California Energy Commission

STAFF REPORT

Energy Efficiency Comparison

California's 2016 *Building Energy Efficiency Standards* and ASHRAE/IESNA Standard 90.1-2013

California Energy Commission

Edmund G. Brown Jr., Governor

September 2016 | CEC-400-2016-XXX

California Energy Commission

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ABSTRACT

The federal Energy Policy Act of 1992 requires each state to certify that it has reviewed and considered adopting the national model energy standard. Every state must determine if its energy code meets or exceeds the current federal reference code and certify to the Secretary of the U.S. Department of Energy its determination. The federal reference energy code for nonresidential or commercial buildings is the American Society of Heating, Refrigerating and Air- Conditioning Engineers and Illuminating Engineering Society Standard 90.1.

States must reevaluate the efficiency requirements of their code against those of the new federal building efficiency reference codes. This report documents the California Energy Commission's response to this federal law by comparing the energy savings effects between California's Title 24, Part 6, *2016 Building Energy Efficiency Standards* to the nonresidential energy requirements of the American Society of Heating, Refrigerating and Air-Conditioning Engineers and Illuminating Engineering Society of North America (ASHRAE/IESNA) Standard 90.1-2013.

This report concludes that California's Building Energy Efficiency Standards exceed the energy savings expected from the commercial building requirements of ASHRAE/IESNA Standard 90.1-2013. While significant improvements have been made to the energy stringency levels of the national reference energy codes, California's nonresidential energy standards contain building measures and building performance operation impacts that are more rigorous, resulting in higher efficiency levels for new nonresidential construction than expected to occur from efficiency requirements of the federal reference energy codes.

Keywords: California Energy Commission, *Building Energy Efficiency Standards*, ASHRAE 90.1, energy comparison

Alatorre, Mark, Ingrid Neumann. 2016. *Energy Efficiency Comparison Nonresidential Construction 2016 CA Title 24 Part 6 vs. 2013 ASHRAE 90.1.*California Energy Commission. Publication Number: CEC-400-2016-XXX.

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CHAPTER 1: Introduction

States are required by federal law to adopt an energy code that is at least as energy-efficient as the federal reference model energy code. When a new national model energy code is adopted, the U.S. Department of Energy (DOE) is required to determine whether the newly adopted code is more stringent than the predecessor. States have two years after the publication of this determination to certify that it has reviewed the provisions of its nonresidential building code regarding energy efficiency and to report whether it is appropriate for that state to revise its energy code requirements to meet or exceed the newly adopted reference national model energy code. The federal reference energy code for nonresidential buildings is the *American Society of Heating, Refrigerating and Air-Conditioning Engineers and Illuminating Engineering Society of North America (ASHRAE/IESNA) Standard 90.1-2013*.

This California Energy Commission staff analysis compares the estimated energy savings for nonresidential building energy efficiency measures of the *2016 Building Energy Efficiency Standards* to the nonresidential requirements of *ASHRAE/IESNA Standard 90.1-2013*.

Building Energy Efficiency Standards

The Energy Commission first adopted energy standards for new buildings in 1977 and continues to revise these requirements in response to legislative mandates, changes, and improvements to building systems and designs, and to improve compliance and enforcement. Overall, the Energy Commission's revisions to the residential and nonresidential standards have resulted in significant statewide energy savings and remain a cornerstone of state policy to reduce statewide energy use and greenhouse gas emissions. The *Building Energy Efficiency Standards* (standards) are contained in Part 6 of Title 24, California Code of Regulations, and often referred to simply as "Title 24."

The *Standards* are separated into two parts: low-rise residential buildings of three stories or fewer, and nonresidential buildings, which also include high-rise residential buildings four stories or higher and hotel/motel occupancies. This report analyzes nonresidential buildings and high-rise residential buildings, while low-rise residential buildings will be discussed in a future report.

There are two methods of demonstrating compliance with the standards: prescriptive and performance. With either the prescriptive or performance compliance method, there are mandatory measures that must always be met. Many of the mandatory measures deal with infiltration control, indoor and outdoor lighting, or sign lighting; other mandatory measures require minimum insulation levels and equipment efficiency. The minimum mandatory levels are sometimes superseded by more stringent prescriptive or performance requirements.

With the prescriptive method of compliance, every applicable measure listed in standards Sections 140.3 through 140.9 must be met or exceeded for the building to comply. These sections include requirements for the building envelope, space-conditioning system, service water-heating system, indoor lighting and outdoor lighting systems, interior and exterior signs, and covered processes. The prescriptive approach offers relatively little design flexibility but is easy to use.

The performance approach allows compliance through a wide variety of design strategies and provides greater flexibility than the prescriptive approach. When the performance approach is used, the energy effects of building features are analyzed to determine the overall effect of these features on the total energy use of the building through alternative calculation method compliance software approved by the Energy Commission. Measures, such as window U-factors, can be less efficient than the prescriptive requirement so long as other measures used in other areas exceed the prescriptive requirement, resulting in less overall energy use.

