California Air Resources Board

Building Retrofit Analysis Methods

October 21, 2026

Clean Space and Water Heaters Technical Assessment



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Abbreviations

AAR	Assumed adoption rate
AC	Air conditioning
Amps	Amperes
APCD	Air pollution control district
ASHP	Air source heat pump
AQMD	Air quality management district
AWHP	Air-to-water heat pump
Btu	British thermal unit
CARB	California Air Resources Board
CBECS	Commercial Building Energy Consumption Survey
CEC	California Energy Commission
CEUS	Commercial End Use Survey
DOE	Department of Energy
ER	Electric resistance
FSSAT	Fuel Substitution Scenario Analysis Tool
GHG	Greenhouse gas
HP	Heat pump
HPWH	Heat pump water heater
HVAC	Heating, ventilation, and air conditioning
kW	Kilowatts
MF	Multi-family
MF 2-4	Multi-family with 2-4 Units
MF 5+	Multi-family with 5 or more Units
MM	Million metric
MMH	Mobile and manufactured homes
NA	Not applicable

NEC	National Electrical Code
NOx	Nitrogen oxides
NLR	National Lab of the Rockies
PTHP	Packaged terminal heat pump
RASS	Residential Appliance Saturation Survey
RTU	Rooftop unit
SFA	Single-family attached
SFD	Single-family detached
TECH	TECH Clean California
UCLA	University of California, Los Angeles
VRF	Variable refrigerant flow system
W	Watts

1 Introduction

1.1 Context

Clean Space and Water Heater Standards have the potential to reduce approximately 39 million metric tons (MMT) of carbon dioxide equivalent (CO2e), 20,000 tons of smog-forming nitrogen oxides (NOx) emissions, and 2,700 tons of fine particulate matter smaller than 2.5 microns in diameter (PM2.5) between 2030-2045, which would result in significant public health benefits. Because of these potential benefits, California Air Resources Board (CARB) committed to explore developing and proposing GHG emission standards for new space and water heaters sold in California as part of the *2022 State Strategy for the State Implementation Plan* (CARB, 2022a). GHG emissions standards for new space and water heaters sold in California are also part of California's climate strategy as laid out in the *2022 Scoping Plan* (CARB, 2022b). The regulatory concept in this report is based on the emissive limits presented at the December 2025 public workshop.

To inform the development of the regulatory concept, CARB staff assessed whether existing residential and commercial buildings would require retrofits when replacing GHG-emissive space and water heaters with zero-emission ones. Residential buildings constructed after 2023 were assumed not to need retrofits due to the Energy Code electric-ready requirements. The analysis characterized California's existing building stock, estimated retrofit needs, and categorized the retrofits as basic, moderate, or extensive. Staff assumed no retrofits would be needed for like-for-like replacements, whether emissive or zero-emission. Although some building owners may choose equipment requiring additional upgrades, staff did not attribute these choices to the regulatory concept and instead assumed owners would select the least complex retrofit pathway for the assumed replacement equipment.

This building retrofit and feasibility analysis is not intended to analyze the existing condition of any single building in California. Rather, this analysis uses data representative of the residential and commercial building stock to estimate the average conditions of buildings and the general need for retrofits to accommodate zero-emission space and water heaters.

CARB staff's analysis for building retrofits and feasibility seeks to answer the following questions:

- What portion of buildings already have zero-emission equipment for space and water heating?
- What portion of buildings in California may need physical space and/or electric retrofits to accommodate installation of zero-emission space and water heating?
- What range of retrofits may be needed to accommodate installation of zero-emission space and water heating?

CARB staff developed this analysis through consultation with public experts[1] and coordination with partner agencies, including but not limited to the California Energy Commission, California Public Utilities Commission, Bay Area Air District, and South Coast Air Quality Management District.

1.2 Scope

1.2.1 Building Types

Both residential and commercial building types were included in the analysis. Industrial buildings are outside of the scope of this work. The residential analysis considers the following five building types: single-family detached (SFD), single-family attached (SFA), multi-family with 2-4 units (MF 2-4), multi-family with 5+ units (MF 5+), and mobile and manufactured homes (MMH). The commercial building analysis considers the following twelve building types:

1. **Small office:** Buildings less than 30,000 square feet used for professional offices.
2. **Large office:** Buildings 30,000 square feet and larger used for professional offices.
3. **Restaurant:** Buildings used for selling prepared food and beverages, including sit-down restaurants, fast food restaurants, and bars.
4. **Retail:** Buildings used for the sale and display of goods other than food, including big box stores, enclosed malls, strip malls, showrooms, and small retailers like post offices.
5. **Food:** Buildings used for the retail or wholesale of food, such as grocery stores, markets, or convenience stores.
6. **Warehouse:** Unrefrigerated buildings used to store goods or raw materials.
7. **Refrigerated warehouse:** Refrigerated buildings used to store goods or raw materials.
8. **School:** Buildings for academic instruction, including primary and secondary schools.
9. **University:** Buildings for or in support of academic instruction on college or university campuses.
10. **Health:** Buildings used as diagnostic and treatment facilities for inpatient and outpatient care, including hospitals, rehabilitation centers, and medical clinics.
11. **Hotel:** Buildings offering accommodation for temporary lodging.
12. **Miscellaneous:** Buildings not covered in the above categories, such as buildings for public assembly, public order and safety, religious worship, service buildings (other

[1] CARB opened a solicitation for individuals and organizations ("Public Experts") possessing expertise in high-priority topic areas, including those with hands-on technical expertise in building decarbonization and building retrofits to help inform the staff analysis. For more information, please visit *https://ww2.arb.ca.gov/our-work/programs/building-decarbonization/clean-space-and-water-heater-standards/public*.

than food service, retail, or office), and storage (other than warehouse or refrigerated warehouse).

Both the residential and commercial building types align with the California Energy Commission's (CEC's) California Energy Demand Forecast (Marshall, 2026) which informs recommendations on state energy policy in the Integrated Energy Policy Report. To maintain consistency among California's energy policy reports, the building types also align with the residential building types defined in the 2019 Residential Appliance Saturation Survey (RASS) (DNV GL Energy Insights USA, 2021) and the commercial building types defined in CEC's 2022 Commercial End Use Survey (CEUS) Report (Barioant, Mort, Alereza, & Dohrmann, 2024).

1.2.2 End-Uses

Space and water heating end uses with capacities below 2 million metric British thermal units per hour (MMBtu/hr) are the focus of this building retrofit and feasibility analysis. Baseline space heating equipment includes wall, floor, and central furnaces and boilers. Water heating end uses include domestic hot water systems. The report differentiates between zero-emission space and water heaters and emissive space and water heaters. Emissive space and water heaters describe equipment that emits carbon dioxide equivalent[2] emissions during standard on-site operation. Methods for assessing retrofit needs for pool/spa heaters are not included in this report. CARB staff did not estimate potential building retrofits for district heating and district water heating systems.

[2] Carbon dioxide equivalent (CO_2e) means the number of metric tons of carbon dioxide emissions with the same global warming potential as one metric ton of another greenhouse gas when calculated using the individual global warming potentials as specified in the "global warming potential" limited to carbon dioxide (CO2), methane (CH4), and nitrous oxide (N2O) as calculated using Equation A-1 Subpart A of Title 40, Part 98 of the Code of Federal Regulations as published on April 25, 2024.

2 Methodology Overview

This report provides the methodology and results for four distinct but related analyses: (1) residential electrical panel and service entrance capacity, (2) residential physical space retrofits, (3) commercial electrical panel and service entrance capacity, and (4) commercial physical space retrofits. For each of these analyses, CARB staff compiled and examined data sources characterizing California's existing residential and commercial building stock.

Potential zero-emission replacement technologies were assumed to be solar thermal, electric resistance, and heat pump equipment that are currently available in the market. The replacement technologies in this report were selected in part because the technologies and related data were readily available for equipment types covered in the regulatory concept at the time of CARB's analysis. Hydrogen space and water heating products are available overseas but are not commercially available for sale in the United States for equipment covered in the proposed regulation. Analysis of performance and cost data for these technologies is limited until such technologies are commercially available for sale in California.

For electrical panel retrofit estimates, CARB staff did not model the buildings' baseline or replacement equipment. For the residential sector, staff relied on UCLA research estimating electrical panel sizes across California homes to determine the share of buildings that may require panel upsizing or panel optimization strategies[3]. For the commercial sector, CARB staff used ComStock and CEUS data on peak energy demand to estimate electrical panel retrofits for commercial buildings.

For physical space retrofits, CARB staff relied upon the National Lab of the Rockies' (NLR's) 2024 ResStock dataset (NLR, 2024) for residential building physical space retrofits and their 2025 ComStock (NLR, 2025) dataset for commercial buildings. Additional datasets are described in the relevant sections below.

[3] Panel upsizing and panel optimization strategies are described in more detail in the sections below, and are based on a home's estimated current panel size (amps) compared to the estimated amperage needed to accommodate the increased electrical load of zero-emission space and water heating equipment.

3 Residential Methodology and Draft Estimates of Building Retrofits

3.1 Residential Electrical Panel and Service Entrance Capacity

Electrical panel amperage capacity can be a retrofit barrier to installing zero-emission space and water heaters (Mahone et al., 2019), (Kenney, Janusch, Neumann, & Jaske, 2021), (StopWaste & Association for Energy Affordability, 2021). CARB contracted with UCLA to estimate the need for future electrical panel upsizing[4] in California's existing residential buildings, and UCLA published a peer-reviewed paper with their results (Fournier, Cudd, Smithies, & Pincetl, 2024).

3.1.1 Electrical Panel Capacity Methodology

To estimate the distribution of electrical panel sizes across California's residential building stock, UCLA inferred existing electrical panel capacity based on the construction date and National Electrical Code (NEC) version. UCLA obtained parcel information from CoreLogic. Using a large sample of digital permit records with documented panel upsizing projects in California, UCLA trained a simulation model to estimate the current electrical panel size in all single- and multi-family residential buildings (Fournier et al., 2024). The UCLA team shared these data with CARB via personal communication, including estimated panel size, building vintage, building type and detailed spatial granularity. California has an estimated 8.8 million residential parcels (Depsky, Cushing, & Morello-Frosch, 2022). The CoreLogic database used by UCLA contained approximately 8.2 million residential parcels, of which approximately 7.7 million had sufficient data to be included in UCLA's analysis.

Because the UCLA data excluded manufactured and mobile homes, CARB staff estimated the distribution of electrical panel sizes for mobile and manufactured housing using ResStock 2025 data, which includes estimated panel size for all buildings.

CARB staff used these two data sources to estimate the percentage of households that may have enough panel capacity, those that could install zero-emission equipment through panel optimization strategies, and those that may need to upsize their panel, as shown in Table 4. CARB applied the same assumptions used by UCLA which indicate the following for single-family homes:

- Homes with 100-amp panels would require upsizing.
- Homes with panels greater than 100 amps but less than 200 amps could support zero emission equipment with panel optimization strategies.

[4] Panel upsizing refers to increasing the amperage of the main panel (e.g. from 100 amps to 200 amps).

- Homes with 200-amp panels or higher could accommodate zero-emission equipment without any changes to the panel.

For multi-family buildings, UCLA identified slightly lower thresholds:

- Buildings with subpanels below 60 amps would require upsizing.
- Buildings with 60-amp subpanels could accommodate zero-emission equipment through panel optimization strategies.
- Buildings with 90-amp panels or more could support zero-emission equipment without modification.

Staff applied the single-family assumptions to mobile and manufactured homes.

CARB staff used the best data available at the time of analysis but did not assess non-panel-related issues, such as knob and tube wiring and electrical panel proximity to gas meters due to data limitations.

Table 1. Residential Electrical Panel Building Retrofit Assumptions

Retrofit Category	Description	Single-family and mobile/ manufactured homes	Multi-family 2-4 and 5+ buildings
Basic	No Retrofit Needed Adequate panel capacity and physical breaker space.	Minimum 200+ amp panel	Minimum 90+ amp sub panel
Moderate	Panel Optimization Install either smart circuit breakers, smart panel, circuit pausers, load-sharing devices, sub-panel, meter collars or smart splitter.	100–199-amp panel	60-amp sub panel[5]
Extensive	Panel Upsizing Lacks adequate panel capacity and service entrance capacity. Install a larger electrical panel.	Under 100-amp panel	Under 60-amp subpanel

[5] There were no instances of panels that were between 60 and 90 amps.

3.1.2 Residential Electrical Panel Capacity Results

Table 2 and Table 3 show the estimated basic, moderate, and extensive retrofits by both building type and aggregated across all building types.

Table 2. Residential Electrical Panel Building Retrofit, by Building Type

Building Type	Retrofit Category		
Single Family	Basic	Moderate	Extensive
Single-Family Detached	51%	46%	3%
Single-Family Attached	40%	57%	3%
Mobile and Manufactured Homes	37%	60%	3%
Multi Family	Basic	Moderate	Extensive
2 - 4 Unit Residential	26%	61%	12%
5+ Unit Residential	38%	55%	7%

Table 3: Residential Electrical Panel Building Retrofits, Aggregated Across all Building Types

	Retrofit Category		
Statewide Results	Basic	Moderate	Extensive
All Building Types	45%	51%	5%

3.2 Residential Physical Space Retrofits

3.2.1 Residential Space Heating

There is a wide range of zero-emission space heating technologies available for different building conditions. For example, for homes with central air conditioning, existing ducts and outdoor condenser space typically make it straightforward to install packaged or split heat pumps. In contrast, housing units without ducts or with duct systems that would require extensive upgrades may be better suited for ductless options such as mini-splits or packaged terminal heat pumps.

