CODES AND STANDARDS ENHANCEMENT INITIATIVE (CASE)

Results Report – HVAC Equipment Efficiency Based on ASHRAE 90.1-2013

Measure Number: 2016-NR-ASHRAE1-F

Nonresidential HVAC

2016 CALIFORNIA BUILDING ENERGY EFFICIENCY STANDARDS

California Utilities Statewide Codes and Standards Team September 2015

Prepared by: Prepared by: Scott Bailey (ASWB Engineering)

This report was prepared by the California Statewide Codes and Standards Enhancement (CASE) Program that is funded, in part, by California utility customers under the auspices of the California Public Utilities Commission.

TABLE OF CONTENTS

Document Information

Category: Codes and Standards

Keywords: Statewide CASE, Statewide Codes and Standards Team, Statewide C&S Team, Codes and Standards Enhancements, Title 24, 2016, efficiency, equipment efficiency.

1. PREFACE

The Codes and Standards Enhancement (CASE) initiative presents recommendations to support California Energy Commission's (CEC) efforts to update California's Building Energy Efficiency Standards (Title 24) to include new requirements or to upgrade existing requirements for various technologies. The four California Investor Owned Utilities (IOUs) – Pacific Gas and Electric Company (PG&E), San Diego Gas and Electric (SDG&E), Southern California Edison (SCE) and Southern California Gas Company (SoCalGas) – and Los Angeles Department of Water and Power (LADWP) sponsored this effort. The program goal is to prepare and submit proposals that will result in cost-effective enhancements to energy efficiency in buildings. This report and the code change proposal presented herein is a part of the effort to develop technical and cost-effectiveness information for proposed regulations on building energy efficient design practices and technologies.

2. EXECUTIVE SUMMARY

2.1 Measure Description

The heating, ventilation, and air conditioning (HVAC) equipment efficiency measure proposes updates to the mandatory efficiency requirements for space conditioning equipment that appear in Tables 110.2-A through K so that the minimum equipment efficiency values are as stringent as the minimum efficiency requirements in ASHRAE 90.1-2013. Not every efficiency value listed in the tables in Section 110.2 needed to be updated. The Statewide CASE Team identified eighty-two (82) efficiency values that needed updating.

The proposal did not result in changes to the Reference Appendices. CEC adopted the 2016 Standards and Reference Appendices on June 10, 2015.

The Nonresidential Compliance Manual and compliance forms will be updated to reflect the changes to the standards. This change does not require changes to the Alternative Calculation Manual (ACM) Reference Manuals or the compliance software.

2.2 Summary of Revisions that Occurred during CEC Pre-rulemaking and Rulemaking

The Statewide CASE Team solicited feedback from a variety of stakeholders when developing the version of the CASE Report that CEC used as a "document relied upon" in their rulemaking package (see Appendix A). In addition to personal outreach to key stakeholders, the Statewide CASE Team conducted a public stakeholder meeting to discuss the proposal on May 20, 2014. Feedback that stakeholders provided during the utility-sponsored stakeholder meeting is summarized in Section 2.4 of the report presented in Appendix A.

During the CEC rulemaking period, an exception was added to Section 110.2(a) of Title 24 to clarify that the minimum efficiency requirements of Section 110.2 do not impact the requirements of Section 120.6 for refrigerated warehouses and commercial refrigeration.

See Section 3 of this report for additional information about changes that occurred during CEC's pre-rulemaking and rulemaking processes.

2.3 Energy Savings

The first year statewide impacts of this code proposal are 9.96 gigawatt-hours per year of electricity, 0.20 Mtherms per year of fuel oil, and 3.46 megawatts of electrical demand. The methodology used to estimate energy savings is described in detail in Section 5.1 of the CASE Report included in Appendix A.

Table 1: First year statewide energy impacts estimate

Measure	Electricity Savings (GWh)	Power Demand Reduction (MW)	Natural Gas Savings (MMtherms)	Fuel Oil Savings (Mtherms)	TDV Energy Savings (Million kBtu)
Air Conditioners	3.30	1.60	0	0	107.6
Heat Pumps	0.72	0.34	0	0	23.3
Chillers	3.14	0.97	0	0	85.9
Package Terminal Air Conditioners (PTAC)	0.10	0.05	0	0	3.3
Split Package Vertical Air Conditioners (SPVAC)	0.50	0.10	0	0	12.1
Split Package Vertical Heat Pumps (SPVHP)	2.17	0.40	0	0	52.6
Evaporative Condensers	0.03	0.01	0	0	0.7
Furnaces (Oil)	0	0	0	0.20	0
Boilers	0	0	0	0	0
TOTAL	**9.96**	**3.46**	**0**	**0.20**	**285.5**

3. EVOLUTION OF REQUIREMENTS

The Statewide CASE Team solicited feedback from a variety of stakeholders when developing the version of the CASE Report that is presented in Appendix A. In addition to personal outreach to key stakeholders, the Statewide CASE Team conducted a public stakeholder meeting to discuss the proposal on May 20, 2014. Section 2.4 of the report presented in Appendix A summarizes issues that were addressed between the time the Statewide CASE Team commenced work on the project and the time the CASE Report was submitted to CEC. The following paragraphs summarize how the code change proposals evolved between the time the most recent version of the CASE Report was submitted to CEC and the time the standards were adopted. See Appendix B for a list of comments relevant to this measure that were submitted to CEC throughout the pre-rulemaking and rulemaking processes.

3.1 Exception for Refrigerated Warehouses and Commercial Refrigeration

The proposed code in the CASE Report is based on the ASHRAE 90.1 (2013) standard. The purpose of this measure is to update the Title 24 Standards' minimum equipment efficiency values to match ASHRAE's minimum equipment efficiency levels.

No comments were submitted and no changes were implemented to the 82 efficiency values proposed to be updated in the CASE Report. The Statewide CASE Team did recommend fixing table formatting issues that did not alter any of the proposed language or values.

The proposed language from the CASE Report only updates the minimum equipment efficiency values. However, some equipment types that the ASHRAE standard had minimum efficiencies for were not present in the tables. Therefore, the Statewide CASE Team recommended adding the following equipment types and their minimum efficiency requirements to Title 24:

- Propeller or axial fan evaporative condensers
- Centrifugal fan evaporative condensers

On September 18, 2015 before the 45-Day Language was published, McHugh Energy notice a conflict between the efficiency tables (Section 110.2) and two other sections of the Title 24 Standards: Section 120.6(a) Mandatory Requirements for Refrigerated Warehouses and Section 120.6(b) Mandatory Requirements for Commercial Refrigeration. Both sections specify their own minimum equipment efficiencies for evaporative condensers, creating a conflict within the efficiency tables in Section 110.2.

In response, The Statewide CASE Team recommended adding an exception to the beginning of Section 110.2:

> **EXCEPTION 3 to section 110.2(a):** Equipment primarily serving exempt or covered process loads.

Section 120.6 states which covered processes have mandatory requirements, including refrigerated warehouses and commercial refrigeration products. With the above exception, which excludes equipment serving loads for covered processes, the minimum efficiency requirements specified in Tables 110.2 A-K do not apply to the two conflicting parts of Section 120.6. The CEC accepted this change and published it in the 45-Day Language.

When the 15-Day Language was published, CEC modified the language to be more specific:

> **EXCEPTION 3 to section 110.2(a):** Equipment primarily serving refrigerated warehouses or commercial refrigeration.

The Statewide CASE Team agreed with this change, because it did not alter the proposed exception. The CEC adopted the 15-Day Language on June 10, 2015 with no further changes.

4. ADOPTED STANDARDS

The adopted 15-Day Language and Reference Appendices are presented in the following sections. Additions released in the 45-Day Language Express Terms are underlined and deletions are struck with lines. Revisions included in the 15-Day Language are in red font and are double underlined if the language was added or struck with double lines if the language was deleted.

4.1 Building Energy Efficiency Standards Code Language

4.1.1 Section 110.2

TABLE 110.2-A ELECTRICALLY OPERATED UNITARY AIR CONDITIONERS AND CONDENSING UNITS – MINIMUM EFFICIENCY REQUIREMENTS

Equipment Type	Size Category	Efficiency [a,b]		Test Procedure [c]
		Before 1/1/2016~~5~~	After 1/1/2016~~5~~	
Air conditioners, air cooled both split system and single package	≥ 65,000 Btu/h and < 135,000 Btu/h	11.2 EER [b] 11.4 IEER [b]	11.2 EER 12.9 IEER	ANSI/AHRI 340/360
	≥ 135,000 Btu/h and < 240,000 Btu/h	11.0 EER [b] 11.2 IEER [b]	11.0 EER 12.4 IEER	ANSI/AHRI 340/360
	≥ 240,000 Btu/h and < 760,000 Btu/h	10.0 EER [b] 10.1 IEER [b]	10.0 EER 11.6 IEER	
	≥ 760,000 Btu/h	9.7 EER [b] 9.8 IEER [b]	9.7 EER 11.2 IEER	
Air conditioners, water cooled	≥ 65,000 Btu/h and < 135,000 Btu/h	12.1 EER [b] 12.3 IEER [b]	12.1 EER 13.9 IEER	ANSI/AHRI 340/360
	≥135,000 Btu/h and < 240,000 Btu/h	12.5 EER [b] 12.5 IEER [b]	12.5 EER 13.9 IEER	ANSI/AHRI 340/360
	≥240,000 Btu/h and < 760,000 Btu/h	12.4 EER [b] 12.6 IEER [b]	12.4 EER 13.6 IEER	ANSI/AHRI 340/360
	≥ 760,000 Btu/h	12.2 EER [b] 12.4 IEER [b]	12.2EER 13.5 IEER	ANSI/AHRI 340/360
Air conditioners, evaporatively cooled	≥65,000 Btu/h and < 135,000 Btu/h	12.1 EER [b] 12.3 IEER [b]		ANSI/AHRI 340/360
	≥ 135,000 Btu/h and < 240,000 Btu/h	12.0 EER [b] 12.2 IEER [b]		ANSI/AHRI 340/360
	≥240,000 Btu/h and < 760,000 Btu/h	11.9 EER [b] 12.1 IEER [b]		ANSI/AHRI 340/360
	≥ 760,000 Btu/h	11.7 EER [b] 11.9 IEER [b]		ANSI/AHRI 340/360
Condensing units, air cooled	≥ 135,000 Btu/h	10.5 EER 11.8 IEER		ANSI/AHRI 365
Condensing units, water cooled	≥ 135,000 Btu/h	13.5 EER 14.0 IEER		
Condensing units, evaporatively cooled	≥ 135,000 Btu/h	13.5 EER 14.0 IEER		

[a] IEERs are only applicable to equipment with capacity control as ~~per~~as specified by ANSI/AHRI 340/360 test procedures

[b] Deduct 0.2 from the required EERs and IEERs for units with a heating section other than electric resistance heat.

[c] Applicable test procedure and reference year are provided under the definitions.

TABLE 110.2-B UNITARY AND APPLIED HEAT PUMPS, MINIMUM EFFICIENCY REQUIREMENTS

Equipment Type	Size Category	Efficiency [a,b]		Test Procedure[c]
		Before 1/1/2016	After 1/1/2016	
Air Cooled (Cooling Mode), both split system and single package	≥ 65,000 Btu/h and < 135,000 Btu/h	11.0 EER[b] 11.2 IEER[b]	11.0 EER 12.2 IEER	ANSI/AHRI 340/360
	≥ 135,000 Btu/h and < 240,000 Btu/h	10.6 EER[b] 10.7 IEER[b]	10.6 EER 11.6 IEER	
	≥ 240,000 Btu/h	9.5 EER[b] 9.6 IEER[b]	9.5 EER 10.6 IEER	
Water source (cooling mode)	≥ 65,000 Btu/h and < 135,000 Btu/h ~~≥ 135,000 Btu/h and < 240,000 Btu/h~~	86°F entering water ~~86°F entering water~~	~~12.0~~13.0 EER ~~13.0 EER~~	ISO-13256-1
Groundwater source (cooling mode)	< 135,000 Btu/h	59°F entering water	~~16.2~~18.0 EER	ISO-13256-1
Ground source (cooling mode)	< 135,000 Btu/h	77°F entering water	~~13.4~~14.1 EER	ISO-13256-1
Water source water-to-water (cooling mode)	< 135,000 Btu/h	86°F entering water	10.6 EER	ISO-13256-2
Groundwater source water-to-water (cooling mode)	< 135,000 Btu/h	59°F entering water	16.3 EER	ISO-13256-1
Ground source brine-to-water (cooling mode)	< 135,000 Btu/h	77°F entering water	12.1 EER	ISO-13256-2
Air Cooled (Heating Mode) Split system and single package	≥ 65,000 Btu/h and < 135,000 Btu/h (cooling capacity)	47° F db/43° F wb outdoor air	3.3 COP	ANSI/AHRI 340/360
		17° F db/15° F wb outdoor air	2.25 COP	
	≥ 135,000 Btu/h (cooling capacity)	47° F db/43° F wb outdoor air	3.2 COP	
		17° F db/15° F wb outdoor air	2.05 COP	

CONTINUED: TABLE 110.2-B UNITARY AND APPLIED HEAT PUMPS, MINIMUM EFFICIENCY REQUIREMENTS

Equipment Type	Size Category	Subcategory or Rating Condition	Efficiency [a]	Test Procedure[c]
Water source (heating mode)	< 135,000 Btu/h (cooling capacity)	68°F entering water	4.~~2~~ 3 COP	ISO-13256-1
	≥ 135,000 Btu/h and < 240,000 Btu/h	68°F entering water	2.90 COP	
Groundwater source (heating mode)	< 135,000 Btu/h (cooling capacity)	50°F entering water	3.~~6~~ 7 COP	ISO-13256-1
Ground source (heating mode)	< 135,000 Btu/h (cooling capacity)	32°F entering water	3.~~1~~ 2 COP	ISO-13256-1
Water source water-to-water (heating mode)	< 135,000 Btu/h (cooling capacity)	68°F entering water	3.7 COP	ISO-13256-2
Groundwater source water-to-water (heating mode)	< 135,000 Btu/h (cooling capacity)	50°F entering water	3.1 COP	ISO-13256-2
Ground source brine-to-water (heating mode)	< 135,000 Btu/h (cooling capacity)	32°F entering water	2.5 COP	ISO-13256-2

[a] IEERs are only applicable to equipment with capacity control as ~~per~~as specified by ANSI/AHRI 340/360 test procedures.

[b] Deduct 0.2 from the required EERs and IEERs for units with a heating section other than electric resistance heat.

[c] Applicable test procedure and reference year are provided under the definitions.

TABLE 110.2-C AIR-COOLED GAS-ENGINE HEAT PUMPS

Equipment Type	Size Category	Subcategory or Rating Condition	Efficiency	Test Procedure[a]
Air-Cooled Gas-Engine Heat Pump (Cooling Mode)	All Capacities	95° F db Outdoor Air	0.60 COP	ANSI Z21.40.4A
Air-Cooled Gas-Engine Heat Pump (Heating Mode)	All Capacities	47° F db/43° F wb Outdoor Air	0.72 COP	ANSI Z21.40.4A

[a] Applicable test procedure and reference year are provided under the definitions.

TABLE 110.2-D WATER CHILLING PACKAGES – MINIMUM EFFICIENCY REQUIREMENTS [a,b]

Equipment Type	Size Category	Path A Efficiency [a,b]	Path B Efficiency [a,b]	Test Procedure [c]
Air Cooled, With Condenser Electrically Operated	< 150 Tons	≥ ~~9.562~~10.100 EER ≥ ~~12.500~~13.700 IPLV	≥ 9.700 EER ≥15.800 IPLV ~~N.A.~~ [d]	AHRI 550/590
	≥ 150 Tons	≥ ~~9.562~~10.100 EER ≥ 14.000~~12.750~~ IPLV	≥ 9.700 EER ≥16.100 IPLV~~N.A.~~ [d]	
Air Cooled, Without Condenser Electrically Operated	All Capacities	Air-cooled chillers without condensers must be rated with matching condensers and comply with the air-cooled chiller efficiency requirements.		
Water Cooled, Electrically Operated, Reciprocating (Reciprocating)	All Capacities	Reciprocating units must comply with the water-cooled positive displacement efficiency requirements.		AHRI 550/590
Water Cooled, Electrically Operated Positive Displacement	< 75 Tons	≤0.~~780~~ 750kW/ton ≤ 0.~~630~~ 6 IPLV	≤ 0.~~800~~ 780 kW/ton ≤ 0.~~600~~ 500 IPLV	AHRI 550/590
	≥ 75 tons and < 150 tons	≤ 0.~~775~~ 720 kW/ton ≤ 0.~~615~~ 560 IPLV	≤ 0.750~~790~~ kW/ton ≤ 0.~~586~~ 490 IPLV	
	≥ 150 tons and < 300 tons	≤ 0.~~680~~ 660 kW/ton ≤ 0.540~~580~~ IPLV	≤ 0.~~718~~ 680 kW/ton ≤ 0.~~540~~ 440 IPLV	
	≥ 300 Tons and < 600 tons	≤ 0.~~620~~ 610kW/ton ≤ 0.~~540~~ 520 IPLV	≤ 0.~~639~~ 625 kW/ton ≤ 0.~~490~~ 410 IPLV	
	≥ 600 tons	≤ 0.560 kW/ton ≤ 0.500 IPLV	≤ 0.585 kW/ton ≤ 0.380 IPLV	
Water Cooled, Electrically Operated, Centrifugal	< 150 Tons	≤ 0.~~634~~ 610 kW/ton ≤ 0.550~~596~~ IPLV	≤ 0.~~639~~ 695 kW/ton ≤ 0.~~450~~ 440 IPLV	
	≥ 150 tons and < 300 tons	≤ 0.~~634~~ 610 kW/ton ≤ 0.~~596~~ 550 IPLV	≤ 0.~~639~~ 635 kW/ton ≤ 0.~~450~~ 400 IPLV	
	≥ 300 tons and < ~~600~~ 400 tons	≤ 0.~~576~~ 560 kW/ton ≤ 0.~~549~~ 520 IPLV	≤ 0.~~600~~ 595 kW/ton ≤ 0.~~400~~ 390 IPLV	
	≥ 400 tons and < 600 tons~~≥ 600 Tons~~	≤ 0.~~570~~ 560 kW/ton ≤ 0.~~539~~ 500 IPLV	≤ 0.~~590~~ 585 kW/ton ≤ 0.~~400~~380 IPLV	
	≥ 600 tons	≤ 0.560 kW/ton ≤ 0.500 IPLV	≤ 0.585 kW/ton ≤ 0.380 IPLV	

CONTINUED: TABLE 110.2-D WATER CHILLING PACKAGES – MINIMUM EFFICIENCY REQUIREMENTS [a,b]

Equipment Type	Size Category	Path A Efficiency [a,b]	Path B Efficiency [a,b]	Test Procedure [c]
Air Cooled Absorption, Single Effect	All Capacities	≥0.600 COP	N.A. [d]	ANSI/AHRI 560
Water Cooled Absorption, Single Effect	All Capacities	≥ 0.700 COP	N.A. [d]	
Absorption Double Effect, Indirect-Fired	All Capacities	≥ 1.000 COP ≥ 1.050 IPLV	N.A. [d]	
Absorption Double Effect, Direct-Fired	All Capacities	≥ 1.000 COP ≥1.000 IPLV	N.A. [d]	
Water Cooled Gas Engine Driven Chiller	All Capacities	≥ 1.2 COP ≥ 2.0 IPLV	N.A. [d]	ANSI Z21.40.4A

[a] No requirements for:

- Centrifugal chillers with design leaving evaporator temperature < 36°F; or
- Positive displacement chillers with design leaving fluid temperature ≤ 32°F; or
- Absorption chillers with design leaving fluid temperature < 40°F

[b] Must meet the minimum requirements of Path A or Path B. However, both the full load (COP) and IPLV must be met to fulfill the requirements of the applicable Path.

