Codes and Standards Program Savings Estimate

For 2005 Building Standards and 2006/2007 Appliance Standards

CALMAC Study ID: SCE0241.01

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0. EXECUTIVE SUMMARY

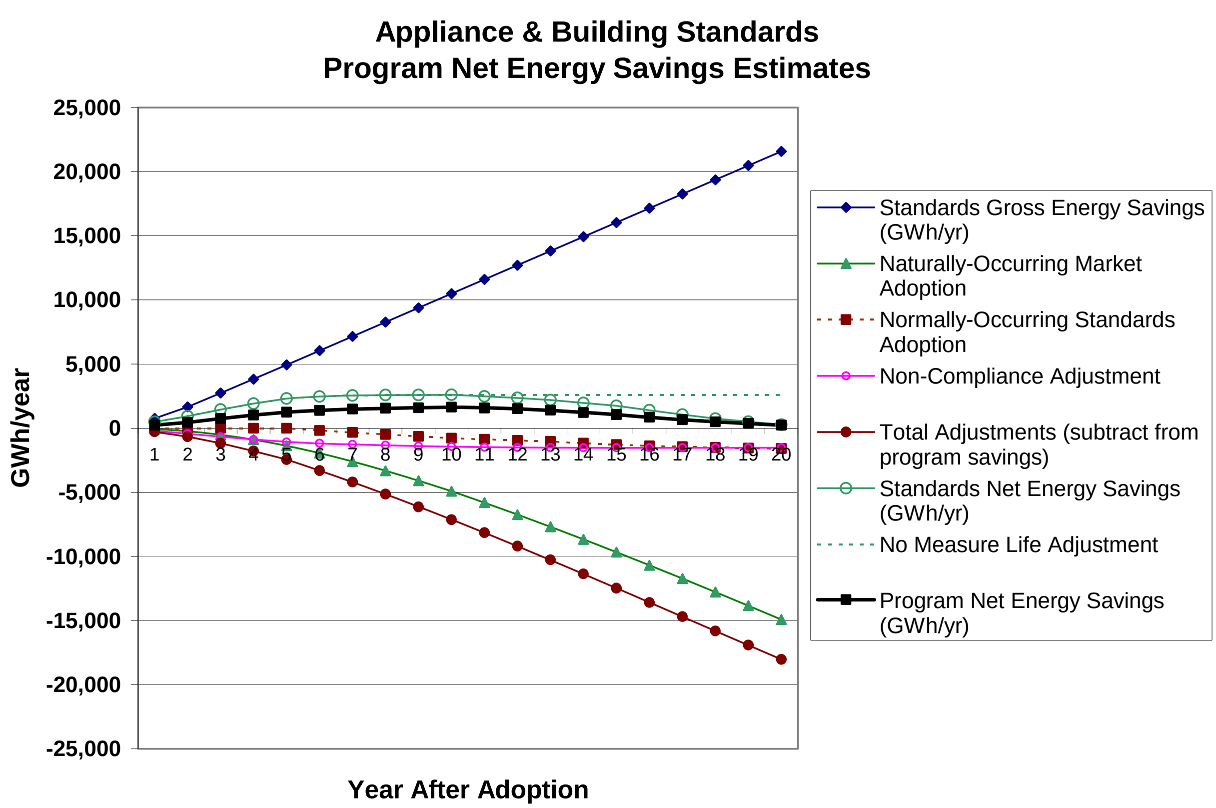
The purpose of this document is to estimate, per the orders of the CPUC, the energy, demand and gas savings that can be reasonably attributed to the efforts of the utilities' Statewide Codes and Standards Program (hereinafter C&S Program). The C&S Program has contributed expertise, research, analysis and other kinds of support to the California Energy Commission to support its efforts to develop and adopt energy efficiency standards for appliances (appliance standards, through Title 20 regulations) and for residential and nonresidential buildings (building standards, through Title 24 regulations). In the past, no savings claims were made for the C&S Program, and so no thorough efforts were made to calculate those savings in a way that estimated their effects over time. This document explains the methodology and model we have developed to calculate those savings.

The algorithms used in preparing this estimate of savings are derived from those developed for the C&S White Paper (HMG 2005a). The calculations start with a first year Standards Gross Savings estimate due to the appliance and building standards savings that are expected to come on-line in 2006, and they end with a stream of annual "Net Program Savings" values. The Program Net Savings are defined as:

> ***Program Net Savings -*** the annual energy (or demand or gas) savings in the market, attributable to the C&S Program, that would not have accrued in the absence of the program's efforts, and extending over the time period in which those savings will occur.

In deriving the net savings, we apply a number of corrections, or discounts, to the initial statewide savings estimate. These are shown graphically for electricity savings in Figure 1 below. These values represent the composite savings for 21 appliance standards and 14 building standards measures.

Figure 1 - Program Net Energy Savings Graph - Exec Summ



The result of the calculation is the dark, hump-shaped curve labeled Program Net Energy Savings (GWh/yr). Similar results are obtained for demand and gas savings. The curve shows annual savings values attributable to the C&S Program, due to new savings coming online in a given year plus continuing savings from previous years' installations.

The overall results of the calculations and adjustments that were explained in this report are shown below in Table 1. The statewide savings goals are taken from Decision 04-09-060 (CPUC 2005). The C&S values are the annual, non-cumulative Program Net Savings calculated for this report, and adjusted to remove the measures that will be installed in non-IOU service territories. The C&S percentages indicate what percent of the statewide goals could be met through the C&S savings.

Table 1 - Total IOU-Attributable C&S Program Net Savings - Exec Summ

IOU Totals	2006			2007			2008		
	Goal	C&S	C&S %	Goal	C&S	C&S %	Goal	C&S	C&S %
Energy (GWh/yr)	2,032	172	8%	2,275	177	8%	2,504	237	9%
Demand (MW/yr)	442	50	11%	478	54	11%	528	64	12%
Gas (Mtherm/yr)	30.0	5.1	17%	37.3	4.5	12%	44.4	4.0	9%

Revision Note V1:
This document amends the first published version of this paper (dated June 30, 2005). While the overall results remain unchanged, we have made an adjustment to the order of the calculations. In the first version, and also in the C&S White Paper (HMG 2005a), the initial step in the basic calculation process was to apply the program attribution weighted score to the annual savings value. Then all the other adjustments (e.g. for naturally-occurring market penetration) were applied. The end result was the program net savings. The problem with this approach is that the statewide standards gross and net savings, absent any program effect, were never explicitly developed or reported. In this version, we have remedied this problem by applying the attribution weighted score at the end of the calculation stream, and we report out the standards gross and net savings values in addition to the program net savings. The standards gross values are of interest to forecasters and system planners, because they show the cumulative effect of the newly adopted standards, absent any adjustments for other market effects. The standards net values may also be of interest to forecasters and system planners, and are certainly of interest to the CEC, as a measure of the net savings induced by the standards statewide. The program net savings numbers are of interest to the utilities and the CPUC as a measure of the net effects expected from the C&S program activities. Again, these final program net savings values are unchanged from the first version of this paper.

Revision Note V2:
This document further amends the previous versions of this paper. In those versions, there was a mismatch between the saving goals and the C&S savings estimates. The goals were annual, not cumulative values, while the C&S savings estimates reported in those versions were cumulative values. The C&S savings values in the tables in this version have been corrected to report the annual values, and therefore to be consistent with the goals listed in those tables.

1. CODES & STANDARDS SAVINGS ESTIMATE BACKGROUND

1.1 INTRODUCTION

The purpose of this document is to estimate the energy, demand and gas savings that can be reasonably attributed to the efforts of the utilities' Statewide Codes and Standards Program (hereinafter C&S Program)[1]. The C&S Program has contributed expertise, research, analysis and other kinds of support to the California Energy Commission to support its efforts to develop and adopt energy efficiency standards for appliances (through Title 20 regulations) and for residential and nonresidential buildings (through Title 24 regulations). In the past, no claims of savings were made for the C&S Program, and so no thorough efforts were made to calculate those savings in a way that estimated their effects over time. This document explains the method and model we have developed to calculate those savings.

The savings that result from the adoption of codes and standards are different from those of typical energy efficiency measures. In the simplest case, a CFL (compact fluorescent lamp) change-out, the IOU pays an incentive to the customer, the customer installs the new CFL to replace an old incandescent lamp, and the savings begin. They accrue until the lamp burns out. The efficiency investment and the start of the savings occur in the same program year. With codes and standards, the efficiency investment is made by the IOU over a period years, beginning two to three years before the new standards take effect. The savings then begin to accrue in the fourth or fifth year following the start of the investment, as new buildings are built and new appliances are purchased. The resulting savings then accrue for the life of the measures and beyond. Every year thereafter, a new set of buildings are built and new appliances are purchased, and a new stream of savings starts for the life of those measures and beyond. There are no direct IOU rebates or spending involved in the realization of those savings; the investment was made several years earlier. This pattern of savings requires a new method of counting, one that can handle this multi-year nature of the C&S Program investments and savings. This paper shows how that method has been developed and applied.

1.2 WHITE PAPER

Prior to the preparation of the savings estimates reported in this paper, the Joint Utilities commissioned a White Paper (HMG 2005a), prepared by a team of experienced evaluators, to identify and discuss the issues associated with such a savings estimate. The White Paper includes a brief history of the C&S Program and its collaborations with the California Energy Commission on updating appliance and building standards. It reviews previous efforts at estimating savings attributable to the C&S Program and at developing an attribution method for dividing credit for savings between the Program and other actors. Perhaps most importantly, it also proposes a method for handling the multi-year stream of savings that result from standards adoption.

We do not repeat the White Paper contents in this report, but rather present the results of savings estimated using substantially the same methodology developed in that report. For background, the reader is referred to the White Paper, which is available on the calmac.org web site (see Section 5 References).

[1] This study was conducted at the request of the California Public Utilities Commission and the Joint Utilities. The study was managed by Marian Brown of the Southern California Edison Co. It was funded through the public goods charge (PGC) for energy efficiency, and is available for download at www.calmac.org.

1.3 ASSIGNED COMMISSIONER RULING

After the White Paper was published, and partially in response to it, CPUC Commissioner Susan Kennedy issued an Assigned Commissioners Ruling (ACR 2005) which stated,

> "During the process of developing future protocols for measuring savings associated with codes and standards advocacy, Joint Staff will also review the historical studies of savings attributable to the 2002 and 2003 codes and standards advocacy work. Based on that review, Joint Staff will make recommendations on (1) what level of savings should be attributed to those activities for resource planning purposes, and (2) whether the Commission should revisit the issue of counting those savings towards the goals established for PY2006-PY2008."

The ruling also emphasized support for the C&S program, and discussed issues relating to how past program efforts might be dealt with in the utilities' program portfolio planning and in the counting of savings attributable to past program efforts that will begin to come online beginning in 2006. It left open the question about whether the Commission would permit the utilities to count those savings toward meeting their goals.

Following the publication of this ACR, ALJ Meg Gottstein issued e-mail instructions on May 25, 2005, which shifted the assignment for calculating C&S Program savings from the Joint Staff to the utilities. The full text of that e-mail follows:

> "To All Parties in R.01-08-028
>
> "On May 11. 2005, Commissioner Kennedy issued a ruling providing clarification on energy efficiency savings issues associated with the 2006-2008 program cycle. Among other things, this ruling clarifies that the record needs to be further developed on the issue of energy savings related to Codes and Standards (C&S) advocacy work. I have further consulted with Commissioner Kennedy's office and Joint Staff to determine the best way to develop this record in the coming weeks, in light of all the other resource demands on Joint Staff and interested parties.
>
> "We have decided on a process that is consistent with the manner in which savings estimates for utility programs that are not currently included in the DEER database are also being developed for Commission consideration:
>
> "The program administrators (PG&E, SCE, SDG&E and SoCalGas) will present their best estimates of energy savings associated with C&S advocacy work to be considered towards meeting the 2006-2008 goals in a July 1, 2005 supplement to their June 1 applications. All supporting workpapers on estimating methodology and assumptions will be presented in that filing.
>
> "Prior to making this supplemental filing, the program administrators will hold a public workshop to present their proposed savings estimates and methodology and to obtain input from interested parties, Joint Staff and other technical experts, as appropriate. In their July 1 filing, the program administrators shall summarize the workshop discussion and indicate how they responded to the parties' comments in finalizing their estimates."

This paper is the result of these instructions. Its scope is limited to preparing the estimate of savings, to documenting that calculation and workpapers, and to reporting on the public workshop. This paper does not address the second question raised in the ACR, about whether the Commission should revisit the issue of whether these savings should be counted toward the utilities' goals. That issue is the domain of the utilities and the Commission, but it will be informed by the data presented herein.

1.4 PUBLIC WORKSHOP

Per ALJ Gottstein's instructions, the Joint Utilities held a public workshop on Friday, June 25th at the Pacific Energy Center. The workshop was noticed a week in advance to the service list for the proceeding, and workshop materials were distributed as well. Over 25 people attended the meeting, which ran from 9:30a to noon. Several attended via telephone conference call and webcast. Douglas Mahone was the presenter. He discussed the savings estimation methodology in detail, and there was a following general discussion on the possible implications of counting the C&S Program savings toward meeting the utilities' goals. A copy of the presentation slides and of the workshop notes are included in the Appendix of this paper.

A number of issues were raised in the Workshop, the more significant, and our responses to them, are briefly summarized here:

- **CASE Energy Estimates and Samples –** The importance of these estimates, and how they are expanded to statewide savings numbers was emphasized, because it is the starting point for all of the calculations. We acknowledge this fact, and point out that we did not prepare any new first year savings estimates for this report, but rather relied on published sources, which are believed to be reliable and the best available data. The numbers could be true-ed up through ex post measurement.
- **Attribution Methodology for Crediting C&S Program Efforts –** Numerous questions were raised about how the judgments were applied, if there was data to support them. One technical argument turned out to be based on a misunderstanding of the nature of the specific measure. One participant complained that the method had not yet been documented for his review, but this was unavoidable due to the short time for the report preparation (this document provides that information). Response: We agree that there is room for tweaking some of the assumptions, and given more time and more input from stakeholders that could be done. In the end, most participants seemed satisfied that the approach was reasonable and tweaks were unlikely to have significant bearing on the overall outcome.
- **Assumptions about Growth** – Participants raised the question as to why the estimates do not attempt to project growth, and asked if the assumptions for new housing starts are accurate. Response: Forecast data was not incorporated into any of the published reports upon which this analysis relies, and we did not have time to seek it out. As such, it represents a conservatism in the savings estimated which could be trued-up with ex post measurements of actual market activity. We have looked into the question of housing start numbers, however, and found that the initial savings estimates are based on housing start numbers that may be 25% lower than actuals (see Section 2.2.1)
- **Compliance Rates** – There was discussion about what to assume for compliance rates; this analysis makes a general assumption about an overall rate and applies it to all measures. Response: With better data, more refined compliance rate estimates could be developed, and we recommend that this be done ex post. See Section 2.2.5 for a more complete discussion of our response to this issue.
- **Policy and Planning Questions** – Although these were discussed at the Workshop (see Section 7.1.8 below), the answers to those questions are beyond the scope of this paper and will be provided directly by the utilities in their filings.

2. METHOD OF ESTIMATING SAVINGS

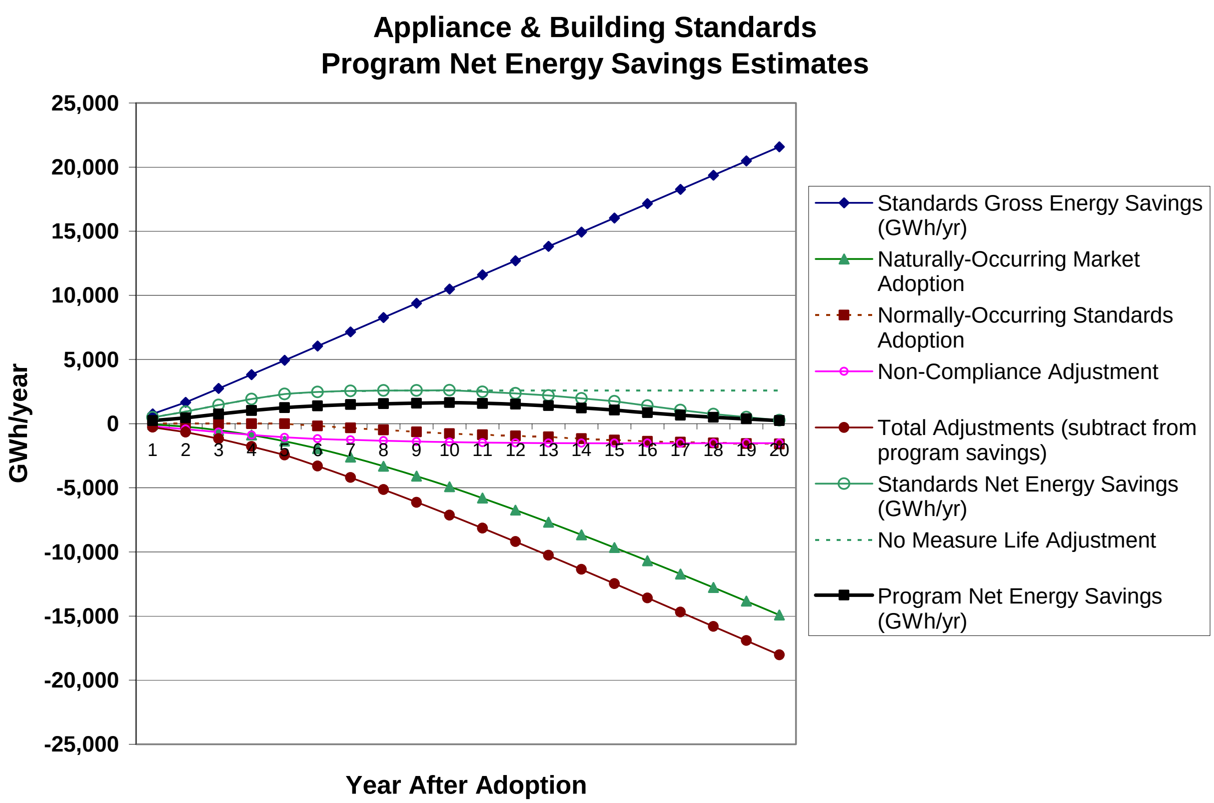
2.1 CALCULATION METHOD

The algorithms used in preparing this estimate of savings are derived from those developed for the C&S White Paper (HMG 2005a). The calculations start with a first year Standards Gross Savings estimate due to the appliance and building standards savings that are expected to come on-line in 2006, and they end with a stream of annual "Net Program Savings" values. The Program Net Savings are defined as:

> ***Program Net Savings*** **-** the annual energy (or demand or gas) savings in the market, attributable to the C&S Program, that would not have accrued in the absence of the program's efforts, and extending over the time period in which those savings will occur.

In deriving the net savings, we apply a number of corrections, or discounts, to the initial statewide savings estimate. The cumulative values of these are shown graphically for electricity savings in Figure 2 below. These values represent the composite savings for 21 appliance standards and 14 building standards measures.

Figure 2 - Program Net Energy Savings Graph



The result of the calculation is the dark, hump-shaped curve labeled Program Net Energy Savings (GWh/yr). Similar results are obtained for demand and gas savings. The curve shows cumulative annual savings values attributable to the C&S Program, due to new savings coming online in a given year plus continuing savings from previous years' installations.

Table 2 shows the total, statewide annual (not cumulative) Program Net Savings for the years 2006 – 2008. These numbers have not yet been adjusted for utility service territories between the IOUs and munis. See Section 3.3 below for the breakdowns of these savings by service territory.

Table 2 - Summary of Statewide C&S Savings by Year

Statewide Totals Annual	2006 Savings	2007 Savings	2008 Savings
Energy (GWh/yr)	240	248	331
Demand (MW/yr)	70	75	89
Gas (Mtherm/yr)	5.1	4.6	4.0

The basic steps in the calculation are outlined here, with more detail and notes provided in the following subsections. The calculations are identical for energy (units of GWh or gigawatthours), demand (units of MW or megawatts), and gas (units of Mtherms or millions of therms). The basic calculation is done for each of the 21 appliance standards and 14 building standards measures, and are then summed to the overall totals.

If the reader has access to the calculation spreadsheet which implements these calculations, it may be easier to follow the calculation process through the spreadsheet tab for one of the standards.

Step 1: Start with the first year statewide Annual Savings estimate value. List this as the Annual Savings number for each year of the calculation stream (which extends out 50 years in the spreadsheet).

Step 2: Multiply each year's Annual Savings by that year's Naturally-Occurring Market Adoption factor, obtained from the lookup table for the assigned adoption rate applicable to each standard. For example, if the Annual Savings is 50 GWh, and the Naturally-Occurring Market Adoption factor for the year is 0.111, then the first adjustment for that year would be 5.55 GWh. The Naturally-Occurring Market Adoption factor increases to a value of 1.0 after the number of years assumed for naturally-occurring market adoption to occur. When the value is 1.0, no further first-year savings are assigned to the C&S Program.

Step 3: For each year, subtract the first adjustment from that year's Annual Savings, and multiply the difference by that year's Normally-Occurring Standards Adoption factor, obtained from the lookup table for the assigned Normally-Occurring Standards Adoption rate applicable to each standard. For example, if the Annual Savings is 50 GWh, the first adjustment is 5.55, and the Normally-Occurring Standards Adoption factor for the year is zero, then the second adjustment for that year would be zero. The Normally-Occurring Standards Adoption factor has a value of zero for the years preceding the assumed normally-occurring adoption year, and it has a value of 1.0 thereafter. When the value is 1.0, no further first-year savings are assigned to the C&S Program.

Step 4: For each year, subtract the first and second adjustments from that year's Annual Savings, and multiply the difference by that year's Non-Compliance Adjustment factor, obtained from the lookup table for the assigned non-compliance rate. For example, if the Annual Savings is 50 GWh, the first adjustment is 5.55, the second adjustment is zero, and the Compliance Adjustment factor is 0.33, then the third adjustment for that year would be 44.45 times 0.33, or 14.67 GWh. This amounts to an energy savings debit for that year due to non-compliance with the standard.

Step 5: For each year, sum the three adjustment factors calculated in the preceding steps to obtain the Total Adjustments.

Step 6: For each year, subtract the Total Adjustments from that year's Annual Savings to obtain the Annual Net Standards-Induced Effect.

Step 7: For each year, determine the Measure Life Adjustment, based on the number of years in the Measure Life. The adjustment is equal to the Annual Net Standards-Induced Effect from the year which precedes the current year by the number of years in the Measure Life. For example, if the Measure Life is 6 years, the Measure Life Adjustment in year 7 would be equal to the Annual Net Standards-Induced Effect from year 1 (7 – 6 = 1). Similarly, the Adjustment in year 8 would be the Effect from year 2, and so on.

Step 8: For each year, calculate the Standards Net Savings as the sum of the current year's Net Standards-Induced Effect, plus the preceding year's Net Standards-Induced Effect, minus the current year's Measure Life Adjustment. Then calculate the Program Net Savings by multiplying each Standards Net Savings yearly value by the Attribution weighted score. The Program Net Savings values tend to follow a hump-shaped pattern, increasing in the early years of standards adoption, and then tapering off in later years as the adjustment factors take away savings.

Step 9: Sum the annual values of Program Net Savings for all of the standards to determine the cumulative total annual savings for the C&S Program. Repeat for demand and gas savings. The annual, non cumulative values are also calculated by not accumulating the savings.

Step 10: Break down the annual, non-cumulative Program Net Savings by utility service territory for the four California investor-owned utilities (IOUs), and for the non-IOU remainder. This is done separately for electricity (energy and demand) and for gas savings.

2.2 DATA SOURCES

The following sections provide additional detail about how each of the adjustment factors are determined and applied in these calculations.

2.2.1 First Year Statewide Savings Estimates

As there was a limited amount of time available for developing the model to perform these calculations, we relied upon published sources for the first year statewide savings estimates for each of the measures. While we did not have the resources to verify the published estimates for consistency or accuracy ourselves, we did verify that the savings values had been scrutinized by the CEC staff, in the case of the appliance standards, and by the CEC staff and an independent evaluator, ADM Associates, in the case of the building standards.

The Appliance Standards savings estimates were extracted from published analysis by Energy Solutions (ES 2005) for 21 different standards adopted by the CEC to take effect in 2006 and beyond (effective dates vary). A list of these standards, their annual first year savings, and their effective dates follows in Table 3. See the Energy Solutions report for a full explanation of each of these standards and the savings estimates developed for each.

The Building Standards savings estimates were extracted from the evaluation report prepared by ADM Associates (ADM 2004). That study conducted an independent review of savings estimates prepared by the CASE report authors and by the Eley Associates (EA 2003) impact analysis. Savings estimates were developed for the 13 standards measures proposed by the C&S Program in its CASE reports. Unfortunately, there are no correspondingly detailed, measure-by-measure savings estimates for the other measures developed by the CEC and other stakeholders, so these were necessarily lumped together and designated as "Composite for Remainder" in these calculations. A list of these measures, and their annual first year savings, follows in Table 4. All of these standards take effect in October, 2005, and are assumed to start producing savings in 2006 for purposes of these calculations. See the ADM report for a full explanation of each of these measures and the savings estimates developed for each.

Table 3 - List of Appliance Efficiency Standards and 1st Year Savings

With CASE Report, Standard Adopted	1st Year Savings (GWh)	1st Year Demand Savings (MW)	1st Year Gas Savings (Mtherms/yr)	Start Year
Commercial Refrigeration Equipment, Solid Door	**9.54**	**1.25**		**Jan-06**
Commercial Refrigeration Equipment, Transparent Door	**8.37**	**1.10**		**Jan-07**
Commercial Ice Maker Equipment	**6.60**	**0.87**		**Jan-08**
Walk-In Refrigerators / Freezers	**47.97**	**6.30**		**Jan-06**
Refrigerated Beverage Vending Machines	**12.63**	**1.66**		**Jan-06**
Large Packaged Commercial Air-Conditioners, Tier 1	**13.47**	**6.99**		**Oct-06**
Large Packaged Commercial Air-Conditioners, Tier 2	**10.05**	**5.21**		**Jan-10**
Residential Pool Pumps, High Eff Motor, Tier 1	**18.59**	**3.54**		**Jan-06**
Residential Pool Pumps, 2-speed Motors, Tier 2	**130.13**	**30.77**		**Jan-08**
Portable Electric Spas	**6.60**	**1.26**		**Jan-06**
General Service Incandescent Lamps, Tier 1	**79.18**	**9.82**		**Jan-06**
Pulse Start Metal Halide HID Luminaires, Tier 1	**49.26**	**8.79**		**Jan-06**
Modular Furniture Task Lighting Fixtures	**0.83**	**0.15**		**Jan-06**
Hot Food Holding Cabinets	**1.50**	**0.22**		**Jan-06**
External Power Supplies, Tier 1	**47.75**	**5.45**		**Jan-06**
External Power Supplies, Tier 2	**8.64**	**0.99**		**Jan-08**
Consumer Electronics - Audio Players, Digital TV Adapters	**53.86**	**6.17**		**Jan-07**
Consumer Electronics - TVs, DVDs	**79.50**	**9.08**		**Jan-06**
Water Dispensers	**6.14**	**0.81**		**Jan-06**
Unit Heaters and Duct Furnaces			**2.05**	**Jan-06**
Commercial Dishwasher Pre-Rinse Spray Valves	**34.31**	**7.39**	**4.54**	**Jan-06**

Table 4 - Building Efficiency Standards Measures

With CASE Report, Standard Adopted	1st Year Savings (GWh)	1st Year Demand Savings (MW)	1st Year Gas Savings (Mtherms/yr)	Start Year
Time dependent valuation, Residential	6.70	27.20		Jan-06
Time dependent valuation, Nonresidential	4.30	18.70		Jan-06
Res. Hardwired lighting	64.60	2.97		Jan-06
Duct improvement	5.70	8.50	1.10	Jan-06
Window replacement	6.34	2.40	0.30	Jan-06
Lighting controls under skylights	25.46			Jan-06
Ducts in existing commercial buildings	9.73	7.36	1.04	Jan-06
Cool roofs	14.60	9.50		Jan-06
Relocatable classrooms	2.90			Jan-06
Bi-level lighting control credits	12.14			Jan-06
Duct testing/sealing in new commercial buildings	8.01			Jan-06
Cooling tower applications	3.01			Jan-06
Multifamily Water Heating			1.50	Jan-06
Composite for Remainder	321.54	134.87	3.25	Jan-06

In general, each of the savings estimates used in this report was derived from engineering estimates of savings, using best-available calculations of savings compared to the previous version of each standard. Where there was no previous standard, current market practices were assumed. The savings estimates were expanded to cover statewide savings, based on annual housing starts, nonresidential new construction, and appliance sales.

In the case of housing starts, the numbers assumed in Eley (2003) impact report , and used in the ADM study, were 108,470 new homes per year and 41,730 Multi-family units (total of about 149k units per year). This is likely a conservative estimate. Table 5 below, provided by Mike Hodgson of Consol, Inc., a consultant to the California Building Industries Association, lists actual and forecast housing starts for the period 2003 – 2006, based on data from the Construction Industry Research Board (CIRB).

Table 5 - Housing Starts (Single- and Multi-Family)

Housing Starts	SF	MF	Totals	
2003	138,762	56,920	195,682	(actual)
2004	151,417	61,543	212,960	(actual)
2005	147,600	59,000	206,600	(forecast)
2006	141,000	61,000	202,000	(forecast)
C&S Estimates	108,470	41,730	150,200	(assumed)

The expectation is that there will be about 200k units per year going forward, so the savings estimates in this report for residential new construction measures may be 25% lower than what will be built.

We have not done a similar check on the reasonableness of nonresidential new construction data or appliance sales, but we believe those estimates to also incorporate conservative assumptions.

There is an additional conservatism throughout this analysis, in that we have not attempted to forecast growth in buildings, population or appliance purchases. Given the population trends for California, it is reasonable to expect there will be continuing growth, which would produce a corresponding growth in savings. This factor could be accounted for in subsequent ex post true-up studies for the C&S Program.

2.2.2 Attribution of C&S Program Efforts Toward Adoption

Attribution, in this calculation, refers to the portion of the first year statewide savings estimate that can reasonably be attributed to the efforts of the C&S Program in helping the CEC to adopt a given standard or measure.

The estimation method used in this paper is a variation of the HMG method described in the White Paper (HMG 2005b) and further discussed the ADM evaluation study (ADM 2004). We chose not to adopt the attribution method used by ADM in their study, because the CEC felt that it unduly oversimplified attribution and underestimated the role of the CEC staff in adopting new standards. Rather than ten adoption steps used in the original HMG approach, and a simple yes/no for utility involvement in each, we developed a five step process. For each step, we estimated the relative importance for each of the adopted standards, and then assigned weights to reflect that importance. We next determined the utility score for each of the steps/standards. Finally, we calculated the weighted score to determine the overall attribution fraction.

The five factors leading to adoption of a standard that were used in this analysis were:

- **Importance of Energy Efficient Products in the Market –** How important was it, to the adoption of this standard, that there was a substantial share of energy efficient products of this type in the market?
  - **Weight -** For some products, such as energy efficient T-8 lamps and electronic ballasts for modular furniture task lighting fixtures, it was crucial that a large number of these products were available in the market and were being routinely installed already; else there would have been a great deal of opposition to making this a standard. Therefore, the weight for this factor for this standard was relatively high (40%). For other kinds of products, such as commercial ice making equipment, there was very little interest in the market for having energy efficient units, and so there was low market penetration. But there were energy efficient models available, and so it was possible to write a standard requiring that they be used. Therefore, the weight for this factor for icemakers was relatively low (10%).

  - **IOU Score** – In cases where the IOUs had played an important role in bringing a given appliance or building measure into the market, through rebates, training or other efforts, the score was awarded as high as 100%. In other cases, where the utility involvement in developing the market or bringing a given appliance or measure into common practice was low, the score awarded was low.

- **Effort Needed for Test Methods/Research –** How important was it, to the adoption of this standard, that new test methods or new research results be developed, and how much effort was required to do this?

  - **Weight** – For some measures, such as walk-in refrigerators, there was a well-established, existing test method that could be cited in the new appliance standard, and so it was of no importance and no effort was needed to develop a new test method. For other measures, such as cool roofs, a great deal of effort was needed to develop a new test method and to do supporting research, and without this work it would have been impossible to write a requirement for cool roofs into the building standards.

  - **IOU Score** – In cases where the IOUs conducted or sponsored the research or development of a test method or standard, they were awarded a high score. In other cases where the utility involvement in this kind of development work was low, the IOU score was correspondingly low.

- **Innovativeness of Standards Idea –** How new or innovative was the idea to develop a standard for this appliance or measure? Was this a type of standard or measure that had already been adopted, or was it entirely new as a standard?

  - **Weight** – In cases where the CEC or some other authority had already had a standard, the weight was low. In cases where there had never been a standard, or where the approach to the new standard was entirely new, then the weight was high. For example, the building standards had never effectively governed relocatable classrooms before, so the idea and approach of developing a standard to do so was new and productive; the assigned weight was relatively high. In other cases, such as refrigerated vending machines, there was already a significant trend toward more efficient products, and so the innovativeness of the idea for making a standard to govern them was less important than other factors.

  - **IOU Score** – If the idea for a given standard was pioneered by the C&S program, then the IOU score was relatively high. For example, the utilities were very actively promoting the development of the new appliance standard for residential pool pumps, with very little involvement by the CEC or others, and so they were awarded a high score. The idea for developing standards for consumer electronics, however, was thought up and promoted by the CEC staff and other third parties, and so the IOU score was zero.

- **Preparation of CASE Analysis –** How important was the analysis and development of the standards language, as presented in the CASE reports by the C&S Program, to the adoption of a given standard? CASE reports include engineering estimates of savings, market availability assessment, drafting of standards language, and development of statewide savings estimates, among other things.

  - **Weight** – In cases where there was substantial question about the viability of a given standard or measure, or where the analysis in the CASE report was important in making the argument to adopt, the weight was higher. For example, for efficiency requirements for large packaged air conditioners, the economic analysis to justify higher standards was critical to their adoption, so the weight was relatively high. In other cases, where there was not a lot of questions or concerns about the analysis, the weight was lower, as with lighting controls under skylights.

- **IOU Score** – In most cases, the C&S Program paid for the development of the CASE reports and arranged for the proper expertise to do the work. In some cases, however, the CEC staff or other stakeholders were actively involved in reviewing or revising the CASE analysis work or standards language; in those cases the IOU score was lower.

- **Worked w/ Stakeholders & Public Process –** How important was it, to the adoption of this standard, and how extensive was the effort required to work with outside stakeholders and to participate in the public process?
  - **Weight** - In some cases, e.g. where there was significant opposition from an interested group or industry, there was significant effort involved in working with the stakeholders, both in public and off-line, and it was critical to the CEC's adoption process that the stakeholders were heard and their concerns addressed. In those cases, this factor had a relatively high weight. An example of this was the new requirements for cooling towers in the building standards; industry groups attended several CEC workshops and commented extensively on the proposed standard. Without the effort expended to address their concerns, it would not have been likely that a cooling tower measure would have been adopted into the standards. In other cases, where there was no significant opposition or public process to win adoption, this factor was weighted low. For example, the portable electric spa industry did not show any interest in the new appliance standard governing their products, so there was very little effort expended in working with them and that effort was not very important to the adoption of the standard.
  - **IOU Score** – In many cases, both the CEC staff and the C&S Program representatives worked with stakeholders and the public process, and so the IOU score was often 50%. In cases where the C&S program expended a great deal of effort outside the CEC's public workshops, the IOU score was higher. In some cases, the work with stakeholders and the public was primarily done by the CEC or other stakeholders, and the IOU score was lower.

The scoring process was carried out by a committee that included representatives from the CEC (Bill Pennington, plus John Wilson and Jim Holland), the PG&E C&S Program (Pat Eilert and Gary Fernstrom), and consultants familiar with the development of the pertinent standards (Ted Pope of Energy Solutions, Douglas Mahone of HMG). The committee, for each of the standards and building measures, reviewed the history of the adoption process, and the roles and activities of the CEC, the C&S Program, and other stakeholders. First the weights were assigned for each of the standards, and were adjusted to sum in all cases to 100%. Then the IOU scores, from 0% to 100%, were awarded for each of the factors for each of the standards. Finally, the attribution weighted score was computed – the product of the weight times the score was developed for each of the five factors, and the sum of those five numbers was the score.

An example of the assigned weights and IOU scores for some of the appliance standards is found in Table 6 below. This procedure was applied to all 21 of the appliance standards, and all 14 of the building standards measures treated in these calculations.

Table 6 - Example of Attribution Weighting and Scoring Method

Appliance Standards	Importance of Energy Efficient Products in the Market		Effort Needed for Test Methods/Research		Innovativeness of Standards Idea		Preparation of CASE Analysis		Worked w/ Stakeholders & Public Process			
With CASE Report, Standard Adopted	**Weight**	**IOU Score**	**Weight**	**IOU Score**	**Weight**	**IOU Score**	**Weight**	**IOU Score**	**Weight**	**IOU Score**	**Weight Sum**	**Weighted Score**
Commercial Ice Maker Equipment	10%	5%	20%	0%	20%	90%	30%	90%	20%	50%	100%	**56%**
Walk-In Refrigerators / Freezers	20%	5%	0%	0%	20%	90%	50%	90%	10%	50%	100%	**69%**
Refrigerated Beverage Vending Machines	25%	5%	20%	0%	10%	90%	35%	90%	10%	30%	100%	**45%**
Large Packaged Commercial Air-Conditioners, Tier 1	20%	15%	0%	0%	10%	80%	40%	90%	30%	30%	100%	**56%**
Large Packaged Commercial Air-Conditioners, Tier 2	10%	15%	0%	0%	20%	80%	40%	90%	30%	30%	100%	**63%**
Residential Pool Pumps, High Eff Motor, Tier 1	10%	100%	20%	100%	30%	100%	35%	90%	5%	75%	100%	**95%**
Residential Pool Pumps, 2-speed Motors, Tier 2	10%	100%	20%	100%	30%	100%	35%	90%	5%	75%	100%	**95%**
Portable Electric Spas	5%	0%	30%	100%	20%	100%	40%	90%	5%	80%	100%	**90%**

There have been some questions about the objectivity of this weighting and scoring process. Given the short period of time available for this calculation project, it is clearly the best that we could have done. It does, however, have the disadvantage that it relied upon the memory of events that took place two and three years ago. Also, it was done by people who were actively involved in the process. Both of these were unavoidable in this case. In the future, however, it might be better practice to appoint a "scorekeeper" to follow the standards development process from beginning to end, and to independently observe the efforts and influence of all the stakeholders and CEC staff in the process. Alternatively, a formal process evaluation could be conducted immediately following adoption of new standards, and involving a wider range of participants in developing the assessments.

2.2.3 Naturally-Occurring Market Adoption

The adjustments made in these calculations for naturally-occurring market adoption are intended to capture the phenomenon that better, more energy efficient products are likely to be adopted by the market even without C&S Program activities or standards being adopted. We do not award savings to the C&S Program that would have shown up in the market anyway. As used in these calculations, the annual rate of naturally occurring market adoption increases over time, and is used to "discount" or reduce the size of the energy savings that we attribute to the program. In doing this, we established a set of simple market adoption curves that grow in a linear fashion up to an ultimate market adoption rate of 100% over a period of years. For example, if we assume a naturally-occurring market adoption time of 10 years for a given measure, we assume that one-tenth of the market naturally adopts the measure in the first years, and one-tenth of the savings are taken away from the C&S Program. In the second year, we take away two-tenths of the savings, and so on until the 10th year when none of the savings are credited to the Program.

It has been suggested that we should not use this type of simple, linear growth rate in naturally-occurring market adoption, and that the actual rate is probably more of an S-curve, starting off slowly in the early years, growing rapidly in the middle years, and leveling off in the later years. This would probably be more accurate for measures or appliances that are early in their adoption process, but it would not be accurate for those that are already undergoing substantial market adoption. For lack of that kind of detailed market data on each of the 35 standards we treated in this analysis, we decided to stick with the simple, linear curve.

In preparing this analysis, we selected from among five variations of market adoption curves:

3 years to naturally-occurring market adoption
6 years to naturally-occurring market adoption
12 years to naturally-occurring market adoption
18 years to naturally-occurring market adoption
24 years to naturally-occurring market adoption

For each standard, the scoring committee, introduced above in Section 2.2.1, reviewed the information developed throughout the adoption process about the appliance or the building measure, and made a judgment about how close the measure was to full market adoption. Shorter time periods were assigned to those measures which were close to full market adoption, and longer time periods to those that are less close. When these adoption curves were applied to the first year savings in the calculation model, we were implicitly assuming that the starting point for market adoption was the market condition when the CASE report was written (two to three years ago), because the savings estimates were based on the remaining market potential for installations of the higher efficiency measures.

Ideally, there would be more market intelligence and less judgment applied in making these assignments, but with the current state of market information this was generally impossible. This is especially so for those measures that are new to standards, as there is no experience of their uptake in the market with which to compare. Furthermore, it is very difficult to obtain market adoption rate data for new technologies coming into buildings; this requires the cooperation of manufacturers and/or distributors. Such a process is being pursued for ENERGY STAR appliances at the national level, and is has been a time consuming and expensive process to obtain even limited sales data, let alone time series data. Until such studies are expanded to include the new technologies being considered for codes and standards, we will have to rely upon this expert judgment approach, and to be relatively conservative (shorter assumed market adoption rates) in our assumptions.

A sample of the assigned adoption rates for some of the appliance standards treated in this analysis is found in Table 7 below.

Table 7 - Examples of Assumed Naturally-Occurring Market Adoption Rates

Appliance Standards	
With CASE Report, Standard Adopted	**Natural Market Adoption**
Commercial Ice Maker Equipment	**18yrNA**
Walk-In Refrigerators / Freezers	**18yrNA**
Refrigerated Beverage Vending Machines	**6yrNA**
Large Packaged Commercial Air-Conditioners, Tier 1	**6yrNA**
Large Packaged Commercial Air-Conditioners, Tier 2	**9yrNA**
Residential Pool Pumps, High Eff Motor, Tier 1	**18yrNA**
Residential Pool Pumps, 2-speed Motors, Tier 2	**24yrNA**

2.2.4 Normally-Occurring Standards Adoption

A primary effect of the C&S Program is to accelerate the time it takes for the CEC to adopt or update standards. The CEC uses a three-year update cycle, with the intent, reinforced by public policy directives, of keeping the standards up-to-date and cost-effective as market conditions change. Of course, the CEC is resource constrained like most state agencies, and so it is not always possible to do this. The resources the C&S Programs brings to the adoption process complement and supplement the CEC staff resources. It is reasonable to assume, therefore, that the standards adopted in 2005 by the CEC would have been adopted in the normal course of time.

To account for this effect, the scoring committee (introduced above in Section 2.2.1), in its review of each of the standards, made a judgment about how long it would have taken the CEC to adopt each standard using only its own resources. Examples of the assigned rates are shown below in Table 8. The values indicate the number of years it would likely have taken. For example, when it says “9yrCode”, it means that after 9 years, the CEC would have normally been expected to adopt the standard. In the calculation, from year 10 on, none of the savings from the standard are assigned to the C&S Program. The Program is only credited for the years of savings prior to the normally-occurring adoption of each standard.

Table 8 - Examples of Normally-Occurring Standards Adoption Rates

Appliance Standards	
With CASE Report, Standard Adopted	**Assumed Code Update Rate**
Commercial Ice Maker Equipment	**9yrCode**
Walk-In Refrigerators / Freezers	**9yrCode**
Refrigerated Beverage Vending Machines	**6yrCode**
Large Packaged Commercial Air-Conditioners, Tier 1	**6yrCode**
Large Packaged Commercial Air-Conditioners, Tier 2	**9yrCode**
Residential Pool Pumps, High Eff Motor, Tier 1	**12yrCode**
Residential Pool Pumps, 2-speed Motors, Tier 2	**12yrCode**

In judging the value to assign, consideration was given to whether the particular standard was already under consideration by the CEC staff. For example, large packaged commercial air conditioners are already governed by the efficiency standards, and the new standard was primarily updating the minimum allowable efficiency levels, so it is likely that the Tier 1 standard would have been adopted within 6 years, and the Tier 2 standard three years later. For pool pumps, by contrast, until they were brought to the attention of the CEC as an efficiency opportunity by the IOUs, there was no CEC staff consideration given them, and so it would likely have taken 12 years or more before this standard would normally have been adopted.

These judgments, of course, are difficult to verify with any precision, because it is difficult to predict future CEC staff resources or California's political will to adopt more stringent standards. For this reason, the committee tried to be conservative in its estimates, opting for shorter adoption periods whenever there was a lack of consensus.

2.2.5 Non-Compliance Adjustment

The adjustment for non-compliance essentially subtracts savings from the standards due to the fact that not all buildings or appliances comply fully with the standards. In the real world, there is often a range of appliances or measures present in the market, some falling below the standard and some above the standard in their efficiency level. Ideally, we would have sales-weighted data on the efficiency levels of measures installed in the field. In practice, these data are very difficult to obtain.

The committee initially went through an exercise to try to assign individual compliance rates to each appliance standard and building measure, using its best expert judgment. It became apparent, however, that these were rather uninformed guesses. For the new appliance standards, such as the requirements for the efficiency of electronics and power supplies, there is no experience to guide a judgment about what levels of compliance can be expected. Much of this equipment is manufactured abroad and is sold through national outlets, so there is even reason to believe that manufacturers and distributors will not be aware of California's efficiency standards. There is also uncertainty about the new requirements for ducts and windows in existing buildings upon replacement. If permits are not obtained, the standards enforcement mechanisms do not apply. For all of the building standards measures, there is the opportunity for trade-offs, and their compliance as part of the whole building efficiency is also open to doubt.

All of these issues are amenable to ex post compliance measurements, and they should all have ex ante baseline compliance levels established. Lacking such data, however, the committee judged that it would be most prudent and defensible to apply a simple, uniform non-compliance value to all of the standards and measures. This, in effect, assumes that some will have better rates of compliance and some will have less, but that overall compliance levels were likely to be no worse than the assumed value. This value was selected as a 30% non-compliance rate.