Reference Model Energy Codes

Building energy codes are minimum requirements affecting energy-efficient design and construction for new and renovated homes and businesses. Overall, building regulations govern all aspects of the design and construction of buildings, and building energy codes set an energy efficiency baseline for the building envelope, building systems, and operating equipment. Improving these minimum requirements or broadening the scope of energy codes helps soften the environmental impact of buildings and result in additional energy and cost savings over the life cycle of a building.

Prior to passage of the 1992 Energy Policy Act, the federal government applied little pressure on states to improve the efficiency of buildings, although equipment improvements were federally mandated that set minimum efficiency levels for manufacturers of space-conditioning and water-heating equipment. With passage of the 1992 Energy Policy Act, a stronger, consistent reference point was established for all states against which to adopt, modify, and/or compare their energy codes.

The DOE is required by law (the Energy Conservation and Production Act, as amended [ECPA]) to issue a determination as to whether the latest edition of ASHRAE/IESNA Standard 90.1 (for commercial buildings and multifamily high-rise residential buildings) will improve energy efficiency compared to the previous edition of the corresponding code or standard. The DOE has one year to publish a determination in the *Federal Register* after each new edition of the code or standard is published, and states have two years from the determination date to respond to the DOE regarding the equivalency of their own energy codes.

ASHRAE/IESNA Standard 90.1 is developed under the auspices of the American Society of Heating, Refrigerating and Air-Conditioning Engineers and the Illuminating Engineering Society of North America, using the consensus process of the American National Standards Institute (ANSI), which requires a balance of stakeholder interests. All interested parties can participate by addressing various ASHRAE technical committees during deliberations, participating in subcommittees, or commenting during public review. The final vote of the standards project committee includes members from a balance of all stakeholders and is not limited to government representatives. Revisions in the development and maintenance of the standard are ongoing and are not approved without achieving consensus from materially affected interest parties. Once an ASHRAE standard is adopted, states and local governments may adopt that standard as their own or make changes to reflect regional building practices or state-specific energy efficiency goals.

CHAPTER 2: Energy Comparison Analysis

The nonresidential and high-rise residential energy codes of California and those of the national model energy codes are relatively identical in scope—each code establishes minimum energy efficiency levels for space heating, space cooling, water heating, and lighting. They differ considerably, however, in the efficiency levels of building components, operating conditions, space and water heating system effects, and lighting allowances and control measures, all of which can lead to differences in the overall stringency between the two sets of energy codes.

The required maximum energy threshold for building energy use depends on three key variables: 1) the climate zone where construction is to occur, (2) baseline building efficiency measures encompassed by the energy code or standard, and (3) building-dependent operating and modeling assumptions used for compliance. The interaction of these variables can result in different estimated energy uses for a given building regardless of mandatory measure requirements or demonstrated compliance using either the prescriptive or performance method.