For this analysis, staff assumed that the diversity of zero-emission heating technologies can meet most physical space constraints without costly retrofits. However, the assumption in this analysis that homeowners will choose the option requiring the least retrofit work is a simplification. Many factors influence equipment choice and retrofit decisions, including aesthetics, personal preferences, and homeowner association requirements, which are outside the scope of this analysis.

Residential Space Heating Methodology

To estimate the statewide retrofits needed to accommodate zero-emission space heaters, staff first matched the baseline heating, ventilation, and air conditioning (HVAC) equipment assigned in ResStock to the groups of consolidated technologies shown in Table 4.

Table 4. ResStock HVAC Equipment Matched to CARB's Baseline Technologies

ResStock HVAC Equipment	Baseline Technology	Percent of Total Housing Units	Included in Analysis?
Natural gas and propane wall/floor furnaces	Wall/Floor Furnace	7%	Yes
Fuel oil, natural gas, propane furnaces	Central Furnace	53%	Yes
Electric air source heat pump (ASHP), electricity baseboard, electric boiler, electric furnace, electricity wall furnace, and electricity shared heating	Zero-Emission	27%	Yes
None or other[6]	None	3%	No
Natural gas and propane shared heating[7]	Shared Heating (Centralized Boiler)	7%	No
Fuel oil, natural gas, and propane boilers	Boiler	3%	No

Data from 2019 RASS (DNV GL Energy Insights USA, 2021) indicate that only 8% of households have "no individual space heating system," which could indicate a shared system or no heating at all. This data generally aligns with the 10% (7% shared heating + 3% none) presented in Table 4. Results from the 2019 California Multi-Family Boiler Market Assessment (Abbaszadeh et al., 2019), which looked at prevalence of boilers across California's gas IOUs, suggest that roughly 5% of all boilers used in multi-family buildings are used for space heating. To simplify the analysis boilers or shared heating systems were omitted from this analysis. However, those systems may require more extensive retrofits.

Using the baseline equipment type, building type, and presence of central air conditioning (AC) from ResStock, staff developed assumptions about available physical space and corresponding zero-emission (ZE) replacement options. These assumptions are outlined in Table 5.

[6] Includes homes with no heat and homes with wood as the primary fuel type.
[7] In ResStock, all shared heating systems are assumed to be shared boiler systems.

Table 5. Assumed ZE Replacement Technologies for Emissive Space Heating Equipment

CARB Baseline Technology	Building Type	Central AC	Assumption	Assumed ZE Replacement Technology
Wall/Floor Furnace	All	Yes	Central AC suggests that the unit has ducts and that there is space for the heat pump (HP) unit where central AC compressor is currently located	Split/Packaged HP or Electric Resistance Furnace
Wall/ Floor Furnace	All	No	No ducts available	Minisplit or Packaged Terminal Heat Pump (PTHP)
Central Furnace	All	Yes	Central furnace and central AC suggest that the unit has ducts and space for the HP compressor unit where the central AC compressor is located	Split / Packaged HP
Central Furnace	SFA, SFD, MMH	No	Central furnace suggests that the unit has ducts and space for a packaged HP where the central furnace is located or enough space outside the home for a compressor.	Split / Packaged HP or Electric Resistance Furnace
Central Furnace	MF	No	While central furnace suggests the presence of ducts, space outside for a split HP is unknown. Wall space for PTHP is more likely available.	PTHP or Electric Resistance Furnace
None	SFA, SFD, MMH, MF	Yes	Central AC suggest that the unit has ducts and that there is space for the HP compressor unit where the central AC unit is currently located	Split / Packaged HP or Electric Resistance Furnace
Already ZE	SFA, SFD, MMH, MF	NA	NA	NA
Boilers and Shared Heating	SFA, MF	NA	Not included in the analysis	NA
None	SFA, SFD, MMH, MF	No	Not included in the analysis	NA

Given this diversity of building and equipment conditions, staff assumed that most residential units could reasonably accommodate at least one ZE heating option without significant retrofits. These homes were assigned a basic retrofit category, reflecting only the

installation-related work (basic wiring, equipment hookup, capping the gas line, and minor drywall repair).

To capture situations where additional modifications may be required, staff identified single-family homes with a central furnace but no central AC as cases likely to require duct resizing or replacement. These homes were assigned a moderate retrofit category, acknowledging potentially higher retrofit costs, particularly in scenarios where homeowners opt for preferred equipment types that require additional space or ductwork.

Residential Space Heating Results

Table 6 summarizes the estimated share of housing units in each retrofit category. Staff estimate that more than half of residential units will need only a basic retrofit, selecting the zero-emission technology that best fits their space and minimizes cost. Approximately 11% of homes fall into the moderate retrofit category. These are single-family homes that currently have a central furnace and ducts but no central AC. Staff used this group to approximate the number of single-family or multi-family homes that may need ductwork resizing or replacement for a zero-emission system. Roughly a quarter of all household units are already zero-emission.

Table 6. Space Heating Retrofits, Statewide

Retrofit Level	Percent of Household Units in ResStock
Basic	50%
Moderate	11%
Extensive	0%
Already ZE	27%
Not Modeled (Boilers / Shared Heating)	13%

3.2.2 Residential Water Heating

Residential Water Heating Methodology

This analysis estimates the retrofits needed to replace all residential emissive water heaters with zero-emission equipment. To quantify how many housing units may require physical retrofits, staff followed the following steps:

1. Translate ResStock water heating equipment into simplified baseline technology categories (Table 7).
2. Apply zero-emission replacement technologies to all emissive baseline water heaters (Table 8).

3. Use the existing water heater location in ResStock and assumptions about available physical space to assign retrofit actions. Possible actions include:
    a. basic installation (no physical modifications)
    b. adding an outdoor enclosure for water heaters currently located outside
    c. adding ventilation to water heaters located in living spaces
    d. moving the water heater to the basement or garage, when such spaces exist
    e. renovation, which assumes substantial work to move the water heater to a new location (other than the basement or garage) or to create a new suitable installation area
4. Aggregate retrofit actions into four retrofit categories: already zero-emission, basic, moderate, and extensive.

HPWHs are the most common zero-emission replacement technology assumed in this analysis, though solar thermal water heaters and electric resistance water heaters are also included. HPWHs typically require more space than emissive units because they incorporate both a storage tank and a heat-pump module. They also require adequate ventilation, drainage, and clearance. While certain configurations, such as split HPWH systems, can mitigate some of these constraints, some existing buildings may still need physical modifications to accommodate HPWH installation.

To estimate the statewide retrofits needed to install zero-emission water heaters, staff first matched the water heating equipment assigned in ResStock to groups of consolidated baseline technologies shown in Table 7.

Table 7. ResStock Water Heating Equipment Matched to Baseline Technologies

ResStock Water Heating Equipment	In-Unit Water Heater	CARB Baseline Technology	Percent Housing Units
Fuel oil indirect, premium, and standard, natural gas premium and standard, propane premium and standard, and other	Yes	Tanked Water Heater (In-Unit)	60%
Natural gas tankless	Yes	Tankless Water Heater (In-Unit)	7%
Fuel oil indirect, fuel oil premium, fuel oil standard, natural gas premium, natural gas standard, other fuel, propane premium, and propane standard	No	Centralized Water Heating System	12%
Natural gas tankless[8]	No	Central Tankless Water Heater	1%

[8] These are assumed to be banked tankless water heaters located in a mechanical room or other multi-family building location.

Electric Heat Pump (80-gal), electric premium, electric standard, and electric tankless	N/A	Zero-emission	21%

Each baseline water heater was then matched to a zero-emission replacement water heater. CARB staff developed adoption rates using input from public experts. Residential tanked and tankless water heaters were assumed to be replaced primarily with 240-volt (V) heat pumps, with a small share of 120-volt and split-system heat pumps based on recent market potential studies (Khanolkar, Egolf, & Gabriel, 2023). Only 5% of small residential water heater replacements were modeled to be solar thermal, given low uptake of that technology today (DNV GL Energy Insights USA, 2021). No electric resistance technologies were assumed for residential tanked water heater replacements as recently adopted U.S. Department of Energy Consumer Water Heater rules (US DOE, 2024) set heat pumps as the minimally compliant technology for several electric storage consumer product sizes. Assumed adoption rates are presented in Table 8.

Table 8. Replacement Water Heating Technology and Assumed Adoption Rate (AAR)

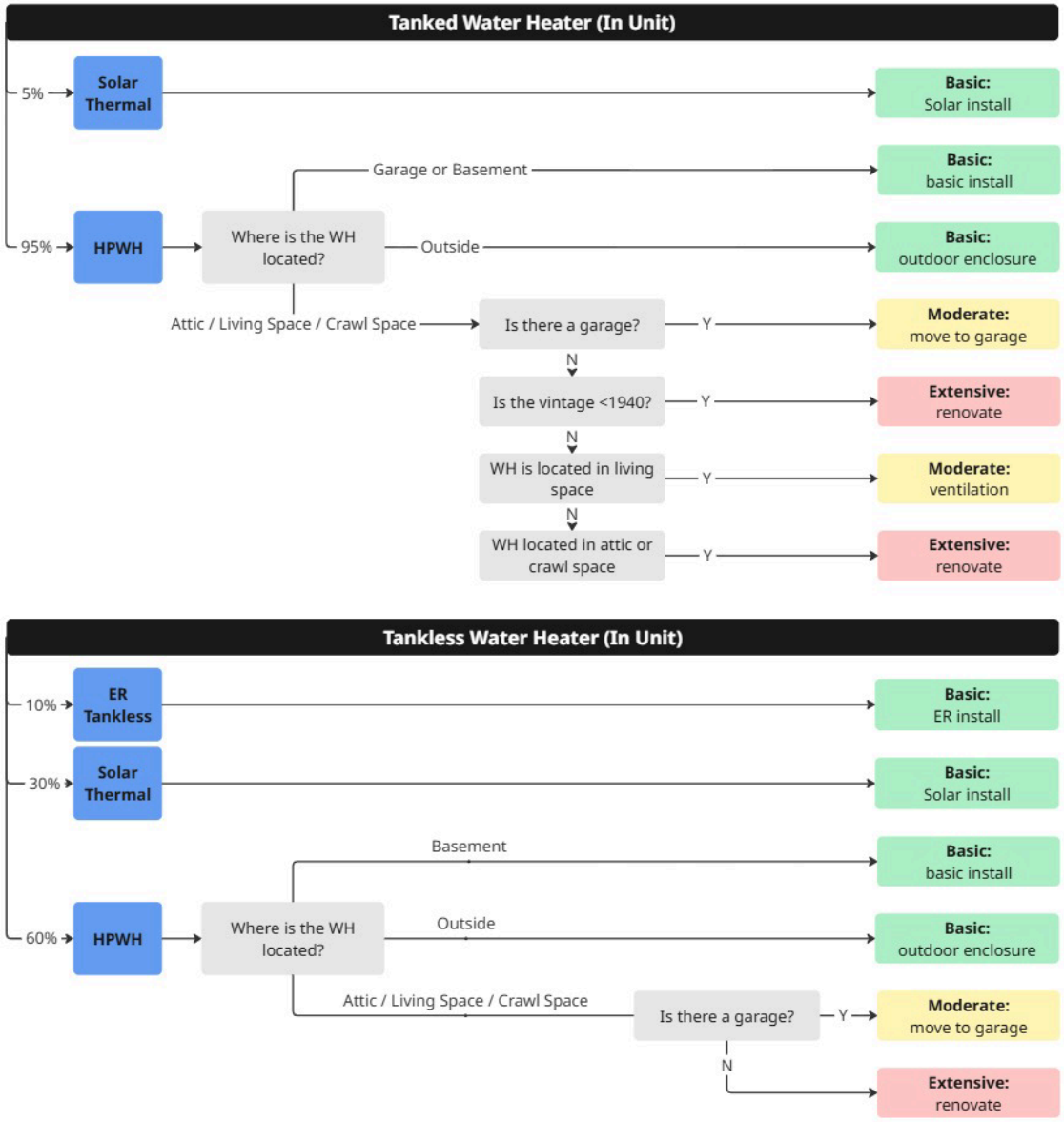
Baseline Technology	**Replacement 1 (AAR)**	**Replacement 2 (AAR)**	**Replacement 3 (AAR)**	**Replacement 4 (AAR)**	**Replacement 5 (AAR)**
Tanked Water Heater (In-Unit)	240V HPWH (70%)	120V HPWH (20%)	Split System (5%)	Solar Thermal (5%)	NA
Tankless Water Heater (In-Unit)	Central 240V HPWH (60%)	120V HPWH (20%)	Split System (5%)	Solar Thermal (5%)	Electric resistance tankless (10%)
Central Water Heater System (Tanked and Tankless)	Residential Central HPWH (70%)	Multi-family Electric Resistance Water Heater (30%)	NA	NA	NA
Zero-emission	NA	NA	NA	NA	NA

Staff considered the building type, location of the existing emissive water heater, and the zero-emission replacement technology to assign expected retrofits. These assumptions are described using the decision trees in the sections below.