One more justification for this selection is that it allows for the possibility that a portion of C&S Program efforts over the next three years could be directed toward improving the compliance rates, especially for those standards and measures which have large promise and potentially poor compliance rates. Such efforts could include building official training, monitoring appliance standards compliance with retailers, and outreach to retailers to inform them about the new standards governing the equipment that they sell.

2.2.6 Measure Life

A final adjustment to the savings estimates is for the life of individual measures. These values were selected to be representative of each type of equipment or measure. The measure life is used to limit time period for counting savings. After first measure life has expired, re-installations are only credited at the rate of naturally-occurring measure installations, rather than counted indefinitely as new installations. The limited measure life is realistic, and it has the effect of bringing the Program Net Savings estimates back down to zero after a number of years have passed.

Examples of the measure life assignments for some of the appliance standards measures are shown below in Table 9.

Table 9 - Examples of Measure Life Assumptions

Appliance Standards	
With CASE Report, Standard Adopted	**Measure Life**
Commercial Ice Maker Equipment	**8**
Walk-In Refrigerators / Freezers	**10**
Refrigerated Beverage Vending Machines	**10**
Large Packaged Commercial Air-Conditioners, Tier 1	**15**
Large Packaged Commercial Air-Conditioners, Tier 2	**15**
Residential Pool Pumps, High Eff Motor, Tier 1	**10**
Residential Pool Pumps, 2-speed Motors, Tier 2	**10**

2.2.7 Breakouts by Utility Service Territory

Once the statewide estimates of Program Net Savings have been estimated, both cumulatively and as annual values, we make a final allocation of the annual savings values to the utility service territories. This is based on the long-standing practice in California of only assigning savings to a utility for measures that are actually installed within their service territory. The allocation of savings to utility territory was done on the basis of electricity or gas sales expected for 2006, as appropriate. While this allocation is probably not as precise as possible – it could be done on the basis of forecasts of new home construction, nonresidential construction square footage, and appliance sales forecasts – this allocation was felt to be sufficiently accurate for the current purpose, as an ex ante savings estimate. The actual installation rates can be determined through ex post measurement, and the savings calculations trued-up at a later date.

The values shown in Table 10 show the expected electricity and gas sales, broken out by IOU service territory and including the other, municipal utilities. Based on these allocations of state energy sales, the relative percentages for each of the IOUs are calculated. These allocations are then applied to the overall statewide Program Net Savings to determine the portion of those savings allocable to each IOU. These savings values are shown in the tables under Section 3.3 below.

Table 10 - Breakouts by Utility Service Territory – Gas and Electricity

Electricity Sales (GWh)	PG&E	SCE	SDG&E	Other	Totals
2006 Sales Forecast	84,311	86,961	19,734	75,948	266,954
Percent of Statewide	31.6%	32.6%	7.4%	28.4%	100.0%

Source: CEC Forecast (2005), Form 1.c - Statewide

Gas Sales (MMtherms)	PG&E	SCG	SDG&E	Other	Totals
2006 Sales Forecast	4,892	7,834	556	133	13,415
Percent of Statewide	36.5%	58.4%	4.1%	1.0%	100.0%

Source: CEC Forecast (2005), Tables 10-5 through 10-7

2.3 REFINEMENTS TO WHITE PAPER METHODOLOGY

The methodology used in estimating the Program Net Savings is based on the algorithms developed for the C&S White Paper (HMG 2005a). We have refined those algorithms somewhat to make these calculations more robust. The reader is reminded that the White Paper developed and recommended the basic methodology, and presented three scenarios showing how it might be applied to the 2005 Building Standards, but the calculations were not intended to provide definitive answers. That is the purpose of this paper, to apply and extend that methodology to develop solid estimates of savings.

There were two primary refinements made to the White Paper methodology in the course of these calculations.

The first refinement is in how the adjustments for naturally-occurring market adoption, normally-occurring standards adoption, and non-compliance are applied. In the White Paper (HMG 2005a), the calculation started by accumulating the first year savings estimates, which doubled in the second year, tripled in the third year, and so on. Each of the adjustments represented a reduction in the savings for a given year. For example, if the naturally-occurring market adoption rate was six years, in the first year one-sixth of the savings were deducted. In the second year, two sixths were deducted, and so forth. When these annual adjustments are applied to the cumulative savings, however, it has the effect of applying multiple discounts. If the adjustment for year 3 is applied to the accumulated three years of savings, then that adjustment is also being applied to years 2 and 1 as well. Then when the year 4 adjustment is applied to the accumulated four years of savings, it is again applied to years 3, 2 and 1. To correct this, the calculations in this paper only apply the adjustments to the single year savings, and only after all the adjustments are the savings accumulated. We believe this refinement gives a more accurate picture of how savings develop over time.

The other refinement made in these calculations, compared to the White Paper, is to explicitly account for measure life. The original method was fine for long-lived measures – many building measures have lifetimes of 15 years or more, but some of the standards have very short lives. General service incandescent lamps have only a 1 year measure life, and some consumer electronics last only 4 years. The refined calculation method assumes that measures installed in year 1 will phase out following the measure life time period, and that their replacements will be taken care of by measures that would have naturally been in the market even absent the new standards. The measure life adjustment, therefore, has the effect of bringing the accumulated savings back down to zero after the time that no new measures are being installed under the standard (due to the previous adjustments).

One additional refinement is made with this amended version of the analysis: the attribution weighted score is now applied as the last step in the analysis, rather than the first (as explained above in section 2.1, Step 8). This change allows us to calculate both the Gross and Net Standards Savings, and then the Program Net Savings. Previously, when referring to the Standards Gross Savings, we were actually describing the program-attributable portion of the Standards Gross Savings. The refined method provides, we believe, a clearer picture of the standards savings before adjusting for program attribution.

A final adjustment, made in version 2 of this document, pulls out the annual, non-cumulative savings. These are the values that are reported in comparison to the annual savings goals, which are likewise annual values, and in the breakdowns by utility.

3. RESULTS – ESTIMATED SAVINGS

The goal of attribution is to determine what portion of the statewide energy savings resulting from a standards adoption cycle should be credited to the efforts of the utility C&S Program. This section presents the savings numbers, and compares them to the savings goals established by the CPUC for the utility portfolios of programs. This comparison gives perspective on the magnitude of the savings attributable to the C&S Program.

3.1 ESTIMATED SAVINGS COMPARED TO GOALS

The overall results of the calculations and adjustments that were explained in the previous chapter are shown below in Table 11. The statewide savings goals are taken from Decision 04-09-060 (CPUC 2005). The C&S values are the annual, non-cumulative Program Net Savings calculated for this report, and adjusted to remove the measures that will be installed in non-IOU service territories. The C&S percentages indicate what percent of the statewide goals could be met through the C&S savings.

As can be seen, the goals are set to increase from year to year, and the C&S savings increase vary from year-to-year as different standards and measures take effect. All of these savings numbers are annual values, representing the new savings that will appear within the IOU service territories in each of the indicated years, but not the accumulated savings from prior years.

Table 11 - Total IOU-Attributable C&S Program Net Savings

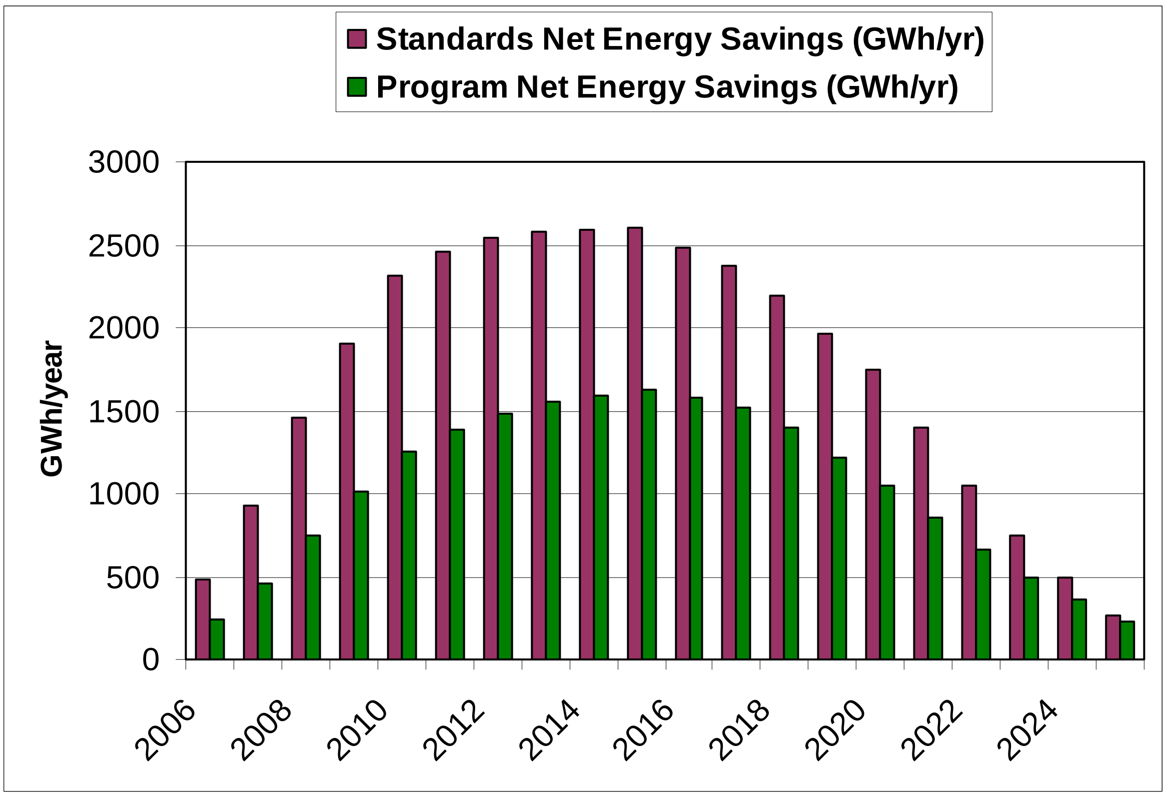
IOU Totals	2006			2007			2008		
	Goal	C&S	C&S %	Goal	C&S	C&S %	Goal	C&S	C&S %
Energy (GWh/yr)	2,032	172	8%	2,275	177	8%	2,504	237	9%
Demand (MW/yr)	442	50	11%	478	54	11%	528	64	12%
Gas (Mtherm/yr)	30.0	5.1	17%	37.3	4.5	12%	44.4	4.0	9%

The tables in the following sections provide greater detail and resolution of the annual savings numbers.

3.1.1 Energy Savings (GWh/yr)

The graph in Figure 3 shows the statewide net and program net energy savings, in gigawatthours per year. It shows the unadjusted accumulation of standards net savings with the red bars, and the adjusted net program savings with the green bars. These numbers are not adjusted for non-IOU service territories. The standards net values accumulate in the early years, and then tail off in the out years, due to adjustments for naturally-occurring market penetration, standards adoption and non-compliance. The program net savings are smaller than the standards net savings, due to only a portion of the standards savings being attributable to the program.

Figure 3 – Statewide Net Energy Savings vs. Program Net Energy Savings



The values shown in Table 12 are the numerical values plotted in the preceding figure. Also shown are the percentages that each year's program net energy savings represent, compared to the standards net energy savings. Note that the percentages tend to increase over time. This is due to the fact that many of the standards provisions having long measure lives also have higher attribution scores, so the program attribution portion is larger in the out years.

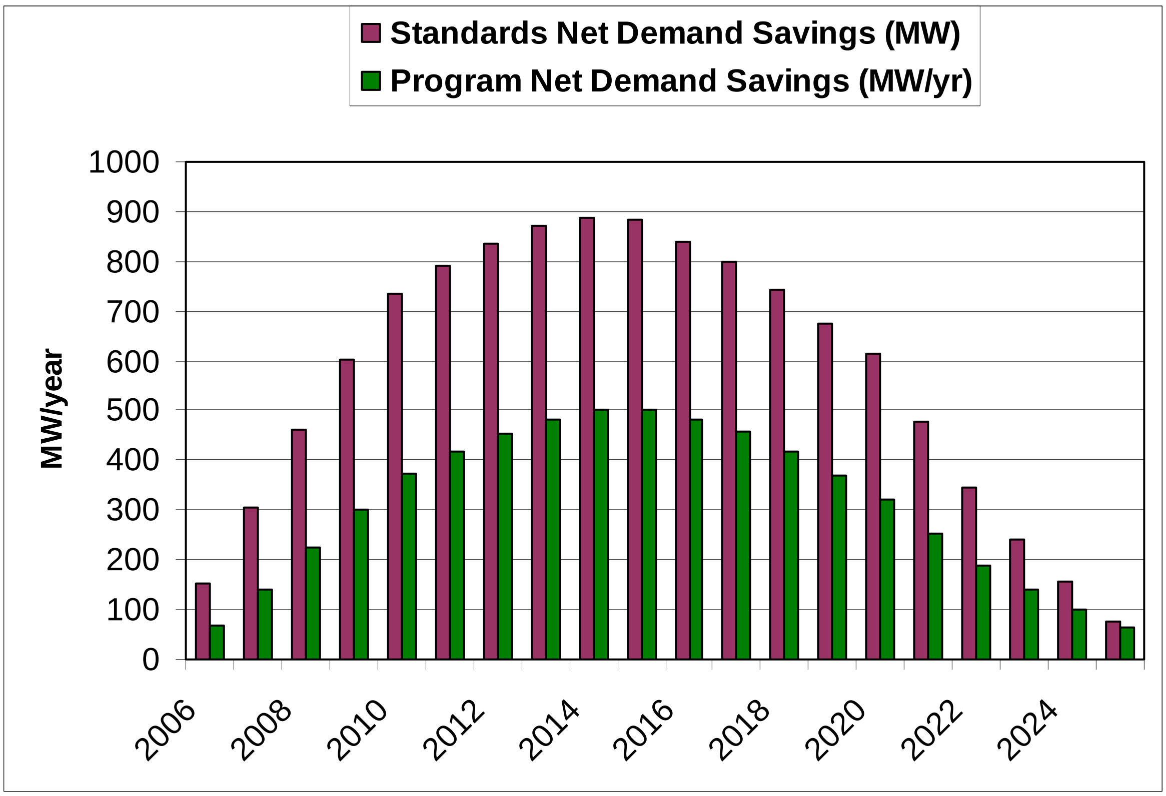
Table 12 - Year-by-Year Breakdown of Energy Savings

Year count	Standards Net Energy Savings (GWh/yr)	Program Net Energy Savings (GWh/yr)	Program %
2006	486	240	49%
2007	930	453	49%
2008	1453	751	52%
2009	1909	1015	53%
2010	2308	1253	54%
2011	2461	1383	56%
2012	2548	1485	58%
2013	2578	1549	60%
2014	2591	1595	62%
2015	2602	1632	63%
2016	2486	1579	64%
2017	2368	1519	64%
2018	2195	1393	63%
2019	1959	1212	62%
2020	1749	1048	60%
2021	1394	858	62%
2022	1049	667	64%
2023	744	497	67%
2024	499	363	73%
2025	270	235	87%

3.1.2 Demand Savings (MW/yr)

The graph in Figure 4 shows the standards net and program net demand savings, in megawatts per year. It shows the adjusted accumulation of net standards savings with the red bars, and the adjusted program net savings with the green bars. These numbers are not adjusted for non-IOU service territories. The standards net values accumulate in the early years, and then tail off in the out years, due to adjustments for naturally-occurring market penetration, standards adoption and non-compliance. The program net savings are smaller than the standards net savings, due to only a portion of the standards savings being attributable to the program.

Figure 4 – Standards Net Demand Savings vs. Program Net Demand Savings



The values shown in Table 13 are the numerical values plotted in the preceding figure. Also shown are the percentages that each year's program net demand savings represent, compared to the standards net savings. Note that the percentages tend to increase over time. This is due to the fact that many of the standards provisions having long measure lives also have higher attribution scores, so the program attribution portion is larger in the out years.

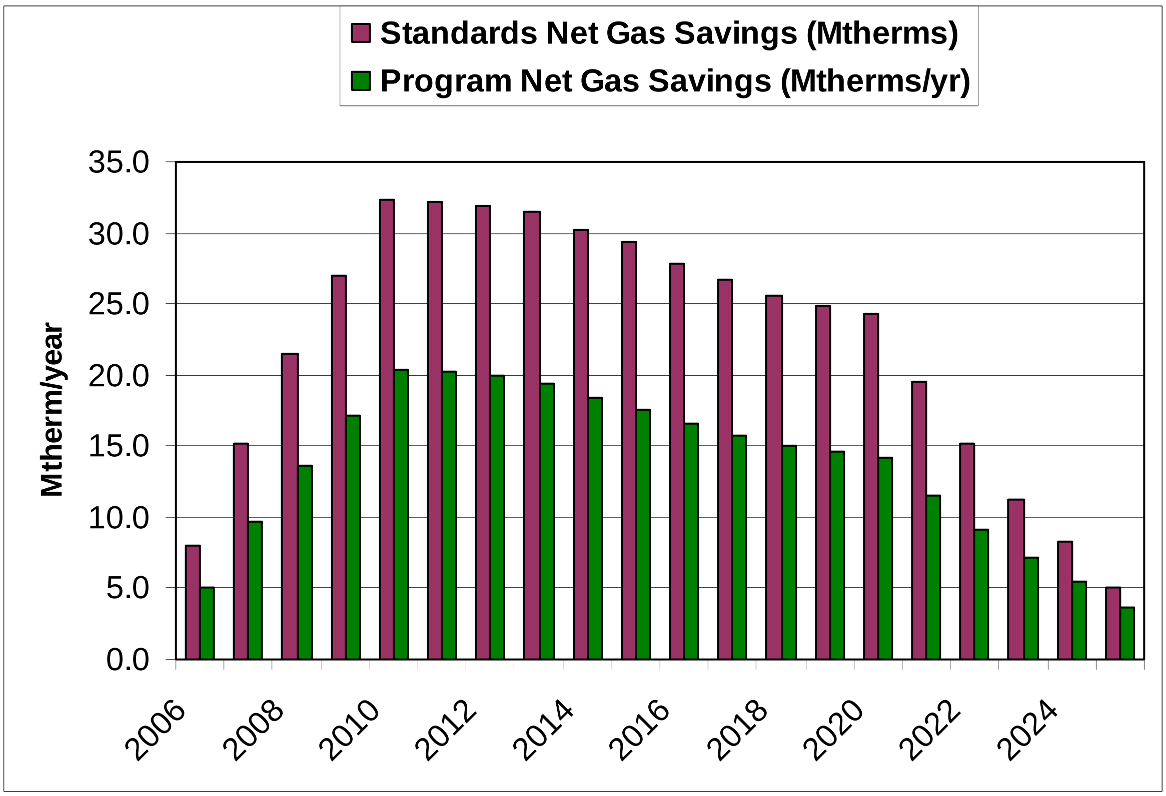
Table 13 - Year-by-Year Breakdown of Demand Savings

Year count	Standards Net Demand Savings (MW)	Program Net Demand Savings (MW/yr)	Program %
2006	152	70	46%
2007	304	141	46%
2008	463	226	49%
2009	604	302	50%
2010	736	375	51%
2011	790	416	53%
2012	834	453	54%
2013	870	484	56%
2014	889	502	57%
2015	883	504	57%
2016	841	481	57%
2017	801	459	57%
2018	744	419	56%
2019	676	368	54%
2020	614	321	52%
2021	476	254	53%
2022	347	190	55%
2023	240	139	58%
2024	158	102	64%
2025	77	63	81%

3.1.3 Gas Savings (Mtherms/yr)

The graph in Figure 5 shows the standards net and program net gas savings, in millions of therms per year. It shows the unadjusted accumulation of standards net savings with the red bars, and the adjusted program net savings with the green bars. These numbers are not adjusted for non-IOU service territories. The standards net values accumulate in the early years, and then tail off in the out years, due to adjustments for naturally-occurring market penetration, standards adoption and non-compliance. The program net savings are smaller than the standards net savings, due to only a portion of the standards savings being attributable to the program.

Figure 5 – Standards Net Gas Savings vs. Program Net Gas Savings



The values shown in Table 14 are the numerical values plotted in the preceding figure. Also shown are the percentages that each year’s program net gas savings represent, compared to the standards net gas savings. Note that the percentages tend to increase over time. This is due to the fact that many of the standards provisions having long measure lives also have higher attribution scores, so the program attribution portion is larger in the out years.

Table 14 - Year-by-Year Breakdown of Gas Savings

Year count	Standards Net Gas Savings (Mtherms)	Program Net Gas Savings (Mtherms/yr)	Program %
2006	8.1	5.1	64%
2007	15.2	9.7	64%
2008	21.5	13.7	63%
2009	27.0	17.1	63%
2010	32.3	20.4	63%
2011	32.2	20.2	63%
2012	31.9	19.9	62%
2013	31.5	19.5	62%
2014	30.3	18.4	61%
2015	29.3	17.6	60%
2016	27.8	16.5	59%
2017	26.7	15.7	59%
2018	25.6	15.0	59%
2019	24.9	14.6	58%
2020	24.3	14.2	58%
2021	19.5	11.6	59%
2022	15.1	9.2	61%
2023	11.3	7.1	63%
2024	8.3	5.5	67%
2025	5.0	3.7	74%

3.2 BREAKDOWNS BETWEEN APPLIANCE AND BUILDING STANDARDS

This paper addresses both Appliance Standards, as governed by Title 20, and Building Standards, as governed by Title 24. The values shown in Table 15 and Table 16 separate the savings between these two groups of standards. These values have been adjusted to remove the non-IOU service territory measure installations. As can be seen, the Appliance Standards account for more than 60% of the savings over this three year time period. Over time, the Building Standards values become relatively larger, due to the longer measure life of many of the building measures.

Table 15 - Appliance Standards – IOU-Attributable C&S Program Net Savings

Appliance Stds.	2006			2007			2008		
Annual	Goal	C&S	C&S %	Goal	C&S	C&S %	Goal	C&S	C&S %
Energy (GWh/yr)	2,032	107	5%	2,275	107	5%	2,504	155	6%
Demand (MW/yr)	442	16	4%	478	17	4%	528	29	5%
Gas (Mtherm/yr)	30.0	3.1	10%	37.3	2.7	7%	44.4	2.3	5%

Table 16 - Building Standards Savings – IOU-Attributable C&S Program Net Savings

Building Stds.	2006			2007			2008		
Annual	Goal	C&S	C&S %	Goal	C&S	C&S %	Goal	C&S	C&S %
Energy (GWh/yr)	2,032	64	3%	2,275	70	3%	2,504	82	3%
Demand (MW/yr)	442	34	8%	478	37	8%	528	35	7%
Gas (Mtherm/yr)	30.0	2.0	7%	37.3	1.8	5%	44.4	1.7	4%

3.3 BREAKDOWNS BY UTILITY TERRITORY

The following tables show how the annual savings and goals are differentiated for each of the four IOU service territories. These breakdowns are done on the basis of statewide energy sales, as summarized above in Table 10.

Table 17 - PG&E Service Territory – IOU-Attributable C&S Program Net Savings

PG&E	2006			2007			2008		
Annual	Goal	C&S	C&S %	Goal	C&S	C&S %	Goal	C&S	C&S %
Energy (GWh/yr)	829	76	9%	944	78	8%	1,053	105	10%
Demand (MW/yr)	180	22	12%	205	24	12%	228	28	12%
Gas (Mtherm/yr)	13	1.9	15%	15	1.7	11%	17	1.5	8%

Table 18 - SCE Service Territory – IOU-Attributable C&S Program Net Savings

SCE	2006			2007			2008		
Annual	Goal	C&S	C&S %	Goal	C&S	C&S %	Goal	C&S	C&S %
Energy (GWh/yr)	922	78	8%	1,046	81	8%	1,167	108	9%
Demand (MW/yr)	207	23	11%	219	25	11%	246	29	12%
Gas (Mtherm/yr)	-	-	-	-	-	-	-	-	-

Table 19 - SDG&E Service Territory – IOU-Attributable C&S Program Net Savings

SDG&E	2006			2007			2008		
Annual	Goal	C&S	C&S %	Goal	C&S	C&S %	Goal	C&S	C&S %
Energy (GWh/yr)	281	18	6%	285	18	6%	284	25	9%
Demand (MW/yr)	55	5	9%	54	6	10%	54	7	12%
Gas (Mtherm/yr)	3	0.2	8%	3	0.2	6%	4	0.2	4%

Table 20 - SCG Service Territory – IOU-Attributable C&S Program Net Savings

SCG	2006			2007			2008		
Annual	Goal	C&S	C&S %	Goal	C&S	C&S %	Goal	C&S	C&S %
Energy (GWh/yr)	-	-	-	-	-	-	-	-	-
Demand (MW/yr)	-	-	-	-	-	-	-	-	-
Gas (Mtherm/yr)	15	3.0	20%	19	2.7	14%	23	2.3	10%

3.4 SENSITIVITY ANALYSIS

In the discussions of the adjustments applied to the savings estimated (see Section 2.2), mention was made of how the assumptions and judgments were made in assigning values. In this section, we present the results of several sensitivity analyses that give an indication of how sensitive the final results are to these assumptions and judgments.

The point of reference for these analyses is the base case shown in Table 21. These are the same values presented earlier in Table 2 and Table 11.

Table 21 - Sensitivity - Base Case

Base	2006			2007			2008		
Case	Goal	C&S	C&S %	Goal	C&S	C&S %	Goal	C&S	C&S %
Energy (GWh/yr)	2,032	172	8%	2,275	177	8%	2,504	237	9%
Demand (MW/yr)	442	50	11%	478	54	11%	528	64	12%
Gas (Mtherm/yr)	30.0	5.1	17%	37.3	4.5	12%	44.4	4.0	9%

As discussed in Section 2.2.5, we judged that an overall non-compliance rate of 30% was appropriate for this analysis. In Table 22, we show how the savings numbers increase if we instead assume a non-compliance rate of only 10%. While this change produces a substantial improvement in the levels of savings, they not overwhelmingly large. They do, however, provide an indication of the magnitude of savings that could be achieved if the non-compliance rate could be significantly reduced.

Table 22 - Sensitivity - 10% Non-Compliance

10% Non-	2006			2007			2008		
Compliance	Goal	C&S	C&S %	Goal	C&S	C&S %	Goal	C&S	C&S %
Energy (GWh/yr)	2,032	221	11%	2,275	228	10%	2,504	305	12%
Demand (MW/yr)	442	64	15%	478	69	14%	528	82	15%
Gas (Mtherm/yr)	30.0	6.5	22%	37.3	5.8	16%	44.4	5.1	11%

In Section 2.2.3, we discussed the phenomenon of naturally-occurring market adoption, and the assumptions we made in estimating its effect on the various standards. The values assigned to this factor ranged from 6 years to 24 years, with most standards assigned values in the 12 to 18 year range. To test the sensitivity of the results to these assignments, we set the value to 6 years for all measures. The results are shown in Table 23. This change reduces the magnitude of the savings slightly. The effect is not larger, because the other adjustments tend to cancel out savings in the out years anyway, so the naturally-occurring market adoption curve primarily affects the first few years of a standard's lifetime.

Table 23 - Sensitivity - 6 Year Naturally-Occurring Market Adoption

6 yr Naturally	2006			2007			2008		
Occurring	Goal	C&S	C&S %	Goal	C&S	C&S %	Goal	C&S	C&S %
Energy (GWh/yr)	2,032	159	8%	2,275	150	7%	2,504	185	7%
Demand (MW/yr)	442	46	10%	478	44	9%	528	47	9%
Gas (Mtherm/yr)	30.0	4.7	16%	37.3	3.8	10%	44.4	2.8	6%

In Section 2.2.2 we discussed the method for estimating the attribution weighted score for utility influence in standards adoption. An alternative approach would have been to apply the attribution method used in the ADM study (ADM 2004), which assigned all the savings to measures for which the C&S Program prepared CASE studies, and none of the savings for measures developed by other parties. If we apply this attribution scheme to the standards treated in this analysis, we obtain the savings estimates shown in Table 24. They increase the savings estimates from the base case estimated, and improve the C&S percentages by a few percentage points. In our judgment, this simplified attribution method is less satisfactory and less realistic than the method we used.

Table 24 - Sensitivity - Simplified Attribution

100% - 0%	2006			2007			2008		
Attribution	Goal	C&S	C&S %	Goal	C&S	C&S %	Goal	C&S	C&S %
Energy (GWh/yr)	2,032	200	10%	2,275	221	10%	2,504	289	12%
Demand (MW/yr)	442	47	11%	478	57	12%	528	67	13%
Gas (Mtherm/yr)	30.0	5.9	20%	37.3	5.2	14%	44.4	4.6	10%

4. EX POST MEASUREMENT ISSUES

The savings estimates presented in this paper are based on a number of assumptions. While these assumptions have been vetted by a small group of experts who understand the nature and history of the standards adoption process and of the C&S Program influences on that process, they are nevertheless based, in many cases, on very limited data. We assume that these savings estimates will be treated as ex ante numbers, and that there will be ex post measurement to verify and refine the key assumptions.

4.1 CONSERVATISMS IN THIS ANALYSIS

Notwithstanding the substantial size of the savings estimated for the C&S Program, there are a number of conservative assumptions embedded in these estimates. These include:

- **Ignores Market Growth** – We have not attempted to forecast growth in the building or appliance markets in this analysis. It would be reasonable to expect that California will continue to grow, both in building stock and in population to purchase appliances. By not assuming a market growth rate, we are underestimating the likely savings.
- **Underestimated New Housing Starts** – As discussed above in Section 2.2.1, the estimates for new housing starts appear to be as much as 25% smaller than current starts, so our savings estimates may be small to begin with. This factor, however, is readily trued-up with ex post measurement.
- **Attribution to C&S Program –** The attribution methodology is certainly more conservative than the ADM methodology (see Section 3.4). Furthermore, we believe that the scoring system and the method used to assign scores represents a reasonable picture of what occurred in the standards adoption process. Whenever there was a question as to the appropriate scoring, the more conservative value was assigned.
- **Assumes Short Market Adoption Rates** – The assumptions for naturally-occurring market adoption rates are mostly in the 12 to 18 year range, with a couple of longer duration and several shorter. While it is true that some new efficiency technologies enter the buildings and appliance markets rapidly, there are also many that are very slow to achieve significant market share. Some might never do so without the force of standards or the push of significant rebates. By assuming finite, and relatively short market adoption rates, we are substantially discounting the savings attributable to the C&S program. The savings zero out over time with this method.
- **Assumes Rapid Normal Code Adoption** – The assumptions for normally-occurring code adoption also zero out the savings in a relatively short period of time. The assumptions here have been vetted with the standards staff at the CEC and are believed to be conservative. If, for example, there were a change in political leadership that became hostile to new standards, these assumptions could prove to be too short.
- **Initial Market Penetration Rate Includes Rebate Activity** – The initial assumptions of current market penetration establish the basic growth rate for savings over time. In this analysis, those initial market penetration rates include the penetration caused by California's efficiency program rebates for many of the measures. We did not attempt to parse the program effects from the natural market penetration, and so we likely overestimated the initial market penetration. Consequently, we likely underestimated the remaining market potential attributable to the standards adoption.

While we have tried, in this analysis, to be as realistic in our savings estimates as time has allowed, we nevertheless believe that these are minimum expectable savings. The many conservatisms discussed above and included in the analysis support this belief.

4.2 EX POST ANALYSIS VARIABLES

Table 25lists each of the key variables and indicates how amenable they are to ex post measurements.

Table 25 - Ex Post Analysis Variables

Factor	Ex Post ?	How?
Engineering Estimates	Yes	Engr. review, field measurements
Attribution	No	Participants, independent observer
Market Penetration	Yes	Sales data, field surveys
Natural Market Adoption	Perhaps	Expert judgment, other markets
Normal Code Adoption	Perhaps	Assess CEC capabilities
Non-Compliance	Yes	Measure compliance rates
Measure Life	No	Current values sufficiently reliable
Utility Territory Allocations	Yes	More appropriate allocations of measures

- **Engineering Estimates** – These can be trued-up in the same way as any other engineering estimate of savings, through detailed review of engineering calculations, and through field measurements of operating hours and conditions, user behavior, etc.
- **Attribution** – Attribution judgments cannot be made better at a later date, because memories of the participants fade over time. In the future, however, attribution could be tracked by an independent observer as the standards adoption process unfolds.
- **Market Penetration** – While sales data can be difficult to obtain, and field surveys are expensive, market penetration can certainly be measured over time to true-up the first year savings estimates, and the subsequent market adoption rate assumptions.
- **Natural Market Adoption** – This is an extension of the market penetration measurement, but it is harder to measure because it requires an outside point of reference to determine what the adoption rate might have been, absent the standard being adopted. Absent measurements in other markets, expert judgment will remain the best approach for estimating this factor.
- **Normal Code Adoption** – This factor is almost entirely judgmental. The initial assumptions made in this analysis could be adjusted over time, based on an assessment of the CEC's capabilities to adopt measures without C&S Program support. However, these changes, if any, are entirely outside the control of the C&S Program and may not appropriately be charged to the program.
- **Non-Compliance** – Both baseline compliance rates and the changes in compliance rates over time are amenable to measurement. We recommend that baseline measurements be undertaken as soon as possible, before the standards have been in place for long, and that subsequent compliance rates be measures on a regular basis to establish time-series data.
- **Measure Life** – It should not be necessary to do separate measure life studies of standards measures, as they will be substantially the same as the measure lives established in other CPUC statewide studies. Possible exceptions might be appliances that are not covered by these studies.

- **Utility Service Territory Allocations** – As discussed in Section 2.2.7, this paper allocates savings on the basis of electricity and gas sales. While this allocation is probably broadly representative, the allocations can be trued-up by measuring more appropriate parameters. For example, residential new construction building standards should be tied to housing starts, and distinguished between single- and multi-family construction, which can vary significantly between regions. Existing building measures should be tied to renovation activity rates. Appliance standards should be tied to sales within each service territory, if data can be found.

The substantial magnitudes of C&S Program savings should justify a significant measurement and verification effort to allow for an accurate ex post true-up of the assumptions made in this analysis.

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6. APPENDIX: SPREADSHEET CALCULATIONS

Notes to reviewers:

The spreadsheet model that was used to develop the C&S Program savings estimate, as well as the tables and graphs in this report, is being posted on the CALMAC web site as an accompaniment to this paper. It is an Excel spreadsheet with the filename: *Total C&S Savings HMG - Posted v2.xls*. CALMAC Study ID: SCE0241.01.

The basic calculation approach applied in this spreadsheet model is described in general terms in Section 2.1 of this paper. That method is implemented on 35 separate tabs of the spreadsheet, each corresponding to one of the appliance standards or building standards measures listed in Table 3 and Table 4. These tabs are indexed in column A on the tab named Inputs. The 21 appliance standards tabs are named Std1, Std2, … Std 21. The 14 building standards measure tabs are named Std B1, Std B2, … Std B14.

The input parameters for each of the tabs are listed in a row at the top of worksheet. These include the name of the measure, the first year savings, the attribution weighted score, and the values for the other adjustments that are applied. Each of the tabs includes savings calculations for energy, demand and gas for the given measure.

The input parameters for all of the tabs are entered on a single tab named "Inputs". Each of the tabs references back to the Inputs worksheet for its input parameters. Many of the parameters on the Input tab are entered by means of drop-down lists, which specify the choices available. For example, the Natural Market Adoption column offers a choice of eight values from which the appropriate one for each standard can be selected.

Each of the input parameters for Natural Marked Adoption, Assumed Code Update Rate, and Assumed Compliance Rate refers to a lookup table. The values in the lookup tables are found on a tab named Lookups. A column on each of the measure tabs takes the input parameter value and, via a lookup function, goes to the appropriate column on the Lookup tab to find the stream of annual adjustment values that it will use in the calculations for the given measure. One of the important advantages of this spreadsheet design is that one can easily change the shapes of the lookup curves (represented in the values in the Lookup table columns), and have them applied throughout the 35 measure tabs in the model. This will greatly facilitate future true-ups of the calculations.

Once the parameters are entered for each of the measures, and the calculations are performed on each of the tabs in the model, they are summed to obtain the totals for all measures. To accomplish this, the model uses Excel's three-dimensional modeling capability. The form and placement of the numbers and calculation results are identical for each of the 35 measure tabs. For example, the values in cell N19 on every one of those tabs represent the 10th year Program Net Energy Savings for each of the measures. The sum of all of the N19 cells represent the 10th year Program Net Energy Savings for all of the measures. These sums are calculated on a tab named Totals.

To accomplish the summations on the Totals tab, the shape and positioning of the Totals worksheet is identical to that of the 35 measure worksheets. The formula in each of the cells on the Totals worksheet is simply the sum of the values in the corresponding cells on the other worksheets. To facilitate this summation, we created two blank worksheets having this same layout, named Begin and End. The summation formulas, then, take the form of =SUM(Begin:End!C10) (using the C10 cell as an example). This formula takes the sum of all the C10 cells on all the tabs that are arranged to the right of the Begin tab and to the left of the End tab at the bottom of the spreadsheet screen.

One of the nice features of this scheme, is that one may include or exclude any of the measure tabs simply by moving the Begin or End tabs. For example, to calculate the savings for just the building standards, one moves the Begin tab to be located between tab Std21 and Std B1. Likewise, one could exclude the final building standards tab, which combines all of the CEC's measures not treated by the C&S Program, simply by moving the End tab to a position between Std B13 and Std B14.

The values on the Totals tab, then, represent the summations of tabs that lie between the Begin and End tabs. The Totals values are then used to generate all of the summary data on the tabs at the beginning of the spreadsheet. For example, the graph on the tab named Energy Net Savings is generated from the gray columns on the Totals tab entitled Energy Graph Data. Likewise, the tabs named Totals - by IOU and Totals-Goals pull data from the Totals tab and perform additional calculations to explain and summarize the data. Thus, any changes made on the Inputs tab are automatically reflected on the individual measure tabs. These, in turn, are automatically reflected on the Totals tabs, and the resulting graphs and tables likewise update automatically.

For questions on these calculations or on the use of the spreadsheet model described in this paper, contact the author, Douglas Mahone, at the Heschong Mahone Group Inc., dmahone@h-m-g.com.

7. APPENDIX: PUBLIC WORKSHOP REPORT

Joint Utilities Workshop on the Estimation of Energy Savings Created by the Statewide Codes & Standards Programs.

Pacific Energy Center, San Francisco.
June 24, 2005, 9:30am – 12:00noon

7.1.1 Attending

Mike Hodgson, Bob Raymer - representing *California Building Industry Association*

Peter Lai, Zenaida Tapawan-Conway, Nora Gatchalian, Tim Drew, Ariana Merlino - *California Public Utility Commission, Energy Division*

Athena Besa, Rob Rubin – *San Diego Gas & Electric/SoCalGas*

Peter Miller—*Natural Resources Defense Council*

Ceci Barrows, Pat Eilert, Gary Fernstrom, Jennifer Barnes, Valerie Richardson, and others - *Pacific Gas & Electric*

Marian Brown, Stephen Galanter and Gregg Ander – *Southern California Edison*

Craig Tyler - *Tyler & Associates*

Tom Hamilton - *CHEERS*

Ted Pope - *Energy Solutions*

Nick Hall – *TecMarket Works*

Bill Boyd? - *SMUD*

By phone: Bill Pennington, Mike Messenger – *California Energy Commission* , Christine Tam - *ORA*, others?

Mudit Saxena, Douglas Mahone – *Heschong Mahone Group Inc.*

7.1.2 Introduction

On June 24th 2005, the Joint Utilities Workshop on the Estimation of Energy Savings Created by the Statewide Codes & Standards Programs was held at the Pacific Energy Center in San Francisco. The workshop was organized by Marian Brown of Southern California Edison, and analysis on the estimation was presented by Doug Mahone of Heschong Mahone Group, Inc.

The following topics were discussed during the presentation, and in the discussion that followed.

7.1.3 Enforcement Date

Tom Hamilton mentioned that on August 1st, the newest version of the electrical code will take effect in California. Some jurisdictions have chosen to start enforcing new building code at the same time, ahead of the CA effective date.

7.1.4 Importance of CASE Energy Estimation and Sample

Nick Hall raised the question that the sample used to estimate the savings for each CASE rises tremendously in importance if credit is now to be given for these energy savings? Doug Mahone acknowledged this and said that savings are based on engineering estimates using sources such as the NRNC database. He thinks they used a good sample for these estimates – the 1,000 buildings in the BEA studies combined database. Doug mentioned that for the appliance standards, Energy Solutions as done the CASE report we were using their values.

Bill Pennington mentioned that savings estimates are dominated by appliance standards forming 60-70% of the total savings.

7.1.5 Attribution Methodology

Tim Drew raised the question; how were attribution weights and scores developed? Doug Mahone explained that the method used in ADM associates study (ADM 2004) was to give the utilities 100% credit, if a CASE initiative was developed for a measure, and 0% credit for the others. HMG developed a different approach, in which a credit score for six categories was used to create a weighted score for each measure. Developing the credit scores for each category and every measure was a six person-day process involving the people who were intimately involved in the code & standards processes: Bill Pennington, John Wilson, and Jim Holland from CEC plus utility C&S program representatives. Gary Fernstrom commented that this was expert professional judgment, with different perspectives of CEC staff and utility staff balancing the process.

An example of the attribution process was discussed for the measure - duct improvement appliance standards for installation of new HVAC in existing buildings.

Mike Hodgson expressed concerned about the process. He stated that Building Industry did a study in the 1980s to determine size of duct leakage problem (28%), developed a voluntary standard that CEC recognized in 1998. He pointed out BIA was very interested in making changes that reduce potential liability. He challenged the claim for utilities getting a high credit for this measure in the "Effort Needed for Test Methods/Research" category (80%). After some discussion on this, it was realized he was talking about new construction, while this is a standard for retrofit installations. He commented that the measure heading does not convey this information.

Bill Pennington explained that the duct retrofit standard was heavily developed by John Proctor, Mark Modera, John McHugh under contract to PG&E. So "Effort Needed for Test Methods/Research" was overall scored low in weight (10%), but 80% of effort was put in by PG&E. Regarding importance of "Energy Efficient Products in the Market", the utility 60% share results a lot from HVAC installer training programs, run beginning in mid-1990s especially by SoCalGas and PG&E.

Ariana Merlino asked if this had been broken down by relative effort by each utility? Doug Mahone replied it was not yet done. Marian Brown said that utilities had not yet reached consensus on how to go about this task, but would do so prior to the July 1 filing.

7.1.6 Assumptions about Growth

Ariana Merlino asked what the economic assumptions were in the analysis. Doug Mahone replied that we did not use any economic assumptions and as of current best estimate the growth remains constant. Installations per year are what the single-year estimates were in 2002-2003 when this work was done.

Bill Pennington noted that for residential new construction, the estimates were based on CEC estimate of 100,000 single-family units per year. Mike Hodgson responded by saying that currently, market has been red-hot for five years. The building industry is wondering how long this is going to continue. He suggested that it might be more prudent to use some long-term average, at least. Ariana Merlino suggested that some kind of range could be used. Variation over time: 380,000 high in mid-80s, low of 80,000, now it is close to 200,000/yr.

Ted Pope and Nick Hall remarked that the true-up process will correct for any errors in initial estimates, so no one will get credited for savings that aren't occurring. Doug Mahone stated that forecast of project growth can easily be included in the model.

7.1.7 Compliance Rate

There was discussion on whether estimating non-compliance rate measure by measure would yield better results than the approach taken of assuming 30% non-compliance across the board. Pennington said they decided it was best to get an overall number they all agreed on, because there is so little information for each measure. The expert judgment group did develop an initial set of case by case estimates, which ranged from 5-50%. Several of new appliance and building standards were breaking new ground, so they had no past history to assess compliance. Examples: power supplies, retrofit duct sealing.

Mike Messenger suggested that a measure by measure approach can be adopted for measure with high amount of certainty. Doug Mahone said that based on a sensitivity analysis he found that because this approach takes so many factors into account, changes in any single one will not have major effects.

This model with non-compliance rates can be used to assess impact of utility programs aimed at increasing code compliance.

7.1.8 Discussion: Policy and Planning Questions

Were these savings part of the goal or the baseline?

Doug Mahone's understanding based on conversation with CEC staff is that the savings were not discounted out of savings goals. The estimates of potential included these savings that codes and standards will be providing.

Are we giving adequate incentive to continue C&W work? (Tim Drew)

Gary Fernstrom said program managers' view is colored by past experience: raising codes/standards shoots other programs in the foot by taking away savings that they could economically obtain. If the CPUC does not allow credit for C&S Program savings, that would remove the utilities' incentive to devote program funds to the program.

On the effect of conveying a message that the C&S goals have been met, Mike Messenger raised the concern of EM&V tail wagging the program planning dog. He expressed his concern on how this would affect two sets of behaviors: (1) Portfolio Administrators adjust portfolios and reduce funding other programs because it's now easier to meet goal. (2) If we don't give credit, we are discouraging Program Managers from funding C&S program efforts. He wanted utilities to address in their July 1 filing what they think about how the choice of way to credit affects their portfolio planning behavior.

Peter Miller was concerned about how this is going to be used/ misused. He expressed his concern about cutting spending on other programs.

Bob Raymer was concerned about how politicians could look at a report like this, oversimplify, and draw bad conclusions such as cutting CEC budget because utility programs can do this work.

How is contribution of different utilities going to be assessed? (Ariana Merlino)

Marian Brown answered that there is already near consensus on this. We take statewide impact attributable to IOU statewide programs, then discount by percent of state that is not IOU service territory. Then we allocate savings to each IOU by their estimated portion of the construction, appliances, etc. This approach uses conventional approach that each utility only takes credit for energy savings occurring in their own service territory.

Gary Fernstrom added that different utilities do different things that support code development. We aren't interested in trying to parse out influence by IOU. It's a statewide program, worked out by the statewide group collaboratively.

Will a Permit for Existing Construction be enforced? (Bob Raymer)

He mentioned HVAC installation and window replacement were two significant building changes in existing construction that require permits. In most cases, however, local jurisdictions don't permit window replacements. He raised the question of will this be enforced? Response: That is the type of issue that can be addressed through ex post measurement, compared to current practice baseline practices.