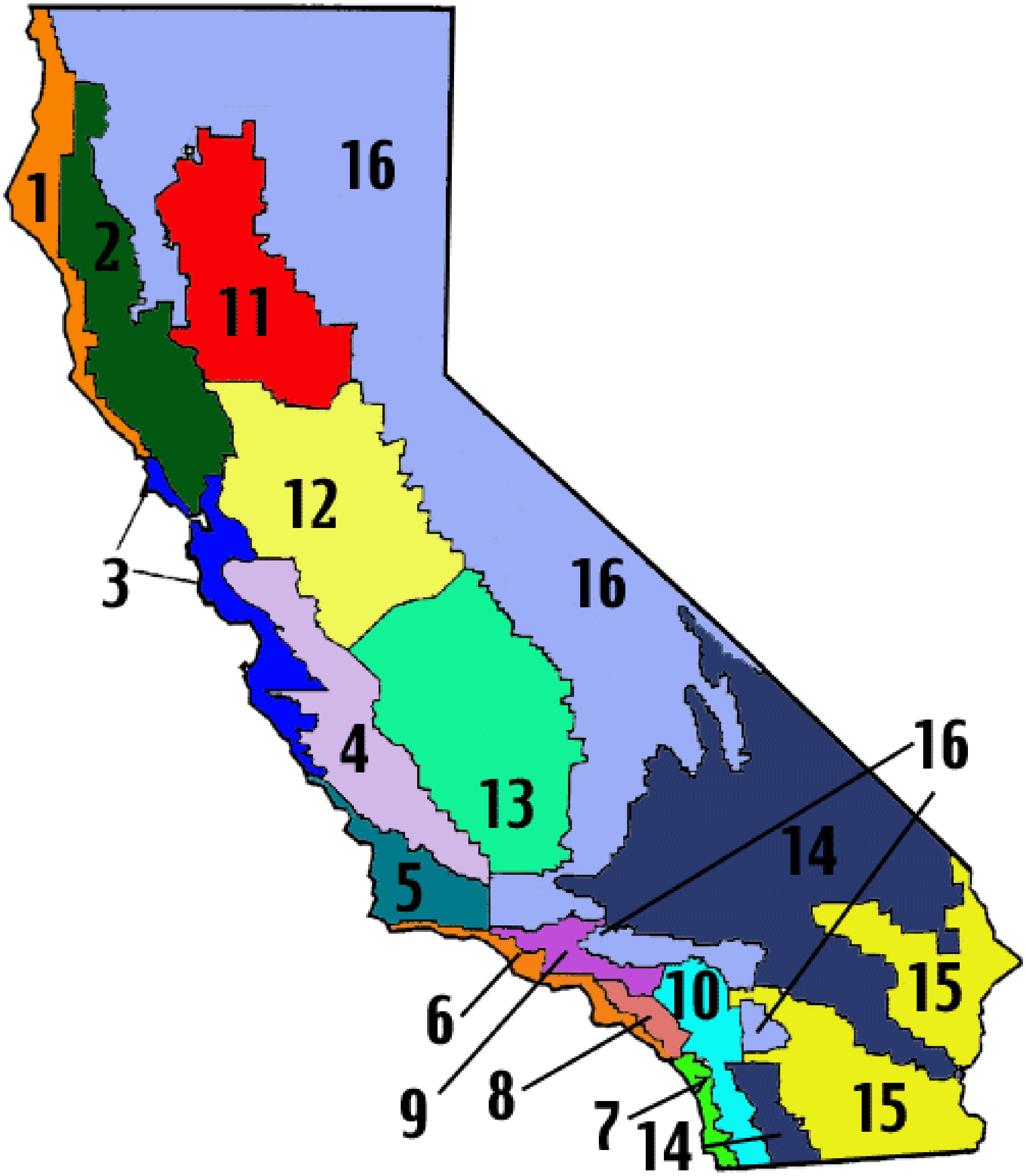
Climate Variables

For building energy efficiency purposes, California's *Building Energy Efficiency Standards* divide the state into 16 climate zones. In contrast, the national model energy codes have established eight climate regions for the nation and subcategorize areas in each region as either moist, dry, or marine with the letter code of "a," "b," or "c," respectively. Figure 1 shows the 16 climate zones use for the state's *Building Energy Efficiency Standards*; Figure 2 displays the climate zones of the IECC and *ASHRAE/IESNA Standard 90.1* as they would apply specifically to California. Table 1 shows a breakdown of the national climate zones within the 16 climate designations of California's *Building Energy Efficiency Standards* and each associated national climate zone.

Five of the eight *ASHRAE/IESNA Standard 90.1* national climates zones (Climate Zones 2-6) are represented in California, though the majority of the state is represented by IECC and *ASHRAE/IESNA Standard 90.1* Climate Zone 3.

