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Multifamily Prototypes

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I. INTRODUCTION

The 2022 Title 24, Part 6 update will have a strong emphasis on multifamily buildings. To ensure accurate energy savings estimates and accurate Standard Design, TRC, on behalf of SCE, conducted analysis and development of new and revised prototypes. These prototypes better align with multifamily new construction trends, as demonstrated in this report.

TRC proposes four multifamily prototypes:

- ◆ **Low-Rise Garden Style:** a two-story, eight-unit building with dwelling unit entry from the building exterior
- ◆ **Loaded Corridor:** a three-story, 36-unit building with dwelling unit entry off of an interior corridor, common laundry, gym, and business center
- ◆ **Mid-Rise Mixed-Use:** a 96-unit building with one story of retail and common area spaces under four stories of residential space.
- ◆ **High-Rise Mixed-Use:** a 108-unit building with one story of retail and common area space under nine stories of residential space.

Note that the proposed prototypes are not a suggestion of delineation between low-rise and high-rise buildings types. The Statewide CASE Team aims to harmonize Title 24, Part 6 requirements for low-rise and high-rise multifamily buildings through requirements based on system or assembly type, rather than number of stories. System type and assembly selection are often based on fire safety and mechanical limitations associated with building height. The harmonization effort therefore indirectly aligns with the Benningfield Group suggestion to delineate by building height instead of number of stories, as stated in the December 2016 report, Multifamily: Energy Code Compliance Challenges.

Figure 1 summarizes the building characteristics of the four prototypes.

	Low-Rise Garden Style	Low-Rise Loaded Corridor	Mid-Rise Mixed-Use	High-Rise Mixed-Use
Stories	2	3	5 (1 commercial, 4 residential)	10 (1 commercial, 9 residential)
No. dwelling units	8 2 1-bedroom 2 2-bedroom	36 6 studio 12 1-bedroom 12 2-bedroom 6 3-bedroom	88 8 studios 40 1-bedroom 32 2-bedroom 8 3-bedroom	117 18 studios 54 1-bedroom 45 2-bedroom
Conditioned floor area	7,320	39,372	113,700	125,400
Foundation	Slab on grade	Slab on grade	Concrete podium with underground parking	Concrete podium with underground parking
Wall assembly	Wood frame	Wood frame	Wood frame over a first floor concrete podium	Steel frame
Roof assembly	Low slope attic roof	Flat roof	Flat roof	Flat roof
Window-to-wall ratio	15 percent	25 percent	25 percent	40 percent
Space heating and cooling	Individual ducted split heat pump	Individual ducted split heat pump	Individual ducted split heat pump	Four-pipe fan coil
Ventilation	Exhaust only	Exhaust only	Exhaust only	Central supply ventilation ducted to corridors and units
Domestic hot water	Individual gas instantaneous	Gas storage serving multiple units	Gas storage serving whole-building	Gas storage serving whole-building

Figure 1: Table summary of proposed prototype characteristics

The sections below summarize the data sources and analysis that informed the above-listed prototype characteristics.

2. DATA SOURCES

TRC used four data sources in identifying common multifamily new construction building characteristics:

- ◆ **CalCERTS HERS Registry.** Energy features for all permitted residential new construction projects under 2013 Title 24, Part 6.
- ◆ **California Multifamily New Homes (CMFNH) Program.** Energy features for projects participating in PG&E's above-code program. Projects in this data set are high performance buildings, exceeding Title 24, Part 6 by a minimum of 15 percent.
- ◆ **CoStar.** Real estate database of all multifamily properties with details related to property size (units, bedrooms, square footage) and amenities.
- ◆ **Project lists shared by consultants.** Targeted data collection, focused on heating and cooling systems, domestic hot water systems, and window-to-wall ratio; and to verify construction assembly and building sizes identified through other sources are reasonable.

TRC began with analysis of CalCERTS, CMFNH, and CoStar data. To exclude the possibility of duplicate project data, no two data sets were combined and were instead compared when similar data points existed across data sets. To crosscheck the results of this analysis and fill gaps in the available data, TRC solicited project data from Title 24 consultants working with large numbers of multifamily properties.

Figure 2 summarizes the size and parameters of each of the data sources used in the prototype analysis.

	CalCERTS HERS Registry	California Multifamily New Homes Program	CoStar	Project lists shared by consultants
Region	California statewide	PG&E service territory	California statewide	California statewide
Years built	2015-2017	2015-2017	2014-2018	2014-2018
Low-rise/high-rise	Low-rise	Low-rise and high-rise	Low-rise and high-rise	Low-rise and high-rise
No. properties	unknown	60	1,395	95
No. buildings	744	unknown	3,915	273
No. dwelling Units	10,768	3,832	164,504	10,064

Figure 2: Summary of data sources

3. ANALYSIS

Using the data sources listed above in section 2, TRC reviewed new construction trends related to building size, envelope characteristics, and mechanical systems to define each of the four prototypes, as described below.

3.1 Building Size

TRC looked at CoStar trends in number of units per floor by number of stories and the average size of dwelling units in order to determine appropriate prototype sizes. Figure 3 and Figure 4 illustrate the unit number and size trends.

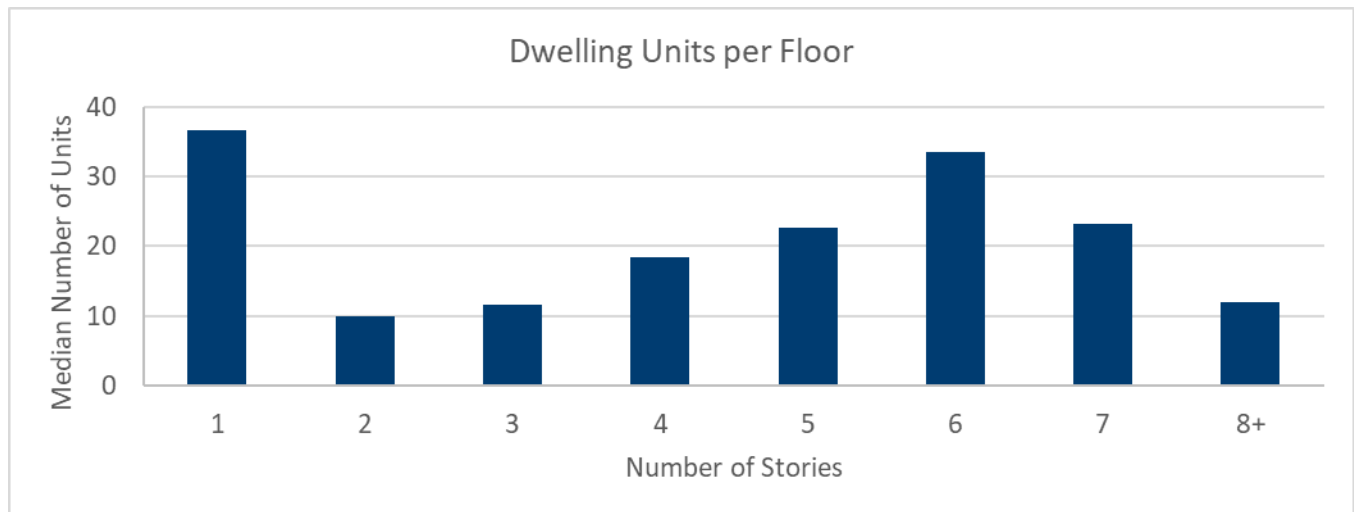


Figure 3: Number of dwelling units by number of floors (Source: CoStar)

Note that the definition of building differs between Title 24, Part 6 and CoStar. Buildings that share a roof (not attic) and are separated by a breezeway are considered separate buildings by Title 24, Part 6. This explains why the number of units per floor is significantly higher in Figure 3 for one- and two-story buildings than is reflected in the proposed garden style prototype.