Effect of other jurisdictions having more aggressive standards than the state

It was pointed out that some jurisdictions (e.g. Berkeley, Santa Monica) have adopted local energy codes that are more stringent than statewide codes. This could affect the savings estimates. Response: these jurisdictions represent a tiny fraction (perhaps 1%?) of statewide C&S savings, and so this problem is "in the noise" of the calculations. It could be addressed through ex post evaluation if desired.

Is there possibility of double dipping if rebates are given for what is required by code? (Ariana Merlino)

Utilities agreed that they do not give rebates for meeting code, only for exceeding code. Code compliance programs should do things like training, education.

Other Remarks by Attendees:

Mike Hodgson thought this study is optimistic on proportion of utility influence. He wanted to know when would be the opportunity to provide input to HMG, and on which topics his comments were required. He said that programs have been very helpful in driving energy efficiency and savings in the market. He could provide help like NAHB 10-year forecast to get a more realistic 2006-08 home building estimate.

Mike Messenger mentioned that we still need to know what each PA's proposal is. Count towards goals now? Count starting in 2009? This will be included in the utilities' July 1st filing.

7.1.9 Workshop Handouts

The following pages contain the slide presentation from the Public Workshop

8. APPENDIX: C&S WHITE PAPER (HMG 2005A)

Codes and Standards White Paper on Methods for Estimating Savings.

Prepared for SCE and the Joint Utilities

CALMAC Study ID: SCE0241.01

Codes and Standards White Paper on Methods for Estimating Savings

April 13, 2005

Prepared for:

Marian Brown, PhD, Southern California Edison
in support of Statewide Codes & Standards Program Evaluation

Prepared by:

Douglas Mahone
Nick Hall
Lori Megdal, PhD
Ken Keating, PhD
Richard Ridge, PhD

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0. EXECUTIVE SUMMARY

This white paper addresses California building and appliance energy efficiency standards, and the role of codes and standards (C&S) programs as part of utility portfolios of energy efficiency programs. It was prepared by a team of consultants both in evaluation and in efficiency programs, and it is addressed to utility portfolio planners and to CPUC policymakers.

0.1 CODES & STANDARDS PROGRAM BACKGROUND

Efficiency Standards Are Important in the Market. California has a history of strong standards for the efficiency of buildings and of appliances, and they are a very important part of the state's strategy to make efficiency a central part of its energy strategy. Energy efficiency standards play a unique role in the marketplace. The standards have two desirable effects: they bring the late adopters along toward improved efficiency, and they reduce the drag on market transformation efforts to push the efficiency curve forward. Standards are part of the latter stages of the technology adoption cycle, coming after efficient technologies have been developed and proven effective, and standards can provide very cost effective energy savings to California.

History of Standards in California Since 2001. In the past, the primary responsibility and effort in developing standards changes was taken on by the CEC staff. This started to change in the late 1990's, when the utilities' codes and standards (C&S) programs started to invest substantially in improving the standards, using public benefits monies allocated by the CPUC. For the 2001 standards upgrade cycle, the C&S program provided 14 proposals that were included in either the Building Standards, or the updated Appliance Standards. For the 2005 cycle of building efficiency standards updates, 12 standards changes that were supported by detailed C&S technology and methodology analyses, including the time dependent valuation (TDV) basis for trade-offs, were adopted by the CEC into standards that take effect in October, 2005. Many of the standards changes were further supported by efforts made through the utilities' on-going market transformation programs; some were only possible because of the familiarity with the technology that utility new construction and retrofit programs developed. The 2006/2007 appliance standards updates, adopted in 2004, cover a wide range of energy-using equipment, including refrigerators, lighting equipment, air conditioners, boilers, clothes washers, etc. The C&S program supported the upgrade or adoption of 27 of these appliance standards. Since 2004, attention at the CEC and in the utility C&S program has shifted to the next standards cycle. This work is planned to be completed in 2006, with adoption in December, 2006. The standards changes would then take effect on July 1, 2008.

Policy Direction Encourages Standards. Efficiency standards are recognized as an important component of California's energy policy and its ability to meet aggressive goals to reduce energy consumption and demand. The CPUC and the CEC, as well as the Schwarzenegger administration, have made this explicit in numerous policy statements. These have included the May 2003 *Energy Action Plan* and the Governor's Green Building Initiative, which directed the CEC to undertake all actions within its authority to increase the efficiency requirements in the Building Energy Efficiency Standards for nonresidential buildings by 20% by 2015.

Standards Help Meet Energy Savings Goals. The CPUC, in setting savings goals for the utilities' energy efficiency portfolios for 2006 and beyond, established very ambitious targets for energy efficiency. In its decision, the Commission has laid the groundwork for starting to count the energy savings that will result from the utilities' C&S programs as part of their portfolio achievements: *"In order to meet today's adopted goals, program administrator(s) should aggressively pursue programs that support new building and appliance standards…"* Beginning in 2006, the utilities are to identify the program-induced savings that first occur in that year, regardless of the program year that funded the savings opportunity, and count them toward their savings goals. Energy standards effects prior to 2003 were probably counted as part of the state's baseline energy use. However, energy savings from utility-program-enabled changes in standards taking effect since then are properly attributable as program savings and should be counted in 2006 and beyond.

This paper discusses the issues and methods for determining the magnitude of C&S program savings that should be "booked" by the utilities toward meeting their savings goals.

0.2 ESTIMATING SAVINGS

Standards Produce Major Savings. This section discusses the methods that have been used or considered for use in estimating the energy savings for efficiency standards in California. It presents a brief summary of the estimated annual savings for the year 2006 that can be expected due to the statewide implementation of building and appliance standards adopted since 2000. It also presents current best estimates of the portion of those savings that can be attributed to the utilities' C&S program investments in helping to get those standards adopted. These estimates are excerpted below in Figure 1; refer to Figure 6 for the full table and sources. The numbers show that the C&S program has produced significant savings, which could amount to more than 15% of the statewide savings goals.

Figure 1. Excerpted Estimates of C&S Program Savings – Single Year 2006 Estimates

	Electric Energy			*Electricity Demand*			*Gas Energy*		
	GWh	*% Standards Savings*	*% Statewide Goal*	*MW*	*% Standards Savings*	*% Statewide Goal*	*Therms*	*% Standards Savings*	*% Statewide Goal*
Total Statewide Standards Savings	**1422**			**689**			**21,700,000**		
Savings Attributable to C&S Program	**445**	**31%**	**22%**	**200**	**29%**	**17%**	**8,090,000**	**37%**	**11%**
Utility Statewide Savings Goals (for 2006)[E]	**2,032**			**1,199**			**72,000,000**		

Estimating Savings Potential for the Next Cycle. Program planners need an estimate of how much could be saved for the 2008 standards cycle. We think a very conservative method should be considered that assumes savings from future updates are likely to be 10% less per building unit than the previous round.

Issues in Estimating Savings. The issues for estimating standards savings are similar to those for any efficiency program. We offer an extended discussion of the technical considerations involved in estimating these savings, including market size and penetration, types of standards implementation, user behavior, prototypes and baselines. As a starting assumption, we recommend that savings be calculated on the basis of standards that have taken effect since 2003.

Savings Should Be Attributed to C&S Programs. There are important issues of attributing savings to the utilities' codes and standards (C&S) program efforts. These entail determination of the share of overall savings from upgraded standards that should be credited to the program. We recommend that attribution studies be conducted concurrently with the standards adoption process by independent and technically knowledgeable evaluators.

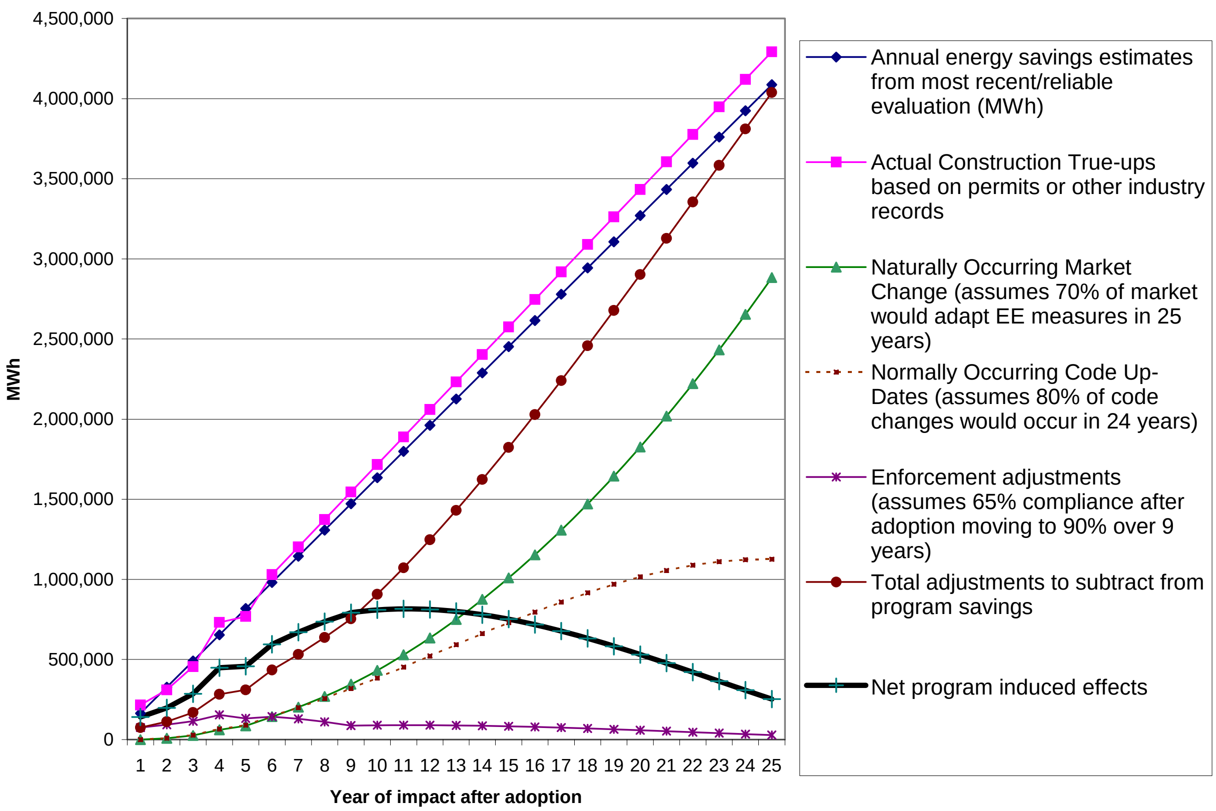
Savings Should Be Counted To Utility Service Territories. As savings from standards come on line, they should be counted to the utility service territories in which they occur, based on a simple, agreed-upon allocation mechanism that recognizes the differences between the territories.

0.3 LIFETIME SAVINGS ESTIMATES

C&S Program Savings Appear Over Extended Time Periods. Standards savings are different from those of a simple retrofit, say a compact fluorescent lamp (CFL) trade-out, because the standards savings begin to "show up" in buildings as they are built subject to the standards. Likewise, appliance standards savings begin to show up as new equipment purchases take place. Unlike a CFL trade-out, which is a one-time occurrence, standards improvements tend to be permanent. Once the standards are in place, they will govern new efficiency purchases every year into the future, so new savings will be realized every year, and the savings will accumulate over time. We present a definition of the *Net Effects Lifetime* and derive a recommended method to calculate it.

Calculating an Expected Savings Timeline. While the savings generated by standards tend to be permanent, it is unrealistic to assume that the efficiency improvements would never have happened without the standards adoption. A number of factors are at play. We recognize that market forces and other utility program efforts would tend to drive up efficiency over time. Also, the new adopted standards would have eventually been adopted without C&S program assistance. In Figure 2, we present a method for crediting these "naturally-occurring" efficiency improvements, which has the effect of discounting future energy standards savings and of limiting the span of years for counting standards savings. This method is discussed in more detail in 3.3.

Figure 2. Excerpt: Expected Savings - C&S Program Energy Impacts – MWh/year Saved

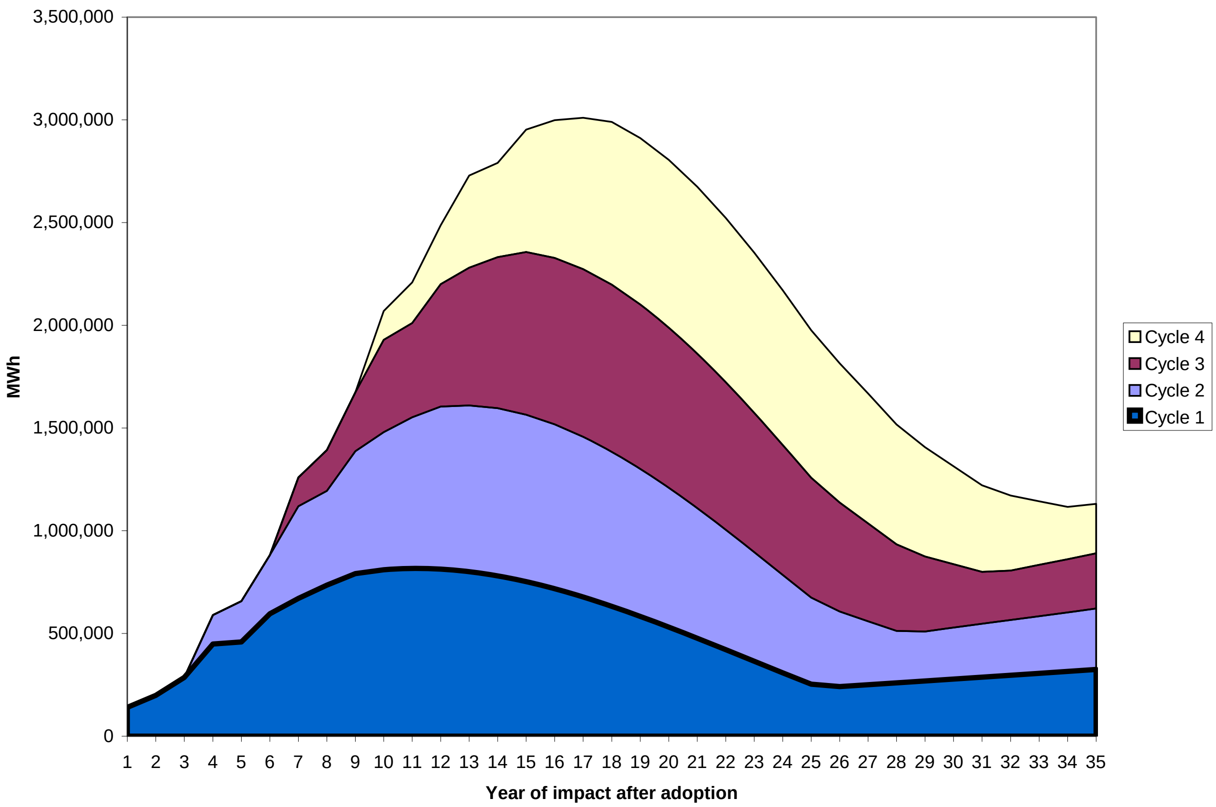


We also include mechanisms for adjusting standards savings estimates for imperfect standards compliance and for fluctuations in actual construction activity. These can be used to "true up" the savings estimates. To illustrate the recommended method for estimating C&S program savings, we present three different scenarios of savings, using conservative, optimistic and expected levels of savings. One of these scenarios is shown above. The “Net Program-Induced Effects” is a hump-shaped savings pattern that tapers off in the future, as naturally-occurring savings cancel out standards savings. The full explanation of the derivation of this example follows in this section.

C&S Program Costs Are Small. The overall costs of the utilities C&S program are small, compared to the value of the energy savings produced. From a utility program cost perspective, the C&S program has an exceptionally high yield. Typical costs are in the range of hundredths of a penny per saved kWh.

Standards Cycles Repeat and Savings Are Additive. Finally, we suggest a mechanism for aggregating the savings associated with different standards cycles. This method essentially starts a new savings stream with each cycle and treats these streams additively, as shown in Figure 3 below. Note that these numbers are illustrative of a mechanism, not necessarily of actual savings to be expected.

Figure 3. Expected Program Impacts from Four Consecutive Standards Cycles - – MWh/year Saved



0.4 VERIFICATION OF SAVINGS

Post-Implementation Studies Should Assess Real Building Practices. These include assessments of how code options are adopted by the market, through analysis of a sample of buildings. Standards compliance rates should be verified in the field in a way that allows for quantifying actual energy savings.

The Unit of Savings Should Be the Whole Building. There is huge variability in the measures installed in buildings, and the building efficiency standards regulate whole building performance. Consequently, it is not practical to verify savings measure by measure. Instead, as has been the practice with new construction program impact studies, savings should be evaluated on the basis of whole building efficiency. The exception to this would be appliances that are not part of whole building efficiency, such as televisions or portable spas; these can be evaluated independently.

Ex Post Savings Should Be Measured to True Up Estimated Savings. True-ups should consider verification of compliance rates, variability in as-built efficiencies, determination of actual construction activity, and trends in efficiency rates. Also, the larger economic factors affecting new construction should be considered.

Attribution Studies Are Important. In order for utility C&S programs to receive proper credit for the savings they achieve, attribution studies must be done to determine what fraction of statewide energy savings from changes in the codes and standards are the result of utility C&S program support.

0.5 BENEFITS/COSTS

Benefit/cost ratios for C&S programs can be calculated using essentially the same methods as for other kinds of efficiency programs, except that the B/C calculations must address the unique characteristics of efficiency standards. These include the multi-year character of the savings streams, and the difficulties of estimating participant costs for whole buildings.

0.6 RECOMMENDATIONS FOR PORTFOLIO PLANNERS

C&S Programs Should Be Integral to the Portfolio. They should not be "information-only" programs, and they should be seen as contributing substantial savings that could not otherwise be acquired through incentive or information mechanisms.

C&S Program Savings Should Be Counted in 2006 and Beyond. These savings are based on utility program investments made since 2003, and will appear as the standards take effect.

M&V Issues for C&S Programs Build Upon Existing Precedents. There are unique aspects to evaluating C&S programs, but existing M&V practices can be adapted to the task.

0.7 RECOMMENDATIONS FOR CPUC POLICYMAKERS

C&S Programs Produce Important Savings. Program savings are important because they reduce the need for more costly ratepayer investments in efficiency.

Relationship to Utility Savings Goals. Savings attributable to C&S program efforts can be properly counted toward meeting utility savings goals beginning in 2006. They are the result of utility program investments made since 2003. Likewise, program C&S investments in 2006 will start to come on line in 2009.

Allocate Savings to Utility Service Territories. The statewide C&S savings should be allotted to the individual utility service territories. The actual allocation proportions, whether simple or complex, need to be determined by the CPUC.

Need for Precision in Savings Estimates. The requirements of procurement planning may necessitate greater precision in savings estimates than were previously developed. The potential savings are large, so even a simple estimate would be sufficient. Further studies are warranted to address this question.

Adopt The Proposed Method For Estimating Lifetime Savings. This paper derives and demonstrates a method for estimating the lifetime savings for standards. The method provides a realistic mechanism for counting savings over time, and could also be adapted to other long time-delay savings programs.

Treat the “Savings Measure” as the Whole Building. For building efficiency standards, the unit of savings (and of verification) should be the whole building, rather than the multitude of different measures used in buildings and governed by standards. This is different from simple retrofit measures, but the distinction has important consequences for program planning and for M&V.

Phase II Studies Needed. A number of M&V studies are identified and verified, that would provide better information on the operation of standards in the marketplace.

1. CODES & STANDARDS PROGRAM BACKGROUND

1.1 SECTION OVERVIEW

Efficiency Standards Are Important in the Market. California has a history of strong standards for the efficiency of buildings and of appliances, and they are a very important part of the state's strategy to make efficiency a central part of its energy strategy. Energy efficiency standards play a unique role in the marketplace. The standards have two desirable effects: they bring the late adopters along toward improved efficiency, and they reduce the drag on market transformation efforts to push the efficiency curve forward. Standards are part of the latter stages of the technology adoption cycle, coming after efficient technologies have been developed and proven effective, and standards can provide very cost effective energy savings to California.

History of Standards in California Since 2001. In the past, the primary responsibility and effort in developing standards changes was taken on by the CEC staff. This started to change in the late 1990's, when the utilities' codes and standards (C&S) programs started to invest substantially in improving the standards, using public benefits monies allocated by the CPUC. For the 2001 standards upgrade cycle, the C&S program provided 14 proposals that were included in either the Building Standards, or the updated Appliance Standards. For the 2005 cycle of building efficiency standards updates, 12 standards changes that were supported by detailed C&S technology and methodology analyses, including the time dependent valuation (TDV) basis for trade-offs, were adopted by the CEC into standards that take effect in October, 2005. Many of the standards changes were further supported by efforts made through the utilities' on-going market transformation programs; some were only possible because of the familiarity with the technology that utility new construction and retrofit programs developed. The 2006/2007 appliance standards updates, adopted in 2004, cover a wide range of energy-using equipment, including refrigerators, lighting equipment, air conditioners, boilers, clothes washers, etc. The C&S program supported the upgrade or adoption of 27 of these appliance standards. Since 2004, attention at the CEC and in the utility C&S program has shifted to the next standards cycle. This work is planned to be completed in 2006, with adoption in December, 2006. The standards changes would then take effect on July 1, 2008.

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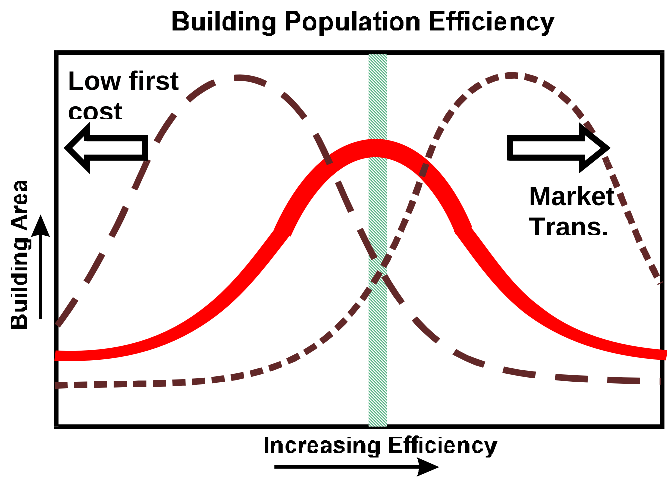
This paper discusses the issues and methods for determining the magnitude of C&S program savings that should be "booked" by the utilities toward meeting their savings goals.

1.2 ROLE OF STANDARDS IN THE EFFICIENCY PORTFOLIO

Energy efficiency standards play a unique role in the marketplace. The conceptual graph in Figure 4[1] helps to illustrate that role. The heavy, bell-shaped curve in the center of the graph represents the distribution of buildings and their energy efficiency in the market.

Figure 4. Theory of Efficiency Standards in the Market



There are some buildings at the right, or high efficiency, end of the distribution, and there are some at the low end of efficiency, but most are somewhere in between. There are two trends shown pushing and pulling on the efficiency of buildings. The dotted line to the left represents the distribution of efficiency that might result if the pressures of lowest first cost prevailed; builders are always pushed to reduce costs for measures that are not as important to consumers, and energy efficiency is not that important to many. The dotted line to the right represents the distribution of efficiency that we might attain if we achieve market transformation for greater energy efficiency. For now, however, there is much yet to do before complete market transformation is achieved, so we rely on efficiency standards to offset the low first cost pressures.

The dashed vertical bar represents the energy standards-mandated level of efficiency. Most buildings have efficiency levels close to the standards level. Many are better than the standards, while many fall short. We can debate whether this vertical bar should be drawn further to the left or to the right on the graph, but that is a detail we can set aside for the present purpose. There are two important principles that apply. The first is that the standards encourage the laggards, the buildings that fall at the low end of the efficiency spectrum, to improve their efficiency up toward the median. With time, education, and enforcement, the left side of the curve will be pushed toward the middle. The buildings that are already above the standards have no difficulty meeting the standards. If anything, having the standards set at an efficiency level lower than that of those buildings adds to the low first cost pressure, and tends to hold back their efficiency levels. The second principle is a consequence of this effect. As time goes on and

[1] Harris, Jeff and Doug Mahone, *Energy Codes and Market Transformation in the Northwest: A Fresh Look.* 2000. ACEEE Summer Study Proceedings, American Council for an Energy Efficient Economy, Washington, DC.

the market transformation programs shift the curve to the right, it is important to also move the vertical bar representing the standards to the right, by setting new, more stringent standards.

Raising the standards has two desirable effects: it brings more of the laggards along toward improved efficiency, and it reduces the drag on market transformation efforts to push the efficiency curve forward. A third order effect of raising the standards is that the cost of better efficiency is reduced. Rather than having to pay incentives to people to produce more efficient buildings, the standards simply tell them that it must be done. Because the standards can only require demonstrably cost-effective measures, they really only impact the laggards who are not building economically smart levels of efficiency. Those are the same market actors who are least likely to be reached by education or incentive programs.

These, then, are the basic reasons for including a codes and standards component in California's portfolio of energy efficiency programs.

A similar conceptual graph could be drawn for appliance efficiency standards, although for a given type of equipment it would likely be more lumpy because of a smaller range of efficiency choices. In any case, the same theory of standards and their effects on the market are equally applicable to appliances.

It is also useful to recognize how standards fit within the continuum of technology adoption, which spreads from initial laboratory research through product development and introduction to ultimate market presence. Standards are part of the latter stages of technology adoption, after they have been developed and proven effective. At that point, performance standards can be developed and adopted to ensure that the technologies work as expected, and are used to advantage in making buildings and appliances more efficient.

1.3 PROGRAM HISTORY

Energy efficiency standards were introduced in California with the passage of the Warren-Alquist Act in 1976. It mandated the Energy Commission to create and periodically update energy efficiency standards. Unlike many building codes, these energy standards are not to be based on consensus or expert opinion, but on life cycle cost effectiveness of the required efficiency measures. This has lead to the adoption of some of the most stringent energy efficiency standards in the nation.

Historically, utilities have had modest involvement with the CEC's Title 24 Building Energy Efficiency Standards and Title 20 Appliance Efficiency Standards; they would send observers and the observers would occasionally engage items of interest. But, in the past, the primary responsibility and effort in developing standards changes was taken on by the CEC staff. This started to change in the late 1990's.

What follows is a summary of recent history in the development and adoption of energy efficiency standards in California. It focuses on the building energy efficiency standards, and also explains how the appliance efficiency standards have developed over the same time period. The year in which the standards took effect is used as the naming convention, although in situations where there were several years of rolling adoption involved we have settled on the primary year for simplicity in naming.

1.3.1 2001 Standards Cycle – Building and Appliance Standards

Utility codes and standards (C&S)[2] programs, began work on codes and standards enhancement (CASE) initiatives in 1998. This included development of the time dependent valuation method for valuing energy savings in energy standards trade-off calculations, which began as a joint study funded by PG&E

[2] For consistency throughout this document, we will refer to the utilities' statewide program activities that are directed toward improving California's building and appliance efficiency standards as the "C&S program", or the "C&S program". When discussing the Title 24 Building Energy Efficiency Standards or to the Title 20 Appliance Efficiency Standards, we will refer to them simply as "standards."

and the CEC. There were numerous other measures considered for possible inclusion in the standards, through a careful vetting process to select the most promising. These efforts were directed toward 2004 standards cycle because the Commission had previously announced that they were “skipping” the 2001 triennial standards cycle.

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 adopt new Building and Appliance Standards in an emergency rulemaking – within 120 days. Updated Residential and Nonresidential Building Standards were adopted by the CEC in early January, 2001, and took effect in June, 2001. The appliance standards from the 2001 cycle were delayed somewhat, and most were ultimately adopted in 2003. The clothes washer standard was adopted in 2004. For simplicity in this document, however, we will refer to all of these as 2001 Appliance Standards.

The CEC could not have accomplished much of this effort without the help and analysis of interested third parties. Of these, the C&S program was the most active and provided the greatest amount of assistance. The program 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) called out a list of measures for further study and analysis with the intent of urging the CEC to adopt them in the 2004 standards cycle. The passage of AB970 changed that and afforded an opportunity to speed up acceptance of some of the standards enhancements the C&S program had been analyzing.

Shortly after AB970 was signed by the Governor, the CEC published a request for standards change proposals for the 2001 adoption cycle. The C&S program offered those CASE initiatives that appeared to be ready for adoption, and asked its contractors to help identify any others that would be promising. The C&S program provided 14 proposals that either ended up in the Building Standards, or were included in the May adoption of updated Appliance Standards. Many of the standards changes were strongly supported by efforts made through the utilities’ on-going market transformation programs; some were only possible because of the familiarity with the technology that utility new construction and retrofit programs developed.

1.3.2 2005 Cycle – Building Standards

Almost as soon as the 2001 standards cycle work finished in 2000, work was started on the 2005 standards cycle changes (standards that would be adopted in 2003). Again, the utility C&S program was actively engaged in developing CASE initiatives for a long list of measures to be considered for adoption in both the building and the appliance standards. Ultimately, 11 standards changes, plus the time dependent valuation (TDV) basis for trade-offs, thatwere supported by the C&S program were adopted by the CEC into standards which take effect in October, 2005.

1.3.3 2006/2007 Cycle - Appliance Standards

The Title 20 Appliance Standards underwent a long process of updating during the 2001 – 2004 time period, culminating in the adoption of new standards on December 15, 2004. These standards cover a wide range of energy using equipment, including refrigerators, lighting equipment, air conditioners, boilers, clothes washers, etc. The C&S program supported the upgrade or adoption of 27 appliance standards. The effective date of the standards varies by equipment type, although many of the new appliance standards take effect on January 1, 2006 or 2007. Some have additional effective dates for higher levels of efficiency later. The CEC is continuing its efforts to extend appliance standards to additional equipment.

1.3.4 2008 Standards Cycle

Once the 2005 building efficiency standards were adopted in 2003, attention at the CEC and in the utility C&S program shifted to the next standards cycle. This work is planned to be completed in 2006, with adoption in December, 2006. The standards changes would then take effect on July 1, 2008. The CEC anticipates that the utility energy efficiency programs can focus Public Goods Charge-funded new construction programs on a transition process for early voluntary compliance with the updated Standards.

As of this writing, PG&E and SCG have selected a contractor team to develop CASE initiatives for nonresidential standards changes, and the CEC is in the process of selecting its own consultant team.

1.3.5 Policy Support for Codes and Standard

In every standards change cycle, there are inevitably practical dimensions, as well as technical dimensions, to the process. For example, following the adoption of the 2005 standards changes, the homebuilders argued that there had been substantial changes to the residential Title 24 requirements, that it would take several years for the industry to adjust to them, and that there should be a hiatus in the development of further changes for one or two standards cycles. Some building officials have also expressed concern that the standards were changing too rapidly for them to keep up. These kinds of concerns appear inevitable, and they tend to balance the push toward higher standards that address energy reliability and environmental concerns..

At this time within the Schwarzenegger Administration, there is high level support for more aggressive standards. The following excerpt from Energy Commission RFQ 400-04-401 for technical support for the 2008 Standards summarizes the status of this support:

> In 2002 and 2003, California’s principal energy agencies (the California Power Authority, Public Utilities Commission, and Energy Commission) joined to coordinate efforts related to California’s energy policy. In May 2003, the group released the *Energy Action Plan* (*EAP*). The *EAP*’s goal is to "ensure that adequate, reliable, and reasonably-priced electrical power and natural gas supplies, including prudent reserves, are achieved and provided through policies, strategies, and actions that are cost-effective and environmentally sound for California’s consumers and taxpayers." Toward this goal, the *EAP* established a “loading order” of energy resources and strategies to guide decisions made by the agencies jointly and singly. At the front of the loading order was optimizing strategies for increasing conservation and energy efficiency to minimize increases in electricity and natural gas demand. Second in the loading order were strategies for new electricity generation to be met first by renewable energy resources and distributed generation. California’s building (and appliance) standards are the most cost-effective means of achieving energy efficiency in the state.
>
> In November 2004, the California Energy Commission released the 2004 version of the legislatively-mandated *Integrated Energy Policy Report* (*IEPR*). The *IEPR* pointed out that over the next several years; California faces significant challenges in ensuring adequate electricity supplies during critical peak demand periods.
>
> On November 18, 2004 Governor Arnold Schwarzenegger joined with the Governors of Washington and Oregon to approve a series of recommendations pertaining to the impacts of global climate change. Recommendations include directives to incorporate aggressive energy efficiency measures into updates of state building codes, with a goal of achieving at least 15 percent cumulative savings by 2015 in each state.
>
> Governor Schwarzenegger is taking a lead role not only on the West Coast Governors’ Global Warming Initiative, but in the Western Governors’ Association (WGA) as well. Prompted by the recommendations of Governor Schwarzenegger, WGA Policy Resolution #04-13, entitled *Clean and Diversified Energy Initiative for the West* (June 22, 2004), was passed that commits Western

> Governors to examine the feasibility of and actions that would be needed to "achieve a goal to develop 30,000 MW of clean energy in the West by 2015 from resources such as energy efficiency [and] solar ….and increase the efficiency of energy use by 20% by 2020."
>
> On December 14, 2004 Governor Schwarzenegger issued Executive Order S-20-04, referred to as the *Green Building Initiative,* which lays out a comprehensive set of actions for California to take to improve the energy efficiency of nonresidential buildings. The Energy Commission is directed to undertake all actions within its authority to increase the efficiency requirements in the Building Energy Efficiency Standards for nonresidential buildings by 20% by 2015.

Clearly, energy standards are seen as a key element in California's new energy efficiency strategy.

1.4 REGULATORY / SAVINGS CLAIM STATUS

Throughout the time period in question, from 1998 to the present, the codes and standards (C&S) program has been treated by both the utilities and the CPUC as an information-only program, and no energy savings claims have been made. This has lead to a tension between the C&S program and the more traditional resource acquisition programs. The dollars devoted to the C&S program were, some have felt, taking away from more direct savings acquisition, and they were increasing the overhead on the portfolio. Furthermore, every time the standards were made more stringent, it became harder for the traditional programs to acquire savings; the standards took over the "easy" savings and raised the bar on additional savings. In effect, increasing the standards was reducing the perceived cost effectiveness of the other programs, and savings achieved through standards compliance were not being credited to the state's energy efficiency programs.

This situation is coming to a head with the new administrative structure, wherein the utilities have overall responsibility for the efficiency and procurement portfolios beginning in 2006.

The savings goals set by the CPUC are very ambitious, and there will be intense competition for program funds to most cost-effectively meet those goals. There are several important details about the savings goals, as they pertain to standards, embedded in the CPUC decision.[3]

1) *In order to meet today's adopted goals, program administrator(s) should aggressively pursue programs that support new building and appliance standards…* (Finding of Fact #27). This clearly indicates the CPUC's recognition of the role of standards in the state's energy efficiency portfolio.
2) *Only actual installations should be counted towards the savings goals.* (Finding of Fact #14). This is further explained in the body of the decision: *…we clarify that only actual installations should be counted towards these goals, and not commitments. That means, for example, that the savings reported for PY2006 will reflect measures actually installed during calendar year 2006 (January through December), regardless of whether the commitments to install those measures were made in PY2006 <u>or in prior program year(s)</u>.* (emphasis added)

One of the implications of these two items is that, beginning in 2006, the utilities will be identifying the savings that show up in that year. This will, of course, include savings that 2006 program expenditures achieve immediately in 2006 (such as CFL direct change-outs), but it should also include savings arriving from prior years' program expenditures. These would include savings funded from program year 2005 budgets but completing installation in 2006, such as a building retrofit completed in 2006 but rebated from the 2005 Standard Performance Contract Program, when funds were reserved for it. They would include nonresidential new construction efficiencies in buildings that were designed in 2004 or 2005, but

[3] Decision 04-09-060, <u>Interim Opinion: Energy Savings Goals for Program Year 2006 and Beyond</u>, September 23, 2004

that completed construction in 2006. By extension, they should also include efficiencies coming on line from the 2005 Title 24 and the 2006/2007 Appliance Standards upgrades, as installed in new buildings that are running in 2006[4]. We believe, therefore, that savings attributable to past and future standards need to be identified.

Another issue that is addressed in the savings goals decision[5] is how savings that are counted beginning in 2006 relate to the savings goals.

3) *Savings achieved by customers not included in the calculation of savings potential should be removed from the calculation of savings accomplishments, in order to ensure consistency when evaluating whether the goals are met.* (Finding of Fact #9.) This means that savings achieved by customers in California located outside the service territories of these utilities should not be counted.

An important related issue is whether the utility energy savings goals were set with an assumption that post-2000 and post-2003 building and appliance energy efficiency increases were assumed to be in place when the baseline of efficiency was developed for the technical potential studies and the utility savings goals. If they were, then savings from these rounds of code changes should not be counted as savings beginning in 2006. This, however, is not the case.

We have confirmed, in conversations with Mike Rufo[6] and Mike Messenger[7], that the KEMA/Xenergy technical potential studies did not include any of the standards upgrades adopted by the CEC since 2000. The subsequent staff study recommending utility program savings goals was based in part on the CEC's 2003 forecast, which factored at least part of the 2001 efficiency standards into the base energy efficiency.[8] It appears clear that the recommended utility savings goals did not include any adjustments to savings potential from future standards, and so the savings dating from the 2005 round of standards, and subsequent updates, are not included in their estimates of achievable savings. They have also confirmed that the estimates of achievable potential for energy efficiency neither include nor exclude savings contributions from standards; the savings were estimated at the portfolio level by multiplying funding trajectories by program effectiveness ratios (kwh/$ of program funds). We conclude that the utilities may therefore claim credit for the portion of those C&S savings that are attributable to their program efforts as part of reaching their savings goals.[9]

There is a need to have a realistic and prudent method for estimating the effects of past C&S program efforts on standards-induced energy savings beginning in 2006. There is also a need to give portfolio planners a way to estimate the savings potentials of future C&S program activities, such as those directed

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[4] There is also a plausible argument that savings from the 2001 and 2004 standards upgrades should be counted as well. These arguments should be reviewed more thoroughly by the CPUC.

[5] Op.cit.

[6] Mike Rufo was one of the lead authors of the KEMA/Xenergy technical potential studies and related publications

[7] Mike Messenger, of the California Energy Commission, was centrally involved in the calculation of the utility savings goals adopted by the CPUC decision (op.cit.)

[8] There is apparently on-going discussion among CEC staff as to whether this accounted for all of the savings.

[9] Communication with Mike Messenger and Bill Pennington, 3/28/05, "Credit for the past 3 years of C&S programs- Taking credit for utility C&S programs started before the 2001 code updates is not appropriate because the impact of the 2001 standard update was already in the CEC baseline forecast in 2003. We would support attributing energy savings from utility C&S programs started beginning in 2001 and ending in 2004 that were targeted to support the 2005 building and 2006/7 appliance standard upgrades. These credits could be applied to the 2006, 2007 and 2008 goals. One could argue that utilities should have received credit for the pioneering work they did on time dependent evaluation of standards impacts before 2000 but the reality is that the regulatory agencies did not recognize them at the time and it's too late now.

at the 2008 standards update cycle. This white paper presents the issues and proposes mechanisms for meeting these two needs.

2. METHODS FOR ESTIMATING SAVINGS

2.1 SECTION OVERVIEW

Standards Produce Major Savings. This section discusses the methods that have been used or considered for use in estimating the energy savings for efficiency standards in California. It presents a brief summary of the estimated annual savings for the year 2006 that can be expected due to the statewide implementation of building and appliance standards adopted since 2000. It also presents current best estimates of the portion of those savings that can be attributed to the utilities' C&S program investments in helping to get those standards adopted. These estimates are excerpted below in Figure 5; refer to Figure 6 for the full table and sources. The numbers show that the C&S program has produced significant savings, which could amount to more than 15% of the statewide savings goals.

Figure 5. Excerpted Estimates of C&S Program Savings – Single Year 2006 Estimates

	Electric Energy			*Electricity Demand*			*Gas Energy*		
	GWh	*% Standards Savings*	*% Statewide Goal*	*MW*	*% Standards Savings*	*% Statewide Goal*	*Therms*	*% Standards Savings*	*% Statewide Goal*
Total Statewide Standards Savings	**1422**			**689**			**21,700,000**		
Savings Attributable to C&S Program	**445**	**31%**	**22%**	**200**	**29%**	**17%**	**8,090,000**	**37%**	**11%**
Utility Statewide Savings Goals (for 2006)[E]	**2,032**			**1,199**			**72,000,000**		

Estimating Savings Potential for the Next Cycle. Program planners need an estimate of how much could be saved for the 2008 standards cycle. We think a very conservative method should be considered that assumes savings from future updates are likely to be 10% less per building unit than the previous round.

Issues in Estimating Savings. The issues for estimating standards savings are similar to those for any efficiency program. We offer an extended discussion of the technical considerations involved in estimating these savings, including market size and penetration, types of standards implementation, user behavior, prototypes and baselines. As a starting assumption, we recommend that savings be calculated on the basis of standards that have taken effect since 2003.

Savings Should Be Attributed to C&S Programs. There are important issues of attributing savings to the utilities' codes and standards (C&S) program efforts. These entail determination of the share of overall savings from upgraded standards that should be credited to the program. We recommend that attribution studies be conducted concurrently with the standards adoption process by independent and technically knowledgeable evaluators.

Savings Should Be Counted To Utility Service Territories. As savings from standards come on line, they should be counted to the utility service territories in which they occur, based on a simple, agreed-upon allocation mechanism that recognizes the differences between the territories.

2.2 REVIEW OF SAVINGS ESTIMATES

Three estimates of energy savings attributable to standards are available. Each is the result of studies that looked at the different measures that were adopted, and summarized the estimated statewide savings attributable to them. These are all “first year” estimates of savings, or estimates of the savings that would be achieved from one year of new construction and appliance/equipment purchases. The results are somewhat different and differently formatted, as the studies were done at different times by different people.

Before reviewing the different estimates, however, in Figure 6 we present a “rolled-up” estimate of the annual savings that can be expected from standards, of the savings that could be attributed to the utility C&S programs. These numbers are single year estimates; they correspond to the savings that could be expected from each of the standards in 2006. The savings are relative to the efficiency levels of the 2000 baseline year which we discuss later in this chapter. The sum of these savings, then represents all of the standards savings expected to “come online” in 2006.

There are two sets of savings numbers in Figure 6. The Total Statewide Savings are just that: the savings expected throughout California from all new buildings and appliance purchases subject to the standards requirements. The savings Attributable to Program are the portion of the statewide savings that can be attributed to the efforts of the C&S program in helping to get those standards adopted. For a discussion of the attribution methodology, see section 2.5.1 below.

Also included in this table is the total statewide savings goal for utility programs in 2006, as a savings per year value (not accumulated from other years). The savings attributable to C&S program contributions, for the 2005 and 2006 standards alone, could amount to over 15% of the goal. There are a large number of issues, however, that must be considered and agreed-upon in deciding how to handle these savings estimates and their relationship to the statewide savings goals. These are discussed in detail in the remainder of this white paper.

Note that the attributable program savings, and the calculations showing what percentage of total statewide savings they represent, are derived individually for each of the standards cycles, and they used different methods (as discussed in section 2.5 below). It is tempting to think that one can generalize these savings, as a kind of typical realization rate, for estimating future C&S program accomplishments. The reader is cautioned that this would be a very rough and potentially inaccurate assumption. Each standards adoption cycle is unique, with different levels of effort and different emphases by the CEC. An independent attribution study will be necessary for each cycle, and its approach will have to be adapted to the particular circumstances of each cycle. Therefore, these attribution percentages should be recognized as examples of past cycles rather than as predictors of future cycles.

Figure 6. Estimates of C&S Program Savings – Single Year 2006 Estimates

	Electric Energy			*Electricity Demand*			*Gas Energy*		
Cycle/Sector	*GWh*			*MW*		*% Statewide Goal*	*Therms*		*% Statewide Goal*
Total Statewide Savings									
2001/Residential[A]	131			199			800,000		
2001/Nonresidential[A]	63			41			650,000		
2001/Appliances[A]	217			76			6,500,000		
2005/Residential[B]	117			104			6,890,000		
2005/Nonresidential[B]	368			107			300,000		
2006/2007/Appliances[C]	526			162			6,560,000		
Totals	**1422**			**689**			**21,700,000**		
Attributable to Program		*% of Code Savings*	*% Statewide Utility Goal*		*% of Code Savings*	*% Statewide Utility Goal*		*% of Code Savings*	*% Statewide Utility Goal*
2001/Residential[A]	21	16%	1%	29	15%	2%	150,000	19%	0%
2001/Nonresidential[A]	26	41%	1%	16	39%	1%	280,000	43%	0%
2001/Appliances[A]	74	34%	4%	29	38%	2%	1,760,000	27%	2%
2005/Residential[B]	83	71%	4%	41	39%	3%	2,900,000	42%	4%
2005/Nonresidential[B]	80	22%	4%	36	33%	3%	1,030,000	---	1%
2006/2007/Appliances[D]	158	30%[4]	8%	49	30%[4]	4%	1,970,000	30%[4]	3%
Totals	**445**	**31%**	**22%**	**200**	**29%**	**17%**	**8,090,000**	**37%**	**11%**
Statewide Savings Goals (for 2006)[E]	**2,032**			**1,199**			**72,000,000**		

[A]Heschong Mahone Group, Inc., (2001) *CA IOU Codes and Standards Earnings Claims Framework, Final Report.* Prepared for Pacific Gas and Electric Co. Note that these are only single year numbers, and do not reflect the fact that five years' of new buildings will be online in 2006. They, therefore, greatly understate the expected savings from the 2001 cycle.
[B]ADM Associates, (2004) *Evaluation of 2002 Statewide Codes and Standards Program.* Prepared for the Statewide Nonresidential New Construction MA&E Program under the auspices of the Southern California Edison Co.
[C]Preliminary numbers, based on Draft Final Project Report: Codes and Standards Enhancement Initiative For PY2003 - 2005: Title 20 Standards Development, prepared for PG&E by Energy Solutions et al. (March 14, 2005). Note that these estimates are not in full agreement with those of the CEC staff.
[D]To date, no independent verification of C&S program allocation of savings has been done. This table arbitrarily, and conservatively, allocates 30% of total savings to the C&S program for illustrative purposes.
[E]CPUC Decision 04-09-060 September 23, 2004, Interim Opinion: Energy Savings Goals for Program Year 2006 and Beyond, Table 1E

The following figures, excerpted from the existing studies of C&S program savings estimates, give an indication of what those estimates have concluded about the types and magnitudes of those savings.

