
Draft Memo

California Building Stock Assessment: Nonresidential Prototypes

PREPARED FOR:

Andres Fergadiotti (for Code and Standards)
Southern California Edison
1515 Walnut Grove Avenue
Rosemead, California 91770

PREPARED BY:

Rahul Athalye
Mohammad Dabbagh

NORESCO

1111 Broadway St.
Oakland, California 94607

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INTRODUCTION

The primary objective of the nonresidential building stock assessment (BSA) was to develop the mix of prototype models that best represent the California building stock for nonresidential and multifamily buildings with four or more stories. A secondary objective was to ensure that all use cases supported by the SCE Prototypes project are covered by the selected prototypes. This BSA and prototype mapping is the first step in developing a unified set of prototype models for California's nonresidential (and mid- and high-rise multifamily) building stock.

The nonresidential BSA was completed for the California Energy Commission (CEC) in December 2022 as part of the 2025 Energy Code development. The assessment relied primarily on permit starts data from Dodge (Dodge 2022) that was provided to NORESKO by the CEC. This permit starts data (hereafter referred to as the 'Dodge data') provides information about building starts on an annual basis beginning in 1968 and extending through 2021. The SCE Prototypes project will leverage the nonresidential BSA performed by NORESKO for the CEC. The CEC nonresidential BSA memo has been reproduced in full in Appendix A of this memo. The objective of this memo is to build on the CEC assessment and evaluate whether the prototypes mix is sufficient to represent all use cases under the SCE Prototypes project; in particular, whether more prototypes are needed to represent other use cases, such as those from the California Public Utilities Commission (CPUC).

The determination of prototype characteristics, such as window-to-wall ratio (WWR), internal gains, HVAC system, etc., will be performed after the prototype mix has been determined and agreed upon by the Prototypes TAG. The primary attributes under consideration for this nonresidential BSA were floor area distribution across building types, vintages, climate zones, and major building categories.

NONRESIDENTIAL BUILDING STOCK ASSESSMENT

The approach to determine the nonresidential prototypes mix was as follows:

- Use the work performed for the CEC to understand the building stock.
- Review the CEC and CPUC prototypes currently in use, including their key features, such as floor areas and building types represented by the prototype.
- Determine prototypes mix that ensures the California building stock is represented and that the CEC and CPUC use cases are satisfied.

Appendix A of this memo provides the CEC memo on nonresidential building stock assessment. The assessment used a new mapping approach to map Dodge building categories to prototypes, which provided a finer and more accurate representation of the relationship between the building stock and the prototypes. Figure 1 shows the distribution of the existing floor area by building category in California. Warehouses, offices, retail, manufacturing, and apartments are the building types with the largest footprint in California.

