential Building Standards, the CEC adopted a set of criteria for verifying tight (less than 6% leakage) ducts in home construction. Credit was allowed for ducts that could be verified to be "tight."

4.1 Description of the Change

The Residential Building Standards adopted by the Commission on an emergency basis in January, and on a permanent basis in April 2001, no longer provide tight ducts a *credit* beyond base case assumptions; but make tight ducts part of the base case.

4.1.1 Old Standard

Under the 1998 Standards homes were assumed to have leaky ducts, and the base case energy budget was calculated with that assumption. This meant that if a builder took the effort to make sure the HVAC ductwork was properly sealed, and had it verified (by a third party) that it was, then s/he could get "credit" for the energy savings. This could provide a significant trade-off if the builder wanted to use something that did not meet the standards in some other area of the house. Likewise, it allowed builders who wanted to sell their products as being better than Title 24 to provide third party corroboration for the measure and amount of improvement.

Problem

Those builders who didn't choose to make the change still built houses with ducts that allowed up to 50% of the heated or cooled air to be wasted through leaks. This not only results in a tremendous amount of squandered energy, it also has a large peak impact since air conditioning could be working twice as hard as it should have to during statewide peak conditions.

4.1.2 New Standard

The 2001 Residential Building Standards reverses the situation and assumes that ducts are installed properly. The computer models calculate the *base case* energy budget using the assumption of 6% leakage. If the builder chooses to have the duct installation verified as "tight," then the assumption entered for the *proposed* building budget is also 6%. If the builder chooses not to go for tight ducts and the verification procedures attendant to that choice, then the assumption for the "standard" leakage is approximately 20%. The user of the modeling program does not actually enter a specific default leakage rate, but a "factor" that embodies other duct system criteria as well. For comparison, the table below provides two representative "factors," one for tested, tight ducts and the other for the non-tested alternative assumption.

Duct systems in homes of all ages, System with refrigerant based cooling, tested after house and HVAC system completion. Total leakage is less than 0.06	Duct systems in homes built after 1999 Not tested
0.96	0.89

Figure 10: Tight and Standard Duct Leakage Factors

The untested duct system has a factor that results in nearly three times the system efficiency degradation that is attributed to tight ducts (0.11 vs. 0.04).

4.2 Code Development Process

There were a lot of contributors to the process of developing and supporting this particular code change. It was supported by Proctor Engineering, EnerComp, CHEERS, and NRDC, in addition to PG&E and SoCal Gas. BIA and individual mechanical contractors participated in providing suggested modifications and in helping to shape the final language of the code change.

4.2.1 IOU Codes and Standard's Contribution

The IOUs and their contractors reviewed all existing data on the performance of existing Residential HVAC systems and worked with Proctor Engineering to develop the criteria for the voluntary tight duct credit in the previous (1998) round of the standards. The requirements for the baseline now are essentially unchanged from the earlier credit criteria.

PG&E submitted data and analysis from research it had conducted with Proctor Engineering, CHEERS, Lawrence Berkeley National Lab and even at its own research facility in San Ramon. The IOUs testified in support of the code change and in support of maintaining the criteria for verification significantly tight enough to assure consumers of quality installations.

4.2.2 Background Efforts

California's investor owned utilities sponsored a significant amount (perhaps over half) of the background research that established the need for duct tightening and verification protocols. One of the landmark studies that raised the issue of conditioned air leakage through the duct system was performed by Proctor Engineering under contract with PG&E nearly ten years ago. The utilities have been the strongest supporters of continued research in this area since.

It is not enough to show that duct systems are generally leaky and should be constructed better. It isn't even enough to develop a method for testing whether they are tight or not. To be effective there must also be a means for verifying through an independent third party that the desired tightness has been achieved. California Home Energy Efficiency Rating Service (CHEERS) was established with significant support and encouragement from the IOUs partly to perform that function. The IOUs have held a place on the Board of CHEERS since its inception, have helped to fund it, and have provided training and education to CHEERS raters.

Utility MT programs were a major contributor to the viability of "baselining" tight ducts. Most of the utilities have included verified tight ducts in their residential new construction programs since the adoption of the 1998 Standards. In some cases verified tight ducts were a minimum requirement for program participation. This market transformation effort helped to increase the number of verification providers, helped to make builders comfortable with the procedures, and helped to bring the cost of the service down.

4.3 Energy Impacts

4.3.1 Background

The analysis that leads to the energy, peak and gas savings in this section were performed with the same team and using the same methodology as for the CEC's adoption process. Some of the assumptions were changed to include buildings and projects not originally accounted for in the CEC's analysis.[16] Specifically, this analysis accounts for the energy savings from multifamily (MF) new construction and from additions and alterations. The original analysis did not.

4.3.2 Methodology

The basic model for single family housing was the CEC's adopted base case 1761 ft² home. It was modeled in each of the sixteen climate zones as compliant with the AB970 Building Standards, then each measure was reset, one at a time, to the level assumed in the 1998 standards. The results of the individual

[16] This analysis also includes an estimate for the energy impacts of the air conditioning modeling change, which was not included in the AB970 analysis. This analysis used an assumption that 1/3 of the homes will use a 12 SEER air conditioner for compliance (10 SEER is all that is required by the AB970 code). This does not affect the estimates for savings from the tight duct measure, but it does affect the combined total savings estimate.

analyses were expanded to the expected number of housing starts for the year 2002. The extension to statewide impacts was accomplished through Climate Zone weighted multipliers based on data from the Construction Industry Research Board (CIRB).

KWh impacts of standards changes are cumulative, whereas kW impacts are not. The table below assumes a measure has an impact of 1 kW and 1kWh (for the sake of simplicity). It also assumes the first year is 2002 since too few homes will be built in 2001 to count them until 2002 (the nominal first year of the standards). Those built in 2002 are not counted until 2003 (the nominal second year), etc. The right hand column provides the estimated kW reduction in each year due to the change in the standards in that year, and assuming an equal number of homes built each year. To estimate the total kWh savings, we can sum the numbers in the right hand column because the homes built in the first year will still be producing the savings in successive years; as will the second-year homes in the third and succeeding years. Therefore, to gain a simple estimate of kWh savings over ten years, we can multiply the first year savings by 55. To estimate the kW reduction in the tenth year, we can multiply the first year reduction by 9.

