# Commercial Rooftop Units

## Market Characterization Report

**August 21, 2025**

CalMTA is a program of the California Public Utilities Commission (CPUC) and is administered by Resource Innovations

REPORT # MR25-005

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This report is also appended as Appendix D to the Market Transformation Initiative Plan for Commercial Rooftop Units.



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## List of Abbreviations

| Acronym | Definition |
|---|---|
| AC | Air Conditioner |
| ACCA | Air Conditioning Contractors of America |
| AFDD | Automated Fault Detection and Diagnostics |
| AHJ | Authority Having Jurisdiction |
| AHRI | Air-Conditioning, Heating, and Refrigeration Institute |
| BAS | Building Automation Systems |
| CalTF | California Technical Forum |
| CARB | California Air Resources Board |
| CCC | Connected Controls and Commissioning |
| CEE | Consortium for Energy Efficiency |
| CEUS | California Commercial End-Use Survey |
| COP | Coefficient of Performance |
| C-PACE | Commercial Property Assessed Clean Energy |
| CRTU | Commercial Rooftop Unit |
| EIA | U.S. Energy Information Administration |
| EPA | Environmental Protection Agency |
| ERTU | Efficient Rooftop Unit |
| ERV | Energy Recovery Ventilator |
| ESCO | Energy Service Company |
| ETP | Employment Training Panel |
| EUL | Effective Useful Life |
| GGRF | Greenhouse Gas Reduction Fund |
| GWP | Global Warming Potential |
| HARDI | Heating, Air-Conditioning, and Refrigeration Distributors |
| HP | Heat Pump |
| HRV | Heat Recover Ventilators |
| HSPF | Heating Seasonal Performance Factor |
| HVAC | Heating, Ventilation, and Air Conditioning |
| HVACR | Heating, Ventilation, Air Conditioning, and Refrigeration |
| IEER | Integrated Efficiency Ratio |
| IOU | Investor-Owned Utility |
| ISP | Industry Standard Practice |
| IVEC | Integrated, Ventilation, Economizing, and Cooling |
| IVHE | Integrated Ventilation and Heating Efficiency |
| MT | Market Transformation |
| MTI | Market Transformation Initiative |
| NEEA | Northwest Energy Efficiency Alliance |
| NEEP | Northeast Energy Efficiency Partnerships |
| NRCC | Nonresidential Certificate of Compliance |

| Acronym | Definition |
|---|---|
| NREL | National Renewable Energy Laboratory |
| O&M | Operations and Maintenance |
| OEM | Original Equipment Manufacturer |
| PG&E | Pacific Gas and Electric Company |
| ROI | Return on Investment |
| RSES | Refrigeration Service Engineers Society |
| RTU | Rooftop Unit |
| SCE | Southern California Edison |
| SDG&E | San Diego Gas & Electric Company |
| SEER | Seasonal Energy Efficiency Ratio |
| U.S. DOE | U.S. Department of Energy |
| V&E | Virtual Compliance Assistant and EnergyPro |
| VRF | Variable Refrigerant Flow |
| WE&T | Workforce Education and Training |
| WSC-SMART | Western States Council of Sheet Metal Workers |

# 1 Executive summary

This Market Characterization report is an output of the Phase II research for the Efficient Rooftop Unit (ERTU) Advancement Plan, finalized in February 2024.[1] The Advancement Plan described the research needed to support the development of the Commercial Rooftop Unit (CRTU) Market Transformation Initiative (MTI) Plan. *Please note the Market Transformation Idea name change from ERTU to CRTU.*

This report examines the California market for Commercial RTUs, characteristics of recent sales, supply chain dynamics, regulations and other factors influencing buying decisions, as well as the light commercial heating, ventilation, and air conditioning (HVAC) workforce.

A rooftop unit (RTU) is a type of HVAC system where all the components are packaged into a single unit that sits on a roof. Although RTUs may be installed in residences, this report focuses on commercial RTUs serving a single-zone.[2]

## 1.1 Objectives and Methods

CalMTA had the following research objectives:

- Characterize recent RTU sales in California to inform a market baseline forecast
- Identify relevant voluntary and required regulations impacting RTUs
- Understand the supply-side dynamics of the RTU market
- Understand the demand-side dynamics of the RTU market
- Assess the light commercial HVAC workforce
- Estimate incremental costs for various high-performance RTU features

To achieve these objectives, CalMTA conducted secondary and primary research, as summarized in Table 1.

**Table 1. Summary of CRTU research activities**

| Task | Details |
|---|---|
| Secondary research | • Analysis of various data sets to understand current RTU sales, workforce statistics, and existing RTU stock in California |
| Literature review | • Reports related to RTU efficiency and light commercial market studies |

[1] CalMTA. February 2, 2024. https://calmta.org/wp-content/uploads/sites/263/MTI-Advancement-Plan-ERTUs.pdf
[2] HVAC zoning divides a building into multiple, independently-controlled temperature zones.

| Task | Details |
|---|---|
| Stakeholder interviews | • Seven staff from organizations working in the California or RTU market |
| Workforce interviews | • 16 interviews with various organizations that support or work with the HVAC workforce |
| Contractor interviews | • 18 contractors that install RTUs in California |
| Distributor interviews | • Five distributors that sell RTUs to customers in California |
| Building Owner and Facility Manager Survey | • 70 facility managers in California who manage one or more buildings with an RTU<br>• 68 building owners in California who have at least one building with an RTU |
| Manufacturer interviews | • Multiple staff from five major RTU manufacturers that sell to California customers |

## 1.2 Key Findings

**The RTU market can be subdivided into two markets: custom design/build and "two-minute" purchases.** Manufacturers estimate custom RTUs make up around 20% of the market and are targeted to precision applications, such as ice rinks and clean rooms, where the performance justifies the inherently higher cost. Each RTU is ordered from a manufacturer representative or dealer and then shipped directly to the customer's job site. A design engineer representing the end user may be involved in developing the system specifications along with the manufacturer representative.

According to a manufacturer, the "two-minute" market is referred to as such because decisions on which RTU to install are made quickly. Unplanned replacements, which account for approximately 80% of RTU purchases, occur when an RTU fails and needs to be replaced right away. In this scenario, availability and price drive market decisions. An end user calls a mechanical contractor for a quote, and the contractor asks a distributor what unit is available in the appropriate size and includes features important to the customer. Contractors strongly prefer to buy RTUs that are readily available or can be delivered within a few days.

Most often, distributors place a large order for RTUs on a quarterly basis, which is then delivered to their local storage facility. Distributors stock what they believe will move off their shelves quickly, although they can order most products from most manufacturers if there is customer demand.[3] Interviews and previous studies reveal that minimum-efficiency RTUs are most often

[3] Some manufacturers will not allow dealers to sell competitor products.

stocked, and high-efficiency RTUs are usually ordered from the manufacturer. As such, the majority of the two-minute market is minimum-efficiency RTUs that comply with code.

**Many regulations and industry standards (required and voluntary) apply to RTUs.** National and state energy efficiency regulations set minimum performance standards for air-cooled packaged HVAC equipment based on cooling capacity, configuration, and heating fuel type. Both state and federal regulations are updated periodically, and they regulate different aspects of RTUs due to federal preemption. In 2025, the U.S. Environmental Protection Agency (EPA) required HVAC manufacturers to switch away from R-410a to refrigerants with lower global warming potential (GWP). Starting in 2029, federal regulation requires commercial unitary equipment with a rated cooling capacity of 5.4 tons or greater to be rated using the integrated ventilation, economizing, and cooling (IVEC) and integrated ventilation and heating efficiency (IVHE) metrics. These metrics are more holistic measurements of HVAC performance and are expected to raise the minimum efficiency level compared to current requirements.

Other regulations potentially impacting RTUs are being developed by the California Air Resources Board (CARB), local air quality management districts, and the California Energy Commission (CEC).[4]

The HVAC industry develops voluntary programs and standards, such as the Air-Conditioning, Heating, and Refrigeration Institute's (AHRI's) certification program that verifies equipment efficiency performance. There are also numerous energy-efficiency programs in California and other states that promote high-efficiency RTUs, such as the Northwest Energy Efficiency Alliance's (NEEA's) Efficient Rooftop Unit program and the statewide Comfortably California program. Interviewed contractors and manufacturers pay attention to incentive programs that can bring down the first cost of an RTU and are willing to manufacture/install what incentive programs require, given sufficient lead time (at least a year for non-custom products).

Furthermore, California law requires permits for new and replacement HVAC installations. The permitting process adds time, complexity, and cost. Secondary research and feedback from market actors suggest many unpermitted HVAC replacements occur in California. Permit applications are filed with the appropriate authority having jurisdiction (AHJ), usually the local building department. However, for certain types of buildings, such as schools, the Division of the State Architect may be the responsible authority. Changing regulations and permitting may increase HVAC contractors' costs.

**Heat pumps are a significant share of the recent California RTU market.** The majority (an estimated 79%) of RTUs in new construction from 2024 are heat pumps, which is likely driven by the 2022 Title 24 prescriptive regulations for single-zone space conditioning systems with direct

[4] The California Energy Commission was directed in California Senate Bill 48 (2023) to explore the implementation of building performance standards.

expansion cooling.[5] New construction projects following the prescriptive pathway are required to use heat pump technology in certain building types (e.g., office and retail) and climate zones. The replacement market, which has historically been driven by like-for-like replacements, has a smaller share of heat pumps (CalMTA estimates between 26% and 46%). Most contractors who spoke with CalMTA recently reported converting at least one customer from packaged gas furnace air conditioners (gas packs) to heat pumps. All major RTU manufacturers offer all-electric heat pump RTUs, although this option may not be available in all sizes and efficiency levels. One manufacturer explained these limitations are due to keeping the chassis size consistent across a range of cooling capacities and being limited by what fits.

Although most contractors were familiar with variable speed (inverter-driven) technology, which allows better matching between the compressor's speed and cooling load, it accounted for only 10% of sales. Additionally, heat or energy recovery in packaged systems was also rare, comprising under 1% of installations.

All-electric heat pumps may include factory or field-installed supplemental heating that activates when the heating load cannot be met through the heat pump alone. California's mild climate makes supplemental heating unnecessary in most climate zones, although some contractors may elect to install it anyway. The most common type of thermostat used to control recently installed RTUs is the Wi-Fi-connected thermostat, followed by programmable thermostats.

**Decision-making in commercial buildings is complex and varies based on the type of decision-maker.** Although most building owners and facility managers showed interest in various improvements for their next RTU purchase, RTU replacement practices differed between the two groups. Most building owners reactively replace failed RTUs, while most facility managers replace RTUs on a schedule. Most facility managers are willing to wait for preferred equipment (up to three months), while the majority of building owners purchase what is available right away. Contractors most often reported working with building owners when making a new RTU sale.

Both groups reported awareness of programs providing financial support for new RTU purchases and a willingness to consider an internet-controlled thermostat to control their RTU. While both groups were willing to consider a heat pump to replace an existing gas pack, most were not willing to purchase a higher-efficiency RTU if the price were higher or switch to a heat pump if it meant increased energy costs. In leased buildings, both owners and facility managers were concerned about increased energy costs if a heat pump were installed.

**There are several barriers impeding the broad adoption of efficient RTUs. These are especially pronounced in the two-minute market.** Reviews of existing literature and interviews with market actors confirmed that availability and costs (upfront and operating) are significant barriers toward

[5] Direct expansion cooling refers to a system where the refrigerant in the evaporator coil absorbs heat and evaporates and expands within the coil, removing heat from the air outside of the coil.

adoption of energy efficient RTUs and/or switching to a heat pump. Upfront cost is the most notable barrier given that building owners are responsible for full upfront costs and, on average, expect an RTU to only last four years, which is very short compared to the California Technical Forum (CalTF) effective useful life (EUL) estimate of 15 years for a packaged heat pump air conditioner. Facility managers were more aligned with the CalTF, expecting just under 14 years of service for a new RTU. The need to minimize upfront cost also translates to limitations from existing conditions as changes to the RTU weight, fuel type, or dimensions could necessitate additional costs and renovations.

The cost of energy, specifically the relatively high cost of electricity compared to gas, is another significant cost-related barrier mentioned by multiple market actors in regard to switching to a heat pump RTU. Even in leased buildings, most decision-makers were *very* or *somewhat* concerned about increased energy costs. Split incentives, which occur when building owners or developers are responsible for capital improvements while tenants are responsible for utility bills, means tenants generally do not have much influence when it comes to selecting an RTU, which was validated through CalMTA's primary research.

Non-cost-related barriers include low awareness and product complexity. Consumers often lack awareness of the energy and non-energy benefits that efficient RTUs provide given that distributors and contractors often have difficulty explaining the value due to their own lack of experience with such products. Given the lack of familiarity or interest of purchasers, distributors tend to stick with code minimum equipment, which results in scarcity and long lead times when consumers are interested in buying efficient models. Product complexity can also result in contractor avoidance and lead to the potential for improper installation, which can reduce the installed system efficiency.

**There is a shortage of experienced HVAC workers, especially during the busy summer months.** The HVAC industry faces a shortage of experienced workers in the summertime. Contractors explained that gas furnaces rarely break compared to air conditioners. This situation forces HVAC companies to train new staff and work hard to retain experienced workers, as poaching has become a major issue within the industry. The nature of the work is generally set in uncomfortable locations, especially in the hot summer months, which happen to be when demand for HVAC workers is highest. Many experienced workers age out from these difficult working conditions, while younger workers tend to drop out. Exacerbating the issue is that HVAC work is scarce in the winter, leaving workers with limited options to pursue when HVAC work is light, especially if they are not trained in other construction-related skills. HVAC workers serving the residential market also serve the light commercial market, creating competition for the same workers between the two markets.

Experts reported that this market mainly reacts to price and does not have a way to distinguish installation quality. This leads HVAC companies to bid the lowest to win the job and avoid the nonessential worker development that adds to costs.

# 2 Introduction and target market

An RTU is a forced-air system that packages fans, filters, heating, and cooling components into a single unit to serve a building's HVAC needs. RTUs can be configured in a variety of ways and options, from the discharge direction to supplemental heating. CalMTA's focus is on RTUs that serve a single zone, with between 3 and 20 tons of cooling capacity, and are installed on the roof of a nonresidential building.

## 2.1 Research objectives

The market characterization seeks to provide a general understanding of the state of the RTU market in California, current trends in RTU uptake, installation practices, technology prevalence, supply chain, purchase decision-making, and workforce characteristics. To accomplish these research objectives, the CalMTA team conducted secondary research, literature review, interviews, and surveys. Details can be found in the Methodology section of the report.

## 2.2 Product definition and evolution

In February 2024, when the ERTU Advancement Plan was published, the CalMTA team was using a preliminary product definition that would be further refined through a technical assessment and market research.[6] Over the course of the year, the working product definition evolved. As of this writing (August 2025), the working product definition is as follows below.

CalMTA's CRTU MTI will promote increased adoption of variable-speed heat pump RTUs that exceed federal minimum cooling efficiency by at least 20%, and use sensors, analytics, cloud-connectivity, and simple app-based tools to:

- Increase installed efficiency through improved startup, commissioning, and compliance with Title 24 Acceptance Testing requirements.[7]
- Optimize operational efficiency through predictive analytics and machine learning.
- Increase grid flexibility through the integration of weather data, utility demand response signals, and thermal load data.
- Remotely monitor RTU performance to detect, diagnose, and resolve RTU faults by providing alerts to owners and actionable information to HVAC technicians.

[6] CalMTA 2024, *op. cit.*

[7] Since 2005, the California Energy Code has required acceptance testing to ensure installed equipment in nonresidential buildings operates as designed and in compliance with the energy code. Third parties called Acceptance Test Technicians (ATT) review the approved design and documentation to the actual installation to verify consistency. Then the ATT conducts a functional test depending on the type of equipment installed. https://energycodeace.com/site/custom/public/reference-ace-2016/index.html#!Documents/136na752constantvolumesinglezoneunitaryairconditionerandheatpump.htm

## 2.3 Target market

The MTI target market is nonresidential buildings with existing RTUs. Nonresidential buildings in California occupy approximately 8.8 billion square feet.[8] Based on data from ComStock, a commercial building stock model developed by the National Renewable Energy Laboratory,[9] 54% of floorspace in California is conditioned by single-zone RTUs; this translates to a total floor area of 4.8 billion square feet. A 2014 California Saturation Study found 53% of commercial HVAC units are package single zone systems, which is consistent with the ComStock results.[10]

Nearly 80% of floor space conditioned by single-zone RTUs is found in single-story buildings, and 16% in two-story buildings. According to ComStock data for California, RTU-conditioned floor space is found in many types of buildings (Figure 1), with warehouse buildings comprising the most total square footage of RTU-conditioned floor area. Note that ComStock does not include certain building types such as grocery stores and religious worship.[11]



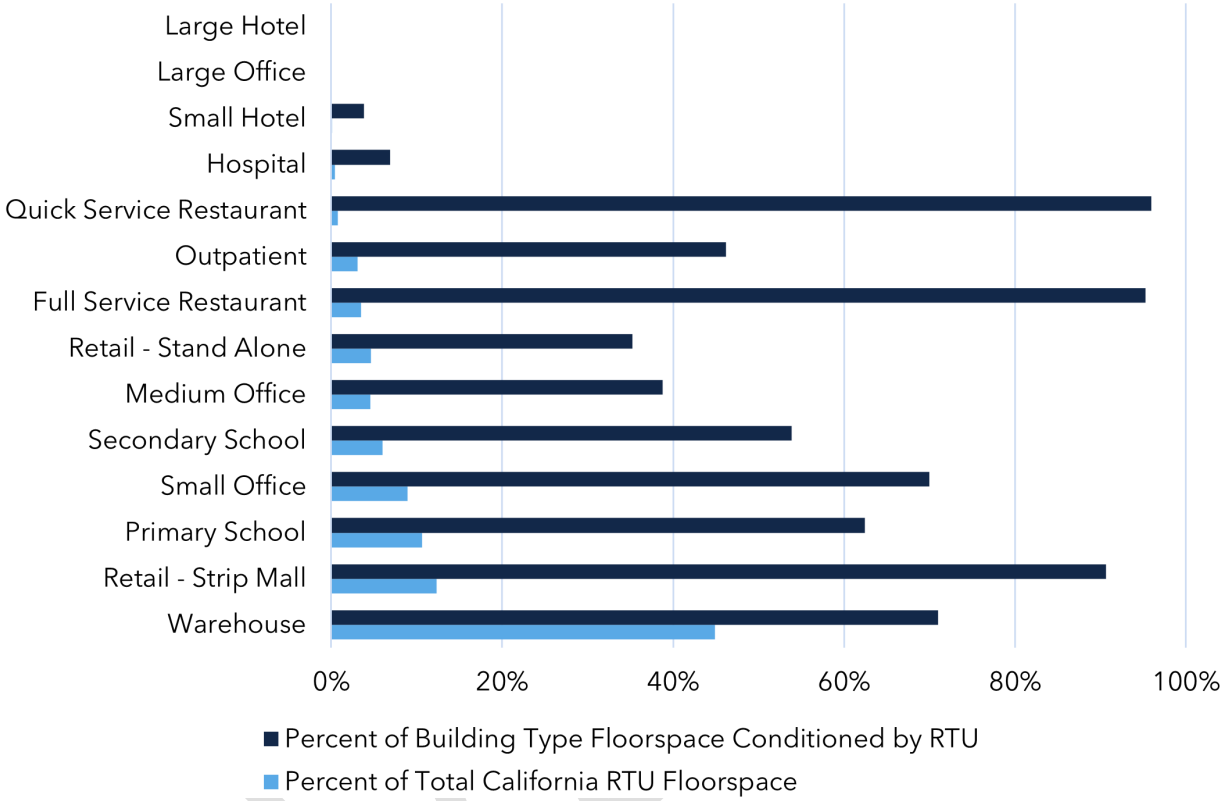
[8] California Energy Commission. February 2024. https://www.energy.ca.gov/sites/default/files/2024-02/2022%20CEUS%20Final%20Report_ada.pdf

[9] The ComStock dataset used is release #2023_2. More information about ComStock and its data sources and limitations can be found at: https://comstock.nrel.gov/

[10] Itron, California Commercial Saturation Survey. August 2014. California_Commercial_Saturation_Study_Report_Finalv2.pdf

[11] Accessed 7/25/2025 https://nrel.github.io/ComStock.github.io/docs/resources/explanations/building_types_not_included.html

**Figure 1. California statewide saturation and distribution of single-zone RTU conditioned floor area, by building type**




Source 1: Comstock, California baseline metadata (U.S. commercial sector circa 2018)

Figure 1 shows the proportion of square footage conditioned by single-zone RTUs in each building type. In restaurants and strip malls, over 90% of floor space is conditioned by single-zone RTUs. Other building types that often use single-zone RTUs include small offices and warehouses.

# 3 California market characteristics

This section combines data from multiple secondary and primary research sources to characterize the California RTU market.

## 3.1 Annual Shipments/Installations

Using shipment data from AHRI[12] and California nonresidential building characteristics from ComStock, CalMTA estimated the market size for single-zone RTUs in California. Table 2 shows the process for estimating the market size for RTUs in 2023.