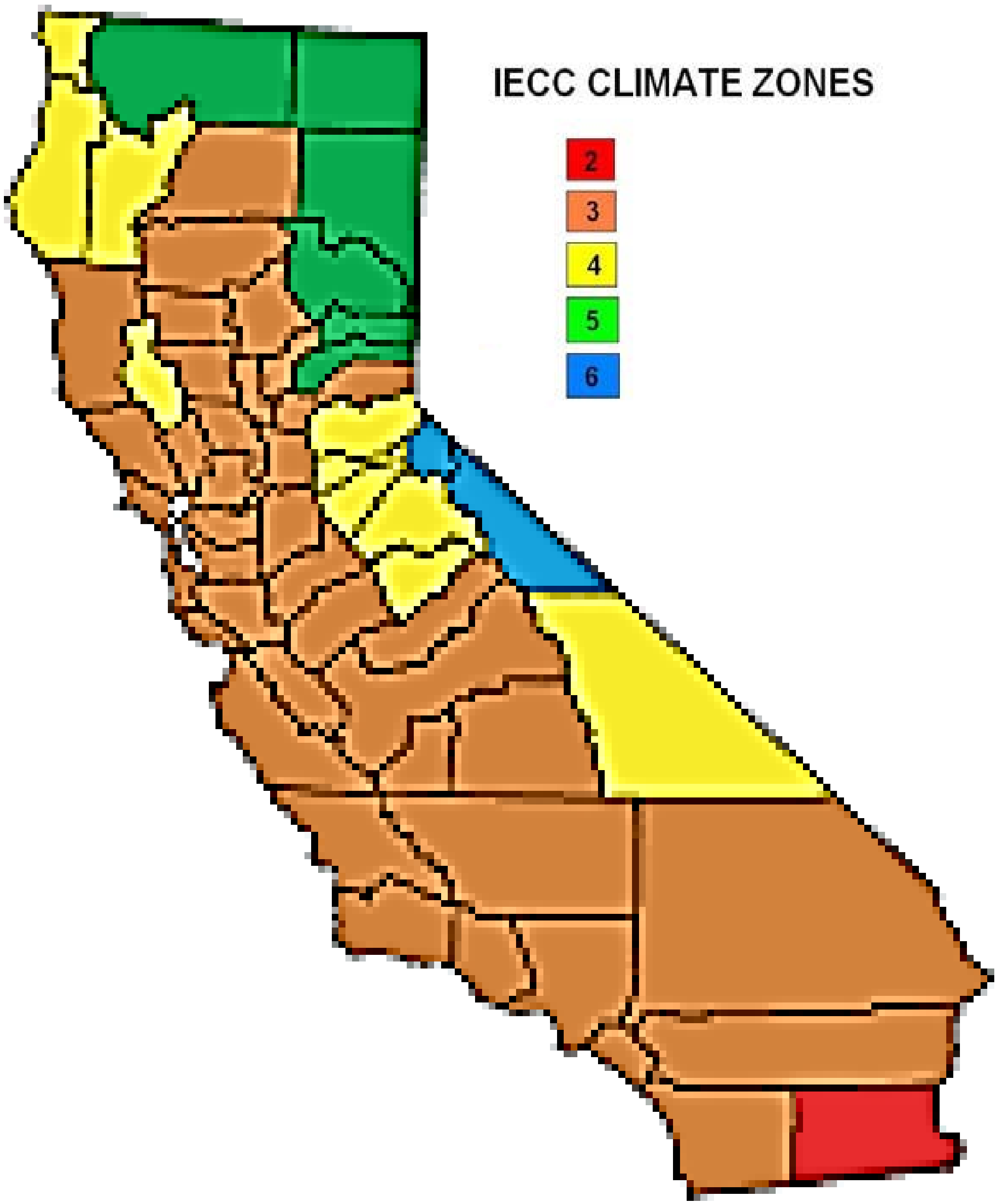
The national climate regions are drawn based on county lines, whereas California's 16 climate zones are drawn based on the results of climate data analysis, where some climate lines may coincide with boundaries of cities or counties. Hence, when showing compliance with California's *Building Energy Efficiency Standards,* a California city or county could have several climate designations within the same jurisdiction, whereas, this does not occur with climate zones of the *ASHRAE/IESNA Standard 90.1*. The weather station whose data were used for each of the 18 climate zone pairs is given in the third column of Table 1.

Figure 1: California Climate Zones—Building Energy Efficiency Standards



Source: California Energy Commission staff

Figure 2: California Climate Zones—IECC and ASHRAE/IESNA Standard 90.1



Source: California Energy Commission staff

Table 1: Comparison of Climate Designations

CA Climate Zone	DoE Climate Zone	Weather Station
1	4c	ARCATA_725945
2	3c	SANTA-ROSA_724957
3	3c	OAKLAND_724930
4	3c	SAN-JOSE-INTL_724945
5	3c	SANTA-MARIA_723940
6	3c	TORRANCE_722955
7	3b	SAN-DIEGO-GILLESPIE_722907
8	3b	FULLERTON_722976
9	3b	BURBANK-GLENDALE_722880
10	3b	RIVERSIDE_722869
11	3b	RED-BLUFF_725910
12	3b	SACRAMENTO-EXECUTIVE_724830
13	3b	FRESNO_723890
14	4b	PALMDALE_723820
15	2b	PALM-SPRINGS-INTL_722868
16	4b	BLUE-CANYON_725845
16	5b	MONTAGUE-SISKIYOU-CO_725955
16	6b	SOUTH-LAKE-TAHOE_725847

Source: California Energy Commission staff

Energy use estimates of building energy features are affected by climate dynamics. For comparative analysis of the two sets of energy codes, energy use estimates were based on climate designations for California's standards, and building measures were altered based on the requirements specific to the respective national energy code. Separate modeling analysis was conducted for each ASHRAE/IESNA Standard 90.1 climate condition for California, illustrated by Table 1.

Building Energy Efficiency Measures

For nonresidential and high-rise residential buildings, the estimated energy use for building measures described in the prescriptive requirements of Sections 140.3-140.9 of the *2016 Building Energy Efficiency Standards* were compared against similar requirements of the *2013 ASHRAE/IESNA Standard 90.1*.

Nonresidential and high-rise residential performance modeling analysis used several prototype buildings provided by the U.S. Department of Energy.[1] Energy Commission

1 https://www.energycodes.gov/development/commercial/prototype_models

staff performed this energy analysis using 2013 version of California Building Energy Code Compliance (CBECC) software for commercial buildings (CBECC-Com)[2].