[c] See Section 100.1 for definitions

[d] NA means not applicable

TABLE 110.2-E PACKAGED TERMINAL AIR CONDITIONERS AND PACKAGED TERMINAL HEAT PUMPS – MINIMUM EFFICIENCY REQUIREMENTS

Equipment Type	Size Category (Input)	Subcategory or Rating Condition	Efficiency		Test Procedure [c]
			~~Before 10/08/2012~~	~~After 10/08/2012~~	
PTAC (Cooling mode) Newly constructed or newly conditioned buildings or additions	All Capacities	95°F db Outdoor Air	~~12.5 - (0.213 x Cap/1000)~~ [a] ~~EER~~	~~13.8~~14.0 - (0.300 x Cap/1000) [a] EER	ANSI/AHRI/CSA 310/380
PTAC (Cooling mode) Replacements [b]	All Capacities	95°F db Outdoor Air	~~10.9 - (0.213 x Cap/1000)~~ [a] ~~EER~~	10.9 - (0.213 x Cap/1000) [a] EER	
PTHP (Cooling mode) Newly constructed or newly conditioned buildings or additions	All Capacities	95°F db Outdoor Air	~~12.3 - (0.213 x Cap/1000)~~ [a] ~~EER~~	14.0 - (0.300 x Cap/1000) [a] EER	
PTHP (Cooling mode) Replacements [b]	All Capacities	95°F db Outdoor Air	~~10.8 - (0.213 x Cap/1000)~~ [a] ~~EER~~	10.8 - (0.213 x Cap/1000) [a] EER	
PTHP (Heating Mode) Newly constructed or newly conditioned buildings or additions	All Capacities	-	~~3.2 - (0.026 x Cap/1000)~~ [a] ~~COP~~	3.7 - (0.052 x Cap/1000) [a] COP	
PTHP (Heating mode) Replacements [b]	All Capacities	-	~~2.9 - (0.026 x Cap/1000)~~ [a] ~~COP~~	2.9 - (0.026 x Cap/1000) [a] COP	
SPVAC (Cooling Mode)	<65,000 Btu/h	95°F db / 75°F wb Outdoor Air	~~9.0 EER~~	~~9.0~~10.0 EER	ANSI/AHRI 390
	≥65,000 Btu/h and <135,000 Btu/h	95°F db / 75°F wb Outdoor Air	~~8.9 EER~~	~~8.9~~10.0 EER	
	≥135,000 Btu/h and <240,000 Btu/h	95°F db / 75°F wb Outdoor Air	~~8.6 EER~~	~~8.6~~10.0 EER	
SPVAC (Cooling Mode) nonweatherized space constrained	≤ 30,000 Btu/h	"95°F db / 75°F wb outdoor air"		9.20 EER	
	> 30,000 Btu/h and ≤ 36,000 Btu/h	"95°F db / 75°F wb outdoor air"		9.00 EER	
SPVHP (Cooling Mode)	<65,000 Btu/h	95°F db / 75°F wb Outdoor Air	~~9.0 EER~~	~~9.0~~10.0 EER	
	≥65,000 Btu/h and <135,000 Btu/h	95°F db / 75°F wb Outdoor Air	~~8.9 EER~~	~~8.9~~ 10.0 EER	
	≥135,000 Btu/h and <240,000 Btu/h	95°F db / 75°F wb Outdoor Air	~~8.6 EER~~	~~8.6~~10.0 EER	
SPVHP (Cooling Mode) nonweatherized space constrained	≤ 30,000 Btu/h	95°F db / 75°F wb Outdoor Air		9.20 EER	
	> 30,000 Btu/h and ≤ 36,000 Btu/h	95°F db / 75°F wb Outdoor Air		9.00 EER	
SPVHP (Heating Mode)	<65,000 Btu/h	47°F db / 43°F wb Outdoor Air	~~3.0 COP~~	3.0 COP	
	≥65,000 Btu/h and <135,000 Btu/h	47°F db / 43°F wb Outdoor Air	~~3.0 COP~~	3.0 COP	
	≥135,000 Btu/h and <240,000 Btu/h	47°F db / 43°F wb Outdoor Air	~~2.9 COP~~	~~2.9~~3.0 COP	
SPVHP (Heating Mode) nonweatherized space constrained	≤ 30,000 Btu/h	47°F db / 43°F wb Outdoor Air		3.00 COP	
	> 30,000 Btu/h and ≤ 36,000 Btu/h	47°F db / 43°F wb Outdoor Air		3.00 COP	

a Cap means the rated cooling capacity of the product in Btu/h. If the unit's capacity is less than 7000 Btu/h, use 7000 Btu/h in the calculation. If the unit's capacity is greater than 15,000 Btu/h, use 15,000 Btu/h in the calculation.

b Replacement units must be factory labeled as follows: "MANUFACTURED FOR REPLACEMENT APPLICATIONS ONLY; NOT TO BE INSTALLED IN NEWLY CONSTRUCTED BUILDINGS." Replacement efficiencies apply only to units with existing sleeves less than 16 inches high or less than 42 inch wide and having a cross-sectional area less than 670 square inches.

c Applicable test procedure and reference year are provided under the definitions

TABLE 110.2-F HEAT TRANSFER EQUIPMENT

Equipment Type	Subcategory	Minimum Efficiency[a]	Test Procedure [b]
Liquid-to-liquid heat exchangers	Plate type	NR	ANSI/AHRI 400

[a] NR = no requirement

[b] Applicable test procedure and reference year are provided under the definitions

TABLE 110.2-G PERFORMANCE REQUIREMENTS FOR HEAT REJECTION EQUIPMENT

Equipment Type	Total System Heat Rejection Capacity at Rated Conditions	Subcategory or Rating Condition	Performance Required [a,b,c,d]	Test Procedure [e]
Propeller or axial fan Open-circuit cooling towers	All	95°F entering water 85°F leaving water 75-°F entering air wb	≥ 42.1 gpm/hp	CTI ATC-105 and CTI STD-201 ~~CTI ATC-105 and CTI STD-201 CTI ATC-105S and CTI STD-201 CTI ATC-105S and CTI STD-201~~
Centrifugal fan Open-circuit cooling towers	All	95°F entering water 85°F leaving water 75-°F entering air wb	- ≥ 20.0 gpm/hp	
Propeller or axial fan closed-circuit cooling towers	All	102°F entering water 90°F leaving water 75-°F entering air wb	- ≥ 14.0 gpm/hp	
Centrifugal fan closed-circuit cooling towers	All	102°F entering water 90°F leaving water 75-°F entering air wb	- ≥ 7.0 gpm/hp	
Propeller or axial fan evaporative condensers	All	" R-507A test fluid 165°F entering gas temp 105°F condensing temp 75°F entering air wb"	≥ 157,000 Btu/h • hp	CTI ATC-106
	All	" Ammonia test fluid 140°F entering gas temp 96.3°F condensing temp 75°F entering air wb"	≥ 134,000 Btu/h • hp	
Centrifugal fan evaporative condensers	All	" R-507A test fluid 165°F entering gas temp 105°F condensing temp 75°F entering air wb"	≥ 135,000 Btu/h • hp	
	All	" Ammonia test fluid 140°F entering gas temp 96.3°F condensing temp 75°F entering air wb"	≥ 110,000 Btu/h • hp	
Air cooled condensers	All	125°F condensing temperature R22 test fluid 190°F entering gas temperature 15°F subcooling 95°F entering drybulb	≥ 176,000 Btu/h·hp	ANSI/AHRI 460

[a] For purposes of this table, open-circuit cooling tower performance is defined as the water flow rating of the tower at the given rated conditions divided by the fan motor nameplate power.

[b] For purposes of this table, closed-circuit cooling tower performance is defined as the process water flow rating of the tower at the given rated conditions divided by the sum of the fan motor nameplate rated power and the integral spray pump motor nameplate power .

[c] For purposes of this table air-cooled condenser performance is defined as the heat rejected from the refrigerant divided by the fan motor nameplate power.

[d] Open cooling towers shall be tested using the test procedures in CTI ATC-105. Performance of factory assembled open cooling towers shall be either certified as base models as specified in CTI STD-201 or verified by testing in the field by a CTI approved testing agency. Open factory assembled cooling towers with custom options added to a CTI certified base model for the purpose of safe maintenance or to reduce environmental or noise impact shall be rated at 90 percent of the CTI certified performance of the associated base model or at the manufacturer's stated performance, whichever is less. Base models of open factory assembled cooling towers are open cooling towers configured in exact accordance with the Data of Record submitted to CTI as specified by CTI STD-201. There are no certification requirements for field erected cooling towers.

[e] Applicable test procedure and reference year are provided under the definitions.

For refrigerated warehouses or commercial refrigeration applications, condensers shall comply with requirements specified by Section 120.6(a) or Section 120.6(b).

TABLE 110.2-H Electrically Operated Variable Refrigerant Flow (VRF) Air Conditioners Minimum Efficiency Requirements

Equipment Type	Size Category	Heating Section Type	Sub-Category or Rating Condition	Minimum Efficiency	Test Procedure[a]
VRF Air Conditioners, Air Cooled	<65,000 Btu/h	All	VRF Multi-split System	13.0 SEER	ANSI/AHRI 1230
	≥65,000 Btu/h and <135,000 Btu/h	Electric Resistance (or none)	VRF Multi-split System	11.2 EER 13.1 IEER[b]	
	≥135,000 Btu/h and <240,000 Btu/h	Electric Resistance (or none)	VRF Multi-split System	11.0 EER 12.9 IEER[b]	
	≥240,000 Btu/h	Electric Resistance (or none)	VRF Multi-split System	10.0 EER 11.6 IEER[b]	

[a] Applicable test procedure and reference year are provided under the definitions.

[b] IEERs are only applicable to equipment with capacity control as ~~per~~ specified by ANSI/AHRI 1230 test procedures.

TABLE 110.2-I Electrically Operated Variable Refrigerant Flow Air-to-Air and Applied Heat Pumps - Minimum Efficiency Requirements

Equipment Type	Size Category	Heating Section Type	Sub-Category or Rating Condition	Minimum Efficiency	Test Procedure [b]
VRF Air Cooled, (cooling mode)	<65,000 Btu/h	All	VRF Multi-split System	13.0 SEER	AHRI 1230
	≥65,000 Btu/h and <135,000 Btu/h	Electric Resistance (or none)	VRF Multi-split System [a]	11.0 EER 12.9 IEER [c]	
	≥135,000 Btu/h and <240,000 Btu/h	Electric Resistance (or none)	VRF Multi-split System [a]	10.6 EER 12.3 IEER [c]	
	≥240,000 Btu/h	Electric Resistance (or none)	VRF Multi-split System [a]	9.5 EER 11.0 IEER [c]	
VRF Water source (cooling mode)	<65,000 Btu/h	All	VRF Multi-split systems [a] 86°F entering water	12.0 EER	AHRI 1230
	≥65,000 Btu/h and <135,000 Btu/h	All	VRF Multi-split System [a] 86°F entering water	12.0 EER	
	≥135,000 Btu/h	All	VRF Multi-split System [a] 86°F entering water	10.0 EER	
VRF Groundwater source (cooling mode)	<135,000 Btu/h	All	VRF Multi-split System 59°F entering water	16.2 EER	AHRI 1230
	≥135,000 Btu/h	All	VRF Multi-split System [a] 59°F entering water	13.8 EER	
VRF Ground source (cooling mode)	<135,000 Btu/h	All	VRF Multi-split System [a] 77°F entering water	13.4 EER	AHRI 1230
	≥135,000 Btu/h	All	VRF Multi-split System [a] 77°F entering water	11.0 EER	

CONTINUED: TABLE 110.2-I Electrically Operated Variable Refrigerant Flow Air-to-Air and Applied Heat Pumps - Minimum Efficiency Requirements

Equipment Type	Size Category	Heating Section Type	Sub-Category or Rating Condition	Minimum Efficiency	Test Procedure [b]
VRF Air Cooled (heating mode)	<65,000 Btu/h (cooling capacity)	- - -	VRF Multi-split System	7.7 HSPF	AHRI 1230
	≥65,000 Btu/h and <135,000 Btu/h (cooling capacity)	- - -	VRF Multi-split system 47°F db/ 43°F wb outdoor air	3.3 COP	
			VRF Multi-split system 17°F db/15°F wb outdoor air	2.25 COP	
	≥135,000 Btu/h (cooling capacity)	- - -	VRF Multi-split system 47°F db/ 43°F wb outdoor air	3.2 COP	
			VRF Multi-split system 17°F db/15°F wb outdoor air	2.05 COP	
VRF Water source (heating mode)	<135,000 Btu/h (cooling capacity)	---	VRF Multi-split System 68°F entering water	4.2 COP	AHRI 1230
	≥135,000 Btu/h (cooling capacity)	---	VRF Multi-split System 68°F entering water	3.9 COP	
VRF Groundwater source (heating mode)	<135,000 Btu/h (cooling capacity)	---	VRF Multi-split System 50°F entering water	3.6 COP	AHRI 1230
	≥135,000 Btu/h (cooling capacity)	---	VRF Multi-split System 50°F entering water	3.3 COP	
VRF Ground source (heating mode)	<135,000 Btu/h (cooling capacity)	---	VRF Multi-split System 32°F entering water	3.1 COP	AHRI 1230
	≥135,000 Btu/h (cooling capacity)	---	VRF Multi-split System 32°F entering water	2.8 COP	

[a] Deduct 0.2 from the required EERs and IEERs for Variable Refrigerant Flow (VRF) Multi-split system units with a heating recovery section.

[b] Applicable test procedure and reference year are provided under the definitions.

[c] IEERs are only applicable to equipment with capacity control as ~~per~~ specified by ANSI/AHRI 1230 test procedures.

TABLE 110.2-J Warm-Air Furnaces and Combination Warm-Air Furnaces/Air-Conditioning Units, Warm-Air Duct Furnaces, and Unit Heaters

Equipment Type	Size Category (Input)	Subcategory or Rating Condition[b]	Minimum Efficiency[d,e]	Test Procedure[a]
Warm-Air Furnace, Gas-Fired	< 225,000 Btu/h	Maximum Capacity[b]	78% AFUE or 80% E_t	DOE 10 CFR Part 430 or Section 2.39, Thermal Efficiency, ANSI Z21.47
	≥ 225,000 Btu/h	Maximum Capacity[b]	80% E_t	Section 2.39, Thermal Efficiency, ANSI Z21.47
Warm-Air Furnace, oil-Fired	< 225,000 Btu/h	Maximum Capacity[b]	78% AFUE or 80% E_t	DOE 10 CFR Part 430 or Section 42, Combustion, UL 727
	≥ 225,000 Btu/h	Maximum Capacity[b]	81% E_t	Section 42, Combustion, UL 727
Warm-Air Duct Furnaces, Gas-Fired	All Capacities	Maximum Capacity[b]	80% E_c	Section 2.10, Efficiency, ANSI Z83.8
Warm-Air Unit Heaters, Gas-Fired	All Capacities	Maximum Capacity[b]	80% E_c	Section 2.10, Efficiency, ANSI Z83.8
Warm-Air Unit Heaters, Oil-Fired	All Capacities	Maximum Capacity[b]	~~80~~81% E_c	Section 40, Combustion, UL 731

[a] Applicable test procedure and reference year are provided under the definitions.

[b] Compliance of multiple firing rate units shall be at maximum firing rate.

[c] Combustion units not covered by NAECA (3-phase power or cooling capacity greater than or equal to 19 kW) may comply with either rating.

[d] E_t = thermal efficiency. Units must also include an interrupted or intermittent ignition device (IID), have jacket losses not exceeding 0.75% of the input rating, and have either power venting or a flue damper. A vent damper is an acceptable alternative to a flue damper for those furnaces where combustion air is drawn from the conditioned space.

[e] E_c = combustion efficiency (100% less flue losses). See test procedure for detailed discussion.

[f] As of August 8, 2008, according to the Energy Policy Act of 2005, units must also include interrupted or intermittent ignition device (IID) and have either power venting or an automatic flue damper.

TABLE 110.2-K Gas- and Oil-Fired Boilers, Minimum Efficiency requirements

Equipment Type	Sub Category	Size Category (Input)	Minimum Efficiency [b,c]		Test Procedure [a]
			Before 3/2/2020	After 3/2/2020	
Boiler, hot water	Gas-Fired	< 300,000 Btu/h	82% AFUE	82% AFUE	DOE 10 CFR Part 430
		≥ 300,000 Btu/h and ≤ 2,500,000 Btu/h [d]	80% E_t	80% E_t	DOE 10 CFR Part 431
		> 2,500,000 Btu/h [e]	82% E_c	82% E_c	
	Oil-Fired	< 300,000 Btu/h	84% AFUE	84% AFUE	DOE 10 CFR Part 430
		≥ 300,000 Btu/h and ≤ 2,500,000 Btu/h [d]	82% E_t	82% E_t	DOE 10 CFR Part 431
		> 2,500,000 Btu/h [e]	84% E_c	84% E_c	
Boiler, steam	Gas-Fired	< 300,000 Btu/h	80% AFUE	80% AFUE	DOE 10 CFR Part 430
	Gas-Fired all, except natural draft	≥ 300,000 Btu/h and ≤ 2,500,000 Btu/h [d]	79% E_t	79% E_t	DOE 10 CFR Part 431
		> 2,500,000 Btu/h [e]	79% E_t	79% E_t	DOE 10 CFR Part 431
	Gas-Fired, natural draft	≥ 300,000 Btu/h and ≤ 2,500,000 Btu/h [d]	77% E_t	79% E_t	DOE 10 CFR Part 431
		> 2,500,000 Btu/h [e]	77% E_t	79% E_t	DOE 10 CFR Part 431
	Oil-Fired	< 300,000 Btu/h	82% AFUE	82% AFUE	DOE 10 CFR Part 430
		≥ 300,000 Btu/h and ≤ 2,500,000 Btu/h [d]	81% E_t	81% E_t	DOE 10 CFR Part 431
		> 2,500,000 Btu/h [e]	81% E_t	81% E_t	DOE 10 CFR Part 431

[a] Applicable test procedure and reference year are provided under the definitions.

[b] Ec = combustion efficiency (100% less flue losses) .See reference document for detailed information.

[c] Et= thermal efficiency. See test procedure for detailed information.

[d] Maximum capacity - minimum and maximum ratings as provided for and allowed by the unit's controls.

[e] Included oil-fired (residual).

4.2 Reference Appendices Code Language

The Statewide CASE Team did not propose changes to the Reference Appendices for the nonresidential HVAC equipment efficiency standards.

4.3 Compliance Manual

In May of 2015, the Statewide CASE Team provided CEC with proposed revisions to the Nonresidential Compliance Manual to describe how to comply with the code change outlined in this CASE Report. The revisions that the Statewide CASE Team provided served as the first draft of CEC's revisions to the Compliance Manual. At the time of writing, CEC has released a

version of the Compliance Manual for public review. The Compliance Manuals are scheduled to be approved during the November 2015 CEC Business Meeting. The Statewide CASE Team recommended updating the minimum equipment efficiency tables in Chapter 4 of the Nonresidential Compliance Manual.

