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.

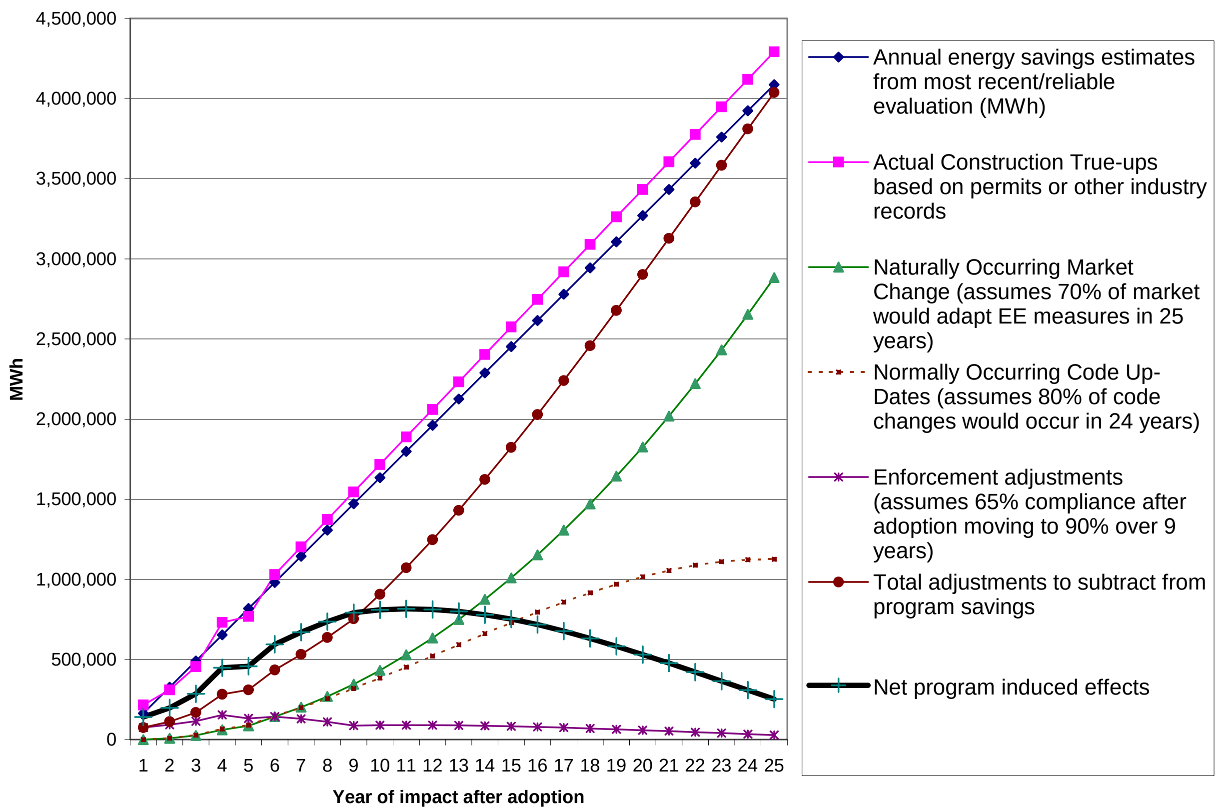
Savings Should Be Counted To Utility Service Territories. As savings from standards come on line, they should be counted to the utility service territories in which they occur, based on a simple, agreed-upon allocation mechanism that recognizes the differences between the territories.