**Table 2. Top-down California single-zone RTU annual shipment estimation**

| Market description | Number of units (2023) | Comments |
|---|---|---|
| [A] U.S. central air conditioner (AC) and heat pump (HP) Shipments (AHRI) | 8,656,674 | This value is for 2023 and covers all of the United States. |
| [B] U.S. shipments 2.75 to 20 tons (commercial) | 817,133 | Assumes 100% of units over 5.4 tons, 5% of units from 2.75-3.24 tons, and 20% of units from 3.25 to 5.4 tons are for commercial applications.[a] |
| [C] California central AC and HP shipments 2.75 to 20 tons | [B] * 9.2% = 75,399 | California represents 9.2% of U.S. commercial floor space. California's floor space estimate is from the California Commercial End-Use Survey (CEUS), while the U.S. floor space estimate is from the U.S. Energy Information Administration (EIA), Table B5. |
| [D] CA RTUs | [C] * 54% = 40,716 | ComStock data for California shows packaged single-zone RTUs serve 54% of commercial floorspace. |

[a] National Renewable Energy Laboratory (NREL). August 2020. *Long and Winding Road to Higher Efficiency—The RTU Story*. https://www.nrel.gov/docs/fy21osti/77092.pdf

Using mechanical system data from the Virtual Compliance Assistant and EnergyPro (V&E) data, the CalMTA team validated the top-down estimate of approximately 41,000 units. NORESCO and Pacific Gas and Electric Company (PG&E) manage the V&E data as part of the Statewide Codes & Standards Compliance Improvement Subprogram. V&E data capture information from thousands of Nonresidential Certificate of Compliance (NRCC) forms, which are used in the permitting process to demonstrate compliance with Title 24.[13,14] Regardless of construction type, state law

[12] AHRI. Accessed July 1, 2024. "Central Air Conditioners and Air-Source Heat Pumps." https://www.ahrinet.org/analytics/statistics/historical-data/central-air-conditioners-and-air-source-heat-pumps

[13] California Energy Commission. January 2022. *Mechanical Systems Form*. https://www.energy.ca.gov/filebrowser/download/5260

[14] California Energy Commission. Revised May 2023. *2022 Nonresidential and Multifamily Compliance Manual*. https://efiling.energy.ca.gov/GetDocument.aspx?tn=250098

requires permits for all new HVAC systems. However, based on direct research and published studies on permitting rates, not all HVAC installations are permitted, and it is possible some enforcement agencies do not require an NRCC form for a like-for-like HVAC replacement. Thus, while most new construction projects and additions are expected to go through the permitting process and be represented in the V&E data, a significant portion of alterations will likely be missing.

As shown in Table 3, the 2024 V&E data include nearly 19,000 single-zone RTUs under 20 tons in California, with the majority of those RTUs being heat pumps. About half of these are for new construction or additions, while the remaining units are for alterations. Alterations include changes to existing buildings, including replacement of heating and cooling systems. Results from a previous HVAC permitting study found the rate of permitting for alterations to be between 13% and 32%, depending on participation in utility incentive programs and service territory.[15] With input from CalMTA technical experts, the team assumed a permitting rate of 25%, and applied this assumption to develop a bottom-up estimate of total annual RTU installations based on units captured in the V&E data. When trued up for the assumed 75% of missing (unpermitted) RTUs, the result is 46,704 total annual units, with 21% for new construction and 79% for replacements (Table 3).

**Table 3. Annual installations under 20 tons using 2024 V&E data with and without true-up**

| Project type | Heat Pump RTUs 2024 V&E data | Other RTUs 2024 V&E data | Total RTUs 2024 V&E data | Total RTUs 2024 V&E data Trued-Up for Missing Compliance Data |
|---|---|---|---|---|
| Alterations | 6,848 | 2,404 | **9,252** | 9,252 ÷ 25% = 37,008[a] |
| New Construction + Additions | 7,701 | 1,995 | **9,696** | 9,696 |
| Total | 14,549 | 4,399 | **18,948** | 46,704 |

[a]Calculated based on assumption that 75% of RTU installation projects are missing from the V&E database

The top-down and bottom-up estimates are reasonably close (~41,000 units versus ~47,000 units). To further check the reasonability of these estimates, CalMTA reviewed a 2017 RTU study for Minnesota, which found that there were 6,400 RTUs shipped annually to the state. Using the total modeled commercial floor area from ComStock[16] to compare California to Minnesota, the team estimated California RTU shipments by scaling up the Minnesota shipments proportionally, resulting

[15] Pacific Gas and Electric Company. October 10, 2014. *HVAC Permitting: A Study to Inform IOU HVAC Programs*. Prepared by DNV GL. https://www.calmac.org/publications/FINAL_REPORT_PGE_HVAC_Permitting_for_IOU_Programs_Study_v20141010.pdf

[16] In ComStock, California has 7.4 times the total commercial floor area of Minnesota

in 47,300 annual California RTU shipments.[17] Based on this additional analysis, the team estimates annual shipments of commercial RTU installations at approximately 47,000 units (Tables 3 and 4).

## 3.2 Installed Base

CalMTA used the estimate of 37,000 annual replacement RTUs with an assumed effective useful life (EUL) of 20 years based on furnace measures in the California eTRM[18] to estimate a total stock of 740,000 commercial RTUs under 20 tons. To check the reasonability of this estimate, CalMTA referenced the same Minnesota study, which estimated there was an installed base of 136,000 RTUs (of all sizes) in Minnesota. Applying the ratio of Minnesota commercial floor area to California commercial floor area results in an estimated installed base of approximately 1 million RTUs in California. One possible reason for the discrepancy between the two estimates is that the actual EUL of commercial RTUs may be closer to 25 years, as found in a recent study.[19]

## 3.3 California RTU characteristics

Additional characteristics of California RTUs are available in the V&E data. To account for the missing alterations data, CalMTA weighted the data to reflect a 79% market share for alterations and 21% for new construction and addition projects. Although the V&E data includes RTUs over 20 tons, CalMTA's analysis in this section focuses on RTUs under 20 tons of cooling capacity.

Figure 2 shows the distribution of RTUs under 20 tons by cooling capacity in 2024, with more than half of RTUs having under 5.4 tons of cooling capacity.

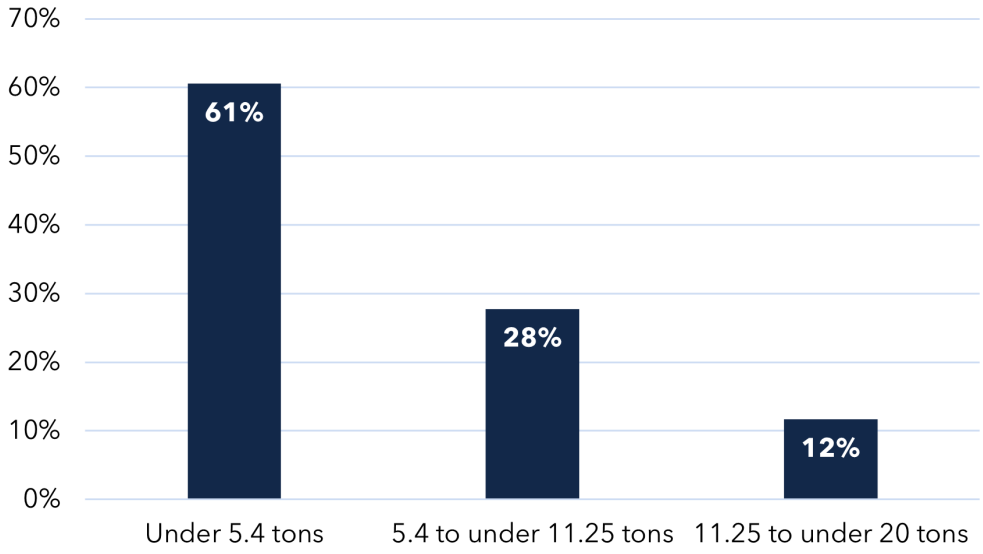


[17] Seventhwave and Center for Energy and Environment. March 2017. *Commercial Roof-top Units in Minnesota: Characteristics and Energy Performance*. https://mn.gov/commerce-stat/pdfs/card-seventhwave-2017-rtu.pdf

[18] https://www.caetrm.com/about/

[19] https://www.caetrm.com/media/reference-documents/CPUC_Group_A_2023_Commercial_HVAC_and_Water_Heating_EUL_Study_Final_Report.pdf. This study reported a median EUL of 24.9 years.

**Figure 2. Distribution of California RTUs under 20 tons by cooling capacity**



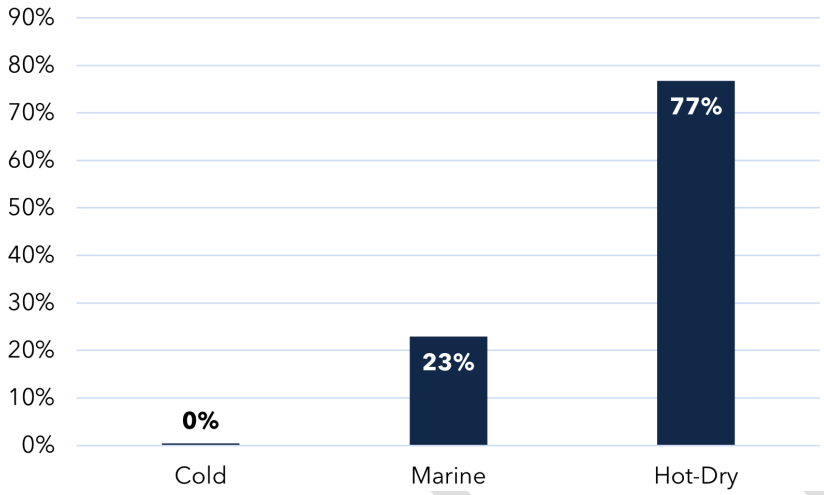

Source 2: 2024 V&E data, weighted

As shown in Figure 3, the majority of RTUs under 20 tons were installed in hot-dry climate regions (climate zones 7 through 15).[20] Less than 1% were installed in cold climates (climate zone 16), while 23% were installed in Marine climate regions (climate zones 1 through 6). Figure 4 is a map of the 16 California building climate zones.



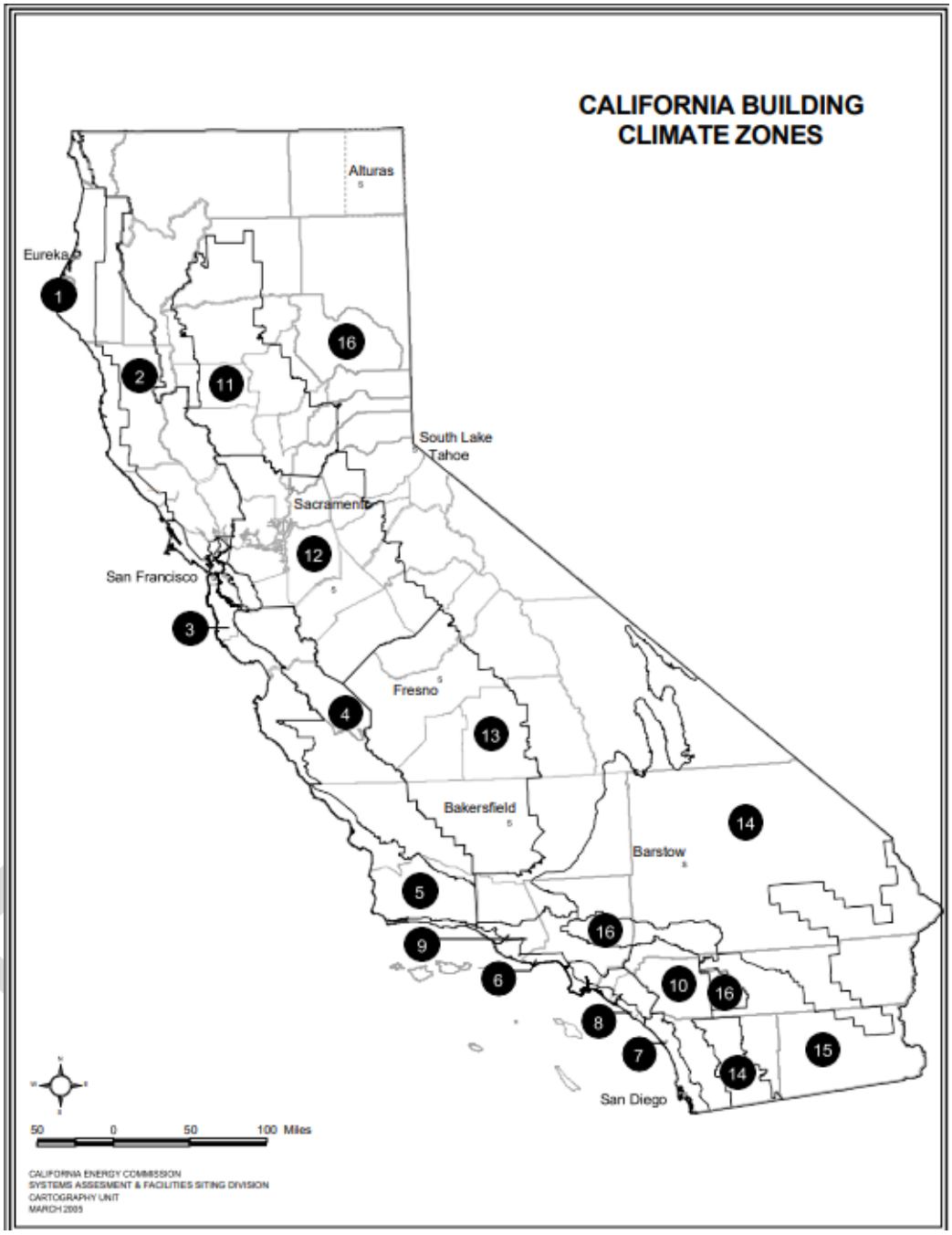
[20] CalMTA used the same climate region definitions as the TECH Clean California Incremental Cost Study. CPUC. October 21, 2014. *California Water Heating Market Study*. Prepared by Opinion Dynamics. https://techcleanca.com/heat-pump-data/evaluation-studies/

**Figure 3. RTUs under 20 tons distribution by climate region**




Source 3: 2024 V&E data, weighted

**Figure 4. California climate zones**




Source 4: California Energy Commission (CEC). Accessed March 6, 2025 "California Climate Zones." https://www.energy.ca.gov/sites/default/files/2020-05/Appendix_C_EnergyStandardsClimateZones.pdf

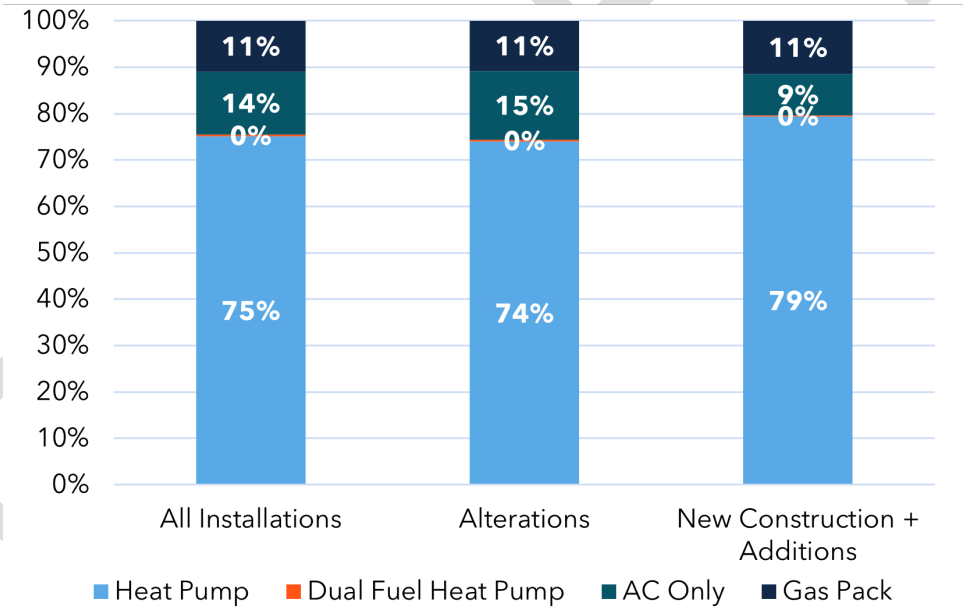
### 3.3.1 Heat Pump RTU Market Share

#### *V&E Data Analysis*

Although CalMTA believes the V&E database is missing 75 percent of alteration projects, it can be used to calculate minimum and maximum possible heat pump market share.

Figure 5 compares the types of RTUs in the V&E database by project type (alterations versus new construction/addition). Heat pump share among new construction and addition projects (79%) did not differ widely from heat pump share of alterations in the database (74%). However, as noted earlier, RTUs missing from the V&E data are expected to be alterations representing like-for-like replacements. Given the high estimated market saturation of gas pack RTUs (see 3.3.2 Heat Pump RTU Saturation), it is likely that most of the projects missing from the V&E database are like-for-like gas pack replacements. Therefore, 74% is almost certainly higher than the true heat pump RTU market share for all alteration projects. This conclusion is supported by findings from interviews with installers (see Figure 7).

**Figure 5. RTUs under 20 tons types by construction type (2024 V&E data)**




Source 5: 2024 V&E data, all installations column is weighted

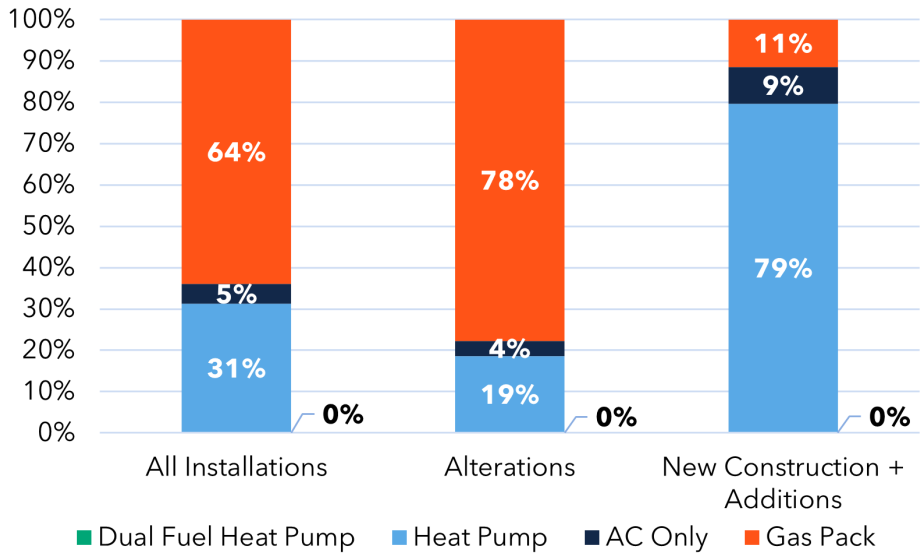
To estimate a *lower bound* for heat pump RTU market share, CalMTA calculated an adjusted market share based on the assumption that all of the alterations not captured in the V&E data were like-for-like replacements of gas packs (Table 4).

**Table 4. Annual installations under 20 tons using 2024 V&E data with gas pack backfill of missing alteration projects**

| Project Type | Total estimated RTUs | Dual Fuel Heat Pump | Gas Packs | AC Only | Heat Pump | % Heat Pump |
|---|---|---|---|---|---|---|
| Alterations | 37,008 | 33 | 28,755 | 1,372 | 6,848 | 19% |
| New Construction + Additions | 9,696 | 16 | 1,112 | 867 | 7,701 | 79% |
| All Installations | 46,704 | 49 | 29,867 | 2,239 | 14,549 | 31% |

Figure 6 shows that under this scenario (using gas packs to fill in missing alterations data), heat pumps represent the majority (79%) of RTUs in new construction, but market share of alterations may be as low as 19%, with 31% across all installation scenarios.

**Figure 6. RTUs under 20 tons Types by Construction Type (V&E data with gas pack backfill)**



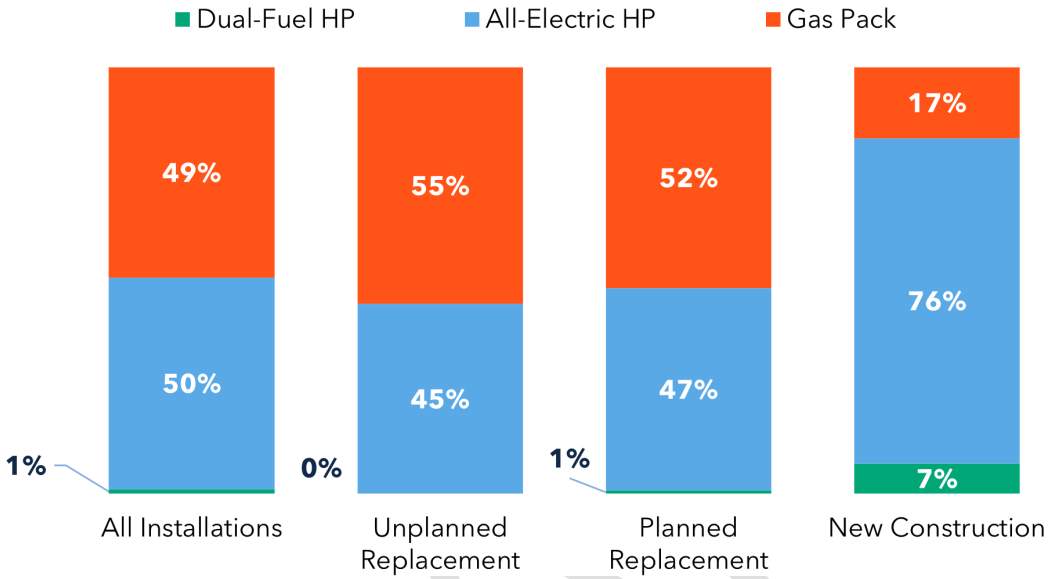

Source 6: 2024 V&E data, weighted

### *Contractor and Distributor Interview Findings*

Sales data from the 18 contractors CalMTA interviewed in late 2024 indicate that heat pumps and gas packs accounted for roughly half of RTU sales each, while dual-fuel heat pump RTUs were less than 1% of RTUs (Figure 7). The finding on low market share of dual-fuel heat pumps RTUs aligns with distributor interview results from a recent market study that estimated 2% of sales were dual

fuel in Minnesota, a much colder climate than California. Both Figure 6 and Figure 7 show a noticeably higher share of heat pump RTUs in new construction scenarios (nearly 80%) when compared with replacement/alterations.

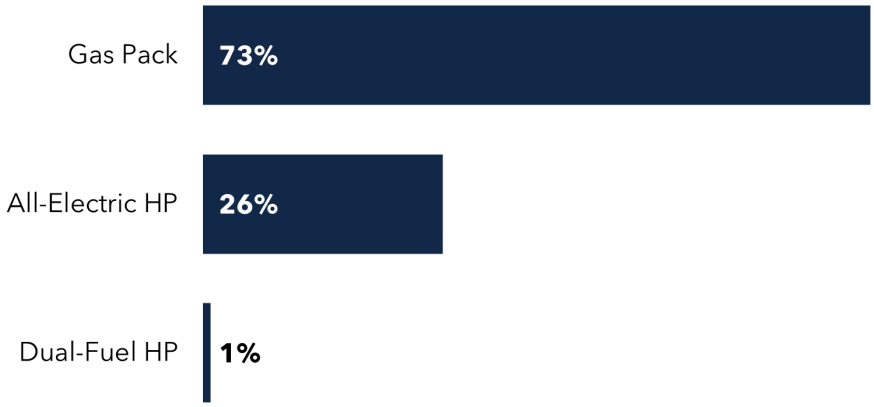
**Figure 7. Contractor sales by fuel type and installation scenario (n=18)**




Source 7: CalMTA HVAC interviews, results weighted by sales

CalMTA also interviewed five distributors about their RTU sales. Figure 8 shows distributors reported selling more gas pack systems than all-electric heat pumps, and very few dual-fuel heat pumps. The distributors' reported sales combined with the contractors' sales corroborate that the V&E dataset is missing many gas pack projects. Since customers can source from channels other than distributors, CalMTA does not recommend using distributor sales alone to inform overall market characteristics, however these results are similar to the lower bound of heat pump market share as shown in Figure 8.