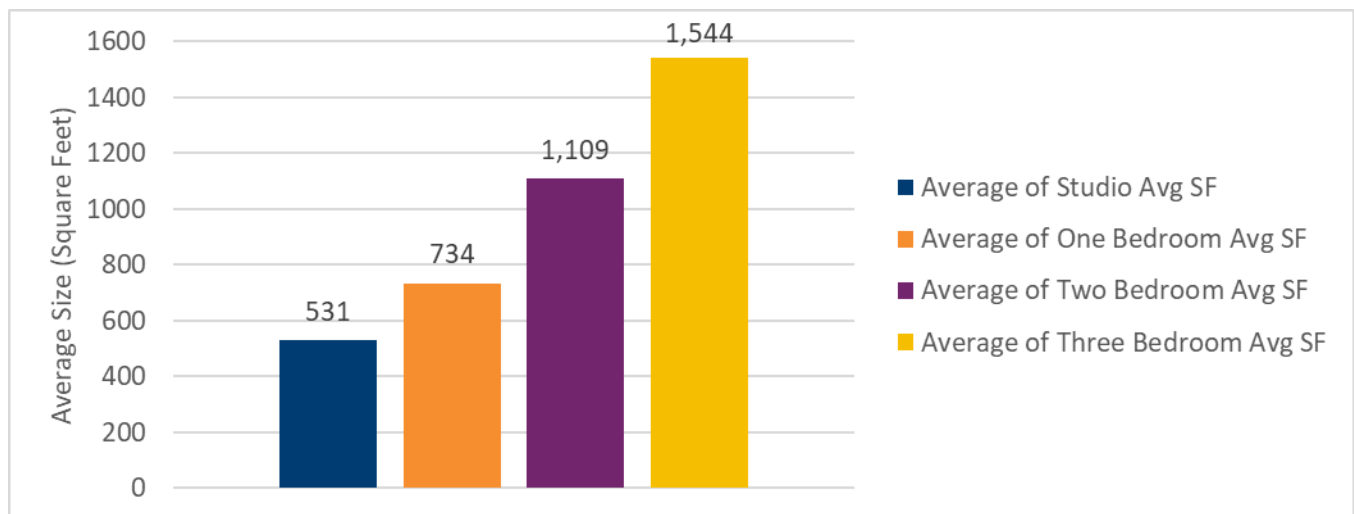


Figure 4: Average unit size by number of bedrooms (Source: CoStar)

TRC targeted the CoStar average dwelling unit square footage by number of bedrooms in the proposed prototypes, while also aiming for simple building geometry.

3.2 Common Areas

TRC used the amenities field in the CoStar data to determine which common areas are typical in each proposed prototype. Note that not all properties in CoStar have reported amenities. In garden style low-rise buildings, common areas are often included in separate buildings. The amenities for the loaded corridor, mid-rise mixed-use, and high-rise mixed-use are shown in Figure 5, Figure 6, and Figure 7 below. For each prototype, TRC included the most prevalent common area spaces, as identified in the CoStar data. Note that few of these spaces are present in the majority of multifamily buildings. Inclusion of a laundry room in the prototype does not suggest that use of shared laundry, rather than in-unit laundry, is prevalent. Many properties include both in-unit laundry hook-ups and common laundry machines.

TRC opted to include a leasing office, fitness center, laundry room, lounge/lobby, and business center on the ground floor of the loaded corridor prototype. TRC excluded on-site retail, limiting spaces to common areas that directly serve the residents. Multifamily low-rise properties are more likely to have separate buildings with nonresidential spaces, such as retail, rather than including it in a mixed-use building.

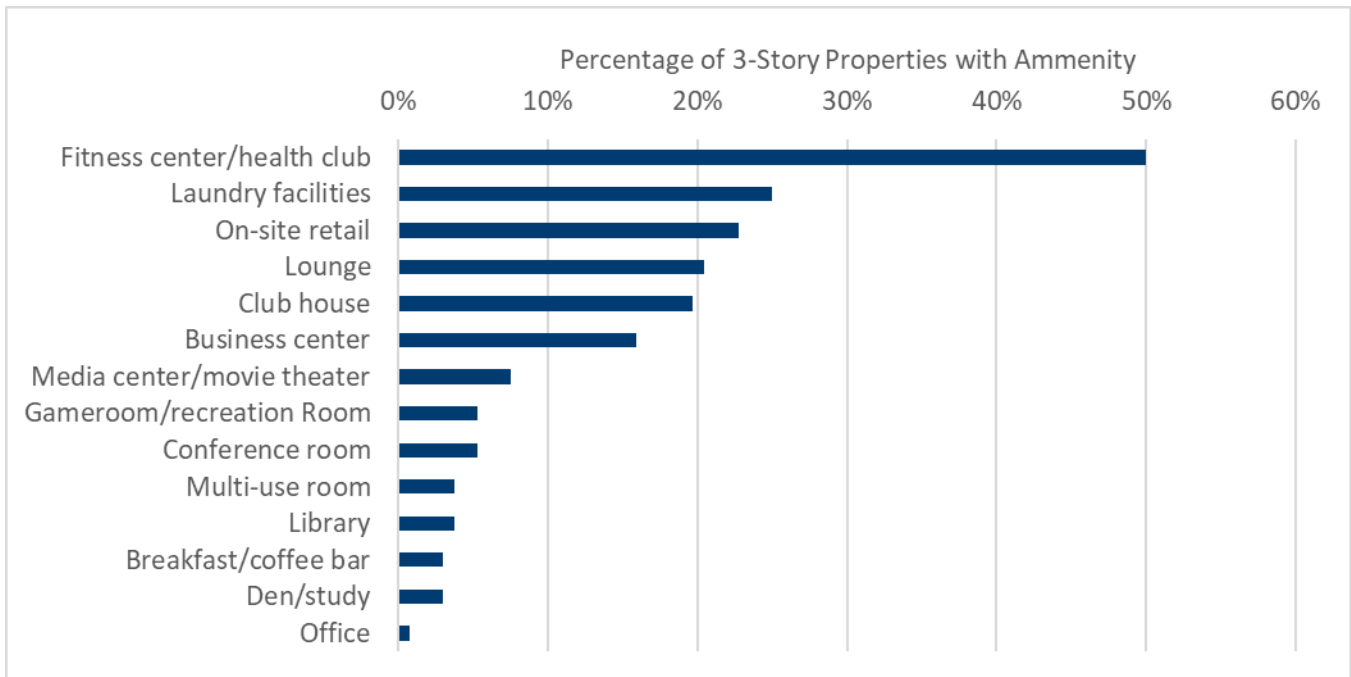


Figure 5: Three-story building amenities (CoStar)

The mixed-use mid-rise proposed prototype includes a fitness center, retail, lounge, business center, and laundry room.

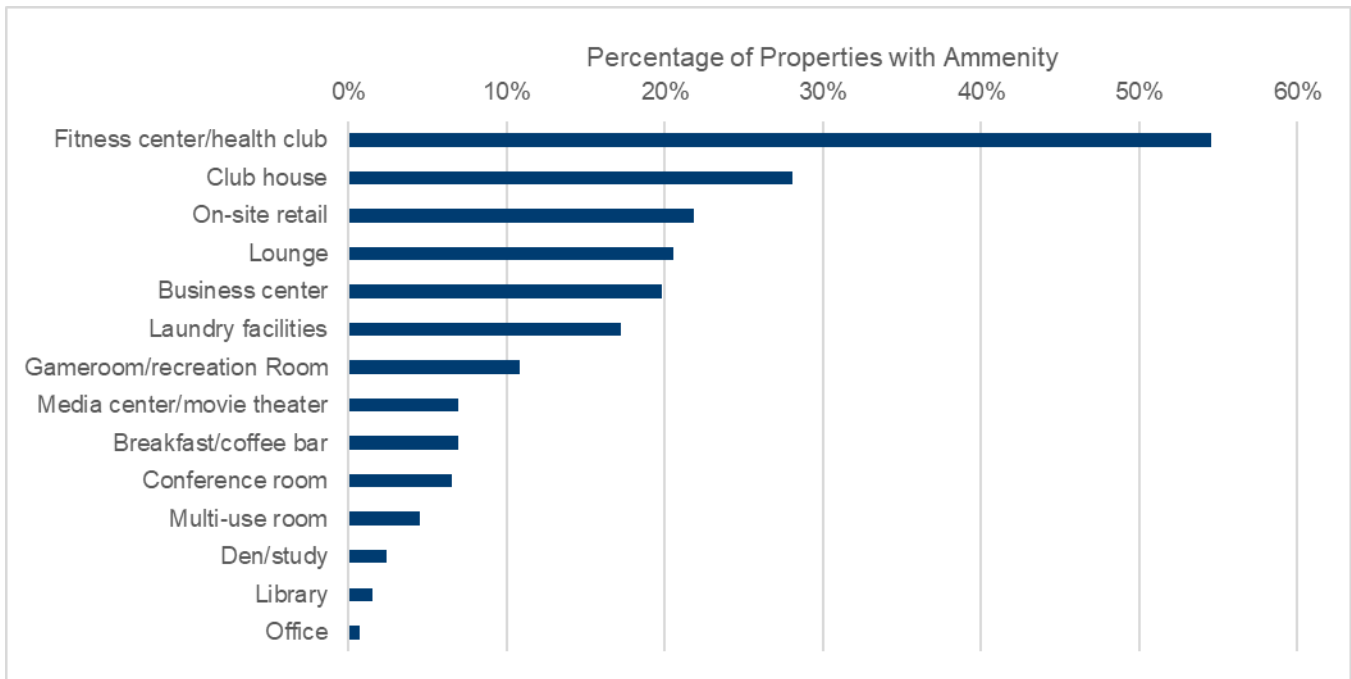


Figure 6: Mid-rise building amenities

The proposed high-rise prototype includes a leasing office, fitness center, retail, lounge, business center, and laundry room.