5. FINAL COST-EFFECTIVENESS RESULTS

5.1 Energy Savings Estimates

The energy savings calculation methodology, results, and assumptions have not changed since the CASE Report was submitted to CEC. Please refer to Section 5.1 of the docketed CASE Report presented in Appendix A of this report.

Statewide impacts from this measure are presented in Table 2.

Table 2: Estimated first year energy savings

Measure	Electricity Savings[2] (GWh)	Power Demand Reduction (MW)	Natural Gas Savings[3] (MMtherms)	Oil Fuel Savings (Mtherms)	TDV Energy Savings[4] (Million kBtu)
Air Conditioners	3.30	1.60	0	0	107.6
Heat Pumps	0.72	0.34	0	0	23.3
Chillers	3.14	0.97	0	0	85.9
Package Terminal Air Conditioners (PTAC)	0.10	0.05	0	0	3.3
Split Package Vertical Air Conditioners (SPVAC)	0.50	0.10	0	0	12.1
Split Package Vertical Heat Pumps (SPVHP)	2.17	0.40	0	0	52.6
Evaporative Condensers	0.03	0.01	0	0	0.7
Furnaces (Oil)	0	0	0	0.20	0
Boilers	0	0	0	0	0
TOTAL	**9.96**	**3.46**	**0**	**0.20**	**285.5**

5.2 Final Cost-effectiveness Estimates

As explained in the docketed CASE Report in Appendix A, CEC can adopt the equipment efficiency values that appear in ASHRAE 90.1-2013 without performing a cost-effectiveness analysis. As such, the Statewide CASE Team has not conducted a cost-effectiveness analysis for this measure.

6. ACKNOWLEDGMENTS

The Pacific Gas and Electric Company, Southern California Edison, Southern California Gas Company, San Diego Gas and Electric Company and Los Angeles Department of Water and Power sponsored this report as part of the CASE (Codes and Standards Enhancement) project for the 2016 Building Energy Efficiency Standards. Stuart Tartaglia of PG&E was the project manager for the 2016 Building Standards Advocacy Project on behalf of the utility team. Patrick Eilert is the program manager for the PG&E's CASE program; Stu Tartaglia, Marshall Hunt and Jon McHugh (McHugh Energy) supported this measure on behalf of PG&E. Randall Higa and Ishtiaq Chisti were the CASE program manager for the SCE; Bach Tsan, Charles Kim, Chris Kuch, Sean Gouw and Yun Han supported this measure on behalf of SCE. Sue Kristjansson, Martha Garcia, Dipo Olatunji and Phil Pratt were SoCalGas's CASE program managers; Lovell Willmore, Ron Caudle, Kirk Morales and Christopher Goff supported this measure on behalf of SoCalGas. Chip Fox was SDG&E's CASE program manager; Adrian Salas and John Barbour supported this measure on behalf of SDG&E. Jim Kemper was the CASE program manager on behalf of LADWP.

Energy Solutions is the prime contractors and provided coordination for all CASE Reports. Scott Bailey of TRC performed the analysis and reporting presented here. TRC provided technical and editorial review.

We would like to thank the many reviewers that volunteered their time and effort to improving this proposal. We would particularly like to thank Mark Alatorre and Payam Bozorgchami for working with us throughout the rulemaking process to develop and refine the code changes presented in this report.

APPENDIX A: DOCKETED VERSION OF CASE REPORT

CODES AND STANDARDS ENHANCEMENT INITIATIVE (CASE)

HVAC Equipment Efficiency Based on ASHRAE 90.1-2013

Measure Number: 2016-NR-ASHRAE1-F

NONRESIDENTIAL HVAC

2016 CALIFORNIA BUILDING ENERGY EFFICIENCY STANDARDS

California Utilities Statewide Codes and Standards Team

Prepared by: Scott Baily (ASWB Engineering)

September 2014

This report was prepared by the California Statewide Codes and Standards Enhancement (CASE) Program that is funded, in part, by California utility customers under the auspices of the California Public Utilities Commission.

TABLE OF CONTENTS

List of Tables

Document Information

Category: Codes and Standards

Keywords: Statewide CASE, Statewide Codes and Standards Team, Statewide C&S Team, Codes and Standards Enhancements, Title 24, 2016, efficiency, equipment efficiency.

EXECUTIVE SUMMARY

Introduction

The Codes and Standards Enhancement (CASE) initiative presents recommendations to support California Energy Commission's (CEC) efforts to update California's Building Energy Efficiency Standards (Title 24) to include new requirements or to upgrade existing requirements for various technologies. The four California Investor Owned Utilities (IOUs) – Pacific Gas and Electric Company, San Diego Gas and Electric, Southern California Edison and Southern California Gas Company – and Los Angeles Department of Water and Power (LADWP) sponsored this effort. The program goal is to prepare and submit proposals that will result in cost-effective enhancements to energy efficiency in buildings. This report and the code change proposal presented herein is a part of the effort to develop technical and cost-effectiveness information for proposed regulations on building energy efficient design practices and technologies.

The overall goal of this CASE Report is to propose a code change proposal for HVAC equipment efficiency. The report contains pertinent information that justifies the code change including:

- Description of the code change proposal, the measure history, and existing standards (Section 2);
- Market analysis, including a description of the market structure for specific technologies, market availability, and how the proposed standard will impact building owners and occupants, builders, and equipment manufacturers, distributers, and sellers (Section 3);
- Methodology and assumption used in the analyses energy and electricity demand impacts, cost-effectiveness, and environmental impacts (Section 4);
- Results of energy and electricity demand impacts analysis, Cost-effectiveness Analysis, and environmental impacts analysis (Section 5); and
- Proposed code change language (Section 6).

Scope of Code Change Proposal

The HVAC Equipment Efficiency measure will affect the following code documents listed in Table 1.

Table 1: Scope of Code Change Proposal

Standards Requirements (see note below)	Compliance Option	Appendix	Modeling Algorithms	Simulation Engine	Forms
M	N/A	N/A	N/A	N/A	N/A

Note: An (M) indicates mandatory requirements, (Ps) Prescriptive, (Pm) Performance.

Measure Description

The purpose of this measure is to update mandatory efficiency requirements for space conditioning equipment that appear in Tables 110.2-A thru K so the minimum equipment efficiency values are as stringent as the minimum efficiency requirements in ASHRAE 90.1-2013. Not every efficiency value listed in the tables in Section 110.2 will be updated. The Statewide CASE Team is proposing that eighty-two (82) values in these tables be updated. Most of these changes will update the minimum efficiency values for equipment that is already covered by Title 24.

This proposal would also add minimum efficiency requirements for the following equipment that is not previously covered by Title 24:

- Propeller or axial fan evaporative condensers
- Centrifugal fan evaporative condensers

With the exception of these three products, the proposed requirements are for systems or equipment that are already covered by Title 24. The proposed changes will impact all building types, and will apply to new construction and retrofits.

As discussed in Section 2.1.2 of this report, the equipment efficiency values that are adopted into ASHRAE 90.1 will most likely become the federal minimum efficiency standards. States have a unique opportunity to adopt the equipment efficiency values that appear in ASHRAE 90.1 using a simplified process. CEC is not obligated to adopt ASHRAE 90.1 equipment efficiency values into Table 110.2, but if CEC chooses to do so it can adopt the equipment efficiency values without conducting a cost-effectiveness analysis. CEC can adopt the efficiency values before the U.S. Department of Energy (DOE) completes their cost-effectiveness analysis and before DOE adopts the standards. Given the DOE rulemaking process is typically slower than CEC's rulemaking process, this essentially means that California can adopt the equipment efficiency regulations that will become federal law several years earlier than when the federal requirements will take effect.

CEC has requested that the Statewide CASE Team submit a CASE Report that identifies changes to Tables 110.2A through 110.2K based on ASHRAE 90.1. CEC Staff indicated that the CASE Report does not need to include Section 4.7 Cost-effectiveness Methodology or Section 5.2 Cost-effectiveness Results, but it should include Section 3.4 Market Impacts and Economic Assessments and Section 3.5 Economic Impacts, but these sections should not include any information about cost-effectiveness. This CASE Report includes information that will help inform CEC's determination that the proposed equipment efficiency levels can be adopted into Title 24.

Section 2 of this report provides detailed information about the code change proposal including: ***Section 2.2 Summary of Changes to Code Documents (page 6)*** provides a section-by-section description of the proposed changes to the standards, appendices, alternative compliance manual and other documents that will be modified by the proposed code change. See the following tables for an inventory of sections of each document that will be modified:

- Table 5: Scope of Code Change Proposal (page 6)
- Table 6: Sections of Standards Impacted by Proposed Code Change (page 7)

- Table 7: Appendices Impacted by Proposed Code Change (page 7)
- Table 8: Sections of ACM Impacted by Proposed Code Change (page 7)

Detailed proposed changes to the text of the building efficiency standards, the reference appendices, and are given in ***Section 6 Proposed Language*** of this report. This section proposes modifications to language with additions identified with underlined text and deletions identified with ~~struck-out~~ text.

Market Analysis and Regulatory Impact Assessment

The expected impacts of the proposed code change on various stakeholders are summarized below:

- **Impact on builders:** The proposed code change is not expected to have a significant impact on builders.
- **Impact on building designers:** The proposed code change is not expected to have a significant impact on designers.
- **Impact on occupational safety and health:** The proposed code change is not expected to have an impact on occupational safety and health. It does not alter any existing federal, state, or local regulations pertaining to safety and health, including rules enforced by California Division of Occupational Safety and Health. All existing health and safety rules will remain in place. Complying with the proposed code changes is not anticipated to have any impact on the safety or health occupants or those involved with the construction, commissioning, and ongoing maintenance of the building.
- **Impact on building owners and occupants:** The building owner or the building occupant, whoever pays their energy bills, will pay less for their energy bills.
- **Impact on equipment retailers (including manufacturers and distributors):** The proposed code change will have an impact on manufacturers, distributors, and retailers. Sales of qualifying equipment will increase and sales of non-qualifying equipment will be diminished over time. Manufacturers, retailers and distributors that produce and sell both qualifying and non-qualifying products will be impacted by the proposed code change. However, the equipment efficiency levels that are proposed for Title 24 have already been adopted into ASHRAE 90.1-2013. As described in Section 2.1.2, equipment efficiency requirements that are adopted into ASHRAE 90.1-2013 typically become the minimum levels that are required by federal law. Adopting the ASHRAE equipment efficiency values into Title 24 will have an impact on retailers, primarily because the more stringent efficiency levels will become effective in California prior to the federal effective date.
- **Impact on energy consultants:** The proposed code change is not expected to have a significant impact on energy consultants.
- **Impact on building inspectors:** As compared to the overall code enforcement effort, this measure has negligible impact on the effort required to enforce the building codes. The proposal does not change how building inspectors verify compliance with the code, and the Statewide CASE Team does not anticipate this measure will have an impact on building inspectors.

- **Statewide Employment Impacts:** The proposed changes to Title 24 are expected to result in positive job growth as noted below in Section 3.5. This particular code change proposal is not expected to have an appreciable impact on employment in California.
- **Impacts on the creation or elimination of businesses in California:** The proposed measure is not expected to have an appreciable impact on California businesses.
- **Impacts on the potential advantages or disadvantages to California businesses:** In general California businesses would benefit from an overall reduction in energy costs associated with the proposed revisions to Title 24. This particular measure is not expected to have an appreciable impact on any specific California business.
- **Impacts on the potential increase or decrease of investments in California:** The proposed measure is not expected to have an appreciable impact on investments in California.
- **Impacts on incentives for innovations in products, materials or processes:** Updating Title 24 Standards could encourage innovation through the adoption of new technologies to better manage energy usage and achieve energy savings. It is not anticipated that this particular measure will have a significant impact on innovation.
- **Impacts on the State General Fund, Special Funds and local government:** The proposed measure is not expected to have an appreciable impact on the State General Fund, Special Funds, or local government funds.
- **Cost of enforcement to State Government and local governments:** Building inspection requirements remain the same. Likewise, training or additional time spent on enforcement, which may lead to increased enforcement costs for the state or local government, are very minimal.
- **Impacts on migrant workers; persons by age group, race, or religion:** This proposal and all measures adopted by CEC into Title 24, Part 6 do not advantage or discriminate in regards to race, religion or age group.
- **Impact on Homeowners (including potential first time home owners):** There is no expected impact on homeowners.
- **Impact on Renters:** This proposal is advantageous to renters as it reduces the cost of energy, which is typically paid by renters.
- **Impact on Commuters:** This proposal and all measures adopted by CEC into Title 24, Part 6 are not expected to have an impact on commuters.

Statewide Energy Impacts

Table 2 shows the estimated energy savings over the first twelve months of implementation of the HVAC Equipment Efficiency measure.

Table 2: Estimated First Year Energy Savings

Measure	Electricity Savings[2] (GWh)	Power Demand Reduction (MW)	Natural Gas Savings[3] (MMtherms)	Oil Fuel Savings (Mtherms)	TDV Energy Savings[4] (Million kBTU)
Air Conditioners	3.30	1.60	0	0	107.6
Heat Pumps	0.72	0.34	0	0	23.3
Chillers	3.14	0.97	0	0	85.9
Package Terminal Air Conditioners (PTAC)	0.10	0.05	0	0	3.3
Split Package Vertical Air Conditioners (SPVAC)	0.50	0.10	0	0	12.1
Split Package Vertical Heat Pumps (SPVHP)	2.17	0.40	0	0	52.6
Evaporative Condensers	0.03	0.01	0	0	0.7
Furnaces (Oil)	0	0	0	0.20	0
Boilers	0	0	0	0	0
TOTAL	9.96	3.46	0	0.20	285.5

1. First year savings from all buildings built statewide during the first year the 2016 Standards are in effect.
1. Site electricity savings.
2. No natural gas savings are derived during the first year of Title 24 implementation (2017) due to that the boiler efficiency requirements are scheduled to take effect in the year 2020.
2. Calculated using CEC's 2016 TDV factors and methodology. Includes savings from electricity and natural gas. TDV factors for fuel oil were not available.

Section 4.6.1 discusses the methodology and Section 5.1.1 shows the results for the per unit energy impact analysis.

Cost-effectiveness

As explained in Section Measure History 2.1.2 of this report, CEC can adopt the equipment efficiency values that appear in ASHRAE 90.1-2013 without performing a cost-effectiveness analysis. The Statewide CASE Team did not conduct a cost-effectiveness analysis for this measure.

Greenhouse Gas and Water Related Impacts

Please refer to Section 5.3 of this report for information regarding possible environmental impacts.

Greenhouse Gas Impacts

Table 3 presents the estimated avoided greenhouse gas (GHG) emissions of the proposed code change for the first year the standards are in effect. Assumptions used in developing the GHG savings are provided in Section 4.8.1 of this report.

Table 3: First Year Estimated Statewide Greenhouse Gas Emissions Impacts

Measure	Avoided GHG Emissions (MTCO2e/yr)
Air Conditioners	1,164
Heat Pumps	253
Chillers	1,109
PTAC	35
SPVAC	177
SPVHP	767
Evaporative Condensers	11
Furnaces (Oil)	0
Boilers	0
TOTAL	3,516

Water Use and Water Quality Impacts

The proposed measure is not expected to have any impacts on water use or water quality, excluding impacts that occur at power plants.

Acceptance Testing

This measure does not propose modifications to acceptance tests.

1. INTRODUCTION

The Codes and Standards Enhancement (CASE) initiative presents recommendations to support California Energy Commission's (CEC) efforts to update California's Building Energy Efficiency Standards (Title 24) to include new requirements or to upgrade existing requirements for various technologies. The four California Investor Owned Utilities (IOUs) – Pacific Gas and Electric Company, San Diego Gas and Electric, Southern California Edison and Southern California Gas Company – and Los Angeles Department of Water and Power (LADWP) sponsored this effort. The program goal is to prepare and submit proposals that will result in cost-effective enhancements to energy efficiency in buildings. This report and the code change proposal presented herein is a part of the effort to develop technical and cost-effectiveness information for proposed regulations on building energy efficient design practices and technologies.

The overall goal of this CASE Report is to propose a code change proposal for HVAC equipment efficiency. The report contains pertinent information that justifies the code change.

Section 2 of this CASE Report provides a description of the measure, how the measure came about, and how the measure helps achieve the state's zero net energy (ZNE) goals. This section presents how the Statewide CASE Team envisions the proposed code change would be enforced and the expected compliance rates. This section also summarized key issues that the Statewide CASE Team addressed during the CASE development process, including issues discussed during a public stakeholder meeting the Statewide CASE Team sponsored in May 2014.

Section 3 presents the market analysis, including a review of the current market structure, a discussion of product availability, and the useful life and persistence of the proposed measure. This section offers an overview of how the proposed standard will impact various stakeholders including builders, building designers, building occupants, equipment retailers (including manufacturers and distributors), energy consultants, and building inspectors. Finally, this section presents estimates of how the proposed change will impact statewide employment.

Section 4 describes the methodology and approach the Statewide CASE Team used to estimate energy, demand, costs, and environmental impacts. Key assumptions used in the analyses can be also found in Section 4.

Results from the energy, demand, and environmental impacts analysis are presented in Section 5. The Statewide CASE Team calculated energy, demand, and environmental impacts using two metrics: (1) per unit, and (2) statewide impacts during the first year buildings complying with the 2016 Title 24 Standards are in operation. Time Dependent Valuation (TDV) energy impacts, which accounts for the higher value of peak savings, are presented for the first year both per unit and statewide.

The report concludes with specific recommendations for language for the Standards, Appendices, Alternate Calculation Manual (ACM) Reference Manual and Compliance Forms.

2. MEASURE DESCRIPTION

2.1 Measure Overview

2.1.1 Measure Description

The purpose of this measure is to update mandatory efficiency requirements for space conditioning equipment that appear in Tables 110.2-A thru K so the minimum equipment efficiency values are as stringent as the minimum efficiency requirements in ASHRAE 90.1-2013. Not every efficiency value listed in the tables in Section 110.2 will be updated. The Statewide CASE Team is proposing that eighty-two (82) values in these tables be updated. Most of these changes will update the minimum efficiency values for equipment that is already covered by Title 24.

This proposal would also add minimum efficiency requirements for the following equipment that is not previously covered by Title 24:

- Propeller or axial fan evaporative condensers
- Centrifugal fan evaporative condensers

The proposed changes will impact all nonresidential building types, and will apply to new construction and retrofits. The equipment types subject to the proposed measure are typically used in nonresidential buildings. However, package terminal air conditioners (PTAC), package terminal heat pumps (PTHP), single package vertical air conditioners (SPVAC) and single package vertical heat pumps (SPVHP) can be used in high-rise residential buildings, motels and hotels.

The changes to equipment efficiency requirements are presented in Table 4.

The U.S. Department of Energy (DOE) has adopted the same efficiency standard for steam commercial packaged boilers over 300,000 BTU/hour that are included in ASHRAE 90.1-2013. The DOE standard becomes effective on March 2, 2022 (74 FR 36312, July 22, 2009). ASHRAE 90.1-2013 has an earlier effective date of March 2, 2020 (ASHRAE 90.1-2013, Table 6.8.1-6). The Statewide CASE Team is recommending that CEC adopt the earlier effective date of March 2, 2020.