**Figure 8. Distributor sales by fuel type (n=5)**




Source 8: CalMTA HVAC interviews

CalMTA believes the heat pump market share in the replacement market falls in the range between 26% and 46% - the share estimated by distributors and contractors, respectively, with heat pump market share in new construction projects at 76%.

### 3.3.2 Heat Pump RTU Saturation

Using data from ComStock for California, CalMTA estimated the saturation of heat pump RTUs circa 2018 to be 9% of RTU conditioned floor space (Table 4).

**Table 4. ComStock RTU Saturation by Floor Space**

| Heat Source for Packaged Unit | 2018 Saturation (Floor space) |
|---|---|
| Heat Pump | 9% |
| Electric resistance | 25% |
| Gas Pack | 64% |
| Other | 2% |
| **Total** | **100%** |

To estimate the saturation of heat pumps in 2025 (Table 5) using previously presented data, CalMTA calculated the total RTU stock starting with 740,000 units in 2024 and assuming each year the stock grows by 9,696 (new construction units from Table 3). Then CalMTA calculated the number of heat pumps, starting with a 9% saturation in 2018. This analysis assumes the RTU saturation on a per-unit basis is comparable to the RTU saturation by floor space.

Annually, the number of heat pump RTUs grows by the number of new construction heat pump RTUs (76% multiplied by 9,696) plus between 26% (per distributor interviews) and 46% (per contractor interviews) of annual replacements (37,008 total RTU units), minus 1/20 of the previous

year's stock that is assumed to have been replaced (using an EUL of 20 years), resulting in an estimated current heat pump saturation between 20% and 26%.[21]

**Table 5. Estimated Heat Pump Stock and Saturation 2018-2025**

| | Total RTUs | Heat Pump RTUs (Lower Bound) | Heat Pump Saturation (Lower Bound) | Heat Pump RTUs (Upper Bound) | Heat Pump Saturation (Upper Bound) |
|---|---|---|---|---|---|
| 2018 | 681,824 | 63,676 | 9% | 63,676 | 9% |
| 2019 | 691,520 | 77,483 | 11% | 84,884 | 12% |
| 2020 | 701,216 | 90,600 | 13% | 105,033 | 15% |
| 2021 | 710,912 | 103,061 | 14% | 124,174 | 17% |
| 2022 | 720,608 | 114,899 | 16% | 142,358 | 20% |
| 2023 | 730,304 | 126,145 | 17% | 159,633 | 22% |
| 2024 | 740,000 | 136,829 | 18% | 176,044 | 24% |
| 2025 | 749,696 | 146,978 | 20% | 191,634 | 26% |

## 3.4 Fuel substitution (conversion to heat pump RTUs)

Of the 18 contractors CalMTA interviewed, 16 said at least one customer converted a gas pack RTU to a heat pump RTU. Of the contractors who said their customers converted their gas pack RTUs to heat pump RTUs, three appeared to do so because they only sold heat pumps. Two other contractors said the buyers chose to convert because they recommended it, with one adding that the switch depended on the individual property and what would enable them to comply with the local air quality district requirements.[22] This contractor further elaborated that they sold heat pumps to avoid having to use ultra-low emissions gas furnaces that are "junk," but that if the requirements were not there, they would push gas "all the time" because "gas is cheap." Another contractor said it depended on the individual circumstance and complying with local requirements, and a couple more said they convert customers to heat pumps if they have enough amperage.

For buyers converting to heat pump RTUs, the biggest potential problem or consideration is whether their electrical panel can support the heat pumps (five of 16 contractors). Older buildings may not have the capacity required to install heat pumps and would require additional electrical work to be done ahead of the RTU installation. Three contractors said most building owners or

[21] Note that this analysis is based on 2024 V&E installation data, which may result in somewhat overstated growth in heat pump RTU saturation since 2018. Previous years of V&E data were incomplete but suggest that RTU installations were lower in 2021 and 2022 – possibly due to COVID-related market stagnation.

[22] This contractor is in the South Coast Air Quality Management District, which has Rule 1111 reducing NOx emissions from Natural Gas Fired Furnaces. The rule would apply to combination heating and cooling units with a cooling rate of less than 65,000 BTU/hr.

managers would not be interested in that added expense. One contractor also noted that the high electricity demand, combined with high electricity prices, poses a problem with heat pumps.

Three contractors cited cost as the rationale for RTU buyers not interested in converting to a heat pump. These contractors noted several reasons for RTU buyers' disinterest in heat pumps, which included that RTU buyers wanted the cheapest upfront cost, preferred gas, or were concerned about increased operating costs due to relatively high electricity prices.

## 3.5 Supplementary heat on RTUs

Because heat pumps move heat from the environment into the building when operating in heating mode in very cold conditions, the heating capacity of the heat pump may decrease to the point where supplemental heating is required to hit the building's set point. Heat pump RTUs may use either electric resistance or gas for supplemental heating. Most of California's population resides in mild or hot climate zones; as such, supplemental heating was not usually required, according to the interviewed HVAC contractors.

Most contractors (11 out of 17 respondents who sold heat pump RTUs) rarely or never sold all-electric heat pump RTUs with supplemental electric resistance heat in the past year. These contractors were primarily located in Southern California, with one also serving the Central Valley. One contractor elaborated that the reason supplemental heat is so rare (in his experience) is because it significantly increases the customer's bill, thus defeating the purpose of fuel substitution and burdening the customer. He added that with a proper load calculation on the ductwork and an accounting of the climate zone, the heat pump should be sufficient on its own.

Of the six respondents out of 17 who did sell (or provide service for) all-electric RTUs with electric resistance supplemental heat in the past year, about half only do so occasionally. One contractor who sells them "all the time" added that they frequently install supplemental heat to improve the performance of the heat pump system in cold weather (this contractor serves Northern and Central California).

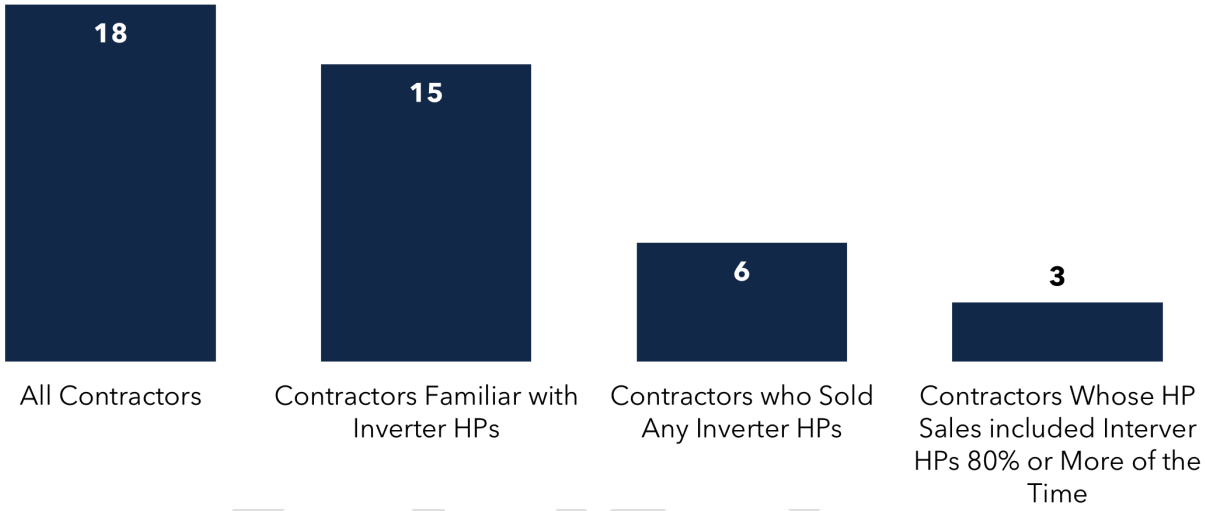
Contractors explained that a heat pump system located in cooler climates may need supplemental heat. They also commonly consider whether a building has enough electrical capacity available to support the separate circuit for the resistance heater. One respondent provided a more holistic view, noting that they consider the building type, age, and how much the system is expected to run and added supplemental heat when the system is expected to run longer.

Similarly, interviewed distributors did not sell many heat pumps with supplemental electric resistance heating circuits – three sold none, while the other two said that roughly 10% to 15% of the systems they sold had supplemental heat. Of the two distributors who reported selling systems like this, one serves the entire state, and the other serves the Bay Area. Note that supplemental heat can be field-installed, so distributors may not be aware of all supplemental heat installations.

## 3.6 Inverter-driven heat pumps

As shown in Figure 9, most contractors (15 out of 18) were familiar with inverter-driven (also called variable speed) heat pump RTUs. However, of those 15 contractors, only six reported selling and installing them. Of those, three contractors sold inverters in 80% or more of their annual heat pump sales, and the other half only sold inverter-driven heat pumps occasionally, citing higher costs as a customer barrier despite the contractor recommending them for efficiency purposes. Overall, inverters were reported in just under 10% of contractors' sales.

**Figure 9. Contractors' familiarity with and sales of inverter-driven RTUs (n=18)**




Source 9: CalMTA HVAC interviews

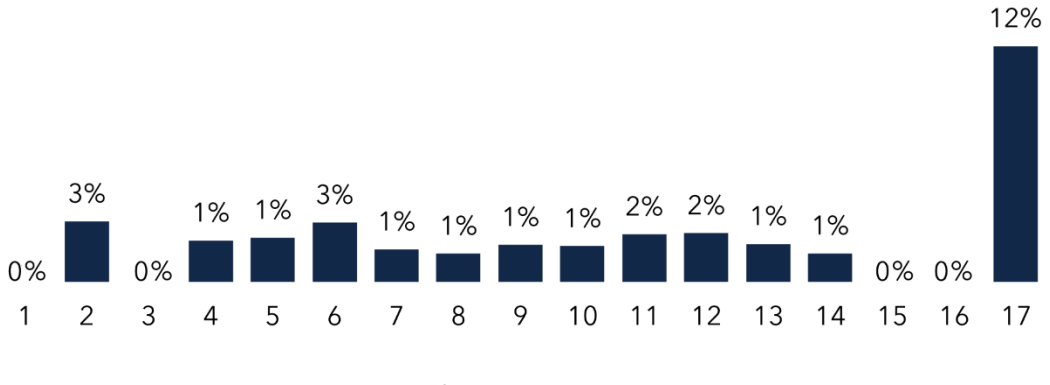
One contractor explained that in a building with tenants where the tenant pays the electricity bills, landlords are often reluctant to pay the additional upfront cost of the variable systems since they do not directly benefit from the energy savings. Several contractors familiar with inverter-driven heat pumps noted the issue of cost but that they had not sold any in the past year. In contrast, the few contractors who frequently sell inverter-driven systems touted the efficiency benefits. These contractors said they either put effort into educating customers or had customers, such as schools, universities, or those who specifically sought out a more efficient heat pump system and were more willing to take on that additional cost.

Similarly, the interviewed distributors did not sell many inverter heat pumps. Of the five respondents who did, none of them stocked inverter-driven heat pumps. Only one reported selling inverter-driven heat pumps, citing the energy and cost savings as advantages. This same respondent also noted that these systems are special order items, typically taking four to five days to obtain. One other respondent said that while they offer inverter-driven heat pumps as an option, they almost never sell them.

## 3.7 Heat and energy recovery

V&E data indicate less than 1% of recently planned RTU installations statewide include heat recovery. Figure 10 shows these low rates of heat recovery across all climate zones, with climate zone 16 (the coldest climate in California) being the only region where heat recovery exceeds 10%.

**Figure 10. RTUs under 25 tons with heat recovery by California building climate zone**




Source 10: 2023-2024 V&E data, weighted

One-third (six of 18) of the contractors interviewed by CalMTA were familiar with heat recovery ventilators (HRVs) or energy recovery ventilators (ERVs), and only two sold RTUs with ERVs in the past year. Among the two contractors who did sell ERVs, one said they install ERVs about 30% to 40% of the time, especially for multi-use spaces, but almost never install systems with HRVs. They added that they recommend ERVs depending on usage and airflow requirements and that customers tend to respond to the recommendation and installation positively because they appropriately match their needs. Another contractor said that although they always recommend ERVs for commercial spaces, they only installed two or three units in the past year, and it really depended on whether the customer could see the cost-saving potential.

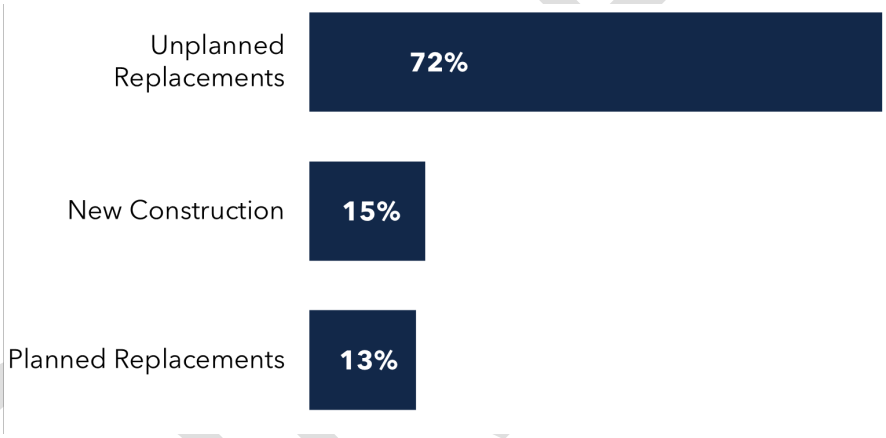
Distributors reported that they did not sell many RTUs with ERVs, either as an original equipment manufacturer (OEM) integrated module or as a bolt-on ERV, and none kept ERVs in stock. Of the five distributors interviewed, only one sold ERVs, and they expect more sales as customers learn about how these systems are easier to use and more efficient. Still, this distributor added that they do not keep ERVs in stock because of their expense and relatively low sales volume.

## 3.8 Planned and unplanned RTU installations

A recent market study estimated that in replacement scenarios, 75% to 95% of new RTUs were replace-on-failure, whereas 5% to 25% of new RTUs were planned.[23] The study also found that small businesses that tended to be more cost conscious were more likely to proceed with a replace-on-failure model, whereas large retail and national accounts were more likely to plan their replacements. Replace-on-failure typically resulted in opting for standard equipment given its availability and price point, while planned replacements increased the likelihood that the customer would opt for high-efficiency equipment due to the extra time and budget for ordering equipment from manufacturers.

CalMTA's contractor interviews found similar rates of planned/unplanned replacements,[24] with only 16% of replacements (13% divided by 85%) being planned. New construction and planned replacements were approximately 28% of recent RTU sales, with unplanned replacements being the majority (Figure 11).

**Figure 11. Contractor RTU sales by installation scenario (n=18)**




Source 11: CalMTA HVAC interviews

According to contractors interviewed by CalMTA, while some end-use customers sought fuel substitution, in most unplanned replacements, contractors not only replaced the existing RTU with another RTU (rather than a different type of HVAC system like a variable refrigerant flow), but they also usually replaced the RTU with a product that was similar or identical to the previous system. While customers sometimes preferred the same product they previously had (i.e., they are already comfortable with it), the reason for installing a similar system was often to limit the need for additional renovations (i.e., ductwork or curb changes), thereby minimizing cost.

[23] Cadeo. 2023. *op.cit.*

[24] Planned replacements are new RTUs installed prior to the existing equipment failing, and unplanned replacements occur when an existing system fails.

## 3.9 Historic California RTU efficiency characteristics

Commercial unitary HVAC equipment includes split and packaged systems, with single-packaged equipment (i.e., RTUs) comprising 95% of the market.[25]

In California's commercial unitary air conditioning and heat pump market, standard practice is code-minimum efficiency. An Industry Standard Practice (ISP) study found that the market share of code-minimum unitary HVAC products was about 60% to 70% with incentive support and would be higher without incentives.[26,27] Because ISP in California is the typical purchase or practice in the market absent incentive program support, the ISP study concluded that code-minimum efficiency was the industry standard practice for the unitary HVAC market.

The ISP survey asked HVAC industry professionals about stocking practices,[28] and respondents indicated that distributors rarely stock products greater than 25 tons because larger-size products "are typically made-to-order and shipped directly to the job site." The ISP study states every manufacturer and distributor always offered code-minimum products. When asked to rate stocking higher-efficiency options on a 5-point scale, where 5 means *highly dependent*, survey respondents reported it was *somewhat dependent* (a score of 3) on rebate program support. Survey respondents reported that 15% to 20% of sales under 20 tons receive utility rebates.

The ISP study found that package systems "dominate the commercial market over split systems, and air conditioners account for more market share than heat pumps, especially with increasing unit size." In this study, air conditioners may or may not have gas heating.

A 2014 commercial market share tracking study reviewed small packaged and split HVAC units (under 5.4 tons).[29] It found that 75% of small HVAC units purchased between 2009 and 2012 were code-minimum efficiency units. Purchasers who participated in energy efficiency programs were more likely to purchase high-efficiency units than those who did not participate. Systems installed by larger contractors (four or more employees) displayed a higher share of minimum efficiency equipment (80%) than for smaller contractors with fewer than four employees (57%).

In addition to the rated equipment efficiency, Southern California Edison (SCE) staff interviewed by CalMTA said RTUs often fail to live up to their rated efficiency due to low-quality installations. Staff explained that a less efficient unit properly installed may operate more efficiently than a unit with a higher rating that was not properly commissioned.

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[25] AESC and ASK Energy. 2021. *Industry Standard Practice Study of Commercial Unitary Air Conditioning and Heat Pump Systems.*

[26] *Ibid.*

[27] Unitary equipment refers to either package or split systems.

[28] HVAC professionals included 12 distributors, two manufacturer representatives, and one manufacturer.

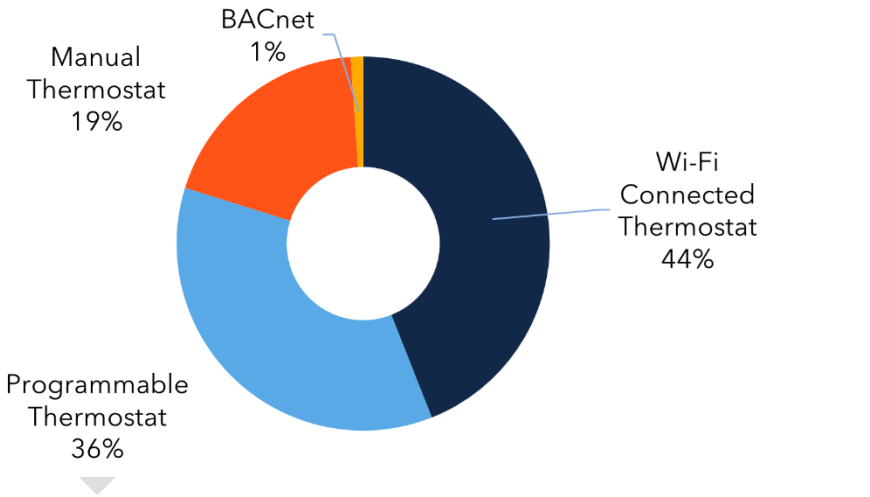
[29] Itron. 2014. *California Commercial Market Share Tracking Study.* California_Commercial_Market_Share_Tracking_Study_Reportv2ES.pdf

## 3.10 RTU controls

HVAC control boards and thermostats play important but different roles in controlling RTUs. The control board is akin to the brain of the system, receiving signals from the thermostat and other sensors to coordinate and control a broad range of functions (i.e., fan speed), while thermostats measure temperature in the conditioned space (in a single zone) and call for heating or cooling from the HVAC system. RTU thermostats range from manual thermostats to internet-connected controls to BACnet thermostats that allow integration with building automation systems (BAS). NREL estimates that 60% of commercial buildings in the United States over 50,000 square feet have a BAS, but only 13% of buildings under 50,000 square feet have adopted the technology.[30]

Figure 12 shows results from CalMTA's interviews with 18 contractors about how RTUs sold in the past year were controlled. Contractors most frequently said by a Wi-Fi-connected thermostat (44%). Some contractors noted there are state requirements and building codes that require programmable controls. Several contractors said they prefer Wi-Fi-connected thermostats due to their ease of use and ability to detect problems, and they frequently recommend them to customers. Contractors still use manual thermostats in some instances (19%). One contractor elaborated that they typically only install manual thermostats for customers who are either replacing an existing manual system or who are not comfortable with programmable or Wi-Fi controls. Only one contractor said they install units controlled with BACnet thermostats, and these represent approximately 10% of their sales.

**Figure 12. Controls used with recently sold RTUs by contractors (n=18)**

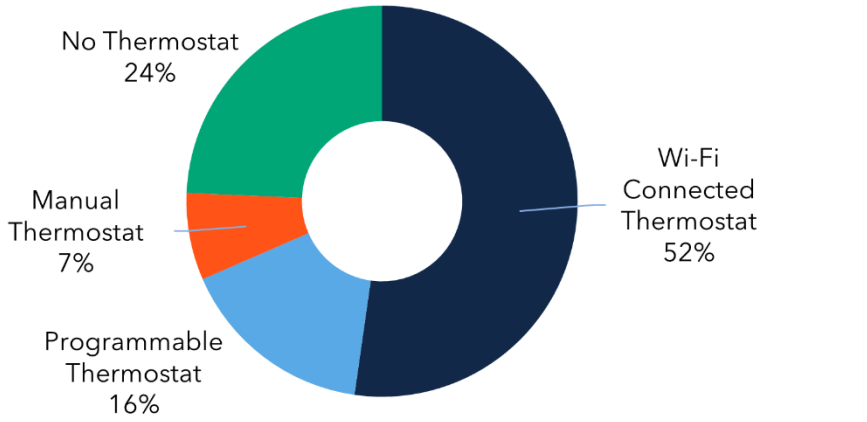



Source 12: CalMTA HVAC interviews

[30] Clean Energy Manufacturing Analysis Center. 2022. *Commercial Building Sensors and Controls Systems: Barriers, Drivers, and Costs.* https://www.nrel.gov/docs/fy22osti/82750.pdf

As illustrated in Figure 13, distributors also reported they sold the majority of RTUs with Wi-Fi-connected thermostats (52%). Distributors estimated that they sold a quarter of RTUs without a thermostat, indicating that the existing thermostat would likely be re-used in those sales. Programmable and manual thermostats together made up the remainder of sales, 16% and 7%, respectively.