The first, in Figure 7, is an estimate of savings prepared by HMG for the 2001 cycle[10], which includes both building standards and appliance standards. These estimates include projections of ten year impacts, i.e. the accumulated savings that would result from ten years of savings due to the new standards.

Note that we have only excerpted the 1st Year Impact numbers from these tables for use in Figure 7 and Figure 8. This is actually a gross understatement of the savings from the 2001 cycle coming online in 2006. The actual number for gWh should be about 5 times higher, based on the accumulated annual energy savings of five years of new building construction and adjusted for compliance rates. The actual number of MW should likewise be about 5 times greater for the same reason. The recommended accumulation mechanism is presented in detail in section 3.3.

Figure 7. 2001 Cycle - Statewide Energy and Demand Savings

	1st Year Impacts			Ten Year Impacts		
	gWh	MW	M therms	gWh	MW	M therms
Residential Standards	**131**	**199**	**0.80**	**5891**	**1793**	**27**
Nonresidential Standards	**63**	**41**	**0.65**	**3414**	**279**	**36**
Appliance Standards	**217**	**76**	**6.50**	**1240**	**605**	**166**
TOTAL	**411**	**315**	**8**	**10544**	**2677**	**230**

PG&E's portion of those savings were estimated by HMG as follows in Figure 8. The attribution methodology is discussed in section 2.5.1 below. Again, these numbers are only single year numbers, and do not reflect the savings from five years of construction that will be online in 2006.

Figure 8. 2001 Cycle – PG&E C&S Program Savings

PG&E C&S Program Energy Impacts	**1st Year Impacts**			**Ten Year Impacts**		
	gWh	**MW**	**M therms**	**gWh**	**MW**	**M therms**
Residential Standards	**21**	**29**	**0.15**	**934**	**262**	**4.9**
Nonresidential Standards	**26**	**16**	**0.28**	**1391**	**107**	**17.4**
Appliance Standards	**74**	**29**	**1.76**	**493**	**210**	**48.7**
Totals	**135**	**82**	**2**	**3567**	**637**	**80**

[10] Heschong Mahone Group, Inc. (2001). *CA IOU C&S Earnings Claims Framework, Final Report.* Prepared for Pacific Gas and Electric Company.

The next estimate of savings we present, Figure 9, was developed by ADM for the 2005 standards-setting cycle[11]. It includes only single year savings for 2006. There are three sets of rows in the table. The first set addresses the residential building standards. The "All 2005 residential code revisions" row refers to the statewide expected savings, while the "C&S code revisions" row refers to the portion of the statewide savings that are attributed to the C&S program. Finally, the third row calculated the percentage of all savings attributed to the C&S program. So, for example, the 83.34 GWh of residential energy savings attributed to the C&S program is 71% of the 117.27 GWh of total statewide residential energy savings. The same pattern holds true for the three nonresidential rows and the three totals rows.

Figure 9. Summary Table of 2005 Building Standards Savings

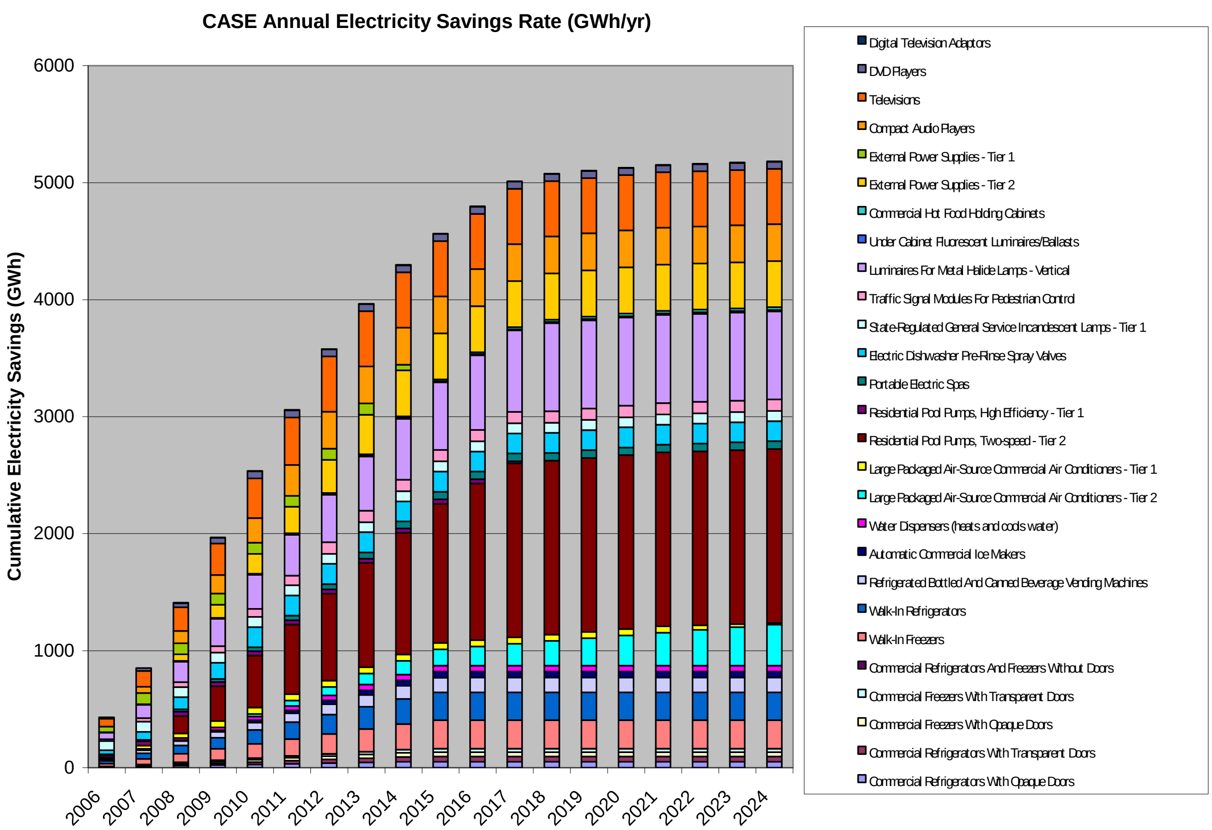
	Estimates from This Study		
	Electricity (GWh)	***Peak (MW)***	***Natural Gas (Therms)***
Residential C&S code revisions	83.34	41.07	2,900,646
All 2005 residential code revisions	117.27	104.50	6,885,570
Percent from C&S code revisions	71%	39%	42%
Nonresidential C&S code revisions	80.15	35.56	1,035,000
All 2005 nonresidential code revisions	367.76	107.00	300,000
Percent from C&S code revisions	22%	33%	n/a[12]
All C&S code revisions	163.49	76.63	3,935,646
All 2005 code revisions	485.03	211.50	7,185,570
Percent from C&S code revisions	34%	36%	55%

[11] ADM Associates. (2004). *Evaluation of 2002 Statewide C&S Program.* Prepared for the Statewide Nonresidential New Construction MA&E Program under the auspices of the Southern California Edison Co.

[12] Note that the overall therm savings are smaller than the therm savings attributable to the C&S program. This is due to non-C&S program measures having negative therm savings (e.g. lighting savings can increase the need for gas heating).

Finally, the estimated savings estimated by Energy Solutions for the 2006/2007 appliance standards updates are presented in Figure 10 (energy savings) and Figure 11 (demand reductions). These numbers are based on a draft report[13] which adds up the anticipated savings in each year, from all of the measures adopted in this cycle. Many of these new appliance standards will not actually take effect until later years, and some produce more stringent efficiency levels in later years[14]. Those later year savings aren't reflected in the 2006 year number included above in Figure 6. The legend of the graph, excerpted from the Energy Solutions report, may be hard to read in its details, but it nevertheless shows that there are actually numerous appliances treated by this cycle of appliance standards, and that their individual savings rates change over time.

Figure 10. 2006/2007 Cycle - Appliance Standards Savings Estimates (GWh/yr)



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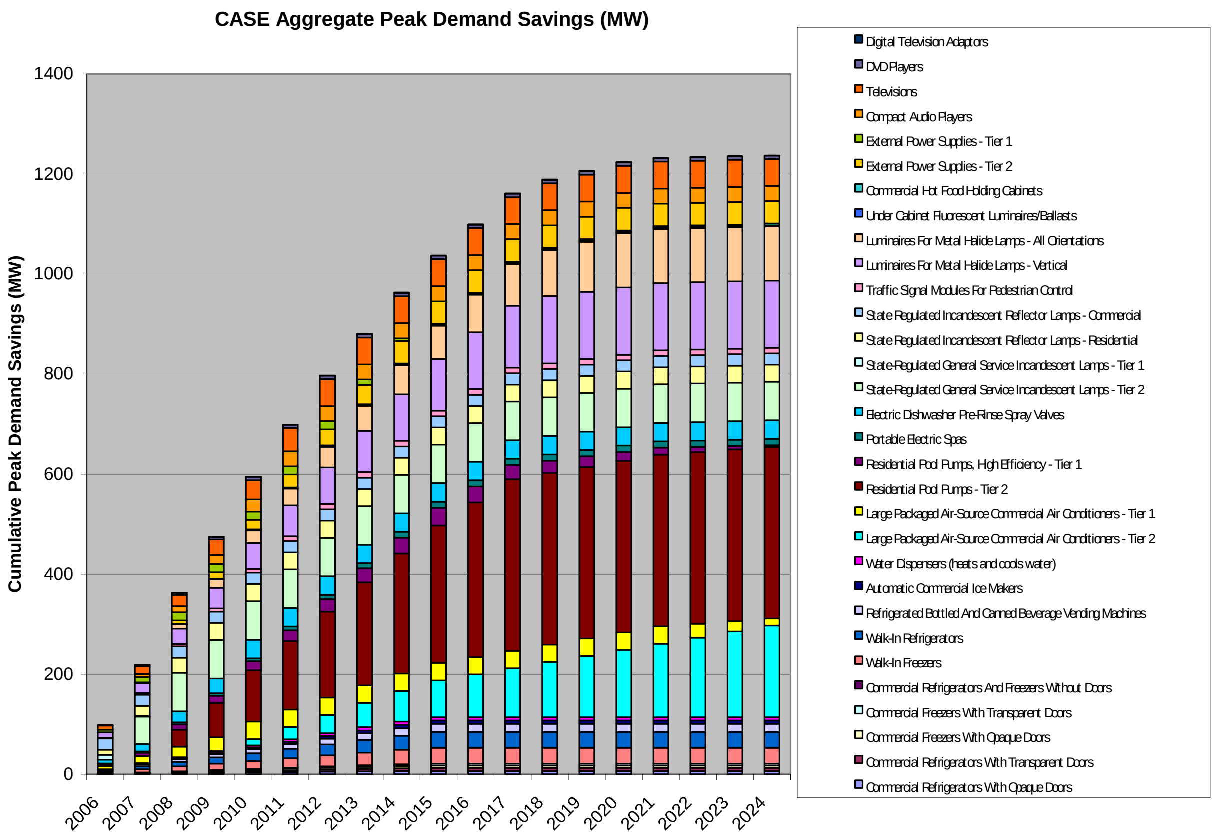
[13] *Draft Final Project Report: C&S Enhancement Initiative For PY2003 - 2005: Title 20 Standards Development*, prepared for PG&E by Energy Solutions et al. (March 14, 2005)

[14] The savings curves are shown to level off, probably due to an assumption that the Standards don't save more energy after the end of the useful life of appliances regulated in the first year of the Standards; CEC staff does not agree with this concept. A formal evaluation study of this program will have to address this disagreement.

Figure 11. 2006/2007 Cycle - Appliance Standards Demand Reduction Estimates (MW)



2.3 ESTIMATING SAVINGS POTENTIAL FOR THE NEXT CYCLE

Program planners need to know what they may reasonably assume for the savings potential for the next, 2008 cycle of standards updates, because C&S program efforts to support that cycle must begin now and continue into 2006 and 2007. Estimating this savings potential is somewhat problematic, because the standards adoption process is not as predictable as, say, a lighting retrofit project; past experience does not necessarily predict future results. Nevertheless, we concur with the CEC staff on how a reasonable estimate for planning purposes may be used: "We think a very conservative method should be considered that assumes savings from future updates are likely to be 10% less per building unit than the previous round. This assumption will reduce estimates of future savings from codes and standards over time on a percentage of base usage basis but it will be counteracted by the growth in the number of buildings and end uses covered."[15]

[15] Communication with Mike Messenger and Bill Pennington, 3/28/05

2.4 ISSUES IN ESTIMATING SAVINGS

Both the HMG and the ADM studies cited above include extensive discussions of the different methods of estimating energy savings. These issues are summarized in this section.

2.4.1 Energy Savings Estimates for Standards Change Measures

There are a number of significant issues that must be addressed in developing reliable estimates of energy savings from standards. These are discussed individually, along with recommendations for how these estimates should be developed in the future. These issues are generally the same for building standards as for appliance standards, except where noted otherwise.

2.4.1.A *<u>Engineering Estimates</u>*

The first issue is the accuracy of engineering estimates. These will vary by measure. Some measures, for example lamp/ballast efficiency improvements, can be straightforward to estimate. Others measures, for example estimates for lighting controls, are for expected average usage since the impact of such controls can vary substantially from building to building. Engineering estimates also depend on how accurately the efficiency of equipment can be characterized, how well weather-dependent effects can be estimated, what type of long-term average weather data should be used, how measures operate differently in different building types, and a host of other variables.

Most of the issues with engineering estimates are common to any energy efficiency program, not just to standards. The primary difference for standards estimates, is that the savings must be estimated for a broad population of unknown buildings, rather than for a known set of individual buildings the way they would be in a retrofit situation.

2.4.1.B *<u>Estimates of Market Size and Penetration</u>*

An accurate estimate of the statewide energy savings attributable to an individual standards measure, whether it be a building measure or an appliance, depends on how large is the market penetration of the measure. For example, the measure may have very large savings when applied to a particular building, but it may only be applicable to a limited number of buildings or appliance uses. Therefore, its total savings may be small compared to other measures. A measure with smaller savings per unit that is widely used could produce much greater statewide savings.

The estimated savings will also be affected by the state of measure acceptance at the time it is adopted into standards. Most measures can be expected to have a reasonable level of market acceptance – they must be "ready for prime time" – before they can be adopted into the standards. But this can be highly variable. For example, dry-type transformers had very small market penetration when the appliance standard for them was adopted, but they were clearly cost effective and available in the market. LED exit signs, by contrast, had achieved a very high rate of market penetration by the time they were adopted. The savings potential is very different depending on the state of the market when adopted.

2.4.1.C *<u>Differences in Standards Implementation</u>*

There are a variety of ways that measures are adopted into codes and standards, and it is important to distinguish between them when designing a method to estimate overall C&S savings.

- ***Mandatory measures*** – these requirements must be met when applicable equipment is installed in buildings, so the savings are expected to accrue whenever that equipment is installed. Of course, the estimate must account for the frequency the equipment is present in the population of buildings. For example, there is a mandatory measure requirement that the lighting in all nonresidential buildings above a certain size must have automatic shut-off controls; this is pretty universal. On the other hand, it is a mandatory measure that residential fireplaces must have an outdoor air intake, except when built over a slab floor and away from an exterior wall. In this case the savings estimate must take into account the frequency that fireplaces are built over slabs on an interior wall.

- ***Prescriptive measures*** – these measures establish the basis for the energy budget for the building energy performance standards, which allows individual measures to be "traded-off" with other more efficient measures if the builder prefers. The trade-off involves installing other measures that are more efficient than the prescriptive measures, so that the overall building still meets the minimum energy budget. The trade-off procedure ensures that the same or better overall building performance will still be achieved.
- ***Compliance options and credits*** – these are measures that are recognized, Commission-approved energy credits in the standards. They are not part of the prescriptive measures, but they can be used as tradeoff measures for showing compliance with the performance standards. For example, a lighting control credit allows an increase in lighting power density in exchange for installing the control. This is basically an energy-neutral trade-off, so the control coupled with a higher lighting power density is expected to save the same energy as the prescriptive requirements, which require a lower lighting power density but no lighting control. The Commission's general policy is to be conservative in assigning compliance credit to an optional measure, so the tradeoff may save more energy in some cases than the prescriptive requirements.
- ***Appliance standards*** – these standards ban the sale of less efficient equipment within California, and they are enforced on the manufacturers and distributors, so builders cannot buy appliances that are less efficient than the standards. The appliance standards are mandatory measures in the building standards.

These differences in the types of standards can have a significant impact on the savings estimates for individual measures, and these differences should be recognized and taken into account by the estimation methodology selected.

2.4.1.D Difficulty of Estimating User Behavior

Measure savings can be highly variable depending on the usage behavior of the building occupants. Utility incentive programs must attempt to measure the user behavior for the population that is targeted by the program. The standards, instead, may be based on the conditions that the building is designed to meet. A classic example of this difference is residential air conditioner usage. For trade-off purposes, the Title 24 standards are based on the expectation that buildings are designed to meet minimum comfort conditions when they are occupied. The standard assumes that occupants use air conditioners on a regular schedule, and that they ventilate their buildings when it is cooler at night. Many occupants, however, use their air conditioners intermittently, failing to meet minimum comfort conditions, and they may keep their windows closed much of the time, failing to take advantage of free natural cooling. These differences can lead to air conditioner energy savings estimated by a utility program being different than the compliance tradeoff credit in the Standards, particularly in the case where the utility's estimate is influenced by a large number of buildings where air conditioners are not operated sufficiently to maintain minimum design comfort conditions.

Energy savings from standards, therefore, must be based on a good understanding of real occupant behavior across the population, especially when those savings are counted toward meeting savings goals and for procurement planning.

2.4.1.E ***Average Building vs. Prototypes***

In the past, standard practice in estimating energy savings for utility programs or standards was to use building simulation models of prototype building to estimate energy savings. These savings estimates for the prototype building were then projected up to the population of buildings on a per house or per square foot basis. The difficulty with using prototypes is that it is hard to know how representative they truly are of the larger population. Even if they are representative in some respects, as in square footage or number of stories, they may be different in others, such as in building orientation or occupancy patterns.

There are very few studies in energy efficiency that looked at using averages versus prototypes. The average, for example, might have 15.4 windows facing south rather than 14 or 16 windows. It is possible that even the nearest prototypes could be 5% off and, when added over the population, could create a significant overall difference in the estimated quantity of savings. A simplistic analogy would be that you are preparing a dinner party for 10 families. Assuming the prototype family is two adults and two children, you would then plan to have food and place settings for 40 people. Yet, if the average family has 2.3 children, you would need to plan food and place settings for 43 people. You would also be less likely to be short of servings. In this simple case, the advantage to using the average rather than the prototype can easily be seen.

In the new construction impact studies that have been conducted in recent years, this problem has been addressed by developing fairly large, representative samples of buildings to represent the population. These individual buildings are then characterized in terms of all their physical and operational parameters. Together, they provide a better picture of the population of buildings, and they also represent the mix of measures employed. This same approach has been used for estimation of standards statewide savings for nonresidential buildings in the last two standards update cycles, and it was used as part of a bounding analysis for residential buildings in the last update cycle.

Using these sample sets of buildings to estimate energy impacts, to study the behavior of bundles of measures and performance trade-offs, represents better practice than the use of simple prototypes.

This question of prototypes vs. whole buildings is less relevant for appliance standards, for example, clothes washers. But it clearly applies for HVAC equipment, water heating equipment and other appliances that are closely tied to building characteristics for their performance.

2.4.2 Selection of Baseline

Any savings estimate must, of course, use an established baseline. In a simple retrofit situation, it is an easy matter to compare the existing measure efficiency against that of the replacement measure. This is a good deal trickier with new construction, because the base case is never even designed, let alone built. It is further complicated with standards because they span periods of many years, during which the market is also changing.

The simplest way to think about the savings effect of building efficiency standards[16] is to assume that buildings are all built at standards efficiencies. Then, when the standards are upgraded, one assumes that the new buildings are built to the new standards efficiencies. The difference in efficiency and energy between these two cases is the savings attributable to the standards. This simple approach has been the norm in most standards adoption settings, and it has also been applied in many building efficiency calculations.

[16] In discussing building efficiency standards here, we are also including those appliance standards that govern building energy equipment. Appliances that are relatively independent of building systems, such as washing machines, may be treated as simple retrofits, and the interactive effects may be ignored for our purposes.

The problem with this approach is that real buildings do not exactly match the efficiency levels of the standards, and the differences may change with circumstance. For example, in 2000, the energy standards had been relatively static for many years, and the efficiency levels were not difficult for builders to meet. Beginning with the 2001 cycle of standards upgrades, and continuing with the 2005 cycle, the standards became much more stringent. If compliance rates under the new standards are worse than they were under the older ones, then not all of the anticipated energy savings will be realized. Alternatively, these two standards cycles adopted a number of requirements for independent verification and acceptance testing of measures (e.g. duct testing or verification of economizer controls operation) which are intended to improve enforcement of measures which may not have worked as intended in the past. These installation problems are also prevalent for efficient equipment receiving utility program incentives.

Imperfect compliance with the standards complicates statewide savings estimation. It may be simplest to assume an equal degree of imperfection between the old baseline and the new standards, and that the difference in efficiency is therefore the same as if one assumed perfect compliance in both cases. Either of the simple assumptions described above offers a great deal of clarity, and lends itself to relatively straightforward engineering estimations of overall savings, which is why they have most often been used in the past.

Of course, even these simple approaches are not as simple as they may sound. Given the large number of different kinds of energy measures installed in a given building, the baseline for each building must be independently determined and compared to the efficiency of the building after the measures have been installed. Only then can the efficiency of the whole building be determined for the “as-built” and “basecase” conditions.

The “true” baseline is “what would have been built, absent the new standards.” One immediately sees the difficulty with this construct, however, because that baseline case has never existed. It cannot be measured in the field, and it cannot even be postulated with any confidence. People have discussed possible approaches to direct measurement of a baseline, using out-of-state buildings, but these approaches would introduce even more confounding factors (different climate, energy costs, standards compliance, etc.).

For appliance standards, the question of baseline efficiency performance and compliance is also important. In general, the baseline issues are the same, except that they are generally tied to a specific kind of equipment rather than to a whole building. Compliance issues are handled at the manufacturer and supplier level, with little involvement by building code officials, and may be more difficult to track for each of the equipment types.

Based on these conditions and considerations, we recommend that, for ex ante estimates, California continue the practice of assuming that the baseline for a given standards upgrade cycle be the efficiency level of the previous or existing standards. This approach is the simplest and most amenable to analysis. It can be trued up through ex post review of the analysis assumptions, as needed to meet the needs for precision determined by the procurement and load forecasting functions.

We further recommend that the starting baseline for calculating C&S program results be the standards that have taken effect since 2003. This time period appears to coincide with the underlying studies to set the utilities’ savings goals. There are plausible arguments, however, that the savings be calculated starting with the 2001standards cycles, reflecting the standards which have received the most substantial PGC-funded investments. This issue should be given greater attention at the policy level.

2.5 ISSUES FOR ATTRIBUTION OF SAVINGS

The goal of attribution is to determine what portion of the statewide energy savings resulting from a standards adoption cycle should be credited to the efforts of the utility C&S program.

2.5.1 Comparison of Approaches

From a practical point of view, the answer to the attribution question reduces to a question of how much precision is needed, and how much effort must one expend in getting that precision. If the savings are large and the need for precision is low, then the attribution could simply be agreed to or deemed. For example, one might simply decide that the C&S program should be credited with one-third of the overall savings expected from the new measures adopted. Of course, this may be too simple and open to argument.

In two previous standards cycles, attribution studies were prepared. The two developed and applied different methods of attribution, both with defensible results. This discussion provides a brief comparison of the approaches. The reader is referred to the studies themselves for a more complete discussion of the methods and their derivations.

For the 2001 cycle of building and appliance standards upgrades, HMG[17] developed a method that may be described as an average of expert opinions. The researchers interviewed participants and stakeholders who were involved in the standards change process, and asked them to attribute varying degrees of influence by the C&S program on each of the steps in the adoption process. They then derived a combined attribution score to allocate the portion of savings that could be awarded to the C&S program efforts. Whenever there was disagreement about the program influence, the more conservative estimates were selected. This method had the advantage that it drew upon the insights of many of the participants and stakeholders. One disadvantage was that it required investigators who were thoroughly familiar with the process, the actors and their interactions to sort out the complex influences leading to adoption. Another disadvantage is that the method may be difficult to repeat or to ensure consistent results, depending on the knowledge, insight and feedback that the investigator is able to compile.

For the 2005 cycle of building standards, ADM[18] developed a different, simpler method. These researchers divided the adopted measures into measures whose research was primarily funded by C&S programs or by the CEC. For measures whose investigation was funded by C&S programs, all of the savings was awarded to the program. ADM did an extensive review of the evaluation literature as it could apply to codes and standards, and also did a critique of the HMG method. In the end, they selected their very simple approach as most appropriate. In addition to its simplicity, it reflected the process that ADM perceived whereby the CEC and the C&S program divided up responsibility for the investigation of their respective measures, and then worked somewhat independently on the investigation. In reality, there was substantial interaction and extensive vetting of the C&S funded initiatives with the Commission, and CEC staff believe this simple division of credit does not accurately reflect either the process or the appropriate attribution. The division of labor was not nearly so clear cut in the 2001 cycle, and this attribution method would have even less plausible, so there is question as to whether the ADM method is repeatable or sufficient for future standards cycles.

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[17] Op.cit.

[18] Op.cit.

2.5.2 Recommendations for Attribution Studies

The ADM approach is easier to implement, but evaluators in the future will need to better understand the extent to which C&S program efforts are clearly assignable to specific measures. The attribution must also recognize that the Commission administers the public vetting process for all standards change proposals and is ultimately the decision maker regarding how the investigation of measures will impact the adopted standards.

We recommend that future attribution studies have the following attributes:

- Studies should be done by independent evaluators who are not directly involved in the standards-setting process.
- Studies should begin while the standards process is still underway, so that evaluators can observe first-hand how C&S program participation helps in the adoption process.
- Evaluators should be selected for their knowledge and experience with standards development processes, and their ability to develop and administer a clear and defensible investigative methodology.
- Evaluators should have the technical expertise and resources to develop independent estimates of future standards savings in a way that will facilitate true-ups of the estimates.

2.5.3 Allocation of Savings to Different Utilities

Once the portion of statewide savings is determined by an attribution study, there remains the problem of allocating the attributable savings to the utilities. We believe that the basic principle for this allocation is straightforward. The savings that are realized will show up within the individual utility service territories as new buildings are built and new appliances are purchased, and only those savings within a given utility's territory should be credited to that utility.

The exact method for allocating the savings is a matter of judgment. The most precise method would be based on measurements of new construction activity and appliance purchases, and on differences in building types. It would also account for climate differences for climate dependent measures. This level of differentiation, however, would require a great deal of data and would be very expensive to achieve.

A simpler allocation method would likely be sufficient. It could be a proportional allocation of the attributable statewide savings, broken out by the relative sizes of each utility's service load. Alternatively, the allocation could be proportional to their savings goals or to their program expenditures, or even to their numbers of customers. The differences between these allocations are not likely to be great, so one of these simple proportioning schemes could be selected for convenience.

We recommend a simple, proportional allocation mechanism, rather than expending a great deal of resources and time in attempting to be more precise. If greater precision is required for procurement planning or forecasting purposes, then a study could be done to determine a more accurate allocation.

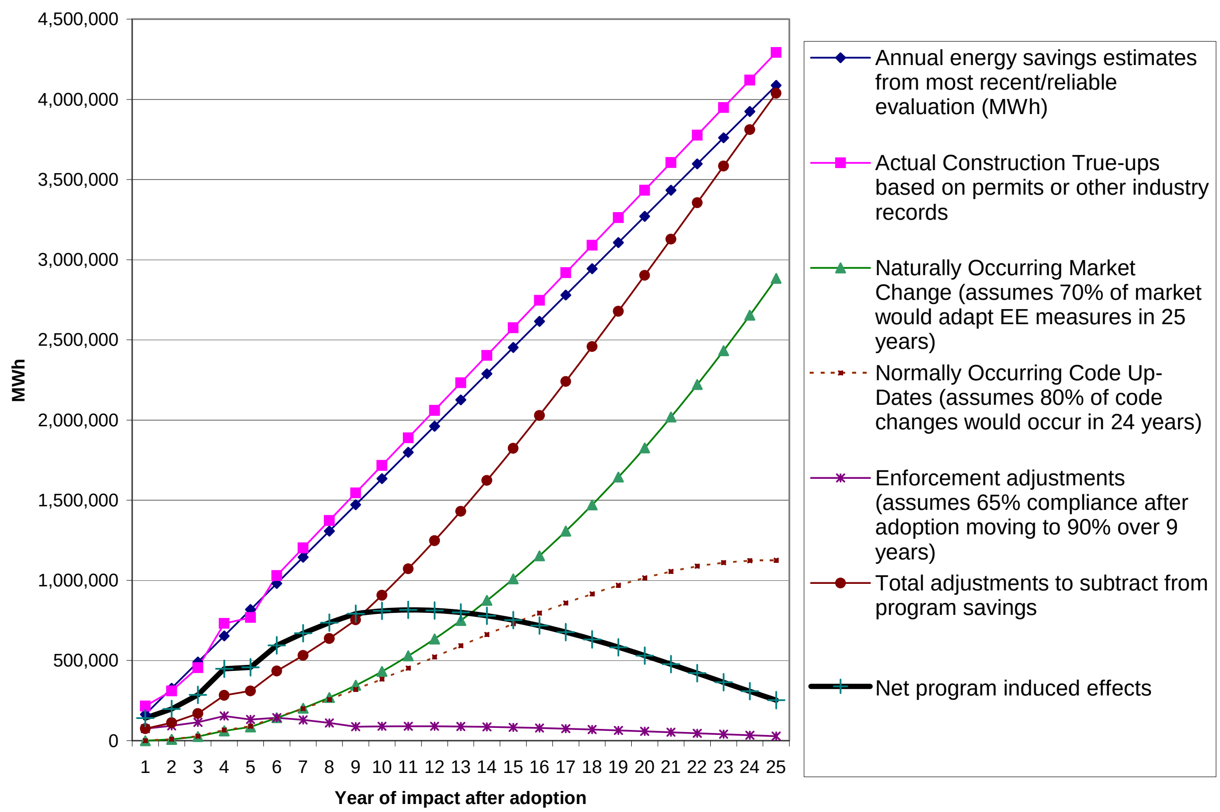
3. METHODS FOR LIFETIME SAVINGS ESTIMATES

3.1 SECTION SUMMARY

C&S Program Savings Appear Over Extended Time Periods. In previous sections, we discussed how the basic estimates of energy savings can be done, and how to attribute to the C&S program its portion of those savings. In this section, we address the question of how to spread those savings over time. Standards savings are different from those of a simple retrofit, say a compact fluorescent lamp (CFL) trade-out, because the standards savings begin to "show up" in buildings as they are built subject to the standards. Likewise appliance standards savings begin to show up as new equipment purchases take place. Unlike a CFL trade-out, which is a one-time occurrence, standards improvements tend to be permanent. Once the standards are in place, they will govern new efficiency purchases every year into the future, so new savings will be realized every year, and the savings will accumulate over time. We present a definition of the *Net Effects Lifetime* and derive a recommended method to calculate it.

Calculating an Expected Savings Timeline. While the savings generated by standards tend to be permanent, it is unrealistic to assume that the efficiency improvements would never have happened without the standards adoption. A number of factors are at play. We recognize that market forces and other utility program efforts would tend to drive up efficiency over time. Also, the new adopted standards would have eventually been adopted without C&S program assistance. In Figure 12, we present a method for crediting these "naturally-occurring" efficiency improvements, which has the effect of discounting future energy standards savings and of limiting the span of years for counting standards savings.

Figure 12. Excerpt: Expected Savings - C&S Program Energy Impacts – MWh/year Saved

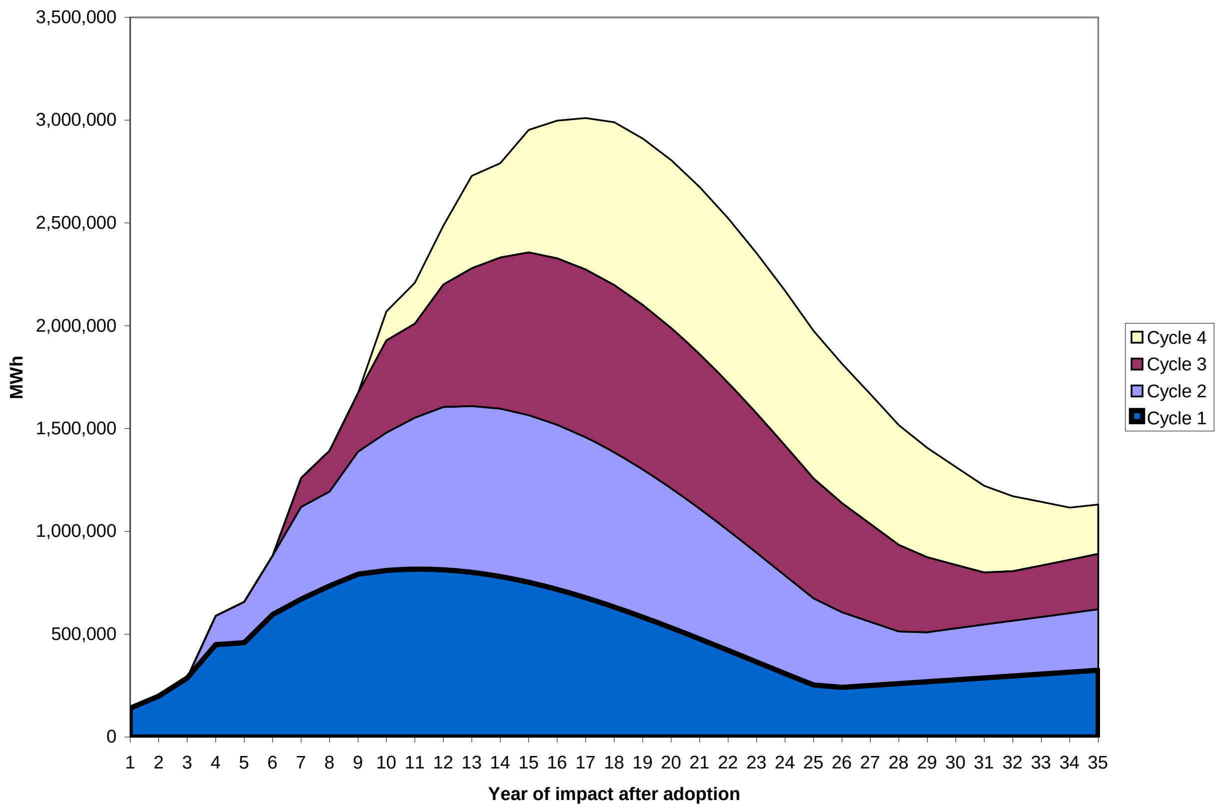


We also include mechanisms for adjusting standards savings estimates for imperfect standards compliance and for fluctuations in actual construction activity. These can be used to “true up” the savings estimates. To illustrate the recommended method for estimating C&S program savings, we present three different scenarios of savings, using conservative, optimistic and expected levels of savings. One of these scenarios is shown above. The “Net Program-Induced Effects” is a hump-shaped savings pattern that tapers off in the future, as naturally-occurring savings cancel out standards savings. The full explanation of the derivation of this example follows in this section.

C&S Program Costs Are Small. The overall costs of the utilities C&S program are small, compared to the value of the energy savings produced. From a utility program cost perspective, the C&S program has an exceptionally high yield. Typical costs are in the range of hundredths of a penny per saved kWh.

Standards Cycles Repeat and Savings Are Additive. Finally, we suggest a mechanism for aggregating the savings associated with different standards cycles. This method essentially starts a new savings stream with each cycle and treats these streams additively, as shown in Figure 13 below. Note that these numbers are illustrative of a mechanism, not necessarily of actual savings to be expected.

Figure 13. Expected Program Impacts from Four Consecutive Standards Cycles - – MWh/year Saved



3.2 DESCRIPTION AND DISCUSSION OF LIFETIME SAVINGS

One of the key considerations for determining the amount of energy savings from a program-induced change in standards is the period of time over which the savings can be credited to the program. While some may suggest that savings should be counted for the total lifetime of the standards change, this approach ignores the way in which markets operate, and can significantly overstate a program's influence. Likewise, when a standards change includes multiple technologies or construction practices, the mix and application of the technologies and practices used effects how long the energy impacts are expected to be generated. When the standards change incorporates the ability to negotiate trade-offs, the issue is further compounded. It may be tempting to make a simple assumption, such as assuming the Standards impacts lasts as long as the useful lifetime of the impacted equipment or building, but this may have little relationship to what would have been the naturally occurring savings absent the Standards. Instead, estimating the savings that are accumulated over the lifetime of the Standards impact requires an integrated approach involving several considerations.

For programs that change standards, the change is typically placed in the market for as long as the standards are in effect. Even when new standards are adopted they seldom undo previous standards, allowing the energy savings to continue or grow (from the new standards) even after retrofits and remodeling efforts. It is seldom a market practice for renovations or retrofits to be implemented below the applicable standards. Essentially, technology and practices changes that are made as a result of a standards change have a very long effective useful life. However, there are market conditions that erode the period over which energy savings can be counted. This paper presents the primary considerations that should be included in estimating the lifetime over which energy effects can be counted from C&S programs.

For the purpose of this white paper the authors present a definition for the "net effects lifetime" for a set of standards changes attributable to the C&S program. In constructing this definition we note that the definition is not grounded by how long the change is expected to function in the market, but rather how long the change is expected to provide effects caused by the program that are beyond the effects that would have occurred without the program's influence. Essentially we are defining the effective program-induced net benefit lifetime.

> Definition: ***Net Effects Lifetime*** is the period of time over which the energy impacts caused by the C&S program provide an energy saving effect in the market that would not have occurred in the absence of the program's efforts.

The use of this definition means that the lifetime estimate must be sensitive to at least the following items:

- ✓ The type of technologies/practices that are being used and its market penetration,
- ✓ The expected lifetime of the adopted technologies/practices ,
- ✓ The persistence of the use of the technologies/practices ,
- ✓ The amount of technology/practice adoption that would have occurred naturally in the market without the program,
- ✓ The period of time over which the change would have appeared in new standards if the C&S program had not contributed to its adoption, and
- ✓ The level of compliance with the new standards over time following adoption.

For the reasons explained in the preceding sections, however, it is most practical to combine the technologies/practices into an aggregated, whole building efficiency metric.

There are other considerations that may need to be included in establishing the lifetime over which savings should be credited. However, this list provides the key considerations and are those discussed in this paper.

The following sections of this chapter discuss these considerations and apply an example lifetime savings calculation approach to address them.

3.2.1 Type of Technology/Practice

When standards changes occur, typically the standards are changed to specify the use of a technology with a specific performance relative to the way the technology consumes energy, or the way in which the technology or design practice influences energy consumption. The type of technology or design practice being specified, or the way in which the performance requirements influence the type of technologies used is important for estimating the lifetime of the energy effects. If the standards change only covers a particular appliance, then the lifetime estimates need only start with an estimation of the period of time that the appliance will be in use (excludes persistence adjustments). If the change specifies a mix of technologies (lighting, motors, HVAC, glazing, envelope change, etc.), as in a building efficiency standard, then the lifetime of the energy effects would ideally be estimated using the energy-effects-weighted effective useful lifetimes of the group of technologies (as a whole). However, this effort requires an understanding of the type and mix-ratios of the technologies or practices that are adopted as a result of the standards changes induced by the program. Once an understanding of the types of technologies or practices being applied and the relative ratios of these in the standards-change-influenced market can be understood, then it is possible to estimate the effective useful life over which the savings would be captured. This level of detail and research may be prohibitively expensive to achieve for building standards, as a result using a whole building aggregated effects approach is likely to be more practical and preferable.

3.2.2 Expected Useful Life

Once we understand the technologies or practices being adopted as a result of the program-induced standards changes, we need to assess the way in which the mix is adopted and applied in the market. This is especially true when there is a performance option that allows buildings to select different technical options or applied designs that can affect other technical choices. The actual way in which the market applies a standards change may not be fully known until the market has accepted and changed practices for individual measures or building systems. More likely however, is the scenario in which the standards-approved mix of measures employed will change over time as the market accepts and adopts the changes in different ways to meet the performance requirements at the whole building level. Once the program-induced standards change technology and practice mix is assessed at the building level, then the effective useful life of the standards changes can be established.

In this process it is necessary to assess the period of time over which the standards changes will provide savings. This calculation is required in order to justify the cost effectiveness of the recommended change package. In California, standards change recommendations are not adopted into upgraded standards unless the cost effectiveness of each recommendation can be individually supported to show the energy savings are greater than the increased total cost of making the change. For a typical mix of technology and design practices the energy savings may not be constant, but rather reflect an annual changing of energy savings based on the installed mix. As a result, it is necessary to calculate not only the expected lifetime of the standards changes, but also the energy savings that are associated with that timeline.

As a practical matter, the energy impacts timeline will need to be grounded on an assessment of the effects of the standards cycle, the whole building efficiency level, and the period of time over which savings are expected from the bundle of adopted measures. This result may then be summarized into an average timeline, depending on the assessment needs. The establishment of the timeline will also need to be informed by estimates of the persistence of the bundle of technologies, practices, and the associated energy savings.

As discussed next under the persistence issue, the expected useful life of measures may be moot for the purposes of estimating savings (i.e., even if replaced, the savings will still be there). The expected useful life, then, may be more an issue for estimating measure cost than for estimating savings.

3.2.3 Retention and Persistence of Use and Savings

The issues associated with persistence of the energy savings needs to be addressed as the timelines and energy savings estimates are being considered. Persistence has several heads, each requiring separate considerations, however two of the primary considerations as they relate to C&S program evaluations are addressed in this paper.

First there is the issue of the retention of the measures or practices being used. This is a technical retention issue – are the technologies still there and still being used? As time moves on, people make decisions that affect the technologies they use. If a technology is taken out and is no longer in use, it cannot provide the savings. For both building and appliance standards, this question is moot. Standards requirements do not go away over time, and they tend to become more stringent. Therefore, any future replacement of measures will be governed by the same or more stringent standards.

The second issue is the persistence of the energy savings provided; are the savings still there? This is a behavior/use/condition issue, and it is the same issue that applies to all program-induced efficiency measures. In some cases the technology may still be in use, but the way the technology is being used is not providing the expected savings. Lighting systems with dimmers that are never used or in which the controls have been over-ridden so that they don't provide the dimming function are examples of this condition. Economizers that use outside air when conditions are appropriate, but fail to operate due to lack of commissioning or maintenance are another example.

These retention and persistence issues will influence the estimate of the savings attributable over time to the C&S program-induced changes. Addressing these issues should be a component of the evaluation of ex post effects of a C&S program.

3.2.4 Naturally Occurring Market Adoption

The very nature of markets is that they are always in a state of change, and energy efficient technologies will diffuse in the market and be adopted with or without the programs that push for energy efficient standards improvements. The key issue is the period of time and the rate of change associated with an energy efficient technology becoming the dominant practice without the program. There is some evidence to suggest that measures adopted into standards would not have been rapidly adopted in the absence of the standards requirements.[19] However there is also some evidence to suggest that building design considerations are driven by more than just first cost, and that energy efficient technology selection and design practices are more directed by customer demand and lifecycle costs. Efficiency choices may move through the market adoption cycle more quickly especially when the technologies are

[19] Sumi, David H. 1996. Commercial New Construction Market Assessment. Report prepared for Consumers Power Company, Inc. and Michigan Public Service Commission. R403-700/CPCO-813. Madison, Wisconsin: Hagler Bailly Consulting, Inc.

cost effective and other energy efficiency programs are present that change the way in which decisions are made.[20]

In order to not count the energy efficiency improvements that would occur as a result of the normal market adoption process, it is necessary to estimate the rate at which the program- and standards-induced changes would be adopted in the absence of the standards upgrades. One way to estimate this rate is to look at the rate at which similar technologies (compared to the standards required items) have entered and been adopted in the market without standards, and set this rate as the naturally occurring acceptant rate for similar standards-covered technologies and practices. This approach would likely need to be done at the technology or design practice level and then rolled up to an aggregated level. Another approach would group multiple technologies to examine in this process to come up with an average rate of normal market change for a given classification of technologies (HVAC, glazing, motors, etc.). As a practical matter, however, assessing the naturally occurring market adoption rate for standards effects may be best estimated at the building level. The NRNC and RNC (new construction) program impact studies have been deriving estimates of the overall levels of whole building efficiency since the early 1990s, and those could provide a reasonable basis for a trends analysis.

Adjusting the standards energy savings projections by the rate that whole building efficiency would naturally increase in the market allows the savings projections to more accurately represent program effects.

3.2.5 Standards Adoption Time Without Program Support

Standards are not static. They are typically up-graded as new technologies are placed in the market and become readily available, reliable and cost effective. This means that given enough time, at least some of the standards changes successfully adopted through the C&S program efforts would be adopted into future standards anyway[21]. The speed at which a more energy efficient cost-effective technology would be incorporated into standards (without the C&S program) increases as the market adapts the technology via the normal adoption process. If the energy efficient technology has captured 5% of the market, there is a lower probability that the technology would be accepted into new standards. Likewise if the technology has captured 60% of the market, there is a greater probability that new standards would be changed to include that technology. As a result, it is possible to estimate how the normal market diffusion process could be expected to influence how quickly a non-program induced standards change would have occurred. This effect can be addressed by examining how past standards have changed without program interventions and setting the rate at a comparable level for similar types of technologies with similar barrier and cost advantages or disadvantages. In practice, this may be difficult to estimate with confidence, but a reasonable, consensus-based estimate should be sufficient because the primary effect is to shorten the effective time period of standards savings.

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[20] Note that, in an ideal world, we would be treating standards influences on the market as part of a continuum with new construction programs and appliance efficiency programs. See the Postscript at the end for further thoughts on this.