Single-Family Detached Homes: Retrofit Assignments and Results

Single-family detached (SFD) homes account for 58% of all housing units in ResStock. This building type only includes in-unit water heating systems. To determine whether a home has adequate physical space to replace its existing emissive water heater with a zero-emission system and identify what retrofit actions would be required if space is insufficient, staff applied the assumptions shown in the decision tree in Figure 1.

Figure 1. Decision Tree for Retrofit Assignments in SFD



Using these assumptions, retrofit actions were assigned. Table 9 presents the distribution of baseline technology (tanked, tankless, already ZE) and retrofit action assignments for single-

family detached units. Table 10 Presents the aggregated data by retrofit categories across all single-family detached housing units.

Table 9. Retrofit Action Assignments, by Baseline Technology in SFD

Baseline Tech and Retrofit Action	Percent of all SFD units
Tanked	77%
Basic preparations or solar replacement (basic)	33%
Add outdoor enclosure (basic)	20%
Move to garage (moderate)	6%
Add ventilation (moderate)	16%
Renovate (extensive)	2%
Tankless	9%
Basic preparations, solar replacement, or electric resistance replacement (basic)	4%
Add outdoor enclosure (basic)	2%
Move to garage (moderate)	1%
Add ventilation (moderate)	2%
Renovate (extensive)	<1%
Already ZE	14%

Table 10. Retrofits for All SFD Units

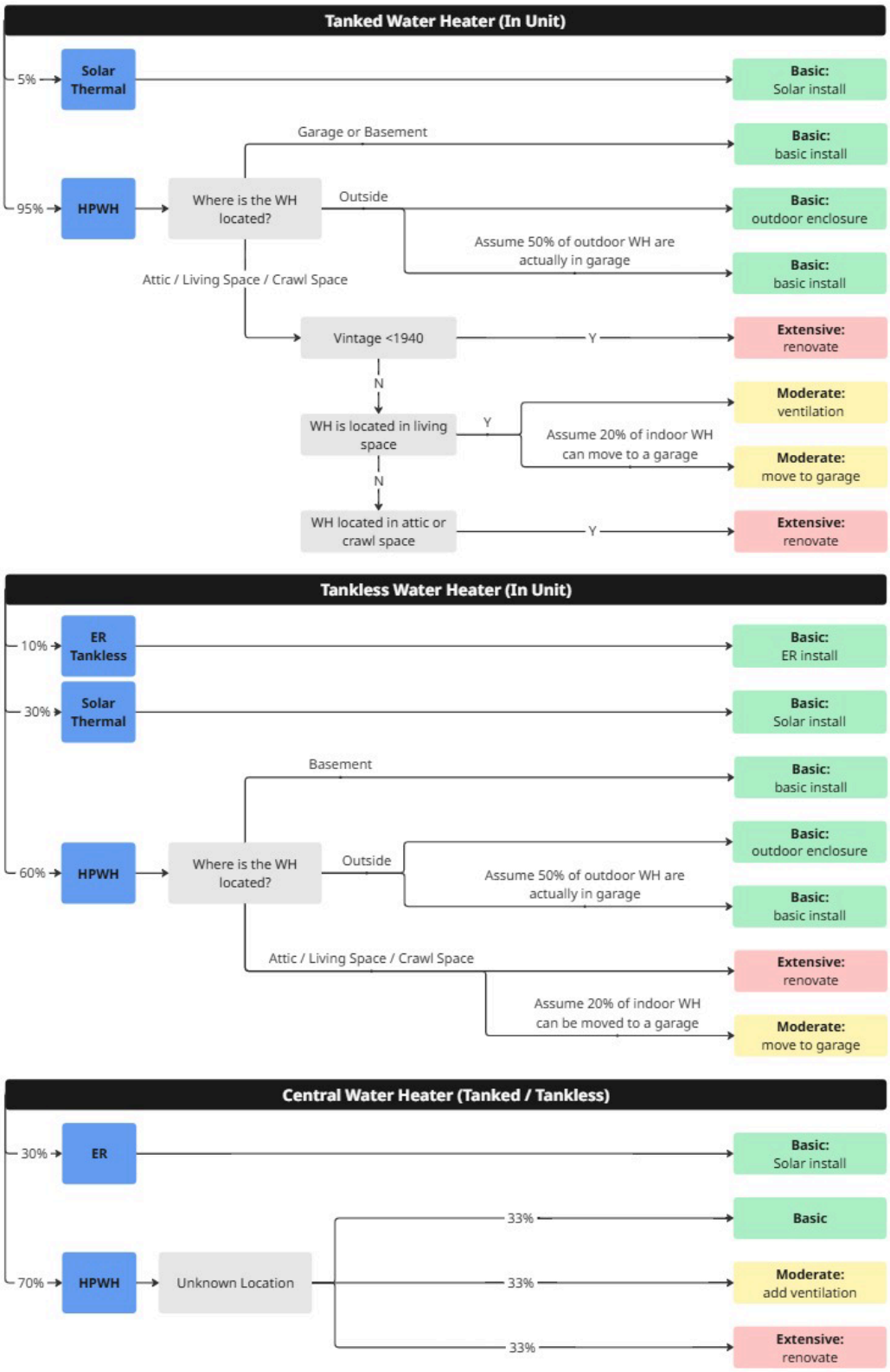
Retrofit Category	Percent of SFD Units
Basic	60%
Moderate	24%
Extensive	2%
Already ZE	14%

Single-Family Attached

The single-family attached (SFA) housing type makes up seven percent of the entire housing stock in ResStock. These homes have both in-unit water heaters and a low number of centralized/shared water heating systems (less than one percent). ResStock does not indicate whether SFA homes have garages. However, the Residential Energy Consumption

Survey (RECS) from 2020 data (US EIA, 2020) show that roughly three quarters of all SFA homes in California have an attached garage. To account for this, staff estimated that 50% of the water heaters located outside (according to ResStock) are actually located in a garage and that 20% of the water heaters located inside (according to ResStock) could relocate to a garage. These assumptions are reflected in Figure 2.

Figure 2. Decision Tree for Retrofit Assignments in SFA



Using these assumptions, retrofit actions were assigned. The tables below present the distribution of the retrofit action assignments for in-unit and centralized water heaters. Results are aggregated by retrofit categories across all single-family attached housing units.

Table 11. Retrofit Action Assignments by Baseline Technology in SFA

Retrofit Action	Percent of all SFA units[9]
Tanked (in unit)	64%
Basic preparations or Solar replacement (basic)	4%
Add outdoor enclosure (basic)	14%
Move to garage (moderate)	20%
Add ventilation (moderate)	26%
Renovate (extensive)	<1%
Tankless (in-unit)	7%
Basic preparations, solar replacement, or ER replacement (basic)	1%
Add outdoor enclosure (basic)	1%
Move to garage (moderate)	1%
Add ventilation (moderate)	2%
Renovate (extensive)	1%
Central (tanked and tankless)	4%
Basic preparations or ER replacement (basic)	2%
Add ventilation (moderate)	1%
Renovate (extensive)	1%
Already ZE	25%

Table 12. Retrofits for All SFA Units

Retrofit Category	Percent of SFA Units
Basic	22%
Moderate	51%

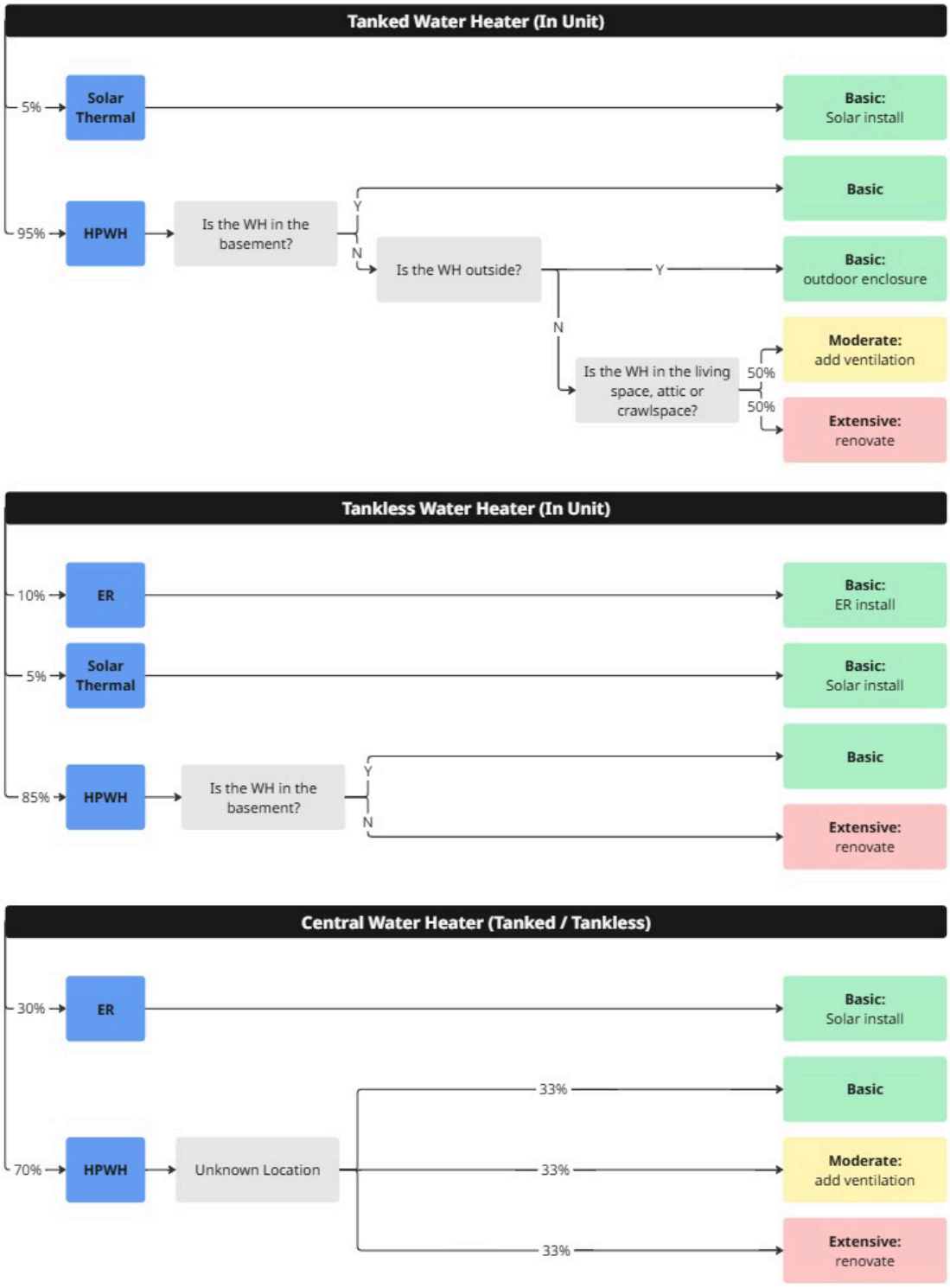
[9] Percentages may not add exactly to sub totals or grand totals due to rounding errors.

Extensive	2%
Already ZE	25%

Multi-Family Homes 2-4 and 5+ Units

The multi-family housing type together makes up nearly one-third of housing units in California, with 8% of all housing units belonging to buildings with 2 – 4 units and 24% of all housing units belonging to buildings with 5+ units. They also have the highest percentages of ZE water heating equipment currently installed. Multi-family units rely on both in-unit water heaters and centralized/shared water heating systems.

Figure 3. Decision Tree for Multi-family Retrofit Assignments



Using the assumptions outlined in Figure 1, retrofit actions were assigned. Table 13 presents the distribution of the retrofit action assignments for in-unit tanked and tankless baseline water heaters and central baseline water heaters. The results for centralized water heating systems in Table 14 reflect the basic adoption rates and simplified assumptions staff made regarding centralized systems.

