Raising the Bar: How California's New 2005 Standard Saves 478 GWh and 181 MW a Year

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ABSTRACT

When California's new energy efficiency standards take effect in 2005, they are projected to save 478 GWh annually and reduce peak demand by 181 MW per year.[1] This paper describes the features of the new standards and the collaborative process between the California Energy Commission (CEC) and the investor-owned utilities.

An initial process calling for ideas from the buildings and construction community in California resulted in more than 270 ideas being submitted. Proponents presented ideas at public workshops. Later they were ranked on:

1. The energy savings and peak demand reduction expected to be achieved by the proposed revision.
2. Whether or not the CEC committed to address the proposed revision during the previous rulemaking.
3. The extent that public funds had been invested to date in developing the proposed revision.

Selected measures were then developed in more detail and considered at additional public workshops. The standards were developed and revised in response to public comment at workshops and hearings.

The new standards continue to place more emphasis on peak demand reduction as time dependent valuation (TDV) replaces source energy for performance calculations. New requirements for performance verification are added for nonresidential mechanical and electrical equipment that is susceptible to failure. The standards also extend the role of third-party field verification and/or diagnostic testing agents. Some measures such as cool roofs and high performance windows apply to building component replacements as well as newly constructed buildings and additions. Additionally, the standards include outdoor lighting and signs requirements for the first time.

Breaking Down the Impact

Per capita energy use in California has remained relatively flat since the late 1970s while per capita use in the rest of the country has increased by about 50% (Rosenfeld 2003). One of the

1 Each year, California constructs about 108,000 new residences and 159 million ft² of nonresidential space, representing an annual growth (under the 2001 standards) of 880 MW/y and 2,452 GWh/y. The projected savings, in effect, reduce this growth. For reference, the peak demand for the roughly 11 million existing residences and 5.7 billion ft² of existing nonresidential buildings is approximately 38,000 MW. Annual electricity use is approximately 170,000 GWh/y.

reasons that California has been able to achieve zero growth in per capita energy use is that the state has been aggressive in developing and implementing energy efficiency standards for newly constructed buildings, additions, and alterations.

The first standards were adopted in 1978, shortly after the California Energy Commission (CEC) was created. The first nonresidential standards were an adaptation of ASHRAE 90.1-1975 – prescriptive in nature, requiring minimum insulation levels and equipment performance. Since then, the standards have been updated periodically (at least every 3 years) to embrace new design strategies and to reflect maturing technologies. The CEC has maintained prescriptive and performance standards for both residential and nonresidential buildings, as required by statue.

The last standards update responded to the California electricity crisis in 2001. The savings associated with the 2001 update were estimated to be 176 GWh/y and 218 MW/y (Eley 2001).[2] These changes were adopted on an emergency basis and took effect in June 2001.

The process of developing the 2005 standards began almost immediately after the 2001 standards were adopted. The CEC selected a contractor team to provide support. A call for change ideas for the standards was issued in the fall of 2001. A wide range of stakeholders, including building industry groups, manufacturers, utilities, and environmentalists, developed change proposals for the standards. These ideas were evaluated in a methodical manner; the ones that passed an initial screening were further evaluated; and the ones that were still considered viable after additional study were incorporated into the standards and the associated Alternative Calculation Method (ACM) Approval Manuals.[3] Specific 2005 changes to the standards are discussed later in this paper.

The CEC estimated the savings potential from the standards by using both a prototype and database approach for residential buildings and a database approach for nonresidential buildings (Eley 2003). Table 1 summarizes the savings potential. Newly constructed buildings account for about 54.7% of the electricity savings, while requirements for building alternations account for 45.2%. The mix for demand savings is 60.5% for newly constructed buildings and 39.2% for alternations.

Nonresidential buildings represent the largest savings for alterations and interior lighting accounting for the biggest share.[4] For newly constructed buildings, changes in the interior lighting standards generated the most annual electricity savings. Of the 262 GWh of estimated savings, 64.6 GWh are related to improvements in the residential lighting standards and 84.1 GWh are related to the nonresidential lighting standards. Interior lighting represents 57% of the total electricity savings. The remaining savings are related to improvements in HVAC design and performance, and building envelope changes.

[2] See footnote 1.