[21] This is the general theory about C&S progress. It is not always so smooth. For example, when California established its first codes for air-conditioner SEERs, the average SEER in Texas started falling. Their market was regressing on energy efficiency rather than progressing. This is because manufacturers, rather than re-tooling all their plants, started shipping all the low SEER ACs to Texas that had been shipped to California and none of the higher SEERs. In fact, it is this occurrence that helped the City of Austin and others respond by creating their own energy codes to protect themselves from this behavior by manufacturers.

3.2.6 Level of Standards Compliance

If building design and construction professionals do not comply with updated standards and instead continue to specify previously used technologies and design practices, there are no savings incorporated into their buildings. Non-compliance can be caused by a number of conditions. Code officials may not be trained on the new calculation or approval approach, or may rely on already established approval processes that do not fully incorporate the new standards changes. Builders may not know about or understand the new standards and continue to use previous approaches that are not caught by code officials in the approval process. Rules-of-thumb tend to play strong roles in how technologies are selected. Building designers and specifiers tend to use approaches that are perceived to provide the least cost and hassle associated the construction and operations of the building. Rules-of-thumb decision approaches tend to resist the adoption of new approaches until the new rules are commonplace, or the designers and specifiers become satisfied that the new approach will not increase costs, hassles, customer complaints or affect their ability to keep their buildings occupied.

To some extent the compliance rate is related to the degree to which the local code officials enforce the new code. There are over 500 separate local building departments in California. Different local building departments devote different levels of effort to checking building plans, doing site inspections and verifying code performance. When reviews and enforcement efforts are not as strong, non-compliance rates can be higher than areas where review and enforcement efforts are stronger.

It may be necessary to adjust expected savings by a compliance or non-compliance factor. A compliance factor would start lower during the year the standards are adopted and increase rapidly as the standards become standard practice and as code officials make sure the standards are met.

3.2.7 Moving Baselines – Estimating Effects Across Different Periods

The conditions discussed above mean that the baseline from which savings are estimated is constantly moving. As noted in the *Framework*[22], the baseline is not a static point estimate, but a trajectory or slope of expected change over time. Evaluators will need to be aware and include this characteristic of the baseline as part of their research design.

There is also the baseline-related issue of how to count future new standards changes that are induced by the program's efforts in relationship to the moving baseline. Each time a code or standard is changed, the baseline for the purpose of consideration of the new change is the previous Standard. As a result, the evaluation approach needs to estimate the difference of effects between the program changes from the previous standards change and estimate the new effects that are associated with the new change.

As we conclude above in section 2.4.2, we recommend using the previous standards as the baseline in estimating the savings for a given standards cycle. For each, subsequent cycle, then, the savings are estimated from that baseline to the new standard. This avoids double counting, and it makes the analysis tractable.

[22] California Evaluation Framework (2004), p. 258.

3.3 ISSUES AND EXAMPLES OF ESTIMATING LIFETIME C&S SAVINGS

The most recent evaluation of the California C&S program is the ADM Associate's study of the 2005 building standards changes[23]. We use this study as the basis for an example of our recommended approach to estimating lifetime C&S savings. A similar approach would be used for appliance standards.

3.3.1 Using Single Year Savings Estimates as a Starting Point

The ADM study examined the changes to the 2005 standards that were directly influenced by the efforts of the program. The report excluded savings for changes that were not caused, in some way, by the program. In conducting the evaluation, the study identified the expected energy savings that would be achieved if the remaining market that had not yet adopted the recommendations, would implement the recommendations as a result of a change in the standards requirements. This approach gave energy effects credit to only the portion of the market that had not yet implemented the standards-specified changes. The estimate was calculated on the amount of construction that was typical over the preceding years, allowing the estimate to be based on actual expected construction rather than a hypothetical estimate of new construction based on economic projections. This evaluation estimated the savings for electric energy, electric demand and natural gas. However, the savings are not adjusted for expected normal market adoptions, for normal expected standards changes, or for compliance factors associated with placing new standards in the market. The study does not estimate the lifetime of the savings, but does provide the annual savings rate in kWh, kW and therms. In order to estimate the net lifetime program-induced savings we must estimate the time period over which savings should be counted (as discussed earlier) and we must adjust the savings for naturally occurring savings, for standards changes that would occur without the C&S program, for persistence, and for compliance rates.

3.3.2 Establishing the Time Period for Savings

As mentioned above, the ADM study did not assess and estimate the time period for savings beyond that of first year savings. This paper provides an example just to illustrate the importance of the different analysis components and to provide a flavor of the type of results that could be provided. For the purposes of this paper and for demonstrating the concepts of savings estimation, we set the calculation lifetime at 25 years because most of the changes are building design configurations that are expected to provide impacts in the market for at least 25 years. This is set at 25 years only as an example. Because gross effects are eroded so quickly in the net effects adjustment process, the time period over which net effects are calculated makes very little difference in the assessment results. In an actual evaluation we would set this period based on an assessment of the technologies and design practices being changed, the expected lifetime of those effects from the technology performance perspective and how the energy savings would be expected to occur over the following years.

3.3.3 Simple Annual Additive Approach for Estimating Effects

To begin the example presented in this paper for estimating the net effects from the C&S program we start with the program savings presented in the ADM report for the 2005 cycle of building efficiency standards upgrades. This report provides the estimated savings, but it is not adjusted for naturally-occurring efficiency changes or other net effects adjustments. In this example we assume the savings being estimated persist in the buildings over the example period and that future changes made to the building will reflect at least the 2005 standards changes, but more likely the standards changes that apply

[23] ADM Associated, Evaluation of the 2002 Statewide C&S Program, Prepared for Southern California Edison, June 2004.

at the time of the change. This is a reasonable assumption, and it simplifies the example we provide. In the future we would expect that the energy impacts reported from the evaluation studies will adjust for the persistence of the measures, based on how the measures are expected to remain in use and provide their intended function, and on how persistence is treated for other utility program measures.

Using this approach, it becomes a simple matter to add up the annual savings over the expected lifetime of the effects. This approach provides a linear accumulation of savings, growing at the rate that new buildings (that would not otherwise incorporate the standards change measures) incorporate those practices as a result of the new standards.

3.3.4 Adjustments for Actual Construction vs. Predicted Construction

The next step in the estimation process is an adjustment for actual construction volume. It is not possible to accurately estimate savings without knowing how much construction was actually accomplished following the standards changes. There are several ways to adjust the energy savings projections to account for actual construction and we do not specify a preferred approach in this white paper, but only recognize that a true-up of actual construction is needed to help the savings estimate be more accurate. If the evaluation is conducted in the 5th year following the standards change, then the true-up should contain estimates of actual construction for the first 4 years of which permitting and building records could be assessed. Once the evaluation has a history of actual construction, the projection of future construction (to estimate future savings) can be based on the historical construction. Once the projection is established, the savings can be projected and the adjustments can then be subtracted (or added depending on actual construction) from these projections to obtain net projected future savings.

Recognize also that the energy savings from standards changes could be greater for some sectors or buildings than others. Given this, a change in the distribution of building growth could also have an effect on the C&S program ex-post impact estimates from the ex-ante estimates. At this time, however, studies to exam how important this issue might be (i.e., how much different the proportional savings are between building types or sectors) have not be undertaken. Research in this area could be considered for future evaluation efforts.

The example provided below in Figure 17 is an example of an energy saving estimate of the 2005 standards changes based on a construction growth rate of 1.05 times the pre-2005 projections contained in the ADM report. The example is not real, but is based on applying the results of the ADM 2005 energy impact evaluation to the 2005 standards changes. The 1.05 projection is not based on real data, as 2006 has not yet arrived, but is based on the increase construction rates experienced in California in 2005. The actual rate will be more or less than this projection depending on what is actually constructed. The example provided in Figure 17 shows the total program-induced effects over a 25-year period.

3.3.5 Adjusting the Projected Effects

Once the 25-year energy savings projection is trued-up using actual construction records, this savings projection must be adjusted to account for naturally occurring technology adoption, naturally occurring standards up-dates, and compliance effects. To provide an example of these effects the authors of this paper provided three professional-judgment based estimates for these three factors. Each author provided their best estimate of these rates based on their professional judgment and their evaluation and program operation experience. The authors provide three scenarios, including an “Expected” program induced change scenario, a “High” program savings scenario and a “Low” program savings scenario.

Caveat: The examples provided in this paper present these scenarios and the results from the scenario calculations to illustrate what the C&S impact evaluation work would be expected to produce. We do not support the use of these estimates for any purpose expect as an example of the issues being discussed. A complete evaluation will be needed to determine defensible estimates and adjustment curves for C&S program impacts.

3.3.5.A How the market adopts new measures

The average "judgment-based" projections of change for the three approaches scored by the authors are presented below. In this example the authors' projections are that the standards changes would have been adopted in the market without the C&S program for the majority of the program induced changes, but the rate of adoption change depends on the scenario provided. The expected path indicates that 70% of the program-induced changes would be incorporated into the market without the program over a 25-year period. In the high-savings path the authors project that 50% of the changes would naturally occur over 25 years. This means that the market would adopt the savings at a slower rate, giving more credit and more savings to the program. In the low savings scenario the authors project that 75% of the changes would normally occur over 12 years. The results of these scenarios are provided in three graphics presenting the three scenarios (below). Figure 14 shows the judgment-based assumptions of market adoption without the program.

Figure 14. Professional Judgment Estimates for the Normal Market Adoption Rates

Scenarios	Normal Market Adoption Rates
Expected path	**70% adopted naturally in 25 years**
High savings path	**50% adopted naturally in 25 years**
Low savings path	**75% adopted naturally in 12 years**

3.3.5.B How standards change in the absence of program support

For this example, the authors also developed estimates for the three scenarios relating to how the standards would change if there were no C&S program. This estimate recognizes that the standards are reexamined every three years and through this process, non-program induced changes are made to the standards. This projection estimates how much of the program-induced changes would have been incorporated into a standards change through the normal standards revision process. The authors project that in the expected path 80% of the program-induced standards change would occur over 24 years. The projection for the high savings path is that 70% of the standards change would be made over a 36 year period. The low savings scenario projects that 90% of the change would occur over three standards change periods, or over 9 years. These estimates are provided in Figure 15.

Figure 15. Professional Judgment Estimates for the Normal Standards Change Rates

Scenarios	Normal Standards Change Rates
Expected path	**80% of standards changes would be made in 24 years**
High savings path	**70% of standards changes would be made in 36 years**
Low savings path	**90% of standards changes would be made in 9 years**

3.3.5.C Effects of enforcement on standards compliance

Finally, the authors projected different standards compliance rates across the three scenarios to complete the adjustment curve estimates for this example. As the market becomes more familiar with standards the compliance rate should increase naturally. The expected scenario places standards compliance at 65% of all new structures during the first year following the standards change when people are least familiar with the new standards. The compliance rate then moves to 90% during the 9th year following adoption and then holds at 90% there after. In the high program savings scenario the compliance rate starts at 55% compliance during the first year, moving to 85% compliance during the 15th year and then holds steady. In the low program savings case the compliance is 75% compliance during the first year, moving to 95% compliance in the 6th year. Figure 16 presents these example estimates.

Figure 16. Professional Judgment Estimates for Standards Compliance Rates

Scenarios	Standards Compliance Rates
Expected path	**65% compliance at 1 year moving to 90% compliance in 9 years**
High savings path	**55% compliance at 1 year moving to 85% compliance in 15 years**
Low savings path	**75% compliance at 1 year moving to 95% compliance in 14 years**

3.3.5.D Estimating the cost of saved energy

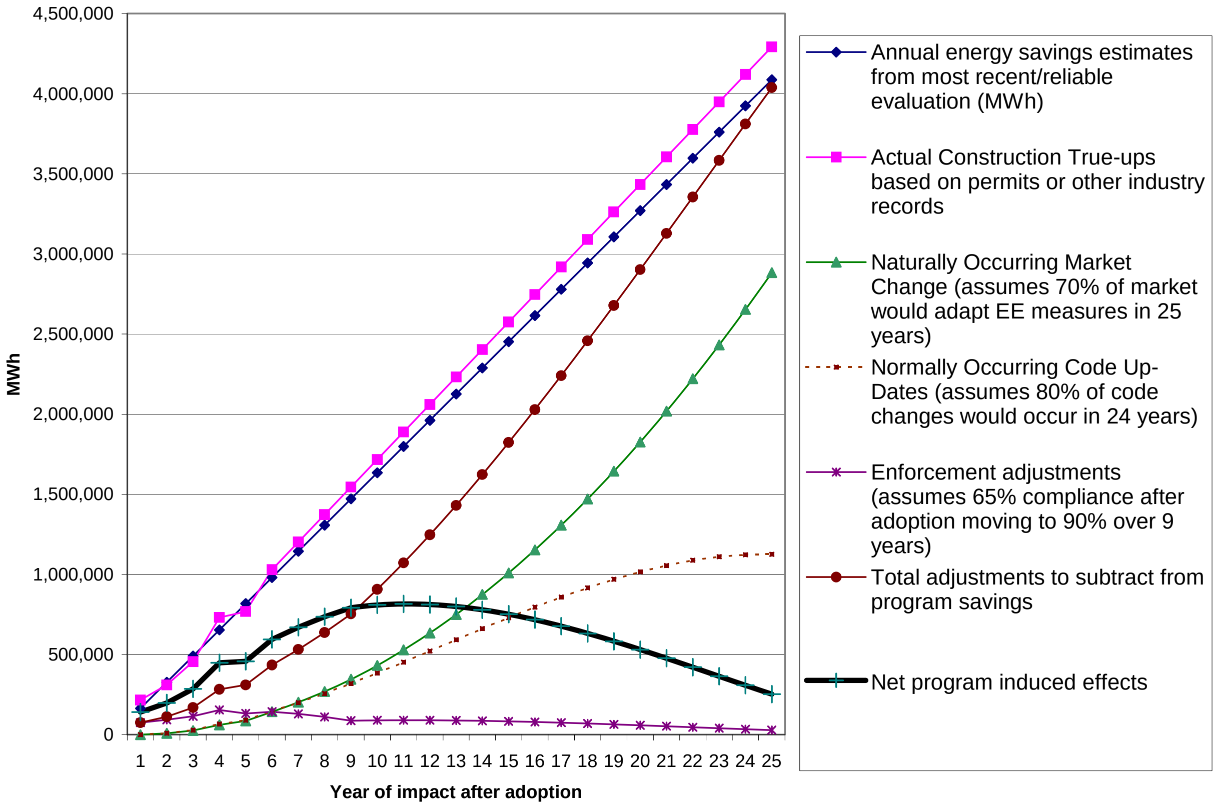
The approach suggested in this white paper starts with the use of actual evaluation results to establish the baseline for adjusting the savings projections. Then the savings can be trued up to actual construction using available data at the time of the estimate realizing these true-ups will change each year. Once the true-ups are made the average annual construction rate can be applied to the evaluation findings for energy savings over the period of time for which savings are estimated. Then these saving estimates can be adjusted to account for normal market diffusion and adoption rates, standards changes without the C&S program, and compliance rates following standards adoption. The results from the three scenarios discussed above are presented below to provide examples of what these scenarios would do to the estimated program savings documented in the 2005 ADM impact evaluation. In each graphic the dark line at the bottom of the graphic that rises up, levels off, then collapses as the adjustments erode the savings, representing the net program effects. From these graphics it is clear that the top lines, representing the ADM program effects estimate adjusted for actual construction, is more than 90% eroded away by the 17th year, but then remains flat as new construction is offset by the adjustments at a somewhat constant rate of change.

3.4 EXAMPLES OF LIFETIME SAVINGS UNDER VARIOUS MARKET CONDITIONS

3.4.1 Scenario 1: The Expected Path

The examples created in this white paper are provided to illustrate the type of issues that must be addressed in a thorough C&S impact evaluation to provide a defensible lifetime savings estimate. Figure 17 provides the total projected savings and the savings adjustment effects using the adjustment estimates associated with the "expected path" scenario. This approach estimates net effects at over 14 million MWh over 25 years.

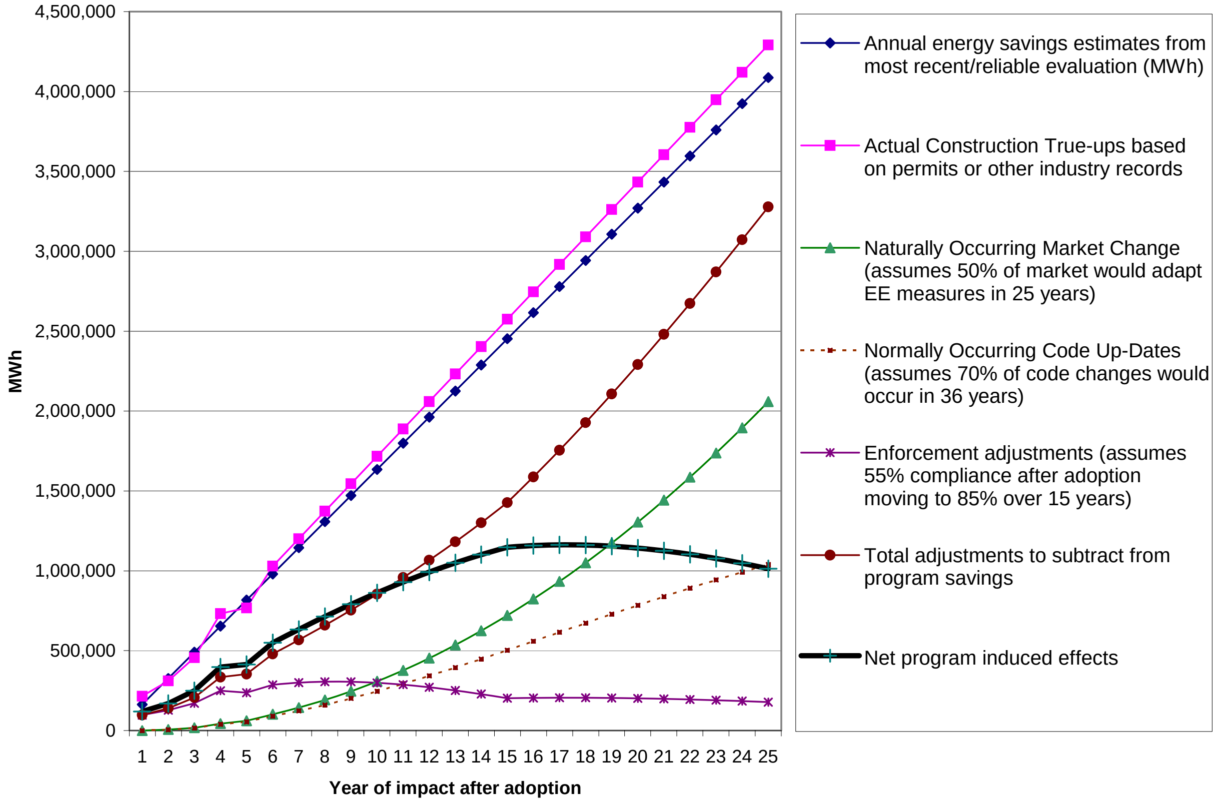
Figure 17. Expected Savings Path – C&S Program Energy Impacts – MWh/year Saved



3.4.2 Scenario 2: The High Savings Path

Figure 18 provides the total savings and the adjustment effects associated with the high savings path example. This approach provides net lifetime program effects of over 21 million MWh over 25 years.

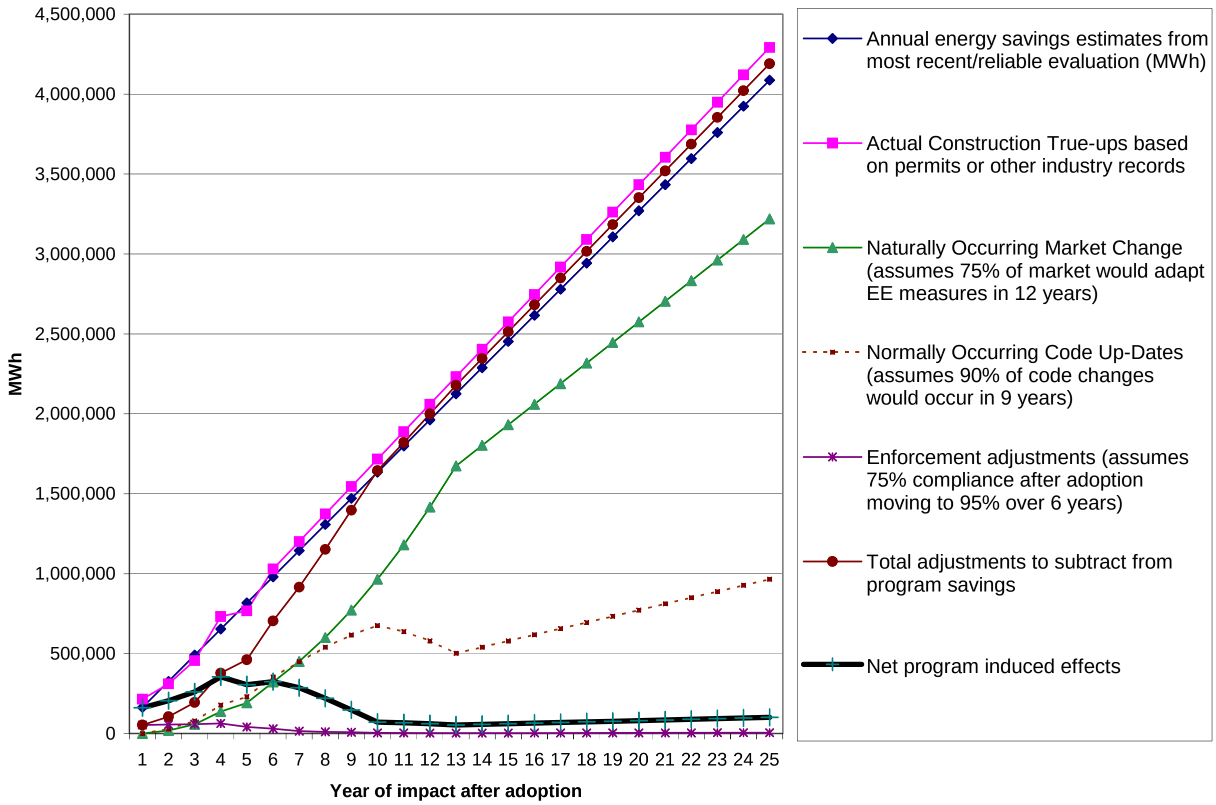
Figure 18. High Savings Path – C&S Program Energy Impacts – MWh/year Saved



3.4.3 Scenario 3: The Low Savings Path

Figure 19 provides the total savings and the adjustment effects associated with the low savings path example, and provides net lifetime program effects of 3.5 million MWh over 25 years.

Figure 19. Low Savings Path – C&S Program Energy Impacts – MWh/year Saved



3.5 SUMMARY OF LIFETIME EFFECTS ASSESSMENTS

These three examples provide scenarios of projections for the net lifetime energy savings from a C&S program. This example applies the 2005 ADM impact evaluation savings results to the 2005 Title 24 standards changes as an example of how the net effects of the changes can be estimated. While each of the three scenarios presented erodes the energy savings in different ways, they all would erode the a very large portion of the savings predicted in the ADM report. However, even though the savings are significantly eroded over time, taking back over 90% of the savings ADM estimated (if accumulated without adjustment), the remaining savings provide net lifetime cost of saved energy at between $.00032/kWh and $.00198/kWh over 25 years. The following table provides the cost of conserved energy for the three scenarios, as an example of how these values might change with the different scenarios.

Figure 20. Estimated Cost of Saved Energy

Scenarios	Estimated cost of conserved energy: $6,869,681 invested vs. Lifetime Savings (2005 Title 24 standards)
Expected path	$.00049/kWh at 25 years
High savings path	$.00032/kWh at 25 years
Low savings path	$.00198/kWh at 25 years

It is important to recognize that these cost estimates do not include all of the costs of implementing standards, such as the cost to the building owner of measure installation. Therefore, these numbers are not comparable to TRC test values; they are more like program efficiency costs. Also, these numbers are simply in present dollars, and are not discounted for future time value of money. Nevertheless, we believe they make the point that C&S program investments are highly cost effective.

An examination of the total budget spent by the C&S program on standards upgrade activities, and on supportive and related program activities, indicates that $15,987,157 was spent from 2000 through 2005. Of this amount, about $6,869,681 was specifically spent on efforts to assess and recommend changes to the 2005 Title 24 standards. The amount of the budget spent on 2005 standards efforts was estimated following discussions with utility program managers associated the efforts to which these funds were allocated[24].

Figure 21. Total Program Expenditures in Developing the 2005 Title 24 Standards

Year	Total allocated to both direct and supportive or related activities	Total spent advocating for the 2005 changes
2000	$2,030,000	$101,500
2001	$3,458,000	$2,074,800
2002	$1,955,500	$1,368,850
2003	$2,693,000	$2,154,400
2004	$2,925,329	$585,066
2005	$2,925,329	$585,066
Totals	**$15,987,157**	**$6,869,681**

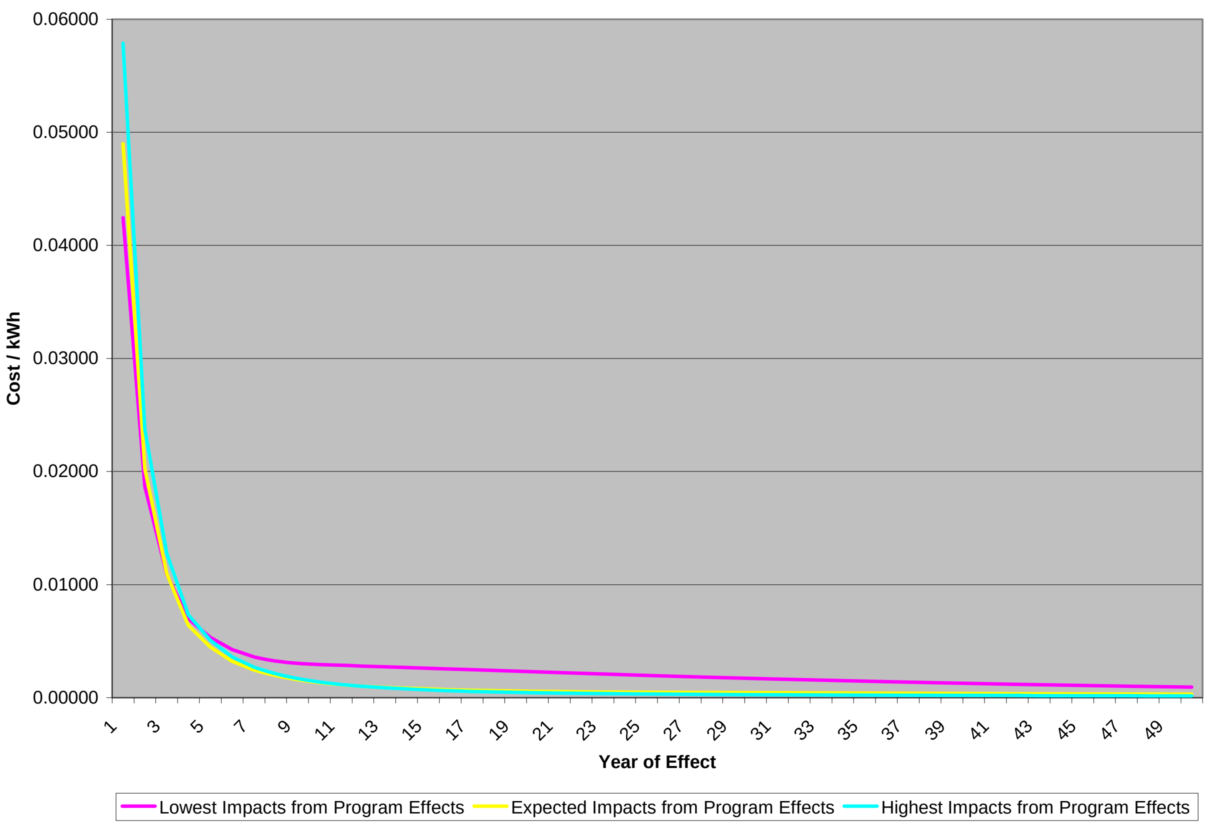
Using the example approaches presented in this paper and the ADM impact evaluation report, the cost of conserved energy over a 50-year period is estimated at three hundredths of a penny per kWh for the expected path of program effects. These examples are not provided to suggest the 2005 standards changes will provide the estimated level of energy savings in this example. But rather the examples are

[24] TecMarket Works, California 2002 Statewide Energy Efficiency Program Effects Summary Report, April 2005.

provided to demonstrate a calculation approach that adjusts evaluation savings to reflect the cost of conserved energy after adjustments for actual construction, normal market adoption rates, standards adoption efforts without the C&S program, persistence, and compliance rates.

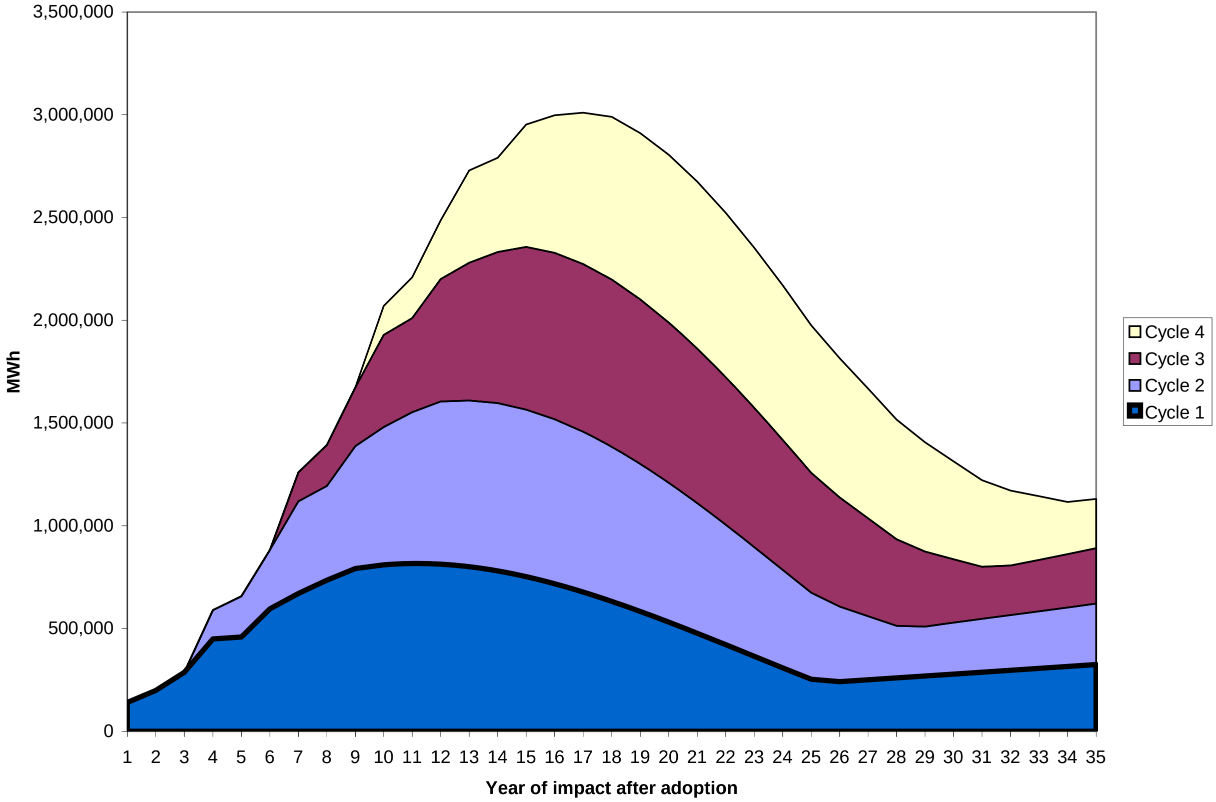
There may be some disagreement over the time period that should be used to estimate program savings and cost effectiveness. One of the advantages of this analysis approach is that it can calculate the cost of savings for any given point in time. To illustrate this, we have graphed the cost of saved energy as a function of time (see Figure 22). Clearly, if a short period of time is used, the costs of energy savings will be higher than if a longer time period is used. This is because the initial cost to support standards changes is fixed, whereas the savings continue to accrue over time. The longer the accrual time, the lower the cost of saved energy. This presentation demonstrates that the length of time considered in the model has very little effect on the results. Once the period of time moves past 10 years the annual change is small and does not significantly impact the results. In all three scenarios the cost of conserved energy moves to less than a penny per kWh at about the 4th year, essentially making the number of years over which savings are estimated a moot point. Changing from a 15 year assessment period to a 50 year period results in net cost of energy changes that are in the hundreds of a penny range.

Figure 22. Cost/kWh as a Function of Time



As new standards are added over the following years the effects of the standards changes build up providing increasing energy savings as the new standards are adopted. However, as the net effects adjustments erode the savings, the total savings eventually begin to decrease, but not until the program has become exceptionally cost effective, providing energy savings at hundredths of penny per kWh. Figure 23 provides an example of the energy savings from four sets of standards changes implemented over a 12-year period and the resulting accumulated energy savings. Again, the savings are estimated to demonstrate an assessment process, rather than to set the basis for a specific savings claim.

Figure 23. Expected Program Impacts from Four Consecutive Standards Cycles - – MWh/year Saved



4. METHODS FOR VERIFICATION OF SAVINGS

4.1 SECTION SUMMARY

The preceding chapters have raised the issues of calculating and allocating savings from standards. This section discusses methods that could be used to verify actual savings following adoption of the standards.

Post-Implementation Studies Should Assess Real Building Practices. These include assessments of how code options are adopted by the market, through a sample of buildings. Standards compliance rates should be verified in the field in a way that allows for quantifying actual energy savings.

The Unit of Savings Should Be the Whole Building. There is huge variability in the measures installed in buildings, and the building efficiency standards regulate whole building performance. Consequently, it is not practical to verify savings measure-by-measure. Instead, as has been the practice with new construction program impact studies, savings should be evaluated on the basis of whole building efficiency. The exception to this would be appliances which are not part of whole building efficiency, such as televisions or portable spas; these can be evaluated independently.

Ex Post Savings Should Be Measured to True-Up Estimated Savings. True-ups should consider verification of compliance rates, variability in as-built efficiencies, determination of actual construction activity, and trends in efficiency rates. Also, the larger economic factors affecting new construction should be considered.

Attribution Studies Are Important. In order for utility C&S programs to receive proper credit for the savings they achieve, attribution studies must be done to determine what fraction of statewide energy savings should be counted toward meeting utility savings goals.

4.2 ASSESSING CURRENT POST-ADOPTION PRACTICE

The first level of verification of savings should entail verifying that the savings estimates and assumptions about market adoption of new standards were valid. The path between ex ante estimates of savings and ex post measurement of the actual conditions in the field should be relatively clear if the original estimates were rigorously derived and well documented.

The more difficult, and expensive, aspect of this process will relate to sample sizes and verification of conditions in real buildings. Due to the large numbers of measures and the diverse applications of those measures, this process can become prohibitively time consuming and complex if attempted at the measure level. For this reason, we reiterate our recommendation that these assessments be done at the whole building level using a representative sample of new buildings. This approach implicitly deals with the problems of assessing impacts where complex trade-offs are allowed in standards. It also reflects the realities of actual buildings in their entirety, rather than focusing on individual technologies or design practices in isolation.

A related study design question is how well the sampling approach on whole buildings represents all the code changes and the diversity of circumstances in their uses. An extended telephone survey/interview using a split sample approach could provide information to characterize the types of changes and to check the applications of code changes across different sectors within the new construction, renovation, and retrofit markets.

4.3 STANDARDS COMPLIANCE

If the energy standards are not complied with, then the full level of expected energy savings will not be realized. Some measures in the standards are quite reliably met, such as minimum air conditioner efficiency, while others may not be met as frequently, such as limitations on glazing area. Historically in California, residential buildings have often been built somewhat below the energy standards, while nonresidential buildings have tended to be somewhat more efficient than the standards. There also tend to be regional differences in compliance rates, perhaps partially as a result of more sophisticated building departments in larger jurisdictions enforcing the standards more rigorously than less sophisticated jurisdictions in more remote areas. Moreover, compliance rates appear to change over time, gradually increasing as familiarity and enforcement efforts increase with time from adoption. Compliance rates are probably lowest immediately after a new standard takes effect, and improve over time.

There have generally been two approaches to measuring standards compliance. The simpler approach is to survey building projects and check off standards violations. The more difficult approach is to identify areas of noncompliance and then to estimate the energy consequences of the violations. To do this right, one should also identify the areas of overcompliance, as these would offset the inefficiencies due to undercompliance. The simpler approach is practically useless for estimating energy savings due to compliance shortfalls.

The only realistic method for estimating the energy impacts of standards compliance is to determine the overall efficiency of buildings as built, and to compare this overall efficiency to what it would be if the building just met the standards. Fortunately, both the residential and nonresidential new construction program evaluations in California have used this approach for several years now, so the methods and history of this approach are well documented.

4.4 INDIVIDUAL MEASURES VS. WHOLE BUILDING EFFICIENCY

One of the big problems in new construction, and especially in standards, is that there are many measures selected and installed at the same time. The energy use patterns of those measures interact; for example, when you reduce the lighting power density in a commercial building, you also substantially reduce the air conditioning energy and you moderately increase the heating energy. The other problem with multiple measures is that they can be traded-off between and among them. The actual bundle of measures installed in two otherwise similar buildings could be very different.

This is very different from the case with retrofit programs, which usually incent a single measure to be upgraded to a more efficient version of the same measure. Unfortunately, many people seem to think about new construction, and so about standards, the same way they think about retrofits. This affects the way they think about estimating the savings from measures, and how C&S program accomplishments should be calculated.

We encountered and addressed this issue in the early 90's when applying the CALMAC M&E protocols to impact evaluations for nonresidential new construction programs. The solution adopted at that time, and recommended again in this White Paper, is to adopt the "measure" as the whole building energy efficiency, rather than attempting to identify, separate out and calculate each of the measures in the building.

Using whole building efficiency as the metric has several advantages:

- It treats the efficiency of each individual measure in its proper context within the larger whole, so that building type, operating schedules, and other characteristics that affect measure efficiency are appropriate.
- It accounts for the interactive energy effects between measures.

- It minimizes the problems associated with trade-offs and standards compliance choices made by the builder.
- It allows for accurate estimation of the compliance margin relative to the standards baseline.
- When applied to a representative sample of buildings, it allows for market characterization of the entire building sector.
- When repeated over time, it allows for tracking trends in building efficiency over time, without becoming hung up on estimating the savings and market penetration of individual measures.
- At the same time, if the sample sizes are large enough, the details of the whole building analysis can provide information on the penetration of different measures, and the prevailing bundles of measures being chosen by the market.

The new buildings impact evaluation studies in California have a long history of dealing with whole building energy efficiency as the "measure" of performance, and we recommend that this practice be used in the evaluation of future C&S programs.

One additional factor, that will have to be considered in the study design of C&S program impact estimation, is the representativeness of the building sample. In new construction program impact studies, samples were selected to be representative of the program participant population. For a C&S program impact study, the sample should be selected to represent the entire population of buildings. Indeed, the sample might best be expanded in size so that it can distinguish between various subsectors of the entire population, such as major renovations, or industrial buildings with major process loads. This approach would provide better information on how the standards affect these different subsectors in the population.

The major exception to this recommendation is for appliance standards which apply in some cases to appliances that are not addressed by the building standards, such as dishwashers or refrigerators. Many of the appliance standards, however, do govern appliances that are part of the building's energy efficiency and are governed by the building standards, such as air conditioners, furnaces, water heaters, and lamps/ballasts. These should be treated as part of the whole building efficiency "measure".

4.5 EX ANTE VS EX POST SAVINGS ESTIMATES

Because estimates of energy savings from standards are developed at the time of adoption, they are projections of future savings. The new regime requires that savings be "booked" as they come on line in real buildings, so there remains the question of whether or how the ex ante projections of savings could be trued up with some sort of ex post measurements. As the above discussion indicates, such a true-up would have to include, at a minimum, consideration of the following parameters:

- Verification of compliance rates
- Variability in actual building efficiency versus standards baseline efficiency
- Determination of actual volumes and types of new building activity, statewide and locally
- Determination of rate of improvement in whole building efficiency, compared to projections

Many of the more detailed questions that can be answered using whole building surveys and analyses of a representative sample of buildings will also be useful in identifying emerging trends in building efficiency and compliance choices in the market, and in projecting the benefits of future standards enhancements.

This White Paper is agnostic on the question of how ex post measurements should be used for reward mechanisms of program administrators or for shareholder incentives. Nevertheless, we believe that ex post verification should be used to true-up the savings estimates of C&S program accomplishments, and to reassure regulators, load forecasters and procurement planners that the savings are real.

4.6 LARGER ECONOMIC FACTORS

The rate of new construction, of course, is highly influenced by economic factors such as interest rates, population growth rates, and the health of the California economy. Estimates of energy savings from codes and standards are based on rates of construction in the years immediately prior to the Standards adoption, but the actual energy savings could differ if the rates of new building construction rise or fall significantly. The savings would need to be adjusted to account for the change in construction rate. This has not historically been done as part of program impact studies, but it has been an important part of load forecasting.

Accounting for these factors to a higher level of precision, if that is required for procurement or forecasting needs, may require studies over time to determine whether estimates of savings are showing up in practice at the levels anticipated.

4.7 ATTRIBUTION STUDIES

Because of the importance of the savings goals established by the CPUC, and the need for the utility programs to demonstrate their cost effectiveness in meeting those goals, it will be important to conduct attribution studies following the adoption of new standards. The methods for doing these studies have been discussed above in section 2.5. As with any evaluation study, it will be most effective to have the processes of the C&S program well documented as they occur, and the objectives and outcomes clearly described. Then it may be relatively straightforward for an independent evaluator to verify the attribution of savings to the program.

5. CALCULATION OF PROGRAM BENEFITS/COSTS

One can calculate the B/C ratio for the C&S Program from program inception to date, or for the program effort required to move from the current standards to a new set of standards. Both should be done.

It seems that the use of the Total Resource Cost Rest (TRC) and the Participant Test (PT) currently used by utilities for resource acquisition programs could be used for the C&S Programs. The one difference is that there are more forecasts required to estimate the net lifecycle impacts than in a traditional resource acquisition program. Whether the uncertainty surrounding the B/C ratios for the C&S program are actually greater than the uncertainty surrounding traditional resource acquisition programs is an interesting question. For the C&S Program, one must forecast:

1. Duration of savings at the building level, or by appliance category
2. Naturally occurring market change,
3. Standards updates occurring without the C&S program, and
4. Compliance adjustments.

These are some of the key inputs to the estimation of net lifecycle benefits. At the same time, measurement errors associated with the inputs to a garden variety SAE (Statistically Adjusted Engineering) regression model used for evaluations of resource acquisition programs are not trivial. Other than these differences in inputs and sources of uncertainty, the basic approach is the same:

- Net kWh, kW, and therm impacts are estimated for a given program year and carried forward using an estimated useful life. The stream of benefits for the program year and each subsequent post-standards adoption year can be handled in separate benefits streams.
- These savings are valued using the current avoided costs over the savings–weighted life of the measures typically involved in complying with the standards.
- Costs are divided into program implementation and participant costs.
    - Program cost would include all C&S Program costs.
    - Participant costs for standards are more difficult to estimate. The incremental cost estimated for compliance with the new codes and standards should be no higher than those used by the Commission to evaluate the adoption of the code/standard.
    - These can be estimated using the DEER data and other sources that estimate incremental measure costs. These incremental costs should be updated to reflect the year in which savings begin due to a standards change.

For appliance standards, which are individually adopted and enforced, these issues are more straightforward. There is still the need to consider the time dimension of the savings in calculating the B/C ratios.

Note that one important effect of a Standard is that it can dramatically drive down the cost of measures used for compliance. Hence, over time, the incremental costs will go down increasing the B/C ratios. Net impacts in each post-standards adoption year will also decrease as both normal updates and market forces begin to overtake the impacts of the earlier standards.

6. RECOMMENDATIONS FOR PORTFOLIO PLANNERS

6.1 C&S PROGRAMS SHOULD BE INTEGRAL TO THE PORTFOLIO

We conclude that C&S programs should not be treated as an “information only” programs, but rather as an integral part of the portfolio. Further, C&S programs should not be seen as taking away resources from direct savings investments, but rather as an important component of overall savings achieved over time. C&S can acquire savings for measures that are “ready for prime time” without having to pay costly incentives. C&S programs will not be reducing the effectiveness of direct savings investments if the savings of C&S programs are properly accounted for. Rather, those programs - NRNC, PEC, CTAC, statewide appliance, residential new construction, etc. - should be seen as acquiring savings that cannot be acquired through C&S. Further, those programs may be thought of as preparing the ground for future standards upgrades.

6.2 C&S PROGRAM SAVING SHOULD BE COUNTED IN 2006 AND BEYOND

As utility program savings start to accrue beginning in 2006, we believe it is logical and prudent to count the savings from C&S program efforts that have been adopted since 2003. It may even be possible to count savings for standards adopted in 2001; depending on further investigation and policy review. Calculations of program savings, and the development of streams of savings over time to account for the long time lags for C&S program effects, need to be done somewhat differently from standard resource acquisition program methods in order to capture realistic estimates.

6.3 M&V ISSUES FOR C&S PROGRAMS BUILD UPON EXISTING PRECEDENTS

The components and the issues that need to be addressed in developing ex ante and ex post estimates for C&S programs have been reviewed in this white paper. Work conducted previously for the new construction program evaluations, the market assessments, and the market effects measurements can provide useful guidance in designing evaluation methods C&S impact estimates.

7. RECOMMENDATIONS FOR CPUC POLICYMAKERS

7.1 C&S PROGRAMS PRODUCE IMPORTANT SAVINGS

Notwithstanding the uncertainty in some of the details, it is clear that utility-directed support for standards adoption works, and produces large and important savings to meet the state energy savings goals.

Any savings that utilities and the CEC get through standards savings reduce the need for ratepayer procurement or public benefits expenditures, because the standards' savings are relatively inexpensive. However, the higher costs for new construction programs need to be considered additively, and the TRC of them, taken together, is much higher than the cost of saved energy presented in Section 3.5 (but still is generally well below the B/C threshold).

Measurement of savings, cumulative lifetime savings, and attribution needs to be done differently in the future in both the standards arena and in the new construction market, and may be best done on a market-wide scale.