Table 4: Summary of Changes to Equipment Efficiency Requirements

Equipment	Equipment Category	Proposed Change to Efficiency
Air conditioners	Air cooled and Water cooled	Maintain current EER and Update IEER to efficiency levels in ASHRAE 90.1-2013
Air conditioners	Evaporatively cooled and condensing units	No change
Heat pumps - cooling & heating mode	Air cooled and others	No change
Heat pumps - cooling & heating mode	Water, Groundwater and Ground source	Update EER and COP to efficiency levels in ASHRAE 90.1-2013
Heat pumps - cooling & heating mode	Air-cooled gas engine	No change
Water Chillers	Air cooled and water cooled	Update EER and IPLV to efficiency levels in ASHRAE 90.1-2013
Water Chillers	Air and water cooled absorption	No change
Package Terminal Air Conditioners (PTAC)	For new construction or newly conditioned buildings	Update EER to efficiency levels in ASHRAE 90.1-2013
Package Terminal Heat Pumps (PTHP) - cooling & heating mode	For new construction or newly conditioned buildings and replacements	No change
Single Package Vertical Air Conditioners (SPVAC)	Both weatherized and nonweatherized space constrained	Update EER and Establishes EER for nonweatherized SPVAC to efficiency levels in ASHRAE 90.1-2013
Single Package Vertical Heat Pumps (SPVHP) - cooling & heating mode	Both weatherized and nonweatherized space constrained	Update EER and COP, and Establishes EER and COP for nonweatherized SPVHP to efficiency levels in ASHRAE 90.1-2013
Heat Exchangers	Liquid-to-liquid plate type	No change
Cooling Towers	Open- and closed- circuit	No change
Condensers	Air cooled and evaporative	Update to Btu / (h x hp) to efficiency levels in ASHRAE 90.1-2013
VRF air conditioners	Air cooled	No change
VRF heat pumps - cooling & heating mode	Air cooled, water, ground and groundwater source	No change
Furnaces	Gas- and oil- fired	No change
Furnaces	Unit Heater, oil-fired	Update Combustion Efficiency to efficiency levels in ASHRAE 90.1-2013
Boilers	Hot water and steam, gas- and oil- fired	No change
Boilers	Steam(≥ 300,000 Btu/h)	Update Thermal Efficiency to efficiency levels in ASHRAE 90.1-2013 and established by DOE*

* Thermal efficiency update for steam boilers (≥ 300,000 Btu/h) is scheduled to take effect 03/02/2020 for ASHRE 90.1- and 03/02/2022 for DOE. The Statewide CASE Team recommends that CEC adopt the earlier 03/02/2020 effective date.

2.1.2 Measure History

Current United States federal law does not require states to adopt building energy efficiency standards for nonresidential buildings. However, if states decide to adopt building efficiency code for nonresidential buildings, those codes must result in energy performance that is equal to or better than the energy performance achieved through the current version of ASHRAE 90.1. In addition, energy performance is evaluated on the code as a whole – not on a measure-by-measure basis. This means that CEC does not have to adopt any one measure in ASHRAE 90.1 as long as the aggregate of all measures in Title 24 result in the same or better energy performance as the aggregate of all measures in ASHRAE 90.1.

Although California is not required to adopt every measure in ASHRAE 90.1, some of the measures adopted into ASHRAE 90.1 are well-suited for California's building code. California typically reviews revisions to ASRHAE 90.1 on a measure-by-measure basis to identify potential revisions to Title 24. It should be noted that ASHRAE 90.1 Standards are designed for all states. Therefore, some of the measures in ASHRAE 90.1 are not ideally suited for California, and oftentimes the ASHRAE 90.1 Standards that are well-suited for California can be further tailored so they are more appropriate for California.

ASHRAE 90.1 and Title 24 are structured differently. In most cases ASHRAE 90.1 code language cannot be adopted verbatim into Title 24 because there are discrepancies in the existing code structures. For example, ASHRAE 90.1 and Title 24 use different climate zones, so climate zone dependent standards need to be evaluated carefully to ensure that the proposed Title 24 Standards are appropriate for Title 24 climate zones.

Typically measures that have been vetted through the ASHRAE 90.1 public review process do not receive significant stakeholder opposition when proposed for Title 24. This is, in part, because stakeholders have already participated in ASHRAE's rigorous consensus-based process to develop the code language that appears in the adopted version of ASHRAE 90.1. Despite the fact that a measure has been vetted through the ASHRAE process and has been adopted into ASHRAE 90.1, proposed changes to Title 24 that are based on ASHRAE 90.1-2013 must also be presented at CEC's public workshops

Federal law direct the U.S. Department of Energy (DOE) to review the federal minimum efficiency requirements for certain commercial and industrial equipment whenever ASHRAE 90.1 amends its standards for such equipment (42USC 6313(a)(6)(A)). The following equipment is subject to this "ASHRAE Trigger" requirement:

- Small, Large, and Very Large Commercial Package Air Conditioning and Heating Equipment
- Single Package Vertical Air Conditioners and Heat Pumps
- Packaged Terminal Air Conditioners and Heat Pumps
- Warm-air Furnaces
- Commercial Packaged Boilers
- Storage Water Heaters, Instantaneous Water Heaters, and Unfired Hot Water Storage Tanks

As a result of the "ASHRAE Trigger" requirements, ASHRAE has taken the lead on establishing more stringent standards for the equipment in question, and DOE typically adopts ASHRAE's equipment efficiency levels. Generally speaking, ASHRAE does not complete a comprehensive market and cost analysis on measures it adopts into ASHRAE 90.1. However, ASHRAE does complete a market and cost effectiveness analysis for the equipment efficiency values. The analysis ASHRAE provides informs the DOE's analysis of the ASHRAE equipment efficiency values and streamlines the adoption of ASHRAE equipment efficiency levels into the federal appliance standards.

Since the equipment efficiency values that are adopted into ASHRAE 90.1 will mostly likely become the federal minimum efficiency standards, states have a unique opportunity to adopt the equipment efficiency values that appear in ASHRAE 90.1 using a simplified process. CEC is not obligated to adopt ASHRAE 90.1 equipment efficiency values into Table 110.2, but if CEC chooses to do so it can adopt the equipment efficiency values without conducting a cost-effectiveness analysis. CEC can adopt the efficiency values before DOE completes their cost-effectiveness analysis and before DOE adopts the standards. Given the DOE rulemaking process is typically slower than CEC's rulemaking process, this essentially means that California can adopt the equipment efficiency regulations that will become federal law several years earlier than the federal requirements will take effect.

ASHRAE 90.1 is under continuous maintenance. CEC can adopt ASHRAE equipment efficiency levels that have been approved by the ASHRAE standards committee prior to the Title 24 adoption date. If the ASHRAE standards committee has not approved the efficiency levels, California is preempted from adopting them into Title 24.

CEC has requested that the Statewide CASE Team submit a CASE Report that identifies changes to Tables 110.2A through 110.2K based on ASHRAE 90.1. CEC Staff indicated that the CASE Report does not need to include Section 4.7 Cost-effectiveness Methodology or Section 5.2 Cost-effectiveness Results, but it should include Section 3.4 Market Impacts and Economic Assessments and Section 3.5 Economic Impacts, but these sections should not include any information about cost-effectiveness. This CASE Report includes the information that will help inform CEC's determination that the proposed equipment efficiency levels can be adopted into Title 24.

Historically, the tables in Section 110.2 of Title 24 include equipment efficiency values that are adopted into the most recent version of ASHRAE 90.1, but are more stringent than, or have an earlier effective date than, the currently adopted California Appliance Efficiency Standards (Title 20) or the federal appliance efficiency standards. Although the tables in Section 110.2 historically included efficiency values that differed from current state or federal regulations, the 2013 Title 24 Standards present an exhaustive list of all relevant minimum efficiency requirement for space conditioning equipment, including equipment efficiency values that are the same as the current state or federal requirements.

2.1.3 Existing Standards

The proposed code change proposal will reaffirm that the equipment efficiency values in Section 110.2 of Title 24 to meet energy efficiency levels that are already established by other recognized standards or codes. The follow standards were reviewed to establish the highest potential efficiency levels:

- 2013 Title 24 Standards
- ASHRAE 90.1 (2013)
- California Appliance Efficiency Regulations (Title 20)
- Federal Appliance Efficiency Standards

Most of the proposed changes will update the minimum efficiency values for equipment that is already covered by Title 24. The proposed standards would add minimum efficiency requirements for the following equipment that is not currently covered by Title 24:

- Propeller or axial fan evaporative condensers
- Centrifugal fan evaporative condensers

2.1.4 Alignment with Zero Net Energy Goals

The Statewide CASE Team and CEC are committed to achieving the State of California's ZNE goals. This measure will improve efficiency of mechanical equipment, which in turn will help move buildings towards ZNE.

2.1.5 Relationship to Other Title 24 Measures

This measure does not impact any other code change proposal being considered for the 2016 code change cycle.

2.2 Summary of Changes to Code Documents

The sections below provide a summary of how each Title 24 document will be modified by the proposed change. See Section 6 – Proposed Language of this report for the proposed revisions to code language.

2.2.1 Catalogue of Proposed Changes

Scope

Table 5 identifies the scope of the code change proposal. This measure will impact the following areas (marked by a "Yes").

Table 5: Scope of Code Change Proposal

Mandatory	Prescriptive	Performance	Compliance Option	Trade-Off	Modeling Algorithms	Forms
Yes	No	No	No	No	No	No

Standards

The proposed code change will modify the sections of the California Building Energy Efficiency Standards (Title 24, Part 6) identified in Table 6.

Table 6: Sections of Standards Impacted by Proposed Code Change

Title 24, Part 6 Section Number	Section Title	Mandatory (M) Prescriptive (Ps) Performance (Pm)	Modify Existing (E) New Section (N)
110.2	Mandatory Requirements for Space Conditioning Equipment	M	E

Appendices

The proposed code change will not modify any sections of the reference appendices (See Table 7).

Table 7: Appendices Impacted by Proposed Code Change

APPENDIX NAME		
Section Number	**Section Title**	**Modify Existing (E) New Section (N)**
N/A	N/A	N/A

Nonresidential Alternative Calculation Method (ACM) Reference Manual

The proposed code change will not modify any sections of the Residential or Nonresidential Alternative Calculation Method References (See Table 8).

Table 8: Sections of ACM Impacted by Proposed Code Change

Residential Alternative Calculation Method Reference		
Section Number	**Section Title**	**Modify Existing (E) New Section (N)**
N/A	N/A	N/A
Nonresidential Alternative Calculation Method Reference		
Section Number	**Section Title**	**Modify Existing (E) New Section (N)**
N/A	N/A	N/A

Simulation Engine Adaptations

The proposed code change can be modeled using the current simulation engine. Changes to the simulation engine are not necessary.

2.2.2 Standards Change Summary

This proposal would modify the following sections of the Building Energy Efficiency standards as shown below. See ***Section 6.1*** of this report for the detailed proposed revisions to the standards language.

Changes in Scope

The proposed code change will not modify the scope of the Building Standards.

Changes in Mandatory Requirements

SECTION 110.2 – MANDATORY REQUIREMENTS FOR SPACE-CONDITIONING EQUIPMENT

Subsection 110.2(a): The proposed code change would update some of the equipment efficiency values in Tables 110.2A through 110.2K.

Changes in Prescriptive Requirements

The proposed code change will not modify the prescriptive requirements in the Building Standards.

2.2.3 Standards Reference Appendices Change Summary

The proposed code change will not modify the appendices of the Standards.

2.2.4 Residential/Nonresidential Alternative Calculation Method (ACM) Reference Manual Change Summary

The proposed code change will not modify the ACM Reference Manuals.

2.2.5 Compliance Forms Change Summary

The proposed code change will not modify the Compliance Forms.

2.2.6 Simulation Engine Adaptations

The proposed code change will not require modifications the simulation engine.

2.2.7 Other Areas Affected

No other areas affected.

2.3 Code Implementation

2.3.1 Verifying Code Compliance

There are no additional requirements for code enforcement entities for determining if a building complies with the proposed code change based on existing Title 24 Standards. As such, no changes to the compliance forms are expected.

2.3.2 Code Implementation

Mechanical equipment is already regulated by Title 24, and builders are required to install equipment that complies with minimum efficiency values. Builders, HVAC system designers, and building inspectors are already accustomed to complying with Title 24 equipment efficiency requirements. Updating the equipment efficiency values will have very little impact on code implementation.

2.3.3 Acceptance Testing

The proposed code change would not will not add or modify any acceptance tests.

2.4 Issues Addressed During CASE Development Process

The Statewide CASE Team solicited feedback from a variety of stakeholders when developing the code change proposal presented in this report. In addition to personal outreach to key

stakeholders, the Statewide CASE Team conducted a public stakeholder meeting to discuss the proposal on May 20, 2014.

No significant issues were raised when developing this code change proposal. The equipment efficiency values that are proposed in this CASE Report have already been vetted on the national stage through the ASHRAE 90.1-2013 development process. The Statewide CASE Team is not recommending any modifications from the efficiency levels that are included in ASHRAE 90.1-2013.

3. MARKET ANALYSIS

The Statewide CASE Team performed a market analysis with the goals of identifying current technology availability, current product availability, and market trends. The Statewide CASE Team considered how the proposed standard may impact the market in general and individual market players. The Statewide CASE Team gathered information about the incremental cost of complying with the proposed measure. Estimates of market size and measure applicability were identified through research and outreach with key stakeholders including utility program staff, CEC, and a wide range of industry players who were invited in the stakeholder meeting that the Statewide CASE Team sponsored in May 2014.

3.1 Market Structure

The proposed measure impacts several types of HVAC equipment. Table 9 list the principal manufacturers of the impacted equipment types. Each of these manufacturers have readily available product capable of fulfilling the requirements of this measure. Each manufacturer has multiple branches in California or actively sales their product in California.

Table 9: Principal Manufacturers of HVAC Equipment Impacted by Efficiency Updates

Equipment Type	Principal Manufacturers
Air Conditioners	Carrier, Lennox, Trane
Heat Pumps	Carrier, Lennox, Trane
Water Chillers	Carrier, Lennox, Trane
Package Terminal Air Conditioner (PTAC)	Amana, Freidrich, General Electric
Package Terminal Heat Pump (PTHP)	Amana, Freidrich, General Electric
Single Package Vertical Air Conditioner (SPVAC)	Amana, Freidrich , General Electric
Single Package Vertical Heat Pump (SPVAC)	Amana, Freidrich , General Electric
Evaporative Condensers	Baltimore Aircoil Company (BAC), Evapco
Furnaces – Oil Fired Unit Heaters	Modine, Reznor, Sterling
Steam Boilers	Ajax Boiler, Bobcock & Wilcox, Cleaver-Brooks

3.2 Market Availability and Current Practices

The manufacturers of the HVAC equipment impacted by the proposed measure already produce equipment that the meets the new proposed efficiency standards. The current practice for building designers and contractors is to build to be minimally compliant with Title 24 (2013) standards. The proposed measure will not affect the system configuration of HVAC equipment used in building construction but it will require such HVAC equipment to meet certain efficiency levels.

ASHRAE 90.1 standards are established through rigorous public consensus process. The equipment efficiency standards within ASHRAE 90.1 undergo even more rigorous evaluation than other standards within ASHRAE 90.1 because, as described in 2.1.2, the efficiency standards that are adopted into ASHRAE 90.1-2013 are very likely to become the national minimum efficiency standards. The key manufacturers and other stakeholders impacted by equipment efficiency standards participate in ASHRAE's code development process. The standards are established only after confirming that compliant products are widely available from a variety of manufacturers, and that equipment that meets the proposed standards is reasonably cost effective. This code change proposal recommends adopting the efficiency standards that were adopted ASHRAE 90.1 without any change. In doing so, it is reasonable to assume that the proposed standard have already been heavily vetted through ASHRAE's code development process, and products that meet the proposed standards are readily available in the United States.

The Statewide CASE Team conducted research to confirm that compliant products are available from the major equipment manufacturers. Our market research included internet research and outreach via email and phone communications to key manufacturers and distributers that offer HVAC equipment in California.

3.3 Useful Life, Persistence, and Maintenance

The useful life and required maintenance of HVAC equipment varies based on the type of equipment and application. Typically, improving equipment efficiency does not impact the useful life or maintenance protocols of HVAC equipment, nor does equipment efficiency modify the persistence of savings from HVAC equipment. The Statewide CASE Team evaluated the HVAC equipment that will be impacted by the proposed standard and determined that the useful life, persistence of savings, and maintenance of specific equipment under consideration will not be impacted by modification to the required minimum efficiencies.

3.4 Market Impacts and Economic Assessments

3.4.1 Impact on Builders

The proposed code change is not expected to have a significant impact on builders.

3.4.2 Impact on Building Designers

The proposed code change is not expected to have a significant impact on building designers.

3.4.3 Impact on Occupational Safety and Health

The proposed code change does not alter any existing federal, state, or local regulations pertaining to safety and health, including rules enforced by the California Department of Occupational Safety and Health (Cal/OSHA). All existing health and safety rules will remain in place. Complying with the proposed code change is not anticipated to have any impact on the safety or health occupants or those involved with the construction, commissioning, and ongoing maintenance of the building.

3.4.4 Impact on Building Owners and Occupants

The building owner or the building occupant, whoever pays their energy bills, will pay less for their energy bills.

3.4.5 Impact on Retailers (including manufacturers and distributors)

The proposed code change will have an impact on manufacturers, distributors, and retailers. Sales of qualifying equipment will increase and sales of non-qualifying equipment will be diminished over time. Manufacturers, retailers and distributors that produce and sell both qualifying and non-qualifying products will be impacted by the proposed code change. However, the equipment efficiency levels that are proposed for Title 24 have already been adopted into ASHRAE 90.1-2013. As described in Section 2.1.2, equipment efficiency requirements that are adopted into ASHRAE 90.1-2013 typically become the minimum levels that are required by federal law. Adopting the ASHRAE equipment efficiency values into Title 24 will have an impact on retailers, primarily because the more stringent efficiency levels will become effective in California prior to the federal effective date.

3.4.6 Impact on Energy Consultants

The proposed code change is not expected to have a significant impact on energy consultants.

3.4.7 Impact on Building Inspectors

As compared to the overall code enforcement effort, this measure has negligible impact on the effort required to enforce the building codes. The proposal does not change how building inspectors verify compliance with the code, and the Statewide CASE Team does not anticipate this measure will have an impact on building inspectors.

3.4.8 Impact on Statewide Employment

The proposed changes to Title 24 are expected to result in positive job growth as noted below in Section 3.5. This particular code change proposal is not expected to have an appreciable impact on employment in California.

3.5 Economic Impacts

The proposed Title 24 code changes, including this measure, are expected to increase job creation, income, and investment in California. As a result of the proposed code changes, it is anticipated that less money will be sent out of state to fund energy imports, and local spending

is expected to increase due to higher disposable incomes due to reduced energy costs.[1] In addition, more dollars will be spent in state on improving the energy efficient of new buildings.

These economic impacts of energy efficiency are documented in several resources including the California Air Resources Board's (CARB) Updated Economic Analysis of California's Climate Change Scoping Plan, which compares the economic impacts of several scenario cases (CARB, 2010b). CARB include one case (Case 1) with a 33% renewable portfolio standard (RPS) and higher levels of energy efficiency compared to an alternative case (Case 4) with a 20% RPS and lower levels of energy efficiency. Gross state production (GSP)[2], personal income, and labor demand were between 0.6% and 1.1% higher in the case with the higher RPS and more energy efficiency (CARB 2010b, Table 26). While CARB's analysis does not report the benefits of energy efficiency and the RPS separately, we expect that the benefits of the package of measures are primarily due to energy efficiency. Energy efficiency measures are expected to reduce costs by $2,133 million annually (CARB 2008, pC-117) whereas the RPS implementation is expected to cost $1,782 million annually, not including the benefits of GHG and air pollution reduction (CARB 2008, pC-130).