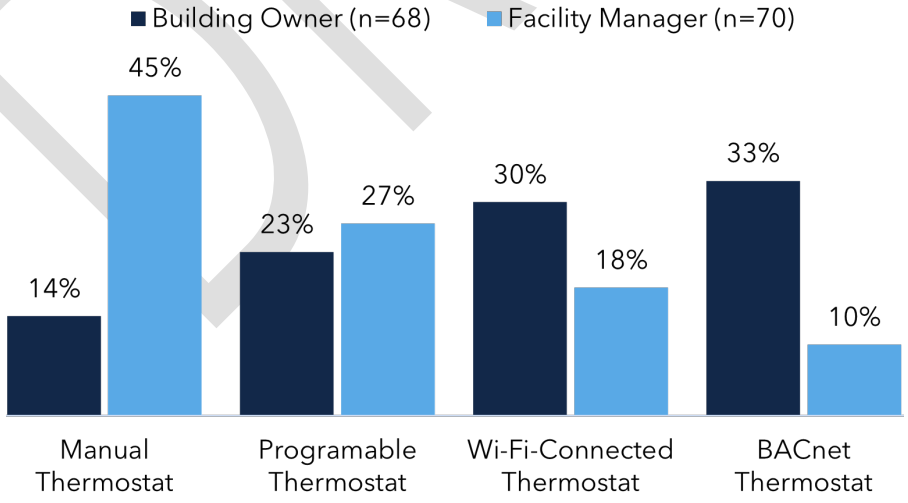
**Figure 13. Types of RTU controls sold by distributors (n=5)**




Source 13: CalMTA HVAC interviews

CalMTA surveyed building owners and facility managers about existing RTU controls (Figure 14). Most building owners were closely split between BACnet thermostats (33%) and Wi-Fi-connected thermostats (30%), while facility managers reported using less sophisticated controls, with manual thermostats being the most common (45%).

**Figure 14. RTU control type**

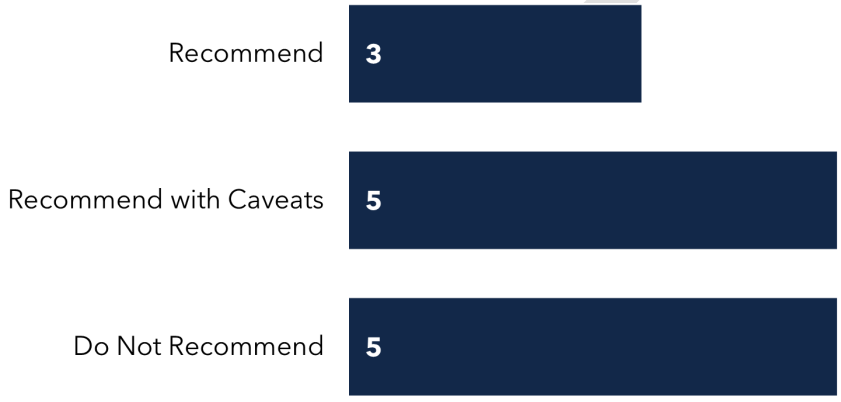



Source 14: California RTU Decision-Maker Survey: How are your RTUs controlled? Please indicate the number of RTUs for each control system type:

## 3.11 Remote monitoring system

Most contractors (nearly 75%) were familiar with internet-enabled RTUs with onboard sensors that allow for remote monitoring and fault detection. However, of those who were familiar with remote monitoring systems for RTUs, just under a quarter recommended them. Of the contractors who recommend remote monitoring systems, all appreciated the improved ability to control the system (Figure 15).

**Figure 15. Contractors recommending RTUs with RMS (n=13)**




Source 15: CalMTA HVAC interviews

Of the contractors who recommended remote monitoring with caveats, their comments varied. One appreciated the potential energy savings, but customers must decide whether they want their unit to be monitored by a third party. One noted that the increased technical complexity of the RTUs with remote monitoring can be overwhelming, especially because the RTU manufacturer is separate from the remote monitoring system developer, and they tend not to communicate with each other. Two contractors would recommend this more if the monitoring service were provided to customers free of charge, but most of their clients do not want to spend money on the service or the time and expense associated with wiring the monitoring system.

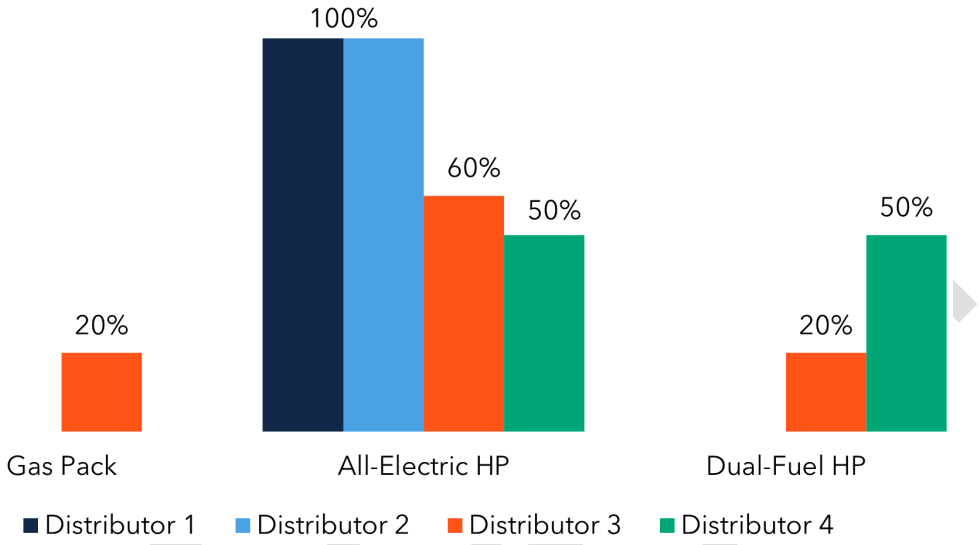
Two out of the five distributors CalMTA interviewed sell RTUs with remote monitoring services. Of those two, one pointed to better control and energy savings as the key benefits, while the other highlighted the benefit of system monitoring and maintenance, including being aware of early warning signs and not having to access the roof to get that information. One of the distributors who does not sell remote monitoring for RTUs said that their customers generally have not been interested in this feature and that they find this feature to be more common in buildings with multiple units.

## 3.12 Market trends

CalMTA asked distributors to predict what the market share of gas pack, all-electric heat pump, and dual-fuel heat pump RTUs will be in 10 years. Of the five distributor respondents, four

predicted that the market would shift toward all-electric heat pumps, and one respondent did not provide a prediction. As shown in Figure 16, of the four who predicted a shift toward heat pumps, two predicted that all-electric heat pumps would comprise 100% of the market. The other two predicted a more even distribution among fuel types. One of these respondents predicted 20% gas pack, 60% all-electric heat pump, and 20% dual-fuel heat pump RTUs, while the other predicted 0% gas pack, 50% all-electric heat pump, and 50% dual-fuel heat pump RTUs.

**Figure 16. Prediction of market share by fuel type in 10 years (n=5)**




Source 16: CalMTA HVAC interviews

The rationale behind these predictions includes a general trend away from gas due to people's personal preferences or state regulations limiting use of natural gas and prioritizing electrification. When asked to predict what fraction of RTUs will be variable speed heat pumps in the next 10 years, only two out of the five distributors felt comfortable or able to provide a response. One distributor predicted around 50%, explaining that there are always variations with installations, so they would not expect more. Another distributor predicted around 25% in the next 10 years because their experience shows that "25% of people they work with will take the most expensive, 25% will take the cheapest, and the middle 50% will go with the middle options."

SCE staff interviewed by CalMTA expect to see more variable speed RTUs moving forward. Although variable speed RTUs have not been cost-effective in this interviewee's experience, given the rapid adoption of variable speed HVAC systems in the residential market, if the technology spills over to the commercial side, then it may become economical in the future.

When asked what fraction of RTUs will include an energy recovery ventilator (ERV) in 10 years, four of the five distributors did not provide a prediction. The one distributor who did respond to this question predicted an increase without a percentage attached, noting that ERVs will be

included with RTUs increasingly over time as more people become aware of it. Their rationale for this prediction is that ERVs are "desirable to people who want to save the planet."

# 4 Policy and program landscape

RTUs must meet federal and California state (title 24, part 6) regulations, including minimum energy efficiency performance and allowable types of refrigerants. Furthermore, relevant policies are currently under development, such as building performance standards and appliance regulations by CARB and regional Air Quality Management Districts.

Voluntary programs promote the adoption of new and efficient RTUs by providing financial incentives or financing. The HVAC industry also develops standards and product performance ratings.

## 4.1 Federal and state regulations

Federal standards supersede state standards through federal pre-emption, which prohibits individual states from imposing regulations that exceed federal minimum efficiency requirements for RTUs. However, states may regulate aspects of RTUs that are not covered by federal standards. The California energy code is called Title 24.

### 4.1.1 Federal standards

Federal standards for air-cooled commercial unitary air conditioners and heat pumps (RTUs) with capacities of 65,000 BTU/hr or more took effect in 2023. As of 2025, efficiency metrics for these units are the integrated efficiency ratio (IEER) for cooling performance and coefficient of performance (COP) for heating performance. Three-phase RTUs under 65,000 BTU/hr must comply with a different set of standards, which took effect in January 2025. These units are rated in Seasonal Energy Efficiency Ratio 2 (SEER2) for cooling and Heating Seasonal Performance Factor 2 (HSPF2) for heating.

Starting on January 1, 2029, new test metrics will take effect for units 65,000 BTU/hr and higher. The new metrics that will replace IEER and COP are as follows:

- For cooling: integrated ventilation, economizing, and cooling
- For heating: integrated ventilation and heating efficiency

### 4.1.2 Title 24

Updated in three-year cycles, Title 24 avoids pre-emption by regulating components or aspects of RTU performance that are not covered under federal efficiency standards, such as low leakage dampers, air filtration, economizer fault detection and diagnostics, thermostats, and automated demand response capability. There are two pathways for compliance: prescriptive and performance. Starting in 2023, the prescriptive pathway for new construction projects using single-zone space conditioning systems with direct expansion cooling and a rated cooling capacity of 24,0,000 BTU/h or less requires heat pumps for space conditioning in certain

scenarios.[31] Gas packs may also be installed via the performance pathway under certain circumstances.

The 2025 code, effective January 1, 2026, allows any of the following for replacement single zone RTUs under 65,000 BTU/h:

- Heat pump with economizer
- Gas pack with economizer and variable speed fan
- Dual fuel heat pump with economizer and variable speed fan

In an interview with CalMTA, staff from SCE said they believe codes and standards have been the most effective drivers of improved efficiency since there is significant potential for efficiency gains without altering the equipment itself (proper clearance, airflow, economizers, etc.). As such, SCE encouraged CalMTA to prioritize improving customer awareness, education, and habits over addressing technological barriers.

In addition, Title 24 mandates permits for each new or replacement HVAC system. Permits are filed with the AHJ, which is often the local building department. AHJs are responsible for enforcement of the energy code, which results in variations in enforcement practices.

### 4.1.3 U.S. Environmental Protection Agency refrigerant mandate

The EPA has mandated that newly manufactured or imported HVAC systems avoid refrigerants with a GWP of 700 or greater. Refrigerants such R-410A, commonly found in HVAC equipment, will be replaced with A2L refrigerants such as R-32 and R-454B in new systems starting January 1, 2025. While existing HVAC systems can still use R-410A, its supply will gradually decrease, leading to higher maintenance and operating costs over time.

HARDI staff said their members expect systems using the new refrigerants will be 10% to 15% more expensive for a basic unit. Due to the slight increase in flammability of A2L refrigerants, new systems are required to have refrigerant leak detectors.

## 4.2 Potential regulations impacting RTUs

In addition to federal standards and Title 24, there are several policies or regulations that are currently in development or under consideration that could possibly take effect in the near future, which would impact the RTU market in California. Such policies include building performance standards, as well as regulations advocated by CARB and Air Quality Management Districts.

[31] 2022 Energy Code Title 24 Part 6 Fact Sheet: Accessed 4/30/2025 https://energycodeace.com/download/66709/file_path/fieldList/FS.NR%20Bldgs.2022

### 4.2.1 Building performance standards

Building performance standards are policies that require existing commercial and large multifamily buildings to achieve and maintain acceptable performance levels that align with clean energy use and reduction goals. These standards are flexible, allowing local and state governments to customize and implement standards that fit their unique circumstances, provided they meet specific performance targets in a stated timeframe.

In 2021, the federal government committed to supporting building performance standards aimed at achieving zero emission requirements by providing funding programs and technical assistance from agencies, such as the U.S. Department of Energy (DOE) and the EPA, to local and state governments that commit to implementing them. In 2022, the White House launched the National Building Performance Standards Coalition, which officially recognizes jurisdictions that have committed to goals that align with the building performance standards.[32] In California, cities such as Berkeley, Sacramento, San Francisco, West Hollywood, Santa Monica, Los Angeles (City), Chula Vista, and San Diego, as well as Los Angeles County and the state, have all committed to the passage of these policies. As of 2024, only Chula Vista has passed building performance standards, whereas all other pledges are at various stages of planning toward implementation.

### 4.2.2 Air quality regulations

CARB is seeking to establish space and water heater standards that would require new residential and commercial appliances to emit zero greenhouse gases (carbon dioxide, nitrous oxide, methane) during operation. CARB's goal is to develop clear and enforceable regulations by 2025 and to implement regulations in 2027. Such regulations would impose bans on the sale of new mixed-fuel and dual-fuel RTUs as soon as 2029.

Air quality management districts have taken similar steps to adopt new regulations aimed at reducing emissions from space heating equipment and prohibiting the sales of appliances that contribute to GHG emissions. The Bay Area Air Quality Management District has adopted regulations, including Rule 9-4, that imposed regulations on the sale of residential and commercial space heating equipment in the Bay Area,[33] which mandated that residential and commercial furnaces manufactured after January 1, 2029, must not emit NOx during operation. Similarly, the South Coast Air Quality Management District has proposed Rule 1111, which aims to reduce the reduction of NOx emissions from natural gas-fired furnaces (both residential and commercial). However, Rule 1111 is currently being challenged in the Central District of California court, with opponents citing that the rule effectively bans sales and installation of natural gas

[32] National Building Performance Standards Coalition. Accessed October 4, 2024. "About the National BPS Coalition." https://nationalbpscoalition.org/

[33] Bay Area Air District. Accessed October 21, 2024. "FAQ About Air District Appliance Rules." https://www.baaqmd.gov/~/media/dotgov/files/rules/reg-9-rule-4-nitrogen-oxides-from-fan-type-residential-central-furnaces/2021-amendments/documents/20230522_faq_appliance-rules_final-pdf.pdf?rev=47f3b1dc912b4e97869a4f2e487fb266&sc_lang=en

appliances and negatively impacts sectors of the economy, such as restaurants that rely on natural gas appliances.

## 4.3 Voluntary programs and RTUs

There are several programs and organizations throughout the United States that promote efficient commercial HVAC equipment. Table 6 highlights some programs most relevant to CalMTA. Although many programs offer financial incentives for efficient HVAC, others develop specifications or qualified product lists to help identify an efficient product. One example is the Consortium for Energy Efficiency (CEE), which works in collaboration with the United States and Canadian energy efficiency program administrators to develop specifications and qualified product lists. Their Commercial Unitary Air Conditioners and Heat Pumps Specification outlines different tiers of efficiency for different equipment types. There is also the California Heat Pump Partnership, which is a public-private partnership to bring various stakeholders together to achieve Governor Newsom's goal of six million heat pumps installed in California buildings by 2030.

**Table 6. Programs and organizations supporting efficient RTU solutions**

| Organization/ Program | Efficient RTU product type | Tier or pathway | Tier or pathway |
|---|---|---|---|
| Minnesota Center for Energy and Environment/Efficient Technology Accelerator | Dual-fuel Heat Pump (HP)<br>or<br>RTU with ERV | Tier 1<br>Multistage compressor dual-fuel HP<br>RTU with ERV | Tier 2<br>Cold climate capable; variable speed compressor<br>N/A for RTU with ERV |
| NEEA/Efficient RTU | Gas pack but looking into dual-fuel RTU | Tier 1<br>81%-plus thermal efficiency<br>Insulated box<br>Low-leakage dampers | Tier 2<br>Condensing furnace<br>or<br>H/ERV |
| CEE/Commercial AC and HP Initiative | Commercial AC and HP | Multiple tiers: CEE tiers based on EER, IEER, SEER, SEER2, or COP ratings | |
| U.S. DOE/Heat Pump Accelerator | HP RTU | Heat Pump Campaign promotes existing and emerging HP technology to building owners | HP challenge for manufacturers to meet advanced technology specifications |
| CLEAResult/ Comfortably CA | Commercial AC and HP | Tiers based on cooling capacity and SEER, HSPF, EER, IEER, or COP values | |
| Silicon Valley Power/ Business Rebates | Commercial AC and HP<br>Fuel substitution | Energy-Efficiency<br>New RTU AC, controls, New RTU HP<br>Must meet SEER or EER requirements | Fuel substitution<br>Replace natural gas space heating with all-electric HP |
| SDG&E/Comprehensive Energy | Unitary AC or HP | Energy efficiency<br>Must meet SEER, IEER, or EER requirements | Fuel substitution |

| Organization/ Program | Efficient RTU product type | Tier or pathway | Tier or pathway |
|---|---|---|---|
| Management Solutions[a] | | | Replace natural gas space heating with all-electric HP |
| LADWP/Business Offerings for Sustainable Solutions | High-Efficiency Package HVAC Units | Paid based on energy savings | |
| Energy Solutions/ CalNEXT | Dual-fuel HP RTU<br>All-electric HP RTU | Any HP RTU | |
| NYSERDA/NYS Clean Heat Initiative (multiple utilities) | Air source HP | Example for NYSEG[b]<br>Fuel substitution projects<br>Meet or exceed ENERGY STAR Light Commercial Criteria for COP47, exceed applicable code for other metrics (IEER, EER, COP17)<br>Cold climate heat pumps must be Northeast Energy Efficiency Partnerships (NEEP) listed | |

[a] As of December 31, 2024, the program has closed.
[b] NYSEG. Accessed February 25, 2025. "NYS Clean Heat Statewide Heat Pump Program Incentives." https://www.nyseg.com/documents/40132/5898956/Incentive+Framework+10.0+printable+landscape.pdf/d9fdd732-a6a7-f974-73d2-b93c7b29589b?t=1726664696395

### 4.3.3 Incentive/Financing programs

In California, there is a statewide investor-owned utility (IOU) program (Comfortably California) that supports the adoption of new, high-efficiency RTUs and other HVAC equipment.[34] Municipal utilities, such as the City of Anaheim and Silicon Valley Power, also offer prescriptive RTU incentives.

Comfortably California, a midstream HVAC resource acquisition program funded by customers of the four California IOUs, is trying to influence distributor stocking practices so that the units on the shelves will be efficient when emergency replacements are necessary. Program staff said ratepayer funding for certain gas energy efficiency measures in residential and commercial new construction will be sunsetting (CPUC Decision 23-04-035), which prevents Comfortably California from promoting efficient gas systems.

Other IOU programs serving nonresidential customers include light commercial incentives, such as San Diego Gas & Electric's (SDG&E) Comprehensive Energy Management Solutions (discontinued at the end of 2024). This program provided deemed incentives for commercial packaged air conditioners. Still, other programs include efficient RTUs as an eligible measure but

[34] This includes Pacific Gas & Electric, Southern California Edison, Southern California Gas, and San Diego Gas & Electric.

promote a variety of efficient products. For example, IOU customers can access financing through GoGreen Financing, which incentivizes participating lenders to improve financing terms for energy efficiency projects, such as efficient HVAC system replacements and heat pumps.

Commercial Property Assessed Clean Energy (C-PACE) is a non-ratepayer-funded option that could support RTUs in participating jurisdictions. C-PACE allows building owners who are not delinquent on property taxes to finance energy or water-saving projects and repay them with an assessment on their property taxes. The Western Riverside Council of Governments offers C-PACE in 384 California jurisdictions in 47 counties, although other programs also exist.

### 4.3.4 Market Transformation (MT) and other programs

Across the United States, there are MT programs and organizations that work to promote high-efficiency commercial HVAC adoption and development. At the national level, the Advanced Rooftop Unit Campaign, which was a collaborative effort between ASHRAE, the Retail Industry Leaders Association, and the U.S. DOE, ran from 2013 to 2019. In addition to achieving energy savings, the Advanced RTU Campaign developed publicly available resources, such as guidance documents and implementation toolkits. In 2024, the U.S. DOE launched the Commercial Building Heat Pump Accelerator, which will operate through 2027. U.S. DOE Better Buildings' Accelerators are short-term and partner-focused activities that address barriers to energy efficiency. According to a manufacturer interviewed by CalMTA, the heat pump accelerator is focused on performance in climates much colder than most of California. The manufacturer said costs will be very high to achieve the performance levels specified by the accelerator.

Regional organizations promoting market-wide adoption of efficient heat pump RTUs include the Minnesota Center for Energy and Environment, NEEA, NYS Clean Heat, and Nicor Gas (Illinois). In contrast to CalMTA, these other MT programs operate in colder climates and some of them include gas efficiency components.