For comparative energy analysis of the nonresidential and high-rise residential buildings, the applicable prescriptive requirements of the *2016 Building energy Efficiency Standards* were used to establish the energy baseline of the standard design building used within the modeling program. Features of the proposed design building were altered, depending on the building prototype, to match building measures required by *AHSRAE/IESNA Standard 90.1-2013*.

Operating Conditions and Modeling Assumptions

Differences in assumed building operating conditions, schedules, and modeling assumptions used for building features can significantly affect a comparative analysis of the stringency of the two sets of energy codes. For this reason, building operating conditions for the analysis were assumed to be from California's standards. For example, the standards require occupancy sensors to control lights and thermostat set points in several space types, and to control minimum ventilation rates in others. To evaluate the estimated energy savings for these measures, occupancy schedules had to be defined that allowed the building to be "occupied" part of the day. For California's standards, occupancy, lighting, thermostat, and minimum ventilation rate schedules were modified accordingly. The same occupancy schedules were applied to the same zones of the AHSRAE/IESNA prototype building models to accurately compare the two sets of standards.

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2 http://bees.archenergy.com/index.html.

CHAPTER 3: Energy Comparison Results

California's metric for building energy use is time-dependent valuation (TDV). *TDV* is the net present value of the time-varying energy used by the building to provide space conditioning, water heating, and specified lighting of buildings. This metric is an alternative to source energy, which is the energy used at a site and consumed in producing and delivering energy to a site, including, but not limited to, power generation, transmission, and distribution losses, and that is used to perform a specific function, such as space conditioning, lighting, or water heating. TDV is used by Energy Commission-approved performance compliance modeling software to depict estimated building energy use.

Unlike source energy, TDV accounts for the time when energy is used. Therefore, building features that save more energy during high electricity peak usage periods are weighted more heavily than during nonpeak periods. For electricity, TDV is high during hot summer afternoons and low under colder temperatures, typically at night. TDV is intended to represent real-time electricity prices. Buildings optimized under TDV tend to be less expensive to operate since more energy would be saved during periods when prices are high.

Nonresidential Energy Use Estimates

Table 2 displays modeling results that compare the estimated annual energy savings between the *2016 Building Energy Efficiency Standards* and ASHRAE/IESNA Standard 90.1-2013. Annual estimates of energy use have been weighted by construction starts for each climate zone.

Data was obtained from CBECC-Com, for each of the 14 types of Nonresidential buildings in TDV energy use intensity (EUI), providing the thousand British thermal units (kBtu) consumed per square foot for each of the 16 California climate zones, as well as the seven ASHRAE climate subzones. Eighteen comparisons could then be made among the corresponding zones, according to Table 1. The final result of this comparison was a balance sheet with 18 lines for each of the 14 buildings where the value was either positive, indicating the amount saved by Title 24 over ASHRAE, or negative, indicating the amount saved by ASHRAE over Title 24. These data were in GBTU consumed per square foot and so was normed for the actual number of such buildings in each climate zone projected to start in 2017 when the 2016 Standards come into effect.

Table 2: Statewide Annual Energy Use—2016 Building Energy Efficiency Standards and ASHRAE/IESNA Standard 90.1-2013

TOTAL Annual TDV EUI GBtu savings Title 24 vs. ASHRAE 90.1									
Weather Station	CA Climate Zone	DoE Climate Zone	Apartment HighRise	Apartment MidRise	Hotel Large	Hotel Small	Office Large	Office Med	Office Small
ARCATA_725945	1	4c	0.39	1.60	0.83	0.58	1.82	0.36	0.59
SANTA-ROSA_724957	2	3c	5.90	15.74	7.16	5.17	11.44	15.98	0.56
OAKLAND_724930	3	3c	42.06	124.54	33.23	24.79	71.31	71.07	2.95
SAN-JOSE-INTL_724945	4	3c	13.43	36.73	18.71	15.06	39.77	40.50	0.67
SANTA-MARIA_723940	5	3c	2.44	7.69	4.04	3.07	8.04	7.99	0.29
TORRANCE_722955	6	3c	29.82	78.14	13.71	10.21	32.09	27.59	-0.28
SAN-DIEGO-GILLESPIE_722907	7	3b	66.38	99.02	17.41	17.44	9.62	14.65	-6.32
FULLERTON_722976	8	3b	100.54	138.32	18.55	14.95	43.49	39.98	-1.97
BURBANK-GLENDALE_722880	9	3b	203.47	246.13	30.84	19.40	36.51	71.37	-3.30
RIVERSIDE_722869	10	3b	49.39	52.91	20.83	14.65	11.07	17.77	-12.08
RED-BLUFF_725910	11	3b	5.38	5.49	3.78	2.85	3.54	8.91	-0.81
SACRAMENTO-EXECUTIVE_724830	12	3b	36.60	36.34	29.48	21.00	28.16	65.59	3.49
FRESNO_723890	13	3b	19.27	16.75	6.96	4.50	6.82	11.03	-0.73
PALMDALE_723820	14	4b	12.50	14.72	2.95	3.45	6.68	3.86	-1.13
PALM-SPRINGS-INTL_722868	15	2b	12.53	10.35	3.43	3.67	9.75	3.90	-1.86
BLUE-CANYON_725845	16	4b	3.50	3.78	0.80	0.97	2.92	1.05	-0.92
MONTAGUE-SISKIYOU-CO_725955	16	5b	7.00	7.01	1.60	1.45	1.78	4.39	-2.23
SOUTH-LAKE-TAHOE_725847	16	6b	2.05	1.35	0.52	0.54	0.83	1.52	-0.90
total by building type			612.66	896.61	214.84	163.76	325.64	407.52	-23.96