7.2 RELATIONSHIP TO UTILITY SAVINGS GOALS

The utilities' savings goals were based on the state of standards prior to 2003, and they did not include anticipated savings from new standards, so C&S program-attributable savings from standards taking effect in 2005 and beyond should be counted as program accomplishments beginning in 2006[25]. While the investment standards upgrades have been made since 1999, the savings continue to accrue each year as new buildings and appliances come on line. The value of these savings should be counted toward meeting the goals as savings come on line with new building completion and occupancy, and with new appliance purchases, in line with the decision to count actual installations from prior program years. This practice should not be seen as double counting, or giving improper credit for previous program efforts. Rather, it acknowledges the reality that savings from standards come online over a period of many years. Savings from C&S program year 2006 will not appear until 2009 and beyond. The savings from prior C&S program efforts are properly counted in 2006 and beyond.

7.3 ALLOCATE SAVINGS TO UTILITY SERVICE TERRITORIES

The building and appliance standards generate savings on a statewide basis, and the utilities' C&S programs are likewise statewide. The savings in new buildings and appliances, however, show up on the individual IOUs grids and gas systems. Therefore, we recommend that savings be allocated to the individual utility program goals on the basis of their separate service territories. We suggest several alternative ways of doing this apportionment, from a simple ratio based on program spending or load served, to a more elaborate accounting of actual construction and appliance purchase activity. We recommend the Commission select its preferred allocation mechanism so that utilities can correctly claim savings.

[25] There are arguments that savings from the 2001 cycle of standards, which were also supported by C&S program activities, should also be counted beginning in 2006; the Commission should review these arguments and provide direction to the utility program planners.

7.4 NEED FOR PRECISION IN SAVINGS ESTIMATES

The application of efficiency savings toward meeting procurement goals may increase the need for precision in savings estimates. In the case of standards savings, there is good reason to believe that savings will be large and persistent, especially when compared to some kinds of incentive programs. At the same time, there are also greater difficulties in estimating standards savings throughout the population, due to the issues discussed in the previous sections of this report. The question, therefore, becomes one of how much precision is needed. Precision is as much about the cost of obtaining a given level of precision as about the reliability of savings. If savings estimates are very conservatively low, then the need for precision in that estimate may be minimized in terms of protecting the minimum amount of generation needed.[26] If the savings estimates are high, approaching the maximum likely savings that could be achieved through standards, then the level of precision required might be higher to protect the total demand estimates and the costs of achieving high confidence levels will be high as well.

We would recommend that the CPUC adopt an initial policy of conservative discounts on savings estimates and a minimal need for precision in the estimates. The two impact estimates cited in section 2.2 provide the most reasonable starting point. C&S evaluations and research into the many issues discussed in this paper could then be used to adjust future C&S methodologies and acceptance of more accurate estimates. If it is later determined that higher and more precise estimates are needed, the requisite additional studies can then be designed and budgets/time allotted to them.

That said, there are really three areas of lost precision:

- establishing the gross savings from an uncertain baseline,
- determining what would happen in the absence of the utility C&S programs that isn't caused by other utility programs, and
- the attribution to the influence of the program when new standards are adopted.

How deeply to discount the initial estimates versus lifetime estimates due to our recommendation to avoid the need for precision is difficult and makes a lot of the decision simply judgmental. For the state as a whole, imprecision can be important. Because each percent of the savings that is uncertain actually means a lot of MWh, being off by 10 percent a few code changes in a row can mean adding or not adding a major power plant. Once again, measuring the actual efficiency of the whole market can get you more certainty than deciding where to be imprecise.

7.5 ADOPT THE PROPOSED METHOD FOR ESTIMATING LIFETIME SAVINGS

This paper derives and demonstrates a method for estimating the lifetime savings for a given cycle of standards upgrades. That method starts with a first year estimate of savings, which then begins to accrue as subsequent years of new buildings or appliances come on line under the standards. That accumulating stream of savings is then discounted to account for variations in actual construction activity, the expected rates of naturally-occurring efficiency improvements and new standards adoption, and the rate of compliance. The result is a stream of annual C&S program savings estimates; it starts small and builds over time, but ultimately tapers off as the other market savings that would have happened take over.

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[26] It should be recognized, however, that very conservative estimates of savings can undermine the level of investment and the estimates of the true cost-effectiveness of various investment alternatives. It may also hinder the ability for the correct relationship and leverage to be estimated from the linkages between the cycle of research and development expenditures, efficiency program efforts, and C&S program efforts as a system.

7.6 TREAT THE "SAVINGS MEASURE" AS THE WHOLE BUILDING

This paper argues that building efficiency standards encompass a wide range of measures and efficiency practices, and that tracking them individually in terms of savings and adoption rates is a prohibitively difficult exercise. We recommend, rather, that evaluations and savings estimates be derived on the basis of whole building efficiency. This continues the practice that has been in place in new construction program impact studies since the mid-90's. For those accustomed to thinking about efficiency programs in terms of simple retrofits, the use of whole building efficiency as the "measure" may be counter-intuitive, but it is the most practical and useful measure to use for evaluating standards and new construction programs. This recommendation does not apply, of course, to individual appliance standards that are independent of building performance, such as those for televisions or portable spas.

7.7 PHASE II STUDIES NEEDED

This paper points out a number of issues that affect the savings of standards programs. At the basic level, we recommend that the key ex ante savings estimate assumptions be trued-up through ex post studies to verify that initial assumptions were correct. If greater precision in the savings estimates are needed, then there are also a series of market-based studies that should be conducted. The results will allow for a more refined and accurate understanding of how the building and appliance standards interact with the market. These Phase II studies would include:

- Alterations and building permits - How much of the alteration and renovation market is captured in building permits and governed by the efficiency standards?
- Appliance standards compliance – How thoroughly are manufacturers and distributors complying with appliance standards requirements?
- Compliance rates for residential and nonresidential new construction – How much of the savings potential is being lost to imperfect compliance? How much additional savings are realized from better-than-standards construction practices?
- Naturally occurring and program-induced adoption of efficiency – How fast would the markets, with the encouragement of other efficiency programs, adopt the efficiency levels mandated by standards, if the standards were not in place?
- Grandfathering – How much of the savings potential of new standards is lost due to grandfathering of older equipment or standards? Could this potential be captured through incentives programs?

8. POSTSCRIPT

Unless there is a successful case made for integrating the C&S programs into their respective market portfolios, we risk marching into the future trying to parse out savings into discrete programs that jointly provide the savings. The state is concerned about the end-state of efficiency in the nonresidential new construction and residential new construction markets, as well as the market for appliances. The codes and standards initiatives are parts of larger portfolios. In the nonresidential new construction market, the utilities operate NRNC programs that support the improved practices that are later codified. In turn these programs depend on the training and demonstration work of CTAC and PEC. On the residential side the Statewide New Construction program and the support from the utilities for Energy Star and Consortium for Energy Efficiency advance residential practice before codes and standards are ever adopted. In order to strategically design market interventions, the utility nonresidential new construction and residential new construction programs need to be planned, budgeted, implemented, evaluated, and rewarded as two comprehensive portfolios.

The C&S programs build on the incentive and training programs, but they also depend on the work of the CEC, non-governmental organizations and the legislature to bring about change. The only way to conceptualize what would happen without the utility programs would be to remove the whole portfolio from the market Without any individual utility program element, the code changes will still advance, just much less effectively and at a slower pace.

Despite the more narrow focus of the preceding white paper, we should really be attempting to separate three aspects of attribution:

- attribution to the legislature and CEC;
- attribution to the portfolio of utility programs; and
- attribution to a single but inseparable C&S program.

The naturally occurring efficiency improvements come from market forces and from the fact that California isn't an island unto itself. National and regional efforts at efficiency would influence CA eventually even if the CPUC, CEC, and the utility efficiency programs went dormant.

We should be clear that the small fraction of direct credit that the utilities may be claiming -- on the order of 30% -- accounts for the fact that standards do follow practice (*and changes in practice maybe should be credited to new construction programs*) and that standards' primary role is to outlaw the lagging tail of construction practice. In both cases the current practice is above old code – and it is in the attribution that this adjustment is made. Otherwise the issues are not directly addressed much in this paper.

9. ACKNOWLEDGEMENTS

This white paper was prepared by a team of consultants with broad experience in evaluation and with energy efficiency programs. Several of the team members also have extensive experience with new construction and standards programs. The team members were:

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9. APPENDIX: TITLE 20 STANDARDS DEVELOPMENT – FINAL PROJECT REPORT (ES 2005)

Codes and Standards Enhancement Initiative
For PY2003 - 2005: Title 20 Standards Development

Final Project Report

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Introduction

The Pacific Gas and Electric Company (PG&E) Codes and Standards (C&S) Program seeks to address energy efficiency opportunities through development of new and updated Title 20 and Title 24 standards. The C&S Program provides individual reports, information and data helpful to the California Energy Commission and other stakeholders in the development of these new and updated standards. In particular, the C&S Program develops Codes and Standards Enhancement (CASE) Reports that provide comprehensive technical, economic, market, and infrastructure information on selected, potential codes and standards. This Final Report summarizes the activities completed by the C&S Program and its technical consulting team over the course of Title 20 proceeding, Docket 04—AAER-1, largely completed in December 2004.

Background

Title 20 is the State of California's appliance and equipment efficiency regulations. California began establishing state appliance standards back in the late 1970s, starting first with efficiency levels for residential refrigerators. Thirty years later, California's appliance efficiency regulations run to over 150 pages, covering 20 general appliance and equipment categories and well over 200 specific standards levels, a good portion of which are unique to California. California has the most aggressive and comprehensive state appliance standards program in the nation. Generally speaking, the California Energy Commission (Commission), which is responsible for establishing Title 20 standards, initiates a new Title 20 proceeding every three to five years, though the Commission is free to proceed when ever it deems there to be sufficient opportunity to warrant a new proceeding. With few exceptions, the state limits its standards setting activities to either adopting federally established standards or establishing its own standards for products not covered by federal appliance standards. While the State has set its own standards for products covered by federal standards on two occasions, the Sate is preempted from actually implementing those standards until it obtains a formal waiver from preemption (which has not yet occurred).

Generally, a Title 20 proceeding occurs over a two to three year period. Formally, the process begins with a public announcement by the Commission that it intends to open a docket for a new proceeding. Usually, this announcement suggests what products may be subject to new or revised standards in the proceeding. Industry and other stakeholders are invited to provide input with respect to the identified products as well as other potential standards opportunities. In the ensuing months, Commission staff with the help of public input begins crafting conceptual standards proposals. One or more official workshops are then noticed and held by the Commission to allow interested parties to comment on the conceptual standards proposals. Following these workshops, substantive comments from stakeholders are received, more data is collected, and the Commission staff refines the conceptual proposals into a more complete draft standards proposal referred to as the "Express Terms of the Proposed Regulations--45 day language". Prior to releasing these express terms, however, the Commission must officially file its intention to set standards and address other administrative requirements required by the State.

Within 45 days of posting of the 45-day language, the Commission will hold a hearing presided over by the Efficiency Committee of the Commission (two Commissioners, their advisors, and legal council) to solicit feedback from stakeholders. It is possible though not typical for there to be no substantive changes made to the 45-day language as a result of the feedback received during the 45-day period. In that unlikely case, the next step is adoption of the draft regulations by the full Commission at a regularly scheduled business meeting. More frequently, substantive changes are made and the regulations are released again as “15-day language”. Within 15 days of publicly posting the 15-day language, the Efficiency Committee will hold another public hearing to hear additional comments from stakeholders. If no additional substantive changes are made to the draft regulations, the regulations will be voted on by the full Commission at a subsequent business meeting. Certain internal Commission processes occur fairly soon after adoption, leading to review by the Office of Administrative Law. Soon after approval by Office of Administrative Law, new standards become law and can be implemented.

PG&E has constructively engaged in recent and past proceedings of Title 20 and Title 24. The PG&E program provides support for the standards process in four ways. First, at the very beginning of a new rulemaking, PG&E proactively recommends conceptual standards proposals it has identified that meet the requirements set forth in the Warren Alquist Act and that are expected to benefit its customers. Second, for those proposals that gain the support of the Commission, the PG&E team proceeds to develop CASE reports. As noted in the Introduction above, PG&E CASE reports provide comprehensive technical, economic, market, and infrastructure information on each potential appliance standard supported by PG&E. Third, PG&E provides on going technical support including testimony at workshops and hearings to defend the Commission’s analyses against industry criticism, both before the standards adoption phase and to a lesser extent after adoption. Similarly, PG&E provides strategic support for draft standards, for example, by developing relationships with key industry stakeholders to pre-negotiate standard levels. Finally, PG&E assists with clarifications and some level of industry outreach after initial standards adoption.

Of the four types of support just described, often the development of the CASE report in support of a given standards proposal represents the majority of the PG&E team’s effort with respect to that standard proposal. Stakeholder criticisms of the initial CASE Report are expected and desired. While most PG&E CASE report analyses and findings ultimately hold up under industry cross-examination, some reports required substantial revisions to assumptions as a result of informative dialogue with industry that is often stimulated by the publication of the initial CASE reports. The results of this dialogue are generally a better, more nuanced, standard specification.

Overview of Scope of Work

The scope of work for this PG&E C&S Program project can be summarized in general terms as follows:

1. Development of CASE Report work plans and stakeholder communications plans,
2. Research and draft CASE reports,
3. Consensus building with standards stakeholders before, during, and after the three key Commission workshops and hearings,
4. Support federal standards activities as necessary, including support for development of a Commission preemption waiver request to US DOE for the California residential clothes washer water efficiency standard, and
5. Project administration, including monthly status reporting, project impacts assessment tracking, and final reporting

More specifically, CASE Reports were to be developed for the following product categories:

1. Packaged commercial refrigeration equipment (including ice makers)
2. Open case commercial refrigerators and freezers
3. Walk-in refrigerators and freezers
4. Refrigerated bottled and canned beverage vending machines
5. Water dispensers
6. Large packaged air-cooled commercial air conditioners (240,000 – 760,000 Btu/hour)
7. Evaporative coolers
8. Ceiling fans
9. Whole house fans
10. Residential exhaust fans
11. Residential air handler (furnace fan)
12. Unit heaters and duct furnaces
13. Residential pool pumps, motors, and controls
14. Portable electric spas
15. Commercial dishwasher pre-rinse spray valves
16. General service incandescent lamps
17. Non-federally regulated incandescent reflector lamps
18. Luminaires for metal halide lamps
19. Under-cabinet fluorescent luminaire ballasts
20. Commercial hot food holding cabinets
21. External power supplies
22. Consumer audio and video electronics standby losses
23. Battery chargers
24. Portable room air cleaners
25. Residential clothes washers
26. Exterior signage

Some product categories that were proposed and considered initially were eliminated for a variety of reasons—most frequently marginal cost-effectiveness or difficulty of addressing the opportunity within the context and scope the Title 20 regulations. Discontinued efforts included:

1. Air conditioner crank case heaters
2. Well pumps
3. Gas oven glow bars
4. Emergency egress lighting
5. Electronically ballasted HPS street lights
6. Exterior lighting fixtures
7. Elevator lighting

Overview of Project Achievements

In the recent proceeding, culminating in adoption on December 15, 2004, and the previous proceeding for the residential clothes washer water efficiency standard, the Commission relied heavily on the extensive research and analysis contained in the PG&E CASE Reports. As part of the main objective of producing and supporting these CASE Reports, the PG&E team successfully completed the defined deliverables, including participation in a variety of live meetings and conference calls with Commission staff, manufacturers, and their trade associations on an informal basis and as part of official Commission workshops and hearings. Additionally, procedural deliverables, including communications plans, monthly reporting, and this final report were successfully completed.

The CASE Stakeholder project ultimately delivered final CASE reports on all but two of the 27 originally designated proposed standards. The PG&E CASE team decided to defer work on the Exterior Signage CASE Report until a subsequent proceeding due to the complexity of establishing this product's definition and additional burden on staff given all of the other proposed standards under way. The Battery Chargers CASE Report was started but left in an incomplete stage following a negotiation by Commission staff with industry to defer development of battery charger standards until a later proceeding when more industry information would be available.

In addition to these two deferred CASE reports, there were two standards proposals that PG&E stopped supporting in the summer of 2004 as a result of ongoing discussions with industry and Commission staff: Portable Room Air Cleaners and Residential Furnace Fans (Air Handlers). The reasoning behind the termination of these efforts is described more fully in the CASE Report Summaries section. As noted above, the final CASE reports recommended a variety of strategies—sometimes different than the initial CASE reports--with respect to the 20+ standards opportunities, including reporting requirements, consumer labeling, prescriptive standards, and/or performance standards, depending on the unique considerations for each product category.

As is evident from the “Final Standards Adoption” sections in the CASE Report Summaries section below, the majority of the standards adopted by the Commission in December 2004 were consistent with PG&E final standards proposal recommendations. With the exception of the lighting proposals noted below, there are only minor differences between the adopted standards and the final PG&E recommendations. For example, the Commission decided against the reporting recommendation on Open Case Refrigeration. Also, following the December adoption hearing, requirements for Walk-in Cooler evaporator motors were loosened.

Under significant pressure from industry, the Commission provided two alternates for the four lighting standards (Pulse Start Metal Halide Luminaires, General Service Incandescent, Incandescent Reflector Lamps, and Under Cabinet Luminaire Ballasts). Ultimately, the commission yielded to industry requests to delay adoption of the second tier standards for General Service Incandescent and Pulse Start Metal Halide Luminaires and the Incandescent Reflector Lamp standards. The Commission indicated that these standards would be considered for adoption in 2005. Furthermore, additional exceptions for specialty applications were provided to manufacturers in the Under Cabinet Luminaire Ballast standard. The PG&E technical team continues to participate in informal efforts underway in the first half of 2005 to address the completion of these delayed lighting standards.

PG&E did not substantively contribute to the development of the pedestrian traffic signals standard, so it is not included in the list above. On the other hand, PG&E contributed revised language to clarify confusion about the torchiere standard adopted in the previous proceeding. It had been expected that this effort would result in an “administrative clarification” to be published separately by the Commission; instead the Commission addressed the confusion by revising the language directly in the appliance regulations.

Commission Proceeding Results and Estimated Impacts

Table 1 below summarizes the standards adopted by the Commission in December 2004. Figures 1 through 4 below depict projected annualized energy savings and demand impacts for these standards with and without the delayed Tier 2 lighting standards together with the recent residential clothes washer standards impacts. As is clear, the inclusion or exclusion of the Tier 2 standard for General Service Incandescent Lamps and Metal Halide Fixtures and the Incandescent Reflector Lamps has a material impact on overall savings. For this reason PG&E continues to aggressively push for adoption of the Tier 2 standards and Incandescent Reflector Lamp standard. Figurers 5 and 6 show the energy savings and demand impacts, respectively, for just the delayed lighting standards. Figure 7 illustrates the projected annual natural gas savings in therms from the adopted standards.

As should be expected, the per unit and aggregate savings analyses presented in the PG&E CASE reports are similar but not always identical to the analyses adopted by the Commission due to the reliance on similar but different assumptions underpinning the analyses. Furthermore, the Commission does not publish estimates of statewide “full turn over” savings but instead presents annual per unit energy savings and statewide “first year savings”. In summarizing the impacts of this recent Title 20 proceeding hereunder, Commission values have been used almost exclusively so that this report’s impacts summary most closely matches Commission analysis. To provide a better understanding of the total potential impacts of these new standards, savings impacts are presented below on the basis of full turn over (the point at which all existing units have been replaced with new, compliant models), rather than first year savings. It should be noted that the savings projections include many simplifying assumptions, including no improvement in baseline efficiency in the base case and no increases in the sales volume of products over time. These two factors would tend to counteract each other in a growing economy. A more nuanced projection of future savings is beyond the scope of this project.

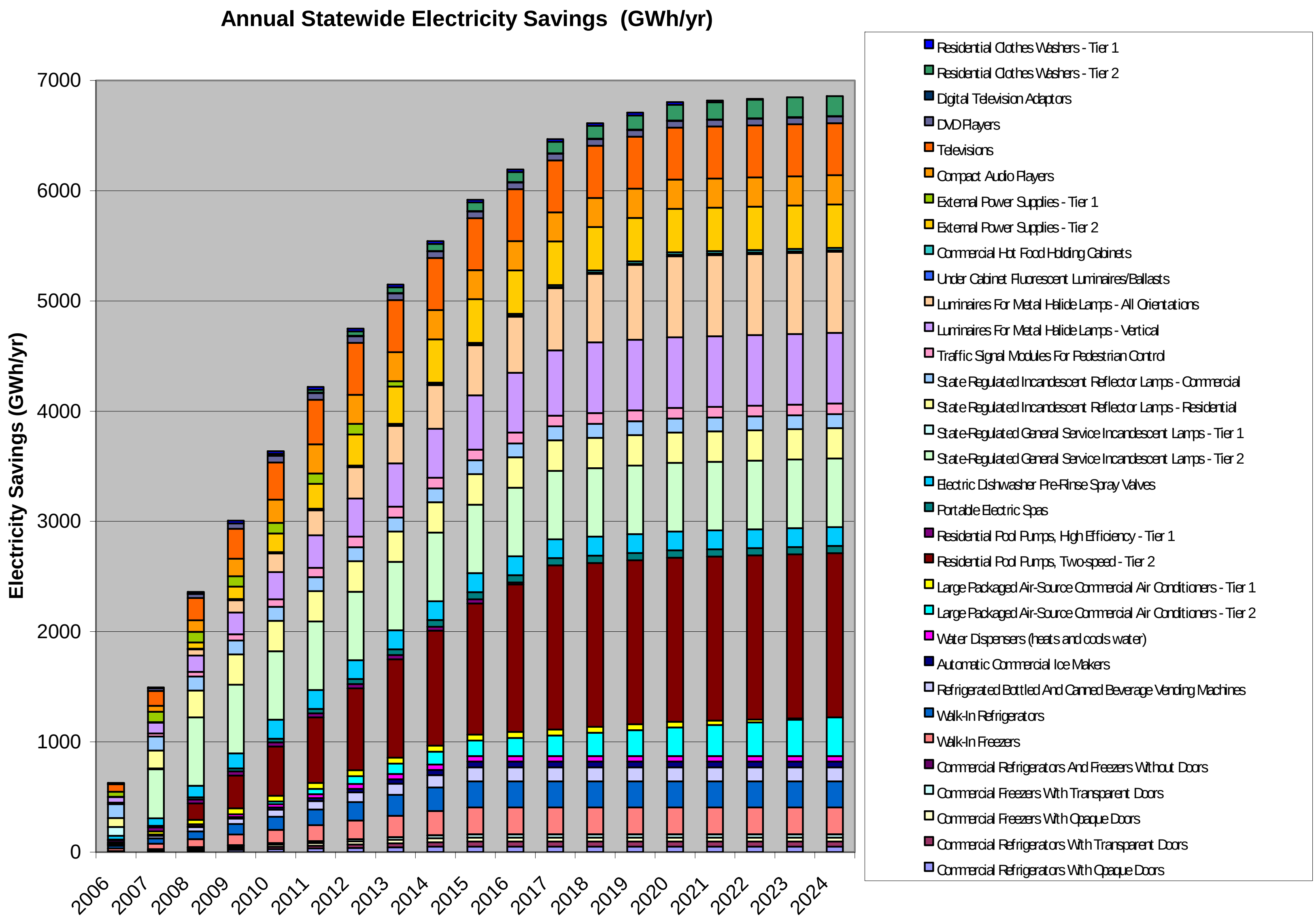
Table 1: Final Title 20 Standards Adopted

Standards Product or Group	Description
Commercial refrigerators and freezers with doors	Performance standards equivalent to Energy Star/CEE Tier 1, generally setting maximum daily energy consumption (kWh) as a function of volume or “adjusted volume”. Standards take effect in January 2006 or 2007, depending on the product category.
Open case commercial refrigerators and freezers	Adopted prescriptive lighting efficacy standard (T8 and electronic ballasts) for open case refrigeration effective in 2006.
Walk-in refrigerators and freezers	Required prescriptive measures including (door closers, added insulation, efficient fan motors, and defrost strategies effective in January 2006
Refrigerated bottled and canned beverage vending machines	Performance standard (maximum daily kWh/bottle capacity) equivalent to Energy Star Tier 1 plus low power mode controls effective in January of 2006.
Automatic commercial ice makers	Performance standards equivalent to Energy Star/CEE Tier 1, generally setting maximum daily energy consumption (kWh) as a function of capacity and type. Standards take effect in January 2008.
Water dispensers	Performance standards requiring Energy Star qualifying level (standby consumption of no more than 1.2 kWh per day) for “hot and cold” water dispensers. Effective January 1, 2006.
Large packaged air-cooled commercial air conditioners (240,000 – 760,000 Btu/hour)	Performance standard requiring EER 10 standard effective October 1, 2006 and EER 10.5 effect January 1, 2010, coincident with a scheduled refrigerant switchover.
Evaporative coolers	Energy reporting requirements based on ASHRAE 133-2001 (and selected parameters).
Ceiling fans	Energy reporting and labeling of products based on EPA Energy Star Solid State Test Method for Ceiling Fans (2004)
Whole house fans	Energy reporting according to HVI-916 and list air flow efficiency in W/cfm.
Residential exhaust fans	Energy reporting for residential exhaust fan products according HVI-916.
Unit heaters and duct furnaces	Prescriptive standard requiring that all natural gas fired unit heaters and duct furnaces shall have either power venting or an automatic flue damper (addresses off-cycle stack losses). Effective January, 2006.
Residential pool pumps	Prescriptive standard prohibiting split phase and capacitor start induction run motors after January 1, 2006. In January 2008, two speed motors and controls required. Rated horsepower of the pump and motor must be labeled.
Portable electric spas	Performance standard setting maximum allowed standby wattage (indexed to spa volume). Effective January 1, 2006.

Table 1: Final PG&E CASE Team Proposals (Continued)

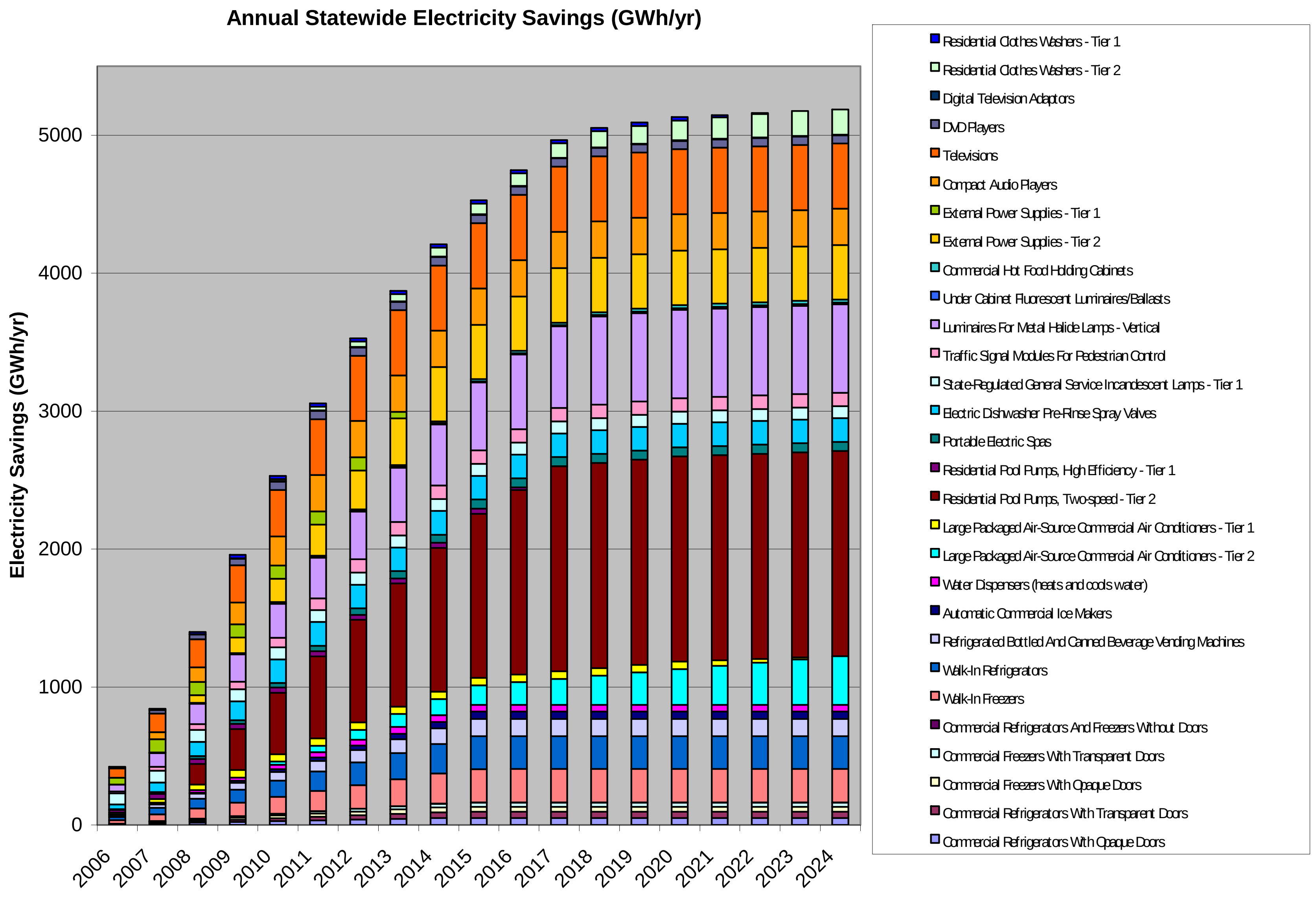
Standards Product or Group	Description
Dishwasher pre-rinse spray valves	Performance standard setting maximum allowed flow rates -- must use less than 1.6 gal/min with standardized cleaning performance requirements. Effective January, 2006.
State-regulated general service incandescent lamps	Performance standard based on efficacy for non-reflector, incandescent medium screw-based lamps between 25 and 150 watts. These lamps are intended for general ambient lighting. Three-quarters of products already qualify for the first tier which yields a ~3% savings. **The CEC plans to adopt second tier standards in 2005.** Then the second tier, scheduled to take effect in 2007, yields ~10% savings.
State-regulated incandescent reflector lamps	**The CEC plans to adopt in 2005.** Performance standard requiring BR, ER and R20 lamps to meet minimum federal EPAct efficacy levels (lumens/Watt) as do PAR and other federally-regulated reflector lamps.
Traffic signal modules for pedestrian control	Performance standard setting maximum allowable power for pedestrian signals at two temperatures, effective January 1, 2006.
Luminaires for metal halide lamps	Prescriptive standard prohibiting probe start ballasts in new vertical base-up fixtures (in range of 150-500 watts) effective on January 1, 2006. **The CEC plans to adopt second tier in 2005.** The second tier extends prohibition of probe start for all lamp positions. Also all types must have electronic pulse start ballasts for metal halide lamps 150-450 Watts. The second tier was to go into effect in 2008.
Under-cabinet fluorescent luminaire ballasts	Performance standard setting minimum ballast efficacy factor (BEF) as a function of lamp length. Effective January 1, 2006.
Commercial hot food holding cabinets	Performance standard based on "idle" power per volume. Effectively requires that all models be insulated. Effective January 1, 2006.
External power supplies	Performance standard that decreases power use in no-load and increases efficiency in active modes. Requires no-load power to be less than set absolute level, and specifies efficiency levels based on output power of the device. Tier 1 effective July, 2006. Tier 2 effective January, 2008.
Audio and video Equipment	Make EPA Energy Star Tier 1 (or similar) the requirement for compact audio, televisions, DVDs, and digital TV adapters. Effective dates are January 1, 2006 or January 1, 2007, depending on product.

Figure 1. Statewide Electricity Savings Including Delayed Lighting Standards



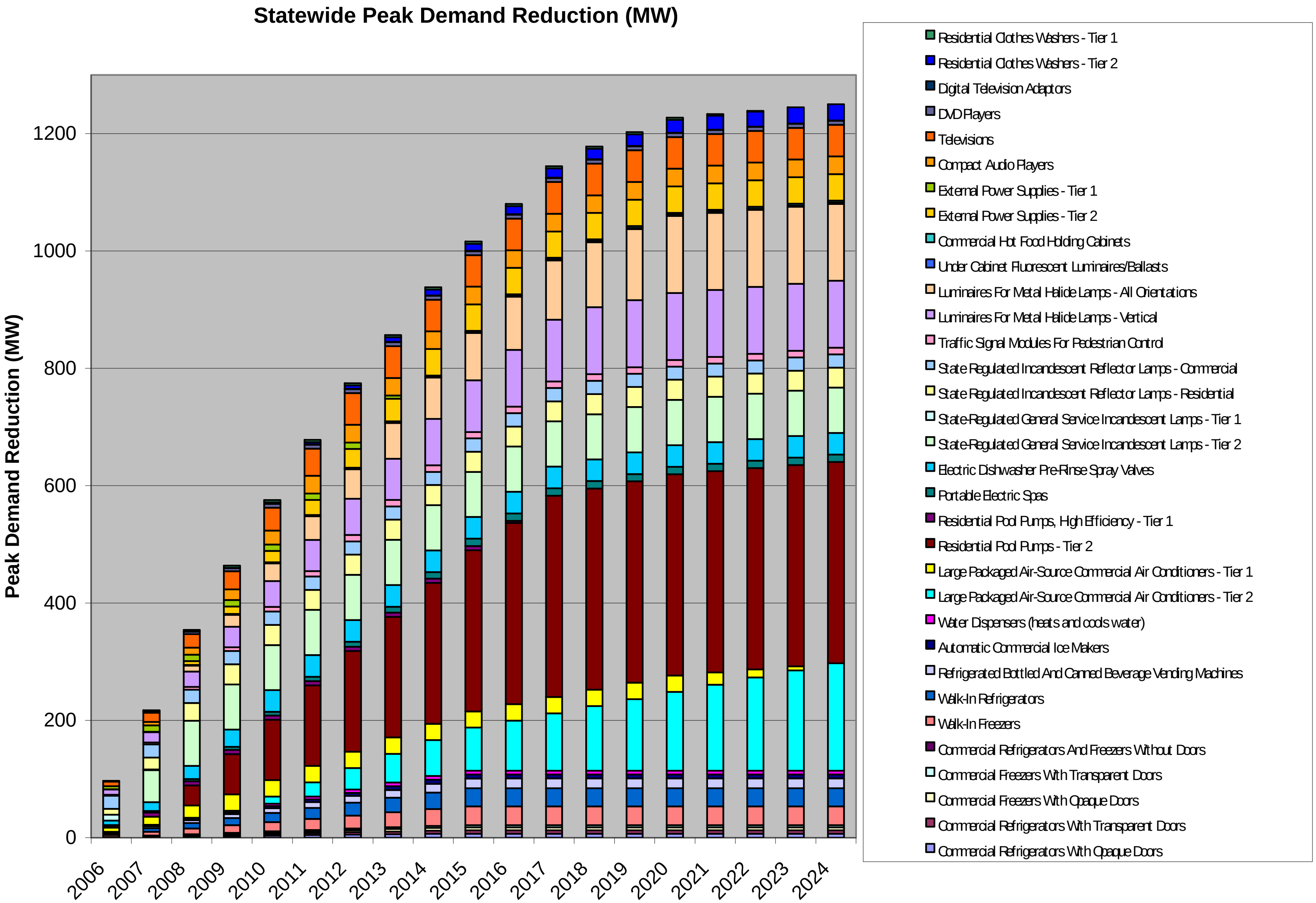
Source Data: Appendix A and B

Figure 2. Statewide Electricity Savings Excluding Delayed Lighting Standards



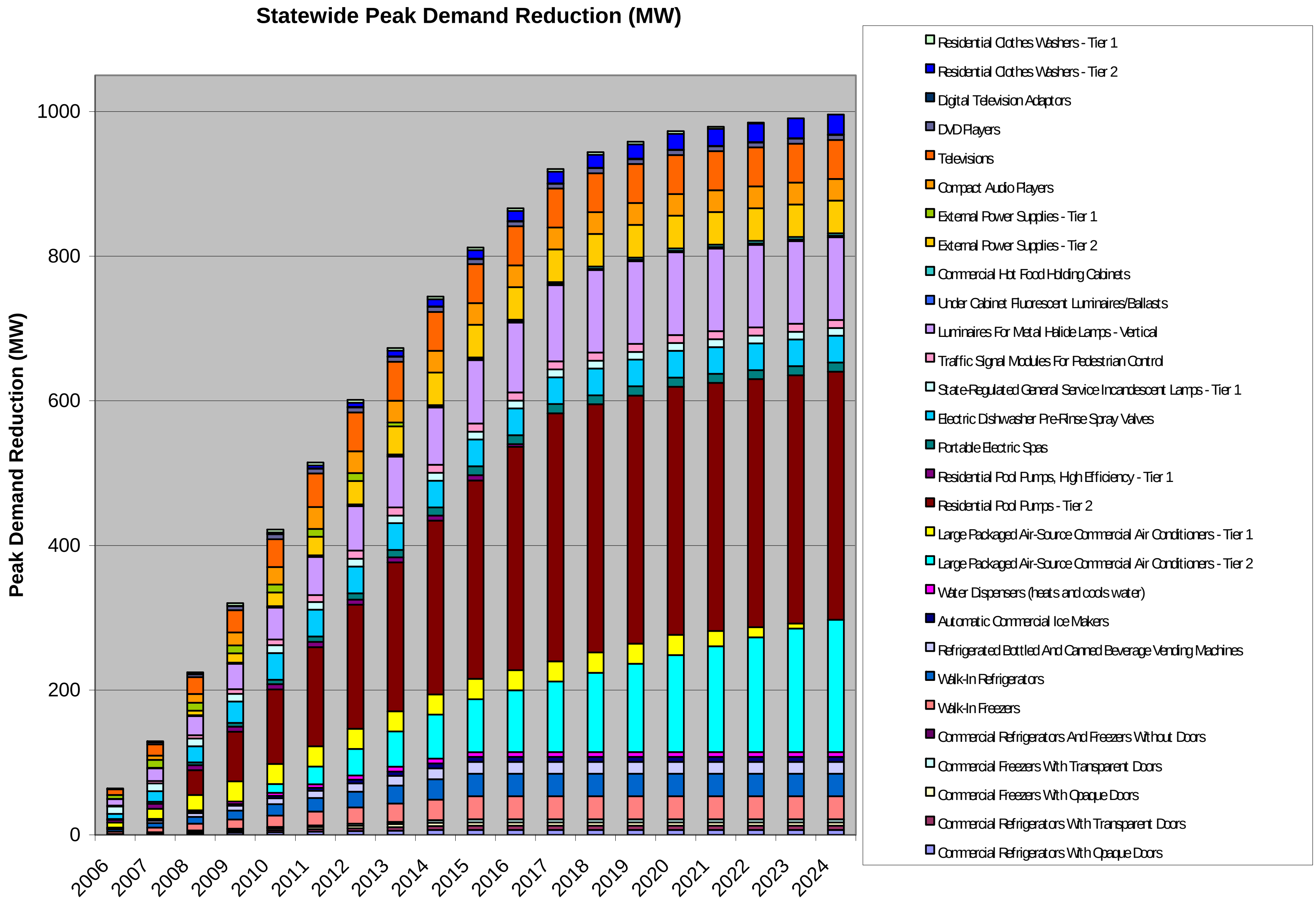
Source Data: Appendix A

Figure 3. Statewide Coincident Peak Demand Reductions Including Delayed Lighting Standards



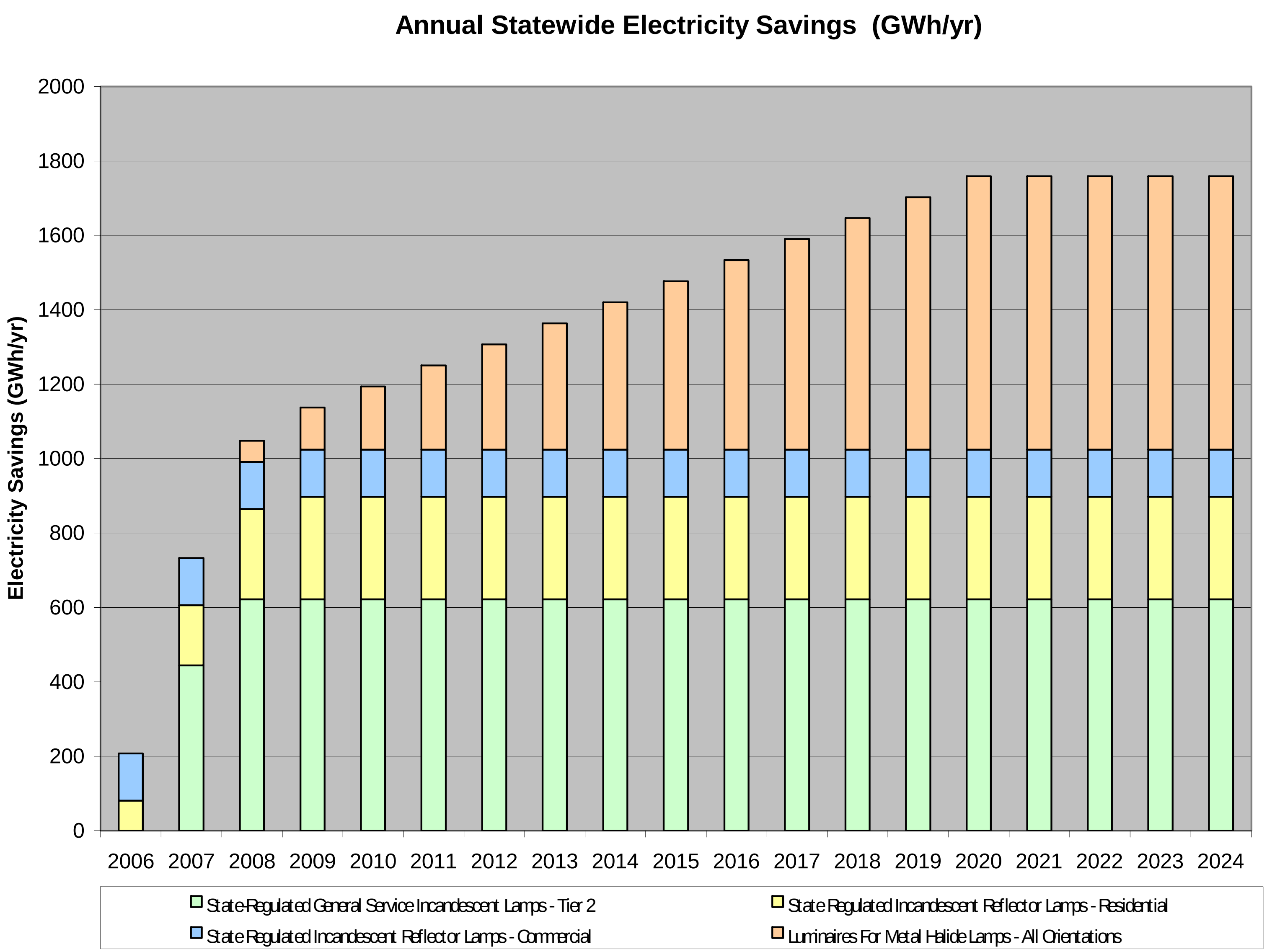
Source Data: Appendix A and B

Figure 4. Statewide Coincident Peak Demand Reductions Excluding Delayed Lighting Standards



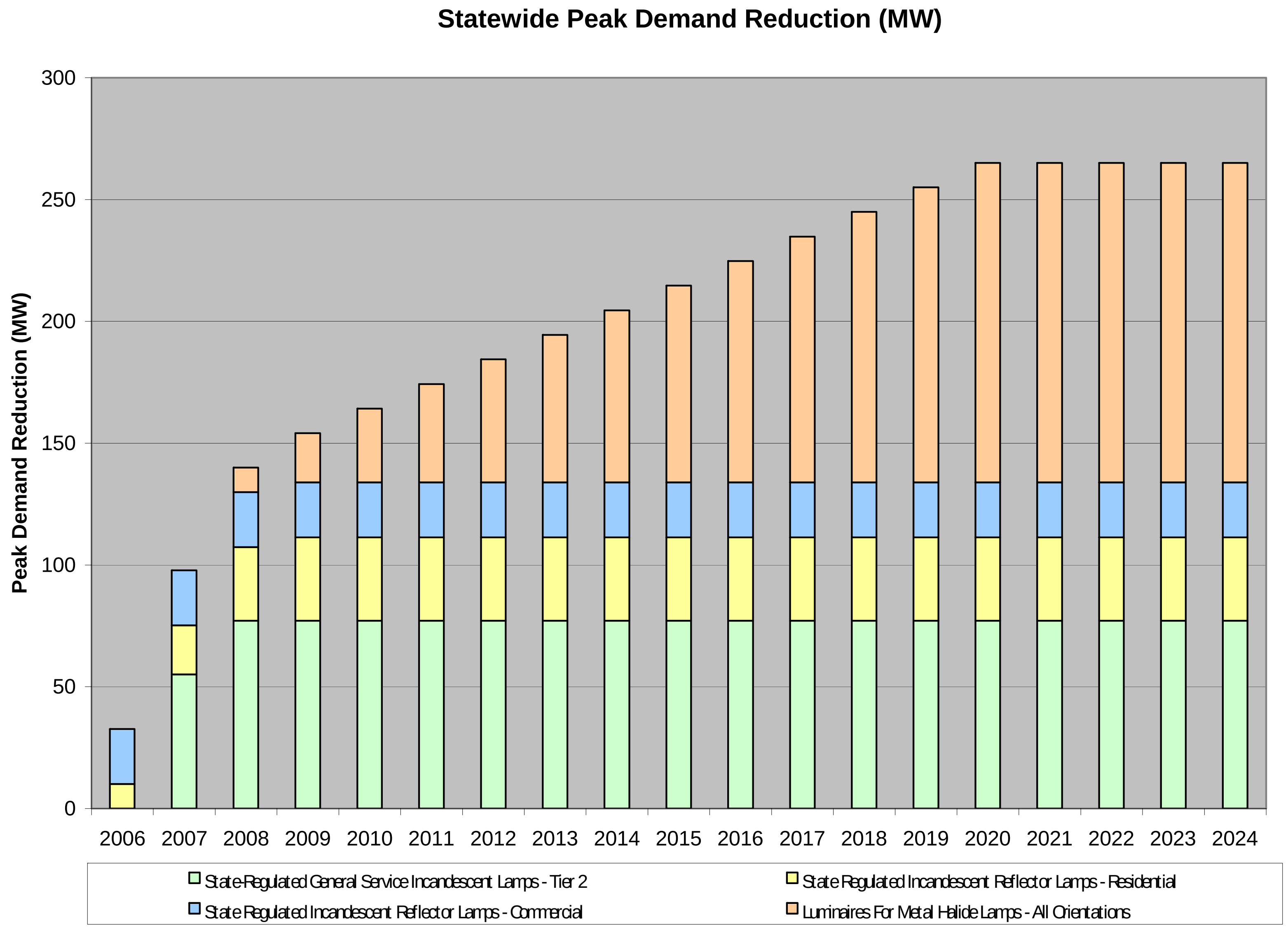
Source Data: Appendix A

Figure 5 Statewide Electricity Savings for Delayed Lighting Standards



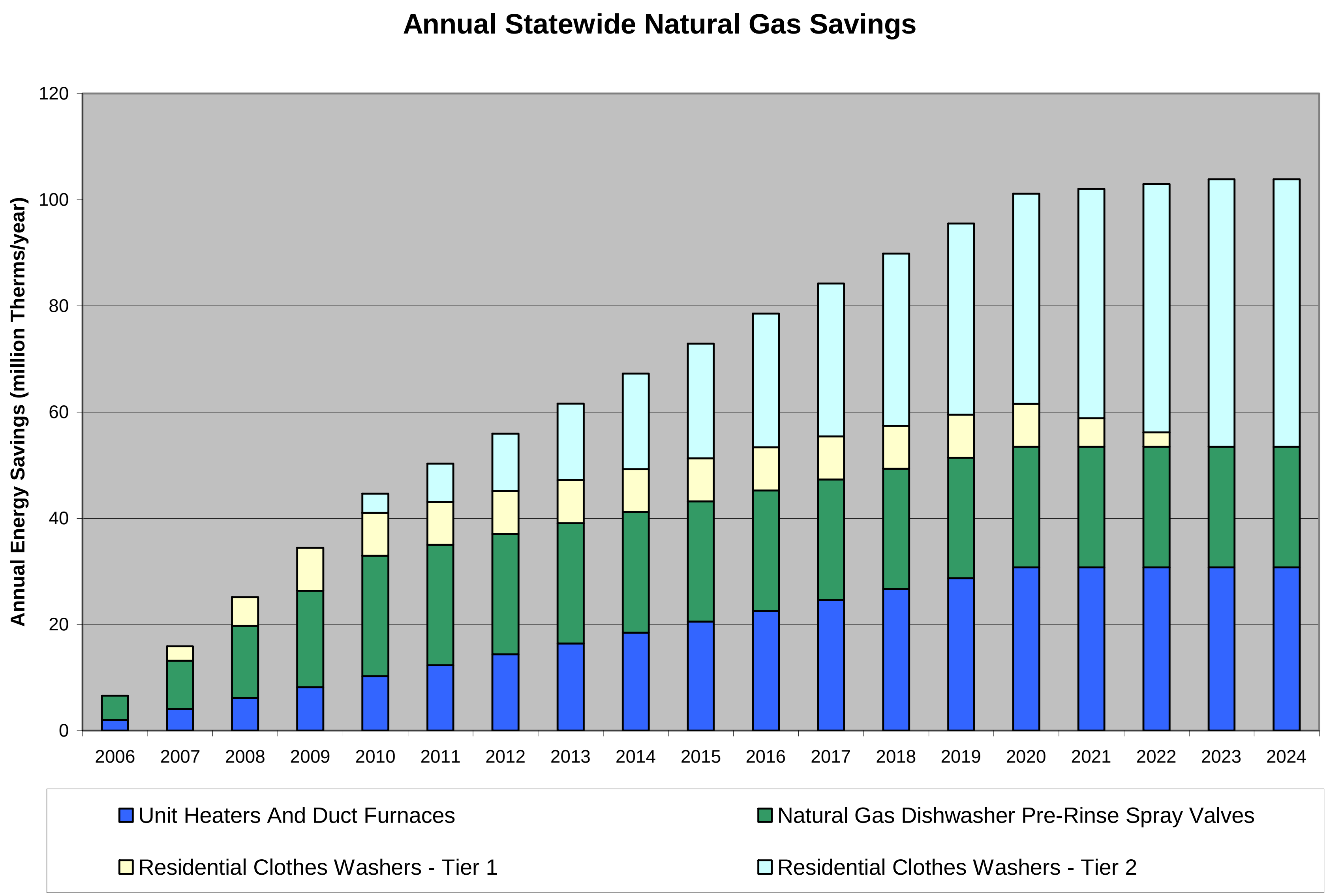
Source Data: Appendix B

Figure 6 Statewide Coincident Peak Demand Reductions for Delayed Lighting Standards



Source Data: Appendix B

Figure 7 Statewide Annual Natural Gas Savings



Source Data: Appendix A

CASE Report Summaries

The following pages contain one to thee page summaries of the various standards proposals put forward by the PG&E CASE team. Generally, the summaries below are similar to the "two pagers" submitted to the Commission in spring of 2003 as preliminary standards proposals. The summaries below have, however, been updated to reflect the most recent savings estimates, other key facts contained in the final CASE reports, and summary of the outcome of the standard relative to the final PG&E recommendation. Given the variety of distinct standards levels within some product categories and the amount of relevant, more detailed information used to justify the standard proposal that cannot be adequately summarized in this two page format, we refer interested readers to the CASE Reports themselves for more information. In the same way, we refer readers to the Commission's preemption waiver request for more information on that activity. These documents may be found at: http://www.pge.com/codesandstandards .

