Impact Analysis

2008 Update to the California Energy Efficiency Standards for Residential and Nonresidential Buildings

November 7, 2007

Prepared for

California Energy Commission
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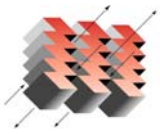

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Acknowledgements

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Executive Summary

This report estimates the statewide impacts of proposed changes to the California Energy Efficiency Standards on a regional and statewide basis. The estimates are based on the 45-day draft of the Standards as of about October 31, 2007.

Table 1 has a summary of the savings. For each year of construction activity (in both newly constructed buildings and alterations to existing buildings) the proposed standards are estimated to reduce the growth in electricity by 561.2 GWh and to reduce the growth in peak demand by 131.8 MW. In addition, natural gas use is expected to be reduced by 19.0 million therms. The savings will accumulate as the Standards affect each subsequent year of construction.

The savings result from changes to both the residential and nonresidential standards as well as new requirements for outdoor lighting and refrigerated warehouses. The standards affect both newly constructed buildings as well as alterations to existing buildings. Alterations are a significant part of the savings. These savings result from retrofit insulation requirements for existing roofs and the requirement that renovated lighting systems meet the new requirements.

More detail of the savings is provided in later tables. Electricity energy savings are summarized in Table 2, electric demand savings in Table 3, and gas savings in Table 4.

Table 1 – Savings Summary

	Electricity		Demand		Gas	
	Savings (GWh)	Percent of Total	Savings (MW)	Percent of Total	Savings (millions therms)	Percent of Total
Single-Family Newly Constructed Buildings and Alternations	97.9	17.8%	33.5	25.7%	6.8	36.1%
Multi-Family Newly Constructed Buildings and Alternations	4.3	0.8%	3.1	2.4%	0.6	3.4%
Nonresidential Newly Constructed Buildings	151.2	27.6%	48.0	36.9%	3.3	17.2%
Nonresidential Alterations	270.5	49.3%	45.4	34.9%	8.2	43.3%
Refrigerated Warehouses	15.6	2.8%	1.8	1.4%	0.0	n. a.
Outdoor Lighting	21.7	3.9%	n. a.	n. a.	0.0	n. a.
Grand Total	561.2	n. a.	131.8	n. a.	19.0	n. a.

Low-rise Residential Newly Constructed Buildings and Alterations

The first-year savings for single-family homes are 97.9 GWh, 33.5 MW and 6.8 million therms of gas. For low-rise multi-family buildings, the first-year electricity savings are 4.3 GWh, the first-year demand savings are 3.1 MW, and the first-year gas savings are 0.6 million therms.

Looking at the entire low-rise single-family detached homes, electricity use is reduced by 22.7% compared to the 2005 Standards, peak demand is reduced by 8.2% and gas is reduced by 10.0%. These percent savings are relative to heating, cooling, lighting and water heating only and do not include other appliances, outdoor lighting that is not attached to buildings, plug loads, or other energy uses.

Single-family estimates are based on 108,021 housing starts each year; multi-family estimates are based on 37,506 housing starts. These data are from the Construction Industries Research Board (CIRB).

Building envelope, HVAC and water heating savings for low-rise residential were calculated using the prototype approach similar to the method used for previous standards updates, although this time multiple prototypes were used to better approximate the nature of construction activity. The savings for each prototype

in each climate were weighted by estimated annual housing starts in each climate to yield an estimate of statewide savings.

Nonresidential Newly Constructed Buildings

The first-year savings for newly constructed nonresidential buildings are 151.2 GWh, 48.0 MW, and 3.3 million therms of gas, representing reductions from the 2005 Standard of 4.9%, 7.2%, and 9.4%, respectively. The savings for nonresidential buildings were calculated using the nonresidential new construction (NRNC) database. A total of 968 buildings were modeled in minimum compliance with the 2005 and 2008 Standards. The buildings in the database occur in each of the 16 climate zones and represent 13 building types. Each site in the sample has a statistical weight attached to it due to the portion of total construction activity that is represented by that building. Nonresidential savings estimates are based on anticipated annual growth of 180.5 million ft² of newly constructed buildings and additions to existing buildings each year.

Alterations to Existing Nonresidential Buildings

Savings for alterations to existing buildings are quite significant, representing almost half of the total electricity savings. First-year electricity savings are expected to be 270.5 GWh, first-year demand reduction is 45.4 MW and first-year gas savings are 8.2 million therms. Most of the energy savings are related to improvements in interior lighting and a new retrofit roof insulation requirement.

Refrigerated Warehouses

The standards also include new provisions for refrigerated warehouses. About 1.3 million ft² new refrigerated warehouses are expected to be constructed each year in the California market. The standards are expected to save 15.6 GWh in the first year.

Outdoor Lighting

The standards regulate outdoor lighting were updated from their original adoption with the2005 Standards. First-year electricity savings are estimated to be 21.7 GWh. There is no impact on gas use savings for outdoor lighting. Peak demand savings are not estimated for the outdoor lighting standards since the California system peak generally occurs during August or September late afternoon hours. However, the California winter peak which occurs after dark in the winter can cause serious electricity system problems and the outdoor lighting standards will affect this peak.

Table 2 – Summary of First-Year Electricity Savings (GWh)

	2005 Standard	2008 Standard	Savings	Percent Reduction from Baseline	Percent of Total Savings
Single-Family Newly Constructed Buildings and Alternations					
	n. a.	n. a.	97.9	22.7%	17.8%
Multi-Family Newly Constructed Buildings and Alternations					
	n. a.	n. a.	4.3	19.7%	0.8%
Nonresidential Newly Constructed Buildings					
Heating	33	21	12	37.2%	2.3%
Cooling	392	360	32	8.3%	5.9%
Lights	822	726	96	11.7%	17.6%
Fans	646	636	10	1.5%	1.8%
Refrigeration	329	329	0	0.0%	0.0%
Equipment	847	847	0	0.0%	0.0%
Water Heating	n. a.	n. a.	n. a.	n. a.	0.0%
Total	3,070	2,919	151	4.9%	27.6%
Nonresidential Alterations					
Interior Lighting	n. a.	n. a.	186.0	n. a.	33.9%
Cool Roofs and Insulation	n. a.	n. a.	84.5	n. a.	15.4%
Total	n. a.	n. a.	270.5	n. a.	49.3%
Refrigerated Warehouses	n. a.	n. a.	15.6	n. a.	2.8%
Outdoor Lighting	n. a.	n. a.	21.7	n. a.	3.9%
Grand Total	n. a.	n. a.	561.2	n. a.	n. a.

Table 3 – Summary of First-Year Electric Demand Savings (MW)

	2005 Standard	2008 Standard	Savings	Percent Reduction from Baseline	Percent of Total Savings
Single-Family Newly Constructed Buildings and Alterations					
	n. a.	n. a.	33.5	8.2%	25.7%
Multi-Family Newly Constructed Buildings and Alterations					
	n. a.	n. a.	3.1	7.4%	2.4%
Nonresidential Newly Constructed Buildings					
Heating	1	1	0	38.2%	0.4%
Cooling	215	195	20	9.3%	15.4%
Lights	144	120	24	16.4%	18.1%
Fans	136	132	4	2.9%	3.0%
Refrigeration	40	40	0	0.1%	0.0%
Equipment	0	0	0	0.0%	0.0%
Water Heating					
Total	667	619	48	7.2%	36.9%
Nonresidential Alterations					
Interior Lighting	n. a.	n. a.	45.4	n. a.	34.9%
Cool Roofs and Insulation	n. a.	n. a.	n. a.	n. a.	n. a.
Total	n. a.	n. a.	45.4	n. a.	34.9%
Refrigerated Warehouses	n. a.	n. a.	1.8	n. a.	n. a.
Outdoor Lighting	n. a.	n. a.	n. a.	n. a.	n. a.
Grand Total	n. a.	n. a.	131.8	n. a.	n. a.