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

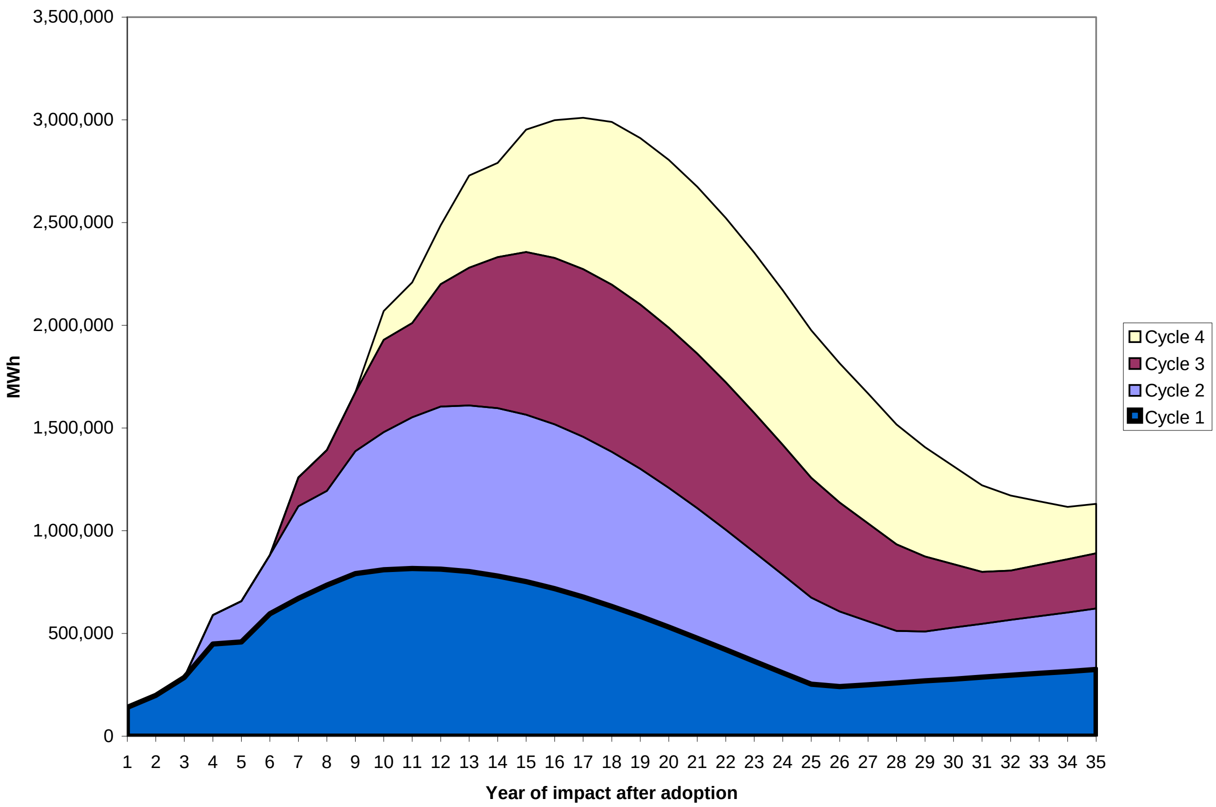


We also include mechanisms for adjusting standards savings estimates for imperfect standards compliance and for fluctuations in actual construction activity. These can be used to "true up" the savings estimates. To illustrate the recommended method for estimating C&S program savings, we present three 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.

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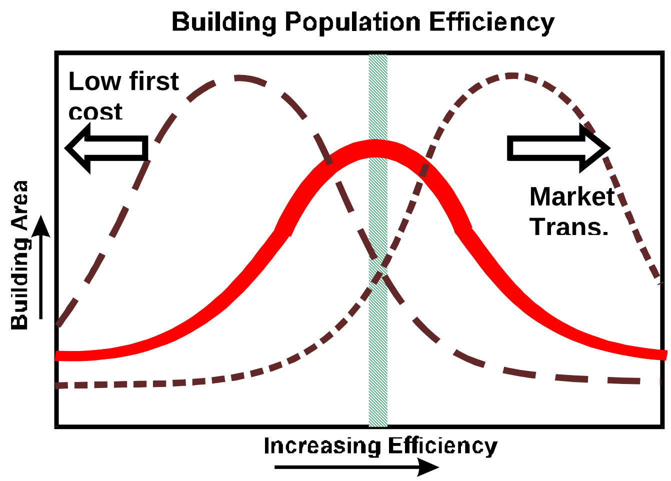
Standards Help Meet Energy Savings Goals. The CPUC, in setting savings goals for the utilities' energy efficiency portfolios for 2006 and beyond, established very ambitious targets for energy efficiency. In its decision, the Commission has laid the groundwork for starting to count the energy savings 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.

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

Cycle/Sector	*Electric Energy*			*Electricity Demand*			*Gas Energy*		
	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