Macro-economic analysis of past energy efficiency programs and forward-looking analysis of energy efficiency policies and investments similarly show the benefits to California's economy of investments in energy efficiency (Roland-Holst 2008; UC Berkeley 2011).

3.5.1 Creation or Elimination of Jobs

CARB's economic analysis of higher levels of energy efficiency and 33% RPS implementation estimates that this scenario would result in a 1.1% increase in statewide labor demand in 2020 compared to 20% RPS and lower levels of energy efficiency (CARB 2010b, Tables 26 and 27). CARB's economic analysis also estimates a 1.3% increase in small business employment levels in 2020 (CARB 2010b, Table 32). This particular code change proposal is not expected to have an appreciable impact on job creation or elimination in California or elsewhere.

3.5.2 Creation or Elimination of Businesses within California

CARB's economic analysis of higher levels of energy efficiency and 33% RPS implementation (as described above) estimates that this scenario would result in 0.6% additional GSP in 2020 compared to 20% RPS and lower levels of energy efficiency (CARB 2010b, Table ES-2). We expect that higher GSP will drive additional business creation in California. In particular, local small businesses that spend a much larger proportion of revenue on energy than other businesses (CARB 2010b, Figures 13 and 14) should disproportionately benefit from lower energy costs due to energy efficiency standards. Increased labor demand, as noted earlier, is another indication of business creation.

Table 10 below shows California industries that are expected to receive the economic benefit of the proposed Title 24 code changes. It is anticipated that these industries will expand due to

---

[1] Energy efficiency measures may result in reduced power plant construction, both in-state and out-of-state. These plants tend to be highly capital-intensive and often rely on equipment produced out of state, thus we expect that displaced power plant spending will be more than off-set from job growth in other sectors in California.

[2] GSP is the sum of all value added by industries within the state plus taxes on production and imports.

an increase in funding as a result of energy efficiency improvements. The list of industries is based on the industries that the University of California, Berkeley identified as being impacted by energy efficiency programs (UC Berkeley 2011 Table 3.8).[3] The table provided below is not specific to one individual code change proposal; rather it is an approximation of the industries that may receive benefit from all of the 2016 Title 24 code change proposals.

Table 10: Industries Receiving Energy Efficiency Related Investment, by North American Industry Classification System (NAICS) Code

Industry	NAICS Code
Residential Building Construction	2361
Nonresidential Building Construction	2362
Roofing Contractors	238160
Electrical Contractors	23821
Plumbing, Heating, and Air-Conditioning Contractors	23822
Boiler and Pipe Insulation Installation	23829
Insulation Contractors	23831
Window and Door Installation	23835
Asphalt Paving, Roofing, and Saturated Materials	32412
Manufacturing	32412
Other Nonmetallic Mineral Product Manufacturing	3279
Industrial Machinery Manufacturing	3332
Ventilation, Heating, Air-Conditioning, & Commercial Refrigeration Equip. Manf.	3334
Computer and Peripheral Equipment Manufacturing	3341
Communications Equipment Manufacturing	3342
Electric Lighting Equipment Manufacturing	3351
Household Appliance Manufacturing	3352
Other Major Household Appliance Manufacturing	335228
Used Household and Office Goods Moving	484210
Engineering Services	541330
Building Inspection Services	541350
Environmental Consulting Services	541620
Other Scientific and Technical Consulting Services	541690
Advertising and Related Services	5418
Corporate, Subsidiary, and Regional Managing Offices	551114
Office Administrative Services	5611
Commercial & Industrial Machinery & Equip. (exc. Auto. & Electronic) Repair & Maint.	811310

[3] Table 3.8 of the UC Berkeley report includes industries that will receive benefits of a wide variety of efficiency interventions, including Title 24 standards and efficiency programs. The authors of the UC Berkeley report did not know in 2011 which Title 24 measures would be considered for the 2016 adoption cycle, so the UC Berkeley report was likely conservative in their approximations of industries impacted by Title 24. The Statewide CASE Team believes that industries impacted by utilities efficiency programs is a more realistic and reasonable proxy for industries potentially affected by upcoming Title 24 standards. Therefore, the table provided in this CASE Report includes the industries that are listed as benefiting from Title 24 and utility energy efficiency programs.

3.5.3 Competitive Advantages or Disadvantages for Businesses within California

In general, California businesses would benefit from an overall reduction in energy costs associated with the proposed revisions to Title 24. This could help California businesses gain competitive advantage over businesses operating in other states or countries and an increase in investment in California. This particular measure is not expected to have an appreciable impact on any specific California business.

3.5.4 Increase or Decrease of Investments in the State of California

CARB's economic analysis indicate that higher levels of energy efficiency and 33% RPS will increase investment in California by about 3% in 2020 compared to 20% RPS and lower levels of energy efficiency (CARB 2010b Figures 7a and 10a). This particular code change proposal is not expected to have an appreciable impact on investments in California.

3.5.5 Incentives for Innovation in Products, Materials, or Processes

Updating Title 24 standards will encourage innovation through the adoption of new technologies to better manage energy usage and achieve energy savings. It is not anticipated that this particular measure will have a significant impact on innovation.

3.5.6 Effects on the State General Fund, State Special Funds and Local Governments

The proposed measure is not expected to have an appreciable impact on the State General Fund, Special Funds, or local government funds.

3.5.6.1 Cost of Enforcement

Cost to the State

State government already has a budget for code development, education, and compliance enforcement. While state government will be allocating resources to update the Title 24 standards, including updating education and compliance materials and responding to questions about the revised standards, these activities are already covered by existing state budgets. The costs to state government are small when compared to the overall costs savings and policy benefits associated with the code change proposals. This particular measure does not require any changes to the existing code enforcement process, so there will not be a measurable impact on the cost of enforcement.

Cost to Local Governments

All revisions to Title 24 will result in changes to Title 24 compliance determinations. Local governments will need to train permitting staff on the revised Title 24 standards. While this re-training is an expense to local governments, it is not a new cost associated with the 2016 code change cycle. The building code is updated on a triennial basis, and local governments plan and budget for retraining every time the code is updated. There are numerous resources available to local governments to support compliance training that can help mitigate the cost of retraining. As noted earlier, although retraining is a cost of the revised standards, Title 24 energy efficiency standards are expected to increase economic growth and income with positive impacts on local revenue.

This proposed code change would revise an existing measure without significantly affecting the complexity of the Standards. Therefore, on-going costs are not expected to change significantly.

3.5.6.1 Impacts on Specific Persons

The proposed changes to Title 24 are not expected to have a differential impact on any of the following groups relative to the state population as a whole:

- Migrant Workers
- Persons by age
- Persons by race
- Persons by religion
- Commuters

The Statewide CASE Team does not anticipate that the proposed standards will have any impact on first-time homeowners, including those purchasing units within high-rise residential buildings.

Renters will typically benefit from lower energy bills if they pay energy bills directly. These savings should more than offset any capital costs passed-through from building owners. Renters who do not pay directly for energy costs may see more or less of the net savings based on how building owners pass the energy cost savings on to renters.

4. METHODOLOGY

This section describes the methodology and approach the Statewide CASE Team used to estimate energy, demand, and environmental impacts. The Statewide CASE Team calculated the impacts of the proposed code change by comparing existing conditions to the conditions if the proposed code change is adopted. This section of the CASE Report goes into more detail on the assumptions about the existing and proposed conditions, prototype buildings, and the methodology used to estimate energy, demand, and environmental impacts.

4.1 Existing Conditions

To assess the energy, demand, costs, and environmental impacts, the Statewide CASE Team compared current design practices to design practices that would comply with the proposed requirements. There are existing Title 24 standard for most equipment in question. When there is an existing standard, the existing conditions assume a building complies with the 2013 Title 24 Standards. When there is no existing Title 24 requirements the Statewide CASE Team used current design practices as the existing conditions.

4.2 Proposed Conditions

The proposed conditions are defined as the design conditions that will comply with the proposed code change. Specifically, the proposed code change will update the minimum equipment efficiency requirements in Tables 110.2A through 110.2K.

4.3 Prototype Building

The prototype buildings the Statewide CASE Team used to estimate energy savings associated with this code change proposal are presented in Table 11.

Table 11: Prototype Buildings used for Energy, Demand, and Environmental Impacts Analysis

Measure #	Equipment Type	Prototype #	Occupancy Type	Area (square foot)	Number of stories
1A	Air Conditioners	Prototype 1	Office (Small)	25,000	2
1A	Air Conditioners	Prototype 2	Restaurant	5,000	1
1A	Air Conditioners	Prototype 3	Retail	15,000	1
1B	Heat Pumps	Prototype 4	Office (Small)	25,000	2
1B	Heat Pumps	Prototype 5	Restaurant	5,000	1
1B	Heat Pumps	Prototype 6	Retail	15,000	1
2	Chillers	Prototype 7	College	250,000	4
2	Chillers	Prototype 8	Hospital	250,000	4
2	Chillers	Prototype 9	Office (Large)	125,000	4
3A	Package Terminal Air Conditioners	Prototype 10	Motel	400	1
4A	Split Package Vertical Air Conditioners	Prototype 11	Temp classroom	960	1
4B	Split Package Vertical Heat Pumps	Prototype 12	Temp classroom	960	1
5	Evaporative Condenser	Prototype 13	Warehouse	200,000	1
6	Oil Fire Unit Heater	Prototype 14	Warehouse	10,000	1

4.4 Climate Dependent

The proposed measure is climate sensitive since the HVAC equipment impacted by the measure, are directly affected by ambient conditions, both temperature and humidity. The types of HVAC equipment include both heating and cooling units, therefore climates with extreme temperatures during winter and summer seasons will draw more energy. Due to the fact that HVAC equipment will be more efficient, savings will be greater in the extreme temperature zones. Energy savings were calculated for all 16 climate zones in California.

4.5 Time Dependent Valuation

The TDV (Time Dependent Valuation) of savings is a normalized format for comparing electricity and natural gas savings that takes into account the cost of electricity and natural gas consumed during different times of the day and year. The TDV values are based on long term discounted costs (30 years for all residential measures and nonresidential envelope measures and 15 years for all other nonresidential measures). In this case, the period of analysis used is 15 years. The TDV cost impacts are presented in 2017 present value dollars. The TDV energy

estimates are based on present-valued cost savings but are normalized in terms of "TDV kBTUs" so that the savings are evaluated in terms of energy units and measures with different periods of analysis can be combined into a single value.

CEC derived the 2016 TDV values that were used in the analyses for this report (CEC 2014). The TDV energy impacts are presented in Section 5.1 of this report, and the statewide TDV cost impacts are presented in Section 5.2.

4.6 Energy Impacts Methodology

The Statewide CASE Team calculated per unit impacts and statewide impacts associated with all new construction and retrofits during the first year buildings complying with the 2016 Title 24 Standards are in operation.

4.6.1 Per Unit Energy Impacts Methodology

The Statewide CASE Team estimated the electricity, natural gas and oil savings associated with the proposed code change. The energy savings were calculated on a per square foot basis.

To calculate energy savings, the energy simulation tool eQUEST was used to simulate each prototype for both a baseline case (existing conditions) and a higher efficiency measure case (proposed conditions). The simulation was repeated for all 16 climate zones and for the building prototypes that were appropriate to the equipment being evaluated. The difference in energy use between the two cases represents the net energy savings. The savings estimates were calculated per prototype building. To estimate savings per square foot, the net energy savings was normalized by dividing by the square footage of the appropriate prototype building, resulting in energy savings per square foot.

Once the energy savings were simulated for the appropriate prototype building types, and all climate zones, they were combined using the statewide new construction forecast data, which was provided by the CEC Demand Analysis Office, per the following equation:

$$Energy\ Savings = \sum Weight\ x\ New\ Const\ Sq\ Ft\ (Model) * \frac{(Sim_{Base} - Sim_{Meas})}{Sim\ Sq\ Ft}$$

See Appendix C: Example Energy Savings Calculation for example calculation for the per unit and statewide energy impacts of Measure 1A: Air Conditioners.

Analysis Tools

The energy savings for all measures was calculated using a combination of eQUEST simulations and spreadsheet calculations. eQUEST was used to model energy use of the existing and proposed conditions for various building prototypes in every California climate zone. Spreadsheet calculations were used to extrapolate savings from prototype buildings to statewide impacts.

Key Assumptions

See Table 21 in Appendix B: Additional Information on Prototype Buildings for detailed information about the assumptions used in each eQUEST simulation.

4.6.2 Statewide Energy Impacts Methodology

First Year Statewide Impacts

Total statewide savings from the proposed measure was calculated by multiplying the per square foot energy savings by the estimates of floor space impacted by the proposed code change.

The CEC Demand Analysis Office provided the Statewide CASE Team with the nonresidential new construction forecast for 2017, which is presented in Table 13. Table 12 provides a more complete definition of the various space types used in the construction forecast.

With ASWB Engineering's expertise, the Statewide CASE Team identified the type of buildings that would be impacted and the percentages square footage 2017 that would be impacted by the proposed code change in 2017. Estimates of the square footage of building space impacted by building retrofits took into account the Effective Useful Life (EUL) of HVAC equipment, voluntary replacement of outdated equipment and other factors that would trigger Title 24.

Table 14 presents the assumed percent of construction that would be impacted by the proposed code change. On the far left side of Table 14, 10 measures are listed that represent all the equipment types that will be affected by the proposed efficiency changes. Each measure specifically applies to one type of equipment. However some measures compete for the same application or building. Competing measures have the same number followed by a letter. An example of this is measures 3A and 3B, which represents Package Terminal Air-Conditioners (PTAC) and Package Terminal Heat Pumps (PTHP), respectively. These two measures compete for the same application or building (square footage); a motel room can have either a PTAC or PTHP but not both. This must be accounted for in the percentage weights that are associated with these two measure given the same building type; cannot add up to greater than 100%.

This table contains two types of percentage weights: category weights and application weights.

The category weights, which are listed on the left side of the matrix, represent the amount of impact that the proposed efficiency changes will have on the equipment type associated with the measure. If the measure proposes to change all the efficiency levels for that particular equipment type, than the percentage weight is 100%; as is the case for PTAC equipment. However, if the measure only changes some efficiency levels for its equipment type, than a value less than 100% is selected; as is the case with heat pumps, where only heat pumps with ground/water loops have new efficiency levels to comply with. These values were selected using conservative engineering criteria and ASWB Engineering's expertise in the California HVAC industry.

The application weights, which are listed in the matrix itself, represent the percentage of equipment that will apply to the particular building type that is listed at the top of the column of the matrix. Again these values were selected using conservative engineering criteria and ASWB's expertise in the California HVAC industry.

Table 15 presents the floor space impacted by the proposed code change in 2017.

Table 12: Description of Space Types used in the Nonresidential New Construction Forecast

OFF-SMALL	Offices less than 30,000 ft^2
OFF-LRG	Offices larger than 30,000 ft^2
REST	Any facility that serves food
RETAIL	Retail stores and shopping centers
FOOD	Any service facility that sells food and or liquor
NWHSE	Non-refrigerated warehouses
RWHSE	Refrigerated Warehouses
SCHOOL	Schools K-12, not including colleges
COLLEGE	Colleges, universities, community colleges
HOSP	Hospitals and other health-related facilities
HOTEL	Hotels and motels
MISC	All other space types that do not fit another category

Table 13: Estimated New Nonresidential Construction in 2017 by Climate Zone and Building Type (Million Square Feet)

Source: CEC Demand Analysis Office

Climate Zone	New Construction in 2017 (Million Square Feet)												
	OFF-SMALL	REST	RETAIL	FOOD	NWHSE	RWHSE	SCHOOL	COLLEGE	HOSP	HOTEL	MISC	OFF-LRG	TOTAL
1	0.058482	0.015769	0.040937	0.013995	0.04007	0.002371	0.045703	0.01828	0.027753	0.030543	0.094263	0.068857	0.457023
2	0.226801	0.088369	0.630464	0.163219	0.326702	0.031262	0.244488	0.163417	0.200483	0.349571	0.741643	1.13955	4.305969
3	0.727817	0.408193	2.913304	0.677174	2.517827	0.182815	0.999855	0.624782	0.728856	1.400191	3.893847	4.95172	20.02638
4	0.483775	0.190288	1.586102	0.412521	0.594754	0.071208	0.541267	0.408194	0.489989	0.88999	1.6412	2.935241	10.24453
5	0.093959	0.036958	0.308055	0.08012	0.115514	0.01383	0.105125	0.07928	0.095166	0.172855	0.318756	0.570086	1.989704
6	0.810506	0.825085	3.071567	0.755923	2.648899	0.12231	0.658921	0.64918	0.508382	0.571497	4.144311	2.263747	17.03033
7	0.959442	0.300456	1.634842	0.501873	1.004372	0.012519	0.772492	0.44818	0.32452	1.05876	3.07717	1.252596	11.34722
8	1.077735	1.106258	4.240566	1.033501	3.588133	0.161622	0.855833	0.931472	0.773248	0.87192	5.860016	3.185764	23.68607
9	0.970961	0.915966	3.975362	0.937434	3.28658	0.118707	0.600395	1.094797	1.126944	1.329387	5.375798	5.675382	25.40771
10	1.372005	0.706559	2.995247	0.839311	2.629586	0.074012	0.883246	0.579892	0.527765	1.056115	8.010305	1.496342	21.17039
11	0.332653	0.087536	0.770031	0.268455	0.875277	0.08922	0.503537	0.156352	0.238787	0.197257	0.737278	0.629	4.885385
12	1.7096	0.502362	3.655505	1.014374	3.156848	0.201819	1.686889	0.678263	1.048493	1.480384	3.637341	4.720634	23.49251
13	0.667734	0.204941	1.606109	0.544176	1.706442	0.286473	1.401011	0.389818	0.520143	0.35945	1.883592	0.817316	10.3872
14	0.22447	0.137983	0.608865	0.161672	0.526854	0.02523	0.156291	0.127638	0.114613	0.185086	1.471572	0.431212	4.171487
15	0.349197	0.096162	0.674793	0.238372	0.7605	0.021959	0.191897	0.098322	0.133017	0.204004	1.122613	0.288874	4.17971
16	0.198815	0.10592	0.506106	0.142191	0.449193	0.041763	0.205229	0.122253	0.125255	0.144237	0.931211	0.39447	3.366645
TOTAL	10.26395	5.728808	29.21785	7.784311	24.22755	1.457119	9.852179	6.570121	6.983418	10.30125	42.94092	30.82079	186.1483