## 4.4 Industry associations, standards, and ratings

There are several heating, ventilation, air conditioning, and refrigeration (HVACR) industry associations that cater to different professionals in the RTU industry. Many of them collaborate on setting industry standards, sharing research and educating industry professionals, advocacy, and networking opportunities for members across different roles (i.e., contractors, manufacturers, designers). Some notable national organizations are:

- **AHRI –** Air Conditioning, Heating, and Refrigeration Institute is a trade association that runs a voluntary program to certify the performance of HVAC equipment. In addition to other functions, the organization also publishes standards, test procedures, and industry guidance documents. Their members are HVACR and water heating equipment manufacturers.
- **HARDI –** Heating, Air-Conditioning & Refrigeration Distributors International is a marketing organization focused on wholesale distribution members. Membership options for adjacent

businesses include manufacturer representatives, marketing partners, and energy efficiency partners.

- **ASHRAE –** American Society of Heating, Refrigeration, and Air-Conditioning Engineers publishes standards related to the energy efficiency of HVAC and refrigeration systems. Full members must have a minimum of 12 years of experience or education in the HVACR industry in order to join.
- **ACCA –** Air Conditioning Contractors of America supports the air-conditioning industry by setting standards, providing education, and industry advocacy. Members include HVACR business owners or technicians; manufacturers, distributors, or wholesalers; utilities; or schools offering HVACR training and programs.
- **SMACNA –** Sheet Metal and Air Conditioning Contractors' National Association sets standards and provides training and resources to the sheet metal and HVAC industry. Its members are contractor firms that have a signed collective bargaining agreement and specialize in sheet metal applications, such as duct and HVAC systems.
- **RSES –** Refrigeration Service Engineers Society offers comprehensive training, education, and certification to professional HVACR technicians and contractors.

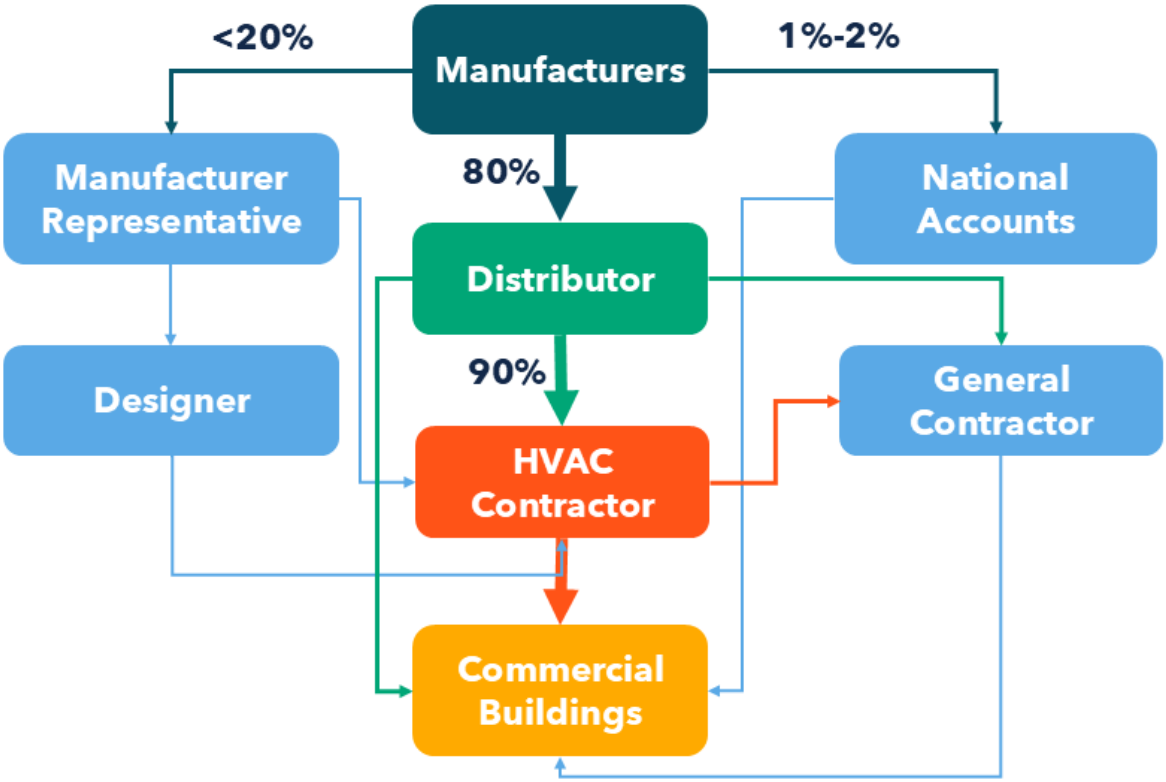
# 5 Supply-side characteristics and perspectives

CalMTA characterized the RTU supply-side by conducting primary and secondary research.

## 5.1 Supply chain map

Based on CalMTA's primary and secondary research, an RTU purchase from the manufacturer to the end-user (see Figure 17) can take one of many pathways.

**Figure 17. RTU market map**




These pathways depend on the type of project (custom design/build versus like-for-like replacement), type of customer (individual location versus national chain account), existing relationships, and brand loyalty. A major pathway is from manufacturers to distributors, then to HVAC installation contractors, and finally to commercial buildings.[35,36] Other possible pathways include direct sales from manufacturers to large national accounts, such as McDonald's or Best Buy, or from an HVAC contractor to a general contractor in new construction.

### 5.1.1 Supply chain market actors

The ISP study defined each market actor's role as follows:[37]

[35] Some reports refer to distributors as wholesalers.
[36] Some reports refer to HVAC contractors as mechanical contractors.
[37] AESC and ASK Energy. 2021. *Op. cit.*

- **Manufacturers** "design and produce equipment" that comply with code requirements, and "although all equipment sizes can be drop shipped to building sites, manufacturers typically ship products to distributors (smaller size units) or direct to buildings (larger units)."
- **Distributors/wholesalers** stock equipment purchased from manufacturers in warehouses, often having "central or regional centers with branches in various territories." They have sales staff that help customers select products, provide design assistance, and provide quotes. They "often provide technical support, training, and design assistance to contractors and building managers responsible for equipment installation, operation, and maintenance." Some distributors also provide equipment installation services.
- **Manufacturer representatives** are "specialized, intermediate parties that help contractors and designers select the right equipment" and are more involved in larger systems or those that are "shipped directly from the manufacturer to the job site."
- **Mechanical or HVAC contractors** install and service HVAC equipment. They are "responsible for purchasing and communicating with distributors." A subset of these contractors are design-build firms composed of a team of engineers, architects, and mechanical contractors that work together to complete projects.

CalMTA found RTU manufacturers tend to specialize in either the custom design/build or the two-minute purchase market. In the former (about 10% to 20% of the market), the equipment's performance is tailored to customers' requirements, such as a clean room or medical clinic, with units manufactured and then shipped directly to a customer's job site. Custom products must be ordered through a manufacturer representative or dealer that does not sell competitors' products. A recent market report also found that a small fraction of the market (custom products) was ordered from a manufacturer representative with input from a designer.[38]

Manufacturers that specialize in the larger two-minute market use multiple channels, with most products going through distributors. For this market, availability and price drive decision-making. While distributors may stock a limited amount of high-efficiency products, they are able to order any tier product from multiple manufacturers. According to Comfortably California staff, what is typically in distributors' stock is minimally compliant RTUs with gas heating. NEEA staff also echoed this, saying most high-efficiency or premium products are not sold through distributors; high-efficiency units must be special ordered through manufacturer representatives. HARDI staff also agreed with this; most of their members (distributors or wholesalers) stock minimally compliant units since that is what sells most often. If someone needs a more efficient unit, they call a manufacturer representative.

Two stakeholder interviewees said educating contractors and building owners on planning RTU replacements is likely to be more effective than midstream HVAC programs since distributors do

[38] Cadeo. 2023. *op.cit.*

not know about customer plans until informed by a contractor and, thus, do not know what new features to stock since distributors tend to order large shipments on a quarterly basis.

### 5.1.2 HVAC supply chain in the literature

A 2023 market characterization found similar RTU distribution pathways from manufacturers to commercial building end users.[39] The study's simplified RTU market map had these three pathways.

- manufacturer → manufacturer representative → designer → contractor → commercial buildings
- manufacturer → manufacturer-specific distributor → contractor → commercial buildings
- manufacturer → distributors →contractor → commercial buildings

A previous RTU market transformation strategy report identified three general distribution channels from the manufacturer to the consumer.[40] CalMTA added a potential step in red, indicating a developer may sell off a newly built property to the ultimate occupant:

- **Replacement channel:** manufacturer → wholesaler → mechanical contractor → consumer
- **New construction channel:** manufacturer → wholesaler → mechanical contractor → general contractor → developer → consumer (occupant)
- **Large national account channel:** manufacturer → consumer (national account)

CalMTA also found larger property owners with in-house facility staff can bypass mechanical contractors and order directly from distributors. For example, one representative from a University of California campus uses in-house facility staff who order equipment directly from and complete installations with distributors. All these pathways are reflected in CalMTA's market map in Figure 17.

A 2005 market progress evaluation reported a similar dynamic for the light commercial (<25 tons) segment in the Pacific Northwest, noting an estimated 90% to 95% of sales are from distributors/wholesalers to HVAC contractors and only 5% to 10% of sales were directly from distributors to general contractors. As far as large national accounts are concerned, the report notes only 1% to 2% of sales in the Pacific Northwest go through this channel.[41]

A recent market study found independent distributors typically "stock standard efficiency products that are likely to sell quickly" and preferred to work with one or two manufacturers.42 The study also found manufacturer-specific distributors who represent a single brand or family of

[39] Cadeo. 2023. *Op. cit.*
[40] NEEP. 2016. *Northeast and Mid-Atlantic High Performance Rooftop Unit Market Transformation Strategy Report*.
[41] NEEA. 2005. *Light Market HVAC Market Progress Evaluation Report*. https://neea.org/img/uploads/Small-Commercial-HVAC-O-and-M-Service-Pilot.pdf
[42] Cadeo. 2023. *Op. cit.*

brands, such as Lennox's factory-owned distribution network. In contrast, the study found contractors were much more likely to source equipment from multiple distributors and brands—distributors tended to focus on their relationships with manufacturers, whereas contractors tended to focus on "availability, cost, as well as working relationships […] prioritizing working with distributors who[m] they have a good relationship with and who[m] they can rely upon for post-installation technical support."

## 5.2 RTU manufacturers

Below is a list of brands that offer commercial RTU products, grouped by common ownership. The bold names are those that cover the majority of the market, according to a CEE 2024 report:[43]

| | | |
|---|---|---|
| • **Trane**<br>• **AAON**<br>• Rheem/RUUD/Russell/Sure<br>• Tuttocool | • **Carrier/Bryant/ ACIQ**<br>• **Lennox/Allied Commercial**<br>• CaptiveAire | • **Daikin North America/Daikin Applied**<br>• **Johnson Controls/York/ Champion Heating and Cooling/TempMaster/ Fraser-Johnston** |

In Minnesota, a 2023 study identified Carrier, Lennox, and Trane as the three major RTU manufacturers.[44] Combined with Bryant and York, these brands had 89% of the RTU market share in Minnesota and were typically sold through distributors (either an independent or a manufacturer-specific distributor). The study also found that AAON and Daikin/McQuay comprised a smaller share of the market (approximately 7%) and focused more on selling premium high-efficiency products through manufacturer representatives.[45] A 2005 NEEA study reported similar market shares, with Trane (50%), Carrier (30%), Lennox (15%), and York (5%) as the most prominent light commercial manufacturers in the Pacific Northwest.

### 5.2.3 California market and drivers for product design

**Energy efficiency regulations and programs.** The California market is important for most large HVAC manufacturers due to its size and its role as a regulatory leader. California often pioneers environmental and energy regulations, which are then adopted by other states, such as New York or Washington. Manufacturers interviewed by CalMTA said that they pay close attention to Title 24 regulations and upcoming air-quality regulations (i.e., low NOx) and work to ensure compliant product options are available. One manufacturer also noted other decision factors

[43] Consortium for Energy Efficiency (CEE). 2024. *2024 Commercial Air Conditioning and Heat Pumps Initiative*.
[44] Cadeo. 2023. *Op. cit.*
[45] AAON is particularly niche, selling almost exclusively to national accounts (CEE 2024), while McQuay tends to produce larger HVAC equipment for the heavy commercial (i.e., > 25 tons) market (EEA 2005).

for its product lines, including ASHRAE 90.1, codes and standards in other areas, and incentive programs from utilities.

Manufacturers also mentioned the importance of energy-efficiency programs. At the local level, they find that rebates or other incentives can encourage customers to purchase high-efficiency RTUs as long as contractors and customers are aware of such programs. However, most manufacturers said that individual local utility or municipal programs do not create enough demand to warrant a shift in product development. Instead, these manufacturers pay closer attention to larger programs and federal requirements, such as changes in U.S. DOE regulations or refrigerant regulations that impact the commercial RTU market, CEE efficiency specifications, and NEEP regional specifications.

**Product design.** Notably, the manufacturers who build custom premium products do not consider California to be that different from other markets, despite acknowledging its importance overall. This is likely because their products already satisfy or exceed the higher standards required in California, and their customers seek out these premium products regardless of their location. Innovations in technology and the desire to offer products that exceed standards and offer exceptional performance and comfort are the drivers of change in this custom, high-end market.

Meanwhile, manufacturers focusing on a broader customer base consider California regulations in their product design and track California as a distinct market within their portfolio. Manufacturers serving the two-minute replacement market sell units primarily to distributors in bulk on a quarterly basis to be purchased quickly by contractors looking for a replacement unit that fits the size and configuration of the retired unit. Regulations at the federal and state levels are driving change in product lines. One manufacturer said they updated product lines several times in the past three years due to regulatory changes, while another said they only adjust product lines if regulations impact many states or North America more broadly.

Manufacturers said they generally produce what customers demand, switching product lines as needed. Developing new products, however, takes at least a year, if not several. NEEA staff noted that when manufacturers update their product lines, that is the time to ask for everything at once because making incremental changes later will be more challenging.

### 5.2.4 California market adoption of high-efficiency features

When asked about the current market adoption rates of 3- to 20-ton heat pump RTUs serving a single zone with various features (i.e., high cooling efficiency, variable speed, factory-installed sensors, software and internet connectivity to enable remote access, automated fault detection and diagnostics (AFDD) beyond T24, and a mobile app that supports startup commissioning), manufacturers estimated different percentages of sales in California.

For high cooling-efficiency RTUs (20% better than the federal standard), high-end manufacturers reported a higher market share than manufacturers serving the two-minute market, with up to 20% of RTU sales having high cooling efficiency. In contrast, other manufacturers reported a lower

uptake of high-efficiency RTUs (under 10%). High-end manufacturers indicated inverters were readily available while mass-market manufacturers lacked variable speed options. One manufacturer expected to have an inverter heat pump within the next few years, while another acknowledged growing demand for these in California but insufficient nationwide demand to justify developing an inverter heat pump product.

A manufacturer serving the two-minute market attributed their low uptake of high-efficiency RTUs to the fact that RTUs are a like-for-like replacement market. Building owners want something that will not require additional electrical capacity or ductwork, which might be required with a high-efficiency unit. Moreover, these customers often want the least expensive option available, making them less likely to choose high-efficiency units or heat pumps with variable speed. All manufacturers estimated market share growth for RTUs with these features over the next five years, though not all connected that growth to the upcoming switch from IEER to IVEC.

Manufacturers generally reported AFDD in their products (80% to 100%), with several noting that California requires it, so all their products have it. Another mentioned that their products are Title 24 compliant, but not all their products sold in other markets include the extra features that California requires. Manufacturers had varied responses on whether they offer the startup commissioning application and remote monitoring. For remote monitoring, some noted that even if it is an available option, they cannot necessarily track whether the unit ends up with remote monitoring because it is up to the contractor or another third party to set up the feature during the installation.

### 5.2.5 Installation considerations

Manufacturers generally reported that installing high-efficiency units is not drastically different than installing standard-efficiency units, though it probably did require additional time, depending on the specific features selected. Higher-efficiency units can be heavier, and integrating AFDD and remote access requires additional steps to set up. Similarly, inverter products require more steps to set up because they have smarter controls.

### 5.2.6 IVEC

IVEC is a more representative and complex energy efficiency rating system that will go into effect in 2029. It will raise the efficiency by over 10%. Consequently, most standard efficiency products that exist today will fail to comply with the new IVEC rating requirements. This is likely to have a greater impact on manufacturers in the two-minute replacement market, who usually have multiple product tiers (i.e., standard, high-efficiency, or ultra-high efficiency). In 2029, the standard-efficiency unit that is compliant today will no longer exist. The high-efficiency product line of today will become standard, and the ultra-high-efficiency line will be reclassified as high-efficiency. Regardless, manufacturers in this market need to do formal testing and potentially redesign once they understand the new components of the metric.

Manufacturers interviewed by CalMTA were aware of the upcoming change to efficiency requirements and use of the new IVEC rating system, but their approaches to and opinions of the change varied. One high-end manufacturer planned to release IVEC ratings for their products early, believing it would make their products stand out more. Meanwhile, another high-end manufacturer saw no advantage to adopting IVEC early since IEER testing will still be required through 2028. The two-minute market manufacturers seemed less informed on the specifics of IVEC, though they agreed it is more representative than IEER and anticipated complying by the deadline and not sooner. Some manufacturers said they have already begun IVEC testing their products.

### 5.2.7 Training and education

Manufacturers reported conducting varying levels of training and education. Higher-end manufacturers invest heavily in training installers and technicians on how to install and service their products, offering regular online and weekly in-person training sessions, as well as special certifications for installers. One manufacturer noted that they do not need additional trainings for variable speed RTUs since their installers are already trained, but they anticipate conducting trainings on IVEC and IVHE. Other manufacturers also said they spend time educating contractors about new products and their product tiers from a sales perspective, especially for large enterprise-level or national clients, from both an installation and maintenance perspective. One of the two-minute market manufacturers mentioned conducting California-specific trainings on topics like economizers, compliance, and the A2L transition, and now transitioning to trainings on IVEC.

## 5.3 Product availability

The most prevalent type of RTU is a gas pack, with all RTU manufacturers offering multiple product lines in this configuration:

- **All-electric heat pumps:** CalMTA's product research indicates most RTU large manufacturers (i.e., Trane, Lennox, Daikin North America, Daikin Applied, York, and Carrier) offer at least one product line that includes an all-electric heat pump as an option; however, this option may not be available in all sizes and efficiency levels.
- **Dual-fuel heat pumps**: CalMTA found many RTU manufacturers (i.e., Trane, Lennox, and Daikin Applied) offer at least one product line that includes a dual-fuel heat pump as an option. Given the push by many programs in colder climates to promote dual-fuel heat pump RTUs, manufacturers are likely to increase the availability and options for dual-fuel products soon. Distributors and contractors in Minnesota thought the dual-fuel market, while currently small, will grow as product availability improves.[46]
- **Variable speed/inverter-driven RTU**: Some RTU manufacturers offer products with variable speed or inverter technology (i.e., Daikin Applied, Lennox, AAON, and CaptiveAire). However, in the case of Lennox, the variable speed technology is only available in a gas pack and not a

[46] Cadeo 2023, *op. cit.*

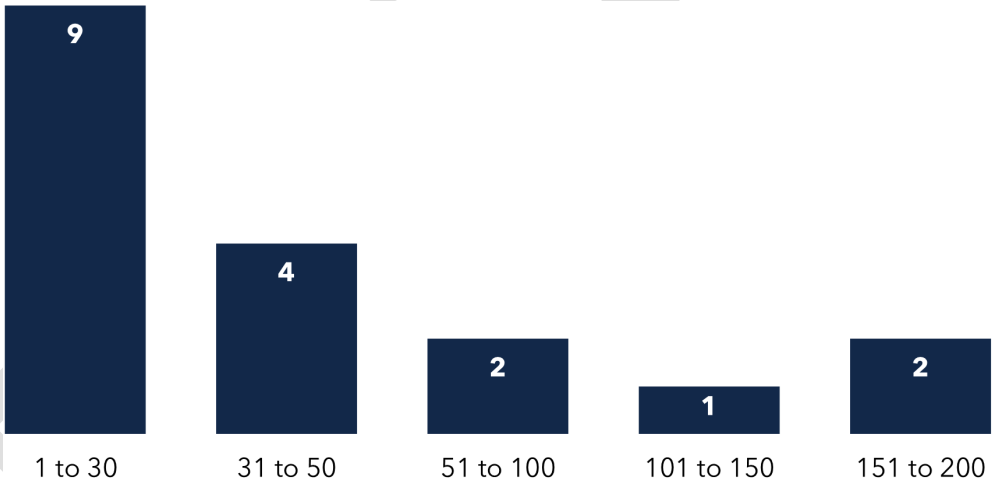
heat pump RTU. Of the five distributors interviewed by CalMTA, none keep variable-capacity heat pumps in stock. One distributor said RTUs with inverters are special order items that take four to five days to obtain. Two manufacturers of custom RTUs say inverter technology has been available for years while two manufacturers serving the two-minute market say the technology is either in development or that there is insufficient demand to justify development. The manufacturer that is not developing this technology acknowledges increasing demand in California, but that there still isn't a big enough market opportunity in North America to justify product development.

- **RTUs with ERV/HRV**: ERVs are available either as a factory-installed or field-installed feature. None of the HVAC distributors interviewed by CalMTA kept them in stock.

## 5.4 Contractor and distributor sales practices

As Figure 18 shows, most RTU contractors sold 50 or fewer RTUs per year. Distributors reported selling two to 50 RTUs annually, with most selling between 11 and 25 RTUs per year.

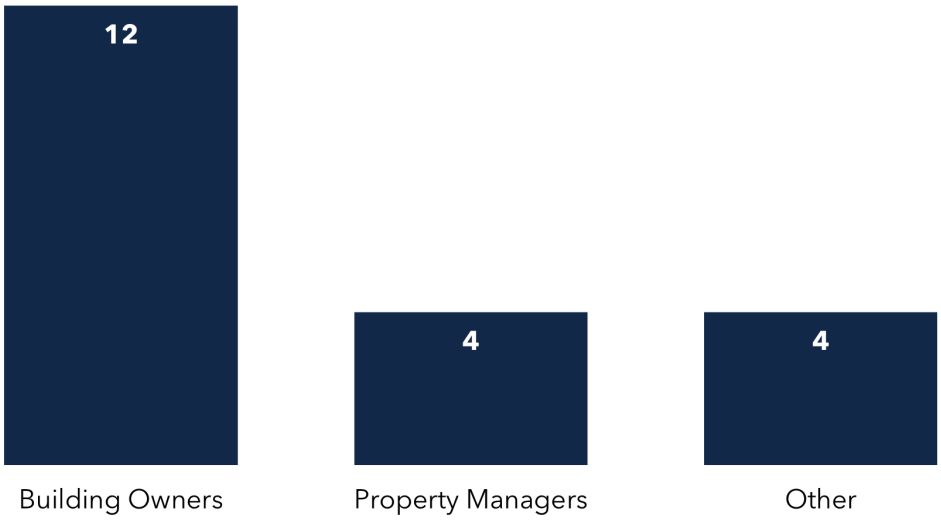
**Figure 18. Contractors' annual RTU unit sales (n=18)**




Source 18: CalMTA HVAC interviews

**Types of RTU buyers.** CalMTA asked contractors to describe their typical customer base for RTU sales. As shown in Figure 19, building owners are the most common RTU buyers (12 mentions), followed by property managers (4 mentions). Contractors also noted other RTU buyers, including general contractors (2 mentions) and schools or universities (1 mention).