	New Homes Built in Year 1	New Homes Built in Year 2	New Homes Built in Year 3	New Homes Built in Year 4	New Homes Built in Year 5	New Homes Built in Year 6	New Homes Built in Year 7	New Homes Built in Year 8	New Homes Built in Year 9	New Homes Built in Year 10	Total kW Savings Per Year
First Year Savings	1	0	0	0	0	0	0	0	0	0	1
Second Year Savings	1	1	0	0	0	0	0	0	0	0	2
Third Year Savings	1	1	1	0	0	0	0	0	0	0	3
Fourth Year Savings	1	1	1	1	0	0	0	0	0	0	4
Fifth Year Savings	1	1	1	1	1	0	0	0	0	0	5
Sixth Year Savings	1	1	1	1	1	1	0	0	0	0	6
Seventh Year Savings	1	1	1	1	1	1	1	0	0	0	7
Eight Year Savings	1	1	1	1	1	1	1	1	0	0	8
Ninth Year Savings	1	1	1	1	1	1	1	1	1	0	9
Tenth Year Savings	1	1	1	1	1	1	1	1	1	1	10
							Total kWh Savings				55

Figure 11 : Cumulative Impact Multipliers

Assumptions

To provide the tenth year savings estimates, we multiplied the first year gWh/yr values and Mtherm values by 55; we multiplied the first year MW estimates by 9. (See the sidebar for an explanation of the rationale for these multipliers.) This conservatively assumes that the "first year" savings actually do not occur until the second year following adoption of the standards, and that the tenth year therefore only represents nine years of accumulated savings. We made this assumption because the code allows any homes built in a subdivision that has a "master plan" approved before the codes' effective date of June 1, 2001, to be "grandfathered" under the approved plan until January 1, 2002. Essentially, this means that for over 90% of the homes to be started before January 1, 2002, these standards are unchanged.

Data from the California Department of Finance (DOF) indicates that in 1999 the number of multifamily housing starts were equal to approximately 38% of the single-family housing starts. We assumed the standard MF unit to be 900 ft² (approximately ½ the CEC single family assumption) and used MF building prototypes developed for a MF energy efficiency program, ***Designed for Comfort***. It's a new construction program that we administered for SDG&E in PY2000 and are administering for Southern California Edison in PY2001.

In terms of square feet added or equipment changed (based on DOF and CIRB data), we estimate that the savings from additions and alterations are conservatively about 10% of those for single family new construction. Without further modeling or analysis, we simply increased the estimated savings for each measure, including tight ducts, by 10%.

4.3.3 Results

Since current "typical" duct systems are assumed to allow approximately 20% of the conditioned air to leak into attic and crawl spaces (actual installation can allow up to 50%), it is not surprising that the impact of improving duct systems so that leakage is held to 6% produces such large energy savings. This code change produces savings in both the heating and cooling mode, but the peak electricity demand impacts are the most notable. By the time the standards have been in place for ten years the peak impact is estimated to be 820 MW, roughly the equivalent of three or four average size power plants. This estimate includes the impact of applying a 0.65 "diversity factor." The diversity factor accounts for some portion of the air-conditioning systems to be off, some portion cycling and some portion full on but not meeting the cooling load. The 0.65 factor was used in the Energy Commission's analysis for the AB970 revision and is based on field data collected by Proctor Engineering.

1st Year Impacts			Three Year Impacts			Five Year Impacts			Ten Year Impacts		
gWh	MW	M therms	gWh	MW	M therms	gWh	MW	M therms	gWh	MW	M therms
27.2	81.8	1.4	160.8	245.3	9.1	401	410	22.1	1202.9	736.9	67.4

Figure 12: Statewide Impacts - Residential Tight Ducts

Using the same method as in Section 3.3.3 for estimating the share of the credit (for producing this code change) that should be ascribed to the IOUs, we assign 20% of the credit to the IOUs' C&S programs, and 30% to them overall.[17] Given this estimate of effect on the standards process for this code change, we estimate that the C&S programs have produced the following energy impacts:

1st Year Impacts			Three Year Impacts			Five Year Impacts			Ten Year Impacts		
gWh	MW	M therms	gWh	MW	M therms	gWh	MW	M therms	gWh	MW	M therms
5.44	16.36	0.28	32.16	49.06	1.82	80.2	82	4.42	294.28	164	16.36

Figure 13: IOU C&S Share of Energy Impact Credit

The IOUs' share of the ten-year peak MW estimated impact of this measure is equivalent to adding three peaker plants of the size currently being built in California. The **first year** energy impacts are equal to all the energy needed to provide heating, cooling and water heating to nearly a thousand Central Valley homes for a year.

[17] This is a particularly conservative estimate considering how many homes with tight ducts were built since 1998 compared to those with tight ducts **because** of the IOUs' residential new construction programs. The utility programs account for virtually all of the verified tight duct installations in new homes.

5. BI-LEVEL SWITCHING, LIGHTING - NONRESIDENTIAL BUILDING STANDARDS

When natural light is available, or even when lower levels of light are desired or acceptable, dimming the lights or switching off a portion of them results in energy savings. This energy saving opportunity is only accessible if the space if equipped with switches to allow it. The code has long recognized this and required bi-level switching in some appropriate areas.

5.1 Description of the Change

The requirement for bi-level switching had exceptions, which resulted in exempting a number of nonresidential spaces to which the requirement would otherwise have applied. Essentially, this code change eliminates many of the exceptional cases.

5.1.1 Old Standard

The 1998 Nonresidential Building Standards required that any space over 100 ft^2 with a lighting load greater than 1.0 Watts/ft^2 had to have bi-level switching for the lighting, unless:

- The lights were controlled by an occupancy sensor,
- The space was a corridor, or
- The lights were controlled by an automatic time switch.

Problem

Because of these exceptions, many areas could not reduce their lighting load during times of peak demand emergencies, even though a lower lighting level would have been acceptable. The choice they had was "on" or "off." With bi-level switching they could have benefited from the *ability* to reduce lighting load when they wanted to.

5.1.2 New Standard

The revisions for AB970 reduce the LPD threshold from 1.0 to 0.8 W/ft^2, eliminate the exception for spaces with occupant sensors, and eliminate the exception for spaces with automatic time controls. It leaves in place the exception for corridors since there was a lack of verifiable data on how cost effectively designs providing required emergency egress lighting in corridors could also comply with an LPD limit of 0.8 W/ft^2.

5.2 Code Development Process

When the Governor signed AB970 in September of 2000, the Energy Commission initiated a process for identifying potential code changes that would help to reduce wasteful energy use and help reduce statewide peak demand. They sent out an invitation to stakeholders to recommend changes to their building and appliance standards. The utilities already had a process of developing such recommendations and providing background analysis to support them: the CASE Project.

5.2.1 IOU Codes and Standard's Contribution

In response to the Commission's call for recommendations, the IOUs requested their contractors to make suggestions for potential additional changes that could be adopted in the extremely short time frame that the Commission had (120 days). The recommendation for eliminating exceptions to the bi-level switching requirement is one of the resultant proposals. The utilities were in a position to develop this particular recommendation because they already had analysis of the lighting market and technologies underway in the CASE Initiative Project. Much of the work needed to establish incremental costs and product availability had been done during June, July and August of 2000, in anticipation of affecting the Commission's 2004 code revision process.