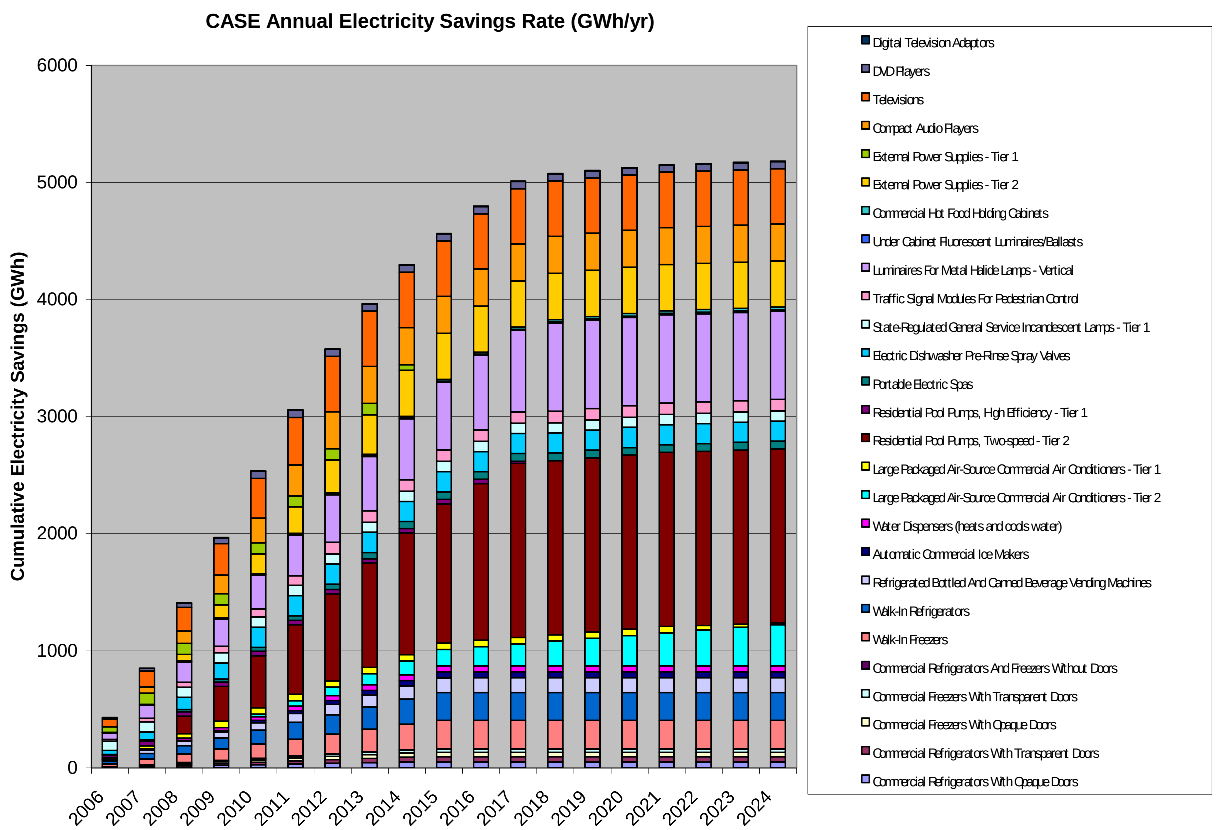
	Estimates from This Study		
	Electricity (GWh)	***Peak (MW)***	***Natural Gas (Therms)***
Residential C&S code revisions	83.34	41.07	2,900,646
All 2005 residential code revisions	117.27	104.50	6,885,570
Percent from C&S code revisions	71%	39%	42%
Nonresidential C&S code revisions	80.15	35.56	1,035,000
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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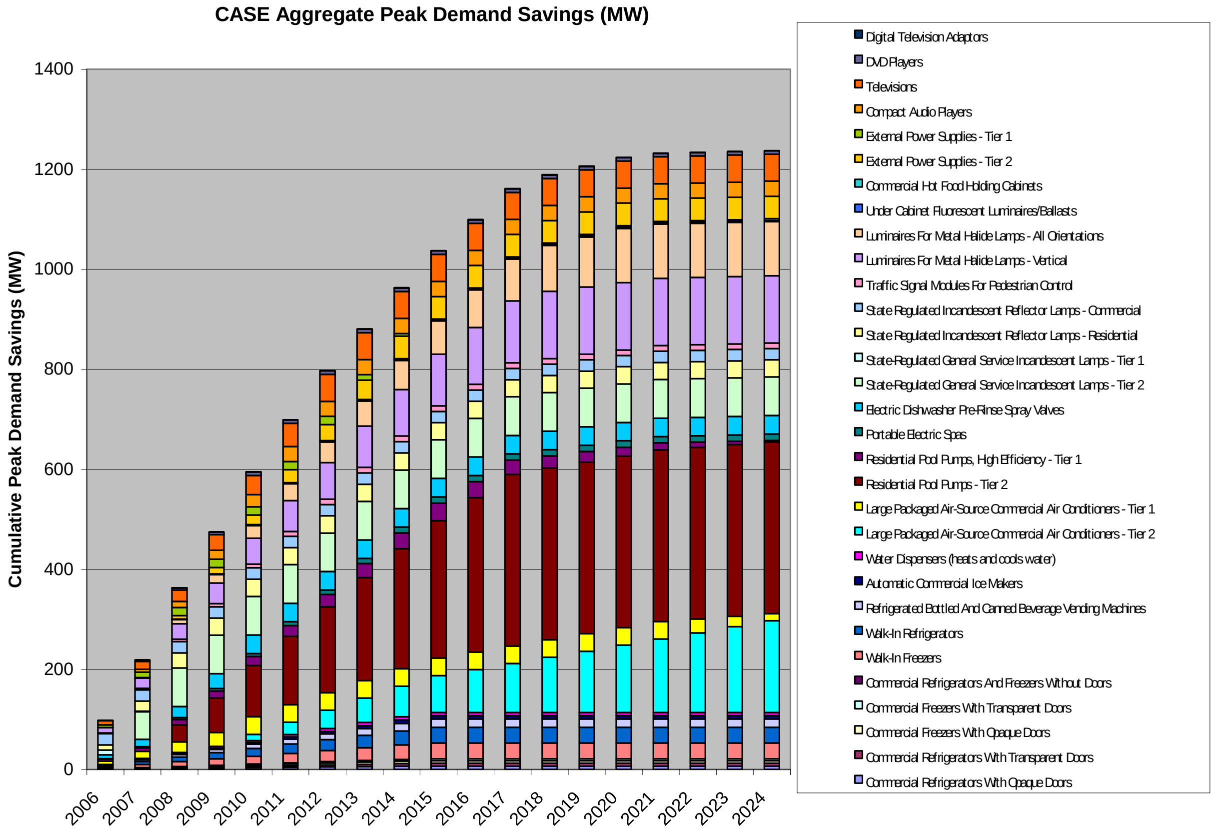
[13] *Draft Final Project Report: C&S Enhancement Initiative For PY2003 - 2005: Title 20 Standards Development,* prepared for PG&E by Energy Solutions et al. (March 14, 2005)

[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 Engineering Estimates

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 Estimates of Market Size and Penetration

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 Differences in Standards Implementation

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.