Table 4 – Summary of First-Year Gas Savings (millions Therms)

	2005 Standard	2008 Standard	Savings	Percent Reduction from Baseline	Percent of Total Savings
Single-Family Newly Constructed Buildings and Alternations					
	n. a.	n. a.	6.8	10.0%	36.1%
Multi-Family Newly Constructed Buildings and Alternations					
	n. a.	n. a.	0.6	7.0%	3.4%
Nonresidential Newly Constructed Buildings					
Heating	20	17	3	15.9%	17.0%
Cooling	0	0	0	9.3%	0.0%
Lights	n. a.	n. a.	0	n. a.	0.0%
Fans	n. a.	n. a.	0	n. a.	0.0%
Refrigeration	n. a.	n. a.	0	n. a.	0.0%
Equipment	n. a.	n. a.	0	n. a.	0.0%
Water Heating	7	7	0	0.0%	0.0%
Total	35	31	3	9.4%	17.2%
Nonresidential Alterations					
Interior Lighting	n. a.	n. a.	0.0	n. a.	0.0%
Cool Roofs and Insulation	n. a.	n. a.	8.2	n. a.	43.3%
Total	n. a.	n. a.	8.2	n. a.	43.3%
Refrigerated Warehouses	n. a.	n. a.	0.0	n. a.	n. a.
Outdoor Lighting	n. a.	n. a.	0.0	n. a.	n. a.
Grand Total	n. a.	n. a.	19.0	n. a.	n. a.

Emissions

The standard is expected to have a significant impact on reducing greenhouse gas and other air emissions. The estimates are shown in Table 5. Carbon dioxide, one of the more significant greenhouse gases, would be reduced by 473,282 tons each year. These estimates are based, when possible, on hourly emission rates for electricity use in southern and northern California. When savings estimates are made on an annual basis, average emission rates are used.

Table 5 – Summary of Air Emissions Reductions

	Emission Reductions				
	NO_X (lb)	SO_X (lb)	CO (lb)	CO_2 (tons)	PM_{10} (lb)
Single-Family Newly Constructed Buildings and Alternations	79,333	138,818	43,054	97,805	14,290
Multi-Family Newly Constructed Buildings and Alternations	6,761	8,459	2,942	6,445	991
Nonresidential Newly Constructed Buildings	59,289	165,208	44,541	144,263	20,051
Electricity	29,336	143,329	34,774	126,092	16,795
Gas	29,952	21,879	9,767	18,171	3,256
Nonresidential Alterations	118,231	311,587	86,831	202,410	28,312
Electricity	42,766	256,464	62,222	156,628	20,109
Gas	75,464	55,123	24,608	45,782	8,203
Refrigerated Warehouses	5,975	14,789	3,588	9,360	936
Outdoor Lighting	8,298	20,538	4,983	12,999	1,300
Grand Total	277,887	659,398	185,939	473,282	65,880

Low-Rise Residential Newly Constructed Buildings and Alterations

The impact of implementing the residential envelope, HVAC, and water heating measures of the 2008 Standards was estimated using a prototype approach. With this approach, three prototypes are used, two for single-family homes and one for multi-family homes. Each prototype is made to minimally comply with the 2005 and 2008 Standards, and the results are weighted by anticipated housing starts in each climate zone.

Standards Requirements

The changes to the Standards that are assumed to result in savings are described in the following sections. Compliance options or "credits" are not considered since these are assumed to be energy neutral.

Building Envelope and HVAC Measures

Measure	***Modeling Notes***
Residential Fenestration. The fenestration requirements are updated for package D, the basis of the standard design building.	The lower U-factor and SHGC are modeled through the ACM algorithms.
Unconditioned Zone (Attic) Model. The residential ACM incorporates a new algorithm for modeling heat transfer through the roof to an unconditioned attic.	The UZM is used for both the 2005 and 2008 prototypes, so changes in modeling assumptions have no impact.
Cool Roofs. Requires cool roofs with a minimum aged reflectance of 0.25 in climate zones 10,11,13,14 and 15. The default aged reflectance is 0.08.	The prototype buildings have an attic and the benefits of cool roofs are accounted for through this model
Charge Indicator Light (CIL). The 2005 Standards allow a TXV in lieu of verifying refrigerant charge. The TXV exception is eliminated and replaced with a CIL.	The effect of this change is not accounted for in the analysis.
Slab Edge Modeling. A revised procedure for modeling heat flow through the slab considers weekly and monthly variation in ground temperatures.	The revised slab model is used for both the 2005 and the 2008 prototypes and has no impact.
Residential IAQ Ventilation. This measure requiring mechanical ventilation adopts requirements of ASHRAE 62.2-2007, requiring that residential buildings have mechanical ventilation, such as a whole-house exhaust, or ducted supply system.	Mechanical ventilation is modeled through the use of an exhaust fan sized to exactly meet the air flow rate specified in ASHRAE Standard 62.2-2007. The fan is assumed to operate continuously at the power ratio of 0.25 W/cfm. The mechanical fan shows up as additional electricity savings, but this is offset somewhat since infiltration is assumed to be lower for the 2008 house, compared to the 2005 house. The SLA for the 2008 prototype is assumed to be 0.5 lower than the 2005 house.

Measure	***Modeling Notes***
Residential Pools. (114) This mandatory measure requires two-speed motors on residential pool pumps over 1 hp, sets maximum suction and return velocities and other pipe design criteria and indicates that multi-port valves (MPVs) be sized to manufacturer's recommendations.	These savings are not included.
Programmable Communicating Thermostats (PCTs) – this mandatory measure requires PCTs that are capable of setting back thermostats 1F to 4F in response to emergency events.	These savings are not included.

Methodology

Prototype Buildings

The energy and electric demand impact of implementing the 2005 building envelope, HVAC, and water heating requirements is estimated through the use of three prototype buildings: two representing all single-family construction and one representing all multi-family construction. Each prototype building is made to minimally comply with the 2005 and the 2008 Standards. Heating, cooling, and water heating energy use is modeled using MICROPAS v7.34p. The analysis is completed for all 16 California climate zones, and the results are then weighted by the estimated number of housing starts in each zone.