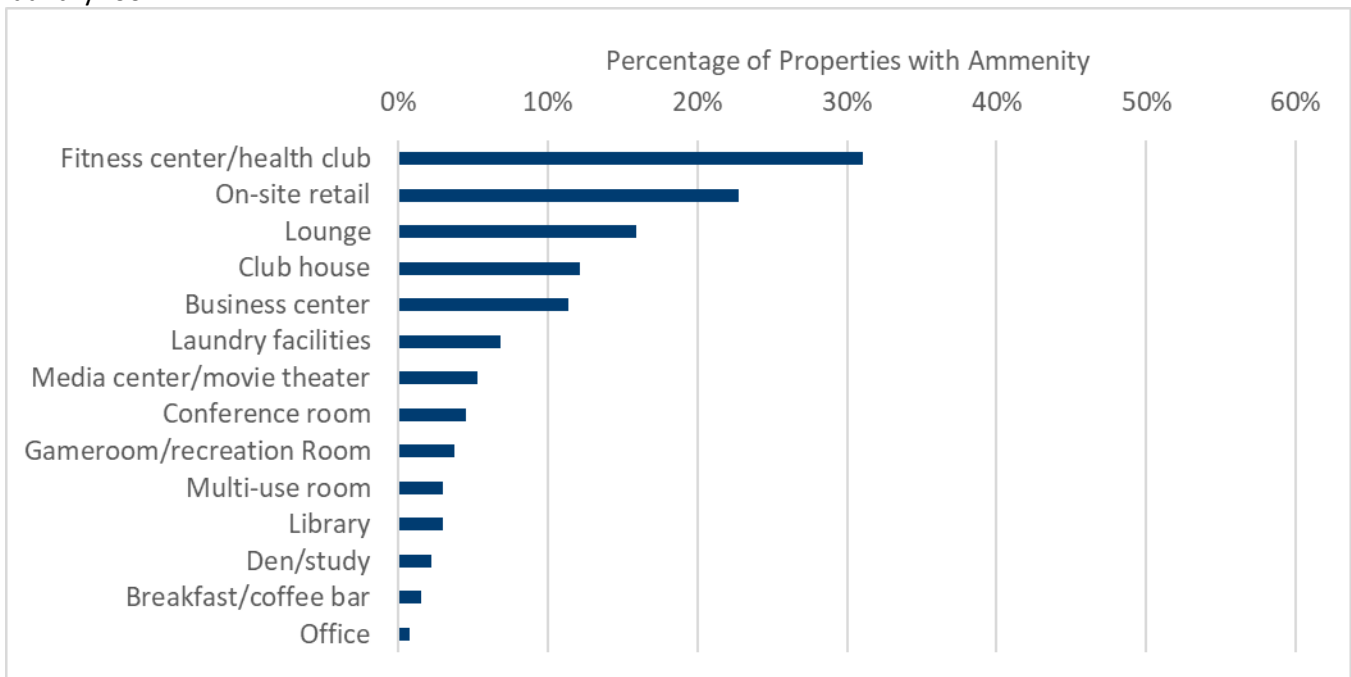


Figure 7: High-rise building amenities

3.3 Construction Assemblies

As shown in Figure 8, the CoStar data shows that wood frame construction is prevalent in one- through five-story multifamily buildings and present, but less prevalent, up to eight or more stories. The CoStar data shows greater prevalence of both reinforced concrete and steel frame construction in high-rise buildings of eight or

more stories.

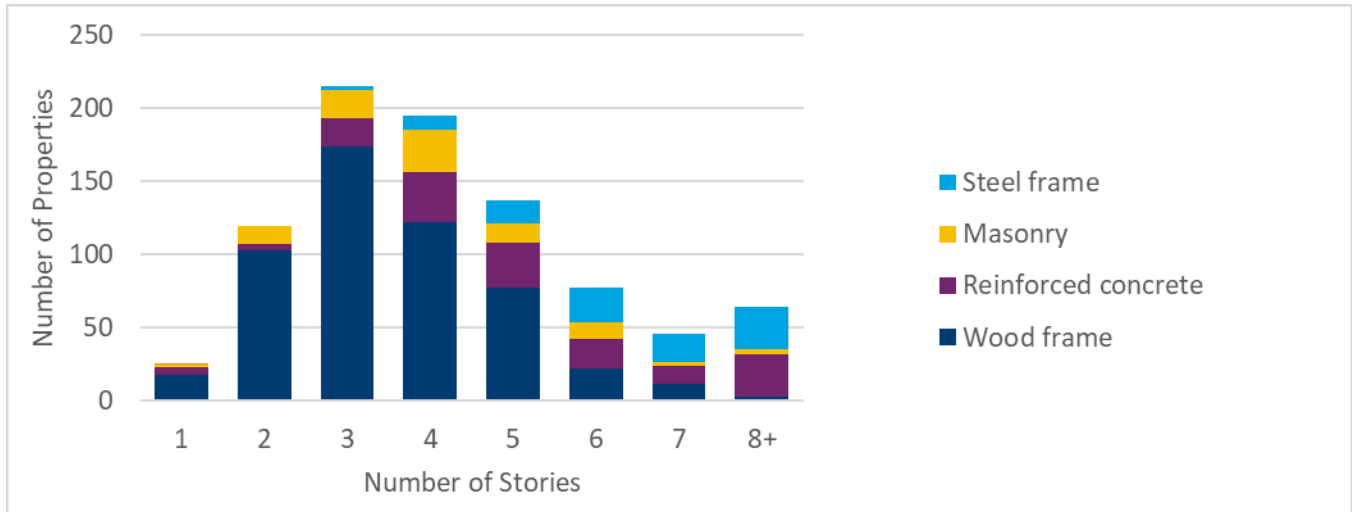


Figure 8: Wall assembly by number of stories (Source: CoStar)

TRC compared the CoStar data to the consultant project data as a crosscheck validation. Figure 9 summarizes the consultant project construction assemblies, which align very closely with the CoStar data through seven stories. TRC was able to collect an additional level of detail from the consultants to show that in many of the four- to seven-story buildings, wood frame construction exists over a first floor concrete podium. Similar to the CoStar results, the consultant high-rise project data showed distribution across multiple assemblies. Because neither data set showed a clear trend, and both showed a significant volume of steel frame construction, TRC proposes that the high-rise prototype maintain a steel framing assumption. For each prototype, TRC assumes the proposed wall assembly (wood frame, concrete, or steel frame) complies with current Title 24, Part 6 prescriptive u-factor requirements by way of Joint Appendix 4.

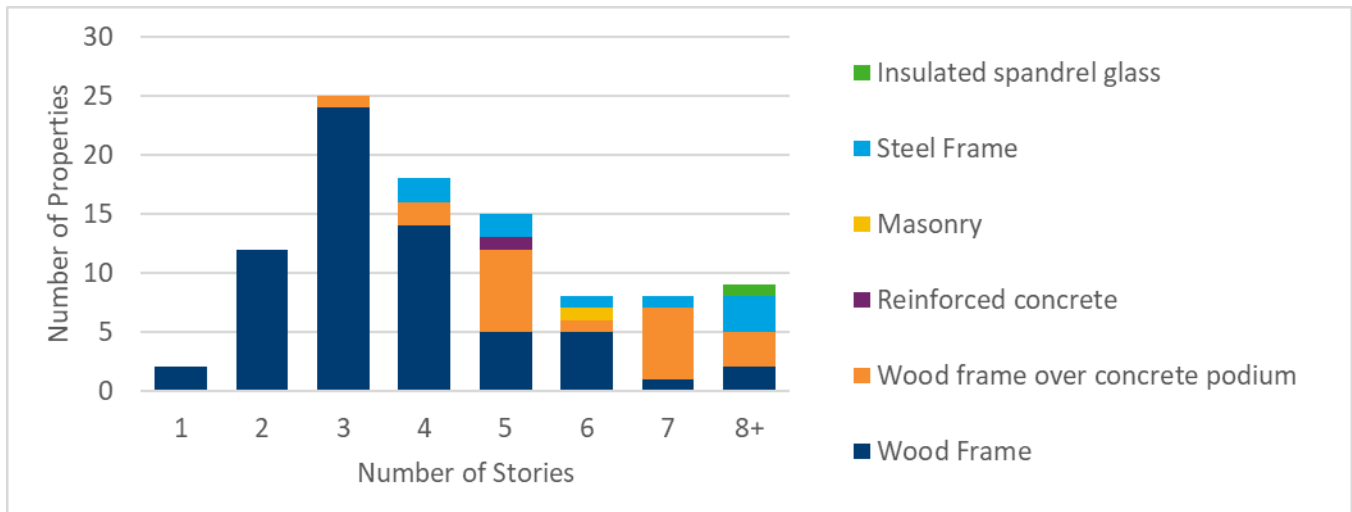


Figure 9: Wall assembly by number of stories (Source: consultant project lists)

3.4 Window Area

Under the 2019 Title 24, Part 6 requirements, low-rise (one- to three-story) multifamily buildings are measured against a window-to-floor ratio (WFR), while window-to-wall ratio (WWR) is used for high-rise multifamily buildings. TRC proposes use of a consistent metric across all multifamily building types. Because the nonresidential portions of the mixed use buildings will use window-to-wall ratio, using window-to-wall ratio for

all multifamily buildings will result in a single metric. The Energy Code Ace team has reported ease in calculating window-to-wall ratio as compared to window-to-floor ratio, and already includes verification of this metric in their building official trainings.