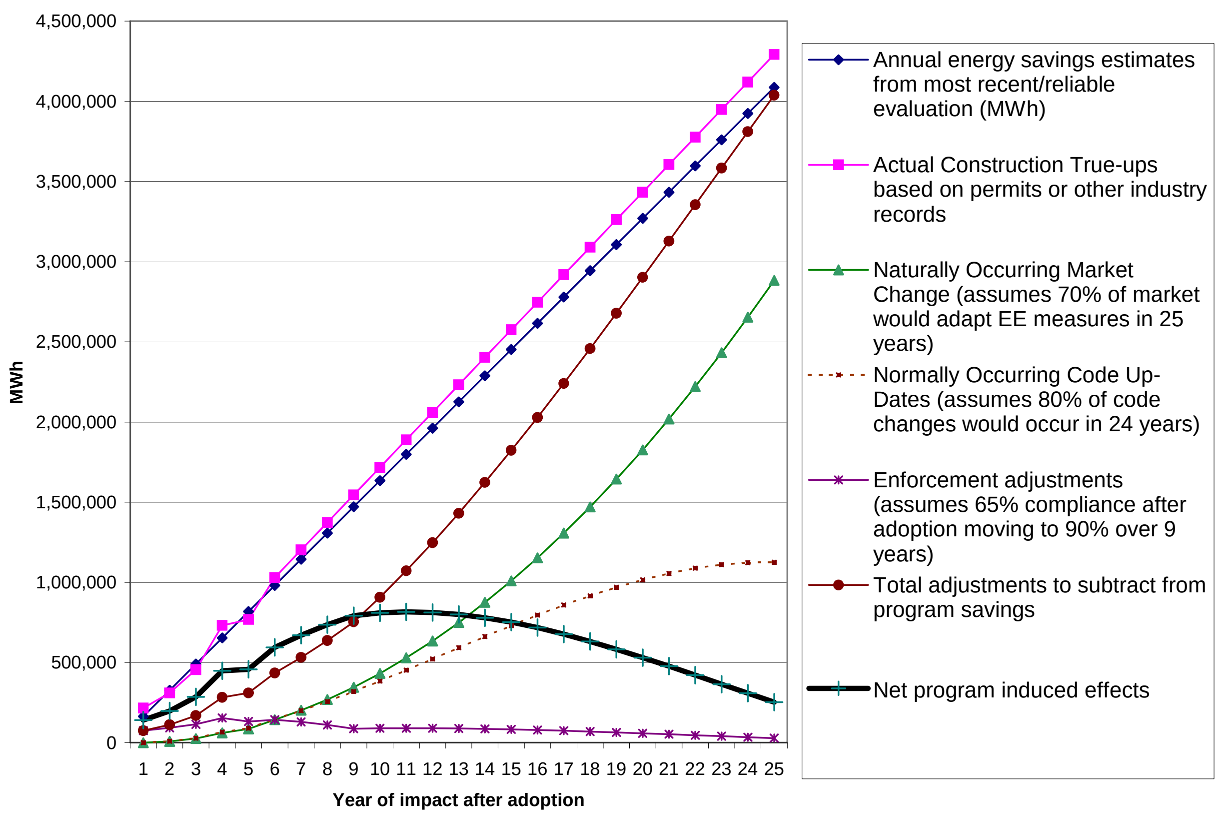
3. METHODS FOR LIFETIME SAVINGS ESTIMATES