Weather Station	CA Climate Zone	DoE Climate Zone	Restaurant Fast Food	Restaurant SitDown	Retail Standalone	Retail StripMall	School Primary	School Secondary	Warehouse
ARCATA_725945	1	4c	-0.84	0.16	1.71	2.29	0.07	0.27	-0.04
SANTA-ROSA_724957	2	3c	-19.36	0.52	27.50	23.40	0.94	4.97	0.08
OAKLAND_724930	3	3c	-75.54	3.76	123.85	132.02	11.88	16.76	-2.04
SAN-JOSE-INTL_724945	4	3c	-48.49	1.59	68.85	61.67	4.51	12.83	-0.99
SANTA-MARIA_723940	5	3c	-8.93	0.34	12.95	14.10	1.08	1.81	-0.33
TORRANCE_722955	6	3c	-95.55	5.16	111.40	87.87	4.37	17.22	-30.52
SAN-DIEGO-GILLESPIE_722907	7	3b	-64.52	3.56	71.99	56.92	4.01	13.33	-12.08
FULLERTON_722976	8	3b	-135.97	4.59	162.61	111.71	6.71	32.24	-35.64
BURBANK-GLENDALE_722880	9	3b	-123.49	-4.57	166.78	96.69	3.32	48.62	-15.44
RIVERSIDE_722869	10	3b	-97.74	-11.69	120.45	71.50	3.03	28.78	-14.79
RED-BLUFF_725910	11	3b	-33.49	-0.63	35.43	19.09	0.18	7.40	0.32
SACRAMENTO-EXECUTIVE_724830	12	3b	-122.38	0.45	150.49	112.24	2.18	28.42	0.77
FRESNO_723890	13	3b	-71.07	-1.92	69.70	37.70	-1.83	19.09	-2.58
PALMDALE_723820	14	4b	-11.02	-1.58	27.50	17.47	1.46	5.98	-3.38
PALM-SPRINGS-INTL_722868	15	2b	-32.38	-2.54	30.70	2.90	-0.10	7.83	-3.88
BLUE-CANYON_725845	16	4b	-3.95	-0.47	7.25	6.92	0.79	1.12	0.06
MONTAGUE-SISKIYOU-CO_725955	16	5b	-4.70	-0.47	15.44	12.71	0.23	2.52	-1.31
SOUTH-LAKE-TAHOE_725847	16	6b	-2.91	-0.31	5.48	5.32	0.09	0.60	-1.02
total by building type			-952.33	-4.06	1210.06	872.53	42.92	249.79	-122.80

Source: California Energy Commission staff

The projected building starts used in the above conversion were taken from a 2016 impact analysis conducted by the Energy Commission. The original data used in the analysis were generated by the Energy Commission's Energy Assessment Division by starting with permit data purchased from Dodge Data and Analytics (formerly McGraw Hill Construction). These raw data were converted to projected building completions using an in-house algorithm that takes into account building types and locations. These completion data were then projected forward 10 years using the mean life of each building type and benchmarking the data from historical commercial end-use surveys. A logistic decay function then honed in to a better approximation by creating a complete historical data series for floor space. This historical floor space series was finally projected forward again using a linear mixed model to include economic and demographic variables such as employment, personal income, and population in each region.

The projected building starts data used for 2017 are in millions of square feet for each of the building types surveyed, and some assumptions are made when splitting up some of those columns into the building types modeled in this analysis. Based on occupancy data discussed in the 2016 impact report, Seventy-four percent of the apartments are classified as low–rise, leaving 26 percent as high rise. Hotels are split evenly into large and small, as are large and medium offices. (Small offices were surveyed separately.) Stand-alone retail and strip mall retail are also divided equally. Lastly, projected building start data were available only for Climate Zone 16 as a whole and not for the three ASHRAE subzones it includes. California Climate Zone 16 projected start data were therefore divided into the three ASHRAE subzones based on population projections from the U.S. Census Bureau for each of the subzones: the large 5b northern inland mountain region was projected to have a population of 122,954, while the smaller but denser 4b zone was projected to have a population of 355,781, and the 6b zone was projected to have a population of 15,019. Ultimately, the chart of projected building starts with 18 lines for each of the 14 buildings in millions of square feet was obtained.