In reviewing consultant project data, TRC observed a wide range of WWR in all multifamily building types. In order to guide selection of an appropriate WWR for each prototype, TRC used eight percent WFR and calculated the correlating WWR. This ratio allows for the four percent openable window to floor ratio (assuming 50 percent of each window opens) suggested by California Building Code 1203.5.1.¹

Figure 10 summarizes the WWR needed to meet a four percent openable window area, the consultant project data range and average for WWR, and the proposed prototype WWR. The proposed WWR for each prototype follows whichever is greater, the WWR needed to meet four percent openable window area, or the consultant project average, rounded to the nearest five percent. This ratio is applied to each orientation in the prototype.

	Low-Rise Garden Style	Loaded Corridor	Mid-Rise Mixed Use	High-Rise Mixed Use
Total floor area	7,320	39,372	113,100	125,400
Window area needed to meet four percent window opening to floor ratio	586	3,150	9,048	10,032
Total exterior wall area	5,472	14,094	39,836	46,592
Window to Wall Ratio	11%	22%	23%	22%
WWR Range from consultant data	4 to 26%	4 to 20%	5 to 40%	24 to 66%
Average WWR from consultant data	15%	9%	20%	41%
Prototype WWR	15%	25%	25%	40%

Figure 10: Window-to-wall ratio (WWR) by prototype (Source: consultant project lists)

3.5 Roof Assembly Types

TRC determined roof assembly types through conversation with multifamily energy efficiency program staff and consultants with multifamily project experience. CMFNH staff and consultants unanimously agreed that a low-sloped roof attic assembly is common for garden style buildings and flat roofs, housing HVAC equipment, are most common in buildings three stories and taller.

3.6 Parking

In order to facilitate future conversation about available roof space for solar photovoltaic (PV) systems, TRC also looked at the location of parking. Figure 11 summarizes parking location by number of stories from the

¹ **1203.5.1 Ventilation area required:** The openable area of the openings to the outdoors shall be not less than 4 percent of the floor area being ventilated.

consultant project list data. Two- and three-story properties show some opportunity for solar PV on adjacent covered parking. Underground parking is prevalent in buildings five stories high and taller and is therefore included in the proposed mid-rise and high-rise prototypes.

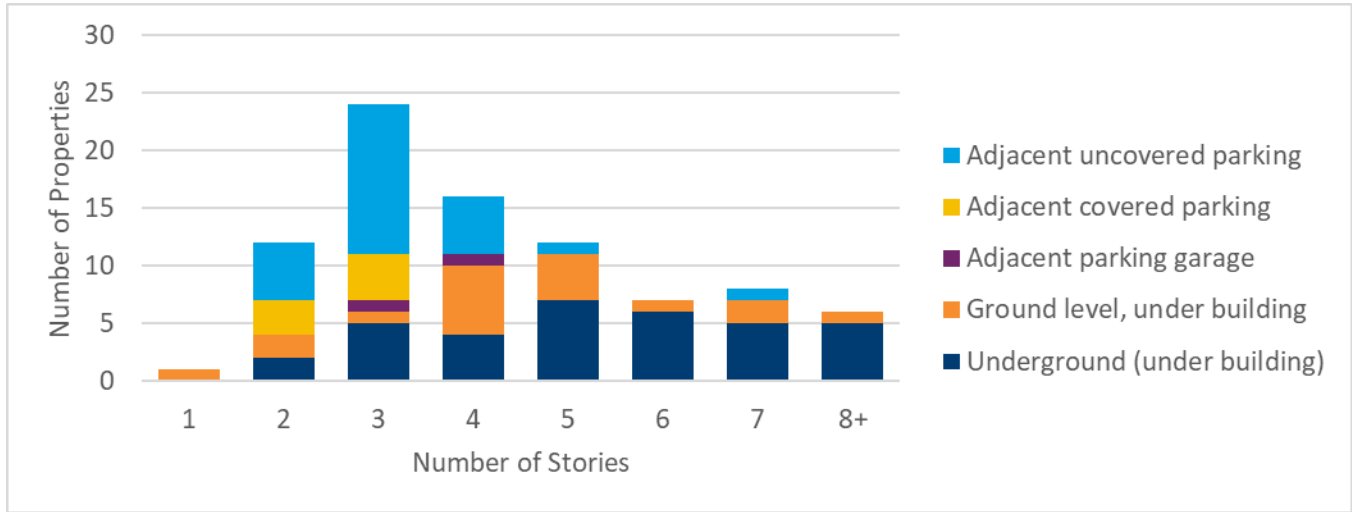


Figure 11: Location of parking by number of stories (Source: consultant project lists)

3.7 Heating, Ventilation, and Cooling

The CMFNH data for space heating systems, as illustrated in Figure 12, shows a wide variety of system types, making identification of prototype systems difficult. TRC was also concerned that the CMFNH data set represented only high performance buildings, rather than typical construction. TRC therefore reviewed consultant project data, shown in Figure 13, to determine appropriate HVAC system type for each prototype.

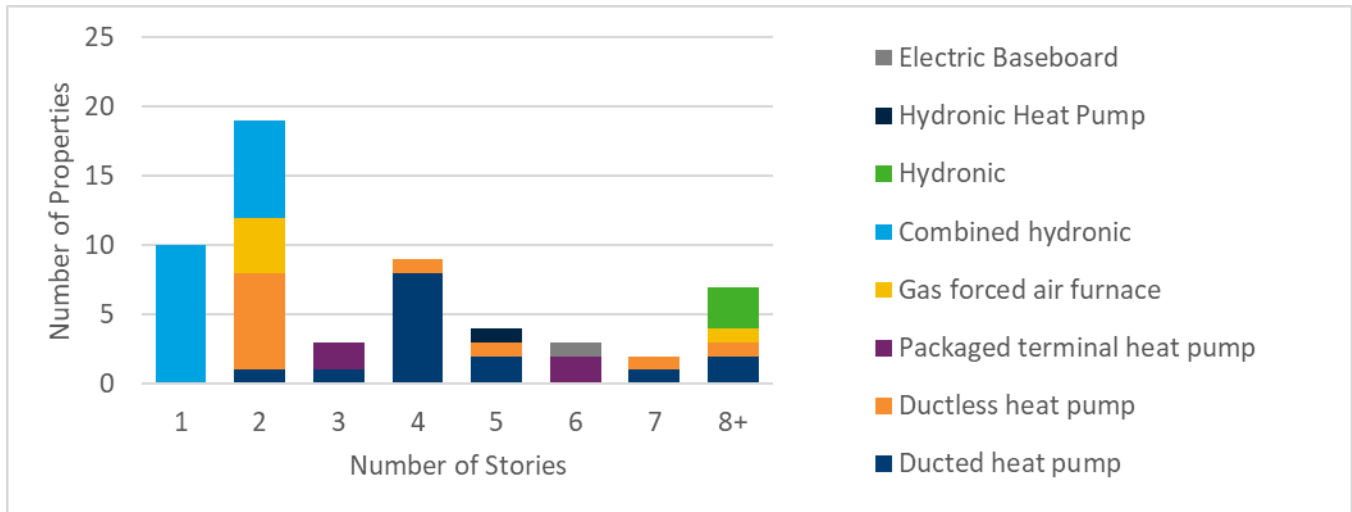


Figure 12: Dwelling HVAC system type by number of stories (Source: CMFNH)

Figure 13 shows a clear trend toward ducted split heat pump systems serving individual dwelling units across all building heights. Within the category of eight stories and higher, the ducted heat pumps are limited to eight- and nine-story buildings. In taller high-rise buildings, split heat pumps systems are not feasible due to refrigerant line limitations. Therefore, heat pump systems are not an appropriate selection for this prototype. Because the CMFNH and consultant list high-rise properties did not present a clear majority system type, TRC recommends

that no change be made to the high-rise HVAC system baseline and to continue with the four pipe fan coil assumption.