[3] The California ACM manuals are detailed regulations that define the modeling rules for performance calculations, and eligibility criteria that must be met for compliance credit to be taken for specific compliance options under the performance standards (including protocols for doing diagnostic testing and field verification for measures that are prone to installation problems). The ACM manuals are adopted through the same rulemaking proceeding in which the standards are adopted.

[4] Anytime more than half the lighting fixtures in a space are replaced, the lighting power density standards apply to all of the fixtures in the space.

Table 1. Potential Impact of the 2005 Standard

		Electricity		Demand		Gas	
		Savings (GWh)	Percent of Total	Savings (MW)	Percent of Total	Savings (millions therms)	Percent of Total
Newly Constructed Buildings	Low-Rise Residential	98.7	20.6%	66.4	36.4%	5.5	62.5%
	Nonresidential	143.0	29.9%	44.0	24.1%	0.5	5.7%
	Relocatable Classrooms	3.1	0.7%	n. a.	n. a.	0.0	0.0%
	Outdoor Lighting	17.1	3.6%	0.0	0.0%	0.0	0.0%
	Total	262.0	54.7%	110.3	60.5%	6.0	68.2%
Alterations	Low-Rise Residential	41.4	8.7%	26.7	14.7%	3.0	34.0%
	Nonresidential	175.0	36.5%	44.3	24.3%	-0.2	-2.3%
	Total	216.4	45.2%	71.0	39.2%	2.8	31.8%
Grand Total		478.5	100.0%	181.4	100.0%	8.8	100.0%

If the savings from the 2001 update are combined with the savings for the 2005 update, they total 654 GWh/y, 400 MW/y, and 10.3 million therms/y.[5]

The Process of Developing the 2005 Standards

To develop the 2005 standards, an extensive public process was held to identify proposals for changes to the standards, to review the technical and cost analysis of potential changes, and to obtain public comment on multiple drafts of standards language. The CEC held 16 full days of public workshops during this process, including discussions on outdoor lighting.

CEC staff, contractors, and stakeholders proposed more than 270 changes. The proponent of each standards change was asked to provide common information in a consistent format. A *Measure Information Template* was used that called for the following information:

- Description of the measure
- Description of the energy and non-energy benefits (e.g., comfort, environmental, indoor air quality, health and safety, productivity benefits, reduced maintenance costs, and increased property value)
- Description of how Time Dependent Valuation (TDV) would affect the benefits
- Identification of any potential adverse environmental impacts
- Identification of the type of change (e.g., mandatory measure, prescriptive requirement, compliance option, or modeling procedure)
- Explanation of the market availability of the measure and estimation of the cost of the measure
- Description of the useful life, persistence, and maintenance implications of the measure
- Description of performance verification that would be needed to ensure that the measure is properly installed and/or performs as designed
- Description of what analysis would be necessary to evaluate the cost effectiveness of the measure

[5] See footnote 1.

- Description of what analysis tools would be needed to quantify the energy savings and peak demand reductions, and to what extent current compliance software is adequate or would have to be modified to complete the analysis
- Description of the relationship of this measure to other measures, either ones currently addressed by the standards or new measures
- Identification of research studies, reports, and other information that provides background on the proposed change, including research that is currently underway and additional research/analysis that would be needed.

Pursuing all 270 measures was not possible given finite resources and fixed schedule, so the CEC and its contractors screened each of the code change proposals based on a number of criteria with particular emphasis placed on the following considerations:

- The extent of energy savings and demand reduction expected to be achieved by the proposed revision
- Whether or not the CEC had made a commitment during the last update proceeding to address the proposed revision in this triennial update
- The extent that public funds had been invested to develop the proposed revision for inclusion in this project.

Based on that review, the CEC chose about one proposal in ten for additional feasibility and cost effectiveness analysis. However, many of the original ideas were related in some respect to the subset of code change ideas selected for more extensive evaluation and thus were included. Further work to develop the selected subset of ideas was funded by the CEC and through California Public Utility Commission (CPUC) public goods charge funds. The CEC also placed priority on some additional proposed revision areas that were beyond the resources of the CEC and utilities to develop – inviting private proponents of those revisions to sponsor completion of the evaluation and developmental work.