The balance sheet from the modeling in GBTU per square foot was then merged with the projected building starts in millions of square feet to yield an 18 by 14 balance sheet of GBTU saved (if positive) by using Title 24 vs. ASHRAE as shown in Table 2. In sum total the energy savings of Title 24 over ASHRAE can be estimated to be at least 3893 GBTU (3.9 TBtu) annually.

A similar analysis as described above was performed for the percentage of annual TDV energy saved by Title 24 over ASHRAE, if positive or negative, indicating the amount saved by ASHRAE over Title 24. The total projected annual TDV EUI in GBtu for buildings complying with Title 24 was subtracted from those complying with ASHRAE 90.1 and this value divided by that for those complying with ASHRAE 90.1 to obtain a total annual Title 24 percent better than ASHRAE 90.1 value for each climate zone and occupancy. These values are displayed in Table 3.

Table 3: Percentage Better Than ASHRAE Table

TOTAL Annual Title 24 Percent better than ASHRAE 90.1									
Weather Station	CA Climate Zone	DoE Climate Zone	Apartment HighRise	Apartment MidRise	Hotel Large	Hotel Small	Office Large	Office Med	Office Small
ARCATA_725945	1	4c	21.6	31.9	33.8	30.3	36.7	13.7	6.4
SANTA-ROSA_724957	2	3c	26.5	27.0	22.7	22.3	14.6	21.6	1.3
OAKLAND_724930	3	3c	31.7	33.8	28.9	29.9	22.4	25.4	2.4
SAN-JOSE-INTL_724945	4	3c	31.0	30.9	24.1	26.8	19.6	22.0	0.7
SANTA-MARIA_723940	5	3c	30.9	34.9	28.8	30.4	21.7	25.1	1.9
TORRANCE_722955	6	3c	35.3	32.5	26.5	28.7	19.3	18.7	-0.2
SAN-DIEGO-GILLESPIE_722907	7	3b	45.9	31.8	18.9	25.4	11.4	17.9	-4.0
FULLERTON_722976	8	3b	48.6	30.7	22.9	26.2	18.6	18.4	-1.1
BURBANK-GLENDALE_722880	9	3b	44.9	25.8	23.3	21.2	9.1	17.4	-2.0
RIVERSIDE_722869	10	3b	45.7	24.6	20.1	19.7	10.4	16.2	-4.8
RED-BLUFF_725910	11	3b	39.3	20.2	19.0	18.8	8.1	18.4	-1.2
SACRAMENTO-EXECUTIVE_724830	12	3b	41.5	21.1	20.6	19.8	8.8	19.5	1.0
FRESNO_723890	13	3b	40.2	18.0	18.9	16.5	11.6	17.5	-0.5
PALMDALE_723820	14	4b	40.6	23.6	16.3	23.2	19.3	12.4	-2.6
PALM-SPRINGS-INTL_722868	15	2b	41.8	17.6	14.8	19.8	30.3	14.5	-1.6
BLUE-CANYON_725845	16	4b	35.4	19.1	19.1	26.4	27.3	13.7	-8.2
MONTAGUE-SISKIYOU-CO_725955	16	5b	31.3	15.8	16.5	18.1	9.0	21.6	-9.4
SOUTH-LAKE-TAHOE_725847	16	6b	26.7	9.4	16.7	20.0	12.0	23.4	-11.6
average by building type			36.61	24.92	21.76	23.52	17.23	18.74	-1.85
Weather Station	CA Climate Zone	DoE Climate Zone	Restaurant Fast Food	Restaurant SitDown	Retail Standalo ne	Retail StripMall	School Primary	School Secondar y	Warehou se
ARCATA_725945	1	4c	-12.8	3.0	36.4	36.3	1.0	9.9	-1.3
SANTA-ROSA_724957	2	3c	-27.3	1.5	30.6	21.1	2.1	16.3	0.3
OAKLAND_724930	3	3c	-29.4	2.5	33.8	27.5	7.6	16.9	-1.1
SAN-JOSE-INTL_724945	4	3c	-29.8	2.2	31.5	22.4	5.1	18.0	-2.4
SANTA-MARIA_723940	5	3c	-29.3	2.5	33.8	28.0	6.7	14.5	-4.1
TORRANCE_722955	6	3c	-34.7	1.6	26.4	16.4	3.8	15.0	-18.7
SAN-DIEGO-GILLESPIE_722907	7	3b	-32.3	3.0	30.4	19.3	2.9	16.5	-18.3
FULLERTON_722976	8	3b	-34.9	1.0	26.5	14.7	4.2	18.5	-15.7
BURBANK-GLENDALE_722880	9	3b	-32.0	-1.2	27.4	13.3	2.7	21.5	-6.9
RIVERSIDE_722869	10	3b	-27.4	-4.0	25.9	12.8	1.7	23.9	-8.0
RED-BLUFF_725910	11	3b	-25.5	-1.7	28.3	13.2	0.2	22.0	0.4
SACRAMENTO-EXECUTIVE_724830	12	3b	-26.4	0.2	27.0	16.8	0.6	20.8	0.3
FRESNO_723890	13	3b	-27.2	-2.2	26.9	12.4	-0.6	22.4	-1.9
PALMDALE_723820	14	4b	-12.4	-2.7	27.9	15.0	4.2	21.5	-8.2
PALM-SPRINGS-INTL_722868	15	2b	-27.9	-5.8	24.4	2.1	-0.2	30.1	-7.0
BLUE-CANYON_725845	16	4b	-15.8	-3.4	30.4	23.5	6.0	14.5	0.4
MONTAGUE-SISKIYOU-CO_725955	16	5b	-7.6	-1.5	28.0	19.3	0.7	13.9	-4.4
SOUTH-LAKE-TAHOE_725847	16	6b	-14.4	-3.1	30.5	24.4	0.9	10.1	-9.4
average by building type			-24.84	-0.45	29.23	18.80	2.77	18.11	-5.88