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

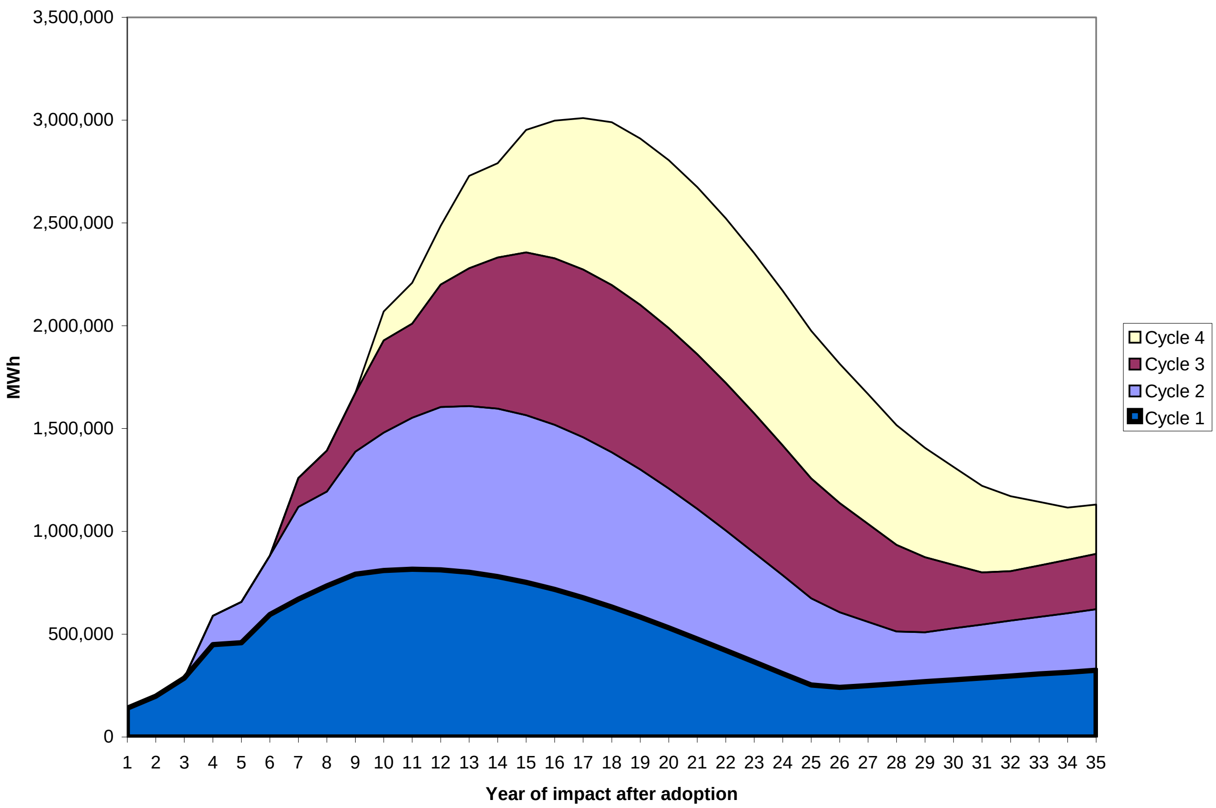


We also include mechanisms for adjusting standards savings estimates for imperfect standards compliance and for fluctuations in actual construction activity. These can be used to “true up” the savings estimates. To illustrate the recommended method for estimating C&S program savings, we present three 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.

[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 9^{th} 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

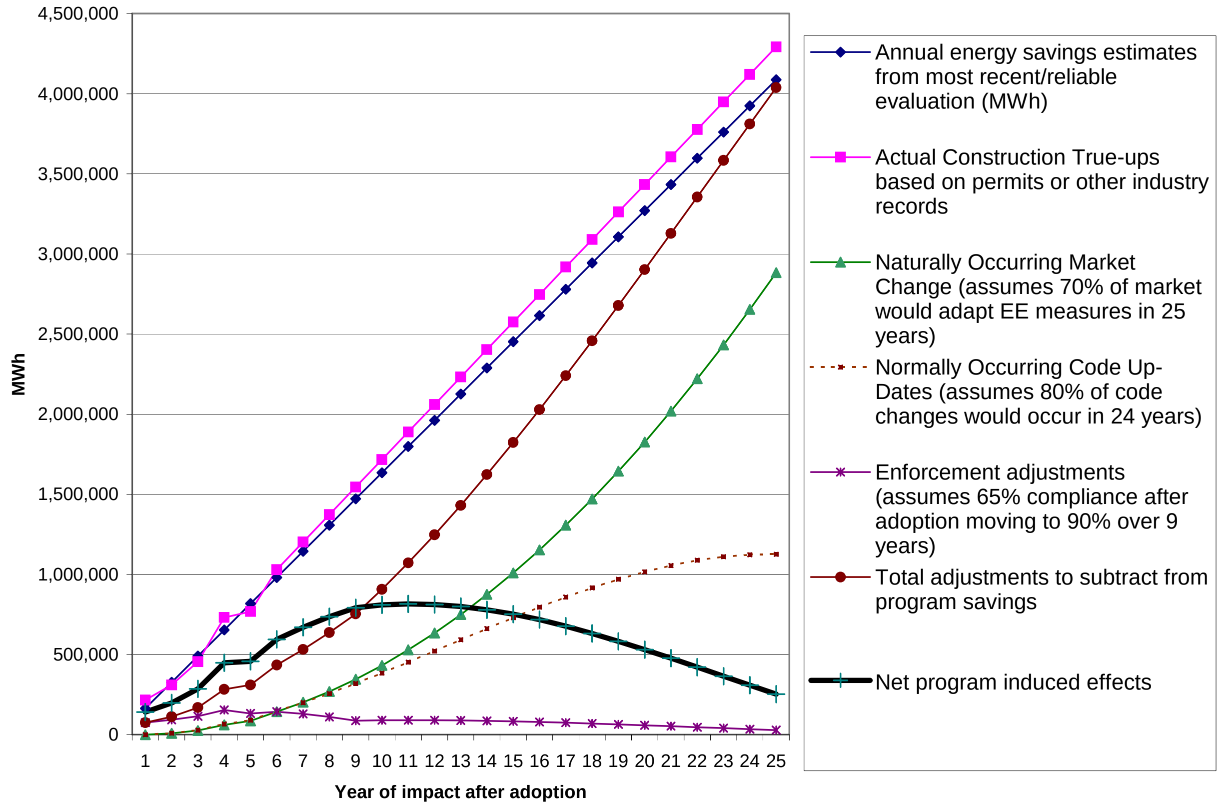
The approach suggested in this white paper starts with the use of actual evaluation results to establish the baseline for adjusting the savings projections. Then the savings can be trued up to actual construction using available data at the time of the estimate realizing these true-ups will change each 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.