The utilities are wholly responsible this particular change. They proposed this change; collected data on existing technologies, costs and usage patterns required to make it cost effective; advocated; provided a forum for stakeholder input; and provided the CEC with draft code language. They solicited comments from knowledgeable lighting and construction industry members, modifying some of the specifics of the proposal based on industry input. And, they strongly supported the code change at CEC workshops and hearings.

5.2.2 Background Efforts

The utilities' Nonresidential Retrofit and Nonresidential New Construction programs provide design assistance to participants. It generally helps participants to understand the advantages of bi-level switching, among other energy efficiency measures. These programs also offer incentives for improving the overall lighting design, of which bi-level switching is one strategy.

One of the most pleasing and cost-effective means for meeting this standard is dimming ballasts and dimming controls. California's IOUs have sponsored research into dimming technologies and effective dimming strategies through the Lighting Research Center and other research organizations.

5.3 Energy Impacts

For the purposes of the AB970 Standards revision process, the only estimate of energy impacts was a simplified calculation that showed how many hours per year lighting would have to be switched down or dimmed for the requirement to be cost-effective. There wasn't time to collect the data needed or perform the analysis to get an accurate estimate of energy and peak savings. This report contains the results of follow-on analysis that can now answer those two questions.

5.3.1 Background

The analysis of bi-level switching that was prepared for the Commission's adoption proceeding differed from typical cost-effectiveness calculations. The true savings rely on human behavior and there have been no large-scale studies of the effect of bi-level switches on energy savings for a variety of occupancies.

It was fairly straightforward to estimate the cost of installing bi-level switching and the typical loads they controlled. Using this information the utility's team calculated the minimum number of hours per year that switches would have to be used in order that a bi-level switching requirement would be cost-effective. Cost-effectiveness in that analysis was defined as the Commission has earlier defined it (the present value of savings over a 15-year period with a 3% real discount rate). This analysis showed that the bi-level switch would have to be used only ½ to 1½ hours a week in most occupancies to be considered cost-effective. For small offices, the minimum number of hours per week was still under four. Given this small number of hours of use and compared with the few existing studies of bi-level use, the Commission considered there to be a reasonable likelihood that the measure was warranted.

For the current study, we relied on the DOE 2 based modeling procedures that had been used by the Commission's contractors for estimating the energy impacts of most of the Nonresidential Building Standards changes.

5.3.2 Methodology

AEC was a subcontractor on the Energy Commission's team, hired to perform the analysis of the energy impacts of the Standards. We also used AEC. They relied on DOE 2 and a set of building descriptions that resulted from the recent Nonresidential New Construction (NRNC) Baseline study managed by RLW. The study has fairly comprehensive data on 990 buildings built in California from 1995-1998, as well as a weighting schema that allows users to project the energy impacts of any code changes being analyzed, up to the population of new buildings for a year. It is an estimating tool familiar to the community of utility program planners and evaluators in California.

In brief, the process involved a series of parametric DOE2.1 E simulations of 990 non-residential buildings contained in the Statewide Nonresidential New

Construction Baseline database (NRNC database)[18]. The impact of the CASE initiatives are estimated by comparing the simulated energy consumption with and without the changes recommended by each initiative. Unlike the AB 970 Impact Analysis, the impacts of each measure in this study were evaluated individually, without accounting for interactive effects. This method provides a decrement for each measure.[19]

Assumptions

The analysis on the original buildings (in the NRNC Baseline Study) assumed bi-level switching was not present where it could be excepted. To model the effect of the bi-level control changes, a 3% credit was applied to all spaces with occupancy sensors or central lighting controls, except in spaces with an allowed lighting power density of less than 0.8 W/ft².

One of the principle assumptions needed to expand single building estimates to statewide estimates is a projection of the number, type and location of new nonresidential construction over the period of interest – in this case, one, three, five and ten years. Since the data from the NRNC study is a one-year projection based on data averaged across three years of permit activity, it should provide a reasonable estimate of the yearly nonresidential area added and number of projects that represents. However, we felt that the construction estimate was high enough that it would be prudent to verify it through other sources.

The following table is excerpted from the *NRNC Market and Program Tracking Report*[20] (MCPAT), and shows an estimate of how many projects and how many square feet of NRNC projects were started last year. The data below are slightly higher than those from the NRNC Baseline study but are significantly higher than projections from the CEC's California Energy Demand Report.[21]

[18] RLW Analytics et al, *California Non-residential New Construction Baseline* Study, California Board for Energy Efficiency, 1999

[19] This methodology works well for most measures, but there are some for which it would not work (primarily appliance standards measures). For those measures we either used the analysis that was performed for the Energy Commission adoption process or developed a custom methodology appropriate for the measure. See the discussion above for Dry Type Transformers.

[20] "NRNC Market and Program Tracking Report, Quarter 2, 2000 - Final." Prepared by Quantum Consulting Inc., for Marian Brown, SCE. October, 2000.

[21] "California Energy Demand, 2000 - 2010." California Energy Commission, June 2000.

Figure 14: Market Summary for Project Starts in California (from MCPAT)

Project Type	Quarter	Value ($ billions)	Area (millions of sqft)	Number of Projects
New and additions	Q1, 2000	3.004	48.08	1,160
	Q2, 2000	2.855	39.77	1,096
	Q3, 2000	3.890	46.31	1,227
	Q4, 2000	3.500	45.99	1,191
	Subtotal	13.249	180.15	4,674
Alterations	Q1, 2000	0.710	-	983
	Q2, 2000	0.958	-	1,101
	Q3, 2000	0.959	-	1,425
	Q4, 2000	0.813	-	1,145
	Subtotal	3.440	-	4,654
Total		16.689	-	9,328

As a third source for an estimate of the amount of new construction to expect, and therefore how great of an energy impact to expect from the code changes, we turned to the CEC's estimate from the June 2000 Energy Demand Report. These data indicate a level of building activity that is significantly lower (approximately 62%) than anticipated by the NRNC Baseline study. Based on this finding we have reduced the estimates of energy and peak savings that we obtained (using the NRNC Baseline) by a factor of 0.65. This makes them more in line with the CEC's estimates and allows for greater comparability of results. It also assures that our estimate is conservative.

5.3.3 Results

The impact from the change to the exceptions for bi-level switching amounts to about 6 gWh/yr from the first year of new construction, and over 320 gWh/yr by the tenth year. Significantly, considering the state's current energy shortage, it also provides over 1MW of peak demand reduction, growing to nearly 12 MW by year ten. Since reduced lighting puts less heat into a building, this change has negative natural gas savings (winter heating).