Table 13. Retrofit Assignments by Baseline Technology, Multi-family

Baseline Tech and Retrofit Action	MF 2-4	MF 5+	All MF
Tanked (In Unit)	40%	19%	25%
Basic preparations, solar replacement, or ER replacement (basic)	3%	1%	2%
Add outdoor enclosure (basic)	9%	4%	5%
Add ventilation (moderate)	14%	7%	9%
Renovate (extensive)	14%	7%	9%
Tankless (In Unit)	4%	2%	3%
Basic preparations, or solar or ER replacement (basic)	1%	0%	0%
Add ventilation (moderate)	0%	0%	0%
Renovate (extensive)	3%	2%	2%
Central Tanked and Tankless	28%	45%	41%
Basic preparations or ER replacement (basic)	14%	24%	22%
Add ventilation (moderate)	7%	10%	9%
Renovate (extensive)	7%	11%	10%
Already ZE	28%	33%	32%

Table 14. In Unit Water Heating Retrofits for all MF Units

Retrofit Category	Percent of MF Units
Basic	18%
Moderate	22%
Extensive	28%
Already ZE	31%

Table 15. Centralized Water Heating Retrofits for all MF Units

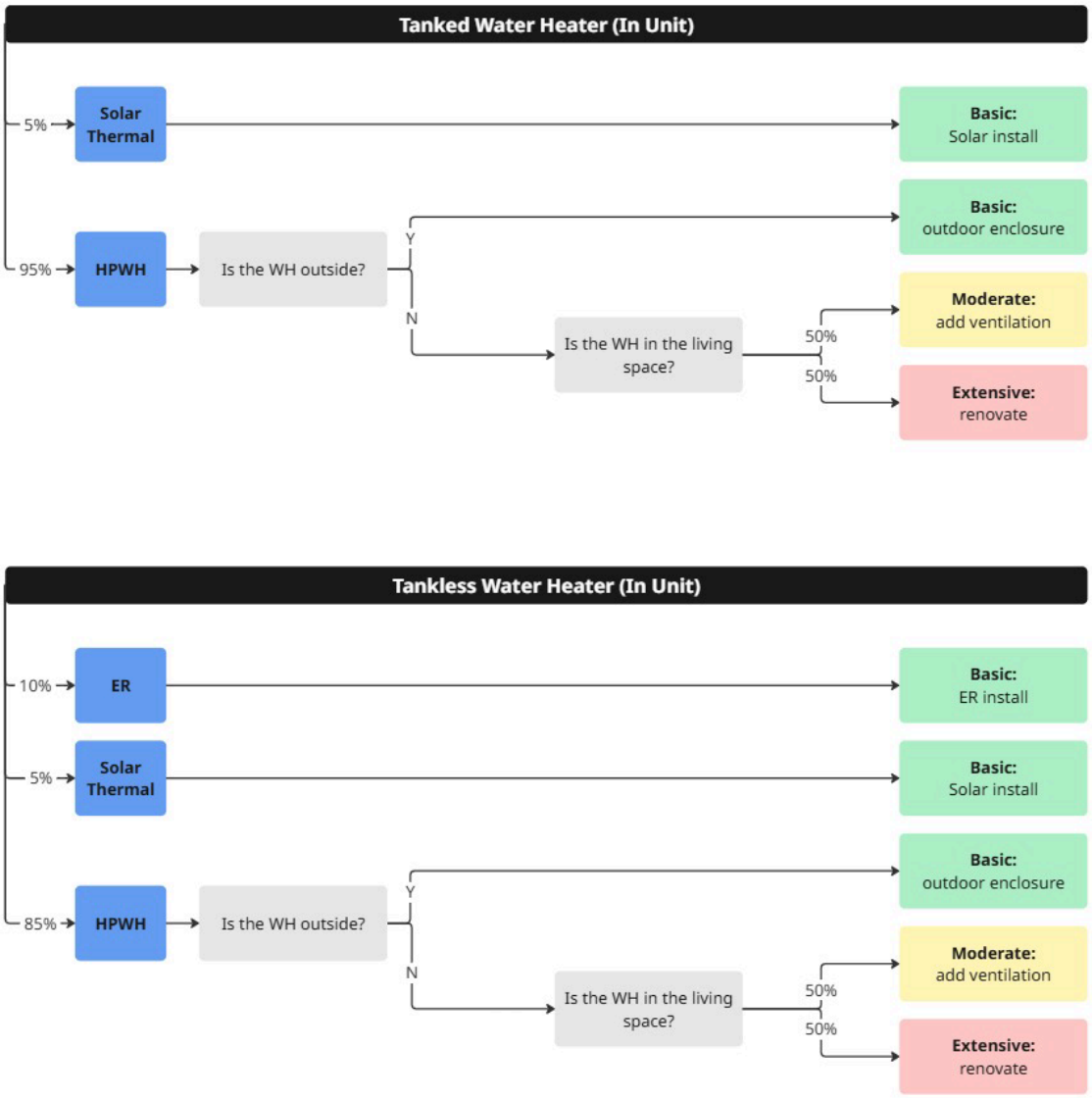
Retrofit Category	Percent of MF Units
Basic	36%
Moderate	15%
Extensive	16%
Already ZE	32%

Mobile and Manufactured Homes

Mobile and Manufactured Homes (MMH) represent 4% of all ResStock housing units. Among these homes, 65% have their water heater located outdoors. As with other building types, staff assumed that emissive tanked water heaters already located outside could remain in place. For tanked water heaters located inside, staff estimated half could remain indoors with additional ventilation work, while the other half would lack sufficient space and require more extensive retrofits. Split-system heat pump water heaters could alleviate both the space and ventilation constraints that are common in mobile homes.

For tankless water heaters located outdoors, staff assumed that an outdoor enclosure could be added (CCR, 2026) and that there is adequate space to install a heat pump water heater.

Figure 4. Decision Tree for Retrofit Assignments in MMH



Using these assumptions, retrofit actions were assigned.

Table 16 presents the distribution of baseline technology (tanked, tankless, already ZE) and assigned retrofit action assignments for manufactured and mobile homes. Table 17 presents the aggregated by retrofit categories across all manufactured and mobile homes.

Table 16. Retrofit Action Assignments by Baseline Technology in MMH

Retrofit Action and Baseline Technology	Percent of MMH[10]
Tanked (In Unit)	72%
Basic preparations or Solar replacement (basic)	4%
Add outdoor enclosure (basic)	46%
Add ventilation (moderate)	11%
Renovate (extensive)	11%
Tankless (In Unit)	8%
Basic preparations, solar replacement, or electric resistance replacement (basic)	1%
Add outdoor enclosure (basic)	4%
Renovate (extensive)	3%
Already ZE	20%

Table 17. Water Heating Retrofits for all MMH Units

Retrofit Category	Percent of MMH Units
Basic	55%
Moderate	11%
Extensive	14%
Already ZE	20%

Aggregated Residential Water Heating Results

Water heater retrofit results are presented separately for in-unit and centralized replacement systems. Staff aggregated retrofit actions into three retrofit categories: basic, moderate, and extensive, and then aggregated the retrofit levels across all building types for the residential sector. As mentioned in the MF section above, the results for centralized water heating systems in Table 18 reflect the basic adoption rates and simplified assumptions staff made regarding centralized systems.

[10] Percentages may not add exactly to sub totals or grand totals due to rounding errors.

Table 18. Residential Physical Space Retrofits (In-Unit Water Heating)

Retrofit Category	Share of Units
Basic (No relocation, add outdoor enclosure or solar/ER replacement)	50%
Moderate (Add ventilation or relocate to garage)	26%
Extensive (Major relocation)	7%
Already ZE	18%

Table 19. Residential Physical Space Retrofits Water Heating (Centralized Water Heating)

Retrofit Category	Share of Units
Basic (No relocation or resistance boiler replacement)	36%
Moderate (Add ventilation to mechanical room)	16%
Extensive (Relocate / renovate mechanical room)	16%
Already ZE	32%

Table 20. Residential Physical Space Retrofits (All Water Heating)

Retrofit Category	Share of Units
Basic	47%
Moderate	24%
Extensive	8%
Already ZE	20%

4 Commercial Methodology and Draft Estimates of Building Retrofits

4.1 Supplementing the ComStock Building Types

To assess commercial retrofit needs, CARB staff first filled gaps for building types not included in the ComStock dataset: food, miscellaneous, refrigerated warehouse, and

university buildings. For example, to add food buildings to the ComStock dataset, staff chose the closest building type, restaurants, available in ComStock and used all restaurant records as proxy data for food buildings. From there, staff adjusted the weighting for each restaurant record so that the overall building count for proxy food buildings in ComStock would align with the overall building counts for food buildings in another dataset of existing commercial buildings in California provided by Dun & Bradstreet (Dun & Bradstreet, 2024).

Staff used the CBECS dataset (US EIA, 2018) for the Pacific census division to determine if the proxy building data in ComStock was similar enough to comparable data for the actual building type of interest in CBECS as described in the Table 21.

Table 21. Comparison Between CBECS and the Proxy ComStock Building Types

Missing ComStock Building Type	CBECS Building Type	Proxy ComStock Building Type	Comparison between CBECS and the proxy ComStock Building Types
Food	Food	Restaurant	• Both have high cooling loads for refrigeration • Both mostly rely on furnaces for space heating • Most are <50,000 square feet
Miscellaneous	Miscellaneous	Office and Retail	• Both rely most heavily on furnaces for heating followed by boilers, then zero-emission equipment. • CBECS shows 25% of Miscellaneous buildings with no air conditioning, whereas ComStock assumes 0% • Most are <100,000 sqft
Refrigerated Warehouse	Refrigerated Warehouse	Offices with data centers	• Both have high cooling loads • The distribution of buildings up to 400,000 sqft is similar across both building types
University	University	Health	• Both building types have a mix of building sizes ranging from small clinics to large operating centers for health buildings and small classrooms to larger laboratories in university buildings. • All buildings in ComStock are assumed to have AC whereas only 56% of university buildings in CBECs do. • Health buildings in ComStock predominantly rely on furnaces and boilers for heating, whereas university buildings in CBECS rely more on district heating systems.

For Food, Miscellaneous, and Refrigerated Warehouse building types, the CBECS and proxy ComStock building types were close enough that staff used the proxy building entries from ComStock directly, only adjusting the building weights to match the prevalence of the actual building type in the real world. University and health buildings had larger discrepancies, so CARB staff updated the ComStock proxy data to match the distribution of buildings with AC

in the CBECS data. Staff did not adjust for discrepancies between different baseline equipment because doing so could have made other variables in the analysis, like equipment capacity, inaccurate.

4.2 Zero-emission and non-applicable buildings

To assess commercial retrofit needs for applicable buildings statewide, CARB pre-classified buildings as either Already Zero Emission or Not Applicable. Each analysis below further specifies any specific qualifications for these categories. Broadly, using the baseline technology specified in ComStock, buildings with "Electric" as its space or water heating fuel type were categorized as zero-emission. For applicability, buildings with boilers over 2 MMBtu/hr (and therefore not covered by the regulatory concept), were omitted. Buildings that relied on district heating were also omitted. The portion of commercial buildings excluded from each analysis is described in greater detail below.

4.3 Commercial Electrical Panel

Commercial building retrofits for electrical panels were estimated independent of baseline or replacement technology. CARB staff evaluated whether the electrical panel could accommodate the added load from both space and water heating. CARB staff relied on available peak electricity demand and space and water heating contribution data respectively from ComStock and CEUS datasets to classify electrical panel building retrofits when installing zero-emission space and water heaters in commercial buildings.

There are two main variables used from ComStock and CEUS data to complete this analysis: 1) baseline peak electricity demand used to estimate a building's original panel size and 2) added water heating and space heating loads used to approximate the impact of new zero-emission loads and estimate a building's new panel size. While much more research has been conducted on estimating the size of electrical panels in residential buildings, little research has been completed on electrical panel sizes for commercial buildings. As a result, CARB staff made assumptions not found in the literature, but informed by expert feedback, to use added space and water heating loads to classify a building's electrical retrofits needs.

Baseline Peak Electricity Demand Methodology

CARB staff identified the baseline peak energy demand for typical commercial buildings, based on data available in ComStock.

Similar to the assumptions used in the modeling in the Nonresidential and Multi-family Alternative Calculation Method Reference Manual (Bucaneg & Wichert, 2023) developed for the California Energy Efficiency Standards, CARB staff assumed that all commercial buildings

use three-phase power.[11] Health buildings, large offices, and university buildings are assumed to have 480V power. To simplify the modeling, CARB staff assumed all other building types had 208V power.

Baseline peak electricity demand data provided in ComStock were listed as total peak demand in kilowatts (kW). CARB staff converted these kW estimates to amps based on the voltage assumptions summarized above regarding three-phase power.

Equation 1. $$Baseline\ Peak\ Electricity\ Demand\ (amps) = Peak\ Electricity\ Demand\ (kW) * \frac{1000\ W}{kW} * \frac{1}{\sqrt{3} * Assumed\ Voltage\ (V)}$$

With these components, CARB staff first converted each building's existing electrical peak demand from kilowatts to apparent power using a power factor of 0.9 and then to amps based on the building's voltage. A 20% buffer was applied before rounding to standard service sizes according to National Electrical Code guidelines to estimate a building's original panel size.

CARB staff assumed that the baseline peak demand represents actual energy demand on-site from real-world usage patterns. CARB staff assumed that this peak electricity demand is likely smaller than the actual size of electrical panels installed that are designed based on National Electrical Code guidelines, which could have significant excess capacity.

Added Peak Energy Demand Methodology

CARB staff estimated the added peak energy demand relative to baseline peak energy demand based on average efficiency for switching to zero-emission space and water heating. Peak energy use for gas space and water heating was provided in CEUS data by building type and climate zone in British thermal units per square foot (Btu/ft^2) (Barioant et al., 2024). CARB staff converted the CEUS estimates to watts/ft^2.

CARB staff then estimated the added peak load for zero-emission space and water heating, accounting for the efficiency of the equipment. CARB staff used the given Btu/ft^2 from CEUS and converted it to watts/ft^2 using Equation 2 to account for equipment efficiency.