**Figure 19. Types of RTU buyers reported by contractors (n=18)**




Source 19: CalMTA HVAC interviews

**Contractor recommendations for energy-efficient RTUs.** Contractors provide a wide range of recommendations to RTU buyers who are interested in high-efficiency RTUs. Over half recommended higher-efficiency rated equipment and two said they recommend variable speed. Other individual recommendations included fuel-switching plus solar PV, high-tech thermostats, conducting a load calculation prior to installation, and specific brand recommendations (York and Trane recommended by one contractor; an AC Pro inverter recommended by another). In contrast, five contractors said they do not provide recommendations, with two elaborating that they provide buyers with all the options and let them make the decision.

**Projected lifecycle cost or return on investment (ROI) analysis for RTU models.** Most contractors said they do not provide projected lifecycle cost or ROI analysis for RTU buyers (15 of 18). The rationale for this included not having many options to offer buyers, not knowing enough about buyers' situations to provide a useful analysis and not wanting to undertake liability for recommending something specific. Other contractors said they prefer to let the customer make their purchase decision on their own. Of the three other contractors, two said they provide these analyses to give customers the full picture and help with their decisions, and one said they provide this information but only if they are working with the person who will be making electricity payments and cares about, or benefits from, energy savings.

**Contractor product information sources.** Half of the contractors said they consult with distributors for input on what high-efficiency RTU product to recommend to RTU buyers (9 mentions out of 18). Five contractors said they consult manufacturers for this purpose. Two contractors said they attend trainings to stay up to date. One mentioned this is because their team is very small, and he does not have the capacity to consult with others, though he would like to work with more

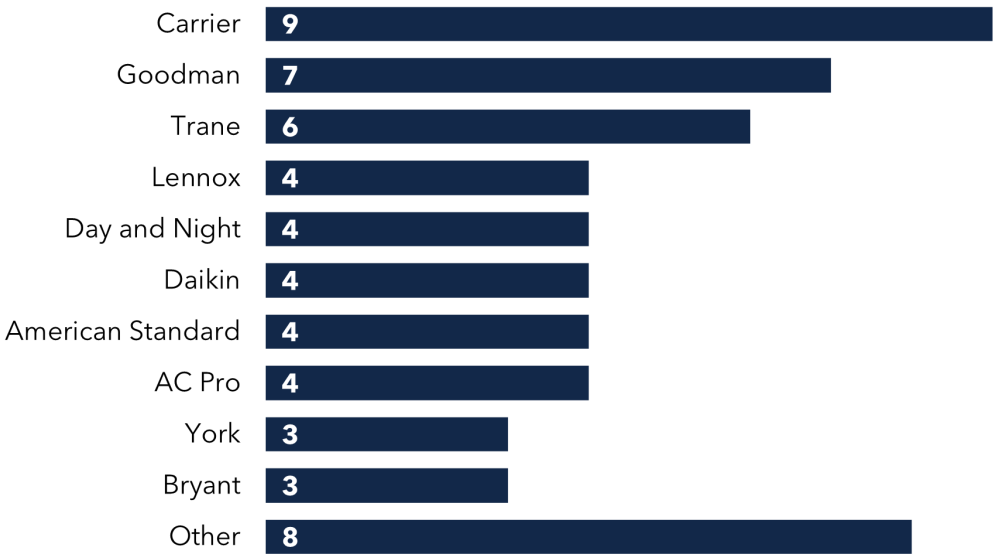
distributors regularly to stay informed. Another said they consult with the territorial managers from their own sales team, and one said they do not consult with anyone nor take any trainings.

**Who buys from distributors.** When asked what kind of customers buy the most RTUs and what features they recommend to a customer interested in high-efficiency RTUs, four out of five distributors said they sell to contractors. The other one said they sell to property managers who are replacing HVAC products. Each distributor had a different recommendation for customers interested in a high-efficiency RTU, including higher-efficiency ratings, economizers, electronically commutated motors, and specific product recommendations for the brands they work with. One distributor does not provide any recommendations and just lets the customer request what they want. Four out of five distributors said that when they have questions, they will consult manufacturers for information on products that help to inform recommendations to end-use RTU buyers. Of the five distributors interviewed, only one provides any training to support contractors. The remaining four did not provide any training, though one said they direct buyers to the manufacturer for help as needed.

**RTU brands.** Contractors reported offering their customers a variety of RTU brands. As shown in Figure 20, the most common brands were Carrier (9 mentions), Goodman (7 mentions), and Trane (6 mentions). AC Pro, American Standard, Daikin, and Lennox were also mentioned with some frequency (4 mentions each). Contractors provided different rationales for why they offered certain brands, including superior product quality, prioritization of U.S.-made products, customer preference for a brand or price point, whether the system is compatible with the ductwork or footprint of the previously installed system, distributor support, and product availability.

Brands such as Goodman target the residential market. Respondents could be installing residential RTUs for commercial customers or are including all RTU brands in their response. Some communities in California, such as Bakersfield, have a notable number of residences with RTUs.

**Figure 20. Number of times contractors mentioned a brand (n=18)**




Source 20: CalMTA HVAC interviews

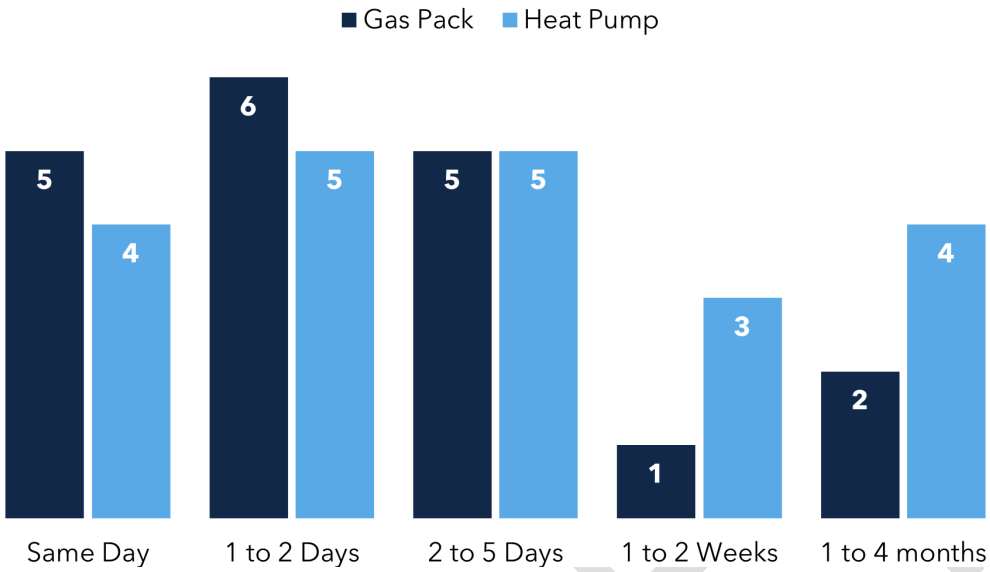
**Contractor buying process.** Contractors prioritized a variety of factors when determining which vendors to buy from. As shown in Figure 21, they most frequently mentioned prior good experience with a distributor (i.e., good relationship with the distributor, responsiveness, service), availability of the product or the ability to get the product quickly, and price. The quality of the product and whether it is made in the United States were also mentioned. For example, one contractor called out Trane as their top vendor choice because that brand has a longer life and requires less maintenance. Another spoke highly of Goodman for having parts and assembly done domestically, while yet another discussed the benefits of Lennox for being manufactured in the United States and for doing everything in-house (i.e., tech support). Two other contractors said they have no choice in vendor because they are licensed dealers (i.e., for Lennox, Goodman, Trane, and Daikin) and are contractually required to buy directly from the manufacturer. One contractor said this choice depends on the situation; they will buy from whichever vendor has the parts they need for a specific job since they will install whatever brand/RTU the customer wants.

**Figure 21. Key factors determining contractors' vendor selection (n=18)**


Source 21: CalMTA HVAC interviews

**Lead times for contractors.** Contractors said they can generally get standard gas pack RTUs quickly. As shown in Figure 22, over 75% said they could get one in less than a week. However, in several instances, contractors noted that if an item was out of stock, it took longer, from a couple of weeks to several months (between 12 to 16 weeks). Most contractors said that there was no difference in the lead time or the way they approached buying heat pump RTUs as compared to the way they purchased gas pack RTUs. Several said that heat pump RTU purchases took one to two days longer, and two other contractors said it could take weeks or months longer if the RTU was not in stock or if the order was placed during a busy time (i.e., summer months). One contractor also noted that the lead time was the same, with the caveat that the property already had the correct amperage to handle the heat pump and that if electrical work was needed, that would increase the amount of time before they could install the system.

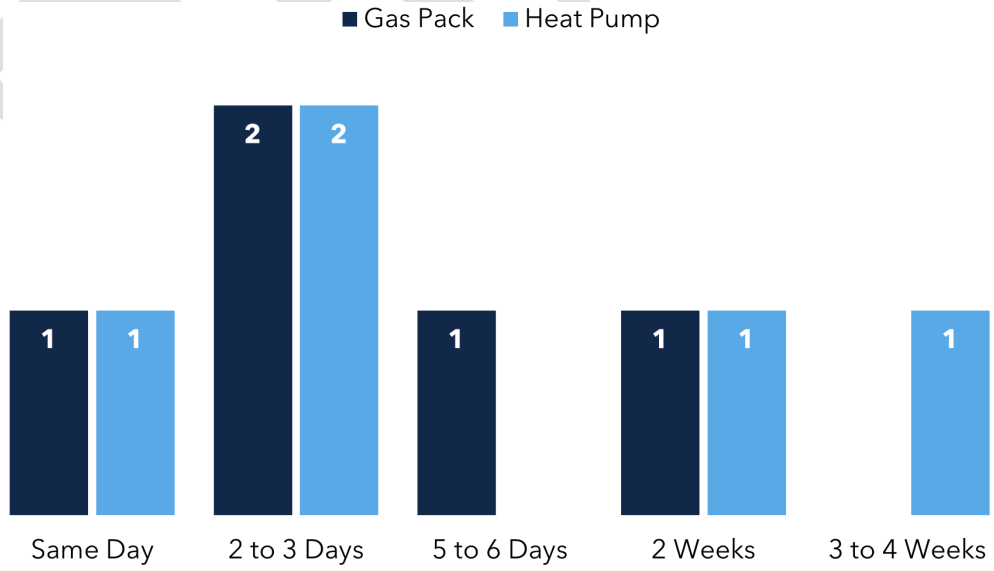
**Figure 22. Contractors' lead times for gas pack vs. heat pump RTUs (n=18)**




Source 22: CalMTA HVAC interviews

**Lead times for distributors.** As shown in Figure 23, distributors provided similar results, providing lead times that range from the same day, two to three days, five to six days, and two weeks. Four out of five distributors reported no difference in timing or approach for heat pump RTUs compared to gas pack RTUs. Another distributor said heat pump RTUs usually take three to four weeks compared to five or six days for gas pack RTUs.

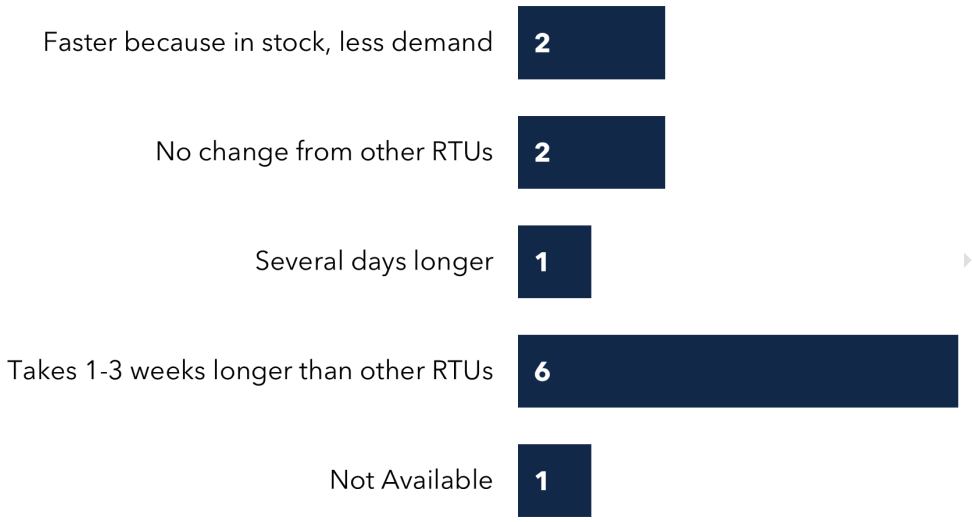
**Figure 23. Distributor lead times for gas pack vs. heat pump RTUs (n=5)**




Source 23: CalMTA HVAC interviews

**Timing for variable speed (inverter-driven) heat pump RTUs.** When asked if they use a different approach or experience different timing when a customer requests a variable speed heat pump RTU, over one-third of contractors said they do not sell this type of RTU. Figure 24 shows that of those who do sell them, half said that variable speed heat pump RTUs require one to three weeks longer lead time than regular heat pumps or gas pack RTUs. Two contractors said there is no difference between them in lead times or approach, and two others said it was faster because they have them in stock and demand is low.

**Figure 24. Variable speed heat pump lead times compared to other RTUs (n=12)**




Source 24: CalMTA HVAC interviews

Three out of five distributors do not sell variable speed heat pump RTUs. Of the two who do sell them, one distributor said that variable speed does not change the lead time for the RTU, and the remaining distributor said that the lead time for a variable speed RTU would probably add another week or two to what would normally be a two-day (or two weeks if out of stock) process for a gas pack RTU.

**Timing for heat pump RTUs with ERV.** When asked if they use a different approach or experience different timing for heat pump RTUs with ERV, most contractors (72%) could not provide any information because they do not sell this product. Of those that do, two contractors said their timing and approach were the same as for other RTU orders. The other contractors each had a different experience, ranging from faster lead times to several months slower to variable lead times depending on availability.

None of the distributors interviewed provided data regarding ERV RTU availability.

**Permitting.** Every contractor said that they always need to pull permits for RTU installations and that they do so early in the process (i.e., as soon as the contract is signed, once a deposit is

received, as soon as the work order is in). Several contractors said that the permitting process varies depending on the municipality and that different cities have different requirements and fee structures. This, combined with state testing (duct leakage), can impact prices. One contractor noted that they do not work in Santa Monica simply because "the city makes permits a big headache." Another said it would be nicer if there was a "one-stop-shop" for permitting throughout the state.

## 5.5 Recommendations to improve adoption of more efficient RTUs

CalMTA asked market actors and other stakeholders how California's energy-efficiency programs could encourage high-efficiency RTU adoption. The main recommendations included educating customers about the benefits of high-efficiency RTUs, offering substantial incentives through programs, focusing on customers who value high-efficiency features, and ensuring stability of programs and regulations.

**Emphasis on market awareness and education.** SCE staff said codes and standards are a powerful driver of improved efficiency, so CalMTA is encouraged to prioritize improving market awareness and education. Manufacturers recommend educating local contractors and manufacturer representatives on the compatibility of heat pumps with California's climate. One manufacturer recommended dual-fuel heat pumps for customers who do not want to make electrical upgrades. This manufacturer is developing a dual-fuel product that allows the use of two 220V connections instead of a 460V, which allows end users to add one extra connection. Manufacturers also mentioned that ensuring that contractors and manufacturer reps are aware of current energy efficiency initiatives and incentives (such as those offered by local utility companies) presents another opportunity for greater uptake of high-efficiency RTUs. For example, when contractors are aware of a rebate program, they can have greater success selling a high-efficiency RTU when they can tell the customer that it will cost less due to the rebate. In contrast, if the contractor is unaware of such programs, they are more likely to simply offer the least expensive option (which is likely to be standard efficiency) because they believe that is what the customer wants.

**Technology-agnostic incentives.** According to NEEA staff and HVAC manufacturers, HVAC manufacturers pay attention to incentives that substantially bring down the final price to RTU buyers. Manufacturers want to work with energy efficiency programs to set realistic specifications. Contractors also indicated they pay attention to what qualifies for incentives and were willing to install whatever meets incentive requirements.

Manufacturers would prefer setting incentive efficiency tiers in line with CEE and using common metrics, such as those used by federal regulations. They also strongly prefer setting incentive performance requirements based on performance outcomes, such as turndown ratios, allowing the manufacturer to decide how to best achieve those targets. Lastly, manufacturers noted that while optimizing one or two parameters is relatively easy, costs markedly increase if improving multiple metrics. Developing new products requires at least a year, if not more, as seemingly simple improvements could require a completely different design.

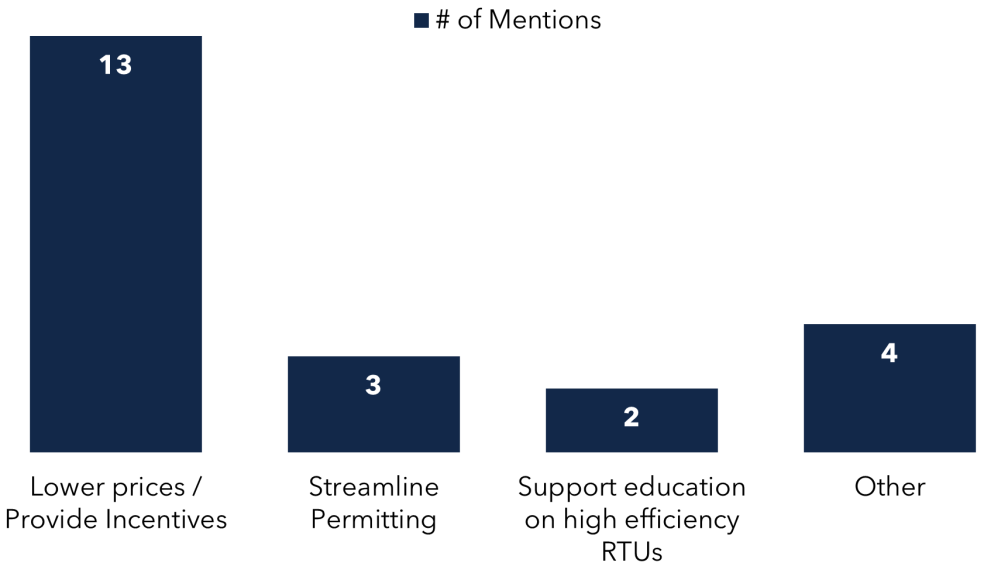
**Focus on premium customers.** Customers who value higher efficiency features include universities, school districts, and other owner/operator entities. One manufacturer elaborated on the example of a school district, highlighting that they have large amounts of capital to build new facilities that are paid for through bond issuances but limited funding for operational expenses. As such, they are highly incentivized to pay more for equipment that has lower operating expenses over the life of the equipment.

**Program and regulatory stability.** Making sure that contractors are involved with efficiency programs and that programs remain stable is important. Contractors can promote things that implementers cannot, but from a contractor's point of view, utility programs and regulations change too often, discouraging some contractors from engagement and increasing their costs and staffing challenges.

**Contractors' recommendations.** As shown in Figure 25, when asked what the energy efficiency programs of California could do to increase adoption of high-efficiency RTUs, more than half of contractors suggested lowering prices for high-efficiency RTUs or providing financial incentives (i.e., rebates or tax credits) that would make the units more affordable. Contractors also suggested streamlining the permitting process. One contractor explained that compliance with Title 24 and pulling permits requires submitting a lot of information, which increases their costs significantly. Two contractors suggested education efforts on high-efficiency RTUs to improve customer demand. One suggested providing contractors with brochures on high-efficiency RTUs that use layman's language so that they can easily explain the benefits and considerations of high-efficiency RTUs to customers. Another suggested that education should not be left only to contractors but that it would be helpful for the state to undertake some of that effort as well.

The remaining recommendations were each unique. One contractor suggested more products, noting there are currently very few models available to sell in the light-commercial sector, so they are limited to what they can offer those customers. Another suggested undertaking an effort to replace units that use "bad refrigerants." A different contractor suggested implementing a mandatory efficiency minimum to encourage more uptake of high-efficiency RTUs. Another suggested a more stable regulatory environment, implying that it is difficult for contractors to adjust to regulatory changes.

**Figure 25. Recommendations to increase adoption of high-efficiency RTUs (n=18)**




Source 25: CalMTA HVAC interviews

Contractors also provided information on the kind of conditions or support that would be most effective in convincing them to sell or install a new RTU product for the first time. Nearly all of the contractors said that the product would have to come from a reputable brand/manufacturer. Some added that having good reviews, a good warranty, a good liability rating, training for contractors, and good availability of parts and service for repairs would also be helpful. Distributors provided similar responses, with three out of five distributors suggesting lower prices or added incentives. One suggested streamlining regulations, and another recommended establishing working relationships with manufacturers to better understand high-efficiency RTU products and what would be needed to expand the market for those high-efficiency RTU products.

# 6 Demand side characteristics

CalMTA conducted surveys with decision-makers (i.e., building owners and facility managers); interviews with distributors, contractors, and a range of stakeholders; and secondary research to gain an understanding of the factors that influence RTU purchases, willingness to switch to a heat pump, and barriers that inhibit widespread adoption of efficient RTUs in California.

## 6.1 Commercial building market decision-making

The commercial building market is heterogenous.[47] Within the same market, different types of occupancies (owner-occupied versus leased) and roles (building owner versus facility manager) influence how energy efficiency decisions are (or are not) made. According to the 2018 Commercial Buildings Energy Consumption Survey data (Table B5), 79% of commercial floorspace in the Pacific census region is nongovernment-owned, with about half of this owner-occupied.