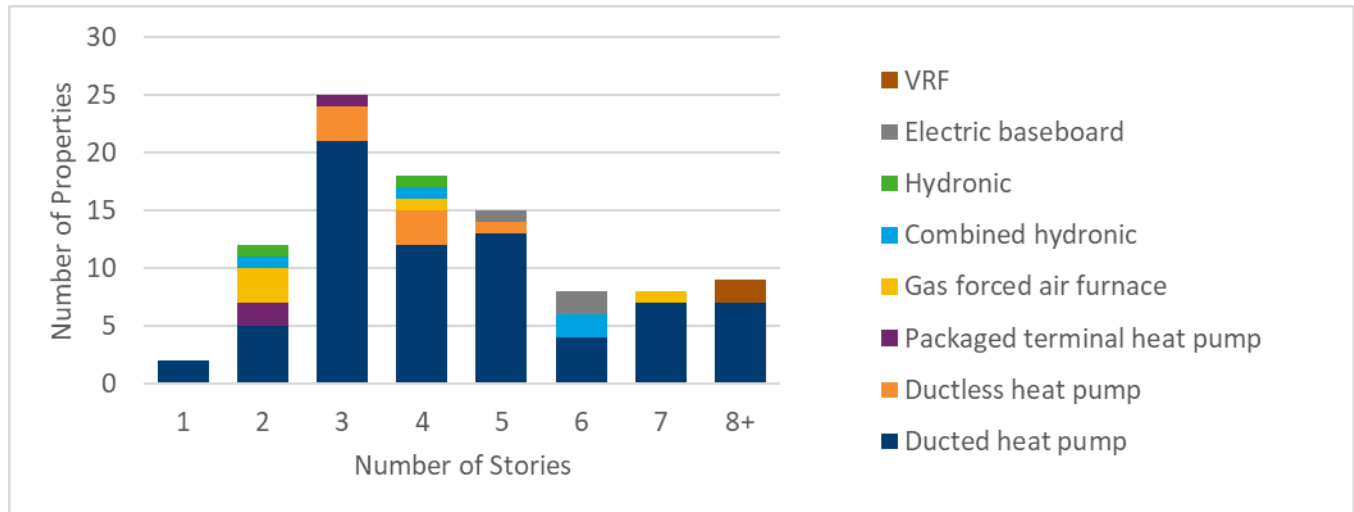


Figure 13: Dwelling HVAC system type by number of stories (Source: consultant project lists)

Through the consultant project lists data, TRC was also able to look at HVAC systems serving common areas and commercial spaces. Figure 14 shows that ducted heat pump systems are prevalent for the common area spaces of the building as well. The results for the nonresidential spaces were similar. In very few cases were HVAC systems shared across dwelling unit, common area, and nonresidential spaces. TRC proposes that residential and nonresidential spaces be served by separate HVAC systems.

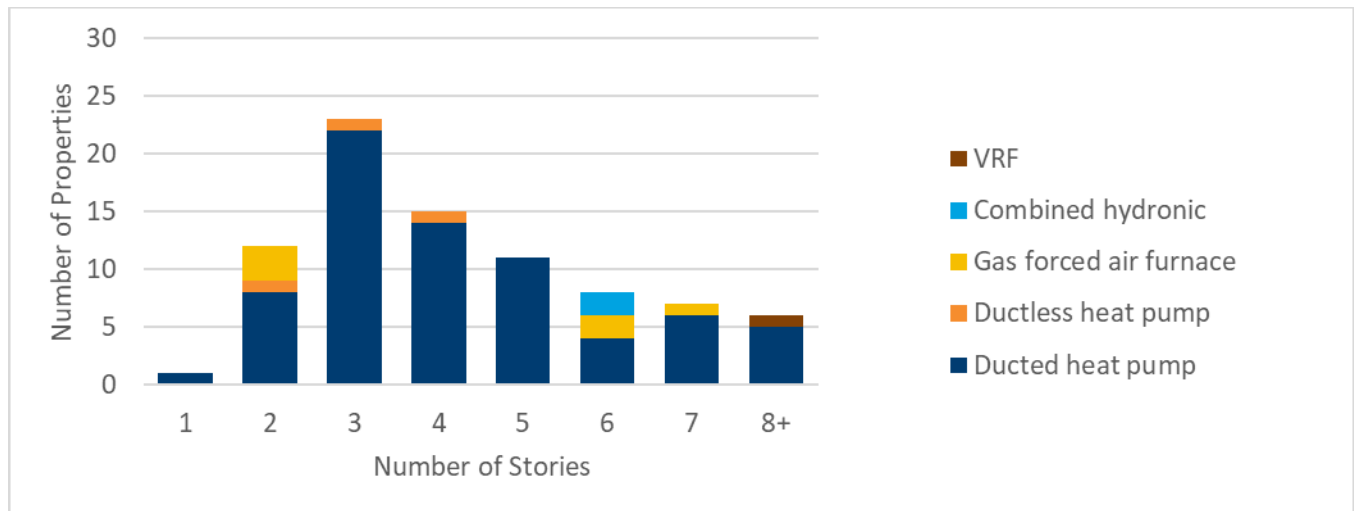


Figure 14: Common area HVAC system type by number of stories (Source: consultant project lists)

2019 Title 24, Part 6 requires either unit compartmentalization or balanced ventilation. Due to the high cost of balanced ventilation, developers are likely to choose exhaust-only ventilation and compartmentalization in low- and mid-rise buildings. In TRC’s investigation of ventilation strategies for the 2022 multifamily infiltration and ventilation CASE topic and multifamily energy efficiency program implementation we seen a trend towards exhaust-only ventilation. Central ventilation systems are more common in high-rise buildings. TRC proposes balanced ventilation in the high-rise prototype through a central ventilation supply duct to hallways and dwelling units with local exhaust to a central shaft.

3.8 Domestic Hot Water

CMFNH data, as shown in Figure 15, suggests that individual gas instantaneous water heating is prevalent in one- and two-story buildings. The small sample size for three-story buildings was inconclusive. Though there is a variety of systems in the mid-rise range of four to seven stories, the most common type is central gas storage systems. High-rise project data showed prevalence of central gas instantaneous. TRC suspects that this is a trend in high performance buildings, but not mainstream.

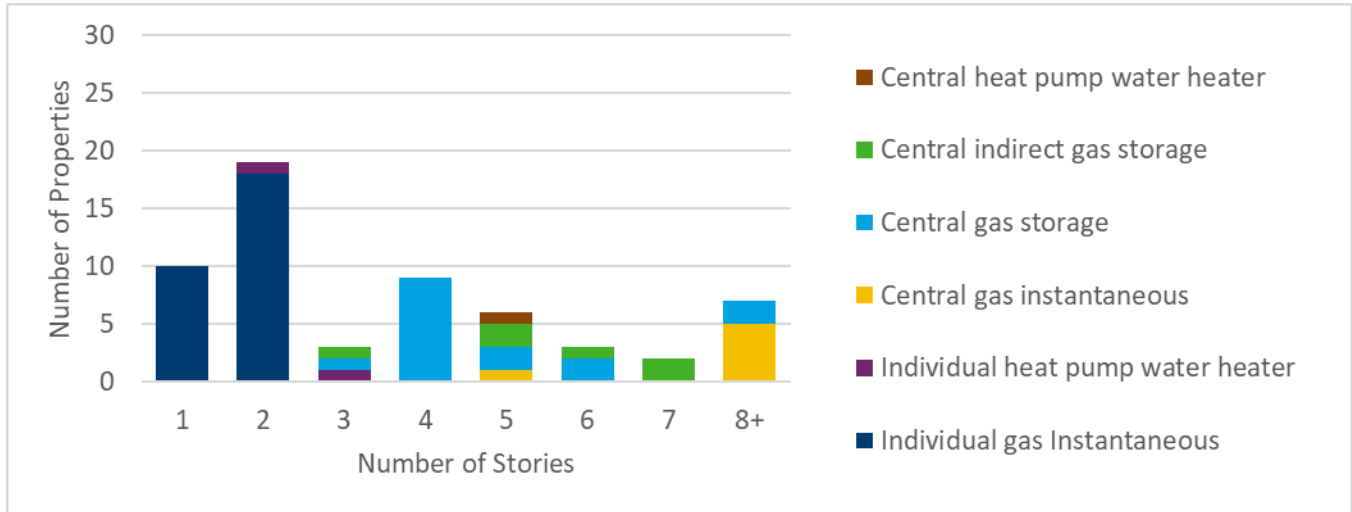


Figure 15: DHW system type by number of stories (Source: CMFNH)

TRC checked these results against the consultant project list data, illustrated in Figure 16, and collected additional detail to better understand whether central systems were serving whole buildings or distributed throughout the building and serving smaller groups of units. TRC confirmed that individual instantaneous gas water heating is a reasonable assumption in garden style (one- and two-story buildings). The data set for three-story buildings in the consultant project lists includes a larger sample of projects than the CMFNH and shows central gas storage water heater serving multiple units is predominant. Buildings four stories and higher have a high occurrence of whole-building gas storage water heating systems.