Table 14: Percent of Floor Space Impacted by Proposed Code Change, by Space Type

Measure #	Application Scope	Category Weight	Weight Explanation	Percent of Square Footage with Specified Equipment (Application Weight)											
				SM-OFF	REST	RETAIL	FOOD	NWHSE	RWHSE	SCHOOL	COLLEGE	HOSP	HOTEL	MISC	LG-OFF
				Offices < 30,000 SF	All restaurants	All Retail	Grocery	Non Refig warehouse	Refig warehouse	K-12 schools	Colleges & universities	Hospitals	Hotels & Motels	All other types	Offices > 30,000 SF
1A	Applies to Air conditioners: air cooled (split and single package) and water cooled units	65%	Moderate percentage of air conditioners are air water cooled units	40%	40%	40%									
1B	Applies to heat pumps: water source, groundwater source and ground source	10%	Small percentage of heat pumps utilize water loops	50%	50%	50%									
2	Applies to all chillers: air cooled with condenser, water cooled with positive displacement, water cooled with centrifugal	100%	Applies to all chillers								60%	70%			50%
3A	Applies to all Packaged Terminal Air Conditioners	100%	Applies to all PTAC										20%		
3B	Applies to all Packaged Terminal Heat Pumps	0%	Does not apply										70%		
4A	Applies to Single Package Vertical Air Conditioners	100%	Applies to all SPVAC							20%					
4B	Applies to Single Package Vertical Heat Pumps	100%	Applies to all SPVHP							70%					
5	Applies to all evaporative condensers with propeller, axial and centrifugal fans	100%	Applies to all condensers						75%						
6	Applies to oil fired unit heaters	100%	Applies to all oil fired unit heaters					5%							
7	Applies to steam boilers natural draft	20%	Does not apply											5%	
N/A	No equipment, or other and unknown equipment			10%	10%	10%	100%	95%	25%	10%	40%	30%	10%	95%	50%
	SUM OF COMPETING MEASURES (= 100%):			100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

Table 15: Floor Space Impacted by Proposed Code Change during First Year Standards are in Effect (2017) (Square Feet)

Measure / Climate Zone	1A	1B	2	3A	3B	4A	4B	5	6	7
1	29,949	5,759	64,824	6,109	N/A	9,141	31,992	1,778	2,004	N/A
2	245,865	47,282	808,164	69,914	N/A	48,898	171,141	23,446	16,335	N/A
3	1,052,822	202,466	3,360,929	280,038	N/A	199,971	699,899	137,111	125,891	N/A
4	587,643	113,008	2,055,529	177,998	N/A	108,253	378,887	53,406	29,738	N/A
5	114,133	21,949	399,227	34,571	N/A	21,025	73,588	10,373	5,776	N/A
6	1,223,861	235,358	1,877,249	114,299	N/A	131,784	461,245	91,732	132,445	N/A
7	752,633	144,737	1,122,370	211,752	N/A	154,498	540,744	9,389	50,219	N/A
8	1,670,385	321,228	2,693,039	174,384	N/A	171,167	599,083	121,217	179,407	N/A
9	1,524,195	293,114	4,283,430	265,877	N/A	120,079	420,277	89,030	164,329	N/A
10	1,319,191	253,691	1,465,542	211,223	N/A	176,649	618,272	55,509	131,479	N/A
11	309,457	59,511	575,462	39,451	N/A	100,707	352,476	66,915	43,764	N/A
12	1,525,542	293,373	3,501,220	296,077	N/A	337,378	1,180,822	151,364	157,842	N/A
13	644,484	123,939	1,006,649	71,890	N/A	280,202	980,707	214,854	85,322	N/A
14	252,543	48,566	372,418	37,017	N/A	31,258	109,404	18,923	26,343	N/A
15	291,240	56,008	296,542	40,801	N/A	38,379	134,328	16,469	38,025	N/A
16	210,819	40,542	358,265	28,847	N/A	41,046	143,660	31,322	22,460	N/A
ALL CZs	**11,754,760**	**2,260,531**	**24,240,860**	**2,060,249**	**N/A**	**1,970,436**	**6,896,525**	**1,092,839**	**1,211,378**	**N/A**

4.7 Cost-effectiveness Methodology

As explained in Section 2.1.2 of this report, CEC can adopt the equipment efficiency values that appear in ASHRAE 90.1-2013 without performing a cost-effectiveness analysis. The Statewide CASE Team has not conducted a cost-effectiveness analysis for this measure. Statewide TDV cost savings were calculated by multiplying the statewide TDV energy savings by the nonresidential 15-year TDV cost factor ($0.089/kBTU). Results of the statewide energy cost savings analysis are presented in Section 5.2.

4.8 Environmental Impacts Methodology

4.8.1 Greenhouse Gas Emissions Impacts Methodology

Greenhouse Gas Emissions Impacts Methodology

The Statewide CASE Team calculated avoided GHG emissions assuming an emission factor of 353 metric tons of carbon dioxide equivalents ($MTCO_2e$) per GWh of electricity savings. As described in more detail in Appendix A, the electricity emission factor represents savings from avoided electricity generation and accounts for the GHG impacts if the state meets the Renewable Portfolio Standard (RPS) goal of 33 percent renewable electricity generation by 2020. Avoided GHG emissions from natural gas savings were calculated using an emission factor of 5,303 $MTCO_2e$/million therms (U.S. EPA 2011).

4.8.2 Water Use and Water Quality Impacts Methodology

The proposed measure is not expected to have any impacts on water use or water quality, excluding impacts that occur at power plants.

4.8.3 Material Impacts Methodology (Optional)

The Statewide CASE Team did not develop estimates of material impacts.

4.8.4 Other Impacts Methodology

There are no other impacts from the proposed code change.

5. ANALYSIS AND RESULTS

Results from the energy, demand, cost, and environmental impacts analyses are presented in this section.

5.1 Energy Impacts Results

5.1.1 Per Unit Energy Impacts Results

Per unit energy and demand impacts of the proposed measure are presented in Table 16. Per unit savings for the first year are expected to be in the range of 0.07 to 0.39 kilowatt-hours per square foot per year (kWh/SF-yr) depending on the climate zone. Demand savings are expected to be in the range of 0 to 0.31 W/SF. Fuel oil savings per unit are expected to be in the range of 0 to 0.00018 therms/SF-yr. Note that no natural gas savings are expected during the first year of Title 24 implementation (2017) due to that the boiler efficiency requirements are scheduled to take effect in the year 2020.

It is estimated that the TDV electricity and natural gas savings for the first year be in the range of 1.82 to 10.13 kBTU/SF-yr depending on the climate zone. The TDV methodology allows peak electricity savings to be valued more than electricity savings during non-peak periods. The savings resulting from switching to more efficient HVAC equipment operate during all hours of the day, including peak hours.

Table 16: First Year[1] Energy Impacts per Square Foot, all Measures

Climate Zone	Electricity Savings (kWh/SF-yr)	Demand Savings (W/SF)	Natural Gas Savings[2] (Therms/SF-yr)	Fuel Oil Savings (Therms/SF-yr)	TDV Energy Savings[3] (kBTU/SF-yr)
Climate Zone 1	0.07	0.00	0	0.0004	1.82
Climate Zone 2	0.15	0.01	0	0	4.31
Climate Zone 3	0.11	0.07	0	0	3.19
Climate Zone 4	0.16	0.31	0	0.0001	4.89
Climate Zone 5	0.13	0.01	0	0.0018	3.85
Climate Zone 6	0.18	0.08	0	0	5.01
Climate Zone 7	0.20	0.03	0	0	5.75
Climate Zone 8	0.23	0.06	0	0	6.31
Climate Zone 9	0.22	0.14	0	0	6.36
Climate Zone 10	0.26	0.27	0	0	8.10
Climate Zone 11	0.21	0.02	0	0.0017	5.76
Climate Zone 12	0.19	0.16	0	0.0003	5.42
Climate Zone 13	0.27	0.30	0	0.0001	7.08
Climate Zone 14	0.22	0.08	0	0.0017	6.52
Climate Zone 15	0.39	0.11	0	0	10.13
Climate Zone 16	0.11	0.00	0	0	3.36

1. Savings per square foot on new building construction for the first year the building is in operation.
2. No natural gas savings are derived during the first year of Title 24 implementation (2017) due to that the boiler efficiency requirements are scheduled to take effect in the year 2020.
3. Calculated using CEC's 2016 TDV factors and methodology. Includes savings from electricity and natural gas. TDV factors for fuel oil were not available.

5.1.2 Statewide Energy Impacts Results

First Year Statewide Energy Impacts

The first year statewide energy impacts of the proposed measure are presented in Table 17. During the first year buildings complying with the 2016 Title 24 Standards are in operation, the proposed measure is expected to reduce annual statewide electricity use by 9.96 GWh with an associated demand reduction of 3.46 MW. Natural gas use is expected to be reduced by 0.0 MMtherms. Note that no natural gas savings are derived during the first year of Title 24 implementation (2017) due to that the boiler efficiency requirements are scheduled to take effect in the year 2020. Fuel oil use is expected to be reduced by 0.20 Mtherms.

All assumptions and calculations used to derive per unit and statewide energy and demand savings are presented in Section 4.6 of this report.

Table 17: First Year[1] Statewide Energy Impacts

Measure	Electricity Savings[2] (GWh)	Power Demand Reduction (MW)	Natural Gas Savings[3] (MMtherms)	Fuel Oil Savings (Mtherms)	TDV Energy Savings[4] (Million kBTU)
Air Conditioners	3.30	1.60	0	0	107.6
Heat Pumps	0.72	0.34	0	0	23.3
Chillers	3.14	0.97	0	0	85.9
PTAC	0.10	0.05	0	0	3.3
SPVAC	0.50	0.10	0	0	12.1
SPVHP	2.17	0.40	0	0	52.6
Condensers	0.03	0.01	0	0	0.7
Furnaces (Oil)	0.00	0.00	0	0.20	0.0
Boilers[3]	0.00	0	0	0	0.0
TOTAL	9.96	3.46	0	0.20	285.5

1. First year savings from all buildings built statewide during the first year the 2016 Standards are in effect.
3. Site electricity savings.
4. No natural gas savings are derived during the first year of Title 24 implementation (2017) due to that the boiler efficiency requirements are scheduled to take effect in the year 2020.
3. Calculated using CEC's 2016 TDV factors and methodology. Includes savings from electricity and natural gas. TDV factors for fuel oil were not available.

5.2 Cost-effectiveness Results

As explained in Section 2.1.2 of this report, CEC can adopt the equipment efficiency values that appear in ASHRAE 90.1-2013 without performing a cost-effectiveness analysis. The Statewide CASE Team has not conducted a cost-effectiveness analysis for this measure.

Given data regarding the new construction forecast for 2017, the Statewide CASE Team estimates that that lifecycle cost savings (15-year) of all new buildings constructed during the first year the 2016 Standards are in effect will be $25 million (See Table 18).

Table 18: Statewide Cost Savings (15-year savings for all buildings constructed in 2017)

Measure	TDV Cost Savings (Million PV 2017$)
Air Conditioners	$9.58
Heat Pumps	$2.07
Chillers	$7.65
PTAC	$0.29
SPVAC	$1.08
SPVHP	$4.68
Condensers	$0.06
Furnaces (Oil)	$0.00
Boilers[1]	$0.00
TOTAL	$25.41

1. No natural gas savings are derived during the first year of Title 24 implementation (2017) due to that the boiler efficiency requirements are scheduled to take effect in the year 2020.

5.3 Environmental Impacts Results

5.3.1 Greenhouse Gas Emissions Results

Table 19 presents the estimated first year avoided GHG emissions of the proposed code change. During the first year the 2016 Standards are in effect the proposed measure will result in avoided GHG emissions of 3,516 $MTCO_2e$.

Table 19: Statewide Greenhouse Gas Emissions Impacts

Sub-measure	Avoided GHG Emissions (MTCO2e/yr)[1]
Air Conditioners	1,164
Heat Pumps	253
Chillers	1,109
PTAC	35
SPVAC	177
SPVHP	767
Evaporative Condensers	11
Furnaces (Oil)	0
Boilers	0
TOTAL	3,516

1. First year savings from buildings built in 2017; assumes 353 $MTCO_2e$/GWh and 5,303 $MTCO_2e$/MMTherms.

5.3.2 Water Use and Water Quality Impacts

Impacts on water use and water quality are presented in Table 20. The proposed measure is not expected to have any impacts on water use or water quality, excluding impacts that occur at power plants.

Table 20: Impacts of Water Use and Water Quality

	On-Site Water Savings[1] (gallons/yr)	Embedded Energy Savings[2] (kWh/yr)	Impact on Water Quality Material Increase (I), Decrease (D), or No Change (NC) compared to existing conditions			
			Mineralization (calcium, boron, and salts)	Algae or Bacterial Buildup	Corrosives as a Result of PH Change	Others
Impact (I, D, or NC)	NC	NC	NC	NC	NC	NC
Per Unit Impacts[3]	n/a	n/a	n/a	n/a	n/a	n/a
Statewide Impacts (first year)	n/a	n/a	n/a	n/a	n/a	n/a
Comment on reasons for your impact assessment	n/a	n/a	n/a	n/a	n/a	n/a

1. Does not include water savings at power plant

5. Assumes embedded energy factor of 10,045 kWh per million gallons of water.

5.3.3 Material Impacts Results (Optional)

The impacts of the proposed code change on material use were not evaluated.

5.3.4 Other Impacts Results

There are no other significant impacts associated with this measure.

6. PROPOSED LANGUAGE

The proposed changes to the Standards, Reference Appendices, and the ACM Reference Manuals are provided below. Changes to the 2013 documents are marked with underlining (new language) and ~~strikethroughs~~ (deletions).

6.1 Standards

Table 120.6-B Fan-powered condensers – Minimum Efficiency Requirements and Table 120.6-C: Fan-powered Condenser-specific Efficiency Requirements may need to be updated so the minimum efficiency values in Table 120.6-B and Table 120.6-C are consistent with the minimum efficiency values in Table 110.2-A through Table 110.2-K. The Statewide CASE Team will provide recommended changes to Table 120.6-B and Table 120.6-C in a separate submission to CEC.

SECTION 110.2 – MANDATORY REQUIREMENTS FOR SPACE-CONDITIONING EQUIPMENT

TABLE 110.2-A ELECTRICALLY OPERATED UNITARY AIR CONDITIONERS AND CONDENSING UNITS – MINIMUM EFFICIENCY REQUIREMENTS

Equipment Type	Size Category	Efficiency [a]		Test Procedure[c]
		~~Before 1/1/2015~~	~~After 1/1/2015~~	
Air conditioners, air cooled both split system and single package	≥ 65,000 Btu/h and < 135,000 Btu/h	~~11.2 EER[b]~~ ~~11.4 IEER[b]~~	Applicable minimum efficiency values as determined by Title 20 California Code of Regulations Section 1605.1	ANSI/AHRI 340/360
	≥ 135,000 Btu/h and < 240,000 Btu/h	~~11.0 EER[b]~~ ~~11.2 IEER[b]~~		ANSI/AHRI 340/360
	≥ 240,000 Btu/h and < 760,000 Btu/h	~~10.0 EER[b]~~ ~~10.1 IEER[b]~~		
	≥ 760,000 Btu/h	9.7 EER[b] ~~11.2 IEER[b]~~ 11.2 IEER[b]		
Air conditioners, water cooled	≥ 65,000 Btu/h and < 135,000 Btu/h	12.1 EER[b] ~~12.3 IEER[b]~~ 13.9 IEER[b]		ANSI/AHRI 340/360
	≥135,000 Btu/h and < 240,000 Btu/h	12.5 EER[b] ~~12.5 IEER[b]~~ 13.9 IEER[b]		ANSI/AHRI 340/360

	≥240,000 Btu/h and < 760,000 Btu/h	12.4 EER[b] ~~12.6 IEER[b]~~ 13.6 IEER[b]	ANSI/AHRI 340/360
	≥ 760,000 Btu/h	12.2 EER[b] ~~12.4 IEER[b]~~ 13.5 IEER[b]	ANSI/AHRI 340/360
Air conditioners, evaporatively cooled	≥65,000 Btu/h and < 135,000 Btu/h	12.1 EER[b] 12.3 IEER[b]	ANSI/AHRI 340/360
	≥ 135,000 Btu/h and < 240,000 Btu/h	12.0 EER[b] 12.2 IEER[b]	ANSI/AHRI 340/360
	≥240,000 Btu/h and < 760,000 Btu/h	11.9 EER[b] 12.1 IEER[b]	ANSI/AHRI 340/360
	≥ 760,000 Btu/h	11.7 EER[b] 11.9 IEER[b]	ANSI/AHRI 340/360
Condensing units, air cooled	≥ 135,000 Btu/h	10.5 EER 11.8 IEER	ANSI/AHRI 365
Condensing units, water cooled	≥ 135,000 Btu/h	13.5 EER 14.0 IEER	
Condensing units, evaporatively cooled	≥ 135,000 Btu/h	13.5 EER 14.0 IEER	

[a] IEERs are only applicable to equipment with capacity control as per ANSI/AHRI 340/360 test procedures

[b] Deduct 0.2 from the required EERs and IEERs for units with a heating section other than electric resistance heat.

[c] Applicable test procedure and reference year are provided under the definitions.

TABLE 110.2-B UNITARY AND APPLIED HEAT PUMPS, MINIMUM EFFICIENCY REQUIREMENTS

Equipment Type	Size Category	Subcategory or Rating Condition	Efficiency [a]	Test Procedure[c]
Air Cooled (Cooling Mode)	≥ 65,000 Btu/h and < 135,000 Btu/h	Split system and single package	11.0 EER[b] 11.2 IEER[b]	ANSI/AHRI 340/360
	≥ 135,000 Btu/h and < 240,000 Btu/h		10.6 EER[b] 10.7 IEER[b]	
	≥ 240,000 Btu/h		9.5 EER[b] 9.6 IEER[b]	
Water source (cooling mode)	≥ 65,000 Btu/h and < 135,000 Btu/h	86ºF entering water	~~12.0 EER~~ 13.0 EER	ISO-13256-1
Water source (cooling mode)	≥ 135,000 Btu/h and < 240,000 Btu/h	86ºF entering water	13.0 EER	
Groundwater source (cooling mode)	< 135,000 Btu/h	59ºF entering water	~~16.2 EER~~ 18.0 EER	ISO-13256-1
Ground source (cooling mode)	< 135,000 Btu/h	77ºF entering water	~~13.4 EER~~ 14.1 EER	ISO-13256-1
Water source water-to-water (cooling mode)	< 135,000 Btu/h	86ºF entering water	10.6 EER	ISO-13256-2
Groundwater source water-to-water (cooling mode)	< 135,000 Btu/h	59ºF entering water	16.3 EER	ISO-13256-1
Ground source brine-to-water (cooling mode)	< 135,000 Btu/h	77ºF entering water	12.1 EER	ISO-13256-2
Air Cooled (Heating Mode) Split system and single package	≥ 65,000 Btu/h and < 135,000 Btu/h (cooling capacity)	47° F db/43° F wb outdoor air	3.3 COP	ANSI/AHRI 340/360
		17° F db/15° F wb outdoor air	2.25 COP	
	≥ 135,000 Btu/h (cooling capacity)	47° F db/43° F wb outdoor air	3.2 COP	
		17° F db/15° F wb outdoor air	2.05 COP	
Water source (heating mode)	< 135,000 Btu/h (cooling capacity)	68ºF entering water	~~4.2 COP~~ 4.3 COP	ISO-13256-1
Water source (heating mode)	≥ 135,000 Btu/h and < 240,000 Btu/h (cooling capacity)	68ºF entering water	2.9 COP	ISO-13256-1
Groundwater source (heating mode)	< 135,000 Btu/h (cooling capacity)	50ºF entering water	~~3.6 COP~~ 3.7 COP	ISO-13256-1

Ground source (heating mode)	< 135,000 Btu/h (cooling capacity)	32ºF entering water	~~3.1 COP~~ 3.2 COP	ISO-13256-1
Water source water-to-water (heating mode)	< 135,000 Btu/h (cooling capacity)	68ºF entering water	3.7 COP	ISO-13256-2
Groundwater source water-to-water (heating mode)	< 135,000 Btu/h (cooling capacity)	50ºF entering water	3.1 COP	ISO-13256-2
Ground source brine-to-water (heating mode)	< 135,000 Btu/h (cooling capacity)	32ºF entering water	2.5 COP	ISO-13256-2

[a] IEERs are only applicable to equipment with capacity control as per ANSI/AHRI 340/360 test procedures.