Decision-making varies based on the size of the company that owns and operates commercial buildings. Very large property-owning firms have more fragmented decision-makers. For example, there may be investment managers, operations managers, and facility managers involved in decision-making for a portfolio of buildings. A study of energy efficiency in commercial buildings found outside contractors are typically brought in for tasks "that go beyond standard maintenance."[48]

Smaller firms have fewer decision-makers involved. For example, a small commercial property owner may make investment decisions instead of using an investment manager. Owners or their staff may work directly with facility managers to operate their buildings. As they would typically lack dedicated design and planning staff, they may also work with consultants on design and planning or directly with contractors to address building projects.[49]

This same study suggests owner-users managing and maintaining their own buildings are falling out of favor compared to professional management and that maintenance and energy efficiency are at the bottom of the owners' list of priorities.

Another study on commercial building decision-making processes found that the typical decision-maker journey followed five main steps: identify the need, make a plan, approve the plan, execute the plan, and showcase the benefit.[50] While not every journey follows all these steps in succession, this sequence is commonly experienced by those involved in major decisions regarding commercial building renovations. Each step presents challenges for energy efficiency considerations as competing priorities are weighed against the pros and cons of addressing energy efficiency. Decision-makers are very concerned with how energy efficiency impacts their ability to attract and retain tenants, but often, the benefits of upgrading buildings remain in question. In cases where benefits are uncertain or unclear, the decision-making journey becomes more difficult to navigate and even more pronounced when there are multiple sources of input (i.e., asset managers and property managers who may have equal say and different agendas).

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[47] Reed, J., A. Oh, N. Hall. 2000. *The Structure and Operation of the Commercial Building Market*. https://www.aceee.org/files/proceedings/2000/data/papers/SS00_Panel4_Paper23.pdf

[48] Reed 2000, *op. cit.*

[49] Reed 2000, *op. cit.*

[50] ETHNO Insights, LLLC. 2024. *BetterBricks Commercial Building Decision Maker Study*. BetterBricks Commercial Building Decision Maker Study

When tangible benefits are easy to discern (i.e., proven savings and increased thermal comfort), decision-makers are much more likely to proceed with energy-efficient upgrades.

## 6.2 Building characteristics and occupancy dynamic

This section provides a breakdown of building characteristics and occupancy type from the RTU decision-maker survey, including data on responsibility for energy bills and the extent to which tenants' input is considered in RTU selection. The decision-maker survey respondents (building owners and facility managers) all were involved in HVAC decision-making and had at least one nonresidential building in California using RTUs for space conditioning.

### 6.2.1 Building characteristics

Table 7Table 1 shows buildings that are owned or managed by survey respondents (building owners and facility managers who own or manage at least one building in California with an RTU). Nearly 80% of the buildings reported were 25,000 square feet or less. This is generally in agreement with the building size distribution from the EIA's 2018 Commercial Buildings Energy Consumption Survey, which found that 88% of buildings in the Pacific region are under 25,000 square feet. Respondents reported that over three-quarters of their buildings are equipped with single-zone RTUs; however, this should be interpreted as the upper limit to the statewide RTU saturation since the sample only includes owners or managers with RTUs on their buildings and not a general population of building owners/managers.

**Table 7. Number of buildings and number of buildings with single-zone RTUs**

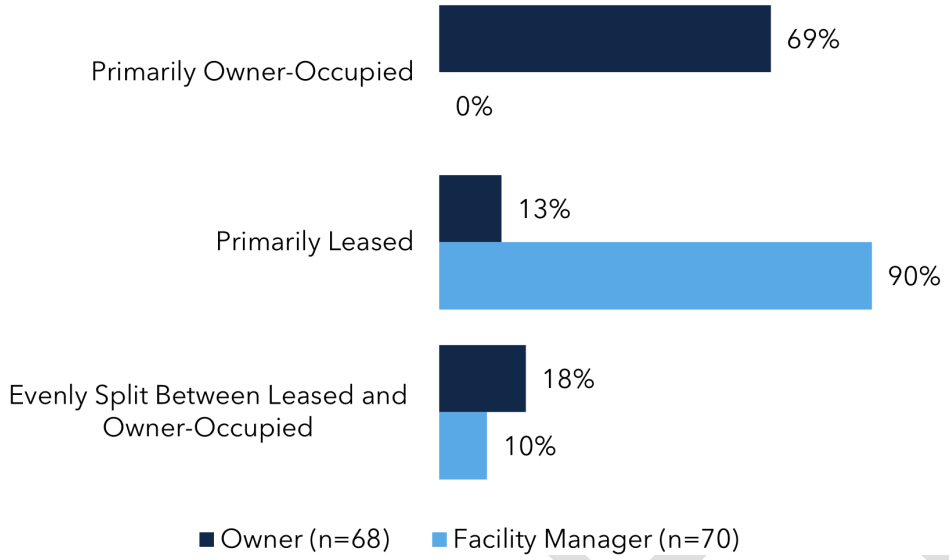
| Building Floorspace (square feet) | # of California buildings | | | # of California buildings w/ RTUs | | | |
|---|---|---|---|---|---|---|---|
| | Owner (n=68) | Manager (n=70) | Total Buildings | Owner (n=68) | Manager (n=70) | Total Buildings with RTUs | RTU Incidence |
| Under 5,000 | 865 | 217 | 1,082 | 663 | 185 | 848 | 78% |
| 5,001 to 10,000 | 690 | 242 | 932 | 538 | 196 | 734 | 79% |
| 10,001 to 25,000 | 481 | 174 | 655 | 367 | 142 | 509 | 78% |
| 25,001 to 50,000 | 339 | 91 | 430 | 248 | 77 | 325 | 76% |
| 50,001 to 100,000 | 217 | 24 | 241 | 157 | 23 | 180 | 75% |
| Over 100,00 | 102 | 1 | 103 | 67 | 1 | 68 | 66% |
| **Total** | **2,694** | **749** | **3,443** | **2,040** | **624** | **2,664** | **77%** |

Source: RTU Decision-Maker Survey: Please indicate the number of buildings you own or manage in California. Please indicate the number of those buildings that have single-zone RTUs for heating, cooling, and ventilation.

### 6.2.2 Building occupancy type

Figure 26 provides a breakdown of buildings by occupancy type. Among building owners, 69% described their buildings as primarily owner-occupied. Among facility managers, the majority (90%) said they primarily manage leased properties.

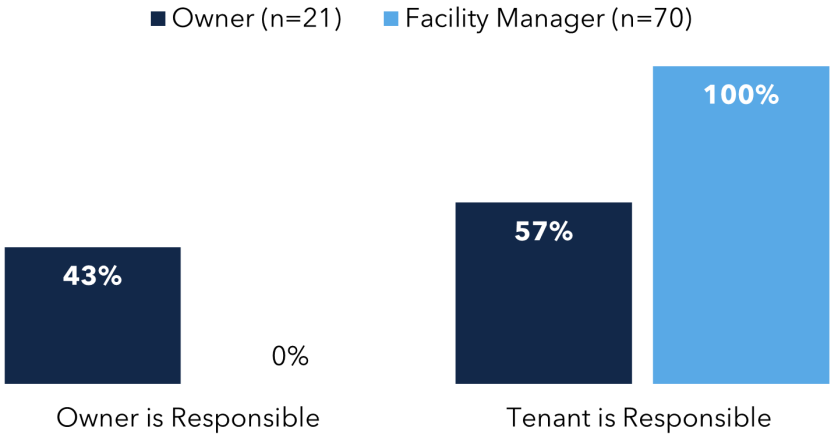
**Figure 26. Owner-occupied vs. leased properties**




Source 26: RTU Decision-Maker Survey: Based on square footage, are your buildings mostly owner-occupied or leased?

The survey asked building owners and facility managers who is responsible for paying the electric and gas bills for leased properties (Figure 27). Among building owners, 57% reported tenants pay the energy bills. In contrast, all of the facility managers who responded to this question said that their tenants are responsible for the electric and gas bills.

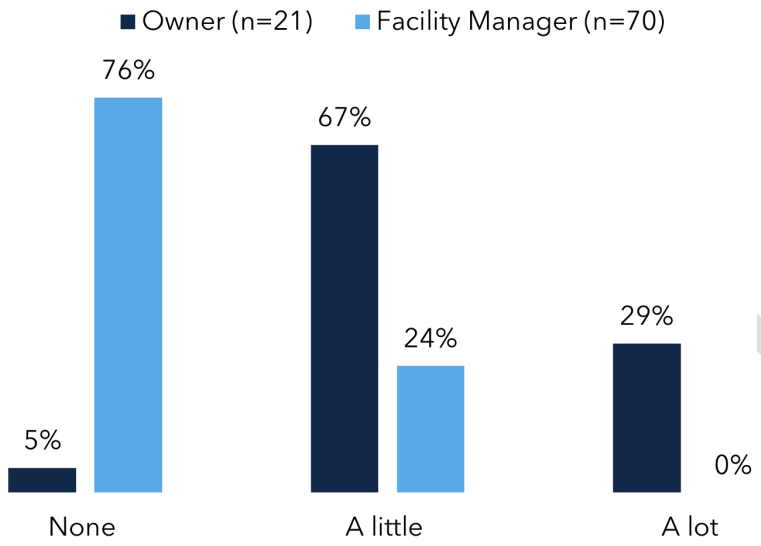
**Figure 227. Who pays electric/gas bills at leased properties**




Source 27: RTU Decision-Maker Survey. Who is responsible for paying the electric and gas bill in leased properties?

The survey then asked decision-makers how much influence their tenants had when it came to RTU selection. Most owners (67%) said that they had *a little* influence, and some (29%) said they had *a lot* of influence. Conversely, the majority (76%) of facility managers said that tenants have *no influence*, and none said that tenants have *a lot* of influence (Figure 28).

**Figure 28. Tenant influence on RTU selection at leased properties**



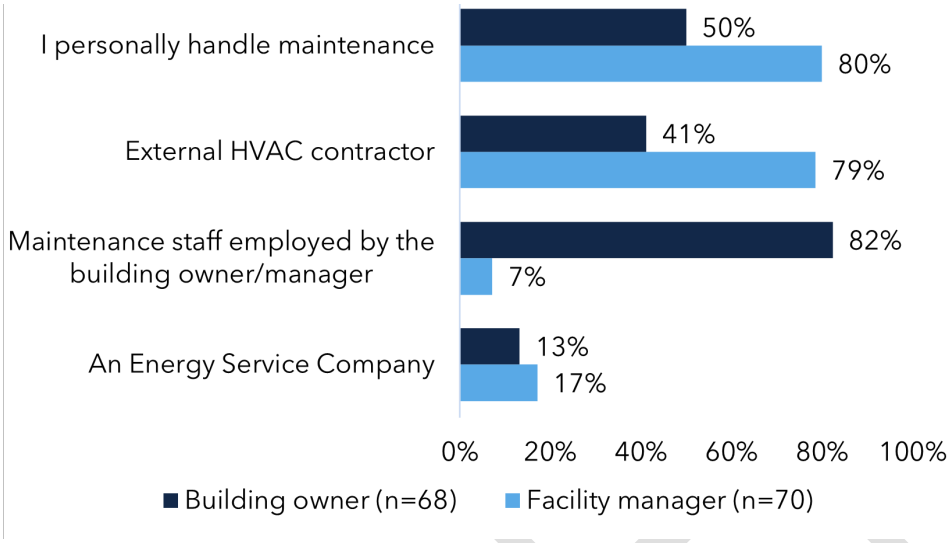

Source 28: RTU Decision-Maker Survey: How much influence do tenants have in the RTU selection process?

## 6.3 RTU purchase drivers

### 6.3.3 Maintenance and replacement practices

Approaches to RTU maintenance varied among decision-makers. Most (82%) building owners primarily relied on in-house maintenance staff, with about half of owners also personally involved in maintenance. Among facility managers, 80% reported handling maintenance themselves, and 79% reported working with external HVAC contractors. Energy Service Companies (ESCOs) played a smaller role, used by 13% of building owners and 17% of facility managers (Figure 29).

**Figure 29. Who maintains RTUs**




Source 29: California RTU Decision-Maker Survey: Who Maintains the RTU? Select all that apply. Note that because respondents could select multiple options, percentages do not sum to 100%.

As for RTU replacements, the prevailing strategy is to replace-on-failure. A recent study observed that RTUs generally have "low operating efficiencies and receive infrequent maintenance" due to most consumers having a "low first cost, run-to-failure, like-for-like replacement" mentality.[51] CalMTA interviews with contractors found that 72% of installations were unplanned and that customers often preferred to replace their old units with the same model they had because they were familiar with the product and less likely to require structural upgrades or renovations. These scenarios are especially common for small businesses, as they tend to be more cost-conscious and less likely able to afford the luxury of planned replacements.[52]

**Factors influencing replacement timing.** Estimates of EUL differed among owners and managers: building owners (n=66) expected a new RTU to last an average of four years, while facility managers (n=70) expected a new RTU to last an average of just under 14 years, significantly more than the average reported by building owners. The overall average lifespan expectation across all respondents was nine years. This figure is lower than that provided by the CalTF EUL estimate of 15 years for packaged heat pump air conditioners.[53]

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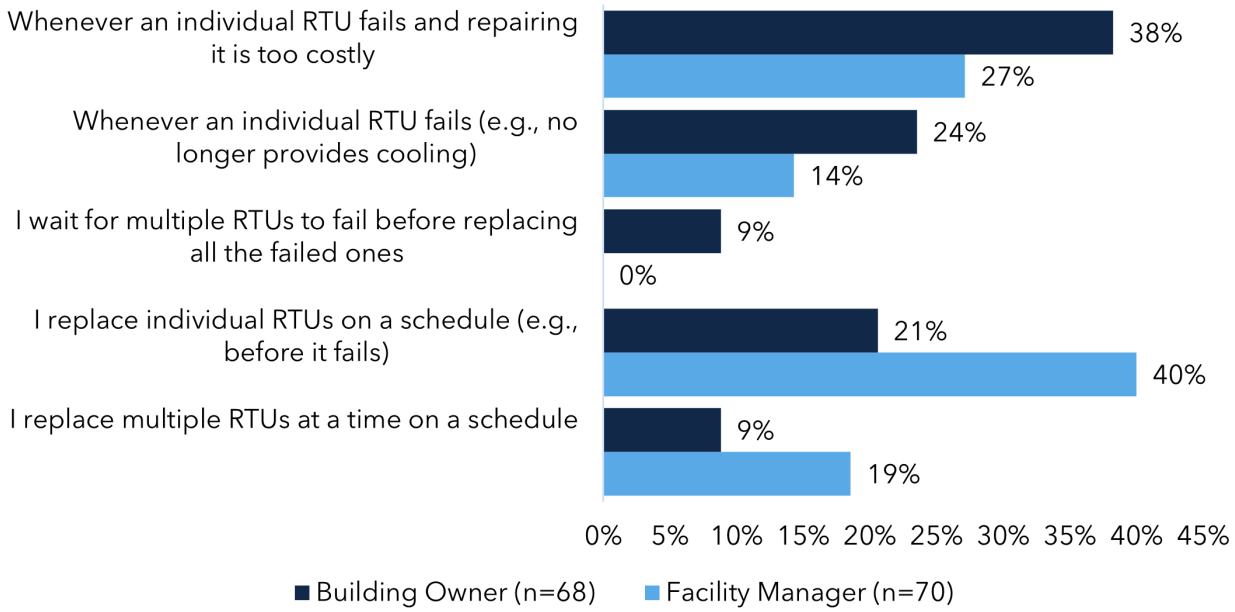
[51] NREL. 2021. *Long and Winding Road to Higher Efficiency—The RTU Story.* https://www.nrel.gov/docs/fy21osti/77092.pdf

[52] Cadeo. 2023. *Op. cit.*

[53] California eTRM. December 10, 2024. Packaged Heat Pump Air Conditioner Commercial, Fuel Substitution | ETRM

When asked about their approach to replacing RTUs, the most common response by commercial building owners was to replace units only after failure (Figure 30). Facility managers more often schedule replacements, either individually or for multiple RTUs at a time.

**Figure 30. Drivers of RTU replacement**

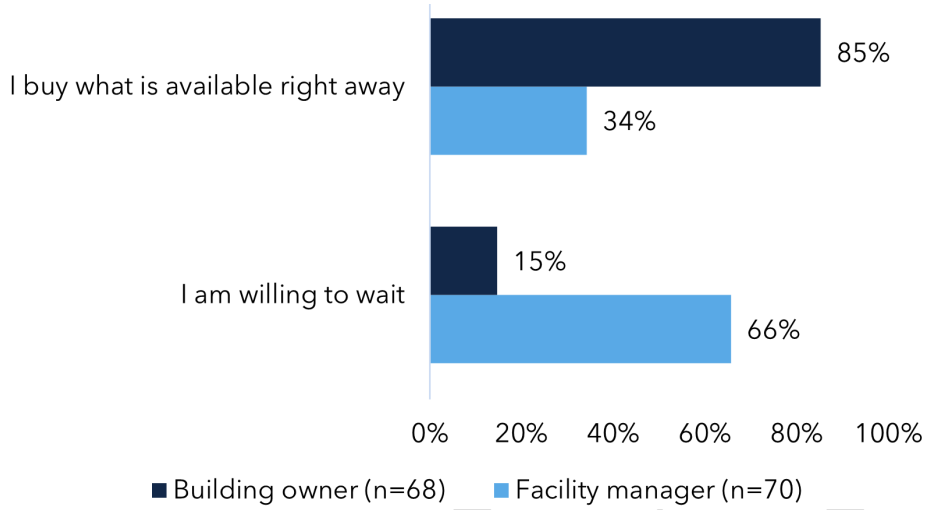



Source 30: California RTU Decision-Maker Survey: How do you decide when to replace an RTU?

### 6.3.4 Purchasing behaviors

When purchasing a new RTU, most (66%) facility managers were willing to wait for their preferred equipment model, whereas only 15% of building owners shared this preference. In contrast, 85% of building owners prioritized purchasing readily available models, compared to just 34% of facility managers (Figure 31).

**Figure 31. Willingness to wait for preferred equipment**

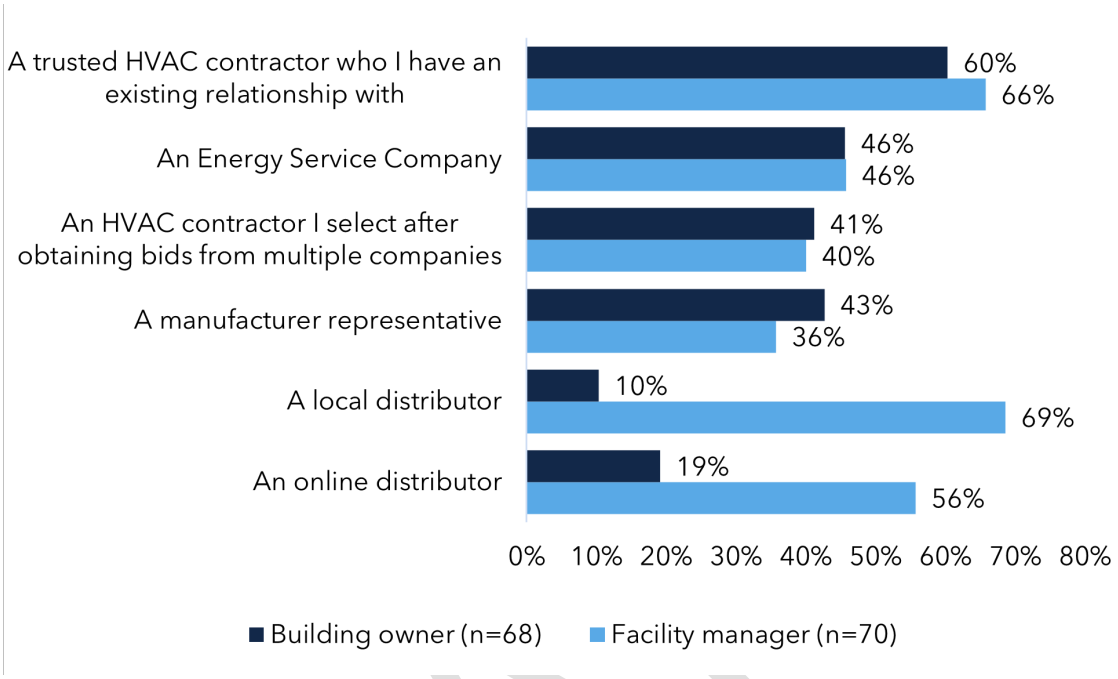



Source 31: California RTU Decision-Maker Survey: When purchasing a new RTU, do you typically purchase what is available (in stock), or are you willing to wait for your preferred model, even if it means ordering in advance?

In a follow-up question, respondents were asked how long they would be willing to wait for a new RTU. Facility managers were willing to wait longer on average—up to 2.7 months—compared to 1.6 months for building owners.

Decision-makers purchase RTUs from various channels (Figure 32). Notably, 69% of facility managers said they purchase through a local distributor, while only 10% of building owners reported using a local distributor. Facility managers are also more likely to use an online distributor than building owners.