Source: California Energy Commission staff

CHAPTER 4: Conclusion

The analysis shows that *California's 2016 Building Energy Efficiency Standards* exceed the energy savings expected from requirements of ASHRAE/IESNA 90.1-2013. While improvements in the energy stringency levels of the national reference energy codes continue, California's nonresidential energy standards contain building measures and building performance operation impacts that are more rigorous, resulting in higher efficiency levels for new nonresidential construction than expected to occur from efficiency requirements of the federal reference energy codes. Table 4 displays the total annual TDV EUI saved in GBtu by complying with Title 24 vs. ASHRAE 90.1, while Table 5 displays the total annual Title 24 percent better than ASHRAE 90.1 values per climate zone. The total amount of energy saved by complying with California's Title 24 Standards is 3.9 GBtu, which is on average 13 percent better than complying with ASHRAE 90.1.

Table 4: Savings Summary Table

TOTAL Annual TDV EUI GBtu savings			
Weather Station	CA Climate Zone	DoE Climate Zone	total by CZ
ARCATA_725945	1	4c	10
SANTA-ROSA_724957	2	3c	100
OAKLAND_724930	3	3c	581
SAN-JOSE-INTL_724945	4	3c	265
SANTA-MARIA_723940	5	3c	55
TORRANCE_722955	6	3c	291
SAN-DIEGO-GILLESPIE_722907	7	3b	291
FULLERTON_722976	8	3b	500
BURBANK-GLENDALE_722880	9	3b	776
RIVERSIDE_722869	10	3b	254
RED-BLUFF_725910	11	3b	57
SACRAMENTO-EXECUTIVE_724830	12	3b	393
FRESNO_723890	13	3b	114
PALMDALE_723820	14	4b	79
PALM-SPRINGS-INTL_722868	15	2b	44
BLUE-CANYON_725845	16	4b	24
MONTAGUE-SISKIYOU-CO_725955	16	5b	45
SOUTH-LAKE-TAHOE_725847	16	6b	13
TOTAL CALIFORNIA ANNUAL			3893

Source: California Energy Commission staff

Table 5: Percentage Better Summary Table

TOTAL Annual Percent better			
Weather Station	CA Climate Zone	DoE Climate Zone	total by CZ
ARCATA_725945	1	4c	18
SANTA-ROSA_724957	2	3c	13
OAKLAND_724930	3	3c	17
SAN-JOSE-INTL_724945	4	3c	14
SANTA-MARIA_723940	5	3c	16
TORRANCE_722955	6	3c	12
SAN-DIEGO-GILLESPIE_722907	7	3b	12
FULLERTON_722976	8	3b	13
BURBANK-GLENDALE_722880	9	3b	12
RIVERSIDE_722869	10	3b	11
RED-BLUFF_725910	11	3b	11
SACRAMENTO-EXECUTIVE_724830	12	3b	12
FRESNO_723890	13	3b	11
PALMDALE_723820	14	4b	13
PALM-SPRINGS-INTL_722868	15	2b	11
BLUE-CANYON_725845	16	4b	13
MONTAGUE-SISKIYOU-CO_725955	16	5b	11
SOUTH-LAKE-TAHOE_725847	16	6b	10
TOTAL CALIFORNIA ANNUAL			13

Source: California Energy Commission staff