Packaged Commercial Refrigeration Equipment

Description

The term packaged commercial refrigeration equipment covers a variety of products, but for purposes of proposed standards, we concentrated on two specific products – commercial reach-in refrigerators and freezers, and commercial ice-cube makers. Reach-in refrigerators and freezers are widely used for food service and food sales and include both solid-door and transparent-door models. CEC adopted standards for these products in November 2002, but updated standards are warranted. Ice-makers are widely used in hotel/motels, hospitals and food service and include air- and water-cooled units including units commonly classified as ice-making heads, self-contained units and remote-condensing units. These products are covered by an ARI testing and certification program.

Statewide Energy Use

Category	*Stock*	*UEC (kWh/yr)*	*AEC (GWh/yr)*	*Peak Demand (MW)*
Solid-door refrigerators & freezers	189,000	4116	778	149
Transparent-door refrig. & freezers	88,000	5727	504	97
Ice-makers	173,000	3746	648	124
Total	450,000		1,930	371

Test Method

Reach-in refrigerators and freezers – ANSI/ASHRAE 117-1992.
Ice-makers -- ARI Standard 810-2003.

Proposed Regulation

Set standards for each of the product types as shown (with minor adjustments for icemakers) in the tables below.

Solid-Door and Transparent-Door Reach-in Refrigerators and Freezers

Equipment	**Door**	**Basis of Specification**	**Maximum Energy Use (kWh/day)**
Refrigerator	Solid	Energy Star level	0.10V + 2.04
	Transparent	CEE tier 1	0.12V + 3.34
Freezer	Solid, not ice cream	Energy Star level	0.40V + 1.38
	Solid, ice cream		0.39V + 0.82
	Transparent	CEC tier 2 – 20%	0.75V + 4.10
Refrigerator-Freezer	Solid	Energy Star level	0.27AV - 0.71 if volume ≥ 5.19 cf 0.70 if volume < 5.19 cf

V = Internal Volume, AV = Adjusted Volume

Note: These standards should apply only to reach-in units and not to roll-in, pass-through and roll-through as these later types use more energy and may have difficulty meeting these standards. The standard for refrigerator-freezers less than 5.19 cf differs from Energy Star and was developed because it is impossible for very small units to have negative energy use as happens under the Energy Star equation.

Ice-Makers

Equipment Type	**Harvest Rate** (lbs. ice/24 hrs)	**Max. Daily Energy Use** (kWh per 100 lbs. ice)	**Max. Daily Water Use** (gallons per 100 lbs. ice)
Ice-Making Head Water Cooled	<500	7.80 - .0055H	200 - .022H
	≥500 and <1436	5.58 - .0011H	200 - .022H
	≥1436	4.00	200 - .022H
Ice-Making Head Air Cooled	<450	10.26 - .0086H	Not Applicable
	≥450	6.89 - .0011H	Not Applicable
Remote-Condensing Air Cooled (but not remote compressor)	<1000	8.85 - .0038H	Not Applicable
	≥1000	5.10	Not Applicable
Remote Condensing and Remote Compressor	<934	8.85 - .0038H	Not Applicable
	≥934	5.30	Not Applicable
Self-Contained Water Cooled	<200	11.40 - .0190H	191 - .0315H
	≥200	7.60	191 - .0315H
Self-Contained Air Cooled	<175	18.0 - .0469H	Not Applicable
	≥175	9.80	Not Applicable

H = harvest rate in pounds per 24 hours. Water use is for the condenser only and does not include potable water used to make ice.

Relationship to Other Standards and Specifications

As noted above, the proposed standards are based on current Energy Star and CEE tier 1 specifications. These specifications are now being used by voluntary programs in the Pacific Northwest, New York and other regions.

Feasibility

These products are widely available. For example, Energy Star lists more than 300 solid-door reach-in models in its list of complying products and the number of products is growing steadily. For transparent-door units, approximately 25% of products in the CEC database meet these standards. For ice-makers, approximately 20% of units in the ARI directory meet these standards.

Design Life

An Arthur D. Little study for DOE estimated average lifetimes of 8-10 years for solid-door refrigerators and freezers and 7-10 years for ice-makers and transparent-door refrigerators and freezers.

Incremental Cost

Comparison of manufacturer list prices shows that often prices for efficient products cannot be distinguished from less efficient products. However, to be conservative, based on a variety of sources, ACEEE estimates an average incremental cost of about $130 for solid-door and transparent-door refrigerators and freezers (relative to the CEC tier 2 standard) and $63 for ice-makers (relative to typical equipment now being sold).

Energy Savings

Category	*Base*	*(GWh/yr) Standard*	*Savings*	*%*	*Demand (MW)*
Solid-door	778	709	69	9%	14
Transparent-door	504	397	107	21%	21
Ice-makers	648	592	56	9%	11
Total	1,930	1,697	233	12%	45

Change in Lifecycle Cost

Our life-cycle cost analysis estimates the following benefit-cost ratios for these standards in California.

Product Type	**NPV for Stock When It Turns Over (million $)**	**Benefit-Cost Ratio**
Solid-door refrigerators & freezers	$90	4.6
Transparent-door refrigerators & freezers	123	10.8
Ice-makers	53	5.8
Total	$266	6.4

Current Status

The CEC adopted the proposed standard in December, 2004. In addition, the CEC and other energy efficiency supporters negotiated an agreement to adopt nearly identical national standards for commercial refrigerators and freezers, effective January 1, 2010. The agreement allows California to enforce its standards prior to 2010 and calls for DOE to review and revise the federal standards at least twice. Discussions are also underway about possibly making the ice-maker standard a national standard.

Open Case Refrigerators and Freezers

Description

Open Case Refrigerators and Freezers (here after referred to as Case(s)) refer to medium temperature and low temperature refrigerated cases, without doors, that are open for easy consumer access to food products. Cases come in several different configurations, such as, multi-deck, single level, and crowned. These Cases are normally found in supermarkets and convenience stores. The products displayed in these cases include meat, frozen foods, beverages, and dairy products. Normally, Cases come in standard sizes from four to twelve feet long and some can be joined together to create cases of seventy-two feet and longer.

Cases have the basic components of a refrigeration system: evaporator, condenser and compressor. The evaporator is inside the unit. The rest of the refrigeration system (the condenser and compressor) can come in one of three configurations: 1) compressor and condenser at the Case (inside), 2) compressor at the Case and the condenser remotely located, and 3) compressor and condenser remotely located. The compressor and condenser in each of these scenarios can either supply refrigeration to that Case only or to other equipment, but the compressor and condenser in scenario one and two usually supply only that Case or group of joined Cases.

Statewide Energy Use

Category	*Stock*	*UEC (kWh/yr)*	*AEC (GWh/yr)*	*Peak Demand (MW)*
Open Case Ref/Freezer	178,000	65,900,	2,700	945

Test Method

ASHRAE Standard 72 Method of Testing Open Refrigerators is adaptable to Cases.

Proposed Regulation

Define an appropriate test procedure and require manufacturers to test and list annual energy use and related data Establish two prescriptive (“design”) standards: Require electronically ballasted T-8 equivalent performance lighting efficiency and ECM or equivalent evaporator motors.

Relationship to Other Standards and Specifications

All or portions of this product category (e.g. fully self-contained open case coolers) could possibly be included in the Packaged Commercial Refrigeration standards revisions being proposed by ACEEE.

Feasibility

Some manufacturers have Cases that they advertise as “energy efficient” and most manufacturers have optional energy efficient lights and fans available now. The estimated savings potential analysis presumes the use of a package of measures with a payback of 4 years using established technologies.

Design Life

The design life presumed in this analysis is ten years.

Incremental Cost

For the average open case refrigerator/freezer, the incremental cost of a package of measures with a simple payback of four years is about $443 --less than two percent of the cost of a new display case used in a typical 100-ton supermarket refrigeration system. The lighting measure that was ultimately adopted had an incremental cost of $40 yielding a simple payback of under 2 years.

Energy Savings

Using current penetration of efficient lighting, the remaining lighting savings potential is approximately two Gigawatt-hours. The requirement of an ECM motor for evaporator fans would provide an additional 158 GWh and 21 MW of peak reduction. First-year savings are estimated to be approximately 16 GWh and 2 MW of peak load reduction.

Change in Life-cycle Cost

The expected savings over the lifetime of a typical open case where only the efficient lighting measure is required is approximately $141.

Final Standards Adoption

The Commission staff accepted the proposal to extend the lighting efficiency requirement to open cases, but did not elect to require test and list or ECM motor requirements for open cases.

Walk-In Refrigerators and Freezers

Description

Walk-in Refrigerators and Freezers (Walk-ins) are medium temperature and low temperature refrigerated spaces that are accessed through an entry door. Not included in this proposal are refrigerated warehouses or walk-in coolers designed to rapidly cool food materials from ambient or warmer temperatures. Walk-ins usually have only one entry door for restocking, but may have multiple reach-in doors for easy consumer access to the product.

Walk-ins are generally constructed of 3.5", 4" and 5.5" thick insulated panels. Studs made of wood (2"x4" and 2"x6") or high-density polyurethane are often used in the panels for structural strength. A majority of Walk-ins are constructed on site and inside a building (most often having been purchased as a complete package), but some are pre-fabricated on skids and placed outside.

Statewide Energy Use

Unit Type	*Stock*	*UEC (kWh/yr)*	*AEC (GWh/yr)*	*Peak Demand (MW)*
Coolers	65,340	16,200	1,100	126
Freezers	33,275	21,400	700	80
Cool-Freezers	7,865	30,200	200	22
Total	106,480		2,000	228

Test Method

There is currently no appropriate test procedure for Walk-ins.

Proposed Regulation

A prescriptive standard requiring the inclusion of the following cost-effective measures is recommended.

Walk-In Cooler and Freezer Measures
Anti-sweat Heat Controls
Thicker Insulation
Evaporator Fan Control
ECM Evaporator Fan Motors
ECM Condenser Fan Motors
Electronic Ballasts (Lighting)
Low Heat/No Heat Doors
Auto Door Closer

Relationship to Other Standards and Specifications

None noted.

Feasibility

The energy efficiency measures included in the package are based on available technologies and have simple paybacks of less than four years in most cases.

Design Life

Ten years for refrigeration system components and 18 years for envelope components

Incremental Cost

For walk-in refrigerators, based on a package of efficiency measures providing on the order of one-third savings, we estimate an incremental cost of $1,121 and $512 for Walk-In Coolers and Freezers, respectively, for a simple payback of three years or less.

Energy Savings

	Walk-ins	First Year Annual Energy Savings (GWh)	Full Potential Annual Energy Savings (GWh)	Full Potential Peak Demand Reduction (MW)
	Walk-in Type	All	All	All
3	Anti-sweat Heat Controls	2	37	4.8
4	Thicker Insulation	1	19	2.5
5	Evaporator Fan Control	3	46	6.0
6	ECM Evaporator Fan Motors	7	118	15.5
7	ECM Condenser Fan Motors	5	81	10.6
8	Electronic Ballasts (Lighting)	1	16	2.2
11	Low Heat/No Heat Doors	7	128	16.7
12	Auto Door Closer	10	174	22.9
13	Total Savings (less interaction)	28	496	65

Estimate energy savings are shown in the table below.

Change in Life-cycle Cost

Total savings of the refrigerator package of efficiency measures over the lifetime of a Walk-in is $3,300. Total savings of the freezer efficiency package over the lifetime of a Walk-in is $8,200.

Final Standards Adoption

The final standard adopted by the Commission was consistent with the CASE Report, with the exception that ECM motors were not required for condenser fans. Subsequent to adoption, the Commission agreed to provide additional exceptions to the ECM motor requirements for evaporator fans and to clarify the scope of the standard.

Refrigerated Beverage Vending Machines

Description

Refrigerated beverage vending machines refer to standalone appliances selling refrigerated canned or bottled beverages. Other beverage merchandisers, such as reach-in refrigerators, fountain serve, or vending machines dispensing beverages in cups, are not covered by this standard.

Statewide Energy Use

Category	*Stock*	*UEC (kWh/yr)*	*AEC (GWh/yr)*	*Peak Demand (MW)*
Refrigerated Beverage Vending Machines	450,000	3,764	1,694	112

Test Method

The American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE) ANSI/ASHRAE 32.1-1997 "Methods of Testing for Rating Bottled and Canned Beverage Vending Machines". ASHRAE is in the last stages of finalizing a revision to the test method.

Proposed Regulation

The proposed standard for refrigerated beverage vending machines is 4.76 + 0.0050*C *kWh per day*, where C represents the total fluid capacity of the vending machine, expressed as the maximum number of 12 oz (355 ml) cans the machine can hold. Additionally, low power mode controls that can place the machine in a low power mode during periods of non-use and are capable of reducing lighting energy use by 80 percent or more and allowing the beverage temperature to rise to as much as 50 °F during periods of non-use, shall be included with all models. Such controls shall be adjustable on-site.

Relationship to Other Standards and Specifications

Two specifications currently exist: 1) The Canadian Standards Agency's (CSA) CAN/CSA-C804-96 "Energy Performance of Vending Machines", which is a daily energy consumption standard and test method. 2) The US EPA has recently issued a draft ENERGY STAR specification that includes a maximum allowable daily energy level and low power mode requirements.

Feasibility

The technologies required to meet this standard are available and in use. The majority of models produced by major manufacturers in 2005 were expected to exceed the proposed standard level.

Design Life

The design life of a refrigerated vending machine is estimated to be 10 years.

Incremental Cost

The incremental cost for various energy efficiency measures applicable to refrigerated vending machines is estimated to be approximately $60. With savings of 308 kWh per year, this yields a simple payback under two years.

Energy Savings

Based on the standards levels proposed, the savings were calculated to be as shown in the table below.

Standard	*Per Unit Annual (kWh/yr)*	*First Year (GWh)*	*Potential (GWh)*	Peak Demand Savings *(GW)*
Refrigerated Vending Machines	308	12.6	92	12.1

Change in Life-cycle Cost

The expected savings over the lifetime of a vending machine due to the proposed standard is $162.

Final Standards Adoption

The Commission adopted the standard supported by PG&E, with the exception that they did not require the capability for user settings for low power mode controls to be retained during power outages.

Water Dispensers

Description

Three types of water dispensers are covered by this proposal. These are (1) bottled water dispensers, (2) point-of-use (POU) or tap water dispensers, and (3) pressurized water dispensers. Both bottled water dispensers and POU dispensers are freestanding appliances that dispense cold and sometimes hot water and are considered functionally identical for purposes of this analysis. The more important distinction is between those that provide only cold water or "cook and cold" (an industry term used for units that supply ambient water for "cooking" and cold water for drinking), and those that provide both hot and cold water. Units providing only ambient or room temperature water are not included in this proposal. Pressurized water dispensers, also known as refrigerated water fountains, are typically permanently attached to a building wall and rarely dispense anything but cold water.

Statewide Energy Use

Category	*Stock*	*UEC (kWh/yr)*	*AEC (GWh/yr)*	*Peak Demand (MW)*
Hot and Cold Water	184,800	704	163	10
Cold Water	431,200	66	36	24
Pressurized Cold Water	457,380	55	18	15
Total	1,073,380		**216**	**50**

Test Method

In 2000, the EPA issued Energy Star bottled water cooler eligibility requirements, which include a test method for standby energy use. The test specifies a 24-hour period with the cold reservoir at 50ºF maximum and the hot reservoir at 165ºF minimum. A lockout timer or control may not be used during the test.

Proposed Standard

"Hot and cold" water dispensers may not use more than 1.2 kWh/day. Cold only and "cook and cold" water dispensers may not use more than 0.24 kWh/day. All units must be listed and labeled with their energy use.

Relationship to Other Standards and Specifications

ASHRAE Standard 18-97 provides a standard method of testing water dispensers to assure that they perform. The standard does not address test conditions or energy consumption. ARI Standard 1010-94 *Self-Contained Mechanically-Refrigerated Drinking-Water Coolers* references ASHRAE 18 and is used for certification of capacity. Canadian Standards Association (CSA) Standard C815-99 focuses on useful heating and cooling energy usage in terms of "gallons per kWh" but does not address standby losses. The Energy Star agreement addresses standby energy specifically and sets performance levels for "hot and cold" and for "cold-only" dispensers of 1.2 kWh/day and 0.16 kWh/day, respectively.

Feasibility

28 products from five manufacturers are currently listed as qualifying under the Energy Star program. Monitoring of existing equipment indicates that simple changes such as adding insulation to the hot tank will allow manufacturers to easily meet the standard level.

Design Life

A design life of eight years was assumed for bottled and POU water dispenser and 14 years for pressurized water dispensers.

Incremental Cost

Added insulation and isolating the hot reservoir from the cold reservoir is estimated to add $12 to the cost of a hot and cold water dispenser yielding a simple payback of well under one year.

Energy Savings

Hot and cold water dispensers meeting the 1.2 kWh/day standard are projected to save 266 kWh/unit. Cold water dispensers are not projected to contribute any savings at the current proposed standard level. The following table estimates statewide savings due to the standard.

Category	First Year *(GWh/yr)*	*Potential (GWh/yr)*	Demand *(MW)*
Hot and Cold Water	6	49	4

Change in Life-cycle Cost

Total savings due to the hot and cold water standard level over the lifetime of the water dispenser is estimated to be $199 per unit.

Final Standards Adoption

Only the hot and cold water dispenser standard was adopted.

Large Packaged Commercial Air-Conditioners

Description

Current federal and California standards cover packaged commercial air-conditioners with a cooling capacity of up to 240,000 Btu/hour (20 tons of cooling capacity). In recent years, equipment above this demarcation line has become more common. We propose to cover equipment between 240,001 and 760,000 Btu/hour (20-63 tons) as this is a category used in ASHRAE standard 90.1-1999.

Statewide Energy Use

Stock	*UEC (kWh/yr)*	*AEC (GWh/yr)*	*Peak Demand (MW)*
54,000	62 ,000	3348	2100

Test Method

ARI standard 340/360-2000.

Proposed Regulation

Equipment shall have an EER of 10 or more effective Oct. 1, 2006 and an EER of 10.5 effective Jan. 1, 2010. The first value is the tier 2 level developed by CEE and used by many utility incentive programs across the country. The second value is based on an analysis of the best equipment now on the market.

Relationship to Other Standards and Specifications

As noted above, this proposed initial standard is based on the CEE tier 2 specifications. This proposed standard is 0.5 EER points higher than the ASHRAE 90.1-2001 value for this equipment. The Maryland, Connecticut and New Jersey legislatures have passed an EER 10 standard (9.8 for equipment with gas-heating coils) as well. A similar standard is pending in other states.

Feasibility

As noted above, several states have recently adopted an EER 10 standard. Many utilities are providing rebates for these units. Five manufacturers produce at least some products at both the EER 10 and EER 10.5 levels, indicating that these standards are technically feasible. In fact, some products on the market exceed these efficiency levels.

Design Life

The ASHRAE Handbook estimates a 15-year average life for this equipment.

Incremental Cost

Based on studies by PNNL, LBNL, Northeast Utilities and PG&E, we estimate an average incremental cost of about $504 to bring a 30 ton unit to the EER 10 level and an additional $420 to raise EER to 10.5. Both levels yield a one year simple payback.

Energy Savings (for the EER 10 Standard)

	(GWh/yr)			Demand
Base	*Standard*	*Savings*	*%*	*(MW)*
3348	3145	203	6%	127

Change in Lifecycle Cost

We estimate net-present value savings of $171 million once the equipment stock turns over. The benefit-cost ratio is 7.3 based on average *annual* California commercial electricity prices; accounting for demand charges and higher electricity prices during the cooling season will improve this ratio substantially.

Final Standards Adoption

Both the EER 10 and EER 10.5 recommendations were adopted by the CEC in December 2004. In addition, CEC and other efficiency advocates reached agreement with manufacturers to seek adoption of a national EER 10 standard (9.8 for equipment with gas-heating coils), effective Jan. 1, 2010. Under the agreement California will be able to enforce its standard prior to 2010 but the federal standard will preempt the California 10.5 EER standard. However, under the agreement, both ASHRAE and DOE are to periodically review and revise the federal standard.

Evaporative Coolers

Description

Two general types of evaporative coolers are covered by this proposal. Single-stage (direct) evaporative coolers generally combine a blower, a pump, an absorbent evaporative pad, and other components in a metal or plastic cabinet that has an air intake and a supply air outlet. Water is recirculated by the pump from a sump in the bottom of the cabinet over the evaporative pad, and the blower draws in outside air, passing it through the moist pad and into the building to be cooled. Two-stage (indirect/direct) evaporative cooler designs add an indirect cooling stage upstream of the direct stage. The indirect stage, most commonly a plastic plate air-to-air heat exchanger, cools the outdoor air without adding moisture by rejecting heat to an evaporatively cooled secondary air stream. Indirect-only evaporative coolers are sometimes used to pre-cool make-up air for larger commercial buildings, but are not addressed by this standard.

Statewide Energy Use

Stock	*UEC kWh/year*	*AEC (GWh/year)*	*Peak Demand (MW)*
1,000,000	479	479	350

Test Methods

ASHRAE Standard 133-2001 *Method of Testing Direct Evaporative Coolers*. ASHRAE Standard 143-2000 *Method of Test for Rating Indirect Evaporative Coolers.*

Proposed Regulation

Manufacturers shall test and list evaporative cooler airflow rate, power input, saturation effectiveness, and evaporative cooler efficiency ratio (ECER) at a standard static pressure differential. ECER is defined as:

$$ECER = \frac{1.08(Tin - (Tdb - \varepsilon(Tdb - Twb)))}{\eta}$$

Where: Tin = 80°F (indoor dry bulb temperature)

Tdb = 91°F (outdoor dry bulb temperature)

Twb = 69°F (outdoor wet bulb temperature)

ε = saturation effectiveness

η = fan efficacy = power input (Watts) / airflow rate (CFM)

Relationship to Other Standards and Specifications

Title 24 building standards allow limited credit for the use of evaporative coolers. In addition they require that evaporative coolers must provide minimum airflows in accord with AMCA Standard 210 which varies by climate zone.

Feasibility

Test facilities that perform testing in accordance with ANSI/AMCA 210-99 have much of the equipment and capabilities needed to complete ASHRAE 133 and 143 tests, but an investment in equipment for measuring and maintaining temperature and psychometric conditions would be required.

Design Life

The design life of an evaporative cooler varies as a function of its design, application, and especially the quality of the water. Most inexpensive coolers have an expected life of about 10 years. Evaporative media is considered an expendable material, much the same as furnace filters. Aspen media may last about two years, whereas rigid cellulose media may last over five years. Thus improving efficiency also results in improved service life.

Incremental Cost

Upgrading a typical evaporative cooler from aspen media would cost about $1.60 for expanded cellulose media and $46 for rigid cellulose media.

Final Standards Adoption

The standard was adopted as recommended.

Ceiling Fans

Description

Ceiling fan are a hard-wired, non-oscillating fans that are suspended from the ceiling for circulating air via the rotation of horizontal fan blades. Most ceiling fans have at least three speeds and attached lights and may have a reversing switch for operation in the winter.

Statewide Energy Use

Category	*Stock*	*UEC (kWh/yr)*	*AEC (GWh/yr)*	*Peak Demand (MW)*
Fan	10,800,000	35	378	92
Attached Lights	10,260,000	43	441	144
Total			**820**	**236**

Note: These energy use figures are subject to uncertainty as they are based on a summer 2001 field study – a period during which operating hours may have been below normal.

Test Method

The solid state test method described in EPA's *Energy Star Testing Facility Guidance Manual: Building a Testing Facility and Performing the Solid State Test Method for ENERGY STAR Qualified Ceiling Fans.*

Proposed Regulation

Manufacturers shall test and list and label ceiling fans with their air flow efficiency (in CFM/Watt) at each of three speeds.

Relationship to Other Standards and Specifications

In 2001, EPA initiated a voluntary Energy Star certification program for ceiling fans. The program included two efficiency tiers with Tier I having an effective date of January 2002 and Tier II an effective date of October 2003. Tier I certification sets airflow efficiency (in terms of CFM/Watt) for low, medium, and high fan speeds. In addition it requires that models sold with integral or attachable light kits must either provide pin-based lighting that meets the requirements of the Energy Star specification for residential light fixtures, or include Energy Star qualified screw-based lamps with the fan. The key requirement of the Tier II level is that lighting will not be able to use the screw-based approach.

Feasibility

Over 400 models are currently listed as qualifying with Energy Star Tier I. Testing by Hunter Fan Company for Energy Star of 25 non-Energy Star-rated fans displayed a greater than five-fold range in fan efficiency, especially at low air flow rates, where fans are likely to be operated.

Final Standards Adoption

The standard was adopted as recommended with the following changes:

1. "Close-to-ceiling" or "hugger" fans were exempted from the test procedure due to the inability to test them accurately using the current procedure.
2. Ceiling fans with a diameter less than 50" were exempted from the labeling requirement based on comments from Hunter fan.

Whole House Fans

Description

Whole house fans are high air volume (1000-8000 cfm) exhaust fans mounted in the ceiling of residences for the purpose of providing cooling and fresh air. Operated in the summer when outdoor temperatures are lower than indoor temperatures, they draw air into the house through open windows and exhaust it directly into the attic, thereby removing warm air from both the house and the attic. When operated through the night, whole house fans can cool building mass as well as indoor air, and can displace air conditioner operation, thereby shifting energy use to off-peak periods.

Whole house fans are normally supplied with a gravity or motor-operated shutter that seals the opening through the ceiling when the fan is not operating. At least one manufacturer provides insulated shutters, but most are uninsulated metal. Fans are propeller type, and may be either direct-drive or belt-driven. Nominal propeller diameters are 24", 30", and 36" for most products. Motors are generally permanent split capacitor-type. Available controls include manual switches, timers, and speed controls. Automatic controls to initiate fan operation when the outdoor temperature is lower than the indoor temperature are not used because unattended fan operation (with windows closed) could result in back-drafting of combustion appliances and fireplaces.

Statewide Energy Use

Projected whole house fan annual energy consumption is summarized in the following table. The peak demand for whole house fans occurs during the night and therefore does not contribute significantly to system peak.

Category	*Stock*	*UEC (kWh/yr)*	*AEC (GWh/yr)*	*Peak Demand (MW)*
Residential Whole House Fans	680,000	280	190	~0

Test Method

The Heating and Ventilating Institute publishes a test standard for certifying exhaust fans, HVI-916, which applies to whole house fans as well as smaller ventilators such as bathroom fans. This voluntary test standard measures airflow rate, sound, and power.

Proposed Regulation

Manufacturers shall test, list, and label whole house fans with their efficacy in Watts/CFM in accordance with HVI-916.

Relationship to Other Standards and Specifications

Although studies have shown that mechanical ventilation can significantly reduce cooling energy use and peak demand, whole house fans are not currently eligible for Title 24 credits.

Feasibility

More data is needed on existing whole house fans to understand the relationship between fan design and operating efficiency. Whole house fan efficiency can easily be improved through the use of more efficient motors, efficient fan blades and venturis, and low-pressure drop louvers or shutters. There are no technological hurdles impeding improved fan designs.

Design Life

An average whole house fan design life of 12 years was assumed.

Incremental Cost

A limited review of fan performance and cost data reveals that the cheaper fans are often more efficient. As with other products, retail price is not necessarily tied to operating efficiency.

Final Standards Adoption

The standard was adopted as recommended.

Small Residential Ventilation Fans

Description

The small ventilating fan category includes permanently installed bathroom, kitchen (including range hoods), and utility room ceiling and wall-mounted exhaust fans typically moving 50 to 200 cfm of air. The primary use of these fans is to transfer objectionable air from inside the home to outside the home. Under these conditions, fan operating time and resulting energy use is typically very low. With increasing interest in indoor air quality, increasingly more small ventilation fans will be operated for extended periods of time.

Statewide Energy Use

Category	*Stock*	*UEC kWh/year*	*AEC (GWh/year)*	*Peak Demand (MW)*
Intermittent Exhaust Fans, 1-75 CFM	1,394,670	15	20	2.3
Intermittent Exhaust Fans, >75 CFM	2,215,975	17	38	4.3
Continuous Exhaust Fans, 1-75 CFM	22,728	365	8	0.9
Continuous Exhaust Fans, >75 CFM	109,851	424	47	5.3
Rangehood Fans	4,840,000	15	71	8.1
Total	8,583,223		184	21.0

Test Method

Home Ventilation Institute standard HVI-916, *Airflow Test Standard - Laboratory Methods of Testing Air Flow Capacity of Residential Ventilation Equipment for Rating.*

Proposed Regulation

Manufacturers shall test, list and label all small residential fans with their efficacy in CFM per Watt.

Relationship to Other Standards and Specifications

The US Environmental Protection Agency (EPA) Energy Star program specifies sound and energy efficiency criteria for residential ventilating fans to qualify for Energy Star status. ASHRAE Standard 62.2P addresses indoor air quality by various means including continuous fan operation. In the future the California Title 24 residential building standards should require that continuously operated ventilation fans installed to maintain indoor air quality must meet minimum efficacy levels similar to Energy Star.

Feasibility

35 fans are currently listed as meeting EPA Energy Star levels. Analysis of a list of high volume products from the top six manufacturers indicated a wide range in efficacy levels.

Design Life

The average design life for small residential fans is assumed to be 12 years.

Incremental Cost

No apparent relationship between fan cost and efficacy was observed.

Change in Life-cycle Cost

Total savings over the lifetime of continuously operated ventilation fans range from $15 to $44.

Final Standards Adoption

The standard was adopted as recommended with the following change:
Microwave / oven hood combination units were exempted from the testing and listing based on comments from AHAM.

Residential Air Handler Fans

Description

Centrifugal fans are a key component of air handler units in residential split system HVAC equipment. The air handler consists of a cabinet which houses the fan motor, blower assembly, and control components, and the source of heating - either a heat exchanger in the case of a furnace, or a DX coil in the case of a heat pump. For most California residential applications, the air handler also includes a cooling coil. Increasing the efficiency of air handler fans would reduce annual fan energy use, slightly increase heating energy use (to counteract lost motor heat), and reduce cooling energy use and peak demand.

Statewide Energy Use

There are 6.6 million central furnace and heat pump fans in California with annual sales estimated at 350,000 units. The following table summarizes energy and demand impacts of air handler fans for heating and cooling in California.

Category	*Stock*	*UEC (kWh/yr)*	*AEC (GWh/yr)*	*Peak Demand (MW)*
Air Handler Fans	6,600,000	495	3,267	2,079

Test Method

ANSI/AMCA 210-99 - *Laboratory Methods of Testing Fans for Aerodynamic Performance Rating* prescribes a detailed methodology and sensor requirements for conducting laboratory tests on air handler fans to determine airflow rate, pressure, power, and efficiency. California based research has shown duct pressure drop to be higher than is reflected in current standards; therefore, the test shall be performed at an external static pressure of 0.5" wc. However, use of this method would require first establishing a "test and list" requirement in order to gather sufficient data about the performance of current products. Another option is to use the Eae value (electric energy use) in the DOE test procedure for residential furnaces. Eae data is available for all furnaces on the market, although this only captures energy use during the heating season.

Proposed Regulation

Two options are possible. First, a standard could be set using Eae data as a percent of total energy use for each furnace, with both values calculated in accordance with the DOE test procedure. This will only capture heating season performance. Second a "test and list" requirement could be promulgated requiring manufacturers to test equipment using the ANSI test procedure. This data could then be analyzed to set a Watts/cfm or similar standard in a future rulemaking.

Relationship to Other Standards and Specifications

Federal standards regulate the gas combustion efficiency of residential furnaces (i.e. AFUE). Furnace air handler power is not regulated and DOE's Office of General Counsel has ruled that DOE does not have the authority to regulate furnace air handlers. Manufacturers claim that this federal standard preempts all state furnace standards, including one for just air handlers. The current law is not clear, but if the federal law preempts state standards, California would petition for exemption from preemption. ARI 210/240, the current method for determining the SEER of central air conditioners includes air handler energy use but allows the use of a default fan efficiency of 365 Watts per 1000 cfm, much lower than typical field measured fan efficiencies. Thus, SEER only includes a portion of air handler energy use.

Feasibility

We estimate that as much as 5% of residential HVAC equipment has more efficient electronically commutated permanent magnet motors (ECPM's). ECPM's represent the best near-term solution for improving furnace fan efficiency. An integrated approach evaluating cabinet and blower design would also improve fan efficiency. At this time, the ECPM technology is largely found in high efficiency furnaces.

Design Life

ECPM's have been available for 10-15 years. ECPM's have exhibited good reliability and are projected to have a service life of 20 years.

Incremental Cost

The incremental cost for an ECPM is estimated at $133. Other refinements such as improved airflow path through the cabinet, improved blade and blower design, etc., would have smaller cost impacts. The simple payback would be on the order of half the design life.

Energy Savings

Annual fan energy savings attributed to ECPM integration are as follows.

Per Unit (kWh/yr)	*First Year (GWh)*	*Potential (GWh)*	*Demand (MW)*
160	56	1,120	312

Change in Life-cycle Cost

The total net present value savings of an ECPM furnace fan over the lifetime of the furnace is projected at $112. The benefit-cost ratio is about 1.8.

Final Standards Adoption/Current Status

The CEC decided to conduct further research on furnace air handlers, particularly to obtain further data on cooling season performance and to try to develop a test method and standard that will result in both significant energy savings year-round and summer peak demand savings. This research is now underway and initial results are expected in mid-2005.

Unit Heaters and Duct Furnaces

Description

The unit heater is a simple space heater with sizes ranging from 25 kBtu per hour input to over 6,000 kBtu per hour, typically installed in ceiling mounted locations, and used primarily to heat industrial and commercial buildings. Fuel sources include natural gas, oil, and LPG, with approximately 80 percent of units burning natural gas. Typical steady state thermal efficiencies are 80 to 84 percent. Low head applications use propeller fans to deliver heat to open areas. Higher head applications use centrifugal blowers with discharge supply ducts.

Off-cycle losses through the vent flue represent the primary parasitic loss for gravity vented units, reducing their seasonal efficiencies from 80-84% to 62-64%. The high off-cycle losses for gravity-vented units are primarily due to stratification affects and the thermal losses associated with having an open flue located at the warmest part of the building.

Statewide Energy Use

Statewide unit heater energy use is summarized in the following table. Peak demand impacts are zero since unit heater operation is not coincident with summer peak loads.

Category	*Stock*	*UEC (therms/yr)*	AEC *(Mtherms /yr)*	*Demand (MW)*
Unit Heaters	182,000	1,056	192	0

Test Method

No test method is proposed.

Proposed Regulation

Prescriptive standard requiring power vent technology or flue dampers to eliminate off-cycle losses.

Relationship to Other Standards and Specifications

Current Title 20 standards effectively require that all natural gas fired models have an intermittent ignition device. Although the U.S. Department of Energy lists unit heaters as a product class for which standards could be developed, it presently does not have the legal authority to do so. The current version of the Energy Policy Act of 2003 requires a DOE rulemaking on unit heaters within two years of passage and the Senate version sets a standard requiring electronic ignition and power vent or flue dampers.

Feasibility

The marketplace is moving toward power vent unit heaters as evidenced by the increase in market share from 20 to 45% over the past 10-15 years. The technology step to achieve the higher annual efficiency levels of power vent units is not significant (nor costly) and it may be advantageous for the industry to have a more efficient baseline product.

Design Life

A 19-year design life was assumed for unit heaters.

Incremental Cost

The estimated incremental cost for power vent technology is $550 for a 220 kBtu/hour unit, which results in a four-year simple payback.

Energy Savings

Per Unit *(therms/yr)*	First Year *(Mtherms/yr)*	Potential *(Mtherms /yr)*
190	2	35

Change in Life-cycle Cost

The total savings of a power vent over the lifetime of a unit heater is projected to be $787 for a 220 kBtu/hour unit.

Final Standards Adoption

The standard was adopted as recommended.

Residential Pool Pumps, Motors, and Controls

Description

Residential swimming pool pumps are used to circulate and filter swimming pool water in order to maintain clarity and sanitation. The pump and motor are sold as a close-coupled unit with motors ranging in size from one half to three horsepower. Pumps are typically controlled by a simple time clock and are operated from four to ten hours per day. Pools may use multiple pumps for pool filtration, bottom cleaning (pool sweep), and for operating water jets for adjoining spas.

Statewide Energy Use

Stock	*UEC (kWh/yr)*	*AEC (GWh/yr)*	*Peak Demand (MW)*
1,200,000	2,600	3120	653

Test Method

The Hydraulics Institute Standard ANSI/HI 1.6-2000: Centrifugal Pump Tests.

Proposed Regulation

1. Motors used for pool pumps shall not have a service factor greater than 1.15.
2. Pool pump flow, head, power and energy factor (in gallons per watt-hour) shall be reported for two different system curves.
3. Pool pump motors may not use shaded pole or capacitor start induction run motors.

Beginning at a future date (to be determined) the following will be required:

4. All pool pump motors with a capacity of greater than 1 hp shall be capable of operating at least two speeds.
5. All pool pump controls shall have the capability of operating the pool pump at least two speeds. The primary circulation speed shall be the low-speed with any high-speed override capability being for a temporary period not to exceed 1 normal on cycle.

Relationship to Other Standards and Specifications

The Energy Policy and Conservation Act (EPCA) established energy efficiency standards and test procedures for commercial industrial electric motors. However, close-coupled pump motors are definite-purpose motors and as such are not covered by EPCA. EPCA does require DOE to consider whether energy conservation standards for certain classes of small motors would be technologically feasible and economically justified, and would result in significant energy savings.

ANSI/UL 1081, *Standard for Swimming Pool Pumps, Filters, and Chlorinators* and ANSI/NSPI-5, *Residential In-Ground Swimming Pools,* cover pool construction and specifications, but not pump energy use.

Feasibility

Six manufacturers currently produce 71 models of two-speed pumps and motors that are likely to meet the requirements for conventional pools. Two speed controls, required for proper control of two-speed pumps are currently available from at least four manufacturers. Pool service contractors and builders are not well versed in two-speed pumps and will require time for training, although conversion to two-speed usually only involves the addition of a new time switch and a single, low-speed wire to the existing wiring.

Design Life

DOE estimates the average service life of swimming pool pumps at ten years. No data are available to determine whether low-speed operation extends or shortens motor life. Anecdotal evidence from a major manufacturer of swimming pool pump motors indicates that motor life is related to loading and the resulting heat generated. When motors are running at half-speed, they theoretically generate one-eight the heat. Consequently, they would be expected to last longer than if fully loaded.

Incremental Cost

The incremental cost of a more efficient motor is estimated to be $85 and for a two-speed pump and control it is estimated to be $579. These costs together with annual energy savings of 260 and 1040 kWh per year, respectively, yield simple paybacks of three and four years, respectively.

Energy Savings

First Year(GWh/yr)	*Potential (GWh/yr)*	*Peak (MW)*
125	1,248	490

Change in Life-cycle Cost

Total savings over the lifetime of the two-speed pool pump is estimated to be $389.

Final Standards Adoption

The standard was adopted as recommended with the following changes:

1. The service factor requirement was dropped in favor of a label listing the total horsepower of the motor, based on information from A.O. Smith.
2. A requirement was added to label the pump with its rated horsepower.

Portable Electric Spas

Description

Portable electric spas refers to pre-fabricated, self-contained, electrically-heated spas and hot tubs with capacities exceeding 75 gallons. This standard does not cover “in-ground” units (such as those attached to a pool), other permanently installed residential spas, public spas, or spas that are operated for medical treatment or physical therapy.

Statewide Energy Use

Category	*Stock*	*UEC (kWh/yr)*	*AEC (GWh/yr)*	*Peak Demand (MW)*
Portable Spas	440,000	2,514	1,106	53

Test Method

The proposed test method is a 24-hour test of a covered spa, preheated to 102ºF, at a fixed ambient temperature of 60ºF. The spa jets shall not be operated during the test period so that only the energy required to filter and maintain the spa at temperature is measured.

Proposed Regulation

Establish an upper limit for standby or “maintenance” energy consumption of 5 x (spa volume)$^{2/3}$ watts for all portable electric spas. Require manufacturers to report selected product specifications including annual energy consumption and label products with energy consumption data.

Relationship to Other Standards and Specifications

The ANSI/NSPI-6 1999 standard covers portable spas; however the standard contains little to no information with respect to energy efficiency. The National Spa and Pool Institute is said to be working on a testing protocol that would address energy efficiency issues.

Feasibility

This standard is easily attainable with existing technology; in fact the majority of spas on the market will already meet it. The regulation will have the effect of eliminating the least efficient spas, thus notably reducing market-wide average energy usage.