Equation 2. $$Added\ Peak\ Energy\ Demand\ (\frac{Watts}{ft^2}) = \frac{Btu/hr}{ft^2} * \frac{Watt}{3.413\ Btu/hr} * \frac{1}{Median\ Equipment\ Efficiency\ (\%)}$$

[11] Three-phase power refers to a three-wire alternating current (AC) power system where the three phases are 120 electrical degrees apart, used for delivering electricity to a building. Three-phase power offers higher efficiency and capacity compared to single-phase power.

Table 22. Assumed Efficiency of Zero-Emission Equipment

End Use	Climate Zone (CZ)	Median Equipment Efficiency
Space Heating	CZ01 - Arcata	3.30
Space Heating	CZ02 - Santa Rosa	4.03
Space Heating	CZ03 - Oakland	4.16
Space Heating	CZ04 - Sunnyvale	4.15
Space Heating	CZ05 - Santa Maria	4.08
Space Heating	CZ06 - Los Angeles	4.31
Space Heating	CZ07 - San Diego	4.32
Space Heating	CZ08 - El Toro	4.40
Space Heating	CZ09 - Pasadena	4.20
Space Heating	CZ10 - Riverside	4.16
Space Heating	CZ11 - Red Bluff	3.98
Space Heating	CZ12 - Sacramento	4.05
Space Heating	CZ13 - Fresno	4.03
Space Heating	CZ14 - China Lake	3.72
Space Heating	CZ15 - El Centro	4.06
Space Heating	CZ16 - Mount Shasta	3.80
Water Heating	All	3.30

Efficiency assumptions are based on data from FSSAT v5.8.0 (Guidehouse Inc., 2020). For space heating, CARB staff assumed that average equipment efficiency varies by climate zone, as shown in Table 22. Since equipment efficiency for water heating does not vary by location, the median equipment efficiency was used across all climate zones.

CARB staff converted watts per square foot to watts by multiplying the total square footage for each building type. Watts were then converted to amps using Equation 3. The estimated added peak load was then compared to the baseline peak electricity demand.

With added loads from space and water heating in amps, CARB staff also estimated a new panel size for buildings by adding those loads to the peak electricity demand and following the same methodology used to estimate the original panel size. This is meant to model, based on standard panel sizes, how adding zero emission space and water heating

equipment would impact the electric panel. CARB staff understand this method is likely conservative.

Equation 3. $Added\ Peak\ Energy\ Demand\ (amps) = Added\ Peak\ Energy\ Demand\ (W) * \frac{1}{\sqrt{3} * Assumed\ Voltage\ (V)}$

Electrical Panel Building Retrofit Classifications

CARB staff classified buildings into one of three categories by comparing their relative load increases to their peak electricity demand or comparing the panel size increases. These categories are Basic, Panel Optimization, and Panel Upsizing; they describe the type of work needed for the building's electrical panel to sufficiently handle zero-emission space and water heating equipment.

Buildings were classified as needing Basic retrofits if:

- Their peak load increase was less than 10 percent of the peak electricity demand, or
- their new panel size was less than or equal to the original panel size

Buildings with basic electrical retrofit needs are assumed to have adequate panel capacity and breaker space at the electrical panel to connect the new zero-emission space and water heaters without significant electrical panel retrofits.

Buildings were classified as needing Panel optimization if:

- their peak load increased the peak electricity demand by 10 to 25 percent, or
- their new panel size increased by less than 100A.

Panel optimization strategies are various approaches to manage a panel's load, allowing buildings to use the existing electrical panel without panel upsizing. The panel optimization strategies considered are largely based off the CPUC report, "Fuel Substitution Behind the Meter Infrastructure Market Study," on the likelihood of contractors installing smart circuit breakers, smart panels, circuit pausers, load-sharing devices, sub-panels, meter collars, or smart splitters (Guidehouse Inc. & Opinion Dynamics Corporation, 2024). This is not an exhaustive list of possible load management strategies, and building owners are likely to rely on contractors' expertise and judgement to decide which to implement. Although the report included strategies like installing a meter collar, consultation with technical experts suggested that meter collar installation is unlikely for space and water heating replacements, so staff excluded it.

Buildings were classified as needing Panel upsizing if:

- their load increased the peak electricity demand by more than 25 percent, or
- the new panel size increased more than 100A

Panel upsizing means installing a larger electrical panel to increase the panel's electrical capacity and likely increase the number of physical breakers.

In some cases, commercial buildings that upsize their electrical panel(s) may also need to perform service-level upgrades such as to their transformers. However, due to limited data on when such are triggered or the portion allocated to the building owners, transformer retrofit impacts were not included in this analysis. As a result, these buildings are not separated from this analysis and are therefore included in the panel upsizing category.

Commercial Electrical Retrofit Results

An estimated 63% of commercial buildings by floor area have adequate electrical panel capacity to install zero-emission space and water heaters, with 21% already using zero emission equipment, as shown in Table 23. Approximately 30% of commercial buildings could optimize their electrical panels through a combination of load management strategies such as installing load-sharing devices or smart circuits to accommodate zero-emission space and water heaters. An estimated 7% of commercial buildings may need to upsize their electrical panels.

Table 23. Assumptions of Anticipated Retrofits Needed to Electrical Panels in Commercial Buildings

Building Retrofit Action	Share of Floor Area
Basic	42%
Panel Optimization	30%
Panel Upsizing	7%
No Retrofit or Already Zero-emission	21%

4.4 Commercial Physical Space Retrofits

4.4.1 Commercial Space Heating

Commercial Space Heating Methodology

For space heating, most of the baseline technology was specified directly in ComStock. All buildings with existing electric resistance heating or an air source heat pump were categorized as zero-emission. While there was insufficient information in the dataset to separate which furnaces were over 2 MMBtu/hr (and therefore not covered by the regulatory concept), CARB staff omitted buildings with boilers over 2 MMBtu/hr and buildings with district heating from the analysis. The ComStock dataset assumes that all commercial buildings have some form of air conditioning.

For space heating, CARB staff estimate that about half of the existing commercial building stock, by floor area, already has zero-emission equipment or may not be covered under the regulatory concept because their equipment either surpasses the capacity threshold or is

fueled by district heating. As shown in Table 24, most of the remaining building area is heated by furnaces, with only about 12% of commercial floor area heated by a boiler.

Table 24. Commercial Baseline Space Heating Technology

Baseline Space Heating	Capacity	%, by Floor Area
Boiler	≤400k Btu/hr	<1%
	>400k, ≤2MM Btu/hr	12%
Furnace	≤2MM Btu/hr	24%
Zero-emission	All capacities	34%
Not applicable (district heating or >2 MMBtu/hr)	All capacities	29%

Each emissive space heating baseline technology was matched to potential replacement technologies, and each replacement technology was assigned an assumed adoption rate, as presented in Table 25.

Ducted central furnaces were assumed to be replaced primarily with ducted zero-emission options, including central heat pumps and electric resistance furnaces. For space heating boilers, replacement technologies modeled include ductless heat pump systems such as variable refrigerant flow, mini split, and air-to-water heat pumps, or electric resistance boilers, which are all currently commercially available. This reflects the fact that buildings with existing boilers used for space heating often lack ductwork, making central ducted systems less feasible. Heat pumps were modeled to be adopted in 90% of HVAC replacements, consistent with the Energy Code guidance discouraging electric resistance technologies in existing buildings.

Replacement technology was determined using a static assumed adoption rate that does not account for owner preferences, building type, building operational needs, or other relevant building attributes. This approach was based on the best data available at the time of analysis, but staff acknowledge that it could lead to different retrofit level estimates where real-world adoption rates do not align with the assumptions.

Table 25. Replacement Space Heating Technology and Assumed Adoption Rate (AAR)

Baseline Heating	Replacement 1 (AAR)	Replacement 2 (AAR)	Replacement 3 (AAR)
Furnace	Central, packaged, or unitary heat pump (90%)	Electric resistance (ER) furnace (10%)	NA

(all sizes below 2MM Btu/hr)			
Boiler **(≤400k Btu/hr)**	Mini split (90%)	Electric resistance boiler (10%)	NA
Boiler **(>400k, ≤2MM Btu/hr)**	Air-to-water heat pump (AWHP) (60%)	Variable Refrigerant Flow System (VRF) (30%)	Electric resistance boiler (10%)

To estimate the retrofit actions needed for installation of zero-emission space heating equipment in existing commercial buildings, CARB staff developed replacement scenarios as outlined in Figure 5 and Figure 6.

Figure 5. Decision Tree for Commercial Furnaces and Small Boilers

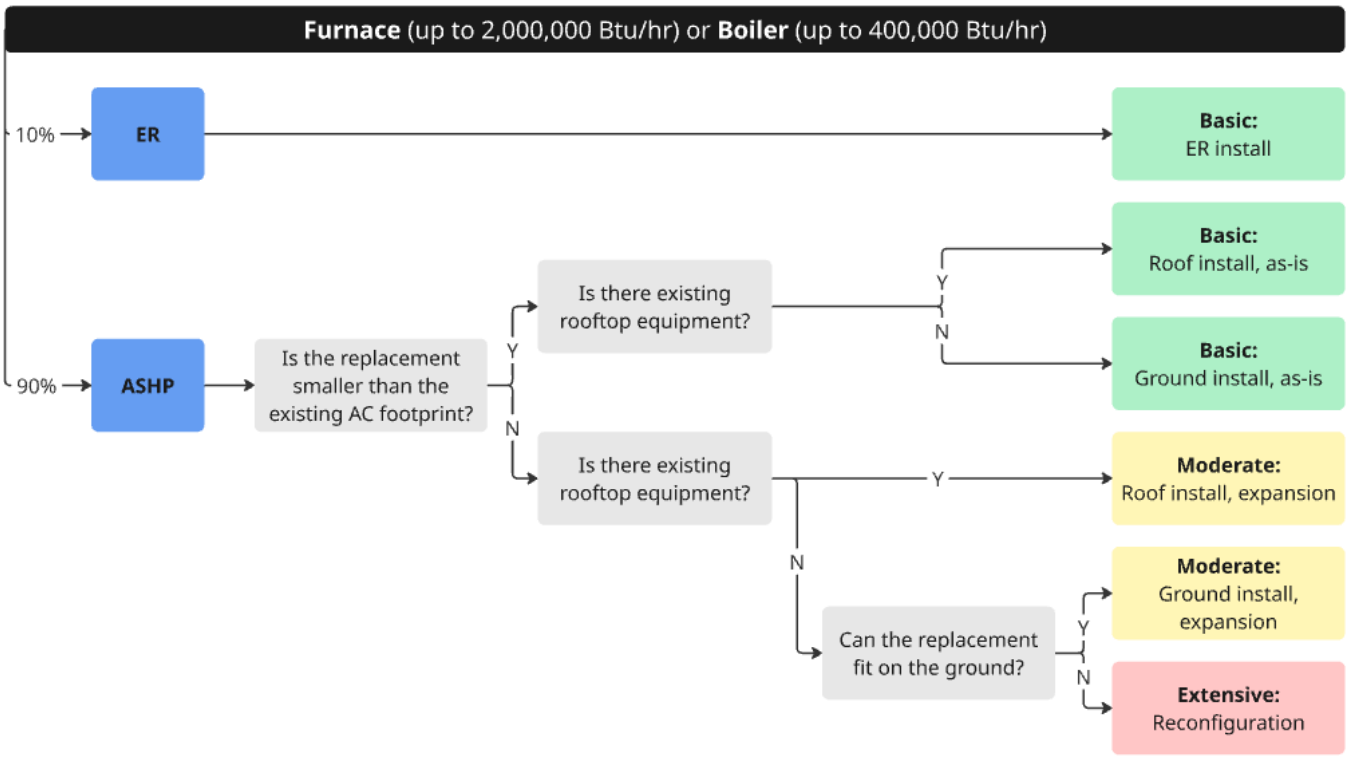
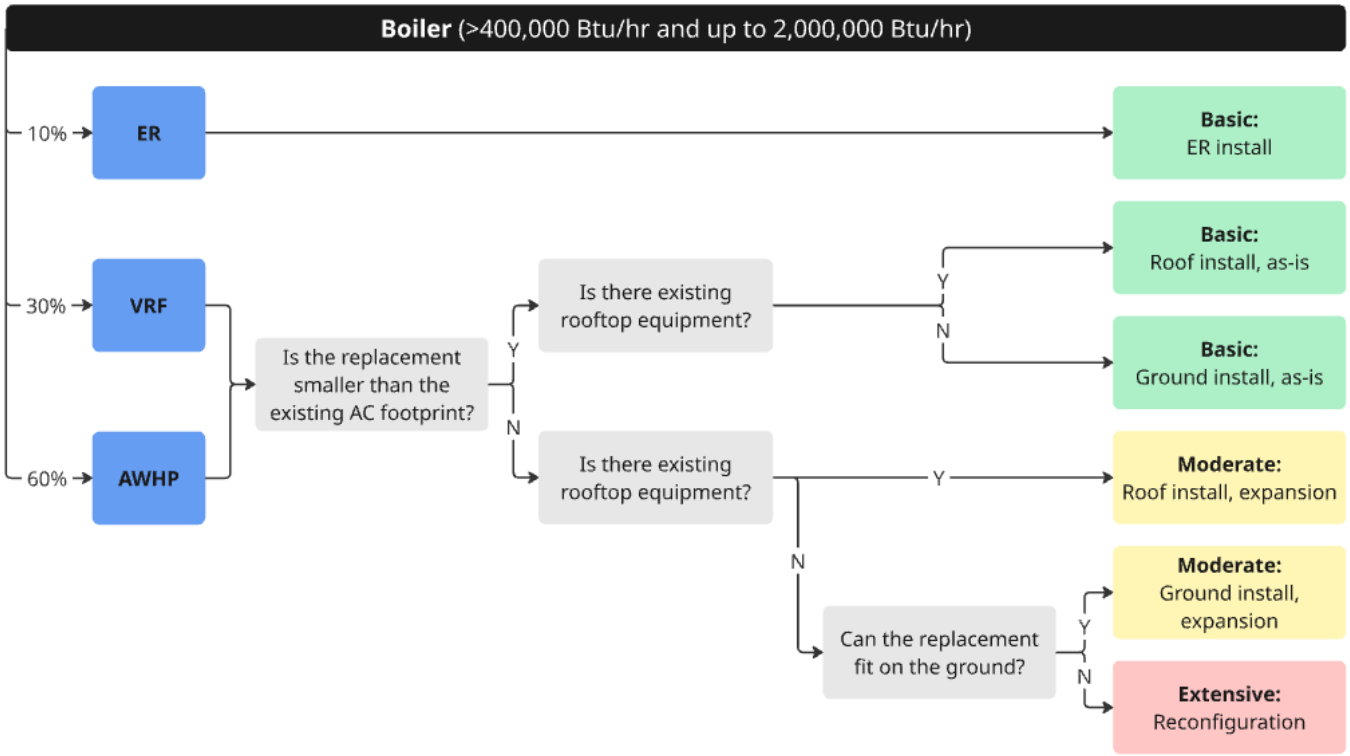