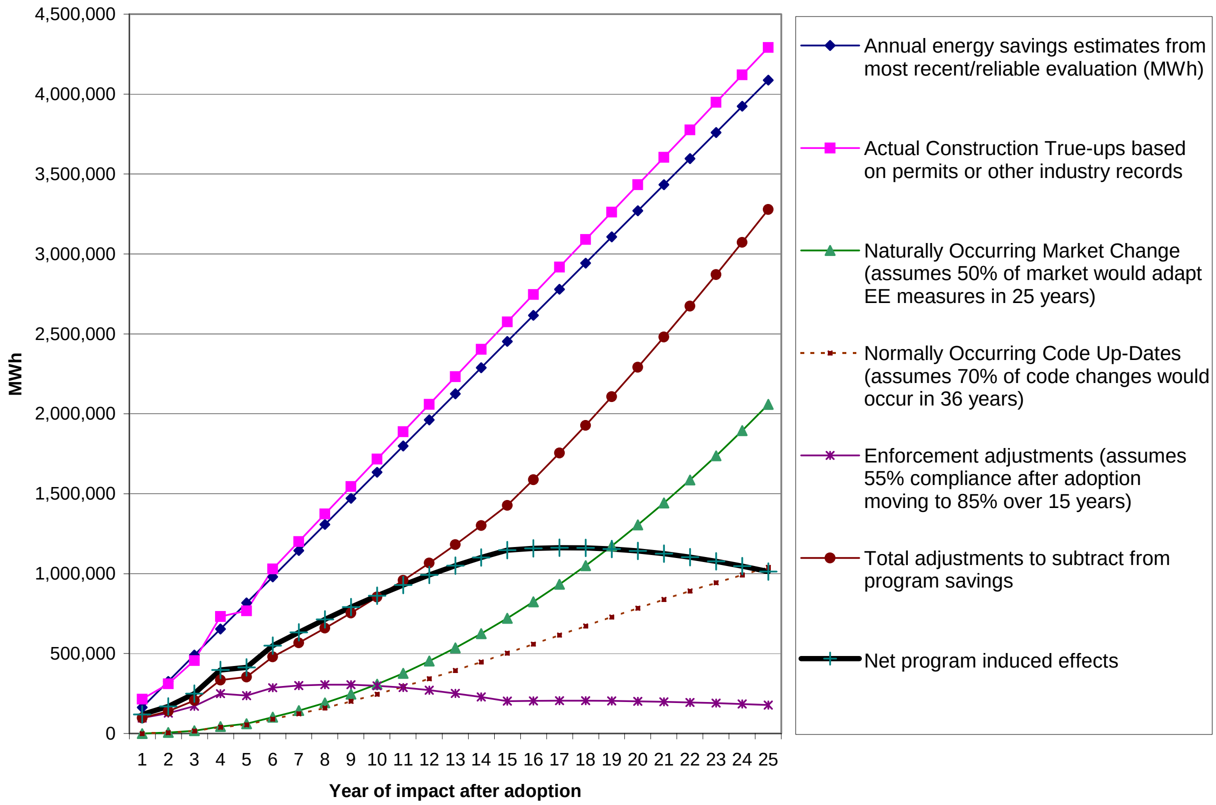
Figure 17. Expected Savings Path – C&S Program Energy Impacts – MWh/year Saved



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.