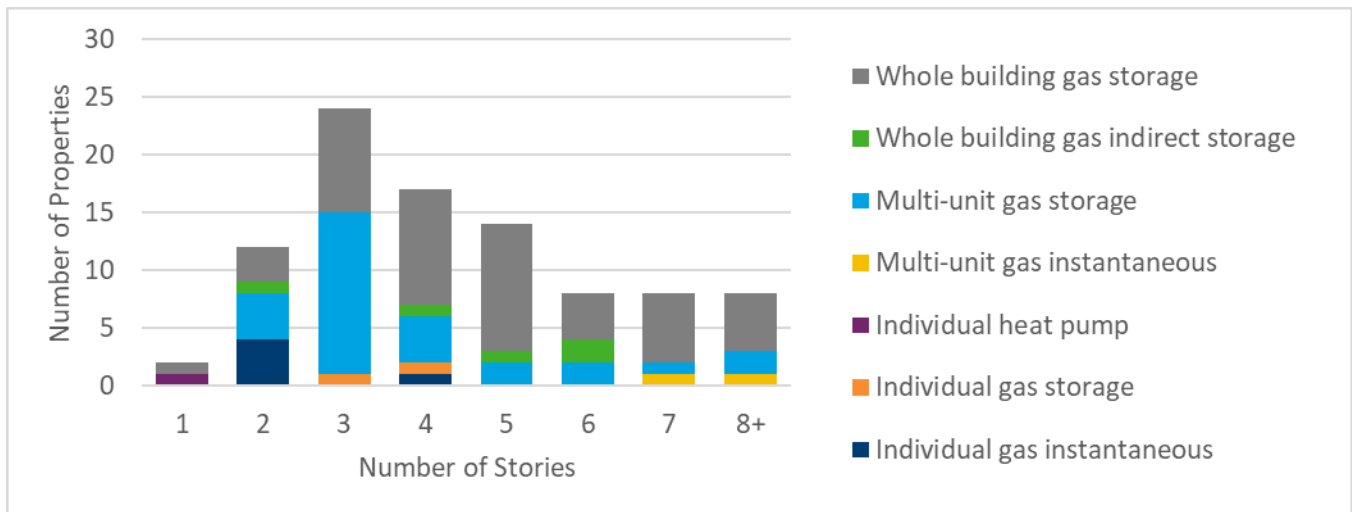


Figure 16: DHW system type by number of stories (Source: consultant project lists)

Based on the trends identified above, TRC proposes individual gas instantaneous systems for the garden style prototype, a central gas storage system serving multiple units in the loaded corridor prototype, and a central gas storage system serving the whole building in the mid-rise and high-rise mixed use prototypes. Due to CBECC modeling limitations, common area and nonresidential spaces will be served through separate central storage gas systems.

4. STATEWIDE WEIGHTS

TRC calculated statewide weights based on the number of buildings built for each number of floors, per CoStar data. These values were multiplied by the proposed prototype square footage to determine weighting based on square footage. Figure 17 illustrates the breakdown of multifamily new construction by number of stories.

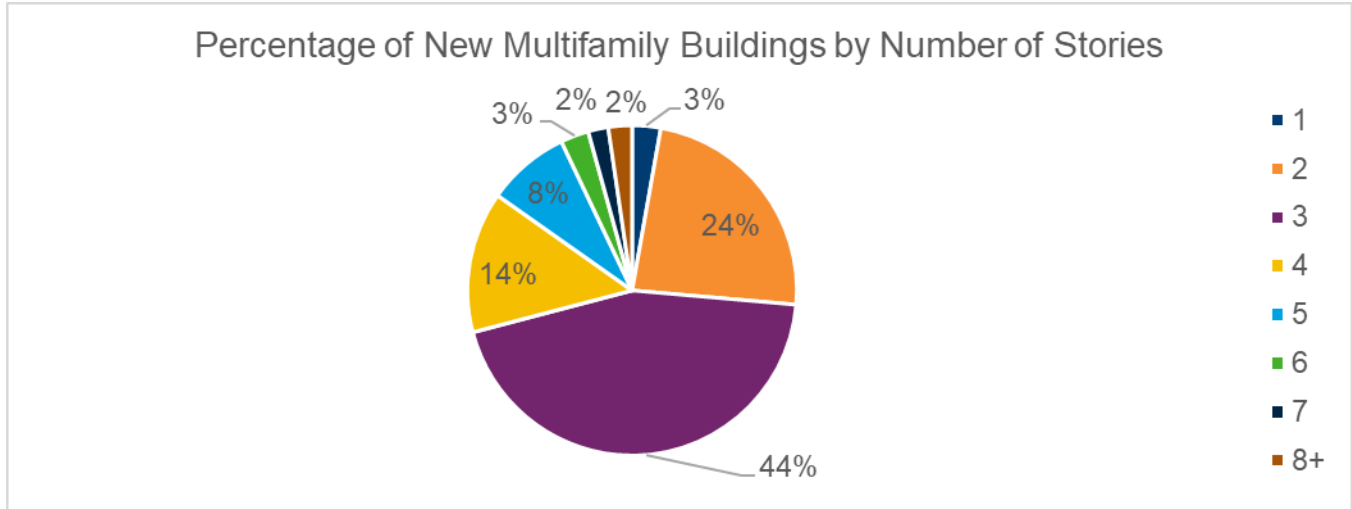


Figure 17: Multifamily new construction by number of stories (Source: CoStar)

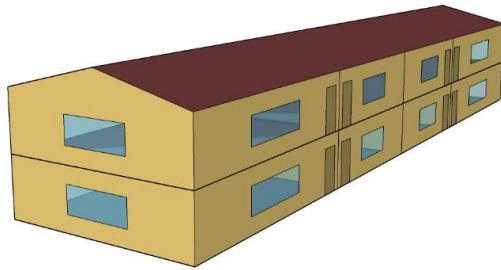
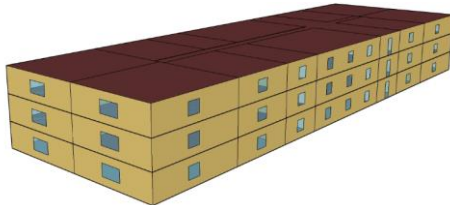
Figure 18 summarizes the weights by number of buildings and by square footage. The Statewide CASE Team will use these weights in calculating statewide energy savings and determining cost-effectiveness for 2022 Title 24, part 6 updates.

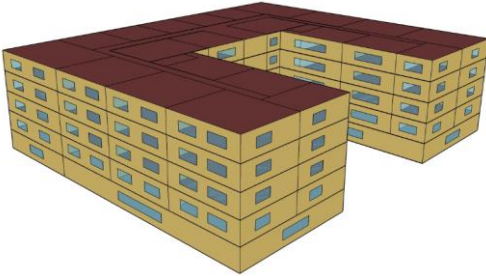
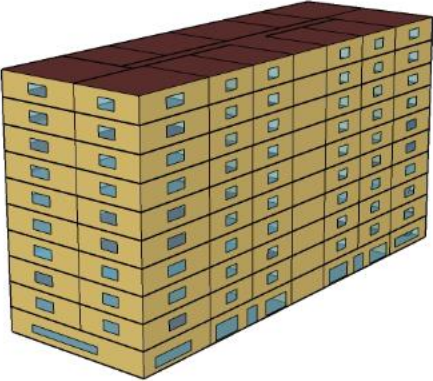
	Low-Rise Garden Style	Loaded Corridor	Mid-Rise Mixed-Use	High-Rise Mixed-Use
Weight by square footage	4%	33%	58%	5%

Figure 18: Table summary of statewide weight

5. APPENDIX A: ACM APPENDIX LANGUAGE

The geometry and zoning of the multifamily prototypes are intended to represent typical building square footage, number of bedrooms, glazing, and mechanical systems. These prototypes are based on California-specific multifamily market assessments conducted in 2018 and 2019.

Prototype	Low-Rise Garden (Revised)
Description	2 story residential building with 8 units, sloped roof, slab on-grade foundation and wood framed wall construction. Window to Wall Ratio 0.15
Total Floor Area (sq. feet)	7,320 ft ²
Building shape	
Space Types	Residential
HVAC System Type	Ducted heat pump – one per dwelling unit
Prototype Description	Loaded Corridor
Description	3 story residential building with 36 units, flat roof, slab on-grade foundation and wood framed wall construction. Window to Wall Ratio 0.25
Total Floor Area (sq. feet)	39,372 ft ²
Building shape	
Space Types	Residential, corridor, leasing office, fitness center, business center, laundry room
HVAC System Type	Ducted heat pump – one per dwelling unit/nonresidential zone

Prototype Description		Mid-Rise Mixed-Use
Description	5 story - 4 story residential + 1 story commercial, 88 units, flat roof, underground parking garage, concrete podium construction and wood framed wall construction. Window to Wall Ratio-0.10 (ground floor) 0.25 (residential floors)	
Total Floor Area (sq. feet)	113,100 ft ²	
Building shape		
Space Types	Residential, lobby, leasing office, fitness center, business center, laundry room, retail, parking garage, and corridors	
HVAC System Type	Ducted heat pump – one per dwelling unit/nonresidential zone	
Prototype Description		High-Rise Mixed-Use
Description	10 story - 9 story residential + 1 story commercial, 117 units, flat roof, underground parking garage, concrete podium construction and steel framed wall construction. Window to Wall Ratio-0.10 (ground floor) 0.40 (residential floors)	
Total Floor Area (sq. feet)	125,400 ft ²	
Building shape		
Space Types	Residential, lobby, leasing office, fitness center, business center, laundry room, retail, parking garage, and corridors	
HVAC System Type	Four-pipe fan coil	