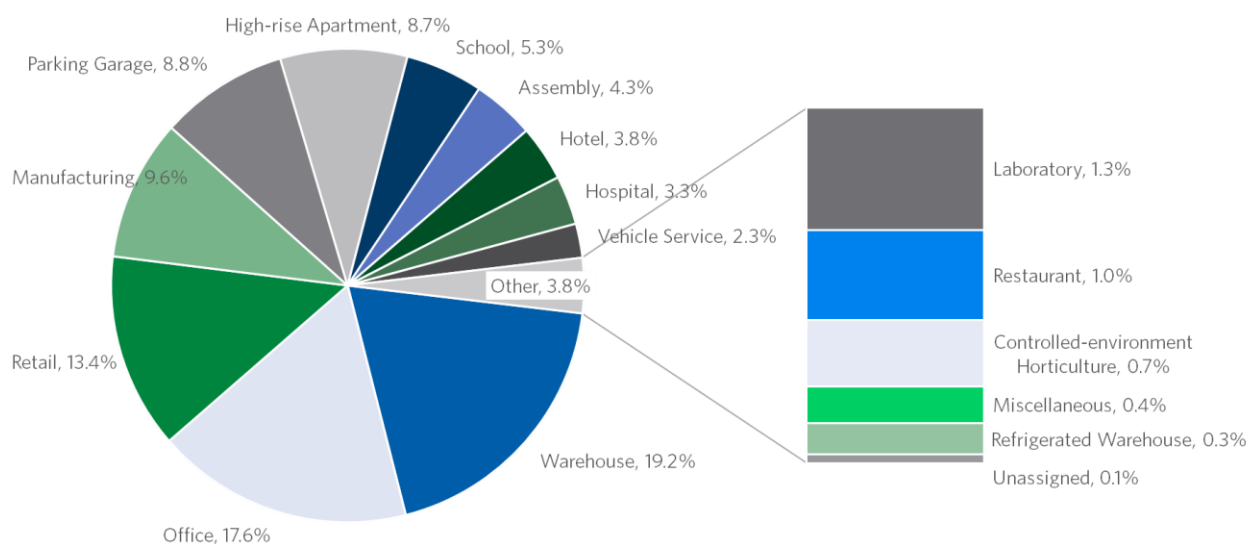


Figure 1: Building category distribution (floor area) in Dodge (all vintages)

The CEC memo describes the mapping from Dodge building categories (and types) to prototype models. For example, the Small and Medium Office prototypes were assigned floor area by dividing office buildings by the size of the project. In other cases, assignments were made based on number of stories. The resulting floor area mapped to prototypes is presented below. Figure 2 shows the floor area by prototype and climate zone and Table 1 provides the same information combined across all climate zones. Table 2 shows the floor area by climate zone.

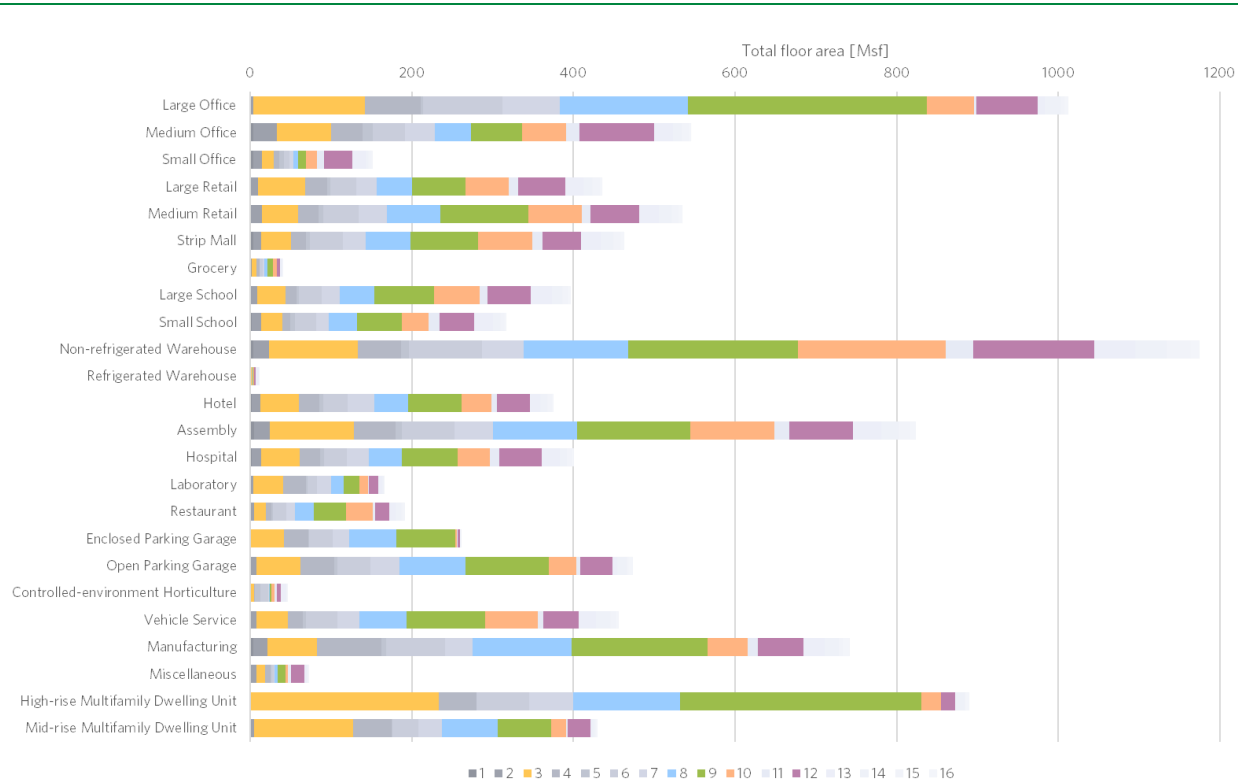


Figure 2: Existing construction floor area across building types and climate zones.