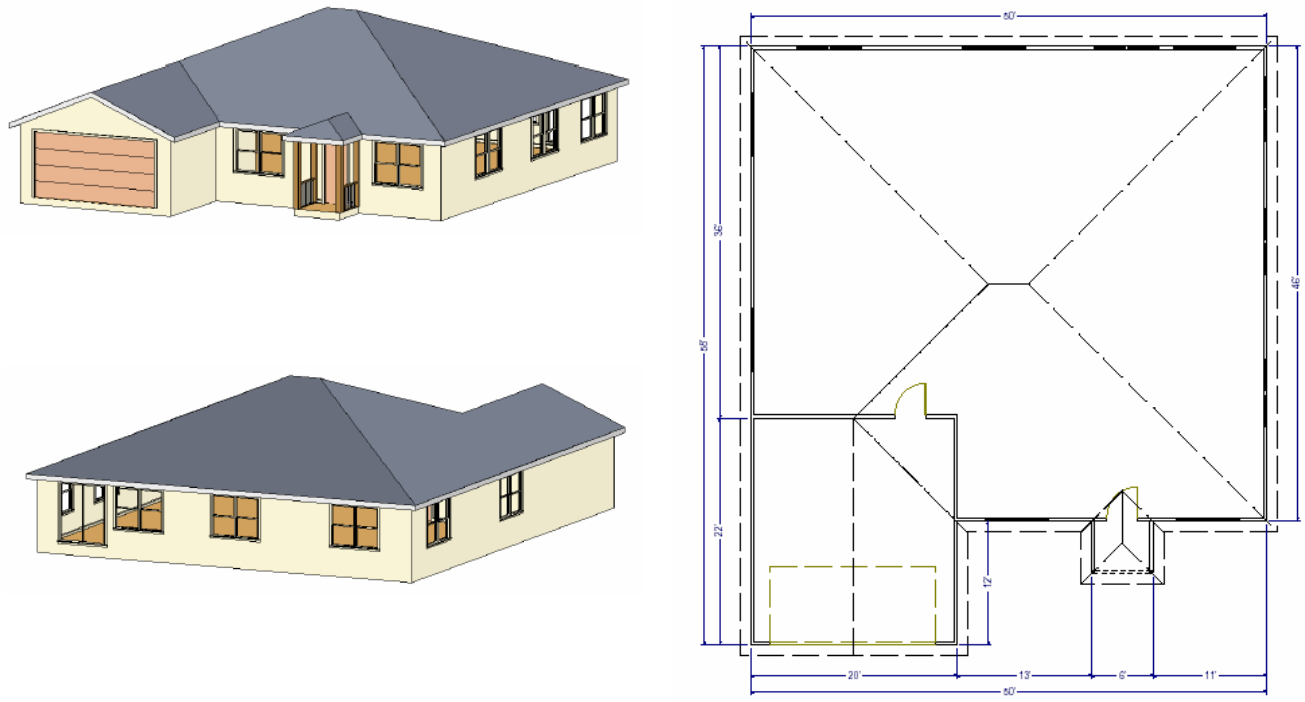

Figure 1 – Low-rise Residential Prototype C

Figure 2 – Low-rise Residential Prototype D

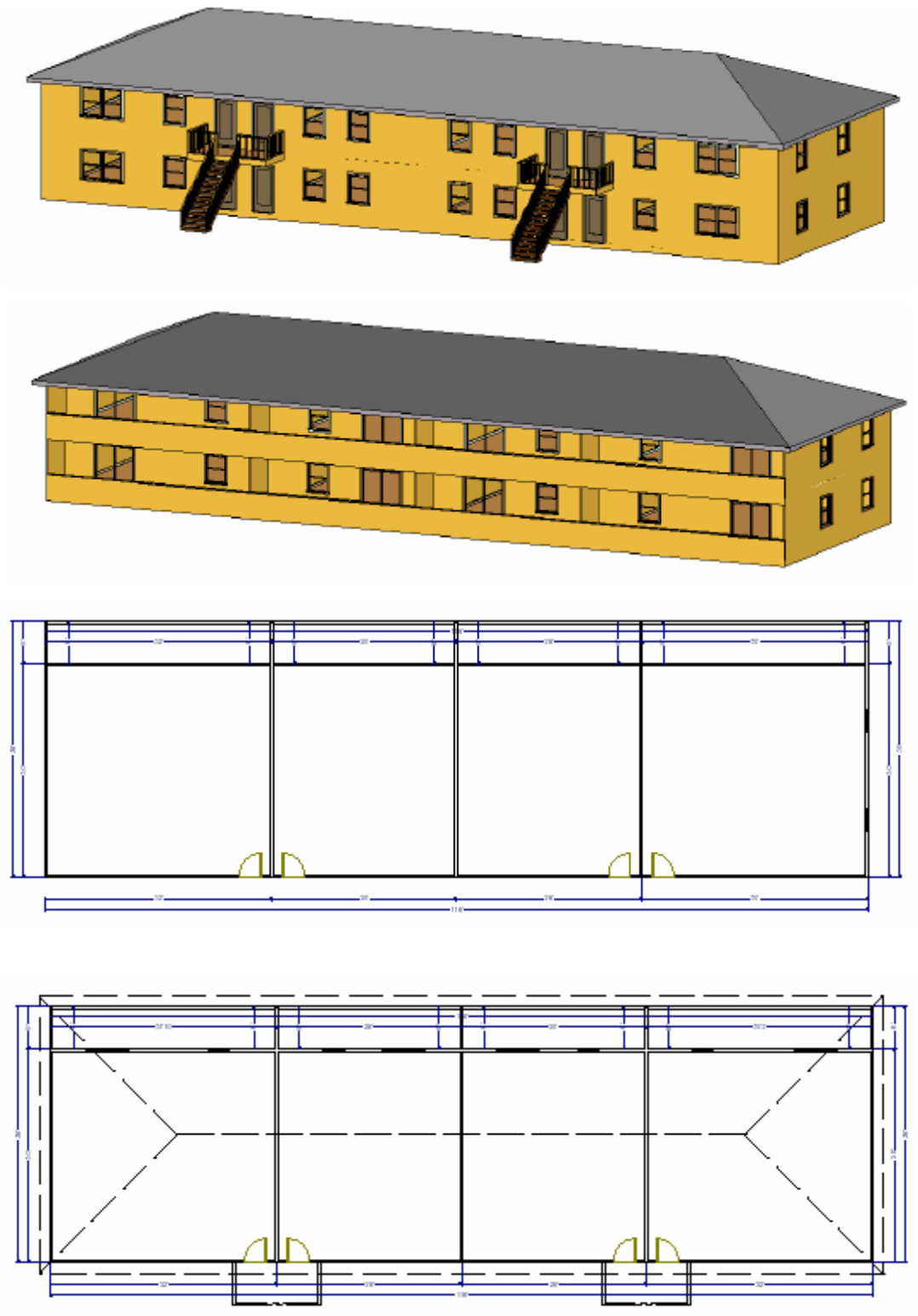

Figure 3 – Low-rise Residential Prototype E

Glazing Area

The glazing area in each prototype is based on a statewide average of 17.3% of the floor area for single-family and 14.5% for multifamily.

Analysis and Detailed Results

Prototype Savings

Table 6, Table 7. and Table 8 show the first-year TDV savings by end use and climate zone for each of the prototype buildings. This data is normalized on a per square foot basis for easy comparison. Space heating and cooling savings are quite significant, resulting primarily from the requirement for more high performance windows. Water heating savings were minor and not evaluated, so these savings are zero.

Table 9 and Table 10 show the first-year gas and electricity savings for single-family and multi-family buildings, respectively. This data is presented on a statewide basis and includes weighting by housing starts. These tables also show estimates of emissions reductions.

Table 11 shows the estimated housing starts for both single-family and multi-family buildings. It is estimated that 108,021 newly constructed single-family homes and 37,506 multi-family homes will be constructed each year in California. This data is taken from the Construction Industries Research Board (CIRB). Construction activity is greatest in the Central Valley and other inland areas of the state. In climate zone 12 (Sacramento area) for instance, 18,641 newly constructed single-family homes are expected to be built each year. Another 16,661 are anticipated for climate zone 10, with 14,095 estimated for climate zone 13. Statewide energy savings projections are based on these anticipated housing starts. It is estimated that 67% of the multi-family housing starts are low-rise and the remaining 33% are high-rise.[1]

Table 6 – 2,100 ft² Single-Family First-Year TDV Savings by Climate Zone and End Use (kTDV/ft²)

Climate Zone	Space Heating	Space Cooling	Fan	Water Heating	Total
1	5.21	0.06	-0.65	0.00	4.62
2	5.04	1.99	-0.65	0.00	6.38
3	5.09	0.39	-0.65	0.00	4.83
4	6.05	0.43	-0.65	0.00	5.83
5	0.11	2.31	-0.65	0.00	1.77
6	-0.33	3.11	-0.65	0.00	2.13
7	2.97	0.19	-0.82	0.00	2.34
8	3.09	1.96	-0.65	0.00	4.40
9	3.11	3.46	-0.65	0.00	5.92
10	2.48	8.05	-0.64	0.00	9.89
11	5.30	10.47	-0.65	0.00	15.12
12	4.90	5.98	-0.65	0.00	10.23
13	3.72	12.21	-0.65	0.00	15.28
14	5.23	12.26	-0.64	0.00	16.85
15	0.89	27.97	-0.64	0.00	28.22
16	8.32	2.91	-0.65	0.00	10.58
Average	3.82	5.86	-0.66	0.00	9.02

[1] U.S. Census Bureau, http://www.census.gov/const/C25Ann/mfbfloorsall.pdf

Table 7 – 2,700 ft² Single-Family First-Year TDV Savings by Climate Zone and End Use (kTDV/ft²)