1st Year Impacts			Three Year Impacts			Five Year Impacts			Ten Year Impacts		
gWh	MW	M therms	gWh	MW	M therms	gWh	MW	M therms	gWh	MW	M therms
5.70	1.20	-0.02	34.50	3.63	-0.11	86.46	6.05	-0.28	316.61	12.10	-1.03

Figure 15: Statewide Impact - Bi-level Switching

We assume that the utilities deserve 95% of the credit for this code change. The proposal was developed through a CASE Initiative. The utilities provided the research and analysis that supported the proposal, wrote the draft code language and facilitated a forum for interested stakeholders to provide input and suggestions. They followed up with strong support at the CEC code adoption hearings. Figure 16 shows the estimated energy and peak savings expected from the C&S program for this one code change.

1st Year Impacts			Three Year Impacts			Five Year Impacts			Ten Year Impacts		
gWh	MW	M therms	gWh	MW	M therms	gWh	MW	M therms	gWh	MW	M therms
5.4	1.1	0.0	32.8	3.4	-0.1	82.1	5.8	-0.3	300.8	11.5	-1.0

Figure 16: IOU C&S Program Credit for Bi-level Switching

This is likely one of the most conservative estimates in the study. Partially this is due to the fact that there is simply too little data to know with any certainty what the impact could be. By any accounting, our estimate of a 3% reduction in lighting use due to this change is very conservative. Lighting logger studies would help researchers to make better assumptions, allow for a more robust analysis, and help in the decisions about other good opportunities for future revisions to the standards.

6. APPENDICES

This report includes a number of appendices. The first three are spreadsheets indicating the estimated impacts of the Residential, Nonresidential and Appliance Standards, respectively. These sheets show the first and third year electricity savings, peak impacts and gas savings for each measure and total them at the bottom.

Following that, Appendix D: Participation Percentage, provides an illustration of the method we used to assess how much credit the utilities should receive for the energy savings embodied in the AB970 revisions to Title 20 and Title 24. The chart in Appendix D is subjective but gives us a fairly good means for evaluating what the utilities undertook, out of all potential efforts; and therefore, what percentage of the credit for adoption they should get.

Appendix 6E provides a picture of when various efficiencies for water heaters become effective. Our initial estimate of energy savings (and peak impacts) was performed with the simplifying assumption that the first year for all measures was the same first year. The analysis for which the results are reported here used a regime that recognizes pieces of “the standards” staging in at separate times. For example, water heaters have three separate dates by which the standards change, depending upon a number of separate criteria (size, fuel source, input ratings). The chart in Appendix 6E illustrates this staged implementation. There are other measures with similar implementation matrices. Appendix 6F provides a similar table for air conditioning equipment.

6.1 Appendix A: Impact Spreadsheet Residential

No.	Code Section	Topic Area	Code Change	Adoption Status (date)	Probable Effective Date	1st Year Impacts (2002)			Three Year Impacts (2004)		
						gWh	MW	M therms	gWh	MW	M therms
1	Title 24, Section 151(f)(7)	TXVs for AC and air source heat pumps	**New Stds.:** In CZs 2 and 8-15, thermal expansion valves (TXV) are required for central ACs and heat pumps for prescriptive compliance Packages C and D). the code provides three "outs" for avoiding use of a TXV: (1) an alternative mechanical means of maintaining the same equipment efficiencies at partial and overcharged refrigerants and low air fow over the coils, (2) alternative measures listed with the packages (e.g., higher performance windows), and (3) computer modeling with tradeoffs. **Old Standards:** No TXV requirement.	January 3, 2001 as a set of emergency code changes. Adopted April 4, 2001 as a final adoption under regular rule-makig procedures.	June 1, 2001	24.7	16.8	0	147.4	49.3	0
2	Title 24, Section 151(f)(10)	Tight Ducts	**New Stds.:** Ducts are required to be in the conditioned space or sealed and verified tight through procdures outlined in the Residential Compliance Manual (ResMan). The code provides three alternatives to doing duct tightness verification: (1) an alternative level of credit for prescriptively making the duct system tight, (2) computer modeling, or (3) an alternate Prescriptive Package that relies heavily on the fenestration to meet the energy budget. **Old Standards:** Duct testing/tightness was allowed as an alternative for credit.	January 3, 2001 as a set of emergency code changes. Adopted April 4, 2001 as a final adoption under regular rule-makig procedures.	June 1, 2001	27.2	81.8	1.4	160.8	245.3	9.1
3	Title 24, Section 151(f)(2)	Radiant barriers	**New Stds.:** Radiant barriers are now required as part of the Prescriptive Packages in cerain CZs, and are included in the energy budgets through the ACMs. Criteria are to be spelled out in the ACM Manual. **Old Standards:** Radiant barriers were allowed as an alternative but were not required or baselined.	January 3, 2001 as a set of emergency code changes. Adopted April 4, 2001 as a final adoption under regular rule-makig procedures.	June 1, 2001	19.5	59.8	0.1	118.1	180.4	0.1
4	Title 24, Section 151(f)4 and Tables 1-Z1 - 1Z16	Fenestration	**New Stds.:** The prescriptive packages now have the same SHGC requirement for all four orientations in those CZs where there is a requirement (2, 4, and 7-15). CZ10 has a U-factor requirement of 0.65. **Old Standards:** Previously, there was no SHGC requirement in CZ2, CZ4 or CZ7. Also, the U-factor for CZ10 was 0.75.	January 3, 2001 as a set of emergency code changes. Adopted April 4, 2001 as a final adoption under regular rule-makig procedures.	June 1, 2001	58.3	40.3	-0.9	347.8	121.9	-5.3
5	Title 24, Section 152(a)	Additions (Prescriptive Approach)	**New Stds.:** SHGC for glazing in additions of up to 100 sf is restricted to SHGCs that meet the Packge D requirements. **Old Standards:** Additions in this size category were only required to meet a maximum glazing area and meet a U-factor requirement.	January 3, 2001 as a set of emergency code changes. Adopted April 4, 2001 as a final adoption under regular rule-makig procedures.	June 1, 2001	Impacts included in Item #4 above.	0	0	0	0	0
6	Title 24, Section 152(b)	Alterations (Prescriptive Approach)	**New Stds.:** SHGC for glazing added as part of an alteration must not exceed the SHGC listed in Package D. **Old Standards:** Glazing in alterations was only required to meet a U-factor requirement of 0.75	January 3, 2001 as a set of emergency code changes. Adopted April 4, 2001 as a final adoption under	June 1, 2001		0	0	0	0	0