6. APPENDIX B: BUILDING FLOOR PLANS

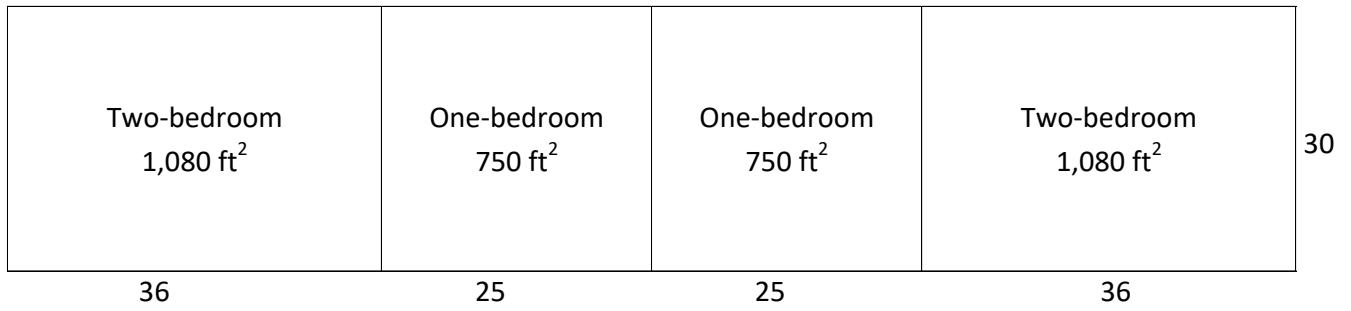


Figure 19: Low-rise garden first and second floor plan

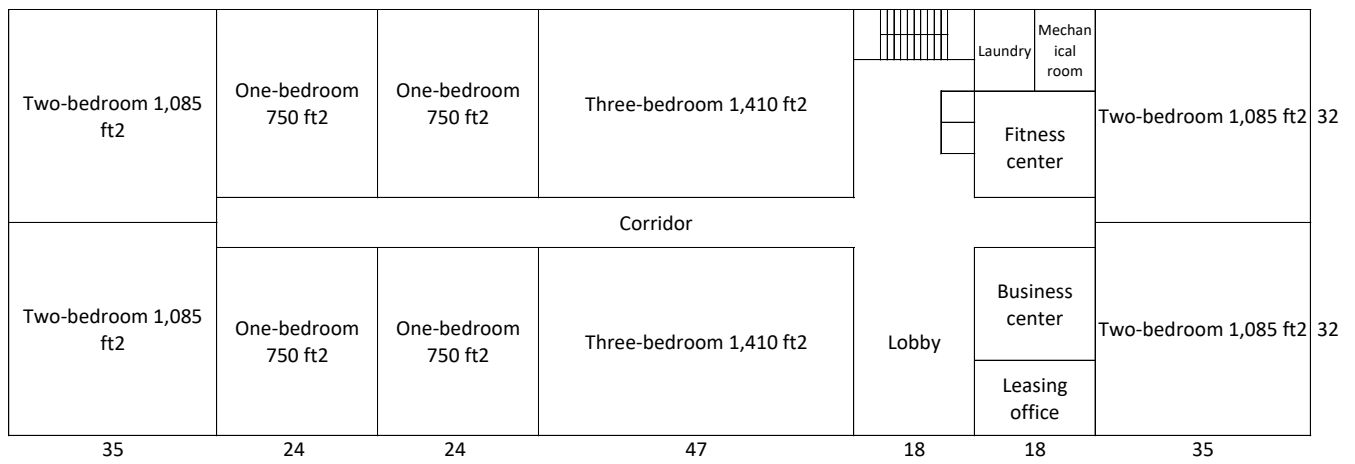


Figure 20: Loaded corridor ground floor plan

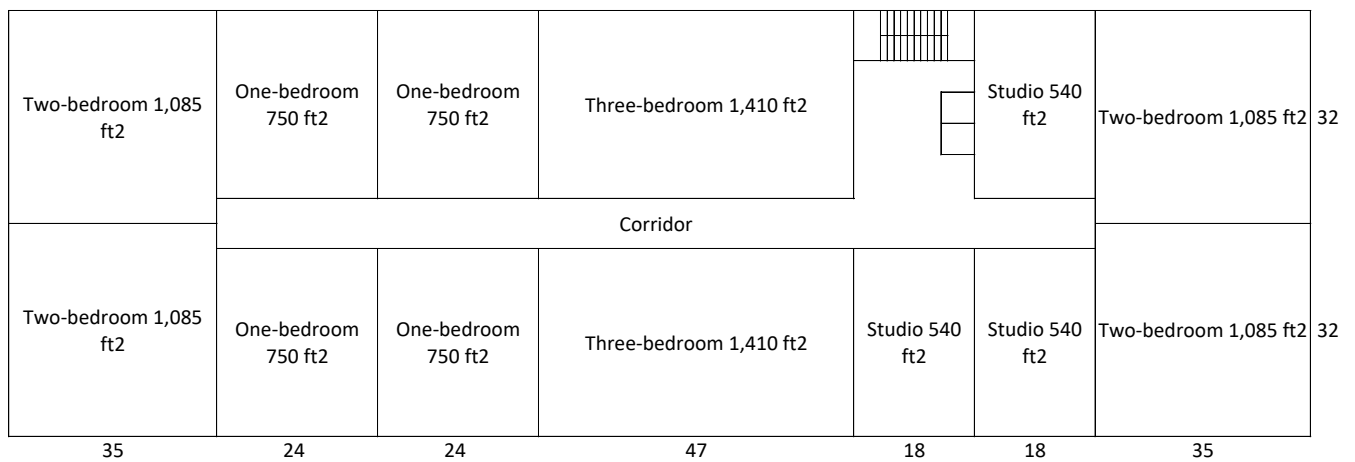


Figure 21: Loaded corridor second and third floor plan

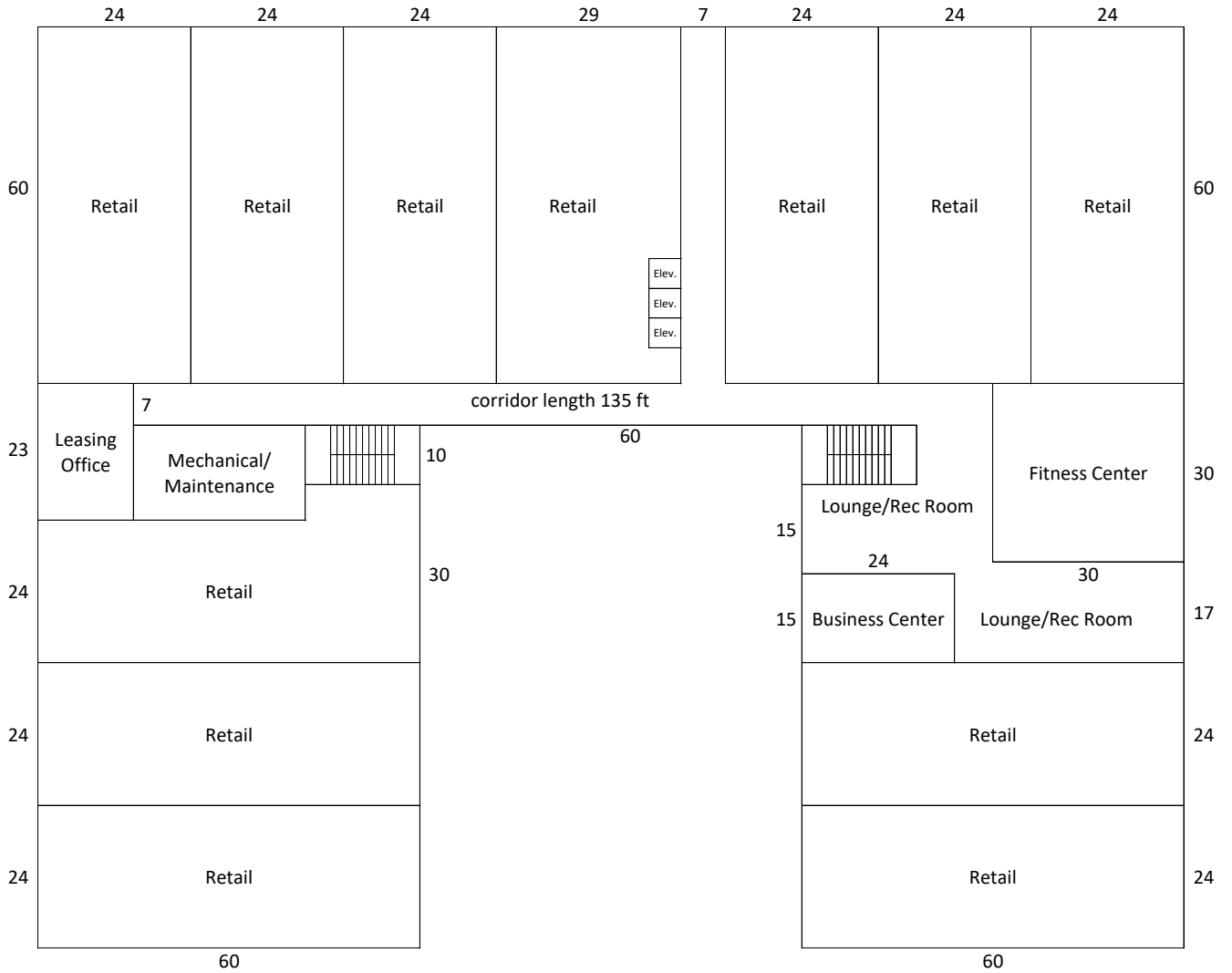