Climate Zone	Space Heating	Space Cooling	Fan	Water Heating	Total
1	6.27	-0.03	-0.65	0.00	5.59
2	6.00	2.79	-0.65	0.00	8.14
3	5.76	0.65	-0.66	0.00	5.75
4	6.64	0.67	-0.66	0.00	6.65
5	2.18	3.40	-0.65	0.00	4.93
6	0.82	3.17	-0.66	0.00	3.33
7	3.34	0.39	-0.83	0.00	2.90
8	3.43	2.55	-0.66	0.00	5.32
9	3.51	4.39	-0.65	0.00	7.25
10	3.10	8.51	-0.65	0.00	10.96
11	6.18	11.04	-0.65	0.00	16.57
12	5.71	6.95	-0.65	0.00	12.01
13	4.48	12.35	-0.66	0.00	16.17
14	6.32	12.54	-0.65	0.00	18.21
15	1.36	27.38	-0.65	0.00	28.09
16	10.16	3.35	-0.65	0.00	12.86

Table 8 – Multi-Family First-Year TDV Savings by Climate Zone and End Use (kTDV/ft²)

Climate Zone	Space Heating	Space Cooling	Fan	Water Heating	Total
1	4.67	0.01	-0.73	0.00	3.95
2	4.72	2.43	-0.73	0.00	6.42
3	4.17	0.44	-0.74	0.00	3.87
4	5.15	0.60	-0.73	0.00	5.02
5	1.85	2.76	-0.73	0.00	3.88
6	0.70	2.67	-0.74	0.00	2.63
7	2.07	0.26	-0.93	0.00	1.40
8	2.30	2.17	-0.74	0.00	3.73
9	2.36	3.69	-0.73	0.00	5.32
10	2.23	7.28	-0.73	0.00	8.78
11	5.05	9.51	-0.73	0.00	13.83
12	4.62	5.97	-0.73	0.00	9.86
13	3.49	10.74	-0.74	0.00	13.49
14	5.05	11.00	-0.73	0.00	15.32
15	0.84	24.32	-0.73	0.00	24.43
16	8.60	2.62	-0.73	0.00	10.49
Average	3.62	5.40	-0.75	0.00	8.28

Table 9 – Statewide Impact – Single-Family

	Energy and Demand			Emissions				
Climate Zone	Gas Savings (MBtu)	Electricity (MWh)	Demand (MW)	NOX (lb)	SOX (lb)	CO (lb)	CO_2 (tons)	PM_{10} (lb)
1	3759	47	0.02	349	297	124	234	40
2	19245	738	0.33	1871	1993	747	1499	243
3	29566	355	0.46	2750	2323	969	1843	319
4	29923	414	-0.09	2788	2403	993	1901	323
5	1676	261	1.22	193	360	110	242	36
6	1119	920	3.92	272	947	245	650	85
7	13535	-87	0.10	1233	827	386	732	129
8	22561	542	0.17	2188	2030	801	1663	271
9	21867	1212	0.91	2234	2618	935	2016	312
10	79886	12828	4.75	9759	17529	5347	12822	1843
11	55045	5855	1.88	6039	9250	2998	6654	998
12	147352	10587	4.03	15200	19939	6856	14529	2243
13	85707	17879	3.47	10807	22708	6683	15458	2204
14	107981	14328	4.99	12532	20839	6535	15162	2204
15	16882	30142	6.64	6441	29709	7439	18671	2429
16	48352	1891	0.66	4677	5042	1885	3729	611
Total	684457	97914	33.45	79333	138818	43054	97805	14290

Table 10 – Statewide Impact – Multi-Family

	Energy and Demand			Emissions				
Climate Zone	Gas Savings (MBtu)	Electricity (MWh)	Demand (MW)	NOX (lb)	SOX (lb)	CO (lb)	CO_2 (tons)	PM_{10} (lb)
1	250	0	0.00	23	17	8	14	3
2	1732	51	0.04	167	165	64	129	21
3	10976	13	0.33	1008	750	332	631	110
4	8080	42	-0.01	747	583	252	484	83
5	203	14	0.12	21	27	9	20	3
6	437	90	0.72	58	115	34	85	12
7	3220	-96	0.04	286	126	75	141	26
8	8138	115	0.10	790	656	271	583	94
9	9180	495	0.53	950	1086	389	870	134
10	4470	718	0.33	553	981	299	730	104
11	2093	205	0.08	228	335	110	245	37
12	8676	556	0.27	890	1110	388	828	129
13	3476	704	0.16	436	901	266	618	88
14	1973	251	0.10	228	370	117	273	40
15	518	1111	0.31	227	1088	271	680	88
16	1562	46	0.03	150	149	58	113	19
Total	64986	4316	3.15	6761	8459	2942	6445	991

Table 11 – Estimated Housing Starts by Climate Zone

Climate Zone	Single-Family	Multi-Family
1	422	95
2	2351	675
3	3486	4671
4	3081	2809
5	996	205
6	3103	1162
7	2805	2816
8	4454	6303
9	4226	6901
10	18661	3631
11	6433	766
12	18641	3468
13	14095	1849
14	12300	715
15	9472	1102
16	3494	337
Total	108021	37506

Sources: Construction Industry Research Board (CIRB), existing house data from the California Department of Finance (DOF), and CONSOL.

Alterations and Renovations

The projected savings for newly constructed homes are increased by 17% to account for additions and alterations to existing homes. This multiplier is based on the dollar value of 2006 CIRB new single family construction compared to addition/alteration construction dollars.

Residential Lighting

Changes to the 2008 Standards for residential lighting are predominantly clean-up and clarification changes, so savings estimates are not made, although as the Standard is clarified, enforcement and compliance should increase.

Changes for 2008:

- Re-defines high efficacy and low efficacy luminaires for low wattages. See 150(k)1., 2. and 3.
- Specifies minimum 20 Hz frequency for electronic ballasts 13 W or greater. See 150(k)4.
- Requires that permanently installed night lights be high efficacy. See 150(k)5.
- Adds new requirements for switching and controls. See 150(k)6.
- Modifies 50% high efficacy requirement for kitchens. See 150(k)7.
- Limits power to 20 W/ft for lighting internal to cabinets. See 150(k)8.
- Extends high efficacy requirement to closets 70 ft² or larger. See 150(k)9.
- Adds exception for detached storage buildings less than 1,000 ft². See 150(k)10.
- Modifies ICAT requirements. See 150(k)11.
- Expands the control exception for outdoor lighting fixtures. See 150(k)12.
- Internally illuminated address signs shall comply with 148. See 150(k)13.

Nonresidential Newly Constructed Buildings

Standards Requirements

The following sections describe the significant changes to the nonresidential standards, organized by building envelope, HVAC, water heating and lighting.

Envelope

Measure	***Modeling Notes***
Opaque Constructions (Roof, Wall, Floor) §143 – The 2008 Standards have increased the prescriptive envelope requirements for low-rise nonresidential and high-rise residential construction. The criteria of roofs are split into two categories: the metal building, and all others.	Impact modeled with the reference method.
Skylight Thermal Performance §143(c) – The U-factors and SHGC for skylights were lowered slightly from 2005 values, to match default fenestration values in Section 116 of the Standards. This was done to prevent credit for products that are not NFRC certified.	No credit taken.
Skylights §143(c) – The 2005 Standards require that at least 50% of the floor area be under skylights in low rise conditioned or unconditioned buildings with greater than 25,000 square feet of floor area, with ceiling heights greater than 15 ft, and with a lighting power density equal to or greater than 0.5 W/ft^2. The 2008 Standards lowered the threshold for the skylight requirement to buildings greater than 8,000 ft^2 of area.	More spaces in the NRNC database are required to have skylights with daylighting controls and this impact is modeled.
Doors **–** The 2008 Standards added a new prescriptive requirement for doors. U-factor requirements for swinging and non-swinging doors were set based on ASHRAE 90.1-2004 requirements.	Impact modeled with the reference method.
Cool Roofs §143(a)1. – With the 2005 standards, cool roofs are required for all low-slope roof applications. The 2008 Standards removed this requirement for low-sloped, low-rise nonresidential buildings in climate zones 1 and 16, but added a requirement for a minimum aged reflectance of 0.25 for steep-sloped, nonresidential roofs in all climate zones except climate zone 1.	Impact modeled with the reference method.
Loading Docks and Weatherseals §116. – The 2008 Standards added a new mandatory requirement for loading dock weatherseals in climate zones 1 and 16.	No credit taken.
Vestibules §116. – The 2008 Standard added a new mandatory requirement for vestibules for certain applications.	No credit taken.