Figure 6. Decision Tree for Commercial Large Boilers



CARB staff did not have precise data on the location of the existing equipment, size of the existing equipment, space needed for the replacement equipment, nor the space available in the existing building. Staff made assumptions based on the best data available at the time of the analysis. Each retrofit scenario was based on the baseline technology, replacement technology, and building attributes below using the following simplifying assumptions:

- **Replacement equipment footprint:** In heating-dominated climates, staff assumed the footprint of heat pump replacement equipment would be larger than that of the existing emissive equipment. In cooling-dominated climates, replacement equipment was assumed to be comparable in size.
- **Presence of existing rooftop equipment:** The building is assumed to have existing rooftop equipment only if the HVAC type contains "RTU" in the name.
- **Replacement equipment location:** Staff assumed that buildings with at least 2,000 square feet of roof area per story or only one story could install replacement equipment on the roof. For roof-constrained buildings with multiple stories and less than 2,000 square feet per story, CARB staff estimated that 93.5% of roof-constrained buildings have less than 90% lot coverage (Dun & Bradstreet, 2024) and could install equipment on the ground. The remaining 6.5% may require extensive reconfiguration to create space within the building footprint for installation of zero-emission equipment.

Each scenario below includes the following retrofit actions (collectively referred to as "basic preparations"): removing and capping pipes or vents from emissive equipment, patching walls and ceilings as necessary, and running wiring from the new equipment to the electrical panel. Additional retrofit actions for each scenario are described below:

1. **Replacing an emissive furnace or boiler with an electric resistance (ER) furnace or boiler:** CARB staff assumed electric resistance equipment replacing comparable emissive equipment would have a smaller footprint due to its smaller components and lack of a combustion chamber and therefore would fit within the existing physical space. This scenario requires only basic preparations.

2. **Replacing an emissive furnace or boiler with a heat pump:**

   Roof installation with existing rooftop heating equipment: CARB staff assumed buildings with existing RTUs have a functioning duct system and space on the roof for a heat pump and its condenser. For heating-dominated climates that need larger replacement equipment, the structural support system may need to be expanded. For cooling-dominated climates, staff assumed existing structural elements could be reused. Retrofit actions for larger replacement equipment include:

   - Adding a pedestal system to support the additional equipment footprint.

   Roof Installation without existing rooftop heating equipment: Staff assumed that buildings with no existing RTUs and adequate roof space would install the replacement equipment with the following retrofit actions:

   - Reinforcing roof framing around the existing air conditioning, constructing an equipment curb, and waterproofing the openings and curb-mounted equipment.

   Ground Installation: Buildings with existing AC and no RTUs were assumed to have a functioning duct system and space for a heat pump and its condenser outside where the existing AC equipment is located. Retrofit actions for larger replacement equipment in heating-dominated climates include:

   - Pouring a concrete pad as necessary beyond the existing pad to support any additional equipment or increased structural loads

   Space Reconfiguration: CARB staff assumed that buildings without adequate roof space and ≤10% open lot area may need to reconfigure the building footprint or roof to allow space for installing zero-emission replacement equipment. Retrofit actions include:

   - Reframing and finishing one-quarter of the existing roof area to create outdoor space for the condenser unit(s). Alternative approaches could reassign usable floor area to house replacement equipment instead.
   - Extending the ductwork to the replacement equipment's new location.

To estimate retrofit impacts across different building sizes, CARB staff found the average heating equipment capacity (Btu/hr), building area, roof area, and number of stories for each combination of baseline and replacement technology as shown in Table 26. Using those parameters and specifications for zero-emission equipment available at the time of analysis, staff estimated the equivalent equipment capacity and corresponding footprint of the replacement heating equipment at a design temperature of 29˚F, the statewide average winter median of extremes. Staff then found the associated retrofit impacts, normalized them by floor area, and scaled them across different building sizes.

Table 26. Average Building Attributes Used to Determine Extent of Retrofit Impacts

Emissive baseline equipment	**Furnace**	**Boiler, Small**	**Boiler, Large**	**Furnace**	**Furnace**	**Boiler, Small**	**Boiler, Large**	**Boiler, Large**
ZE equipment	**ER furnace**	**ER furnace**	**ER furnace**	**Packaged HP**	**Split HP**	**Mini-split HP**	**VRF**	**AWHP**
Capacity (Btu/hr)	674,000	220,000	1,540,000	1,200,000	944,860	288,000	1,680,000	1,680,000
Number of Units	Unknown	Unknown	Unknown	4	3	5	7	1
Equipment footprint (sqft)	Unknown	Unknown	Unknown	360	108	24	134	168
ZE model	Unknown	Unknown	Unknown	Trane, HP-TWA300KD	Trane, HP-TWA300KD	Daikin, RXTQ60TBVJUB	Lennox, VPD240S6M-5Y	Trane, ACS-140
Building Stories	1	3	2	1	1	3	2	2
Building Roof Area (sqft)	8,150	2,547	28,500	8,150	8,150	2,547	28,500	28,500
Building Area (sqft)	8,150	7,640	57,000	8,150	8,150	7,640	57,000	57,000

Commercial Space Heating Results

Staff estimated the percentage of commercial buildings expected to undergo each space heating retrofit scenario. Table 27 shows the percentage of buildings estimated for each retrofit level. These results include the entire commercial building stock, including buildings with equipment not applicable to the regulatory concept and buildings that already have

zero-emission equipment for heating. CARB staff estimate that over half of the commercial floor area would not have to make any changes to their equipment to comply, 13% by floor area may require basic retrofits, 26% may require moderate retrofits, and 8% may require extensive retrofits.

Table 27. Space Heating Retrofit Levels by Floor Area

Retrofit Level	Percent of Floor Area in ComStock
Basic	13%
Moderate	26%
Extensive	8%
Already Zero-Emission or Not Applicable	53%

4.4.2 Commercial Water Heating

Commercial Water Heating Methodology

For baseline water heating equipment, the ComStock dataset indicates the fuel type used for water heating, the equipment's total volume (gallons), and the count of water storage tanks in each building. However, ComStock does not specify the baseline water heating technology. Staff assumed 1.5% of commercial buildings use tankless water heaters based on the average from the Commercial Energy Demand by Technology Type in CEC's FSSAT tool (Guidehouse Inc., 2020). The remaining 98.5% of buildings were assumed to use either storage or boiler water heaters.

CARB staff used a threshold of 120 gallons to differentiate between storage and boiler water heaters by evaluating storage water heater products available from four major water heater manufacturers at the time of analysis: A.O. Smith, Bradford White, Rheem, and State Water Heaters. Storage water heaters typically ranged from 50 to 120 gallons. Of the storage water heaters assessed, the large majority (94%) were 120 gallons or less, as seen in Table 28.

Table 28. Count of Storage Water Heater Models by Manufacturer in May 2024

Manufacturer	30-49 gal.	50-74 gal.	75-120 gal.	121-249 gal.	250+ gal.
A.O. Smith	2	15	50	3	3
Bradford White	0	8	12	0	0
Rheem	5	12	48	0	0
State Water Heaters	2	13	36	3	3

To approximate the baseline technology, CARB staff made the following assumptions:

- Buildings with an average water heater volume up to 120 gallons were made up of:
  - 98.5% Storage Water Heaters
  - 1.5% Tankless Water Heaters ≤200,000 Btu/hr
- Buildings with an average water heater volume over 120 gallons were made up of:
  - 98.5% Boiler Water Heaters
    - Large hotels and offices, hospitals, university buildings, primary schools, and secondary schools as defined in ComStock were assumed to have boiler water heaters >400,000 Btu/hr and ≤2,000,000 Btu/hr.
    - All other building types were assumed to have boiler water heaters ≤400,000 Btu/hr.
  - 1.5% Tankless Water Heaters >200,000 Btu/hr and ≤2,000,000 Btu/hr

Similar to space heating, buildings with electric water heating were assumed to already be zero-emission. There was insufficient data to separate storage water heaters over 2,000,000 Btu/hr (and therefore not subject to the regulatory concept). Any building that relied on district heating for the water heating fuel type was omitted from the analysis.

As shown in Table 29, almost half of the existing building stock already has zero-emission equipment or may not be covered under the regulatory concept for water heating. Storage water heaters serve about 34% of the commercial floor area and boiler water heaters serve about 15%, with all other water heating equipment technologies serving less than 1% of the commercial floor area.

Table 29. Commercial Baseline Water Heating Technology

Baseline Water Heating	Capacity	%, by Floor Area
Boiler	≤400k Btu/hr	<1%
	>400k, ≤2MM Btu/hr	15%
Storage water heater	≤400k Btu/hr	34%
Tankless water heater	≤200k Btu/hr	<1%
	>200k, ≤2MM Btu/hr	<1%
Zero-emission or Not Applicable (district heating)	All capacities	49%

Staff mapped each water heating baseline technology to potential replacements, and each replacement technology was given an assumed adoption rate using input from public experts.

For commercial water heating, boilers, tanked storage, and small tankless water heaters were assumed to be replaced primarily with heat pump water heaters, with smaller

percentages of electric resistance units due to their higher operating costs. Low voltage (120V) heat pumps were not assumed as a replacement technology for commercial buildings as these systems are less suitable for meeting the high-demand requirements for commercial applications. Similar to residential buildings, only 5% of replacements were assumed to be solar thermal given low uptake of the technology to-date.

Similar to the commercial space heating analysis, replacement technology was determined using a static assumed adoption rate based on the best data available at the time of the analysis. These assumptions may not perfectly capture reality. Assumed adoption rates are presented in Table 30.

Table 30. Replacement Water Heating Technology and Assumed Adoption Rate (AAR)

Baseline Heating	Replacement 1 (AAR)	Replacement 2 (AAR)	Replacement 3 (AAR)
Boiler water heater (≤400k Btu/hr)	HPWH (85%)	Electric resistance boiler (10%)	Solar WH (5%)
Boiler water heater (>400k, ≤2MM Btu/hr)	Central HPWH (70%)	Electric resistance boiler (30%)	NA
Storage water heater (≤400k Btu/hr)	HPWH (85%)	Electric resistance WH (10%)	Solar WH (5%)
Tankless water heater (<200k Btu/hr)	HPWH (85%)	Electric resistance WH (10%)	Solar WH (5%)
Tankless water heater (≥200k, ≤2MM Btu/hr)	Central HPWH (70%)	Electric resistance tankless WH (30%)	NA
Zero-emission	NA	NA	NA

To estimate the retrofit actions needed to support the installation of zero-emission water heating equipment in existing commercial buildings, CARB staff developed replacement scenarios as outlined in Figure 7 and Figure 8.

Figure 7. Decision Tree for Small Commercial Water Heaters.