The next step was to prepare more detailed reports on each of the proposed revision areas to fully investigate the feasibility and cost effectiveness of the potential revisions, completing the information in the Measure Information Templates in detail. Once the technical reports for each proposed revision area were completed, workshops were scheduled. Typically, six to eight reports were addressed in each workshop. In some cases, the reports were revised based on public comment and reviewed again at a subsequent workshop.

During the public workshops on the investigation of feasibility and cost effectiveness of the potential revisions to the standards, the CEC received a large number of comments related to improving the conceptual approach of the potential revisions. Based on these comments, the CEC developed draft standards and held two public workshops to obtain public comments. The CEC received numerous ideas for revision, and they extensively revised the draft standards to respond to those comments. During the course of this process, the CEC also has received many letters, email, and verbal comments on the potential standards and ideas for improving them.

At this stage a formal rulemaking proceeding was conducted in compliance with the California Administrative Procedures Act and California Building Standards law. (It should be noted that the CEC’s enabling legislation, the Warren-Alquist Act, has extensive requirements for ensuring public input in CEC decision-making, and as a result the CEC has a reputation for conducting extremely open public proceedings). The CEC opened the rulemaking with "express terms" that were released for a 45-day comment period (known in California as the "45-day language"). The CEC held hearings at the middle and end of that period. It then responded to the public comment and released a revised version for another review period of at least 15 days (this draft is known as the 15-day language). The CEC then held an adoption hearing at the end of the proceeding. The rulemaking proceeding included public consideration and adoption of the standards (Title 24, Part 6), administrative regulations for the standards (Title 24, Part 1), and supporting documents, including the Residential Alternative Calculation Method Approval Manual, Nonresidential Alternative Calculation Method Approval Manual, and Joint Appendices. Concurrent with the rulemaking proceeding, the CEC completed a public review of the Environmental Impact Report required by the California Environmental Quality Act for state regulations. The standards revisions are the result of this extended interactive process. The standards have been extensively shaped by response to public comments and ideas.

Stakeholders in the process wrote several letters to the CEC expressing their appreciation of the openness and fairness of the process. The following are some examples of comments received:

> "In this round of the standards I think the CEC has set a whole new precedent where the proposals that were put forth were asked to not only be cost effective, they were asked to account for market conditions, demonstrate that the measures were ready for prime time, that the market was mature enough, that it was enforceable….And I think that's one of the reasons why this whole round of standards has been, in many ways, more rational, more open, more fair than most standard setting processes that I've ever been involved with." (Doug Mahone, Heschong Mahone Group, September 4, 2003, hearing)

> "It's been extremely well organized, considering the vast number of questions, different issues, and everything else that have come up. It's been handled extremely well, and that's not to say … we weren't required to make technical points and support them vigorously. But it was amazing how much information got through and how little angst was generated in the process…." (Michael Day, Rockwood Consulting, September 4, 2003, hearing)

> "This has been a long road and I think it's been actually a very positive and cooperative road …CBIA is here to offer their endorsement for adoption of the proposed language…." (Mike Hodgson, California Building Industry, September 4, 2003, hearing)

> "The changes that are proposed are very comprehensive, covering all areas of energy use including the building shell, the lighting, HVAC, and building controls … overall, we're just very excited about these changes. And we are very supportive of them." (Jim Parks, Sacramento Municipal Utility District, September 4, 2003, hearing):

Collaborating with the Utilities

Of the standards changes that were extensively evaluated by the CEC during the revision process, many were sponsored by the Pacific Gas and Electric Company (PG&E) through its statewide public goods funded Codes and Standards Enhancements (CASE) program. The collaboration is an excellent example of how public and private interests can work toward a common good. One of the more significant outcomes of the partnership was the change from source energy to TDV. It also shows how utilities can enhance the standards improvement process to an extent greater than the CEC or environmental interest groups can do alone.

In the late 1970s, subsequent to the first national energy crisis, the CPUC formally ordered the state's investor-owned utilities to offer energy-efficiency programs. These early programs were mostly informational and educational (energy-efficiency audit based). Financial incentives (rebates) were added in the mid 1980s to help influence consumers to purchase more efficient products than they would otherwise have selected for their homes and commercial buildings. By the early 1990s, when utility energy-efficiency programs reached their highest level of sophistication and effectiveness, PG&E program developers recognized an evolutionary improvement model, which took improvement opportunities from the research and development phase, through demonstration, commercialization, and incentives to help build market share, to widespread acceptance and eventual inclusion in applicable codes and standards.