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[2] From AEC, Insulation Requirements, CASE Final Report, March 2007.

HVAC

Measure	***Modeling Notes***
Equipment Efficiency Updates - §112 – the required efficiency of some types of air conditioning equipment will increase in January 1, 2010. There is also a new class of equipment for single package vertical air conditioners and heat pumps.	Modeled for buildings where this equipment is applicable.
Dual VAV Box Maximum Control for DDC Systems §144(k) – one of five measures that apply to systems with DDC control to the zone level. This prescriptive measure requires that VAV boxes have a separate maximum setpoint in cooling and heating to minimize the amount of reheat required in VAV-reheat systems. The 2005 Standards allow a minimum airflow fraction of 30% of maximum, 0.4 cfm/ft2, or the ventilation minimum. The 2008 Standards eliminate the 0.4 cfm/ft2 option, set limits for airflow in heating, and set limits for fan energy in deadband mode to be no more than 20% of maximum, or the ventilation requirement, whichever is larger.	For VAV and PVAVS systems: THERMOSTAT-TYPE=REVERSE-ACTION MINIMUM-FLOW-RATIO=0.20
Global Temperature Adjustment for DDC Systems §122(h) – This mandatory measure requires that controls have the capability to automatically reset the temperature setpoints of all non-critical zones by 1 to 4°F from a single central command in the building energy management and control system (EMCS).	Not modeled.
Hydronic Pressure Reset for DDC Systems §144(j)6 – Requires demand based reset of the pressure setpoint for pumps serving variable flow systems based on valve demand. This measure is the hydronic analog of the existing prescriptive measure for supply air pressure reset.	In loops with a variable speed pump, HEAD-SETPT-CTRL=VALVE-RESET
Demand Control Ventilation (DCV) §121 – This measure extends the DCV requirement to systems controlling multiple-zones that have DDC control to the zone level.	PVAVS, VAV, MZS systems added to the condition
Supply Air Temperature Reset for DDC Systems §144(f) – Clarifies the requirement for demand based supply air temperature reset for variable air volume (VAV) systems that operate when the system is on 100% free cooling from the air-side economizer.	In VAV or PVAVS systems: COOL-CONTROL=WARMEST
Single Zone VAV Systems – This measure requires single zone systems with cooling capacity greater than 110,000 Btu/h to have either two-speed motors or variable speed drives. However, the measure does not take effect until 2012; therefore it may not be necessary to estimate the impact of this measure.	Side calculation.
Other Measures (§144) • *WLHP Deadband (144) – requires* deadband controls on water loop heat pumps to prevent simultaneous heating and cooling. • *Humidification and Dehumidification Controls* (144) - introduces a requirement for dead band controls within zones served by both humidification and dehumidification systems to prevent simultaneous operation. Exceptions to this requirement include zones served by desiccant systems that are used with direct evaporative cooling in series and zones where specific humidity levels are required, such as book archives, computer rooms and	Not modeled.

museums.

Water Heating

Measure	***Modeling Notes***
Distribution System Multipliers (Res ACM RE) **–** distribution system multipliers have changed for recirculating systems.	Not modeled.
Instantaneous Water Heater Efficiency – the ACM assumes an 8.8% efficiency degradation of instantaneous water heaters, to more accurately reflect typical use.	Side calculation.
Recirculating Heaters – the 2008 standards introduce a new mandatory requirement for the installation of a check valve in the cold-water makeup pipe of central DHW systems, to prevent reverse flow and require backflow prevention valves when single-lever faucets or mixing valves are installed. This change applies to multi-family residential buildings.	Side calculation.
Demand or Temperature Modulation Controls – a new prescriptive requirement for recirculating hot water systems in multifamily buildings should have either temperature modulation controls or recirculation pump demand controls. This change applies to multi-family residential buildings.	Residential not modeled.

Lighting

Measure	***Modeling Notes***
Lighting Power Density §146 – Prescriptive lighting power density values in Tables 146-B, 146-C and 146-D for high bay and retail spaces were lowered to reflect advances in electronic ballasts and metal halide lamps. Prescriptive lighting power density values for convention centers, office buildings and parking garages were lowered to be in line with ASHRAE 90.1-2007.	Modeled with the area category method.
New Lighting Power Density Categories (§146) - Two *new* project types have been identified by the Commission as needing specific LPD allowances and other rules, namely (a) Salons and (b) Video Conferencing Facilities. Salons and video conferencing areas have LPD allowances of 1.7 W/ft² and 3.2 W/ft², respectively.	No area in the building database falls in the new categories
Sidelighting Controls (§119, §131) –This change defines a primary sidelit and secondary sidelit area for use in photocontrols. Manual controls are required for spaces with primary sidelit areas greater than 250ft^2 and automatic controls are required for spaces with a primary sidelit area greater than 2,500ft^2. For more information, see Sidelighting – Daylighting Requirements for Sidelit Areas near Windows,	Daylighting control enabled under these conditions.
Demand Responsive Lighting Controls (§119) – The proposal recommends a mandatory requirement for demand responsive lighting controls in retail spaces greater than 50,000 ft^2. An exception is given to spaces with daylighting controls are installed on 50% of the lighting power.	Not modeled.

Lighting Control Measures

The following measures are changes in modeling rules for lighting controls; the measures that involve compliance credits are not factored into the impact analysis.

1. Automatic daylighting control device requirements (119f) – devices must be capable of reducing power consumption of lighting in the controlled area by at least two-thirds in response to the availability of daylight. Other device requirements have been added to prevent flicker and cycling.
2. Exception for lighting switching or control (131a) – the current Standards allow up to 0.5 W/ft2 in any area that must be continuously illuminated for reasons of building security or emergency egress. This limit was lowered to 0.3 W/ft2 to reflect changes in lighting technology.
3. Prescriptive requirement for independent skylight control for skylit areas greater than 2,500 ft² (8,000 ft²). (131c). Currently, either astronomical time switches or photocontrols are allowed for these areas. The existing standard allows for a compliance credit if photocontrols are used, since they typically save more energy than time switches. This change removes the credit for photocontrols by making them required for these spaces. Time switches may be allowed as an alternative in certain instances.
4. Daylit area under skylights. This is a change to the modeling of the skylit affected area. Currently the skylit area boundary is limited by the distance to the nearest partitions that are 60 inches or taller. The new 2008 definition revises this definition so that daylit area is only limited by partitions that are farther away than 70% of the height of the space between the top of the partition and the ceiling.
5. Mandatory requirement for a control of primary sidelit areas in any enclosed space 250 ft2 or greater. The primary sidelit area is defined as the horizontal distance from the window equal to the height of the window above the floor. For such spaces, 50% of the lighting must be on a separate control. (Since this may be a manual control, this might not need modeling in the impact analysis.)
6. Mandatory requirement for an automatic daylighting control is required in enclosed space 2500 ft2 or greater. In rooms with window head heights of 10 ft above the floor, this would require a sidelit area that is 250 ft long.
7. Revised definition of the effective aperture. Currently the effective aperture for windows is the window to wall ratio (WWR) multiplied by the visible transmittance (VT) of the window. The effective aperture is used to define the exception to the requirement for separate circuiting of lighting in the daylit area by windows. This definition is essentially applied for calculating the Power Adjustment Factor for photocontrols in that a matrix of WWRs and window VTs are used to define bins of power adjustment factors. This definition would be acceptable if the desired metric was for the average amount of daylight that enters the room. However, the metric of interest is how much daylight enters the daylit area. One can have the same configurations of window properties, areas and spacing in two rooms but if one room is larger than the other, the WWR will be lower and the effective aperture is lower. However, this does not impact the amount of light in the sidelit area. Thus the new definition does not include the variable window wall ratio. The new definition of primary sidelit area effective aperture is the total window area times the area weighted window visible transmittance divided by the area of the primary sidelit area. The secondary sidelit area effective aperture is the same except it is divided by the total areas of the primary and secondary sidelit areas. In general for a given space, the secondary sidelit area effective aperture will be one half that of the primary sidelit area effective aperture.
8. Demand responsive lighting controls. The proposal recommends a mandatory requirement for demand responsive controls in spaces greater than 100,000 ft^2. These spaces would further be defined as a continuous building footprint or in the case of office buildings, malls, theaters, the common areas greater than 100,000 ft^2 would be affected by the recommended requirement. In response to an emergency event, lighting power consumption must be reduced by 15%. An exception is provided for spaces where more than 50% of the lighting power is controlled by daylighting controls.
9. Lighting control credits. The 2005 Standards model lighting control credits as Power Adjustment Factors (PAFs), which provide a fixed reduction in lighting power density. The 2008 Standards provide a set of lighting schedules for different control credits, to account for TDV impacts of lighting. Since this is a

modeling change of a compliance credit, this may not factor into the impact analysis. Details are provided in Chapter 2 of the 2008 draft Nonresidential ACM manual.