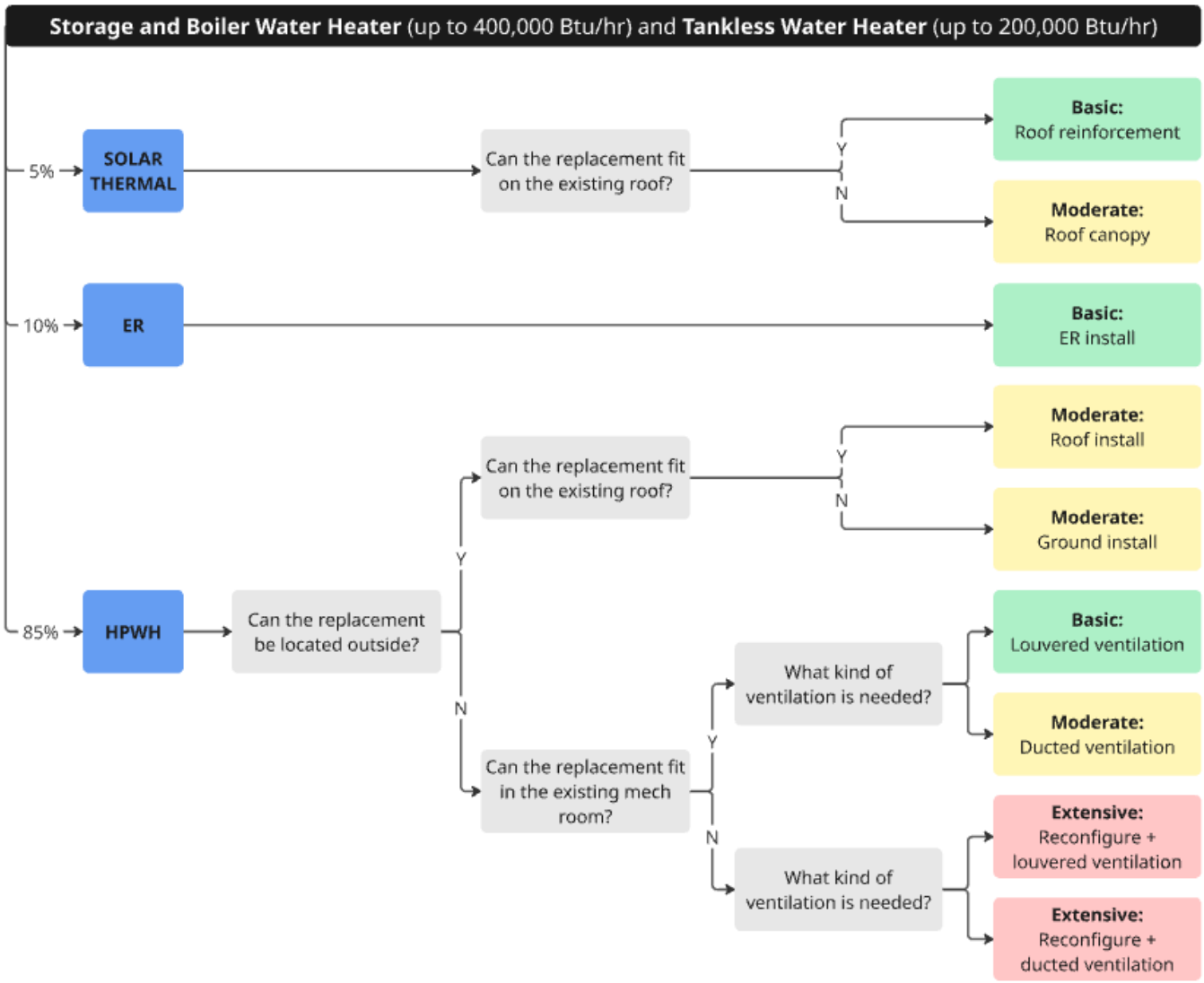
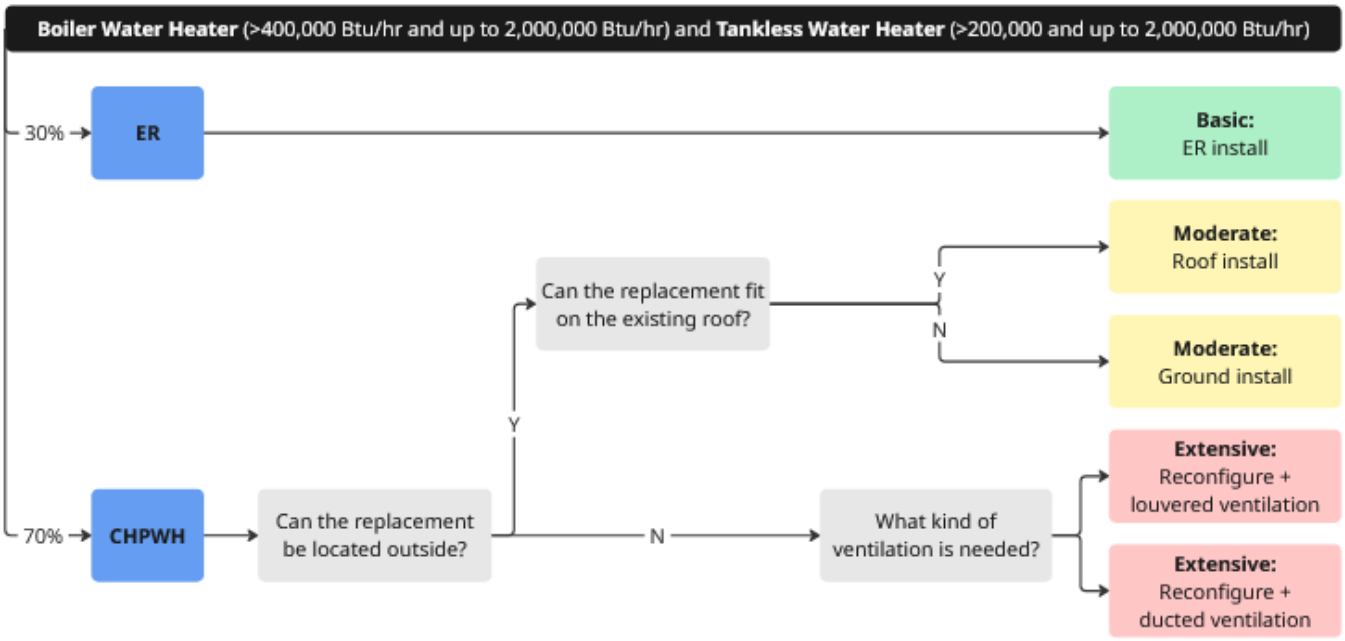


Figure 8. Decision Tree for Large Commercial Water Heaters.



CARB staff did not have precise data on the location of the existing equipment, size of existing equipment, space needed for the replacement equipment, nor the space available in the existing building. Staff made assumptions based on the best data available at the time of the analysis. Each retrofit scenario was based on the baseline technology, replacement technology, and the building attributes below using the following simplifying assumptions:

- **Outdoor location potential:** CARB staff assumed that heat pump water heaters could be located outdoors with some sort of enclosure in warm climates. Warm climates were defined as climate zones that fell below 40˚F for less than 10% of the year and below 32F for less than 1% of the year, based on EnergyStar recommendations (Energy Star) that heat pump water heaters operate between 40˚F and 120˚F ambient temperature. Using weather files, CARB staff determined that all California climate zones except climate zones 14 and 16 meet this definition for a warm climate.
- **Replacement equipment location:** The ComStock dataset provides the count of water heaters per building. Staff assumed that buildings with only one existing water heater could find a way to fit replacement water heating equipment into the existing mechanical room. Buildings with multiple water heaters may need to relocate the new equipment. Staff assumed that buildings with at least 2,000 square feet of roof area per story or only one story could install replacement equipment on the roof. For roof-constrained buildings with multiple stories and less than 2,000 square feet per story, CARB staff estimated that 93.5% of roof-constrained buildings have less than 90% lot coverage (Dun & Bradstreet, 2024) and could install equipment on the ground. The remaining 6.5% may require extensive reconfiguration to create space for installation of zero-emission equipment.

- **Ventilation needs:** CARB staff developed a threshold of 2,500 square feet per floor to estimate if a building's mechanical room is likely exterior-adjacent. This threshold is based on a 20-foot-wide room, a 10-foot-wide hallway, and another 20-foot-wide room (for a total of 50 feet wide and 50 feet long), where all rooms border the exterior. Ventilation needs were estimated using assumptions about the mechanical room location:
    - Buildings with up to 2,500 square feet per story were assumed to have exterior-adjacent mechanical rooms, needing louvered ventilation.
    - Office and Health buildings with over 2,500 square feet per story and less than 75 feet tall or seven stories above grade per the National Fire Protection Association (NFPA) were assumed to have a mechanical room with no adjacency to the exterior, needing ducted ventilation.
        - Other building types in this category were assumed to have exterior-adjacent mechanical rooms, needing louvered ventilation.
    - Buildings with over 2,500 square feet per story and less than 75 feet tall or seven stories above grade per NFPA were assumed to have a mechanical room with no adjacency to the exterior, needing ducted ventilation.

Each scenario below includes the following retrofit actions (collectively referred to as "basic preparations"): removing and capping any pipes or vents from emissive equipment, patching any ceilings or walls as necessary, and running wiring from the new equipment to the electrical panel. Additional retrofit actions for each individual scenario are described below:

1. **Replacing an emissive water heater with an electric resistance heater:** CARB staff assumed electric resistance equipment replacing comparable emissive equipment would have a smaller footprint due to its smaller components and lack of a combustion chamber and therefore would fit within the existing physical space. As a result, this scenario requires only basic preparations.

2. **Replacing an emissive water heater with a HPWH or Central HPWH:**

    Roof installation: CARB staff assumed that building owners may install replacement water heaters on the roof of buildings in warm climates with adequate roof space. Retrofit actions include:

    - Roof curb expansion and roof reinforcement
    - Adding a weatherproof enclosure to protect outdoor equipment
    - Extending wiring and piping from the existing mechanical room to the roof
    - Adding a 135-gallon water storage tank for buildings with multiple water heaters

    Ground installation: CARB staff assumed that building owners may install replacement water heaters on the ground outdoors for buildings in warm climates with adequate ground space. Retrofit actions include:

- Installing a concrete pad and performing associated earthwork
- Adding a weatherproof enclosure to protect outdoor equipment
- Extending wiring and piping from the existing mechanical room to the ground
- Adding a 135-gallon water storage tank for buildings with multiple water heaters

Add louvered ventilation and/or reconfigure the mechanical room: Buildings where the replacement water heater is likely to go in an existing, exterior-adjacent mechanical room may need to install louvered ventilation for adequate airflow and heat pump performance. Buildings with multiple water heaters and no space for the replacement equipment on the roof or ground may also need to reconfigure the existing mechanical room. Retrofit actions include:

- Adding wall vents as recommended by product literature
- (If necessary) demolishing existing mechanical room walls and expanding to accommodate the footprint of the new water heater(s)
- Adding a 135-gallon water storage tank for buildings with multiple water heaters

Add ducted ventilation and/or reconfigure the mechanical room: Buildings where the replacement water heater is likely to go in an existing mechanical room not adjacent to the exterior may need to install ducted ventilation for adequate airflow and heat pump performance. Buildings with multiple water heaters and no space for the replacement equipment on the roof or ground may also need to reconfigure the existing mechanical room. Retrofit actions include:

- Adding ducts for air intake and exhaust as recommended by product literature
- (If necessary) demolishing existing mechanical room walls and expanding to accommodate the footprint of the new water heater(s)
- Adding a 135-gallon water storage tank for buildings with multiple water heaters

3. **Replacing an emissive water heater with a solar thermal water heater:**

Roof Reinforcement: CARB staff assumed that buildings with space on the roof would just need to reinforce the existing roof. Retrofit actions include:

- Reinforcing roof framing as necessary to support the new thermal collector.

Roof Canopy: Buildings without space on the roof may need to build a canopy above the roof for the new thermal collector(s). Retrofit actions include:

- Building a canopy over the existing roof and equipment.
- Reinforcing roof framing as needed to support the new canopy and thermal collector(s).

Commercial Water Heating Results

CARB staff similarly estimated the percentage of commercial buildings at each retrofit level in Table 31. These results include the entire commercial building stock, including buildings not covered by the regulatory concept and buildings that already have zero-emission equipment for water heating. CARB staff estimate that almost half of the commercial floor area would not have to do anything additional to comply with the regulatory concept, 22% by floor area may require basic retrofits, 28% may require moderate retrofits, and 1% may require extensive retrofits.

Table 31. Water Heating Retrofit Levels by Floor Area

Retrofit Level	Percent of Floor Area in ComStock
Basic	22%
Moderate	28%
Extensive	1%
Already Zero-Emission or Not Applicable	49%

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Appendix: CARB Retrofit Results for the Bay Area Air District

This appendix provides a supplemental analysis of building retrofit needs in the Bay Area in response to the Bay Area Air District's zero-nitrous oxides (NOx) rules for space and water heaters. While the California Air Resources Board (CARB) regulatory concept would regulate greenhouse gas (GHG) emissions from space and water heating equipment and the Bay Area rules regulate NOx emissions, CARB staff expect that space and water heaters that comply with zero-NOx rules would also comply with CARB's regulatory concept.

The analysis uses the same data and retrofit methodology described in the *Building Retrofit Analysis Methods*, with additional adjustments to approximate the equipment scope, compliance timelines, and proposed exemptions in the Bay Area Rules 9-4 and 9-6.[1] Both the *Building Retrofit Analysis Methods* and this Appendix support the development of CARB's statewide GHG emission standards through the Clean Space and Water Heater Standards (CSWHS).

1 Differences between the Bay Area Rules and CARB's CSWHS Regulatory Concept

1.1 Space Heating

Rule 9-4 would apply to new natural gas-fired furnaces with a heat input capacity of <175,000 British thermal units per hour (Btu/hr) starting in 2029. The rule differs from CARB's statewide December 2025 regulatory concept in several important ways, which are summarized in Table 1. Table 2 describes how these differences are reflected in this appendix.