Table 1: Existing construction floor area across building types

Building Type	Floor Area [MsF]	Portion of Total
Large Office	1,012.1	9.7%
Medium Office	545.6	5.2%
Small Office	151.1	1.5%
Large Retail	435.6	4.2%
Medium Retail	535.2	5.1%
Strip Mall	462.4	4.4%
Grocery	40.1	0.4%
Large School	396.8	3.8%
Small School	317.3	3.0%
Non-refrigerated Warehouse	1,175.1	11.3%
Refrigerated Warehouse	11.1	0.1%
Hotel	375.5	3.6%
Assembly	823.3	7.9%
Hospital	400.5	3.8%

Building Type	Floor Area [Msf]	Portion of Total
Laboratory	165.7	1.6%
Restaurant	191.8	1.8%
Enclosed Parking Garage	261.3	2.5%
Open Parking Garage	473.2	4.5%
Controlled-environment Horticulture	45.8	0.4%
Vehicle Service	456.3	4.4%
Manufacturing	742.3	7.1%
Miscellaneous	72.5	0.7%
High-rise Multifamily Dwelling Unit	889.5	8.5%
Mid-rise Multifamily Dwelling Unit	430.0	4.1%
Total	10,410.1	

Table 2: Existing construction floor area across climate zones

Climate Zone	Floor Area [Msf]	Portion of Total
1	35.0	0.3%
2	210.4	2.0%
3	1,354.5	13.0%
4	677.9	6.5%
5	96.4	0.9%
6	855.4	8.2%
7	631.0	6.1%
8	1,340.4	12.9%
9	2,127.1	20.4%
10	1,015.7	9.8%
11	194.2	1.9%
12	1,035.8	9.9%
13	372.7	3.6%
14	245.6	2.4%
15	132.3	1.3%
16	85.8	0.8%
Total	10,410.1	

CEC's Demand Analysis Office (DAO) produces a forecast of building floor area, which is based on an econometric model. The forecasted floor area in 2026 was used to develop the floor area by prototype for the new construction vintage. This 2026 floor area will be used to evaluate measure impact during 2025 Energy Code development. Figure 3 and Table 3 show the floor area for the new construction (2026) vintage. Table 4 shows the floor area proportions by climate zone.