Methodology

Each building in the Nonresidential New Construction (NRNC) database was simulated with the 2005 and 2008 requirements using DOE-2.2, version 44E3AEC. For each building in the database, the requirements applicable to that building and its systems and equipment from both the 2005 and 2008 Standards were simulated. The difference between these cases is the impact of the standard. The database of runs consists of 968 sites distributed in all 16 climate zones, representing the principal nonresidential building occupancy types. Table 12 summarizes the sites in the database by climate and building type.

The Title 24 modeling assumptions in the nonresidential ACM were followed for all the runs, except that the schedules that were reported from the surveys for each building were used to estimate the savings rather than the standard schedules specified in the nonresidential ACM.

Table 12 – Nonresidential New Construction Database Sites by Occupancy Type and Climate Zone

	Climate Zones																
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**Total**
Colleges, Universities		1	8	6		4	1	3	7	1	1	2	2	3			39
Elem/Scndry Schools		4	13	7	2	12	4	8	12	18	7	22	29	15	4	1	158
Food Stores	1	1	7	8	2	3		2	2	2	3	7	5		2		45
Hospitals		1	5			2		1	1			9	1			1	21
Hotel/Motel		2	1			2	1					1			1		8
Large Office		3	17	9		8	3	5		6	1	5					57
Large Retail	1	3	6	5		8	2	8	10	11		6	1	2	1		64
Medical Clinic		2	6	2	2	4	1	4	1		3	1	4		1		31
Misc.	2	9	40	12	5	17	7	22	32	17	11	28	11	11	7	2	233
Non-Refrg Whses		2	9			1		2	2		3	11	8	1			39
Restaurants	1		4	3	2	5		2	3	6		1	4	3	1		35
Small Office		2	25	23	2	17	14	11	7	5	7	14	6	6			139
Small Retail		3	10	13	3	8	8	6	9	8	1	18	3	5	4		99
Grand Total	5	33	151	88	18	91	41	74	86	74	37	125	74	46	21	4	968

Analysis and Detailed Results

Table 13 – Nonresidential Statewide First-Year Savings

Climate Zone	Electricity (GWh)	Non-Coincident Demand (MW)	Coincident Demand (MW)	Gas (therms)	TDV (MBtu)
1	0.23	0.09	0.05	0	4,997
2	9.15	3.36	3.46	1	186,681
3	23.99	7.47	6.54	6	491,940
4	15.73	6.22	4.15	2	328,261
5	1.79	1.15	0.88	0	40,034
6	6.91	2.23	2.13	6	166,916
7	18.28	4.60	4.83	1	320,071
8	11.09	3.97	2.93	1	257,642
9	11.65	4.27	4.00	1	287,575
10	9.22	3.47	2.80	1	217,162
11	1.81	0.95	0.71	1	43,912
12	26.01	11.73	10.28	8	579,638
13	5.61	2.06	2.51	4	136,329
14	3.57	1.63	1.21	0	91,375
15	2.95	1.01	0.99	1	72,497
16	0.17	0.37	0.10	0	4,738
Total	148.17	54.58	47.55	33	3,229,769

Table 14 – Nonresidential Projected Construction Activity by Climate Zone

The distribution of construction activity among the California climate zones is based on the surveyed sites in the NRNC database.

	Representative City	Percent of Total Floor Area	Floor Area (ft²)
1	Arcata	0%	559,643
2	Santa Rosa	7%	12,655,153
3	Oakland	16%	28,632,058
4	Sunnyvale	7%	12,871,789
5	Santa Maria	2%	3,375,911
6	Los Angeles	6%	10,867,906
7	San Diego	7%	13,467,538
8	El Toro	9%	15,814,428
9	Pasadena	10%	18,702,908
10	Riverside	8%	15,218,679
11	Red Bluff	1%	2,527,420
12	Sacramento	15%	26,176,850
13	Fresno	6%	10,759,588
14	China Lake	2%	4,332,720
15	El Centro	2%	3,574,494
16	Mount Shasta	1%	992,915
Total			180,530,000

Table 15 – Nonresidential First-Year Energy and Demand Savings

Climate Zone	Electricity (kWh/ft²)	Non-Coincident Demand (W/ft²)	Coincident Demand (W/ft²)	Gas (Btu/ft²)	TDV (kBtu/ft²)
1	0.42	0.16	0.09	0.0058	8.93
2	0.72	0.27	0.27	0.0076	14.75
3	0.84	0.26	0.23	0.0207	17.18
4	1.22	0.48	0.32	0.0177	25.50
5	0.53	0.34	0.26	0.0078	11.86
6	0.64	0.21	0.20	0.0525	15.36
7	1.36	0.34	0.36	0.0109	23.77
8	0.70	0.25	0.19	0.0090	16.29
9	0.62	0.23	0.21	0.0038	15.38
10	0.61	0.23	0.18	0.0049	14.27
11	0.72	0.37	0.28	0.0229	17.37
12	0.99	0.45	0.39	0.0316	22.14
13	0.52	0.19	0.23	0.0343	12.67
14	0.82	0.38	0.28	0.0081	21.09
15	0.82	0.28	0.28	0.0190	20.28
16	0.18	0.38	0.10	0.0339	4.77
Total	0.84	0.30	0.27	0.0180	18.20

Table 16 – Nonresidential Anticipated Energy and Demand Growth with 2005 Standard

Climate Zone	Electricity (kWh/ft²)	Non-Coincident Demand (W/ft²)	Coincident Demand (W/ft²)	Gas (Btu/ft²)	TDV (kBtu/ft²)
1	32.62	5.52	4.51	0	635
2	19.36	4.44	3.94	0	376
3	14.81	3.73	3.16	0	292
4	19.48	5.02	3.60	0	386
5	18.09	4.60	3.67	1	360
6	20.34	5.08	3.83	0	455
7	15.82	4.85	3.95	0	278
8	15.56	4.58	3.18	0	353
9	15.13	4.27	3.24	0	342
10	19.72	5.62	3.63	0	437
11	24.76	8.43	4.28	1	485
12	15.71	4.49	3.59	0	315
13	17.29	8.34	6.10	0	331
14	12.70	4.79	3.14	0	303
15	23.41	9.00	5.20	0	520
16	10.69	4.90	2.73	0	219
Weighted Average	17.01	4.96	3.69	0	352

Table 17 – Nonresidential Anticipated Energy and Demand Growth with 2008 Standard

Climate Zone	Electricity (kWh/ft²)	Non-Coincident Demand (W/ft²)	Coincident Demand (W/ft²)	Gas (Btu/ft²)	TDV (kBtu/ft²)
1	32.20	5.36	4.42	0	626
2	18.64	4.17	3.66	0	361
3	13.97	3.47	2.93	0	275
4	18.26	4.54	3.28	0	360
5	17.56	4.26	3.41	0	348
6	19.71	4.88	3.63	0	440
7	14.46	4.50	3.60	0	254
8	14.86	4.33	3.00	0	336
9	14.51	4.04	3.02	0	327
10	19.12	5.39	3.44	0	422
11	24.04	8.05	4.00	0	467
12	14.72	4.04	3.20	0	293
13	16.76	8.15	5.86	0	318
14	11.87	4.41	2.86	0	282
15	22.59	8.71	4.92	0	500
16	10.52	4.53	2.62	0	214
Weighted Average	16.17	4.66	3.43	0	334

Nonresidential Interior Lighting Alterations

Standards Requirement

New lighting systems in existing buildings and modifications to existing lighting systems that affect more than 50% of the luminaries must meet the mandatory control requirements and lighting power requirements of §146. The way the standards apply to alterations to existing buildings does not change between 2005 and 2008, but the standards are more stringent.