Table 1. Comparison of Space Heater Scopes for the Bay Area Rule 9-4 and CARB's CSWHS Regulatory Concept

	Bay Area Rule 9-4	**CARB CSWHS**
Equipment type(s)	Natural gas furnaces	All space heating equipment
Equipment capacity (Btu/hr)	<175,000	≤2,000,000
Geography	Bay Area counties	Statewide

[1] BAAQMD. (2024). *Rules 9-4 and 9-6 Building Appliances*. Bay Area Air Quality Management District. *https://www.baaqmd.gov/rules-and-compliance/rule-development/building-appliances*

Building types	All types except mobile homes	All types[2]
Emission Standard	(Zero) NOx emissions	(Zero) GHG emissions

Table 2. How Differences Between CARB's Current Regulatory Concept for a Statewide Rule and the Bay Area's Rule 9-4 are Represented in this Appendix

Bay Area Rule Criteria	How the Bay Area Rule is Represented in this Appendix[3]
Natural gas furnaces only	Propane/oil equipment and equipment other than furnaces are classified as out of scope.
<175,000 Btu/hr	Other capacities are classified as out of scope.[3]
Bay Area counties	Results are filtered to the nine Bay Area counties.
Mobile homes excluded	Mobile homes with emissive space heating are classified as out of scope.[3]

1.2 Water Heating

Rule 9-6 and the amendments proposed in July 2026 would apply to new natural gas-fired water heaters. The rule differs from CARB's statewide regulatory concept in several important ways, which are summarized in Table 3. Table 4 describes how these differences are captured in this appendix.

Table 3. Comparison of Water Heater Scopes for the Bay Area Rule 9-6 and CARB's CSWHS Regulatory Concept

	Bay Area Rule 9-6 and Proposed Amendments	CARB CSWHS
Equipment type(s)	Natural gas storage tank water heaters in 2028 Natural gas storage tank, tankless, and boiler water heaters in 2033	All water heating equipment
Equipment capacity	>30 gallons and ≤75,000 Btu/hr in 2028 >30 gallons and ≤2,000,000 in 2033	≤2,000,000 Btu/hr

[2] CARB's regulatory concept would regulate equipment sales rather than the type of building in which the equipment is installed. The statewide retrofit analysis therefore includes all building types.

[3] Buildings may be covered under CARB's regulatory concept but classified as out of scope in this Appendix so CARB's retrofit estimates can be compared using the same criteria applied in the Bay Area Rules.

Geography	Bay Area counties	Statewide
Building Types	All types except mobile homes* *Limited exemptions are proposed for businesses with high hot water demands. Exemptions are outlined in Table 4.	All types[4]
Proposed Exemptions	One-time and ongoing exemptions are outlined in Table 4.	N/A as of December, 2025
Emission Standard	(Zero) NOx emissions	(Zero) GHG emissions

Table 4. How Differences Between CARB's Current Regulatory Concept for a Statewide Rule and Bay Area's Rule 9-6 are Represented in this Appendix

Bay Area Rule Criteria	**How the Bay Area Rule is Represented in this Appendix[5]**
Natural gas storage tank water heaters in 2028 Natural gas storage tank, tankless, and boiler water heaters in 2033	Propane/oil equipment is classified as out of scope in all years.[5] Tankless and boiler water heaters are classified as out of scope in 2028 but included beginning in 2033.
>30-gallons and ≤75,000 Btu/hr in 2028 >30-gallons and ≤2,000,000 Btu/hr in 2033	Other capacities are classified as out of scope.[5] Commercial buildings use a threshold of 80 gallons to approximate the 75,000 Btu/hr threshold in the Bay Area Rules due to data limitations.
Bay Area counties	Results are filtered to the nine Bay Area counties.
Mobile homes excluded	Mobile homes with emissive water heating are classified as out of scope.[5]
Exemptions for projects with space or electrical constraints	Buildings estimated to need extensive retrofits are classified under "Extensive/Exemptions" in the results tables.
Exemptions for businesses with high hot water demands, including restaurant, food service, laundry, dry cleaner, healthcare, and assisted living buildings	Businesses with high hot water demands are classified under "Extensive/ Exemptions" in the results tables.

[4] CARB's regulatory concept would regulate equipment sales rather than the type of building in which the equipment is installed. The statewide retrofit analysis therefore includes all building types.

[5] Buildings may be covered under CARB's regulatory concept but classified as out of scope in this Appendix so CARB's retrofit estimates can be compared using the same criteria applied in the Bay Area Rules.

Exemptions for hydronic water heaters manufactured before 2031	Hydronic water heaters used for space heating are covered under space heating in this Appendix.
Exemptions for multi-family buildings (5+ units) with a water heater manufactured before 2033	The multi-family housing exemption is not considered in this analysis.
Exemptions for deed-restricted affordable housing with a water heater manufactured before 2033	Deed-restricted affordable housing is not disaggregated in this analysis due to data limitations.
Exemptions for emergency loaner equipment for licensed contractors	Buildings using emergency loaner equipment are not disaggregated in this analysis due to data limitations.
Exemptions for low-income property owners	Buildings with low-income property owners are not disaggregated in this analysis due to data limitations.

1.3 Terminology

For the result tables presented in the Residential and Commercial sections below, the following definitions apply:

- **Already zero-emission (ZE):** Buildings that have zero on-site emissions based on the building's existing space or water heating equipment as specified in the ResStock and ComStock datasets.
- **Out of scope:** Buildings with equipment that is not covered by the proposed Bay Area Rules 9-4 or 9-6.
- **Exemption:** Buildings with equipment that is covered by the proposed Bay Area Rules 9-4 or 9-6, but the building, owner, or tenant meets specified conditions that could exempt them from compliance with the rules. In the results tables, CARB staff group these buildings with other buildings with estimated extensive retrofit needs, which could also be eligible for exemptions.

2 Residential

2.1 Residential Electrical Panel

The electrical panel analysis for all building types except mobile and manufactured homes uses data provided by the University of California, Los Angeles (UCLA) (Fournier, Cudd, Smithies, & Pincetl, 2024). Roughly 20% or 1.6 million of the 7.7 million statewide residential parcels analyzed as part of the UCLA study are located in the nine Bay Area counties[6]. Table 5 shows the estimated counts of buildings that would require residential panel retrofits in

[6] The UCLA paper reports that their analysis includes 96% - 99% of single-family homes and 79 – 99% of multi-family building depending on county across the nine counties analyzed in this appendix.

the Bay Area. Mobile and manufactured homes are excluded from this table because they are out of scope for Bay Area Rules 9-4 and 9-6.

Table 5. Residential Panel Retrofits, by Building Type

Building Type	Basic	Moderate	Extensive	Total
Single-Family Detached	860,700	568,600	32,200	1,461,500
Single-Family Attached	19,200	28,000	1,600	48,800
2-4 Unit Residential	16,700	47,600	5,400	69,700
5+ Unit Residential	11,700	22,800	1,800	36,300
Total	908,300	667,000	41,000	1,616,300
Percent Total	56%	41%	3%	100%

2.2 Residential Space Heating, Physical Space

The physical space analysis for space heating uses data from ResStock 2024. Roughly three million of ResStock's 14 million residential housing units in California are in the nine Bay Area Air District counties, representing about 20% of all statewide ResStock units. Table 6 Shows the estimated counts of residential space heating retrofits in the Bay Area.

Table 6. Residential Space Heating, by Building Type

Building Type	Already ZE	Basic	Moderate	Out of Scope	Total
Single-Family Detached	258,600	866,200	327,200	112,500	1,564,500
Single-Family Attached	64,100	193,300	-	10,800	268,200
Multi-Family with 2 - 4 Units	88,300	94,600	-	105,700	288,600
Multi-Family with 5+ Units	404,900	181,700	-	191,500	778,100
Mobile Home	8,600	-	-	50,700	59,300
Total	824,500	1,335,800	327,200	471,200	2,958,700
Total Percent	28%	45%	11%	16%	100%

2.3 Residential Water Heating, Physical Space

The physical space analysis for water heating uses data from ResStock 2024. Roughly three million of ResStock's 14 million residential housing units in California are in the nine Bay Area Air District counties, representing about 20% of all statewide ResStock units. Table 7 and Table 8 show the estimated counts of residential water heating retrofits in the Bay Area, with results broken out by compliance date in Table 7 and building type in Table 8.

Table 7. Residential Water Heating, by Equipment Compliance Date

	Already ZE	Basic	Moderate	Extensive/ Exemption	Out of Scope	Total
2028 Equipment	404,400	955,700	404,400	278,800	93,400	2,136,700
2033 Equipment	211,700	326,800	126,900	137,200	19,400	822,000
Total	616,100	1,282,500	531,300	416,000	112,800	2,958,700
Total Percent	21%	43%	18%	14%	4%	100%

Table 8: Residential Water Heating, by Building Type (All Equipment, Regardless of Compliance Date)

Building Type	Already ZE	Basic	Moderate	Exemption	Out of Scope	Total
Single-Family Detached	199,800	911,600	263,900	136,900	52,200	1,564,400
Single-Family Attached	61,300	64,900	74,800	64,200	3,000	268,200
Multi-Family with 2 - 4 Units	78,700	81,800	57,300	68,500	500	286,800
Multi-Family with 5+ Units	270,000	224,300	129,000	146,400	4,000	773,700
Mobile Home	6,300	-	-	-	59,300	65,600
Total	616,100	1,282,600	525,000	416,000	119,000	2,958,700
Total Percent	21%	43%	18%	14%	4%	100%

3 Commercial

The commercial results include only buildings from the nine counties that make up the Bay Area. However, in the commercial analysis, CARB staff assigned counties to buildings based

on the weather file location used in 2025 ComStock – Release 2 energy simulations. This means the results may reflect buildings in climates similar to the Bay Area rather than buildings that are truly part of the Bay Area building stock. Still, this data set represents the best information available at the time of the analysis, and CARB staff estimate approximately 130,000 of ComStock's 650,000 California commercial buildings are in the Bay Area.

3.1 Commercial Electrical Panel

The commercial electrical panel analysis assigns buildings to retrofit categories based on their additional space and water heating loads, as described in the *Building Retrofit Analysis Methods*. Aligning CARB's analysis with the Bay Area rules shifts most commercial buildings into the "out of scope" category. Notably, the 175,000 Btu/hr natural gas furnace threshold reduces the number of buildings included in the sample, which lowers the reliability of the results. Nevertheless, the results are shown in Table 9 by number of buildings.

Unlike other tables in this Appendix, some buildings counted as "out of scope" in Table 9 repeat across multiple rows because the data could not be fully disaggregated. As a result, the total building count in the final column is the same for each row. Buildings already using zero-emission equipment were grouped with out-of-scope buildings to avoid inflated shares of zero-emission equipment caused by ComStock capacity-filtering limitations.

Table 9. Commercial Electrical Panel Retrofit Needs, by Building Count.

Geography	Basic	Moderate	Extensive/ Exemption	Out-of-Scope and/or Already ZE	Total
Bay Area counties, 2028 Equipment ≤80 gallons and space heating <175,000 Btu/hr	900	3,500	3,100	123,100	130,700
Bay Area counties, 2033 Equipment >80 gallons and space heating <175,000 Btu/hr	1,200	6,600	50	122,900	130,700
Total	2,100	10,100	3,150	115,300	130,700
Percent Total	2%	8%	2%	88%	100%

3.2 Commercial Space Heating, Physical Space

Similar as mentioned in the commercial electrical panel section, looking at buildings with space heaters below 175,000 Btu/hr reduced the sample enough to make the commercial

space heating results for physical space retrofits unreliable. To address this concern, staff expanded this analysis to include all commercial buildings statewide below 175,000 Btu/hr and then applied the Bay Area criteria with the results shown in Table 10. Buildings with zero-emission equipment were grouped with out-of-scope buildings to avoid inflated shares of zero-emission equipment due to capacity-filtering limitations in ComStock.

Table 10. Statewide Commercial Space Heating Retrofits, by Building Count, for Equipment <175,000 Btu/hr

Geography	Basic	Moderate	Extensive/ Exemption	Out of Scope and/or Already ZE	Total
Statewide	31,600	68,000	200	550,500	650,300
Percent Total	5%	10%	<1%	85%	100%

3.3 Commercial Water Heating, Physical Space

Using the 80-gallon threshold to approximate the Bay Area Rule 9-6 thresholds resulted in a large enough sample to report CARB staff's preliminary retrofit results for the Bay Area. Table 11 shows CARB's preliminary results for compliance with the proposed Bay Area rules in 2028 and 2033. Buildings with zero-emission equipment were grouped with out-of-scope buildings to avoid inflated shares of zero-emission equipment due to capacity-filtering limitations in ComStock.

Table 11. Bay Area Commercial Water Heating Retrofits, by Building Count

Geography	Basic	Moderate	Extensive/ Exemption	Out of Scope and/or Already ZE	Total
Bay Area counties, 2028 Equipment >30 and ≤80 gallons	23,100	7,000	5,500	50,500	86,100
Bay Area counties, 2033 Equipment >80 gallons	4,400	23,900	1,000	15,300	44,600
Total	27,500	30,900	6,500	65,800	130,700
Percent Total	21%	24%	5%	50%	100%