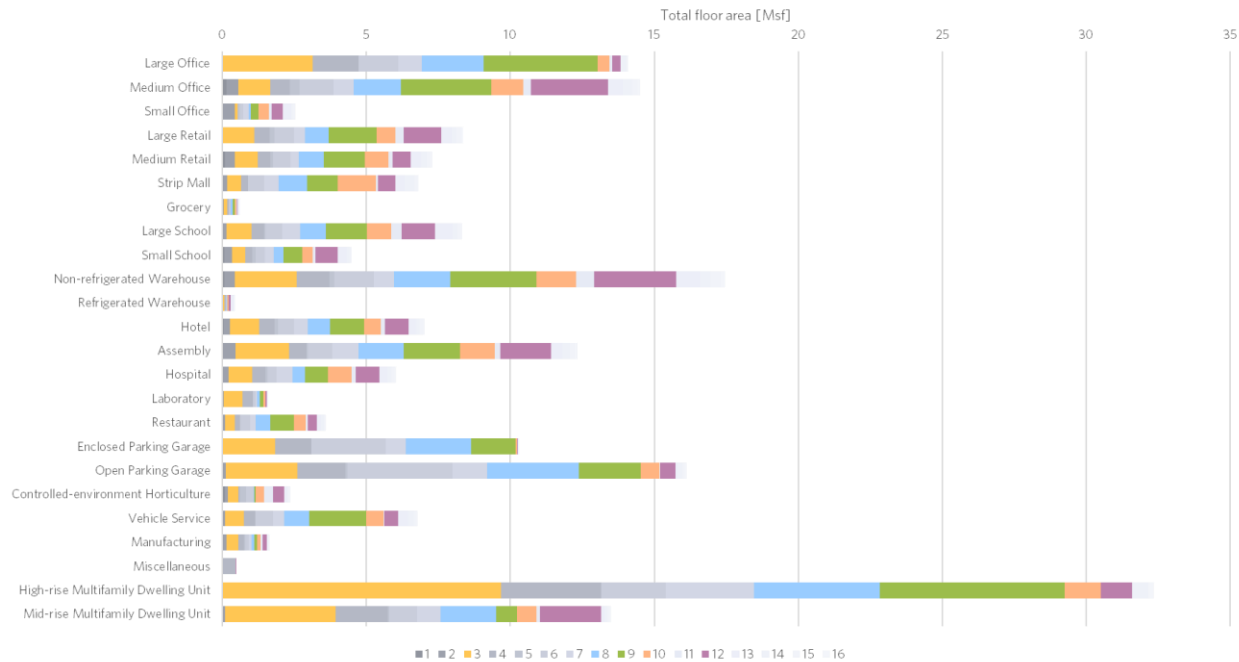


Figure 3: New construction floor area (2026) across building types and climate zones

Table 3: New construction floor area (2026) across building types

Prototype	Floor Area [MsF]	Portion of Total
Large Office	14.1	7.1%
Medium Office	14.5	7.3%
Small Office	2.5	1.3%
Large Retail	8.3	4.2%
Medium Retail	7.3	3.7%
Strip Mall	6.8	3.4%
Grocery	0.6	0.3%
Large School	8.3	4.2%
Small School	4.5	2.3%
Non-refrigerated Warehouse	17.4	8.8%
Refrigerated Warehouse	0.4	0.2%

Hotel	7.0	3.5%
Assembly	12.3	6.2%
Hospital	6.0	3.0%
Laboratory	1.6	0.8%
Restaurant	3.6	1.8%
Enclosed Parking Garage	10.3	5.2%
Open Parking Garage	16.1	8.1%
Controlled-environment Horticulture	2.3	1.2%
Vehicle Service	6.8	3.4%
Manufacturing	1.6	0.8%
Miscellaneous	0.4	0.2%
High-rise Multifamily Dwelling Unit	32.4	16.3%
Mid-rise Multifamily Dwelling Unit	13.5	6.8%
Total	198.8	

Table 4: New construction floor area (2026) across climate zones

Climate Zone	Floor Area [Msf]	Portion of Total
1	0.6	0.3%
2	3.7	1.9%
3	34.3	17.3%
4	16.7	8.4%
5	1.7	0.9%
6	19.5	9.8%
7	12.9	6.5%
8	26.0	13.1%
9	34.5	17.4%
10	14.0	7.1%
11	3.1	1.6%
12	19.4	9.7%
13	5.4	2.7%
14	3.6	1.8%
15	2.0	1.0%

16	1.3	0.6%
Total	198.8	

CEC Prototypes

The CEC work (summarized above) and the prototype mapping represent a starting point for this analysis. The building stock analysis provided a picture of the building types and where floor area is located within the state. The building types from the Dodge data were mapped to prototypes and to 'non-prototyped' building types. Table 5 shows the prototypes selected for the 2025 code cycle, which represent over 95% of the projected new construction building stock. The non-prototyped building types either occupied a very small fraction of the overall floor area or their energy impact was deemed to be small or unregulated by the energy code. For example, refrigerated warehouses were deemed to have a very small fraction of the floor area.

Manufacturing facility energy consumption is dominated by the process load within the facility. Both the CPUC and the CEC evaluate measures applicable to process loads within manufacturing facilities. However, building energy modeling is generally not needed to evaluate the impact of those measures because the process load has little to no interaction with the building loads, except in cases where the building must treat or condition the air or water as a result of the process (a laboratory is a good example and is represented within the prototypes). The impact of a lighting measure that would be applicable to a high-bay manufacturing facility would be just as easily captured in other prototypes. The impact of such measures on the statewide savings can be captured by using the manufacturing facility floor area numbers within the building stock assessment.