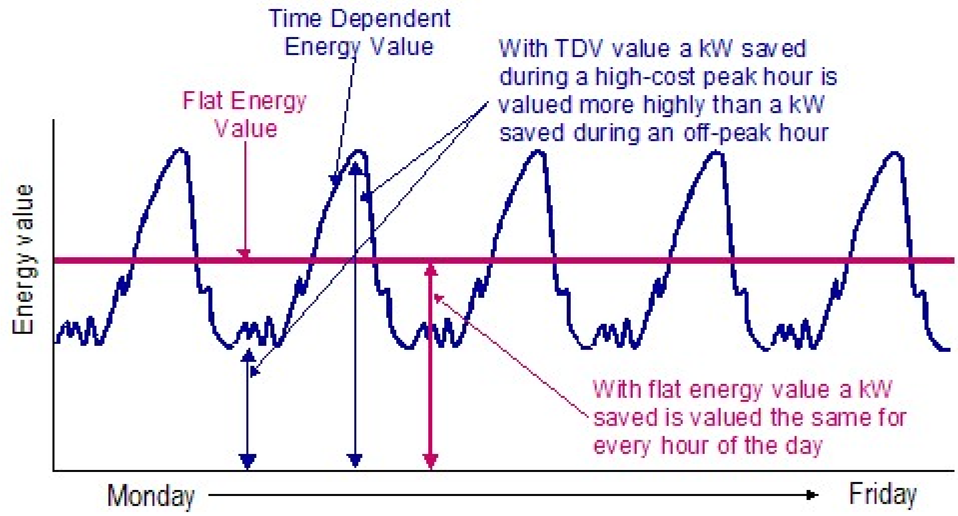
The CPUC's regulatory policy goal of the early 1990s was one of "resource acquisition," where utilities were rewarded for influencing the selection of appliances, building materials, and design practices that were more efficient than the standard (or what would otherwise have been selected). With savings estimates based on the standards, it was not particularly in utilities' self-interest to pursue raising the standards, as that would reduce savings and the utilities' rewards for their efforts. Nonetheless, PG&E efficiency program managers aided the CEC on an ad-hoc basis by providing information on the market effects and results obtained through the efficiency incentives programs. This information and advocacy aided the CEC's staff in supporting arguments for improving the standards.

In the late 1990s, the regulatory policy goal changed from resource acquisition to market transformation. In this paradigm, the objective was not so much to count the "widgets" with their associated savings, but to bring about a permanent improvement in efficiency where support for building the market for greater efficiency through incentives could be eventually eliminated by an "exit strategy." With utility rewards no longer tied to savings measured against a baseline, PG&E program planners reasoned that program effectiveness in the market transformation paradigm would be greatly enhanced by a more focused codes and standards improvement effort.

PG&E's energy standards program was proposed to the CPUC in October 1997. It offered to form the foundation of market transformation efforts at PG&E by focusing on capturing the fruits of equipment, materials, and design practices market transformation program work in the appropriate state and federal energy standards. PG&E had done a good job in the past of working with the CEC and other standards-setting bodies, but these ad-hoc efforts could be made more effective if a focused program were initiated, featuring better representation and the development of technical supporting material that would be better integrated into the energy-efficiency standards modification processes.

In particular, this program planned to address the idea of changing the economic basis of Title 24 from "Source Energy Values" to "Seasonally and Time Differentiated Source Energy Values," which later became known as Time Dependent Valuation (PG&E 2002). This peak demand reduction initiative later became particularly important relative to the California electric energy crisis of 2001. TDV was probably the single most significant change to the 2005 efficiency standards, and the first major revision to the economic basis of the standards since they were developed in 1978. This change was proposed by PG&E primarily to try to provide increased utility electric and gas asset use (by building) for inclusion in the energy code with an emphasis on decreasing demand relative to overall energy use. The resulting economic benefits would be returned to customers through the lower costs associated with the need to provide facilities of high capacity – where the cost of high capacity facilities is largely recovered over a long time, based on the total energy delivered and sold through them.