6.2 Appendix B: Impact Spreadsheet Nonresidential

No.	Code Section	Topic Area	Code Change	Adoption Status	Probable Effective Date	1st Year Impacts (2002)			Three Year Impacts (2004)		
						gWh	MW	M therms	gWh	MW	M therms
8	Title 24, Section 112	AC Efficiency	**New Stds.:** AC efficiency requirements have been increased to match what is in ASHRAE 90.1. **Old Standards:**	January 3, 2001 as a set of emergency code changes. Adopted April 4, 2001 under regular rule-making procedures.	June 1, 2001	43.5	20.669	-0.0461	263.08	62.687	-0.279
9	Title 24, Section 112	Cooling Tower Efficiency	**New Stds.:** Minimum performance requirements are prescribed as a function of flow rate divided by motor horse power. **Old Standards:** Cooling tower eficiencies were not specifically called out.		June 1, 2001	4.646	1.095	0	28.095	3.321	0
10	Title 24, Section 121	Demand Ventilation	**New Stds.:** Demand Control Ventilation Devices are now required for assembly occupancies and must be designed to reduce ventilation when sensors indicate the space air is acceptable. Devices and systems used for this purpose have to meet a number of spec		June 1, 2001	1.241	1.71	0.38844	7.506	5.186	2.3492
11	Title 24, Section 101, and Nonre ACM	Duct Testing	**New Stds.:** Credit is allowed in the compliance calculations if the duct system has been tested to no more than 6% leakage. **Old Standards:** No standard or credit for duct leakage.		June 1, 2001	10.998	6.138	0.3694	7.672	9.308	0.2577
12	Title 24, Section 131(d)	Automatic Shut-off - Lighting	**New Stds.:** The automatic shut-off requirement in the standards now applies to buildings of all sizes. **Old Standards:** Buildings, and floors of buildings, under 5000 sf were exempted from the automa		June 1, 2001	1.881	0.400	-0.0042	11.379	1.212	-0.0253
13	Title 2, Section 131(b)	Bi-level Switching - Lighting	**New Stds.:** Bilevel switching is required in spaces over 100 sf where the connected lighting load is greater than 0.8 Watts/sf. except in corridors. **Old Standards:** Bilevel switchin		June 1, 2001	8.776	1.840	-0.0287	53.075	5.579	-0.1734
14	Title 24, Section 146(b)	Lighting Power Density	**New Stds.:** Lighting power density was lowered in a few cases (conference and meeting rooms, hotel lobbies and locker rooms) to match ASHRAE 90.1 (1.5, 1.7, and 0.8, respectively). **Old Stan**		June 1, 2001	1.062	0.208	-0.004	6.425	0.632	-0.0243
15	Title 24, Section 146(a)	Task Lighting	**New Stds.:** Actual task lighting product data is to be used in the calculation of lighting power density, unless it is unknown at the time, in which case the calculations must assume 0.2 Watts/sf.		June 1, 2001	7.448	1.793	-0.0393	45.045	5.439	-0.2377
16	Title 24, Section 130(c), and 131(f)	Exterior Lighting	**New Stds.:** Exterior lighting has to be 60 lumens/Watt or controlled by a motion sensor. **Old Standards:** Exterior lighting was exempt.		June 1, 2001	15.394	0.000	0	93.099	0.000	0
17	Title 24, Sections 10-112, 118, and 143	Cool Roofs	**New Stds.:** Roofs that meet certain reflectance and emittance criteria can be counted as "cool roofs." This allows use of a higher reflectance in the building performance calculations. By January 1, 2002, the Cool Roof Rating Council must have adopted rat		June 1, 2001	12.436	6.063	-0.4434	17.298	4.230	-0.6168
18	Title 24, Section 112(c)	Furnace Efficiency	**New Stds.:** Intermittent ignition devices, power venting, and flue or vent dampers required. Establishes a lower limit on jacket losses. **Old Standards:** Constant burning pilots a		June 1, 2001	0	0	0.00184	0	0	0.0111
19	Title 24, Sections 10-111, 116, and 143	Fenestration	**New Stds.:** ASHRAE levels for SHGC. Changes in the default tables and methods for U-factors and SHGCs. NFRC rating and labeling for site built vertical fenestration. **Old Standards:**		June 1, 2001	17.386	9.809	0.35607	105.15	29.749	2.1534
				Subtotals for Nonres Buildin		124.77	49.73	0.55	637.82	127.34	3.41

6.3 Appendix C: Impact Spreadsheet – Appliances

No.	Code Section	Topic Area	Code Change	Adoption Status (date)	Probable Effective Date	1st Year Impacts (2002)			Three Year Impacts (2004)		
						gWh	MW	M therms	gWh	MW	M therms
1	Title 20, Section 1605.1(b)-(c) & 1605.3 (b)-(c)	Air conditioning and air source heat pumps	**New Stds.:** EER and HSPF minimums must be met for air conditioners and air source heat pumps under 65kBtu. Efficiency (performance) measures for AC and HP under 240kBtu are increased and generally slightly exceed that for equipment that meets the next DOE minimums (for EER). Second level of EER (~2.6% higher) goes into effect January 1, 2006 for equipment under 65kBtu. **Old Standards:** Only SEER required for AC under 65kBtu. EER and, where applicable SEER approximately 30-34% lower (varies by size and type - split or package).	February 7, 2001 - The Residential Standards include essentially the same provision and were adopted in January 2001.	February 7, 2004, assuming Federal preemption and granting of a waiver.	6.106	5.8	0	188	109	0
2	Title 20, Section 1605.2(b)-(c)	Air conditioning and air source heat pumps	**New Stds.:** Each air conditioner or heat pump under 240kBtu must either (a) have a thermostatic expansion valve or (b) have some other device that gives the equipement the same efficiency ratings under 90% and 120% design refrigerant charge, and under 80% air flow conditions. **Old Standards:** No TXV requirement.	February 7, 2001	February 7, 2004 If a waiver is denied, TXVs will not be required since they are not included in the DOE standard	The savings from this Appliance Standards change is captured in the estimate above of Residential and Nonresidential Building Standards savings from air conditioning and heat pumps. TXVs are typically part of nonresidential equipment and are part of the					
3	Title 20, Section 1604(f) (4)	Water heaters	**New Stds.:** The new state standards base minimum requirements on actual water heater (DHW) size, while DOE standard uses "rated" size (which is usually larger). Other than that the new CA standar matches the DOE standard for Oil and Electric storage DHW. State Gas storage DHW requirement is ~3.5% higher than DOE's. Instantaneous and small electric DHW requirements are from 4.5%-10.5% higher than Federal standards; mostly because DOE did not adopt new efficiencies for these types of DHW. **Old Standards:** The Federal standards that were in effect for all these DHW types since 1986 was, by preemption, the CA standard	February 7, 2001	February 7, 2004 The somewhat lower DOE standards are scheduled to take effect January 20, 2004.	0	0	0	24	22	12
4	Title 20, Section 1605.2(k)(1)	Exit signs	**New Stds.:** Would establish an efficiency standard for illuminated exit signs that limits them to 5 watts per face while maintaining high visibility criteria. **Old Standards:** Current Appliance Standards do not address exit signs, though (until June 1, 2001) building standards give exemption from LPD calculation to CFL exit signs.	*January 2002* This is the likely date for adoption.	*January, 2003* The Commission could require compliance earlier but will likely delay implementation to 12 months after adoption on all Title 20 changes that are not noted otherwise.	5.0	0.6	0.0	17.7	2.0	0.0
5	Title 20, Section 1605.2(k)(2)	Traffic Signals	**New Stds.:** Would establish a maximum watage allowed for traffic signals based on color and type of signal. The standard would have a rated efficiency level at two different temperatures and apply to new and replacement traffic signal lamps in all three colors.	*January 2002* This is the likely date for adoption.	*January, 2003* The Commission could require compliance earlier but will likely delay implementation to 12 months after adoption on all Title 20 changes that are not noted otherwise.	51.3	21	0	68.4	28	0
6	Title 20, Section 1605.2(k)(3)	Torchieres	**New Stds.:** Would establish a maximum design wattage for torchieres of 190 Watts (200, and 150 watts were also under consideration). **Old Standards:** None	*January 2002* This is the likely date for adoption.	*January, 2003* The Commission could require compliance earlier but will likely delay implementation to 12 months after adoption on all Title 20 changes that are not noted otherwise.	32	22.0	0	55	37.9	0
7	Title 20, Section 1605.2(q)	Dry-type transformers	**New Stds.:** Would establish minimum efficiencies for distribution transformers of 97.0%-98.9% depending upon the phase and kva rating. **Old Standards:** None	*January 2002* This is the likely date for adoption.	*January, 2003* The Commission could require compliance earlier but will likely delay implementation to 12 months after adoption on all Title 20 changes that are not noted otherwise.	27	3	0	80.7	9	0