[b] Deduct 0.2 from the required EERs and IEERs for units with a heating section other than electric resistance heat.

[c] Applicable test procedure and reference year are provided under the definitions.

… {Section of code omitted; not proposed changes to Table 110.2-C} …

TABLE 110.2-D WATER CHILLING PACKAGES – MINIMUM EFFICIENCY REQUIREMENTS [a,b]

Equipment Type	**Size Category**	**Path A Efficiency [a,b]**	**Path B Efficiency [a,b]**	**Test Procedure [c]**
Air Cooled, With Condenser Electrically Operated	< 150 Tons	~~≥ 9.562 EER~~ ~~≥ 12.500 IPLV~~ ≥ 10.100 EER ≥ 13.700 IPLV	~~N.A.[d]~~ ≥ 9.700 EER ≥ 15.800 IPLV	AHRI 550/590
	≥ 150 Tons	~~≥ 9.562 EER~~ ~~≥ 12.750 IPLV~~ ≥ 10.100 EER ≥ 14.000 IPLV	~~N.A.[d]~~ ≥ 9.700 EER ≥ 16.100 IPLV	
Air Cooled, Without Condenser Electrically Operated	All Capacities	Air-cooled chillers without condensers must be rated with matching condensers and comply with the air-cooled chiller efficiency requirements.		
Water Cooled, Electrically Operated, Reciprocating (Reciprocating)	All Capacities	Reciprocating units must comply with the water-cooled positive displacement efficiency requirements.		AHRI 550/590
Water Cooled, Electrically Operated	< 75 Tons	~~≤0.780 kW/ton~~ ~~≤ 0.630 IPLV~~ ≤0.750 kW/ton	~~≤ 0.800 kW/ton~~ ~~≤ 0.600 IPLV~~ ≤ 0.780 kW/ton	AHRI 550/590

Positive Displacement		≤ 0.600 IPLV	≤ 0.500 IPLV	
	≥ 75 tons and < 150 tons	~~≤ 0.775 kW/ton~~ ~~≤ 0.615 IPLV~~ ≤ 0.720 kW/ton ≤ 0.560 IPLV	~~≤ 0.790 kW/ton~~ ~~≤ 0.586 IPLV~~ ≤ 0.750 kW/ton ≤ 0.490 IPLV	
	≥ 150 tons and < 300 tons	~~≤ 0.680 kW/ton~~ ~~≤ 0.580 IPLV~~ ≤ 0.660 kW/ton ≤ 0.540 IPLV	~~≤ 0.718 kW/ton~~ ~~≤ 0.540 IPLV~~ ≤ 0.680 kW/ton ≤ 0.440 IPLV	
	≥ 300 tons and < 600 tons	~~≤ 0.620 kW/ton~~ ~~≤ 0.540 IPLV~~ ≤ 0.610 kW/ton ≤ 0.520 IPLV	~~≤ 0.639 kW/ton~~ ~~≤ 0.490 IPLV~~ ≤ 0.625 kW/ton ≤ 0.410 IPLV	
	≥ 600 tons	≤ 0.560 kW/ton ≤ 0.500 IPLV	≤ 0.585 kW/ton ≤ 0.380 IPLV	
Water Cooled, Electrically Operated, Centrifugal	< 150 Tons	~~≤ 0.634 kW/ton~~ ~~≤ 0.596 IPLV~~ ≤ 0.610 kW/ton ≤ 0.550 IPLV	~~≤ 0.639 kW/ton~~ ~~≤ 0.450 IPLV~~ ≤ 0.695 kW/ton ≤ 0.440 IPLV	
	≥ 150 tons and < 300 tons	~~≤ 0.634 kW/ton~~ ~~≤ 0.596 IPLV~~ ≤ 0.610 kW/ton ≤ 0.550 IPLV	~~≤ 0.639 kW/ton~~ ~~≤ 0.450 IPLV~~ ≤ 0.635 kW/ton ≤ 0.400 IPLV	
	≥ 300 tons and ~~≤ 600~~ 400 tons	~~≤ 0.576 kW/ton~~ ~~≤ 0.549 IPLV~~ ≤ 0.560 kW/ton ≤ 0.520 IPLV	~~≤ 0.600 kW/ton~~ ~~≤ 0.400 IPLV~~ ≤ 0.595 kW/ton ≤ 0.390 IPLV	
	≥ 400 tons and < 600 tons	≤ 0.560 kW/ton ≤ 0.500 IPLV	≤ 0.585 kW/ton ≤ 0.380 IPLV	
	≥ 600 Tons	~~≤ 0.570 kW/ton~~ ~~≤ 0.539 IPLV~~ ≤ 0.560 kW/ton ≤ 0.500 IPLV	~~≤ 0.590 kW/ton~~ ~~≤ 0.400 IPLV~~ ≤ 0.585 kW/ton ≤ 0.380 IPLV	
Air Cooled Absorption, Single Effect	All Capacities	≥0.600 COP	N.A. [d]	ANSI/AHRI 560
Water Cooled Absorption, Single Effect	All Capacities	≥ 0.700 COP	N.A. [d]	
Absorption Double Effect, Indirect-Fired	All Capacities	≥ 1.000 COP ≥ 1.050 IPLV	N.A. [d]	
Absorption Double Effect, Direct-Fired	All Capacities	≥ 1.000 COP ≥1.000 IPLV	N.A. [d]	
Water Cooled Gas	All Capacities	≥1.2 COP	N.A. [d]	ANSI Z21.40.4A

Engine Driven Chiller		≥2.0 IPLV		

[a] No requirements for:

- Centrifugal chillers with design leaving evaporator temperature < 36°F; or
- Positive displacement chillers with design leaving fluid temperature ≤ 32°F; or
- Absorption chillers with design leaving fluid temperature < 40°F

[b] Must meet the minimum requirements of Path A or Path B. However, both the full load (COP) and IPLV must be met to fulfill the requirements of the applicable Path.

[c] See Section 100.1 for definitions

[d] NA means not applicable

TABLE 110.2-E PACKAGED TERMINAL AIR CONDITIONERS AND PACKAGED TERMINAL HEAT PUMPS – MINIMUM EFFICIENCY REQUIREMENTS

Equipment Type	Size Category (Input)	Subcategory or Rating Condition	Efficiency		Test Procedure [c]
			~~Before 10/08/2012~~	~~After 10/08/2012~~	
PTAC (Cooling mode) Newly constructed or newly conditioned buildings or additions	All Capacities	95°F db Outdoor Air	~~12.5 - (0.213 x Cap/1000)[a] EER~~	~~13.8 - (0.300 x Cap/1000)a EER~~ 14.0 - (0.300 x Cap/1000)[a] EER	ANSI/AHRI/CSA 310/380
PTAC (Cooling mode) Replacements [b]	All Capacities	95°F db Outdoor Air	~~10.9 - (0.213 x Cap/1000)[a] EER~~	10.9 - (0.213 x Cap/1000)[a] EER	
PTHP (Cooling mode) Newly constructed or newly conditioned buildings or additions	All Capacities	95°F db Outdoor Air	~~12.3 - (0.213 x Cap/1000)[a] EER~~	14.0 - (0.300 x Cap/1000)[a] EER	
PTHP (Cooling mode) Replacements [b]	All Capacities	95°F db Outdoor Air	~~10.8 - (0.213 x Cap/1000)[a] EER~~	10.8 - (0.213 x Cap/1000)[a] EER	
PTHP (Heating Mode) Newly constructed or newly conditioned buildings or additions	All Capacities	-	~~3.2 - (0.026 x Cap/1000)[a] COP~~	3.7 - (0.052 x Cap/1000)[a] COP	
PTHP (Heating mode) Replacements [b]	All Capacities	-	~~2.9 - (0.026 x Cap/1000)[a] COP~~	2.9 - (0.026 x Cap/1000)[a] COP	
SPVAC (Cooling Mode)	<65,000 Btu/h	95°F db / 75°F wb Outdoor Air	~~9.0 EER~~	~~9.0 EER~~ 10.0 EER	ANSI/AHRI 390
	≥65,000 Btu/h and <135,000 Btu/h	95°F db / 75°F wb Outdoor Air	~~8.9 EER~~	~~8.9 EER~~ 10.0 EER	
	≥135,000 Btu/h and <240,000 Btu/h	95°F db / 75°F wb Outdoor Air	~~8.6 EER~~	~~8.6 EER~~ 10.0 EER	

SPVHP (Cooling Mode)	<65,000 Btu/h	95°F db / 75°F wb Outdoor Air	~~9.0 EER~~	~~9.0 EER~~ 10.0 EER	
	≥65,000 Btu/h and <135,000 Btu/h	95°F db / 75°F wb Outdoor Air	~~8.9 EER~~	~~8.9 EER~~ 10.0 EER	
	≥135,000 Btu/h and <240,000 Btu/h	95°F db / 75°F wb Outdoor Air	~~8.6 EER~~	~~8.6 EER~~ 10.0 EER	
SPVHP (Heating Mode)	<65,000 Btu/h	47°F db / 43°F wb Outdoor Air	~~3.0 COP~~	3.0 COP	
	≥65,000 Btu/h and <135,000 Btu/h	47°F db / 43°F wb Outdoor Air	~~3.0 COP~~	3.0 COP	
	≥135,000 Btu/h and <240,000 Btu/h	47°F db / 43°F wb Outdoor Air	~~2.9 COP~~	~~2.9 EER~~ 3.0 COP	
SPVAC (Cooling Mode), nonweatherized space constrained	<30,000 Btu/h	95°F db / 75°F wb Outdoor Air		9.2 EER	
	≥30,000 Btu/h and <36,000 Btu/h	95°F db / 75°F wb Outdoor Air		9.2 EER	
SPVHP (Cooling Mode), nonweatherized space constrained	<30,000 Btu/h	95°F db / 75°F wb Outdoor Air		9.2 EER	
	≥30,000 Btu/h and <36,000 Btu/h	95°F db / 75°F wb Outdoor Air		9.2 EER	
SPVHP (Heating Mode), nonweatherized space constrained	<30,000 Btu/h	47°F db / 43°F wb Outdoor Air		3.0 COP	
	≥30,000 Btu/h and <36,000 Btu/h	47°F db / 43°F wb Outdoor Air		3.0 COP	

… {Section of code omitted; not proposed changes to Table 110.F) …

TABLE 110.2-G PERFORMANCE REQUIREMENTS FOR HEAT REJECTION EQUIPMENT

Equipment Type	Total System Heat Rejection Capacity at Rated Conditions	Subcategory or Rating Condition	Performance Required ,[a,b,c,d]	Test Procedure [e]
Propeller or axial fan Open-circuit cooling towers	All	95°F entering water 85°F leaving water 75 °F entering air wb	≥42.1 gpm/hp	CTI ATC-105 and CTI STD-201
Centrifugal fan Open-circuit cooling towers	All	95°F entering water 85°F leaving water 75 °F entering air wb	≥20.0 gpm/hp	CTI ATC-105 and CTI STD-201
Propeller or axial fan closed-circuit cooling towers	All	102°F entering water 90°F leaving water 75 °F entering air wb	≥14.0 gpm/hp	CTI ATC-105S and CTI STD-201
Centrifugal fan closed-circuit cooling towers	All	102°F entering water 90°F leaving water 75 °F entering air wb	≥7.0 gpm/hp	CTI ATC-105S and CTI STD-201
Propeller or axial fan evaporative condensers	All	R-507A test fluid 165°F entering gas temperature 105°F condensing temperature 75°F entering wetbulb	≧ 157,000 Btu/h·hp	CTI ATC-106
Propeller or axial fan evaporative condensers	All	Ammonia test fluid 140°F entering gas temperature 96.3°F condensing temperature 75°F entering wetbulb	≧ 134,000 Btu/h·hp	CTI ATC-106
Centrifugal fan evaporative condensers	All	R-507A test fluid 165°F entering gas temperature 105°F condensing temperature 75°F entering wetbulb	≧ 135,000 Btu/h·hp	CTI ATC-106
Centrifugal fan evaporative condensers	All	Ammonia test fluid 140°F entering gas temperature 96.3°F condensing temperature 75°F entering wetbulb	≧ 110,000 Btu/h·hp	CTI ATC-106
Air cooled condensers	All	R22 test fluid 125°F condensing temperature ~~R22 test fluid~~ 190°F entering gas temperature 15°F subcooling 95°F entering drybulb	≧ 176,000 Btu/h·hp	ANSI/AHRI 460

[a] For purposes of this table, open-circuit cooling tower performance is defined as the water flow rating of the tower at the given rated conditions divided by the fan motor nameplate power.

[b] For purposes of this table, closed-circuit cooling tower performance is defined as the process water flow rating of the tower at the given rated conditions divided by the sum of the fan motor nameplate rated power and the integral spray pump motor nameplate power.

[c] For purposes of this table air-cooled condenser performance is defined as the heat rejected from the refrigerant divided by the fan motor nameplate power.

[d] Open cooling towers shall be tested using the test procedures in CTI ATC-105. Performance of factory assembled open cooling towers shall be either certified as base models as specified in CTI STD-201 or verified by testing in the field by a CTI approved testing agency. Open factory assembled cooling towers with custom options added to a CTI certified base model for the purpose of safe maintenance or to reduce environmental or noise impact shall be rated at 90 percent of the CTI certified performance of the associated base model or at the manufacturer's stated performance, whichever is less. Base models of open factory assembled cooling towers are open cooling towers configured in exact accordance with the Data of Record submitted to CTI as specified by CTI STD-201. There are no certification requirements for field erected cooling towers.

[e] Applicable test procedure and reference year are provided under the definitions.

… {Section of code omitted; not proposed changes to Table 110.2-H or Table 110.2-I) …

TABLE 110.2-J Warm-Air Furnaces and Combination Warm-Air Furnaces/Air-Conditioning Units, Warm-Air Duct Furnaces, and Unit Heaters

Equipment Type	Size Category (Input)	Subcategory or Rating Condition	Minimum Efficiency	Test Procedure[a]
Warm-Air Furnace, Gas-Fired	< 225,000 Btu/h	Maximum Capacity[b]	78% AFUE or 80% E_t	DOE 10 CFR Part 430 or Section 2.39, Thermal Efficiency, ANSI Z21.47
	≥ 225,000 Btu/h	Maximum Capacity[b]	80% E_t	Section 2.39, Thermal Efficiency, ANSI Z21.47
Warm-Air Furnace, oil-Fired	< 225,000 Btu/h	Maximum Capacity[b]	78% AFUE or 80% E_t	DOE 10 CFR Part 430 or Section 42, Combustion, UL 727
	≥ 225,000 Btu/h	Maximum Capacity[b]	81% E_t	Section 42, Combustion, UL 727
Warm-Air Duct Furnaces, Gas-Fired	All Capacities	Maximum Capacity[b]	80% E_c	Section 2.10, Efficiency, ANSI Z83.8
Warm-Air Unit Heaters, Gas-Fired	All Capacities	Maximum Capacity[b]	80% E_c	Section 2.10, Efficiency, ANSI Z83.8

Warm-Air Unit Heaters, Oil-Fired	All Capacities	Maximum Capacity[b]	~~80% E_e~~ 81% E_c	Section 40, Combustion, UL 731

[a] Applicable test procedure and reference year are provided under the definitions.

[b] Compliance of multiple firing rate units shall be at maximum firing rate.

[c] Combustion units not covered by NAECA (3-phase power or cooling capacity greater than or equal to 19 kW) may comply with either rating.

[d] E_t= thermal efficiency. Units must also include an interrupted or intermittent ignition device (IID), have jacket losses not exceeding 0.75% of the input rating, and have either power venting or a flue damper. A vent damper is an acceptable alternative to a flue damper for those furnaces where combustion air is drawn from the conditioned space.

[e] E_c= combustion efficiency (100% less flue losses). See test procedure for detailed discussion.

[f] As of August 8, 2008, according to the Energy Policy Act of 2005, units must also include interrupted or intermittent ignition device (IID) and have either power venting or an automatic flue damper.

TABLE 110.2-K Gas- and Oil-Fired Boilers, Minimum Efficiency requirements

Equipment Type	Sub Category	Size Category (Input)	Minimum Efficiency [b,c]		Test Procedure [a]
			Before 3/2/2020	After 3/2/2020	
Boiler, hot water	Gas-Fired	< 300,000 Btu/h	82% AFUE	82% AFUE	DOE 10 CFR Part 430
		≥ 300,000 Btu/h and ≤ 2,500,000 Btu/h [d]	80% E_t	80% E_t	DOE 10 CFR Part 431
		> 2,500,000 Btu/h [e]	82% E_c	82% E_c	
	Oil-Fired	< 300,000 Btu/h	84% AFUE	84% AFUE	DOE 10 CFR Part 430
		≥ 300,000 Btu/h and ≤ 2,500,000 Btu/h [d]	82% E_t	82% E_t	DOE 10 CFR Part 431
		> 2,500,000 Btu/h [e]	84% E_c	84% E_c	
Boiler, steam	Gas-Fired	< 300,000 Btu/h	80% AFUE	80% AFUE	DOE 10 CFR Part 430
	Gas-Fired all, except natural draft	≥ 300,000 Btu/h and ≤ 2,500,000 Btu/h [d]	79% E_t	79% E_t	DOE 10 CFR Part 431
		> 2,500,000 Btu/h [e]	79% E_t	79% E_t	DOE 10 CFR Part 431
	Gas-Fired, natural draft	≥ 300,000 Btu/h and ≤ 2,500,000 Btu/h [d]	77% E_t	79% E_t	DOE 10 CFR Part 431
		> 2,500,000 Btu/h [e]	77% E_t	79% E_t	DOE 10 CFR Part 431
	Oil-Fired	< 300,000 Btu/h	82% AFUE	82% AFUE	DOE 10 CFR Part 430
		≥ 300,000 Btu/h and ≤ 2,500,000 Btu/h [d]	81% E_t	81% E_t	DOE 10 CFR Part 431
		> 2,500,000 Btu/h [e]	81% E_t	81% E_t	DOE 10 CFR Part 431

a Applicable test procedure and reference year are provided under the definitions.

b Ec = combustion efficiency (100% less flue losses) .See reference document for detailed information.

c Et= thermal efficiency. See test procedure for detailed information.

d Maximum capacity - minimum and maximum ratings as provided for and allowed by the unit's controls.

e Included oil-fired (residual)

6.2 Reference Appendices

There are no proposed changes to the Reference Appendices.

6.3 ACM Reference Manual

No changes to the Nonresidential ACM Reference Manual are necessary.

6.4 Compliance Manuals

Section 4.2.2 Equipment Efficiency of the Nonresidential Compliance Manual lists the mandatory equipment efficiency values that appear in Tables 110.2A – 110.2K. These tables will need to be updated to be consistent with the revised tables. See Section 6.1 of this report for marked-up versions of the relevant tables.

6.5 Compliance Forms

There are not changes to the compliance forms.

7. REFERENCES AND OTHER RESEARCH

[AHRI] Air-Conditioning Heating and Refrigeration Institute, "2015 Chiller Efficiency ASHRAE 90.1 Change Proposal Justification." Richard Lord, November 5, 2012.