Design Life

Product	*Design Life (years)*
Cover	5
Spa (Including Insulation, Motors, Heaters, and Controls)	10

Incremental Cost

The majority of spas already conform to the standard and would see no price increase. Average price increase for non-conforming spas would be $300, providing a five-year payback.

Energy Savings

Average Savings	*Per Unit (kWh/yr)*	*First Year (GWh)*	*Potential (GWh)*	*Demand Savings (MW)*
Improved standard cover & additional insulation	500	22	220	10

Change in Life-cycle Cost

The expected savings over the lifetime of this product due to the proposed standard is $83.

Final Standards Adoption

The standard was adopted as recommended.

Commercial Dishwasher Pre-Rinse Spray Valves

Description

The commercial dishwasher pre-rinse spray valve is designed to clean plates, flatware, and other items before they are placed into a commercial warewasher. Pre-rinse valves include a spray nozzle, a squeeze lever, and a dish guard bumper. Pre-rinse valves are inexpensive and easily interchangeable within different manufacturer's assemblies. These spray valves utilize hot water under pressure to clean food items off the wares. They are usually placed at the entrance to a warewasher and can also be located over a three-compartment sink.

Statewide Energy Use

The estimated installed base and associated energy use is show in the table below.

Category	*Stock*	*UEC (therms/year)*	AEC *(Mtherm /year)*
Commercial Pre-Rinse Valve	90,000	1,500	135

Test Method

ASTM International (ASTM) Standard Test Method for Prerinse Spray Valves, ASTM designation F 2324-03. The test procedure includes methods for measuring water consumption and determining cleanability and was developed by the Food Service Technology Center (FSTC).

Proposed Regulation

The pre-rinse spray valve shall demonstrate a flow rate that does not exceed 1.6 ± 0.1 gpm when tested with a dynamic water pressure of 60 ± 2 psi at a water temperature of 120 ± 4°F. Additionally, to qualify spray valves must be able to rinse sixty plates within an average of 26 seconds per plate or fewer in accordance with ASTM F2324-03.

Relationship to Other Standards and Specifications

None noted.

Feasibility

Several manufacturers offer low flow pre-rinse valves. It should be noted that not all low flow designs exhibit comparative cleaning performance. Designs employing a high velocity spray pattern will exhibit substantially better cleaning performance than designs using a flow restrictor to achieve the recommended flow rating.

Design Life

Unless the unit is of substandard manufacture, is improperly installed, or is installed in a facility where poor water quality would seriously diminish the unit's effectiveness, a typical pre-rinse valve would last at least 5 years.

Incremental Cost

An incremental cost of $10 was determined from actual prices offered in the market place; a simple payback of a few days results.

Energy Savings

Estimated energy savings are 820 therms per unit per year, with a potential statewide savings of 74,000,000 therms per year once all spray valves are changed out.[1] It should be noted that this statewide estimate is conservative because it includes only savings from 90,000 spray valves in use in conjunction with commercial dishwashers, whereas another 60,000 to 110,000 are used for a variety of applications with an undetermined proportion of hot water usage for an undetermined period of daily use. In addition to water heating savings, low-flow valves will reduce water and sewer charges substantially.

Change in Life-cycle Cost

Total savings due to the standard over the lifetime of a low-flow spray valve is estimated at $2,000 per unit.

Final Standards Adoption

The standard was adopted as proposed by PG&E with the exception that additional time per plate (31 seconds) would be allowed when applying test method ASTM F2324-03.

[1] Assumes a savings of 1.65 gpm savings for 4 hours of use per day, 363 days per year, a temperature rise of 52 degrees Fahrenheit and combustion or burner efficiency of 76 percent. It should be noted that current high efficiency products have tested at flow rates closer to one gpm (Koeller, 2003). It was conservatively assumed that the average complying spray valve would have a flow rate of 1.5 gpm after the standard takes effect.

General Service Incandescent Lamps

Description

This standard covers non-reflectorized, medium screw-based incandescent lamps intended for general lighting applications, including: A-lamps, PS-lamps, and halogen BT and MB-lamps with power ratings between 25 and 150 watts. Rough service, decorative, 3-way, and colored lamps are excluded. Full spectrum, vibration service and "soft white" lamps are included.

Statewide Energy Use

The installed base of all general service incandescent lamps (GSILs) is about 430 million units in California (11% of Navigant's national estimate of 3.9 billion units), though the installed units covered by this standard would likely number closer to 300 million. Total California energy use of all GSILs is approximately 26 Twh/year, or about 18 Twh/year for products covered by this standard. The energy use resulting from one year's worth of covered product sales from major California retailers is about 7 Twh/year.

Test Method

IESNA Subcommittee on Photometry of Light Sources of the IESNA Testing Procedures Committee, *IESNA approved method for electrical and photometrics of general service incandescent filament lamp*, LM-45-00 and others described in the Federal Register notice at www.eere.energy.gov/buildings/appliance_standards/residential/incandescent_lamps.html.

Proposed Regulation

An analysis of current covered products yielded the following linear equations predicting typical power consumption in watts as a function of initial light output in lumens:

Lamp Type	**Power Use (Watts)**
Frost or Clear	Watts = 0.05 * Lumens + 19.04
Soft White	Watts = 0.05 * Lumens + 21.38
Vibration Service Lamps	Watts = 0.07 * Lumens + 15.24

The R^2 values for these equations range from 0.94 to 0.96, indicating very high correlations between the equations and actual lamp performance. About half of the models analyzed in each category fall above each line (less efficient than average) and half fall below each line (more efficient than average). The proposed standards for each of the categories are equations that allow approximately 1/3 of available lamps of that type to qualify, as follows:

Lamp Type	**Maximum Power Use (Watts)**	**Average Savings (Watts)**
Tier-1 Frost or Clear	Watts = 0.0500 * Lumens + 21	2.1 watts
Tier-1 Soft White	Watts = 0.0480 * Lumens + 23	2.2 watts
Tier-1 Vibration Lamps	Watts = 0.0730 * Lumens + 13.5	2.0 watts
Tier-2 Frost or Clear	Watts = 0.0485 * Lumens + 15	6.2 watts
Tier-2 Soft White	Watts = 0.0490 * Lumens + 15.5	5.8 watts
Tier-2 Vibration Lamps	Watts = 0.0740 * Lumens + 9	5.1 watts

Relationship to Other Standards and Specifications

The U.S. DOE has no minimum efficiency standards for non-reflectorized GSILs. EPCA in 42 U.S.C 6295 (i4) required DOE to initiate a rulemaking between October 2000 and April 2002 to determine if federal standards should be promulgated for general service incandescent lamps other than the reflectorized ones mandated by EPCA. DOE never initiated that rulemaking. There do not appear to be other applicable state or international standards and specifications.

Feasibility

The proposed efficiency improvement for non-qualifying products is equivalent to a roughly 6 to 10% gain in lumens per watt. Incandescent efficiency gains of 10% can be met through at least two different non-proprietary means – krypton gas fill and infrared-reflective (dichroic) coatings. Other technologies can be employed incrementally and in combination to achieve particular combinations of improved lamp efficiency and longevity, including halogen or xenon gas fill, coiled-coil filaments, increased lamp transparency, reduced number of support wires, and higher temperature ceramic filaments.

Design Life

Although incremental measures can reduce incandescent lamp life, the 6 to 10% efficiency improvement measures proposed here tend to hold lamp life constant at 750 to 1000 operating hours or increase it for all incandescent lamp types except a small number of ultra-long-life designs that currently achieve very low efficiency.

Incremental Cost

Compliance with Tier 2 would likely yield incremental costs of roughly $0.25 to $0.50 per lamp, which would vary from a modest to substantial price premium depending on the base cost of the particular lamp model in question. The current average product retail price is $0.50/unit. Actual costs will be lower than this for many lamp types, since some of available models already comply with the proposed standard at competitive market prices and may simply increase their market share. Simple paybacks of a year or less are indicated in most cases.

Energy Savings

We estimate that expected first year savings would be 80 GWh for Tier 1 and 441 GWh for Tier 2.

Change in Life-cycle Cost.

Due to the short product life, it is not useful to calculate a present value for energy savings. If the average lamp purchase cost increases by $0.25 to $0.50 to improve its efficiency by 10% with constant lamp life of 1000 hours, average lifetime lamp energy consumption would drop from 60 kWh to 55 kWh, saving 5 kWh or about $0.55 to $0.70 worth of electricity per lamp. Net lifecycle savings could be as much as $0.45 per lamp or as little as $0.05 per lamp, with the most likely value in the range of $0.25.

Final Standards Adoption

The Commission adopted the standard for tier 1 as proposed by PG&E. Under pressure from industry, the Commission deferred implementation for six months to allow time to plan collaborative marketing programs designed to educate customers about the importance of lumens rather than watts in specifying lamps. PG&E continues to lobby aggressively for timely implementation of Tier two of this standard.

BR, ER and R20 Incandescent Reflector Lamps

Description

BR, ER and R20 lamps are types of incandescent reflector lamps that are not covered by federal efficiency standards. They consist of a filament, a reflector, and a housing. Incandescent reflector lamps aim light in one direction and are commonly used for display lighting and for recessed ceiling fixtures. Other types of incandescent reflector lamps are R and BR lamps, both of which are covered by federal standards.

Statewide Energy Use

We estimate that BR, ER and R20 incandescent reflector lamps account use about 4,490 GWh annually in California, of which about 2,660 is in the commercial sector and 1,830 in the residential sector. Peak demand is about 153 MW in the residential sector and 569 MW in the commercial sector. BR, ER and R20 lamps

Test Method

IESNA test procedure LM-20-94 – *Photometric Testing of Reflector-Type Lamps.*

Proposed Regulation

We recommend that BR, ER and R20 lamps be subject to essentially the same standards as PAR and R lamps. However, we recommend that 50 Watt ER lamps be excluded and that the covered wattage start at 41 W so that conventional 40 W lamps can still be sold. Thus, the proposed standard is as follows:

Rated Lamp Wattage	Minimum Avg. Efficacy (lumens/W)
41-50	10.5
51-66	11.0
67-85	12.5
86-115	14.0
116-155	14.5
156-205	15.0

Relationship to Other Standards and Specifications

As noted above, these proposed standards are nearly identical to the current federal standards on PAR and R lamps. The original intent of the federal standard was to cover most incandescent reflector lamps. BR lamps were a minor niche product at the time but have since grown to account for the majority of the residential market.

Feasibility

A variety of products now on the market would meet the standards including halogen lamps, halogen IR lamps, CFLs, and high-efficacy R and BR lamps (e.g. those with a silver reflector or a krypton fill gas). ER50 and conventional 40W lamps could also be sold. Each of the major manufacturers make most of these lamp types.

Design Life

The typical BR, ER and R20 lamp has a 2000 hour life.

Incremental Cost

Products meeting the standard range in incremental cost from about $0 to nearly $6. The most common replacements will be about $0.50-3.00 more. Simple paybacks of less than one-half year can be expected.

Energy Savings

Statewide, we estimate that the proposed standards will save about 420 GWh/year once the stock turns over. Peak demand savings will be about 60 MW.

Change in Life-cycle Cost

There are dozens of possible lamp substitutions, nearly all of which have net lifecycle cost savings. On average, the benefit-cost ratio is about 6.

Final Standards Adoption/Current Status

In December 2004, the CEC deferred a decision on these standards until mid-2005, pending further discussions with lamp manufacturers. Several other states are considering legislation to adopt these standards.

Pulse Start Metal Halide High Intensity Discharge Luminaires

Description

Metal Halide High Intensity Discharge (HID) lighting is the bright, white light, often found in fixtures mounted high up in the ceiling of warehouses, gymnasiums and warehouse type retail stores. It is also often used for outdoor area lighting and parking lots.

Within Metal Halide HID lighting, the most common types of fixtures are in the 175 to 400 Watt range. These lamps and ballasts may be either standard probe start, or the more efficient pulse start. Probe start lamps utilize a probe in the lamp arc tube, which allows the arc to start over a shorter distance. A thermal cutout switch in the lamp disconnects the probe, after the lamp starts to warm up. Pulse start lamps have no probe, and the arc is started over its full distance by a high voltage pulse. Pulse start lamps feature better lumen maintenance (i.e., more light output over the life of the lamp), longer lamp life, shorter warm-up and faster re-strike times, more consistent color, and improved color rendering.

Statewide Energy Use

From national data extrapolated to California, we estimate that metal halide lighting in California uses about 6,000 GWh per year. Peak demand is on the order of 1100 MW.

Test Method

For lamps: Illuminating Engineering Society of North America Standard IESNA LM-51-00: *Electrical and Photometric Measurements of High Intensity Discharge Lamps.*
For ballasts: American National Standards Institute, ANSI C82.6-1985 (R1996): *Ballasts for High Intensity Discharge Lamps – Method of Measurement*.

Proposed Regulation

The proposed standard would require new fixtures to be sold with only pulse-start lamps, effective Jan. 1, 2006 for vertical applications and Jan. 1, 2008 for other applications. The difference in effective date is to permit manufacturers to introduce new products since availability is currently more limited for other applications. In addition, a ballast performance specification would take effect Jan. 1, 2008. This specification can primarily be met by electronic ballasts.

Relationship to Other Standards and Specifications

DOE was directed under EPAct to consider standards for HID lamps and has started some research in this area. However, this research is focused on mercury vapor lamps and is not considering standards on metal halide lamps.

Feasibility

Approximately 20% of metal halide lamp sales in California are pulse start. All major manufacturers have products for vertical applications; only some manufacturers have products for horizontal applications. Of ballasts sold, about 2% are now electronic. Eleven manufacturers currently sell products and several more are considering entering the market in the near future.

Design Life

In a typical application, pulse-start ballasts have an average life of about 13.5 years. New fixtures have a longer life but we based our analysis on ballast life to be conservative, for example to allow for the possibility of luminaire replacement at the end of the ballast life due to changing lamp/ballast technologies not accommodated by the luminaire.

Incremental Cost

We estimate an incremental cost of about $5 for a pulse start lamp, $15 for a pulse-start magnetic ballast, and an additional $30 for an electronic ballast. Simple paybacks from both tiers would be one year or less.

Energy Savings

Once the existing metal halide stock turns over, we estimate that use of pulse-start lamps will save 827 GWh/year and reduce peak demand by 166 MW. The proposed electronic ballast start will save an additional 557 GWh/year and 112 MW once the stock turns over.

Change in Life-cycle Cost

Total savings of pulse start over the lifetime of a HID fixture is estimated to be $247. The electronic ballast adds an additional $168.

Final Standards Adoption/Current Status

In December 2004, the CEC approved the pulse-start standard for fixtures with vertical lamps, effective Jan. 1, 2006. The CEC postponed adoption of the 2008 standards for horizontal applications and electronic ballasts until mid-2005. The CEC is considering incremental refinements to the adopted standard. In the meantime, several other states are considering standards to require new fixtures to use pulse-start ballasts.

Under-cabinet Fluorescent Luminaire Ballasts

Description

Modular furniture task lighting fixtures refers to the under cabinet fluorescent lighting that is increasingly found supplied with, or as an accessory for, modular office furniture. This task lighting serves as a supplement to general area lighting.

Statewide Energy Use

Commercial Floor Area ($x10^6$ ft^2)	*UEC ($kWh/ft^2/yr$)*	*AEC (GWh/yr)*	*Peak Demand (MW)*
1,893	0.67	1260	361

Test Method

No test associated with this proposal is needed.

Proposed Regulation

The ballast efficacy factor for all T8 ballasts in under cabinet fixtures designed to be attached to office furniture sold in the State on or after January 1, 2006 shall meet or exceed the applicable values shown in Table J, except for T8 ballast designed for dimming.

Table J
Standards for Ballasts

Lamp Length (inches)	Ballast Efficacy Factor (BEF) for 1 Lamp	Minimum Ballast Efficacy Factor (BEF) for 2 Lamps
≤ 29	4.70	2.80
30 and 35	3.95	2.30
36 and 41	3.40	1.90
42 and 47	3.05	1.65
≥ 48	2.80	1.45

Relationship to Other Standards and Specifications

Title 24 is presently moving towards electronic ballast requirements for residential fluorescent fixtures.

Feasibility

Premium fixture products are currently available with electronic ballasts. This efficiency improvement should represent no particular problem for the industry.

Design Life

The design life for this measure is the same for fluorescent lighting fixtures, 15 years.

Incremental Cost

The incremental cost of electronic ballasts for modular furniture task lighting fixtures is $5, which yields a simple payback of under three years.

Energy Savings

The table below shows the savings estimated for the proposed standard.

Per Fixture Annual Savings			Statewide savings per year when entire stock turns over		Statewide savings for first year's sales	
kWh	Watts	Percent	GWh	Coincident MW	GWh	Coincident MW
16	8	17.5%	11	2.2	1	0.2

Change in Life-cycle Cost

Option	**Energy Savings (kWh/year)**	**Incremental Cost**	**Present value of savings (15 years)***	**Customer Net Present Value****
1 Lamp T8 electronic ballast	8	$ 5.00	$ 7.86	$ 2.86
2 Lamp T8 electronic ballast	24	$ 5.00	$ 23.57	$ 18.57

Final Standards Adoption

The Commission adopted the standard as proposed by PG&E, though the standard included exemption provisions for applications near sensitive electronic equipment.

Commercial Hot Food Holding Cabinets

Description

Commercial solid door, free standing, electricity powered hot food holding cabinets are available with a variety of features, including insulated and non-insulated, temperature and humidity controls, auto-door closers, magnetic gaskets, and Dutch doors (for access to part of the cabinet without losing heat from the entire cabinet).

Statewide Energy Use

The projected statewide annual energy consumption for standard solid door hot food holding cabinets is summarized in the following table. The estimated inventory assumes 25,000 full-size and 25,000 half-size units.

Category	Stock	UEC (kWh/y)	AEC (GWh/y)	Peak Demand (MW)
Hot Food Holding Cabinets	50,000	2,402	120	28

Test Method

ASTM F2140 – 01, *Standard Test Method of Hot Food Holding Cabinets*, is a standard test method for evaluating the performance of commercial hot food holding cabinets.

Proposed Regulation

The commercial hot food holding cabinet shall have an idle energy rate equal to or less than 42 watts/ft3 when tested in accordance with the "idle energy rate—dry test" in ASTM F2140-01 and volume is determined according to US EPA's Energy Star guidelines, "Measuring Interior Volume".

Relationship to Other Standards and Specifications

None noted.

Feasibility

Insulated energy efficient models are currently available and there should not be any technological hurdles in achieving the proposed efficiency levels.

Design Life

The design life for a commercial hot food holding cabinet is 15 years.

Incremental Cost

The incremental cost associated with this measure is estimated to be $453 on a shipment weighted basis allowing for the already market share for insulated units. The simple payback is approximately half of the measure life.

Energy Savings

Standard	Per Unit Annual Savings (kWh/yr)	Projected Savings (%)	Projected Annual Savings of Stock (GWh/yr)	Projected Peak Demand Savings (MW)
42 watts/ ft^3	454	19%	23	5.2

In addition to saving energy, insulated cabinets radiate less heat into the kitchen, thus helping to keep the work environment more comfortable and reducing kitchen cooling loads.

Change in Life-cycle Cost

Total savings due to the standard over the lifetime of a hot food holding cabinet is estimated at $7,824 per unit.

Final Standards Adoption

That Commission adopted that standard described above consistent with PG&E’s post-CASE Report recommendation that the level be set at 40 watts/square foot or less in order to be consistent with Energy Star.

External Power Supplies

Description

This proposed standard covers devices that convert line voltage alternating current (110 to 230 volts AC) into low voltage alternating current or direct current (typically 1.5 to 24 volts DC) within a housing external to the low voltage consuming product itself. External power supplies normally plug directly into an AC outlet or have a short AC cord on one end, with a thinner DC cord on the other end connecting to a range of low voltage DC products such as cordless and cellular phones, notebook computers, printers, etc.

Statewide Energy Use

About 23.5 million external power supplies are sold in California each year. Their annual energy consumption is up to 1.9 TWh. The total stock of external power supplies in California is approximately 100 million units, consuming as much as 8 to 13 TWh/year. These energy use estimates account for time spent unplugged, in no-load condition, and at full load, but overstate total energy use somewhat by estimating all active mode energy use at full load.

Test Method

The test method is currently in development by EPRI, E2I, PEAC, and Ecos Consulting under contract to the California Energy Commission's PIER program. It will be based on IEEE Standard 1515-2000, part 4.3.

Proposed Regulation

External power supplies sold alone or in combination with other products shall achieve the following efficiencies in active mode:

Proposed Standards	***Nameplate Power Supply Output***		
Tier 1 (2006)	***<=1 Watt***	***>1 to 60 Watts***	***>60 Watts***
	Efficiency > 0.48(Watts)	Efficiency > 0.89Ln(Watts) + 0.48	Efficiency > 84%
Tier 2 (2008)	***<=1 Watt***	***>1 to 51 Watts***	***>51 Watts***
	Efficiency > 0.50(Watts)	Efficiency > 0.09Ln(Watts) + 0.50	Efficiency > 85%

Proposed no-load requirements are as follows: For Tier 1, power consumption shall be no more than 0.5 watts in units with a nameplate output power of 0 to 10 watts and no more than 0.75 watts in units with a nameplate output power of more than 10 watts. For Tier 2, power consumption shall be no more than 0.5 watts for all covered units.

Relationship to Other Standards and Specifications

The no-load requirement of 0.75 Watts exactly matches the European Commission's Code of Conduct specification for external power supplies. EPA is evaluating external power supplies for possible Energy Star consideration. A provision of the pending federal energy bill directs DOE to consider standards for standby energy use of for power supplies. China is also considering labeling and standards programs for external power supplies. External power supply efficiency is also influenced indirectly by numerous Energy Star specifications for cordless phones, answering machines, monitors, printers, etc.

Feasibility

The technology to achieve high efficiency in active mode is mature, the market is competitive, and numerous independent solutions exist. It primarily involves replacing linear (transformer-based) designs with switching (integrated circuit-based) designs that more closely match input loads to power drawn by the output.

Design Life

External power supplies are frequently discarded with “obsolete” electronic devices like cellular phones and laptop computers before they actually fail. Typical design lifetimes should be 3 to 10 years, with the efficient products typically lasting longer than the inefficient products they replace.

Incremental Cost

Incremental costs range from $0.90 to $1.40 depending on output wattage and are projected to decline rapidly as technology improvements and economies of scale lead to further cost reductions in the more efficient designs. Some highly efficient power supplies already compete favorably on cost and design simplicity with less efficient alternatives. Simple paybacks are estimated at two to three years.

Energy Savings

The unit savings estimated above yield savings of up to 237 GWh/year from one year’s worth of sales, or up to approximately 950 GWh/year across the whole stock of current external power supplies. Demand savings are difficult to estimate, because the coincidence of power supply loads is unknown. Typical demand reductions are 0.5 to 7 Watts for each power supply, or 140 MW for the whole stock of current external power supplies.

Change in Life-cycle Cost

Total savings due to the standard over the lifetime of a power supply range from $0.42 to $22 depending on the output wattage of the power supply.

Final Standards Adoption

The Commission adopted a standard quite similar to that proposed by PG&E, but it was made slightly more rigorous in 2006 to dovetail with the Energy Star program specifications.

Consumer Audio and Video Electronics Standby Losses

Description

This proposed standard covers audio and video consumer electronic products that run off of mains power and use an internal power supplies. These include televisions (TV), digital versatile disk players and recorders (DVD), and compact audio systems. Set-top box products such as integrated receiver decoders and digital television adapters are covered by another proposed standard.

Statewide Energy Use

Standby energy use by audio and video products is summarized in the following table:

Category	*Stock (millions)*	*Standby (W)*	*UEC (kWh/yr)*	*AEC (GWh/yr)*	*Demand (MW)*
TV	18.7	7.3	45	359	289
DVD	3.1	4.2	27	29	23
Compact Audio	7.8	9.8	64	257	196
Total	**29.5**			**645**	**508**

Test Method

International Electrotechnical Commission Standard IEC 62087:2002(E), *Methods of measurement for the power consumption of audio, video and related equipment.*

Proposed Regulation

The maximum allowable standby power level for each product shall be as follows:

Product	*Maximum Standby Power (Watts)*
Compact Audio	2
TV	3
DVD	3

Relationship to Other Standards and Specifications

The EPA Energy Star program currently has specifications, which cover audio and video products, many of which will be dropping to a new tier II level soon. Executive Order 13221 currently requires the US government to purchase products that use no more than one Watt in their standby-power-consuming mode if possible. Numerous international specifications require low levels of standby power use.

Feasibility

Over 2500 audio and video products are currently listed by EPA and FEMP as meeting their specifications. Changes to power supply configurations required to meet the standard have very low to negative costs. The short design cycles of consumer electronics will allow manufacturers to easily incorporate required changes without having to modify existing designs.

Design Life

Product	*Design Life (years)*
Compact Audio	5
TV	7
DVD	5

Incremental Cost

Price increase is estimated to be $1 for compact audio and DVD, and $3 for TV. These costs yield a simple payback of one year of less.

Energy Savings

Savings	*Per Unit (kWh/yr)*	*First Year (GWh)*	*Potential (GWh)*	*Demand (MW)*
Compact Audio	51	80	398	45
TV	27	71	499	57
DVD	8	5	23	3
Total		**155**	**920**	**105**

Change in Life-cycle Cost

Total savings due to the standard over the lifetime of the covered products ranges from $5 to $25.

Final Standards Adoption

The standard was adopted as recommended with the following changes:

1. An additional 2W of power were allowed for compact audio products with a permanently illuminated clock display.
2. The effective date for compact audio products was moved back to January 1, 2007.
3. The product definitions were refined based on feedback from manufacturers and the EIA, including the exclusion of compact audio products that can provide video output, and TV and DVD products that have electronic programming guide (EPG) functions.

Battery Chargers

Description

This proposed standard covers battery chargers for consumer products. Covered products are those with a mode in which they use mains power only to charge a battery that is the product's primary source of power. Examples include chargers for: cordless appliances such as telephones, toothbrushes, razors, toys, and power tools; mobile appliances such as cellular phones, laptops and video cameras; and stand-alone battery chargers, typically used to charge small cells for use in a wide variety of consumer products. Products with a variety of functions of which charging is one, such as home security systems and the like, are not covered by this standard.

Statewide Energy Use

Category	*Stock*	*Standby (W)*	*UEC (kWh/yr)*	*AEC (GWh/yr)*	*Peak Demand (MW)*
Battery Chargers	44 million	3	13	578	66

Test Method

EPA's Energy Star program has established a standby power limit of 1W for qualification of cordless phones (effective January 2004). As part of this category, EPA also defined a standby power testing protocol for cordless telephones, which requires that the unit be connected and the battery charged before measurement begins.

Proposed Regulation

The proposed standard sets wattage limits for standby power, defined to include the charge maintenance stage as well as no-load conditions (when batteries are not in place). The proposed standard also requires that each product include an indicator light or other clear signal indicating when the batter pack has achieved a full state of charge. The levels listed below include the power required by wall transformer or embedded power supply.

Battery Chargers *Battery Capacity (Wh)*	*Maximum Standby Power (Watts)*
0, No-load (no batteries in place)	1
0-12	1
>12	greater of C/50*, 2W

** A C/50 rate is defined as the rated capacity of the battery pack, in Wh, divided by 50 hours. This average rate is sufficient to maintain a fully-charged battery.*

Relationship to Other Standards and Specifications

We are not aware of any existing energy standards that specifically address rechargeable batteries and chargers. Executive Order 13221 currently requires the US government to purchase products that use no more than one watt in their standby power mode, if possible. Numerous international specifications require low levels of standby power use. The German Blue Angel (www.blauer-engel.de) program has a battery labeling standard (RAL-UZ 92) that addresses the recyclability of rechargeable batteries.

Feasibility

Small devices could comply with a wattage limit that is possible and inexpensive using current technology. Standby limits for larger devices appear feasible based on products that already qualify and are based on the battery capacity and allow for sufficient maintenance of fully-charged batteries.

Design Life

We assume a life of most consumer electronics of 5 years. While the products themselves may well last longer than this, technical obsolescence may encourage consumers to replace equipment before EOL.

Incremental Cost

Discussions with integrated circuit (IC) manufacturers involved in the newest charger designs indicate that the incremental cost for appropriate small chargers—existing technologies—is in the range of zero to a few dollars per unit. Short-to medium-term cost is around $2.50 per unit. Long-run incremental costs may well be less than zero. Initially, simple paybacks of two years or less are expected.

Energy Savings

	Per Unit (kWh/yr)	*First Year (GWh)*	*Annual Savings Potential (GWh)*	*Demand Savings (MW)*
Battery Chargers	8.7	76	383	44

Change in Life-cycle Cost

Total savings due to this proposed standard over the lifetime of a battery charger is $1.62

Final Standards Adoption

This two page summary is consistent with the “two pager” submitted in May of 2003. Some refinements were made to the proposal as research continued; however, work on this CASE report was deferred to a subsequent rulemaking when more accurate industry information would be available as a result of negotiations between industry and Commission staff.

Portable Room Air Cleaners

Description

Room air cleaners refer to plug-in, portable air cleaners ranging in size from desktop models to portable air cleaners that are advertised as whole house models. Central HVAC in-line air cleaning devices are not included in this proposal. Portable air cleaners typically consist of a cabinet, sometimes with wheels, that contains one or more air filters, a fan and motor that draw air through the filter(s), and controls to regulate the fan speed.

Statewide Energy Use

Category	*Stock*	*UEC (kWh/yr)*	*AEC (GWh/yr)*	*Peak Demand (MW)*
Portable Room Air Cleaner	2,700,000	670	1,809	207

Test Method

Currently, no test method exists for measuring energy use of portable room air cleaners. However, the Association of Home Appliance Manufacturers (AHAM) has developed standard ANSI/AHAM AC-1-1988, which measures air-cleaning efficacy. The resulting efficacy rating, the Clean Air Delivery Rate (CADR), measures a portable room air cleaner's effectiveness at removing three pollutants: dust, tobacco smoke, and pollen particulate matter from a room. With minor modifications the AHAM AC-1-1988 test method could include measurement of energy consumption. For the purpose of comparing the energy efficiency among models, power consumption would be normalized by the cleaning performance (CADR/Watt).

Proposed Regulation

Manufacturers shall test, list, and label air cleaners with their energy efficiency in CADR/Watt. A standard of 2.7 CADR/W (normalized basis) or greater is proposed.

Relationship to Other Standards and Specifications

The EPA has just begun discussion of a draft Energy Star specifications for air cleaners. We have not yet analyzed preliminary data made available by Energy Star, but the standard level may be modified based on that analysis.

Feasibility

A variety of high and low efficiency models are readily available in the market. There appears to be no substantive correlation between power and capacity or between power and cost, when normalized for capacity. Thus existing products demonstrate technical and economic feasibility.

Design Life

A design life of eight years was used in this analysis.

Incremental Cost

Given the lack of correlation between price and power draw for the variety of models analyzed, it is assumed that there is not substantive incremental cost associated with meeting the proposed standard.

Energy Savings

The analysis found that the proposed standard would result in the following savings:

Standard	Projected Savings (%)	Per Unit Annual Savings (kWh)	First Year Statewide Savings (GWh)	First Year Peak Demand Savings (MW)	Full Replacement Statewide Annual Savings (GWh)	Full Replacement Peak Demand Savings (MW)
>= 2.7 CADR/W	23%	69	22	4	187	32

Change in Life-cycle Cost

The expected savings over the lifetime of an air cleaner due to the proposed energy standard is $121.

Final Standards Adoption

After completion of the CASE Report for Room Air Cleaners, AHAM reacted strongly in opposition to the PG&E CASE Report alleging manipulation of data, use of inaccurate research findings (provided by AHAM) and unreasonably low incremental costs. AHAM alleged that the high volume of small, inexpensive air cleaners that was overlooked in the CASE analysis resulted in much lower than anticipated saving and much higher than anticipated incremental costs. While the new data provided by AHAM still suggested that the standard could be cost effective on a statewide basis, the combination of uncertainty over the data, including incremental costs, and smaller statewide potential saving impacts caused PG&E and the Commission to terminate efforts on that proposal.

Residential Clothes Washers

Description

Clothes washer means a consumer product designed to clean clothes, utilizing a water solution of soap and/or detergent and mechanical agitation or other movement, and must be one of the following classes: automatic clothes washers, semi-automatic clothes washers, and other clothes washers (see 10 CFR Section 430 Subpart A). Residential clothes washers are designed primarily for use in single household settings and generally have a clothes container compartment capacity of less than 3.5 cubic feet.

Statewide Energy Use

The table below shows the energy use attributed only to energy embedded in water as it arrives at consumer's property.

Category	Stock	UEC (kWh/yr)	AEC (GWh/yr)	Peak Demand (MW)
Residential Washers	7,800,000	54	421	48

Test Method

10 CFR Section 430.23(j) (Appendix J1 to Subpart B of Part 430)(2000)

Proposed Regulation

In the California Assembly Bill 1561, the energy commission was directed to "not later than January 1, 2004, amend any regulations in effect on January 1, 2003, pertaining to the energy efficiency standards for residential clothes washers to require that residential clothes washers manufactured on or after January 1, 2007, be at least as water efficient as commercial clothes washers." To this end, we propose that effective January 1, 2007, residential clothes washers sold in California must have a water factor (WF) of 8.5 or lower. In 2010 and thereafter water factors must be equal to or less than 6.0..

Relationship to Other Standards and Specifications

The proposed WF standard complements the existing federal NAECA standard for residential clothes washers 10 CFR 430.

Feasibility

Seventy-three of 123 total residential washer models on the Energy Star website including both horizontal-axis and vertical-axis designs meet or exceed this WF. Some more recent models have a WF as low as 4.0.

Design Life

Consistent with US DOE analyses, a 14-year measure life is assumed.

Incremental Cost

An incremental cost of $66 for the 8.5 WF level and $130 for the 6.0 WF level was estimated based on a number of factors. Simple paybacks based on energy savings exceed measure life, but water savings result in paybacks of less than half of the 14 year measure life.

Energy Savings

The energy savings estimated below are derived from reduced water usage and the resulting reduction in the energy embedded there in.

Standard Option	Per Unit Annual Savings (kWh)/(Therms)	Statewide Saving (GWh)/(M Therms)s (
Option 1: WF=6.0	18/4	487/40
Option 2: WF=8.5	13/3	279/28

Change in Life-cycle Cost

Including the present value of water savings and incidental energy savings anticipated, the reduction in life-cycle-cost is $120 and $70 (ignoring detergent savings), respectively for 6.0 and 8.5 WF respectively, using a real discount rate of 3%.

Final Standards Adoption/Current Status

This standard was adopted as proposed in a proceeding ended early in 2004. Given that this standard is preempted by federal standards, California is required to obtain a waiver from preemption by the US Department of Energy. The PG&E CASE team has been assisting with the development of that waiver document. The Commission Counsel is completing the development of this document at this time.

Television Set-top Boxes

Description

This proposal covers set-top box products that run off of mains power and use an internal power supply. Set-top boxes include two major subcategories that are not always clearly distinct: Integrated receiver decoders (IRDs) and converter boxes. IRDs, such as analog and digital cable boxes and satellite receivers, as the name implies, receive and decode signals from either cable or satellite providers for use by TVs and VCRs. Converter boxes, such as digital television adapters (DTA) and high definition television (HDTV) conversion boxes, convert digital television signals to a composite video signal used by standard analog televisions.

Statewide Energy Use

Standby energy use by current set-top box products is summarized in the table below. However, the change over to digital TV sometime after 2007 will result in an explosion of digital television adapters which are yet to show up in market data.

Category	*Stock (millions)*	*UEC (kWh/yr)*	*AEC (GWh/yr)*	*Demand (MW)*
Analog cable box	1.3	68	88	14
Digital cable box	4.4	143	629	101
Satellite receiver	3.2	99	317	51
Total Set-top Box	9.0		1,034	166

Test Method

International Electrotechnical Commission Standard IEC 62087:2002(E), *Methods of measurement for the power consumption of audio, video and related equipment.*

Proposed Regulation

The maximum allowable standby power level for each set-top box category shall be as follows (satellite boxes are allowed an additional 5 Watts for each LNB):

Category	*Maximum Standby Power (Watts)*	*Maximum On Power (watts)*
DTA	1	8
Basic IRD	15	N/A

Relationship to Other Standards and Specifications

The EPA Energy Star program currently has specifications which cover set-top boxes. Numerous international specifications require low levels of set-top box standby power use.

Feasibility

Changes to power supply configurations required to meet the standard have very low to negative costs. The short design cycles of consumer electronics will allow manufacturers to easily incorporate required changes without having to modify existing designs if given sufficient lead time before standards take effect.

Design Life

Design life for set-top boxes is estimated to be four years.

Incremental Cost

Price increase is estimated to be $3 for a basic IRD and $1 for a digital television adapter resulting in simple a payback of less than one year for DTAs.

Energy Savings

Savings	*First Year (GWh)*	*Potential (GWh)*	*Demand (MW)*
Basic IRD	101	486	28
DTA	32	313	18
Total Set-top Box	133	799	46

Change in Life-cycle Cost

Total savings over the lifetime of the various set-top box products averages about $12.

Final Standards Adoption

Only the DTA standard recommendation was adopted; the basic IRD standard was delayed until a later rule-making.

Appendix A. Approved CASE Appliance Standards Data

Appliance Type	Implementation Date	1 – Initial saturation	Appliance Life (years)	Annual Sales
Commercial Refrigerators With Opaque Doors	1/1/2006	0.55	9	13,000
Commercial Refrigerators With Transparent Doors	1/1/2007	0.45	9	8,460
Commercial Freezers With Opaque Doors	1/1/2006	0.85	9	8,000
Commercial Freezers With Transparent Doors	1/1/2007	0.69	9	1,760
Commercial Refrigerators And Freezers Without Doors	1/1/2007	0.05	10	17,800
Walk-In Freezers	1/1/2006	1.00	10	2,040
Walk-In Refrigerators	1/1/2006	1.00	10	3,960
Refrigerated Bottled And Canned Beverage Vending Machines	1/1/2006	1.00	10	41,000
Automatic Commercial Ice Makers	1/1/2008	0.3	8	23,000
Water Dispensers (heats and cools water)	1/1/2006	1.00	8	23,100
Large Packaged Air-Source Commercial Air Conditioners - Tier 1	10/1/2006	1.00	15	3,600
Large Packaged Air-Source Commercial Air Conditioners - Tier 2	1/1/2010	1.00	15	3,600
Unit Heaters And Duct Furnaces	1/1/2006	1.00	15	10,800
Residential Pool Pumps, High Efficiency - Tier 1	1/1/2006	0.5	10	143,000
Residential Pool Pumps, Two-speed - Tier 2	1/1/2008	1.00	10	143,000
Portable Electric Spas	1/1/2006	1.00	10	48,000
Natural Gas Dishwasher Pre-Rinse Spray Valves	1/1/2006	1.00	5	13,500
Electric Dishwasher Pre-Rinse Spray Valves	1/1/2006	1.00	5	4,500
State-Regulated General Service Incandescent Lamps - Tier 1	1/1/2006	1.00	1.1	74,000,000
State-Regulated General Service Incandescent Lamps - Tier 1	1/1/2006	1.00	1.1	74,000,000
Traffic Signal Modules For Pedestrian Control	1/1/2006	1.00	7	30,000

Appliance Type	Implementation Date	1 – Initial saturation	Appliance Life (years)	Annual Sales
Luminaires For Metal Halide Lamps - Vertical	1/1/2006	0.52	13	363,000
Under Cabinet Fluorescent Luminaires/Ballasts	1/1/2006	0.19	15	280,000
Commercial Hot Food Holding Cabinets	1/1/2006	1.00	15	3,300
External Power Supplies - Tier 1	1/1/2006	1.00	7	12,700,000
External Power Supplies - Tier 2	1/1/2008	1.00	7	12,700,000
Compact Audio Players	1/1/2007	0.94	5	1,100,000
Televisions	1/1/2006	1.00	7	2,500,000
DVD Players	1/1/2006	1.00	5	1,500,000
Digital Television Adaptors	1/1/2007	1.00	4	15,640
Residential Clothes Washers - Tier 1	1/1/2007	0.70	14	900,000
Residential Clothes Washers - Tier 2	1/1/2010	0.80	14	900,000
Residential Clothes Washers - Tier 1	1/1/2007	0.70	14	900,000
Residential Clothes Washers - Tier 2	1/1/2010	0.80	14	900,000
Total - (Delayed light standards NOT Included)	N/A	N/A	N/A	N/A

Appliance Type	Unit Savings (kWh/yr or therms/yr)	1st Year Statewide Electricity Savings (GWhr/yr.)	Statewide Energy Savings at Full Replacement (GWh/year)	1st Year Statewide Peak Demand Reduction (MW)	Statewide Peak Demand Reduction at Full Replacement (MW)	1st Year Statewide Natural Gas (Millions of Therms/yr.)	Statewide Energy Savings at Full Replacement (Millions of Therms/yr.)
Commercial Refrigerators With Opaque Doors	777	5.56	50.00	0.73	6.56		
Commercial Refrigerators With Transparent Doors	1,354	5.15	46.39	0.68	6.09		
Commercial Freezers With Opaque Doors	586	3.98	35.86	0.52	4.71		
Commercial Freezers With Transparent Doors	2,647	3.21	28.93	0.42	3.80		
Commercial Refrigerators And Freezers Without Doors	250	0.22	2.23	0.03	0.29		
Walk-In Freezers	11,875	24.23	242.25	3.18	31.79		
Walk-In Refrigerators	5,995	23.74	237.40	3.12	31.15		
Refrigerated Bottled And Canned Beverage Vending Machines	308	12.63	126.28	1.66	16.57		
Automatic Commercial Ice Makers	928	6.60	52.76	0.87	6.92		
Water Dispensers (heats and cools water)	266	6.14	49.16	0.81	6.45		
Large Packaged Air-Source Commercial Air Conditioners - Tier 1	3,742	13.47	53.88	6.99	27.96		
Large Packaged Air-Source Commercial Air Conditioners - Tier 2	6,533	23.52	352.78	12.20	183.05		
Unit Heaters And Duct Furnaces	190		0.00	0.00	0.00	2.05	30.78
Residential Pool Pumps, High Efficiency - Tier 1	260	18.59	37.18	3.54	7.07		
Residential Pool Pumps, Two-speed - Tier 2	1,040	148.72	1487.20	34.31	343.06		
Portable Electric Spas	138	6.60	66.00	1.26	12.56		
Natural Gas Dishwasher Pre-Rinse Spray Valves	336		0.00	0.00	0.00	4.54	22.68
Electric Dishwasher Pre-Rinse Spray Valves	7,625	34.31	171.56	7.39	36.95		
State-Regulated General Service Incandescent Lamps - Tier 1	1	79.18	79.18	9.82	9.82		
State-Regulated General Service Incandescent Lamps - Tier 1	1	79.18	87.10	9.82	10.81		
Traffic Signal Modules For Pedestrian	465	13.95	97.65	1.59	11.15		

Appliance Type	Unit Savings (kWh/yr or therms/yr)	1st Year Statewide Electricity Savings (GWhr/yr.)	Statewide Energy Savings at Full Replacement (GWh/year)	1st Year Statewide Peak Demand Reduction (MW)	Statewide Peak Demand Reduction at Full Replacement (MW)	1st Year Statewide Natural Gas (Millions of Therms/yr.)	Statewide Energy Savings at Full Replacement (Millions of Therms/yr.)
Control							
Luminaires For Metal Halide Lamps - Vertical	261	49.26	640.34	8.79	114.22		
Under Cabinet Fluorescent Luminaires/Ballasts	16	0.83	12.43	0.15	2.22		
Commercial Hot Food Holding Cabinets	454	1.50	22.47	0.22	3.33		
External Power Supplies - Tier 1	4	47.75	95.50	5.45	10.90		
External Power Supplies - Tier 2	4	56.39	394.72	6.44	45.06		
Compact Audio Players	51	52.73	263.67	6.02	30.10		
Televisions	27	67.50	472.50	7.71	53.94		
DVD Players	8	12.00	60.00	1.37	6.85		
Digital Television Adaptors	72	1.13	4.50	0.15	0.62		
Residential Clothes Washers - Tier 1	13	0.00	24.57	0.75	3.74		
Residential Clothes Washers - Tier 2	18	0.00	181.44	0.75	27.62		
Residential Clothes Washers - Tier 1	3	2.70	0.00	0.00	0.00	2.70	8.10
Residential Clothes Washers - Tier 2	4	3.60	0.00	0.00	0.00	3.60	50.40
Total - (Delayed light standards NOT Included)	N/A	N/A	5186	N/A	996	12.89	111.96

Appendix B. Delayed CASE Appliance Standards Data

Appliance Type	Implementation Date	1 - Initial saturation	Appliance Life (years)	Annual Sales	Unit kWh/yr
State-Regulated General Service Incandescent Lamps - Tier 2	1/1/2007	1	1.4	74,000,000	6
State Regulated Incandescent Reflector Lamps - Residential	1/1/2006	0.73	3.4	10,100,000	11
State Regulated Incandescent Reflector Lamps - Commercial	1/1/2006	0.376	0.8	8,800,000	48
Luminaires For Metal Halide Lamps - All Orientations	1/1/2008	0.588	13	363,000	265
Total for delayed lighting standards	N/A	N/A	N/A	N/A	N/A

Appliance Type	Unit Savings (kWh/yr or therms/yr)	1st Year Statewide Electricity Savings (GWhr/yr.)	Annual Statewide Energy Savings at Full Replacement (GWh)	1st Year Statewide Peak Demand Reduction (MW)	Statewide Peak Demand Reduction at Full Replacement (MW)	Natural Gas (Millions of Therms/yr.)
State-Regulated General Service Incandescent Lamps - Tier 2	6	444.00	621.60	55.09	77.13	
State Regulated Incandescent Reflector Lamps - Residential	11	81.10	275.75	10.06	34.22	
State Regulated Incandescent Reflector Lamps - Commercial	48	158.16	126.53	28.21	22.57	
Luminaires For Metal Halide Lamps - All Orientations	265	56.57	735.45	10.09	131.18	
Total for delayed lighting standards	N/A	N/A	1759	103	265	NA