8	Title 20, Section 1605.2(m)	Commercial washers	**New Stds.:** Would establish minimum efficiencies for top loading and front loading commercial washers. The modified Energy Factor accounts for water use as well as direct energy use. **Old Standards:** None	*January 2002.* Adoption may be delayed if no compromise is reached with laundromat owners.	January 1, 2007 NOTE: this is a compromise to maintain the portion of the standard that provides water savings from commercial washers	0	0.000	0	0	0	0
9	Title 20, Section 1605.2(a)(1)	Wine Chillers (consumer styles)	**New Stds.:** Would set a maximum energy consumption based on size and varying by whether the defrost cycle is manual or automatic. **Old Standards:** Same performance level as required under 1604(a)(1), Table A-1, since DOE declared that consumer wine chillers were not DOE covered products.	*January 2002* This is the likely date for adoption.	n.a. This is simply putting into a clear standard a previously existing requirement.	0	0	0	0	0	0
10	Title 20, Section 1605.2(a)(3)	Refrigerated beverage vending mahines	**New Stds.:** Would require internal lighting to be prvided by T8 lamps and electronic ballasts. This requirement would actually apply to reach-in and roll-in refrigerators and freezers too. **Old Standards:** None.	*January 2002* Despite weak opposition, this will likely be adopted.	January 2003.	16.6	1.9	0	49.8	5.7	0
11	Title 20, Section 1605.2(a)(4)	Commercial reach-in refrigerators and freezers	**New Stds.:** Would establish a very energy efficient standard for these types of equipment cutting energy use by 30-50%. **Old Standards**: Reporting only.	*January 2002* This is the likely date for adoption.	July 2002 for Phase I July 1, 2004 for Phase II	5.3	0.90	0	32.0	2.69	0
12	Title 20, Section 1605.2(g)(4)	Heat pump pool heaters	**New Stds.:** Would set the average COP (avg. of Standard rating conditions and Low temp rating conditions) minimum at 3.5.	*January 2002* This is the likely date for adoption.	January 2003.	0.3546	0.028	0	2.1276	0.0851	0
				APPLIANCE SUBTOTAL		143.8	55.2	0.0	518.0	216.4	12.0

6.4 Appendix D: Participation Percentage

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1				Developed Testing or measrmnt Standards	Funded Research into Tstg & Msrmt	Worked with Org that Dvlpd Test Std	Original Suggestion for Std	Conducted Tech Evaluation	CASE Studies	MT or RA Programs	Hosted Mtgs/Conf Calls of Key Stkhldrs	Drafted Code Language	Appeared at Public Wrkshps and Hearings		**Percent IOU C&S Attribution**	**Percent ANY IOU Attribution**
2	Residential Building Stds	1	TXV - AC & air source HP	no	yes	no (ARI)	yes	yes	no	yes	no	no	yes		10%	30%
3		2	Tight Ducts	yes (LBL)	yes	yes (LBL)	yes (Proctor	no	no	yes	no	yes	yes		25%	30%
4		3	Radiant barriers	no	no	no	no	no	no	no	no	no	yes		5%	5%
5		4	Cool Roofs	yes (CRRC)	yes (LBNL)	yes (CRRC)	yes	yes (LBNL)	no	no	no	no	yes		50%	75%
6		5	Insulation Protection	no	no	no	no	no	no	no	no	no	yes		0%	0%
7		6	Cloth Duct Tape	no	yes	yes	no	yes	no	yes	no	no	yes		10%	10%
8		7	Shading - Multiple Orientation	no	no	no	no	no	no	no	no	no	yes		5%	5%
9		8	Shading - Interior Shades	no	no	no	no	no	no	no	no	no	no		0%	0%
10		9	Package A	no	no	no	no	no	no	no	no	no	no		0%	0%
11		10	Package B	no	no	no	no	no	no	no	no	no	no		0%	0%
12		11	Fenestration - U-factor & SHGC	yes (NFRC)	yes (NFRC)	yes (NFRC)	no	yes	no	yes	no	no	yes		20%	30%
13		12	Additions (Prescriptive Approach)	no	no	no	no	no	no	no	no	no	yes		5%	5%
14		13	Alterations (Prescriptive Approach)	no	no	no	no	no	no	no	no	no	yes		5%	5%
15		14	HVAC - ACM calculation methodology	no	yes	yes	no	yes	no	yes	no	no	yes		20%	25%
16	Nonresidential Bldg Stds	15	AC Efficiency - ASHRAE 90.1 levels	yes	yes	yes	no	yes	yes	yes	no	no	yes		15%	20%
17		16	Cooling Tower Efficiency	yes	yes	yes	no	no	no	yes	no	no	yes		10%	15%
18		17	Demand Ventilation	yes	yes	yes	no	yes	no	yes	no	no	yes		15%	20%
19		18	Duct Testing - per ACM Manual	yes (LBL)	yes (LBL)	yes (LBL)	yes	yes (LBL)	yes	yes (res)	yes	yes	yes		50%	60%
20		19	Automatic Shut-off - Lighting	no	no	no	yes	yes	yes	yes	yes	yes	yes		95%	95%
21		20	Bi-level Switching - Lighting	no	no	no	yes	yes	yes	no	yes	yes	yes		95%	95%
22		21	Lighting Power Density	no	no	no	no	no	no	yes	no	no	yes		5%	10%
23		22	Task Lighting	no	no	no	yes	no	no	no	contributed	contributed	yes		20%	20%
24		23	Exterior Lighting	no	no	no	no	no	no	no	contributed	contributed	yes		10%	10%
25		24	Cool Roofs	yes (CRRC)	yes (LBNL)	yes (CRRC)	yes	yes (LBNL)	yes	no	yes	yes	yes		95%	95%
26		25	Furnace Efficiency	no	no	no	no	no	no	no	no	no	no		0%	0%
27		26	Fenestration - U-factor & SHGC and NFRC 100SB	yes (NFRC)	yes (NFRC)	yes (NFRC)	yes	yes	yes	yes	yes	yes	yes		80%	85%
28	Appliance Standa	1	Air conditioning and air source heat pumps	no	yes	yes (ASAP)	yes (CEE)	no	yes	yes	no	no	yes		25%	35%
29		2	Air conditioning and air source heat pumps	no	yes	no	yes	yes	yes	yes	no	no	yes		25%	35%
30		3	Small water heaters	no	yes	yes	no	yes	no	yes	no	no	yes		30%	40%
31		4	Exit signs	no	no	yes	yes	yes	yes	yes	yes	yes	yes		100%	100%
32		5	Traffic Signals	yes (LRC & I	yes (LRC & IT	yes (LRC & I	no	contributed	no	yes	no	contributed	yes		50%	75%
33		6	Torchieres	no	no	no	no	yes	no	yes	no	contributed	yes		5%	25%
34		7	Dry-type transformers	no	no	yes (NEMA &	yes	yes	yes	yes	yes	yes	yes		90%	95%
35		8	Commercial washers	no	yes	yes	yes	yes	yes	no	yes	yes	yes		25%	30%
36		9	Wine Chillers (consumer styles)	no	no	no	no	no	no	no	no	no	yes		0%	0%
37		10	Refrigerated beverage vending mahines	no	no	yes	no	yes	no	no	no	no	yes		5%	5%
38		11	Commercial reach-in refrigerators and freezers	no	no	no	no	no	no	no	no	no	no		0%	0%