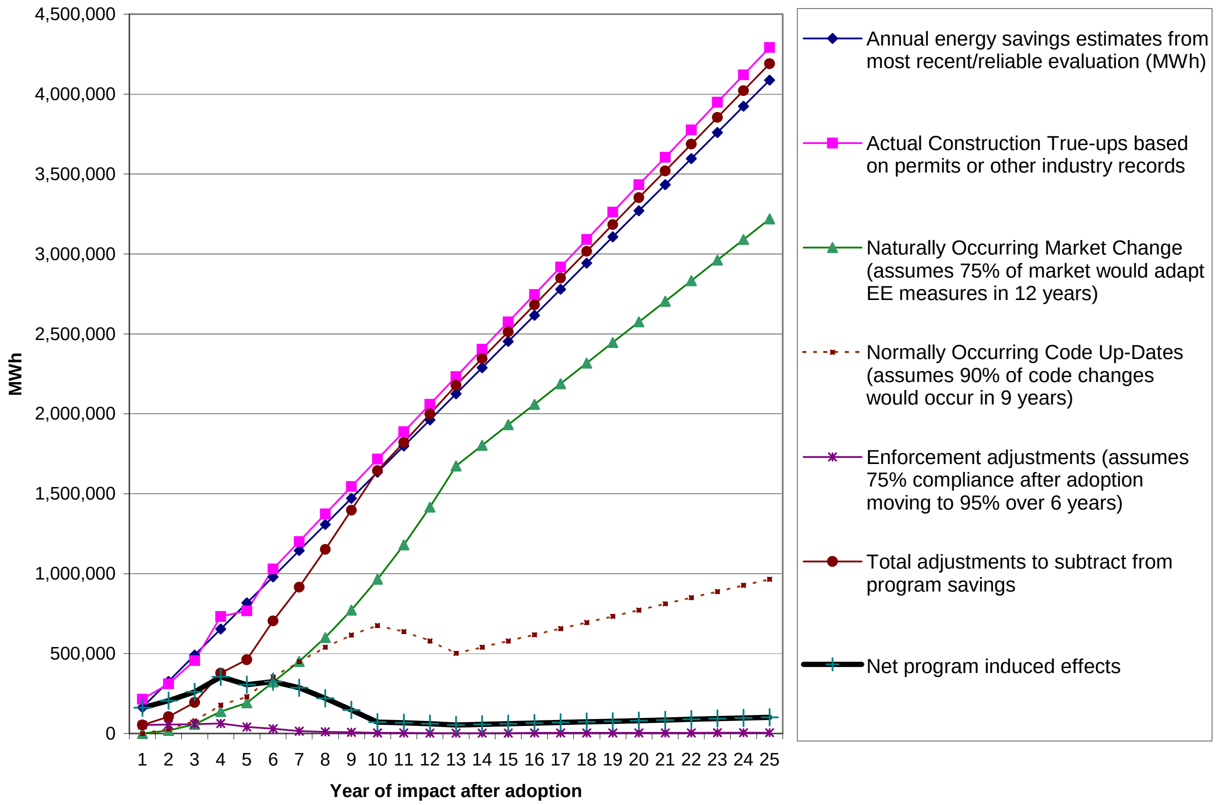
Figure 18. High Savings Path – C&S Program Energy Impacts – MWh/year Saved



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**

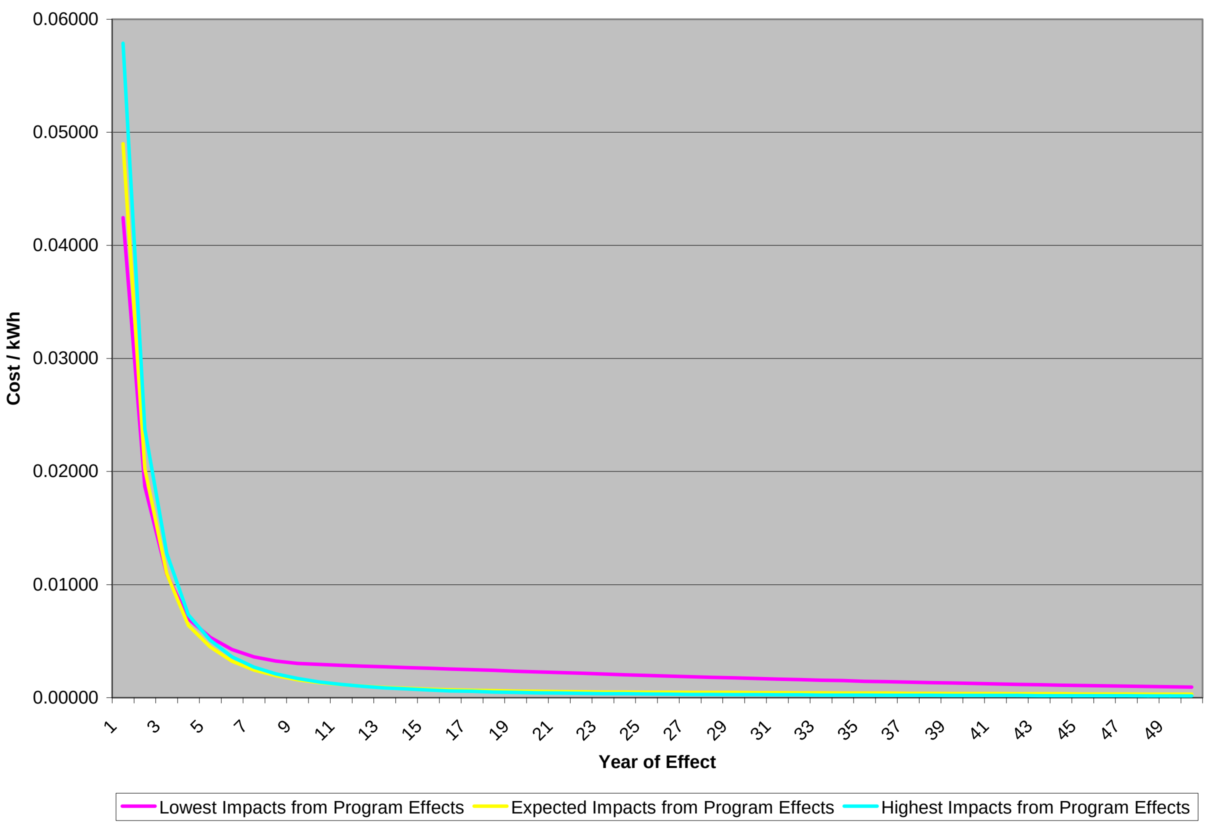
Using the example approaches presented in this paper and the ADM impact evaluation report, the cost of conserved energy over a 50-year period is estimated at three hundredths of a penny per kWh for the expected path of program effects. These examples are not provided to suggest the 2005 standards changes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