Table 5: Prototypes selected for the 2025 Energy Code Analysis

Building Types/Prototype	CEC Prototype for 2025 Energy Code Analysis
Large Office	YES
Medium Office	YES
Small Office	YES
Large Retail	YES
Medium Retail	YES
Strip Mall	YES
Large School	YES
Small School	YES
Non-ref. Warehouse	YES
Hotel	YES
Assembly	YES
Hospital	YES
Laboratory	YES
Restaurant	YES

Encl. Parking Garage	YES
Open Parking Garage	YES
Grocery	NO
Ref. Warehouse	NO
CEH	NO
Vehicle Service	NO
Manufacturing	NO
Miscellaneous	NO

CPUC Prototypes

Table 6 shows the list of CPUC 2020 nonresidential prototypes, including the floor area, number of buildings (in each model), and the weighting factor. None of the CPUC prototypes match the CEC prototypes in terms of floor area, even though both sets seemingly represent the same California building stock.

Table 6: Existing CPUC/DEER 2020 prototypes

Prototypes	Total Floor Area (SF)	Number of Buildings	Weighting Factor
Assembly	100,000	1	6.3%
Education - Community College	300,000	2	2.3%
Education - Primary School	50,000	2	2.5%
Education - Relocatable Classroom	1,920	2	2.5%
Education - Secondary School	150,000	4	2.5%
Education - University	1,000,000	2	2.3%
Grocery	50,000	1	2.3%
Health/Medical - Hospital	235,500	2	4.5%
Health/Medical - Nursing Home	60,654	2	2.3%
Lodging - Hotel	140,000	2	2.3%
Lodging - Motel	30,000	2	2.3%
Manufacturing Biotech	200,000	1	6.3%
Manufacturing Biotech - Extended Hours	200,000	1	6.3%
Manufacturing Light Industrial	100,000	1	2.3%
Office - Large	175,000	1	2.3%
Office - Small	10,000	1	16.9%
Restaurant - Fast-Food	2,500	2	5.2%
Restaurant - Sit-Down	5,600	2	1.4%

Retail - Multistory Large	120,000	1	1.4%
Retail - Single-Story Large	130,000	1	5.6%
Retail - Small	8,000	4	5.6%
Storage - Conditioned	250,000	1	5.6%
Storage - Unconditioned	250,000	1	8.2%
Warehouse - Refrigerated	100,000	1	0.8%
Total			100%

The CPUC use case is different from the CEC use case because incentives are measure-specific, i.e., a measure that improves the efficiency of a refrigerated warehouse must be modeled in the refrigerated warehouse even though at the refrigerated warehouse building type has a very small footprint compared to other building types. Thus, it may be important to develop prototypes that relate to specific measures and program designs.

RECOMMENDATION

The CEC analysis already provides a near-complete representation of the building stock for the purpose of analyzing energy code impacts. The other major use case for the SCE Prototypes project is the CPUC analysis of deemed and custom measures. For this type of analysis, the measure base case and the typical usage and operational patterns must be represented. To analyze whether the CEC-based prototypes mix is sufficient, a table was created that listed the Dodge building categories, the mapping to CEC prototypes, and the corresponding existing CPUC prototypes along with key features of the CEC and CPUC prototypes such as the floor area, space mix, and HVAC systems. Appendix B provides this cross-mapping information. Using this cross-mapping information, the existing CEC and CPUC prototypes were compared with each other. The final recommendation for nonresidential and high-rise multifamily prototypes for the TAG is shown in Table 7. The primary criteria to include a prototype were as follows:

1. Does the prototype represent a significant fraction of the floor area?
2. Does the prototype present opportunities for future evaluation of measure impact that cannot be captured in other prototypes?
3. Will the prototype be used by CEC, CPUC, and other agencies?

When the prototype met one or more of the criteria above, it was included in the mix. It should be noted, however, that this is a preliminary recommendation that may be subject to changes as California moves towards economy-wide decarbonization. For example, mobile homes, ADUs, low-income housing and their characteristics may become important from a policy perspective and may be developed at a later time.