	D	E	F	G	H	I	J	K	L	M
44		***Explanation of Column Headings:***								
45	**Developed Tstg/msrmt Standards**	**Funded Research into Tstg & Msrmt**	**Worked with Org that Dvlpd Std**	**Orig. Suggestion for Std**	**Conducted Tech Evaluation**	**CASE Studies**	**MT and RA Programs**	**Hosted Mtgs/Conf Calls of Key Stkhldrs**	**Wrote Code Language**	**Appeared at Public Wrkshps and Hearings**
46	This is work to develop the rating methods, and includes work done at the PG&E Food Service Technology lab. It also includes IOU personnel and contractors participating at DOE, NFRC, ASHRAE, CEE, CRRC, etc.	This includes IOU funding for associations such as EPRI, ASAP, NFRC, CRRC, etc. beyond direct activities of personnel.	This is similar to the first column, but includes work toward establishing a performanc e standard, such as ASHRAE 90.1 or CEE's tier two appliance standards.	When the CEC put out the call for AB970 suggested standards, the IOUs provided a list. This column capures those items and similar (perhaps pre-AB970) suggestions .	Much of the work that went into developing the tight duct, TXV and similar protocols began as IOU funded research. This column captures those activities. Those that the IOUs helped fund, but did not direct, are captured in Column D.	Ious began funding some work by NBI before AB970. Some of those efforts will lead to changes in 2004, but others fed into AB970 changes. Additional CASE work began in **response** to AB970.	The groundwork for adoption of measures in code is often laid by Market Transfor- mation programs. This column indicates whether the IOUs had such programs for each measure w/o attempting to compare to the size or nature of other IOUs programs.	Many conversatio ns were required to work out solutions to comments/c ritiques made after the initial code suggestions were made. IOUs provided the forum (conference calls and meetings) for many of those discussions.	In some cases, IOUs or their contractors wrote the language that was adopted into building or appliance code. This column captures those items.	Includes initial Staff workshops to help identify potential areas for code enhance- ments, Efficiency Committee workshops and hearing, and CEC hearings.