Methodology

The impact on new lighting systems in existing buildings is the difference between the 2001 and the 2005 standards, which is an average first-year energy savings of 0.50 kWh/ft² and a demand reduction of 0.12 W/ft². This is the weighted average of the 968 buildings in the NRNC database (see the analysis of nonresidential newly constructed buildings). The CEC estimates that the nonresidential building stock in California is 6.7 billion ft². If we assume that the lighting systems in these buildings are replaced every twenty years, then about 335 million ft² of nonresidential newly constructed buildings would be affected each year.

Analysis and Detailed Results

This calculation results in 186.0 GWh of statewide first-year electricity savings and 45.4 MW of statewide first-year demand reduction.

Nonresidential Cool Roof and Insulation Alterations

Standards Requirement

The standards require low-slope roofs, when replaced, to be cool roofs with an aged reflectance of 0.55 or more and an emittance of 0.75 or more. High-sloped roofs were not previously regulated, and now are required to be replaced with cool roofs at a reflectance of 0.15 to 0.20 depending on weight and an emittance of 0.75. When the roof is replaced and the existing roof is uninsulated, retrofit insulation of either R-8 or R-14 is required, depending on occupancy and climate zone.

Methodology

A simulation model of a typical building was built and run with different roof types in each occupancy schedule and climate zone. These models resulted in savings estimates per square foot of roof area. The per-square foot results were weighted by building type for each climate zone using data for existing building stock, assuming that 5% percent of roofs are replaced each year. Buildings built before 1979 (approx 32% of existing buildings) are assumed to have uninsulated roofs. The U value for the currently uninsulated roofs is assumed to be 1. For cool roofs, 10% of the roof area is assumed to be high-slope, the type of roof regulated in 2008 but not in 2005.

Analysis and Detailed Results

Table 18 – Roof Alterations – First Year Savings by Climate Zone

	Insulation				Cool Roofs			
CZ	Million ft^2	TDV (GBtu)	Mtherms	Total GWh	Million ft^2	TDV (GBtu)	Mtherms	Total GWh
1	0.55	0.10	0.07	0.138	0.17	0.19	0.00	0.06
2	2.82	0.51	0.38	2.235	0.88	4.94	-0.01	0.51
3	10.81	1.97	1.14	4.468	3.38	15.61	-0.03	1.45
4	4.93	0.90	0.54	3.591	1.54	12.35	-0.01	0.87
5	1.50	0.27	0.16	0.663	0.47	2.69	0.00	0.21
6	9.46	1.72	0.67	3.803	2.96	145.69	-0.02	1.50
7	5.07	0.92	0.31	3.000	1.58	16.86	-0.01	0.90
8	11.65	2.12	0.79	8.680	3.64	38.23	-0.02	2.25
9	13.42	2.44	1.02	11.669	4.19	42.84	-0.02	2.63
10	6.87	1.25	0.56	7.253	2.15	16.40	-0.01	1.46
11	1.75	0.32	0.19	1.734	0.55	5.26	0.00	0.33
12	8.61	1.57	0.97	8.065	2.69	23.67	-0.02	1.60
13	3.18	0.58	0.28	3.819	0.99	10.85	-0.01	0.72
14	2.94	0.53	0.33	3.532	0.92	9.06	-0.01	0.65
15	1.87	0.34	0.10	3.037	0.59	8.66	0.00	0.48
16	3.71	0.68	0.71	2.623	1.16	6.94	-0.02	0.58
Totals	89.13	16.22	8.20	68.310	27.85	360.27	-0.199	16.20

Table 19 – Roof Alterations – Cool Roofs First-year Savings Calculations

Assumptions		
Existing building stock	6,963,378,000	ft²
Frequency of Roof Replacement	20	Years
Percent non-insulated (pre 1978 buildings)	32	%
Percent high-slope application	10	%
Ratio of roof area to floor area	80	%
Average U value of existing	.1	
Total cool roof replacement market	27,850,000	ft^2
Total insulation replacement market	89,130,000	ft^2
Unit Energy Savings – Insulation		
Unit Electricity Savings	766.4	kWh/1,000 ft²
Unit Gas Impact	92	therms/1000 ft²
Unit Energy Savings – Cool Roofs		
Unit Electricity Savings	581.7	kWh/1,000 ft²
Unit Gas Impact	-7.9	therms/1000 ft²
Statewide Impact – Insulation		
Electricity savings	68.31	GWh
Gas Savings	8.2	Mtherms
TDV	16.22	GBtu
NOx	101,603	lbs
CO	48,511	lbs
CO_2	177,912,000	lbs
PM10	9,839	lbs
Statewide Impact – Cool Roofs		
Electricity savings	16.2	GWh
Gas impact	-0.2	Mtherms
TDV	360.27	GBtu
NOx	4,365	lbs
CO	2,926	lbs
CO_2	17,100,000	Lbs
PM10	832	Lbs

Refrigerated Warehouses[3]

Standards Requirements

Refrigerated warehouses have not previously been regulated. The measures required by the new standards include required insulation R-values of R-36 in freezer roofs, walls, and floors and R-28 in cooler roofs and walls. Electric underfloor heating must be thermostatically controlled and controlled off during summer on-peak periods. For all condenser fan motor sizes, the motor speed should be controlled based on space temperature, with a provision for a minimum speed setting that can be defined by the operators of the refrigerated warehouses. Evaporative condensers are required on all ammonia systems, and evaporative condenser wetbulb approach temperature is limited to 20°F or less. Air-cooled condenser drybulb approach temperature limited to 15°F or less in coolers and 10°F or less in freezers. Floating head pressure control to a minimum of 70°F is required on all condensers, with drybulb offset controls on air-cooled condensers. Variable speed control is now required on condenser fan motors. Permanent split capacitor (PSC) or electronically commutated (EC) motors are required on single phase condenser fan motors less than 1 hp.

Variable speed controls required on at least one compressor per suction group on refrigeration plants with screw compressors, or a combination of slide valve controls and parallel-unequal compressor sizing strategies that can attain an equivalent part-load performance to a compressor line with one VSD compressor. All compressors and accessories supplied by manufacturers should be capable of operating at a minimum condensing temperature of 70°F. The current requirements for non-refrigerated warehouses are now applied to refrigerated warehouses: maximum lighting power density is limited to 0.6 W/SF (this requirement is already in Section 146), and bi-level lighting controls are required in storage spaces.

Methodology

Non-energy benefits associated with improved refrigerated warehouse energy efficiency include increased equipment reliability and stored product security. Strategies used to improve the efficiency of the refrigeration equipment reduce the operating pressures and temperatures, reducing stress on compressors, condensers and associated equipment. Improved U-value requirements for the insulated shell allow the warehouse to "coast" longer through power and equipment outages while keeping the stored product within an acceptable temperature range.

Research conducted in the Pacific Northwest for the Northwest Energy Efficiency Alliance indicated improved product quality and reduced mass loss in fruit stored in controlled atmosphere rooms with variable speed drive (VSD) controls on evaporator fans. VSDs applied to evaporator fans in freezers provided good temperature control while reducing wind-chill effects on warehouse employees.