Table 7: Prototypes mix to represent CEC and CPUC use cases

Building Type	CEC 2025	DEER 2020	Prototypes TAG	Notes
Office - Large	X	X	X	Need these three prototypes for diversity of HVAC systems, geometry, and other differences.
Office - Medium	X		X	
Office - Small	X	X	X	
Retail - Medium/Large Multi-story		X		Not sufficient floor area and measures can be represented in other prototypes.
Retail - Medium/Large Single-story	X	X	X	
Retail - Small/Stripmall	X	X	X	
Retail - Mixed-use				Hard to determine square footage. Useful for shared central systems. Use other prototypes to model mixed use or use Strip Mall prototype with adiabatic roof.
Retail - Grocery/Supermarket		X	X	CPUC and ORNL models will provide starting points.
School - Large/Secondary	X	X	X	
School - Small/Primary	X	X	X	
School - Relocatable Classroom		X	X	Floor area estimates currently not available. Regulated by CEC.
School - Community College		X		Represent using other school prototypes

Building Type	CEC 2025	DEER 2020	Prototypes TAG	Notes
School - University		X		Represent using other school prototypes
Warehouse - Unconditioned		X		
Warehouse - Non-refrigerated/Conditioned	X	X	X	
Warehouse - Refrigerated		X	X	Load is unique and measure impact cannot be captured in other prototypes. CPUC model will serve as starting point.
Hotel - Large		X	X	Large hotels use central systems and have large square footage dedicated to common areas. CPUC and DOE models will serve as starting points.
Hotel - Small/Motel	X	X	X	
Assembly	X	X	X	Use newly developed Assembly prototype for CEC.
Parking Garage - Enclosed				Low EUI but very high square footage. Part of multifamily prototypes.
Parking Garage - Open	X		X	Low EUI but very high square footage. New one was built for CEC.
Healthcare - Hospital	X		X	
Healthcare - Nursing Home		X	X	Need to be able to separate out clinic from nursing home.
Healthcare - Outpatient		X	X	Possibly try simplifying DOE model.
Laboratory	X	X	X	
Restaurant - Fast Food	X	X	X	
Restaurant - Sit-Down		X	X	
Controlled-environment Horticulture			X	Energy-intensive but hard to determine square footage.
Vehicle Service				Highest exhaust requirements in CA but currently does not represent unique opportunities to capture impact.
Manufacturing - General				Manufacturing facility consumption is dominated by process loads. Measures to improve efficiency of process loads generally do not require building energy modeling.
Manufacturing - Biotech		X		
Manufacturing - Biotech - Extended Hours		X		
Manufacturing - Light Industrial		X		
Data Center				Hard to determine square footage but energy intensive. Low to negative growth in California.
High-rise Multifamily	X		X	
Mid-rise Multifamily	X		X	
Total	16	25	24	

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APPENDIX A: CEC NONRESIDENTIAL BUILDING STOCK MEMO



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APPENDIX B: CROSS-MAPPING BETWEEN DODGE BUILDING CATEGORIES, CEC PROTOTYPES, AND CPUC PROTOTYPES

Table 8: Crosswalk between Dodge building categories and CEC and CPUC prototypes

Building Category	CEC 2025	CPUC/DEER 2020	Dodge Building Types
Assembly	Building Types: Religious, Sports, Library, Exhibits & Events, Terminals <ul style="list-style-type: none"> – 313,339 sf – Single Zone VAV (except Library: SZ HP) 	Activity Areas: Auditorium, Office <ul style="list-style-type: none"> – 100,000 sf – Rooftop DX 	Arenas/Coliseums (Non-School/Univ), Auditoriums (Non-School/College), Railroad Terminals, Religious Bldgs, Airline Terminals, Arenas/Coliseums, Auditoriums, Bus, Truck and Railroad Terminals, Clubs and Lodges, Exhibition Halls, Funeral/Internment Facilities, Houses of Worship, Other Religious Bldgs, Libraries, Museums, Theaters, Miscellaneous Amusement/Recreational, Gyms/Field Houses/Indoor Pools, Bowling Alleys
Healthcare	Hospital: <ul style="list-style-type: none"> – 241,501 sf – VAV with central plant (gas boiler) 	Activity Areas: Dining Area, Kitchen and Food Preparation, Laboratory Medical, Medical and Clinical Care, Office Health/Medical – Hospital: <ul style="list-style-type: none"> – 235,500 sf – FPFC systems Health/Medical – Nursing Home: <ul style="list-style-type: none"> – 60,654 sf – Rooftop DX – VAV 	Hospitals, Clinics/Nursing Convalescent Facilities
Office	Large Office <ul style="list-style-type: none"> – 498,589 sf – Built-up VAV with central plant Medium Office <ul style="list-style-type: none"> – 53,628 sf 	Large Office: Conference Room, Copy Room, Corridor, Lobby, Mechanical/Electrical Room, Office (Executive/Private), Office (Open Plan), Restrooms <ul style="list-style-type: none"> – 175,000 sf – CV Reheat/VAV 	Offices and Banks/Financial Bldgs (incl all owner); Banks/Financial, 1-3 stories; Banks/Financial, 4+ stories; Capitols/Court Houses/City Halls; Police/Fire Stations; Post Offices Large Office: ≥ 5 stories; floor area ≥ 150k sf