Figure 22: Mid-rise mixed-use ground floor plan

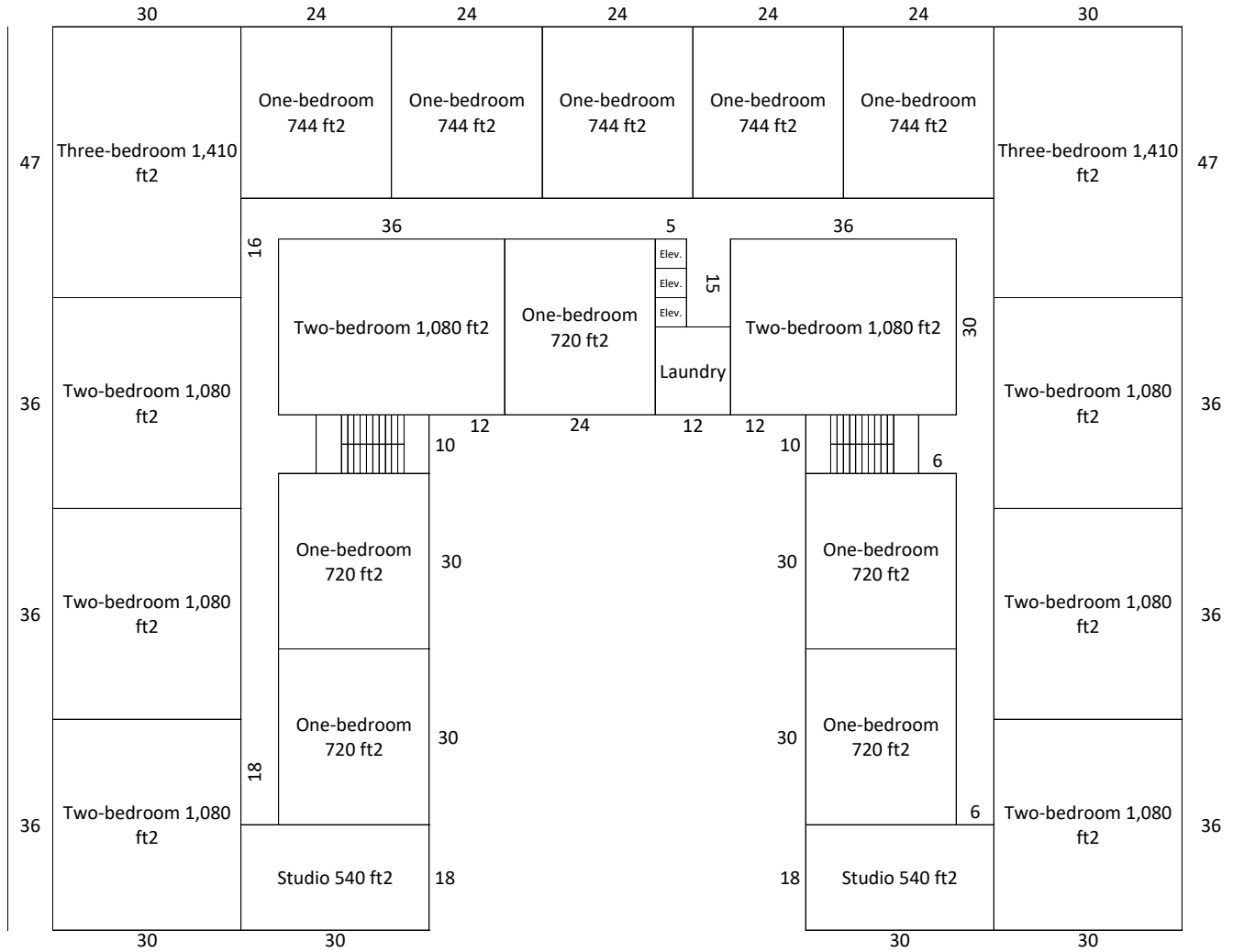


Figure 23: Mid-rise mixed-use second through fifth floor plan

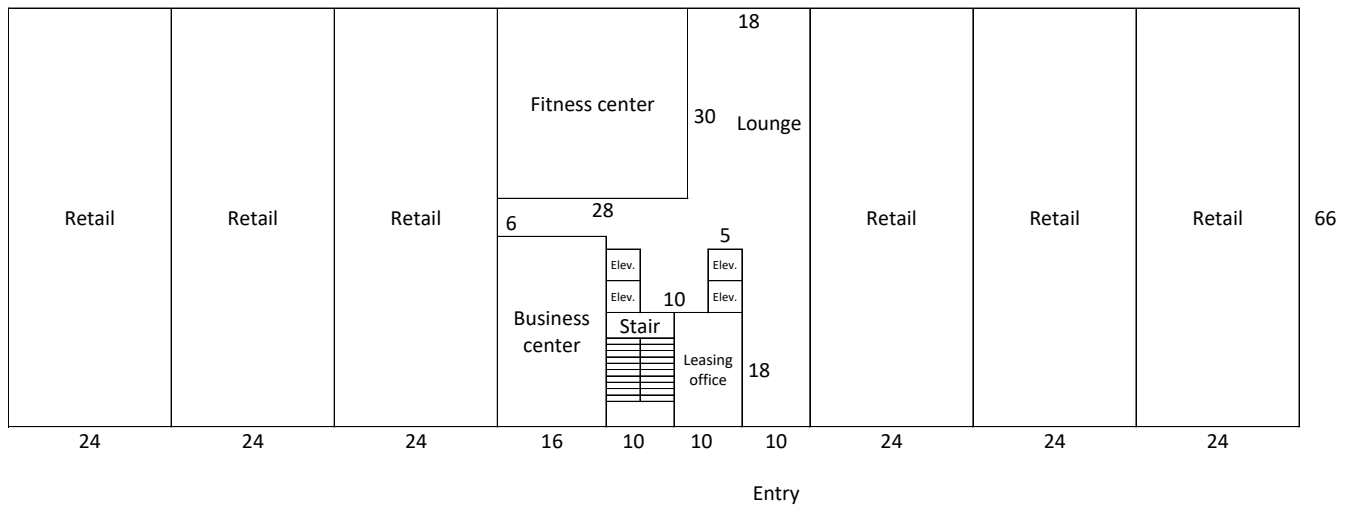


Figure 24: High-rise mixed-use ground floor plan

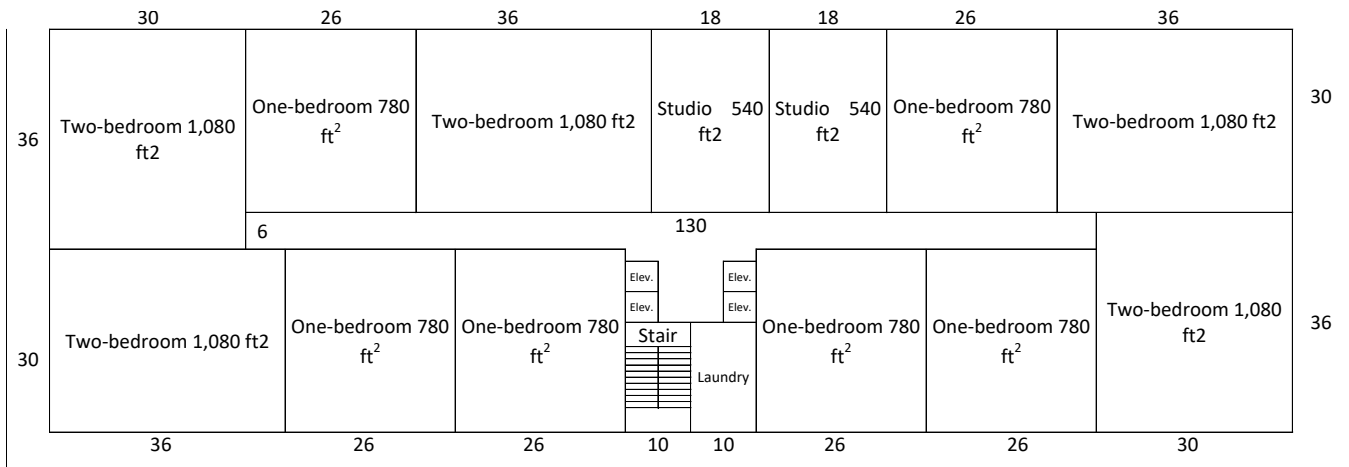


Figure 25: High-rise mixed-use second through tenth floor plan