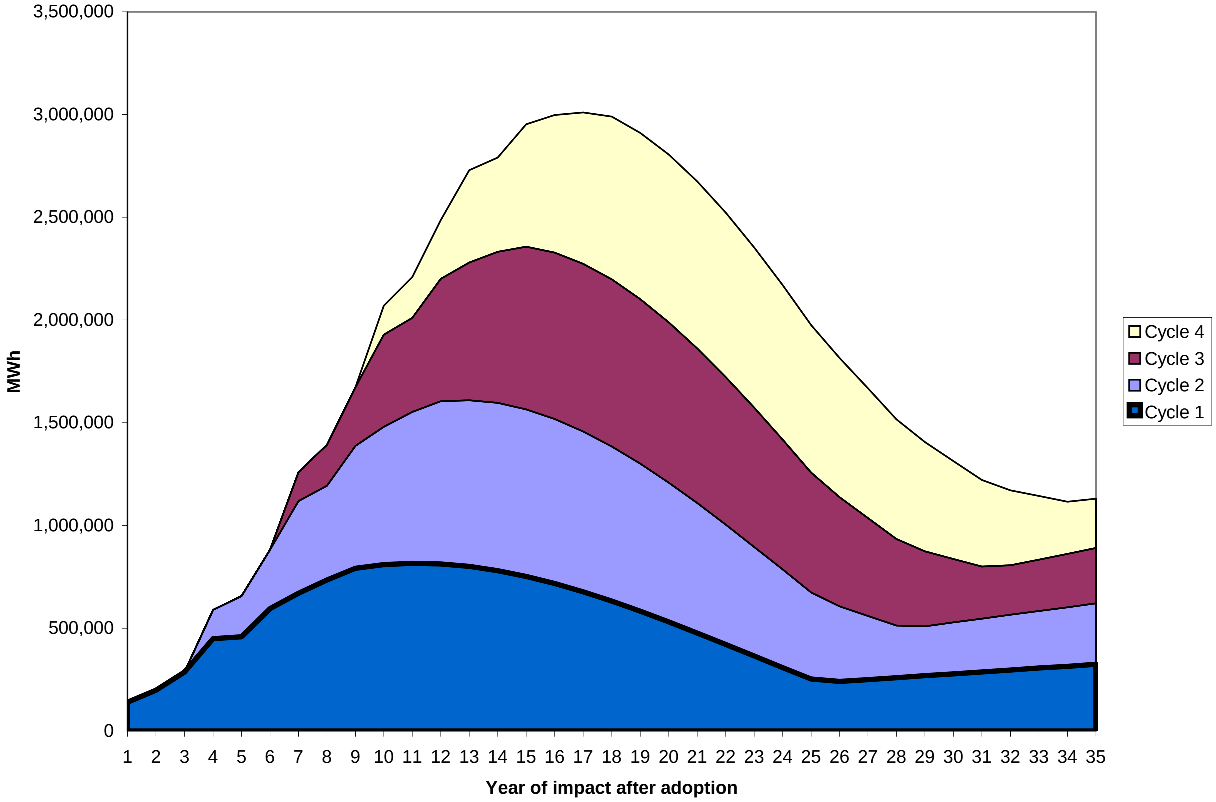
There may be some disagreement over the time period that should be used to estimate program savings and cost effectiveness. One of the advantages of this analysis approach is that it can calculate the cost of savings for any given point in time. To illustrate this, we have graphed the cost of saved energy 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.

[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:

Douglas Mahone, Heschong Mahone Group Inc., Study Lead

Nick Hall, TecMarket Works

Ken Keating, PhD

Lori Megdal, Megdal & Associates

Richard Ridge, Ridge & Associates

The consultant team was assembled and supervised by Marian Brown, Southern California Edison Co.

A codes and standards working group, comprised of utility evaluation and program personnel, as well as representatives from the California Energy Commission and the CPUC's Energy Division, provided advice and review comments. The team would especially like to thank Mike Messenger and Bill Pennington from the CEC for their detailed comments and thoughtful contributions to this document.