6.5 Appendix E: Water Heater Standards Implementation

		Category	Size	Current Requirements					First Stage					Second Stage				
	Equipment Type	Btu/hr/gal	Btu/hr or Gal	Minimum Thermal Eff. (%)	Maximum Standby Loss (Btu/hr)	Notes	Start Date	Code Sections	Minimum Thermal Eff. (%)	Maximum Standby Loss (Btu/hr)	Notes	Start Date	Code Sections	Minimum Thermal Eff. (%)	Maximum Standby Loss (Btu/hr)	Notes	Start Date	Code Sections
LARGE WATER HEATERS	Gas Storage	< 4,000	< 155,000	78	1.3 + 114/V		1/1/1994	1605.1 F-2	80	Q/800 + 110√V		10/29/2003	1605.1 F-3					
			> 155,000	78	1.3 + 95/V		1/1/1994	1605.1 F-2	80	Q/800 + 110√V		10/29/2003	1605.1 F-3					
	Gas Instantaneous	> 4,000	< 10 gal	80	no req.		1/1/1994	1605.1 F-2	80	no req.								
			> 10 gal	77	2.3 + 67/V		1/1/1994	1605.1 F-2	80	Q/800 + 110√V		10/29/2003	1605.1 F-3					
	Oil Storage	< 4,000	< 155,000	78	1.3 + 114/V		1/1/1994	1605.1 F-2	78	Q/800 + 110√V		10/29/2003	1605.1 F-3					
			> 155,000	78	1.3 + 95/V		1/1/1994	1605.1 F-2	78	Q/800 + 110√V		10/29/2003	1605.1 F-3					
	Oil Instantaneous	> 4,000	< 10 gal	80	no req.		1/1/1994	1605.1 F-2	80	--		10/29/2003	1605.1 F-3					
			> 10 gal	77	2.3 + 67/V		1/1/1994	1605.1 F-2	78	Q/800 + 110√V		10/29/2003	1605.1 F-3					
	Gas Hot Water Supply Boiler	> 4,000	> 10 gal	77	2.3 + 67/V		1/1/1994	1605.1 F-2	80	Q/800 + 110√V		10/29/2003	1605.1 F-3					
	Oil Hot Water Supply Boiler	> 4,000	> 10 gal	77	2.3 + 67/V		1/1/1994	1605.1 F-2	78	Q/800 + 110√V		10/29/2003	1605.1 F-3					
	Electric	all	all	no req.	0.30 + 27/V		1/1/94	1605.1 F-2										
			Size	Energy Factor		Notes	Start Date	Code Sections	Energy Factor		Notes	Start Date	Code Sections	Energy Factor		Notes	Start Date	Code Sections
SMALL WATER HEATERS	Gas Storage		< 75,000 Btu/hr	0.62-(0.0019*V)		These Energy Factors (EF) are per a DOE [illegible]	########	1605.1 F-4	0.67-(0.0019*V)		This is a change in the DOE standard, referenced by Title 20	1/20/2004	1605.1 F-4	0.686-(0.0019*V)		These EFs increase vs. DOE stds.	7/1/2005	1605.2 F-5
	Gas Instantaneous		<200,000 Btu/hr	0.62-(0.0019*V)			########	1605.1 F-4	0.62-(0.0019*V)			1/20/2004	1605.1 F-4	0.686-(0.0019*V)			7/1/2005	1605.2 F-5
	Oil Storage		<105,000 Btu/hr	0.59-(0.0019*V)			########	1605.1 F-4	0.59-(0.0019*V)			1/20/2004	1605.1 F-4	0.59-(0.0019*V)		These values are the same as in the DOE standard effective 1/20/04.	7/1/2005	1605.2 F-5
	Oil Instantaneous		<210,000 Btu/hr	0.59-(0.0019*V)			########	1605.1 F-4	0.59-(0.0019*V)			1/20/2004	1605.1 F-4	0.59-(0.0019*V)			7/1/2005	1605.2 F-5
	Electric Storage (exc. table top)		< 12KW	0.93-(0.00132*V)			########	1605.1 F-4	0.97-(0.00132*V)			1/20/2004	1605.1 F-4	0.97-(0.00132*V)			7/1/2005	1605.2 F-5
	Electric Table Top		< 12KW	0.93-(0.00132*V)			########	1605.1 F-4	0.93-(0.00132*V)			1/20/2004	1605.1 F-4	0.97-(0.00132*V)		These EFs increase due to simplifying	7/1/2005	1605.2 F-5
	Electric Instantaneous (exc. table top)		< 12KW	0.93-(0.00132*V)			########	1605.1 F-4	0.93-(0.00132*V)			1/20/2004	1605.1 F-4	0.97-(0.00132*V)			7/1/2005	1605.2 F-5

Notes: These standards do not go into effect w/o a waiver from Federal preemption or a change in Federal law.

No change to standards.

6.6 Appendix F: HVAC Appliance Standards Implementation Schedule

		First Stage					Second Stage					Third Stage			
Equipment Type	Size (kBtu/h)	Cooling Eff		Heating Eff	Start Dt.	Code	Cooling Eff		Heating Eff	Start Dt.		Cooling Eff		Heating Eff	Start Dt.
AC - air cooled	<65						11.3 EER	13.0 SEER		7/1/2005	1605.2 TC-6	11.6 EER	13.0 SEER		1/1/2006
	>65, <135	10.3 EER		N.A.	10/29/2001	T24	11.0 EER			7/1/2005	1605.2 TC-6	11.0 EER			1/1/2006
	>135, <240	9.7 EER		N.A.	10/29/2001	T24	10.8 EER			7/1/2005	1605.2 TC-6	10.8 EER			1/1/2006
	>240, <760	9.5 EER		N.A.	10/29/2001	T24									
	> 760	9.2 EER		N.A.	10/29/2001	T24									
AC - water cooled	<65						12.1 EER			10/29/2003	1605.1 TC-5	12.1 EER			########
	>65, <135	11.5 EER		N.A.	10/29/2001	T24	11.5 EER			10/29/2003	1605.1 TC-5	11.5 EER			########
	>135, <240	11.0 EER		N.A.	10/29/2001	T24	9.6 EER			10/29/2003	1605.1 TC-5	11.0 EER			########
	>240, <760	11.0 EER		N.A.	10/29/2001	T24									
	> 760	11.0 EER		N.A.	10/29/2001	T24									
Condensing Units - air cooled	<65														
	>65, <135														
	>135, <240	10.1 EER		N.A.	10/29/2001	T24									
	>240, <760	10.1 EER		N.A.	10/29/2001	T24									
	> 760	10.1 EER		N.A.	10/29/2001	T24									
Condensing Units - water cooled	<65														
	>65, <135														
	>135, <240	13.1 EER		N.A.	10/29/2001	T24									
	>240, <760	13.1 EER		N.A.	10/29/2001	T24									
	> 760	13.1 EER		N.A.	10/29/2001	T24									
Heat Pump - air cooled	<65						11.3 EER	13.0 SEER	7.9 HSPF	7/1/2005	1605.2 TC-6	11.6 EER	13.0 SEER	7.9 HSPF	1/1/2006
	>65, <135	10.1 EER		3.2 COP	10/29/2001	T24	11.0 EER		3.4 COP	7/1/2005	1605.2 TC-6	11.0 EER		3.4 COP	1/1/2006
	>135, <240	9.3 EER		3.1 COP	10/29/2001	T24	10.8 EER		3.3 COP	7/1/2005	1605.2 TC-6	10.8 EER		3.3 COP	1/1/2006
	>240, <760	9.0 EER		3.1 COP	10/29/2001	T24									
	> 760	9.0 EER		3.1 COP	10/29/2001	T24									
Heat Pump - water cooled	<17	11.2 EER		4.2 COP	10/29/2001	T24	11.2 EER		4.2 COP	10/29/2003	1605.1 TC-5				
	>17, <65	12.0 EER		4.2 COP	10/29/2001	T24	12.0 EER		4.2 COP	10/29/2003	1605.1 TC-5				
	>65, <135	12.0 EER		4.2 COP	10/29/2001	T24	12.0 EER		4.2 COP	10/29/2003	1605.1 TC-5				
	>135						9.6 EER		2.9 COP	10/29/2003	1605.1 TC-5				
Heat Pump - groundwater	< 135	16.2 EER		3.6 COP	10/29/2001	T24	16.2 EER		3.6 COP	10/29/2003	1605.3 TC-8				
	>135						16.2 EER		3.6 COP	10/29/2003	1605.3 TC-8				
Heat Pump - ground source	< 135	13.4 EER		3.1 COP	10/29/2001	T24	13.4 EER		3.1 COP	10/29/2003	1605.3 TC-8				

NOTES: This is an estimated effective date IF a waiver is granted: one year to get it plus three years delay after that. This also includes TXVs.

This is a Federal standard that affects the sale of equipment. The state standard in T24 takes precedence for new construction.