Figure 1. Concept of Time Dependent Valuation (TDV)



Source: http://h-m-g.com/TDV/index.htm

While initially funded by the CPUC, the fledgling energy standards program has not been without its challenges. PG&E energy-efficiency department top-management, and later the CPUC, questioned why public purpose funds were needed to help the CEC "do its job." In 2002, the CPUC's policy goals had reverted from market transformation back to resource acquisition, in light of the immediate challenge presented by the energy crisis. Sadly, the energy standards program was targeted for elimination, in deference to other programs that were perceived to bring more immediate benefits and be more visible to utility customers.

The CEC is simultaneously charged with the responsibility for providing for a high level of energy efficiency in the state and overseeing the code improvement process. The competing low-first-costs interests of industry and the market must be balanced with the longer-term operational cost savings associated with greater energy-efficiency. Faced with this challenge, the CEC presented comments in PG&E's efficiency program case with the CPUC, which supported and highly valued the utility's involvement in the standards improvement process.

Fortunately, reason prevailed in the decision-making process, and the extraordinarily cost-effective codes and standards program was preserved. The energy codes and standards program continues as an essential part of PG&E's public purpose energy-efficiency program portfolio. Since the evolution of efficiency improvement is continuous, new opportunities are readily available to be addressed by utility incentive programs, leading the way to future and continuing code improvements.

What's New and Different

This section describes the most significant changes that were adopted.

All Buildings

- *TDV.* Source energy (which has served California well) was replaced with TDV energy. TDV energy values energy savings greater during periods of likely peak demand, such as hot summer weekday afternoons, and values energy savings less during off peak periods. TDV gives more credit to measures such as daylighting and thermal energy storage that are more effective during peak periods.
- *New Water Heater and Air-Conditioner Standards.* Coincident with the 2005 standards, new standards for water heaters and air conditioners took effect. These changes affect all residential buildings but also affect many commercial buildings that use water heaters and/or "residential size" air conditioners.

Residential Buildings

- *Efficient Lighting*. High efficacy lighting (e.g., fluorescent) is required for all permanent lighting applications or controls; high efficacy is required in kitchens; high efficacy or motion sensor is required in bathrooms, utility rooms, garages, laundry rooms; high efficacy or combined photo sensor/motion sensor is required for exterior lights; high efficacy, or dimmer is required for other lighting; and airtight type IC luminaires are required in recessed ceilings.
- *Duct Insulation*. Insulation levels depend on climate zones: R-4.2 is required for mild climates, R-6 is required for moderately hot summer and cold winter climates, and R-8 is required for deserts and mountains.
- *Pipe Insulation*. Hot water pipes greater than ¾ in. diameter in the kitchen are required to have an inch of insulation.
- *Loopholes Closed*. Credit is no longer given for reduced glazing area or for using a central water heating system in multi-family buildings.
- *Replacement Windows*. These have to meet the same requirements as windows in new buildings.
- *Duct Sealing*. Ducts must be tested and verified to have low leakage when the air conditioner/furnace is replaced or ducts are replaced
- *Compliance Credit*. High EER air conditioners, gas cooling, high quality insulation installation, properly sized air conditioners, efficient air conditioner fan motors, and ducts buried in attic insulation may be used to comply with the performance standards.
- *Third-Party Field Verification*. Procedures for third-party testing and verification are improved, and new verification protocols are added to encourage quality insulation installation.

Nonresidential Buildings

- *Water Cooled Chillers*. Large chilled water plants weighing more than 300 tons must be water-cooled.
- *Cooling Towers*. The use of centrifugal cooling towers is restricted.
- *Cool Roofs*. The nonresidential prescriptive standards require cool roofs (high reflectance and high emittance) in all low-slope applications. The cool roof requirements also apply to roof replacements in existing buildings.