Building Category	CEC 2025	CPUC/DEER 2020	Dodge Building Types
	<ul style="list-style-type: none"> - Packaged VAV with gas reheat Small Office: <ul style="list-style-type: none"> - 5,502 sf - Single Zone HP 	Small Office: Conference Room, Copy Room, Corridor, Lobby, Mechanical/Electrical Room, Office (Executive/Private), Restrooms <ul style="list-style-type: none"> - 10,000 sf - Rooftop DX 	Medium Office: 2-4 stories; 25k sf ≤ floor area < 150k sf Small Office: 1 story; floor area < 25k sf
Hotel-Motel	Small Hotel: <ul style="list-style-type: none"> - 42,554 sf - PTAC+gas furnace for guestrooms; Packaged VAV with central plant for common areas. 	Lodging – Hotel: Bar Cocktail Lounge, Corridor, Dining Area, Hotel/Motel Guest Room, Kitchen and Food Preparation, Laundry, Lobby, Office <ul style="list-style-type: none"> - 140,000 sf - Rooftop DX Lodging – Motel: Corridor, Hotel/Motel Guest Room, Laundry, Office <ul style="list-style-type: none"> - 30,000 sf - PTAC/PTHP (Motel) 	Hotels/Motels 1-3 Stories, Hotels/Motels 4+ Stories, Hotels/Motels (Stories Unknown or Alts)
Education	Small School: <ul style="list-style-type: none"> - 24,413 sf - Single Zone HP Large School: <ul style="list-style-type: none"> - 210,886 sf - Built-up VAV with central plant 	Community College: Classroom/Lecture, Computer Room, Dining Area, Kitchen and Food Preparation, Offices <ul style="list-style-type: none"> - 300,000 sf - VAV Primary School: Classroom/Lecture, Dining Area, Kitchen and Food Preparation, Exercising Centers and Gymnasium <ul style="list-style-type: none"> - 50,000 sf - Rooftop DX Secondary School: Classroom/Lecture, Computer Room, Dining Area, Kitchen and Food Preparation, Offices, Exercising Centers and Gymnasium <ul style="list-style-type: none"> - 150,000 sf - Rooftop DX 	Small/Large School: Primary Schools; Schools-Educational/ Science Bldgs; Sunday Schools; Colleges/Universities Except Community; Community Colleges; Junior High Schools; Senior High Schools; Special Schools; Vocational Schools

Building Category	CEC 2025	CPUC/DEER 2020	Dodge Building Types
		University: Classroom/Lecture, Comm/Ind Work, Computer Room, Corridor (Dormitory), Dining Area, Hotel/Motel Guest Room (Dormitory), Kitchen and Food Preparation, Offices <ul style="list-style-type: none"> - 1,000,000 sf - VAV Relocatable Classroom: Classroom/Lecture <ul style="list-style-type: none"> - 1920 sf - Rooftop DX 	
Retail	Large Retail: <ul style="list-style-type: none"> - 240,000 sf - Single Zone VAV Medium Retail: <ul style="list-style-type: none"> - 24,563 sf - Single Zone VAV, Single Zone VAV HP Mixed-Use Retail/Strip-Mall Retail: <ul style="list-style-type: none"> - 9,375 sf - Single Zone HP, Single Zone VAV HP 	Retail - 3-Story Large: Office, Retail Sales and Wholesale Showroom, Storage <ul style="list-style-type: none"> - 120,000 sf - CV Reheat - VAV Retail - Single-Story Large: Auto Repair Workshop, Kitchen and Food Preparation, Office, Retail Sales and Wholesale Showroom, Storage <ul style="list-style-type: none"> - 130,000 sf - Rooftop DX Retail - Small: Retail Sales and Wholesale Showroom, Storage <ul style="list-style-type: none"> - 8,000 sf - Rooftop DX Grocery: Loading Dock, Office, Refrigerated, Retail Sales Grocery <ul style="list-style-type: none"> - 50,000 sf - Rooftop DX 	Large/Medium Retail: Stores; Stores and Other Mercantile Bldgs Large Retail \geq 50k sf Medium Retail < 50k sf Strip Mall Retail: Shopping Centers
Warehouse	Warehouse: <ul style="list-style-type: none"> - 52,045 sf - Gas heater, Single Zone VAV 	Activity Area: Storage (conditioned/unconditioned) <ul style="list-style-type: none"> - 250,000 sf 	Warehouses (Non-Refrigerated); Refrigerated Warehouses Freight Terminals, Air; Freight