[CARB] California Air Resources Board. 2010. "Proposed Regulation for a California Renewable Electricity Standard Staff Report: Initial Statement of Reasons Appendix D." http://www.arb.ca.gov/regact/2010/res2010/res10d.pdf. Accessed November 12, 2013.

__. 2011a. California Air Resources Board. "Appendix C: Cost Effectiveness Calculation Methodology." March 10. http://www.arb.ca.gov/msprog/moyer/guidelines/2011gl/appc_3_10_11.pdf.

__. 2011b. "Emission Reduction Offsets Transaction Cost Summary Report for 2011." http://www.arb.ca.gov/nsr/erco/erco.htm.

__. 2012. "Emission Reduction Offsets Transaction Cost Summary Report for 2012." http://www.arb.ca.gov/nsr/erco/erco.htm.

__. 2013a. "Mail-Out #MSC 13-09." March 25. http://www.arb.ca.gov/msprog/mailouts/msc1309/msc1309.pdf.

__. 2013b. "California Air Resources Board Quarterly Auction 3, May 2013 – Summary Results Report." http://www.arb.ca.gov/cc/capandtrade/auction/may-2013/results.pdf.

[CEC] California Energy Commission. 2011. "Life-Cycle Cost Methodology: 2013 California Building Energy Efficiency Standards. July 2011. http://www.energy.ca.gov/title24/2013standards/prerulemaking/documents/general_cec_documents/2011-01-14_LCC_Methodology_2013.pdf. Accessed August 2014.

___ 2014. "Time Dependent Valuation of Energy for Developing Building Efficiency Standards: 2016 Time Dependent Valuation (TDV) Data Sources and Inputs." July 2014. http://www.energy.ca.gov/title24/2016standards/prerulemaking/documents/2014-07-09_workshop/2017_TDV_Documents/Title24_2016_TDV_Methodology_Report%20v3.docx. Accessed July 2014.

[U.S. EPA] United States Environmental Protection Agency. 2011. "Emission Factors for Greenhouse Gas Inventories." http://www.epa.gov/climateleadership/documents/emission-factors.pdf. Accessed December 2, 2013.

APPENDIX A: ENVIRONMENTAL IMPACTS METHODOLOGY

Greenhouse Gas Emissions Impacts Methodology

The avoided GHG emissions were calculated assuming an emission factor of 353 metric tons of carbon dioxide equivalents ($MTCO_2e$) per GWh of electricity savings. The Statewide CASE Team calculated air quality impacts associated with the electricity savings from the proposed measure using emission factors that indicate emissions per GWh of electricity generated.[4] When evaluating the impact of increasing the Renewable Portfolio Standard (RPS) from 20 percent renewables by 2020 to 33 percent renewables by 2020, California Air Resources Board (CARB) published data on expected air pollution emissions for various future electricity generation scenarios (CARB 2010). The Statewide CASE Team used data from CARB's analysis to inform the air quality analysis presented in this report.

The GHG emissions factor is a projection for 2020 assuming the state will meet the 33 percent RPS goal. CARB calculated the emissions for two scenarios: (1) a high load scenario in which load continues at the same rate; and (2) a low load rate that assumes the state will successfully implement energy efficiency strategies outlined in the AB32 scoping plan thereby reducing overall electricity load in the state.

To be conservative, the Statewide CASE Team calculated the emissions factors of the incremental electricity between the low and high load scenarios. These emission factors are intended to provide a benchmark of emission reductions attributable to energy efficiency measures that could help achieve the low load scenario. The incremental emissions were calculated by dividing the difference between California emissions in the high and low generation forecasts by the difference between total electricity generated in those two scenarios. While emission rates may change over time, 2020 was considered a representative year for this measure.

Avoided GHG emissions from natural gas savings were calculated using an emission factor of 5,303 $MTCO_2e$/million therms (U.S. EPA 2011).

Water Use and Water Quality Impacts Methodology

The proposed measure is not expected to have any impacts on water use or water quality, excluding impacts that occur at power plants.

[4] California power plants are subject to a GHG cap and trade program and linked offset programs until 2020 and potentially beyond.

APPENDIX B: ADDITIONAL INFORMATION ON PROTOTYPE BUILDINGS

Table 21 presents detailed information about the prototype buildings and assumptions used for the eQUEST analysis. The Statewide CASE Team ran an eQUEST simulation for the base case and measure case for each prototype building in each climate zone.

Table 21: Detailed Information on Prototype Buildings and Assumptions Used for Energy Simulations

Prototype #:	Prototype 1	Prototype 2	Prototype 3	Prototype 4	Prototype 5	Prototype 6	Prototype 7
Measure # Evaluated:	1A	1A	1A	1B	1B	1B	2
Equipment Type Evaluated:	Air Conditioners	Air Conditioners	Air Conditioners	Heat Pumps	Heat Pumps	Heat Pumps	Chillers
Building Type:	Office, 2 story	Rest, Full Service	Retail, Strip Mall	Office, 2 story	Rest, Full Service	Retail, Strip Mall	School, College
Floor space (SF):	25,000	5,000	15,000	25,000	5,000	15,000	250,000
Cooling Eq:	DX Coils	DX Coils	DX Coils	DX Coils	DX Coils	DX Coils	Chilled H2O
Heating Eq:	Furnace	Furnace	Furnace	DX Coils (HP)	DX Coils (HP)	DX Coils (HP)	Hot H2O
System Type:	Packaged Single Zone DX	Packaged Single Zone DX	Packaged Single Zone DX	Water-Source HP (single/multi-zone)	Water-Source HP (single/multi-zone)	Water-Source HP (single/multi-zone)	Standard VAV with HW Reheat
Heat Pump Source:				Water Loop	Water Loop	Water Loop	Hot H2O Loop
Cooling SP:	74	74	74	74	74	74	74
Heating SP:	70	70	70	70	70	70	70
Cooling Unit Size:	135-240	135-240	135-240	>135	>135	>135	2*300
Condenser Type:	Water Cooled	Water Cooled	Water Cooled				Water Cooled
Cooling Units:	EER	EER	EER	EER	EER	EER	kW/ton
Base Value:	11.78	11.78	11.78	13.05	13.05	13.05	0.694
Measure Value:	12.96	12.96	12.96	14.50	14.50	14.50	0.657
Heating Units:				COP	COP	COP	
Base Value:				3.475	3.475	3.475	
Measure Value:				3.530	3.530	3.530	
Number of Floors:	2	1	1	2	1	1	4
Footprint Shape:	Rectangle	Rectangle	Rectangle	Rectangle	Rectangle	Rectangle	Rectangle
Zoning Pattern:	Perimeter / Core	Perimeter / Core	Perimeter / Core	Perimeter / Core	Perimeter / Core	Perimeter / Core	Perimeter / Core
Condenser Config:	Fluid Cooler	Fluid Cooler	Fluid Cooler	Fluid Cooler	Fluid Cooler	Fluid Cooler	Open Tower
Capacity Control:	Variable Speed Fan	Variable Speed Fan	Variable Speed Fan	One Speed Fan	One Speed Fan	One Speed Fan	One Speed Fan
Fan Efficiency:	High	High	High	High	High	High	High
Prototype #:	**Prototype 8**	**Prototype 9**	**Prototype 10**	**Prototype 11**	**Prototype 12**	**Prototype 13**	**Prototype 14**
Measure # Evaluated:	2	2	3A	4A	4B	5	6

Equipment Type Evaluated:	Chillers	Chillers	PTAC	SPVAC	SPVHP	Evaporative Condenser	Oil Fire Unit Heater
Building Type:	Health, hospital	Office, Mid-rise	Lodging, Motel	School, Relocatable	School, Relocatable	Storage, Uncond Low Bay	Storage, Cond High Bay
Floor space (SF):	250,000	125,000	400	960	960	10,000	200,000
Cooling Eq:	Chilled H2O	Chilled H2O	DX Coils	DX Coils	DX Coils	No Cooling	DX Coils
Heating Eq:	Hot H2O	Hot H2O	Electric Resistance	No Heating	DX Coils (HP)	Furnace	No Heating
System Type:	Dual Duct Air Handler with HW Heat	Standard VAV with HW Reheat	Package Terminal AC with Elect Resist	Package Terminal AC with no heating	Package Terminal HP	Gas or Fuel Furnace with no zone ventilation	Split System Single Zone
Heat Pump Source:	Hot H2O Loop	Hot H2O Loop			Air		
Cooling SP:	74	74	74	74	74	74	50
Heating SP:	70	70	70	70	70	70	70
Cooling Unit Size:	2*300	1*300	7-15	>15	>15	>= 225	> 760
Condenser Type:	Water Cooled	Water Cooled					Water Cooled
Cooling Units:	kW/ton	kW/ton	ERR	ERR	ERR	Efficiency	Efficiency
Base Value:	0.694	0.694	11.10	8.83	8.83	0.80	Standard
Measure Value:	0.657	0.657	11.30	10.00	10.00	0.81	Premium
Heating Units:					COP		
Base Value:					2.900		
Measure Value:					3.000		
Number of Floors:	4	4	1	1	1	1	1
Footprint Shape:	Rectangle	Rectangle	Rectangle	Rectangle	Rectangle	Rectangle	Rectangle
Zoning Pattern:	Perimeter / Core	Perimeter / Core	One Per Floor	One Per Floor	One Per Floor	One Per Floor	Perimeter / Core
Condenser Config:	Open Tower	Open Tower	N/A	N/A	N/A	N/A	N/A
Capacity Control:	One Speed Fan	One Speed Fan	N/A	N/A	N/A	N/A	N/A
Fan Efficiency:	High	High	N/A	N/A	N/A	N/A	N/A

APPENDIX C: EXAMPLE ENERGY SAVINGS CALCULATION

This appendix demonstrates the method the Statewide CASE Team used to calculate statewide energy impacts for Measure 1A: Air Conditioning Equipment. The Statewide CASE Team replicated the process explained in this appendix for each type of equipment.

The general steps used to calculate statewide savings are as follows:

- Step 1: Identify prototype buildings (results shown in Table 22). Building types and occupancy were selected based on the most appropriate application of the equipment that the measure would impact. In this example case for Air Conditioners, small offices, restaurants, and retail stores were selected. These three occupancy types represent the majority of square footage that would be impacted by air-conditioner efficiency. Although other building types could be used, their contribution to savings is much smaller and therefore not used.
- Step 2: Identify assumptions for base case and measure case for eQUEST simulations (results shown in Table 21 in Appendix B: Additional Information on Prototype Buildings)

Step 3: Run eQUEST simulations for each climate zone to derive savings per prototype building (results of eQUEST simulations for Prototype 1 shown in

- Table 23; simulated energy savings for Prototype buildings 1, 2, and 3 shown in Table 24.). The eQUEST simulations result in hourly energy impacts. For simplicity annual savings results are presented in the tables below.
- Step 4: Divide savings per prototype building by floor area of prototype building (results of per square foot energy savings for Prototypes 1, 2, and 3 shown in Table 24).
- Step 5: Identify square footage of construction occurring in 2017 that will be impacted by the proposed measure. See Section 4.6.2 for more information on the new construction forecast, and assumptions used to determine the floor space impacted by the proposed measure. Table 24 presents the floor space impacted by Measure 1A.
- Step 6: Multiply per square foot savings by floor space impacted by the measure (See Table 25 for results for Measure 1A).
- Step 7: Calculate statewide TDV savings by multiplying hourly energy savings by 2016 TDV factors. Results for Measure 1A are shown in Table 25.

As mentioned, the steps outlined above were repeated for every proposed measure. The first year statewide savings for each measure are presented in Table 26.

Table 22: Building Prototypes for Air Conditioner Standard

	Occupancy Type	Equipment Type	Area (square foot)	Number of stories
Prototype 1	Office (Small)	AC	25,000	2
Prototype 2	Restaurant	AC	5,000	1
Prototype 3	Retail	AC	15,000	1

Table 23: Per unit Energy Impacts – Air Conditioners: Prototype 1 (Small Office)

	Annual Electricity Use Existing Conditions (kWh/Building-yr)	Annual Electricity Use Proposed Conditions (kWh/Building-yr)	Annual Electricity Savings (kWh/Building-yr)	Annual Electricity Savings per Square Foot (kWh/SF)
Climate Zone 1	189,784	189,175	609	**0.02437**
Climate Zone 2	223,702	220,139	3,563	**0.14253**
Climate Zone 3	208,815	206,596	2,219	**0.08876**
Climate Zone 4	229,325	225,196	4,128	**0.16513**
Climate Zone 5	219,102	215,980	3,122	**0.12487**
Climate Zone 6	229,159	225,112	4,047	**0.16188**
Climate Zone 7	235,622	230,993	4,629	**0.18516**
Climate Zone 8	244,120	238,709	5,411	**0.21642**
Climate Zone 9	247,124	241,444	5,679	**0.22717**
Climate Zone 10	247,199	241,458	5,741	**0.22964**
Climate Zone 11	235,973	231,324	4,649	**0.18594**
Climate Zone 12	235,128	230,476	4,652	**0.18609**
Climate Zone 13	249,446	243,485	5,961	**0.23845**
Climate Zone 14	240,293	235,182	5,111	**0.20444**
Climate Zone 15	278,948	270,162	8,785	**0.35142**
Climate Zone 16	209,214	206,998	2,217	**0.08867**

Table 24: Annual Electricity Savings – per SF, by Prototype Building

Climate Zone	Prototype A (Small Office)		Prototype B (Restaurant)		Prototype C (Retail)	
	Annual Electricity Savings (kWh/SF)	**Floor Area Impacted in 2017 (SF)**	**Annual Electricity Savings (kWh/SF)**	**Floor Area Impacted in 2017 (SF)**	**Annual Electricity Savings (kWh/SF)**	**Floor Area Impacted in 2017 (SF)**
Climate Zone 1	**0.024**	15,205	0.039	4,100	0.028	10,644
Climate Zone 2	**0.143**	58,968	0.324	22,976	0.215	163,921
Climate Zone 3	**0.089**	189,232	0.174	106,130	0.120	757,459
Climate Zone 4	**0.165**	125,782	0.376	49,475	0.259	412,386
Climate Zone 5	**0.125**	24,429	0.198	9,609	0.144	80,094
Climate Zone 6	**0.162**	210,732	0.285	214,522	0.213	798,608
Climate Zone 7	**0.185**	249,455	0.353	78,119	0.258	425,059
Climate Zone 8	**0.216**	280,211	0.440	287,627	0.309	1,102,547
Climate Zone 9	**0.227**	252,450	0.515	238,151	0.343	1,033,594
Climate Zone 10	**0.230**	356,721	0.539	183,705	0.346	778,764
Climate Zone 11	**0.186**	86,490	0.486	22,759	0.300	200,208
Climate Zone 12	**0.186**	444,496	0.440	130,614	0.293	950,431
Climate Zone 13	**0.238**	173,611	0.616	53,285	0.382	417,588
Climate Zone 14	**0.204**	58,362	0.514	35,876	0.318	158,305
Climate Zone 15	**0.351**	90,791	0.872	25,002	0.529	175,446
Climate Zone 16	**0.089**	51,692	0.209	27,539	0.137	131,588

Table 25: First Year Statewide Savings – Air Conditioning

Climate Zone	First Year Statewide Electricity Savings (kWh/yr)				TDV Energy Savings (kBTU/yr)
	Prototype A Small Office	Prototype B Restaurant	Prototype C Retail	Total	
Climate Zone 1	371	159	293	822	37,921
Climate Zone 2	8,405	7,453	35,316	51,174	1,786,073
Climate Zone 3	16,797	18,436	91,086	126,319	4,562,090
Climate Zone 4	20,770	18,622	107,004	146,396	5,150,227
Climate Zone 5	3,051	1,905	11,543	16,499	578,604
Climate Zone 6	34,114	61,079	170,361	265,554	8,351,272
Climate Zone 7	46,190	27,581	109,849	183,620	5,787,727
Climate Zone 8	60,644	126,619	340,647	527,910	16,194,267
Climate Zone 9	57,350	122,566	354,173	534,089	17,420,065
Climate Zone 10	81,917	99,014	269,589	450,520	15,117,656
Climate Zone 11	16,082	11,066	60,003	87,150	3,010,685
Climate Zone 12	82,716	57,444	278,016	418,175	14,079,972
Climate Zone 13	41,397	32,842	159,385	233,625	7,476,690
Climate Zone 14	11,931	18,425	50,311	80,668	2,761,590
Climate Zone 15	31,906	21,806	92,899	146,610	4,207,713
Climate Zone 16	4,583	5,769	17,998	28,351	1,111,636
TOTAL	518,223	630,785	2,148,473	**3,297,481**	**107,634,188**

Table 26: Estimated First Year Energy Savings

Equipment Type	First Year Statewide Savings				First Year TDV Savings	
	Electricity Savings (GWh)	Power Demand Reduction (MW)	Natural Gas Savings (MMtherms)	Oil Fuel Savings (Mtherms)	TDV Electricity Savings (Million kBTU)	TDV Natural Gas Savings (Million kBTU)
Air Conditioners	3.30	1.60	0.00	0.00	107.6	0.0
Heat Pumps	0.72	0.34	0.00	0.00	23.3	0.0
Chillers	3.14	0.97	0.00	0.00	85.9	0.0
Package Terminal Air Conditioners (PTAC)	0.10	0.05	0.00	0.00	3.3	0.0
Split Package Vertical Air Conditioners (SPVAC)	0.50	0.10	0.00	0.00	12.1	0.0
Split Package Vertical Heat Pumps (SPVHP)	2.17	0.40	0.00	0.00	52.6	0.0
Condensers	0.03	0.01	0.00	0.00	0.7	0.0
Furnaces (Oil)	0.00	0.00	0.00	0.20	0.0	0.0
Boilers*	0.00	0	0.00	0.00	0.0	0.0
TOTAL	**9.96**	**3.46**	**0.00**	**0.20**	**285.5**	**0.0**

* Note: No natural gas savings are derived during the first year of Title 24 implementation (2017) due to that the boiler efficiency requirements are scheduled to take effect in the year 2020.

APPENDIX B: DOCKETED COMMENTS LOG

CEC administered a public pre-rulemaking and rulemaking process to update the Title 24 Standards. The table below lists comments that were submitted to CEC through the pre-rulemaking and rulemaking process that are pertinent to this measure. The version of the CASE Report that is presented in Appendix A was developed taking comments that were submitted to CEC in response to the Scoping Workshops held April – August 2014 into account. See Section 3 of this report for a discussion of issues that stakeholders raised in comments that were submitted to CEC after the Statewide CASE Team submitted the CASE Report to CEC (comments submitted in response to the November 3, 2014 Scoping Workshop, the 45-Day Language, and the 15-Day Language).

Comment Letter #	Comment Letter ID	Link
Comments Submitted to CEC Response to Scoping Workshops Held April - August 2014		
1	NRDC	Natural Resources defense Councils Comments on the Title 24 2016 Pre-Rulemaking Workshops 2014-08-07 TN-73569.pdf
Comments Submitted to CEC in Response to Scoping Workshops Held November 3, 2014		
2	Schneider Electric USA	Schneider Electric Comments 2014-11-24 TN-74051.pdf
Comments Submitted to CEC in Response to 45-Day Language and 45-day Hearings Held March 2-3, 2015		
3	Taylor Engineering (2)	Taylor Engineering - Jeff Stein Comments on 45 Day Language 2015-03-27 TN-75539.pdf
4	Unico Inc.	Unico Inc Shawn Intagliata and Craig Messmer Comment on Small Duct High Velocity Product Class in Title 24 2015-03-16 TN-75427.pdf