- *Acceptance Requirements*. Basic "building commissioning" is required for electrical and mechanical equipment that is prone to be installed improperly, such as economizers, daylighting controls, and occupant sensors.
- *Demand Control Ventilation*. Controls that measure CO_2 concentrations, and vary outside air ventilation, are required for spaces such as conference rooms, dining rooms, lounges, and gyms.
- *T-Bar Ceilings*. Placing insulation directly over suspended ceilings is not permitted as a means of compliance, except for limited applications, since the suspended ceiling does not provide an adequate air barrier and insulation is not continuous.
- *Relocatable Public School Buildings.* Climate-independent insulation requirements are added for relocatable classrooms since they can be moved to any climate zone.
- *Duct Efficiency.* R-8 duct insulation and duct sealing with field verification is required for ducts in unconditioned spaces. This requirement applies to new buildings but also to existing buildings when the air conditioner is replaced.
- *Indoor Lighting*. The lighting power limits for interior lighting are reduced in response to advances in lighting technology.
- *Skylights for Daylighting in Buildings*. Skylights with controls to shut off the electric lights are required for top story of large, open spaces (spaces larger than 25,000 ft² with ceilings higher than 15 ft).
- *Thermal Breaks for Metal Building Roofs*. Continuous insulation or thermal blocks at the supports are required for metal building roofs.
- *Efficient Space Conditioning Systems.* A number of measures are required that improve the efficiency of HVAC systems, including variable speed drives for fan and pump motors greater than 10 hp, electronically commutated motors for series fan boxes, better controls, efficient cooling towers, and water cooled chillers for large systems.
- *Unconditioned Buildings*. Lighting controls and power limits apply to unconditioned buildings, including warehouses and parking garages. Lighting power tradeoffs are not permitted between conditioned and unconditioned spaces.
- *Compliance Credits.* Compliance credit established for gas cooling and underfloor ventilation.

Outdoor Lighting

- *Lighting Power Limits*. The standards set limits on the power that can be used for outdoor lighting applications such as parking lots, driveways, pedestrian areas, sales canopies, and car lots. The limits vary by lighting zones that recognize varying ambient levels in nature preserves, rural areas, urban areas, and areas with high intensity nighttime use. Lighting power tradeoffs are not permitted between outdoor lighting and indoor lighting.
- *Shielding*. Luminaires in hardscape areas larger than 175 W are required to be cutoff luminaries, which will save energy by reducing glare.

Signs

- *Lighting Requirements*. Lighting power limits or alternative equipment efficiency requirements apply to externally and internally illuminated signs used either indoors or outdoors.

Summary

The average power plant in California is about 250 MW — 300 MW. The CEC estimates that the 2005 standards will reduce growth in demand by 181 MW. If these savings are combined with the recently adopted 2001 standards, peak demand is reduced by 400 MW every year. This means that every nine months, California can defer construction of a new power plant from these changes alone. Not only are these changes good in terms of the electricity grid, they also save owners money and create buildings that are more comfortable and productive.

The process pursued in California is a model for how utilities can work with state energy offices to develop more effective standards. Indeed, the process shows how all stakeholders can be more effectively engaged in the process and encouraged to work more cooperatively with the standards writers.

The California standard breaks new ground in a number of significant ways. TDV provides a better "currency" for performance evaluation, giving proper weight to design strategies and technologies that reduce peak demand. Extending the role of third-party inspectors (HERS raters) takes a burden from building officials and brings better diagnostic and verification skills to the code enforcement process. Nonresidential requirements for acceptance testing add verification and testing requirements to building equipment and controls that are prone to failure. Requiring skylights (with lighting controls) in large, high volume spaces breaks the paradigm of restricting glass and moves toward encouraging low-cost integrated solutions. New requirements for chilled water plants for the first time require large plants to be water cooled, restrict the use of centrifugal cooling towers, and encourage many other energy efficiency measures. Outdoor lighting and signs are regulated in California for the first time and the concept of lighting zones is introduced, whereby less lighting is permitted in areas with ambient darkness.

The California 2001 standard has been shown to be about 12% more stringent than American Society of Heating Air-conditioning Engineers (ASHRAE) Standard 90.1-1999/2001 (Eley 2001). The changes discussed in this paper result in an additional 10.7% improvement between the California 2001 and 2005 standards.[6] This means that the 2005 California standard is more than 20% more stringent than ASHRAE. California has clearly shown that this level of stringency is cost effective, justified, and even supported by the building industry. This raises the bar for ASHRAE Standard 90.1, the International Energy Conservation Code (IECC) and other organizations.

[6] Based on electricity savings.

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