Analysis and Detailed Results

A detailed analysis found that the first year's implementation of the mandatory requirements for building shell, evaporator fan controls, evaporative condensers and compressor controls would reduce electricity energy consumption by 15.6 GWh per year, reduce electrical demand coincident with utility system peak by 1.8 MW. There are no expected impacts on natural gas savings at the site. The discounted life cycle energy cost savings (3% discount rate, 15 year period) is $24.6 million for one year's new construction. After 10 years of

[3] Pacific Gas and Electric Company, "Refrigerated Warehouses," Codes and Standards Enhancement Initiative Final Report, February 2007

this code measure the savings would be approximately tenfold or about $246 million of present valued energy savings that accrue over the life of these buildings.

This estimate was based upon a unit energy savings estimate of 12 kWh/ft² and expanded up to the population of one year's new construction which is estimated to be 1.3 million square feet per year for refrigerated warehouses.

Table 20 – Refrigerated Warehouses – Evaporative Condenser Sizing and Control Cost Effectiveness

Measure	Climate Zone 3			Climate Zone 13		
	TDV Savings/ ton	Incr. Cost/ ton	BCR	TDV Savings/ ton	Incr. Cost/ ton	BCR
Floating head pressure, fixed at 70°F	$561	$20	27.88	$752	$20	37.34
Floating head pressure, min of 70°F, 9°F wetbulb offset	$566	$27	20.80	$852	$27	31.34
VSD condenser fans	$76	$100	0.76	$58	$100	0.58
Oversized, efficient condenser (4°F reduction in wetbulb approach, 400 Btu/watt)	$30	$67	0.45	$32	$67	0.48
Oversized, efficient condenser (6°F reduction in wetbulb approach, 400 Btu/watt)	$46	$112	0.41	$44	$112	0.39
Oversized, efficient condenser (8°F reduction in wetbulb approach, 400 Btu/watt)	$55	$168	0.33	$54	$168	0.32
Oversized, efficient condenser (10°F reduction in wetbulb approach, 400 Btu/watt)	$68	$240	0.28	$68	$240	0.28
Oversized, efficient condenser (12°F reduction in wetbulb approach, 400 Btu/watt)	$86	$335	0.26	$85	$335	0.25
Floating head pressure, fixed at 70°F, VSD condenser fans	$613	$119	5.14	$799	$119	6.70

Table 21 – Refrigerated Warehouses – Impact of Air-Cooled Condenser Fan Power and Control Strategies

Measure	Climate Zone 3		Climate Zone 13	
	Energy Savings (kWh / SF)	TDV Energy Cost Savings (PV $ / SF)	Energy Savings (kWh / SF)	TDV Energy Cost Savings (PV $ / SF)
Float head pressure with fixed setpoint	1.93	$2.87	< 0	< 0
Float head pressure with drybulb following	2.03	$3.04	2.06	$3.63
VSD condenser fans	1.48	$2.41	1.50	$2.32
Efficient condenser 60 Btu/hr-watt	0.15	$0.27	0.44	$0.87
Efficient condenser 80 Btu/hr-watt	0.43	$0.77	1.27	$2.52
Efficient condenser 100 Btu/hr-watt	0.59	$1.08	1.77	$3.51
Efficient condenser 120 Btu/hr-watt	0.71	$1.28	2.10	$4.18

Table 22 – Refrigerated Warehouses – Energy and Cost Savings for VSD Compressor Controls

	Climate Zone 3			Climate Zone 13		
	TDV Savings/ ton	Incr. Cost/ ton	BCR	TDV Savings/ ton	Incr. Cost/ ton	BCR
VSD trim compressor (parallel unequal baseline)	$74	$171	0.43	286	$171	1.7
VSD trim compressor (parallel equal baseline)	$3,020	$171	17.6	$3,661	$171	21.4

Table 23 – Refrigerated Warehouses – Summary of Statewide Impact

Electricity savings	15.6	TDV
Demand Savings	1.8	MW
TDV		Gbtu
NOx	5974.8	lbs
CO	3588	lbs
CO_2	18720000	lbs
PM10	936	lbs

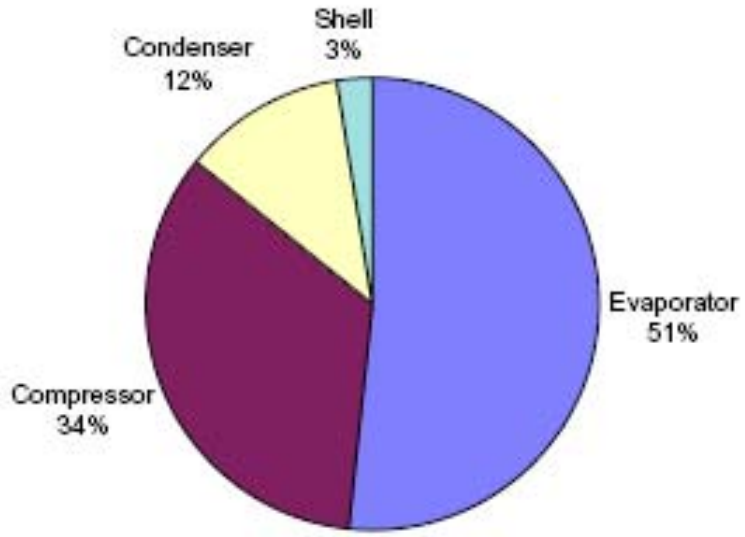

Figure 4 – Refrigerated Warehouses – Relative Contribution of Each Measure to Overall Savings

Outdoor Lighting[4]

Standards Requirements

The changes to the outdoor lighting standards are mostly quantitative, rather than qualitative. In particular Table 147-A "Lighting Power Allowances for General Site Illumination" and Table 147-B "Lighting Power Allowances for Specific Applications" are revised and lighting power densities are reduced where appropriate. Some of the changes provide consistency with the 2008 Appliance standards and the Illuminating Engineering Society of North America (IESNA) recommendations. The exception for high security is clarified and made more limited. Dimming or nighttime lighting reduction requirement is added in Section 132(c) for outdoor lighting that is operated during the daylight and at night. The definition of façade lighting is revised such that at least 50% of the light emitted from the luminaire directly lights the façade, preventing "wall packs," or other forward throw area lights from being used as façade lighting.

Methodology

Statewide energy savings estimates are based on unit energy savings multiplied by estimates of statewide quantities of total areas by application type and lighting zone (LZ).

Analysis and Detailed Results

Table 24 summarizes the outdoor lighting electricity savings related to the Standards. These savings are for the first year, and will accumulate in each year thereafter, doubling in year two, tripling in year three, etc. Peak demand savings are not estimated for the outdoor lighting standards since the peak generally occurs during August or September late afternoon hours.

[4] Pacific Gas and Electric Company, "Outdoor Lighting," Codes and Standards Enhancement Initiative Draft Report, May 16, 2006

Table 24 – Statewide Outdoor First-Year Lighting Electricity Savings[5]

	Savings kWh			
Lighting Standard	LZ1	LZ2	LZ3	LZ4
Hardscape including parking lots	62538	965787	14590261	146140
Driveways, Site Roads, Sidewalks, Walkways and Bikeways	18484	80532	4307671	43205
Building Entrances (without canopy)	726	1608	19364	754
Outdoor Sales Area	11200	28378	0	0
Building Façades	na	0	0	0
Outdoor Sales Frontagelinear feet)	0	0	0	0
Vehicle Service Station Canopies	339	1584	0	0
All Other Sales Canopies	na	0	0	0
Non-sales canopies	0	0	0	0
Landscape and Ornamental Lighting	na	0	0	0
Internally Illuminated Panel Signs	na	44163	986637	11775
Externally Illuminated Signs	5273	10488	323988	3832
Totals				
Signs	1,386,154			
Outdoor Lights	20,278,571			
Total	21,664,725			

Table 25 – Statewide Emission Reductions from Outdoor Lighting Changes

Pollutant	Annual Reduction
NO_x	8298 lbs
CO	4983 lbs
CO_2	25997670 lbs
PM_{10}	1300 lbs

[5] From Pacific Gas and Electric Company, Heschong Mahone Group Inc.