Building Category	CEC 2025	CPUC/DEER 2020	Dodge Building Types
		<ul style="list-style-type: none"> – Conditioned Storage: Rooftop DX – Unconditioned Storage: UH systems (only for freeze protection) Storage - Refrigerated Warehouse: <ul style="list-style-type: none"> – 100,000 sf - Rooftop DX 	Terminals, Marine; *Freight Terminals, Trucks; Freight Terminals, Truck Rail and Marine
Restaurant	Small Restaurant: <ul style="list-style-type: none"> – 2,501 sf – Single Zone VAV, Single Zone AC Large Restaurant: <ul style="list-style-type: none"> – 240,000 sf - Single Zone VAV HP 	Activity Areas Restaurant - Sit-Down: Dining Area, Kitchen and Food Preparation, Lobby, Restroom <ul style="list-style-type: none"> – 5,600 sf – Rooftop DX Restaurant - Fast-Food <ul style="list-style-type: none"> – 2,500 sf - Rooftop DX 	Food/Beverage Service
Manufacturing	None	Manufacturing - Bio/Tech: Comm/Ind Work, Computer Room, Conference Room, Corridor, Dining Area, Kitchen and Food Preparation, Office <ul style="list-style-type: none"> – 200,000 sf – Rooftop DX Manufacturing - Light Industrial: Comm/Ind Work, Computer Room, Storage <ul style="list-style-type: none"> – 100,000 sf - Rooftop DX 	88 STCs beginning with “Mfg”

APPENDIX C: BUILDING TYPE RANKING BY ENERGY CONSUMPTION AND FLOOR AREA

As part of the work performed for the CEC, building types within the building stock were ranked by both the floor area as well as the energy cost using the Time Dependent Valuation (TDV) metric. TDV is used to evaluate the cost-effectiveness of new energy code measures and represents the long-term marginal cost of energy. Table 9 shows the building categories and their respective floor area and TDV percentages compared to the statewide totals. The construction starts period used for this ranking was from 2013 through 2020, representing the newly constructed stock. The TDV EUIs (applied to the floor area) were developed using CBECC and prototype models from the 2022 code edition.

Table 9: Building category distribution by floor area and TDV (Dodge data range 2013-2020)

Statewide Floor Area		Statewide LCC impact			
Building Category	% Floor Area	Building Category	% Floor Area	2022 TDV EUI	% 2022 TDV
High-rise Apartment	54%	High-rise Apartment	54%	195.00	63%
Parking Garage	19%	Office	5%	278.40	8%
Warehouse	12%	Warehouse	12%	86.50	6%
Office	5%	Retail	2%	297.50	4%
Hotel	2%	Vehicle Service	1%	898.10	4%
School	2%	Parking Garage	19%	26.50	3%
Retail	2%	Hotel	2%	228.80	3%
No Category	1%	School	2%	210.20	3%
Manufacturing	1%	Restaurant	0%	1185.20	2%
Vehicle Service	1%	Assembly	1%	439.70	2%
Assembly	1%	Laboratory	0%	656.70	1%
Restaurant	0%	Manufacturing	1%	237.60	1%
Laboratory	0%	Hospital	0%	313.40	1%