**Figure 32. Where building owners and facility managers purchase RTUs**

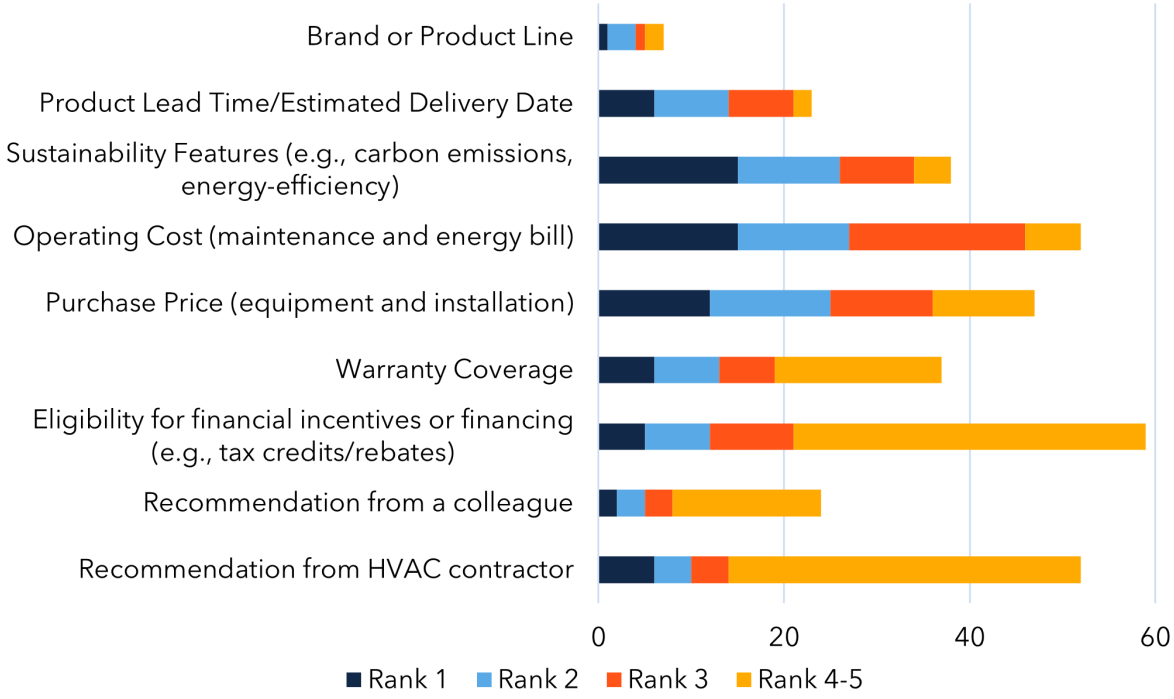



Source 32: California RTU Decision-Maker Survey: From where do you or your organization purchase RTUs?

Building owners (Figure 33) and facility managers (Figure 34) prioritized different factors when selecting RTUs. While both groups prioritized purchase price and operating costs, they diverged in other areas. Building owners were more influenced by recommendations from HVAC contractors and the availability of financial incentives, whereas facility managers placed greater value on warranty coverage and what their peers recommended.

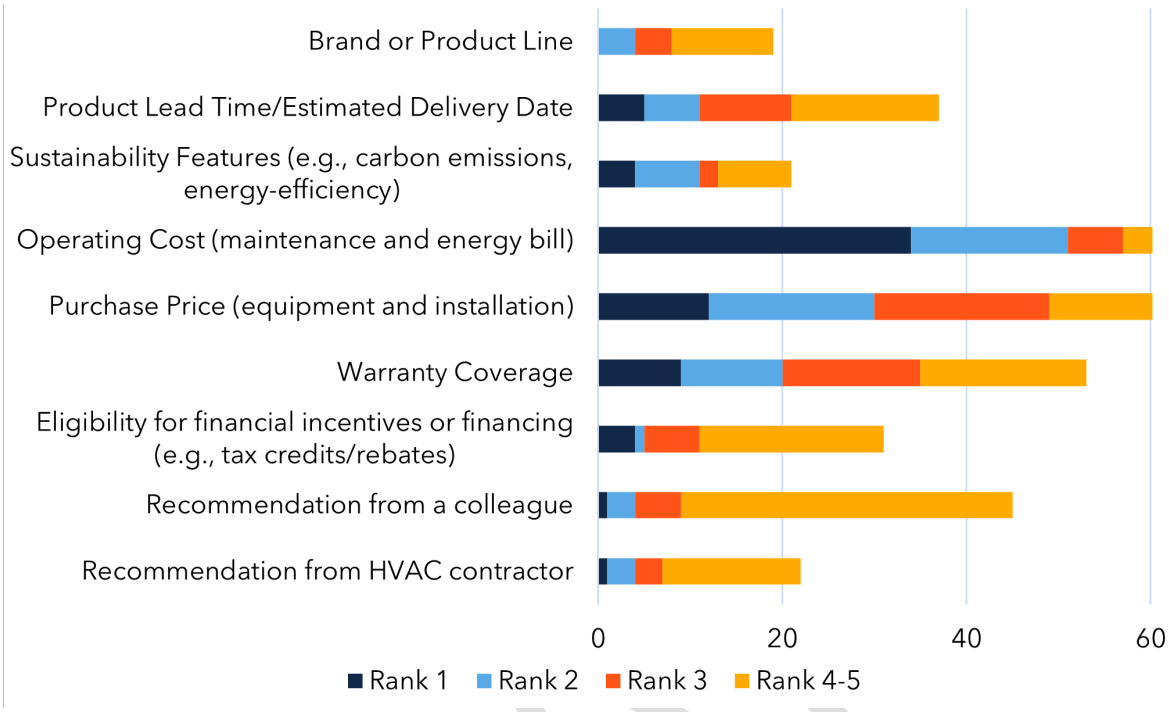
Compared to facility managers, building owners placed greater weight on sustainability features, which received 15 first-rank responses, and showed a stronger interest in financial incentives.

**Figure 33. Most important information for purchasing RTU: Building owners**




Source 33: California RTU Decision-Maker Survey. Please rank the most important kinds of information your organization looks for when deciding which RTU to purchase, with 1 being most important, up to 5. (Building Owners, n=68)

**Figure 34. Most important information for purchasing RTU: Facility managers**




Source 34: California RTU Decision-Maker Survey Please rank the most important kinds of information your organization looks for when deciding which RTU to purchase, with 1 being most important, up to 5. (Facility Managers, n=70)

### 6.3.5 Expected initial costs and estimated operating costs

Both initial and operating costs are major factors considered by decision-makers. Survey respondents were asked how much they expect to pay for standard-efficiency RTUs with air conditioning and natural gas heating. Table 8 summarizes the respondents' expected costs for 3-ton, 5-ton, and 7.5-ton RTUs, including averages, medians, cost ranges, and standard deviations reported by building owners and facility managers.

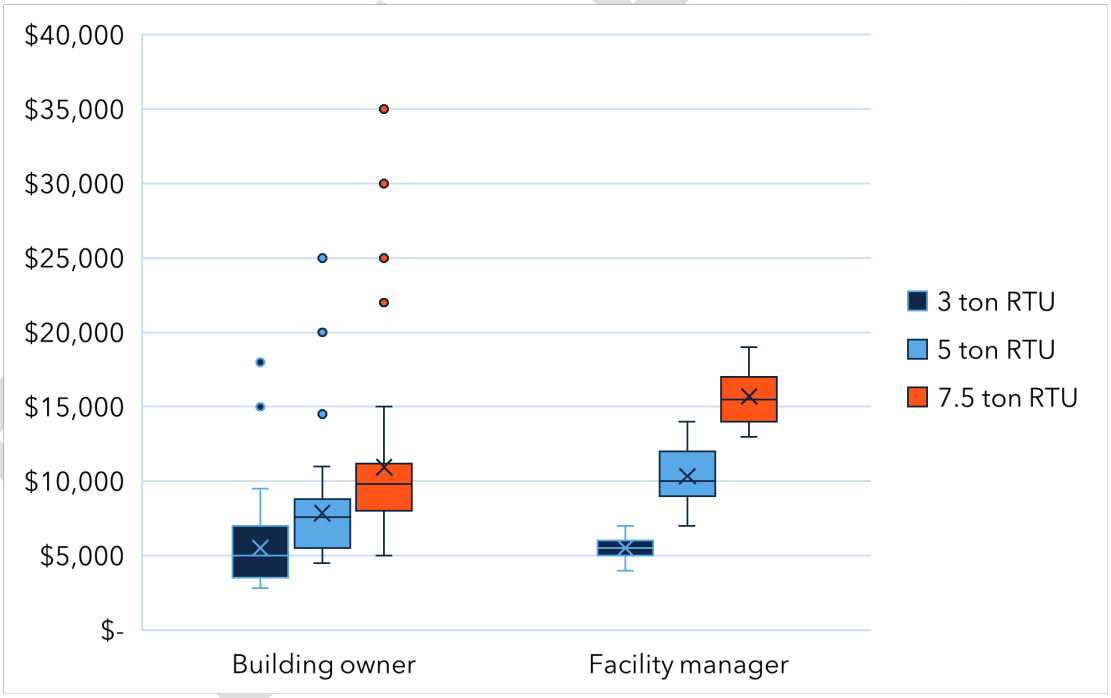
**Table 8. Expected cost for standard RTU with air conditioning and gas heating**

| Category | 3-ton | 5-ton | 7.5-ton |
|---|---|---|---|
| **Average Cost** | | | |
| Building Owners | $5,515 | $7,855 | $10,939 |
| Facility Managers | $5,500 | $10,343 | $15,707 |
| **Median Cost** | | | |
| Building Owners | $5,000 | $7,600 | $9,800 |
| Facility Managers | $5,500 | $10,000 | $15,500 |

| Category | 3-ton | 5-ton | 7.5-ton |
|---|---|---|---|
| **Cost Range** | | | |
| Building Owners | $2,800 - $18,000 | $4,500 – $25,000 | $5,000 - $35,000 |
| Facility Managers | $4,000 - $7,000 | $7,000 - $14,000 | $13,000 - $19,000 |
| **Standard Deviation** | | | |
| Building Owners | $2,611 | $3,468 | $5,448 |
| Facility Managers | $799 | $1,787 | $1,813 |

These results, also reflected in Figure 35, indicate that facility managers generally anticipate higher costs, especially for larger RTUs, compared to building owners. In the figure, outliers are represented as dots, denoting values that fell outside 1.5 times the interquartile range. One respondent from the building owner group was excluded due to providing very low estimates, which suggested they misunderstood the question.

**Figure 35. Expected cost for standard RTU with air conditioning and gas heating**

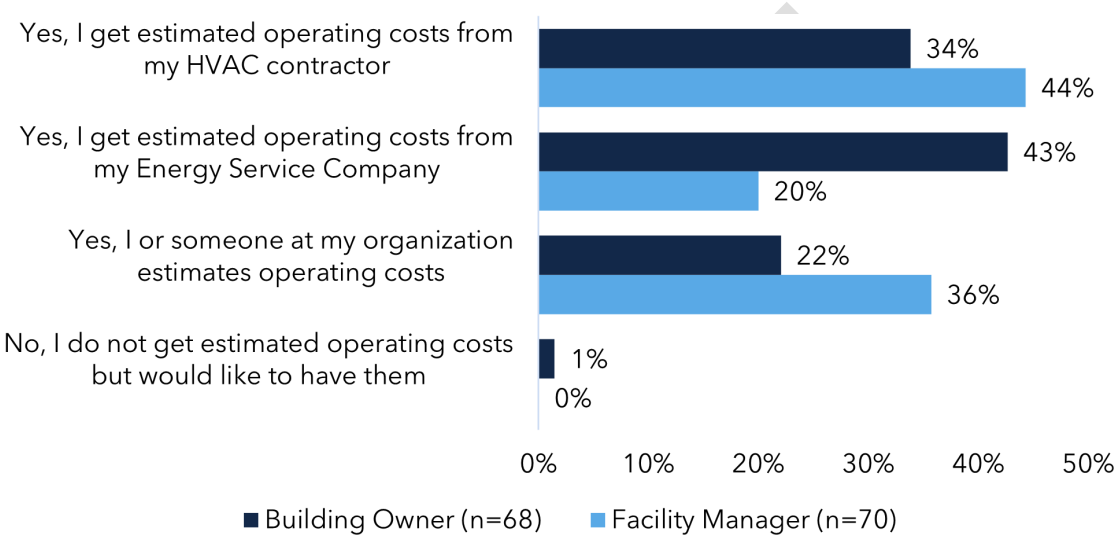



Source 35: California RTU Decision-Maker Survey: How much do you or your organization expect to pay (equipment plus installation) for a standard efficiency RTU with air conditioning and natural gas heating?

In terms of operating cost, both building owners and facility managers obtain estimates when purchasing RTUs, but their sources differ (Figure 36). The most common source for both groups is HVAC contractors, consulted by 34% of building owners and 44% of facility managers. However,

building owners are more likely to consult ESCOs, with 43% relying on this resource compared to 20% of facility managers. In contrast, facility managers are more inclined to use internal estimates, with 36% relying on someone within their organization compared to 22% of building owners. Notably, only one building owner reported not obtaining operating cost estimates when purchasing an RTU.

**Figure 36. Estimating operating costs for new RTU**

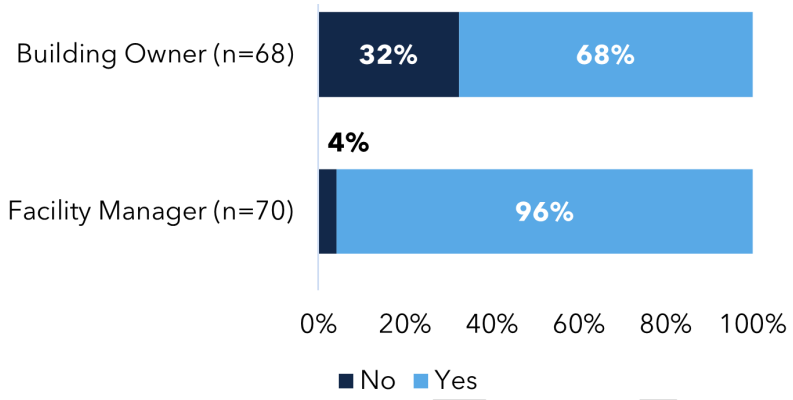



Source 36: California RTU Decision-Maker Survey: When purchasing an RTU, do you typically obtain or estimate operating costs (energy bills and maintenance?

### 6.3.6 Awareness of energy efficiency programs

Figure 37 shows a difference in awareness of energy efficiency or decarbonization programs that provide financial support for new RTU purchases between building owners and facility managers. Only 68% of building owners were aware of these programs, whereas nearly all facility managers (96%) were aware of these programs.

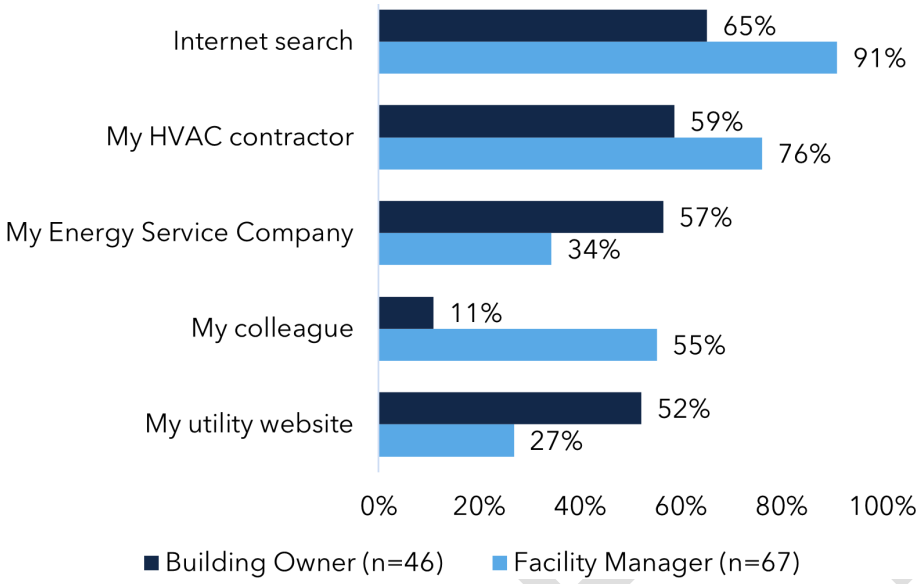
**Figure 37. Awareness of financial support for new RTU purchases**




Source 37: California RTU Decision-Maker Survey: Do you know of any energy efficiency or decarbonization programs that provide financial support for new RTU purchases?

Building owners and facility managers who reported awareness of financial support for new RTUs relied on different sources to learn about energy efficiency programs (Figure 39). However, both groups most commonly turned to internet searches (65% building owners, 91% facility managers). Facility managers also frequently consulted HVAC contractors (76%) and colleagues (55%), while building owners relied more on utility websites (52%) and rarely consulted colleagues (11%). The two groups differed in their use of ESCOs as a source to learn about energy efficiency programs as well, with 57% of building owners and 34% of facility managers citing them as a resource.

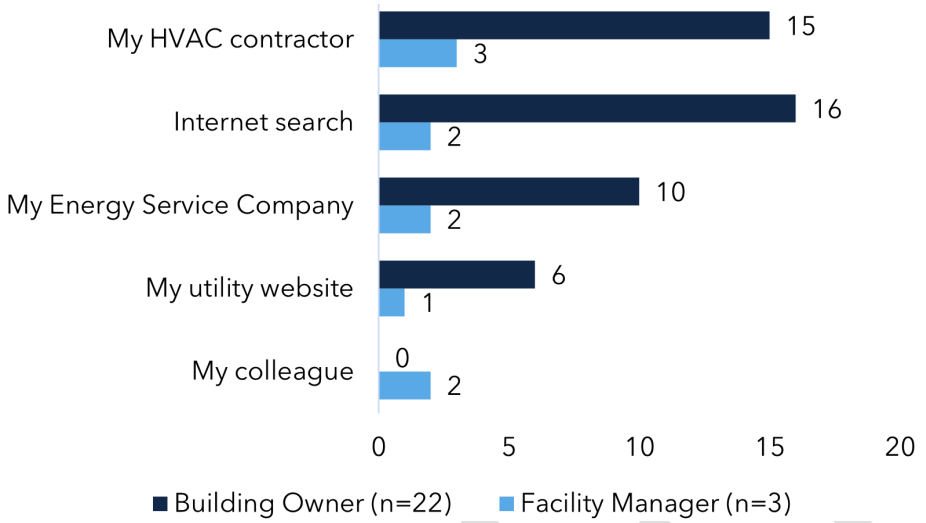
**Figure 38. Source of awareness for financial support for new RTUs**




Source 38: California RTU Decision-Maker Survey: How do you find out about these programs? Select all that apply. (Among those who are aware of programs that provide financial support for RTU purchases)

Figure 39 illustrates the preferences of those currently unaware of financial support for RTU purchases when seeking information about energy efficiency programs. Among building owners, the majority favored internet searches (16 out of 22 building owners) and HVAC contractors (15 building owners). Building owners also reported interest in learning about energy efficiency programs from ESCOs (10) and utility websites (six). In contrast, only three facility managers answered this question and had a preference for HVAC contractors (three) and colleagues (two).

**Figure 39. Sources for information on financial programs for RTUs**



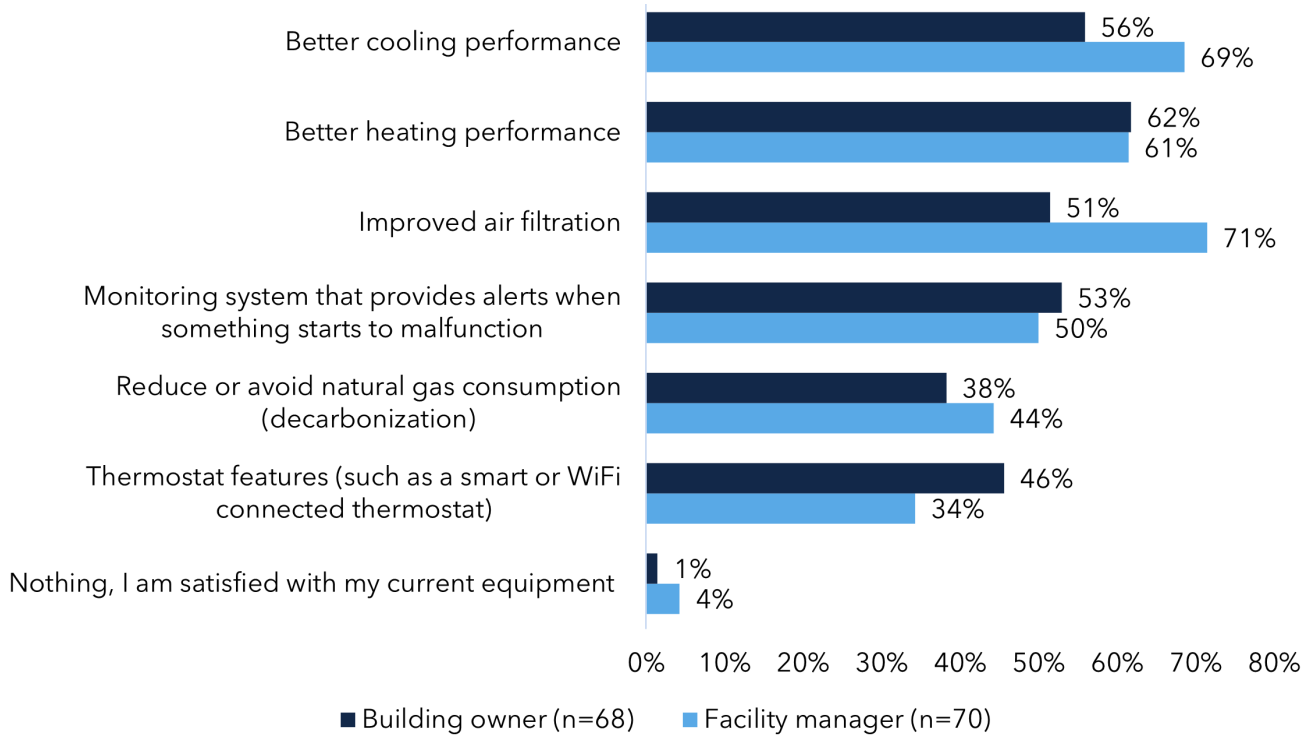

Source 39: California RTU Decision-Maker Survey: If you were interested in finding out about these programs, where would you look? (Among those who are unaware of programs that provide financial support for RTU purchases, n=25)

### 6.3.7 RTU feature priorities

Survey results revealed key considerations that factor in RTU purchases, including desired improvements and willingness to consider Wi-Fi-enabled RTUs, as well as how customers balance upfront costs with operating costs and brand preferences.

**Key considerations for next RTU purchase.** Building owners and facility managers share common priorities for improving their next RTU, though their focus differs slightly (Figure 40). Only a small fraction (3%) of respondents (one building owner and three facility managers) reported being fully satisfied with their current RTUs. Key areas for improvement included heating and cooling performance as well as air filtration. Facility managers tended to prioritize air filtration and cooling performance more than building owners, while owners showed slightly greater interest in thermostat features. Both groups show interest in monitoring systems that provide malfunction alerts, with 50% of facility managers and 53% of building owners identifying this as desirable. Additionally, 44% of facility managers and 38% of building owners expressed interest in reducing or avoiding natural gas consumption.

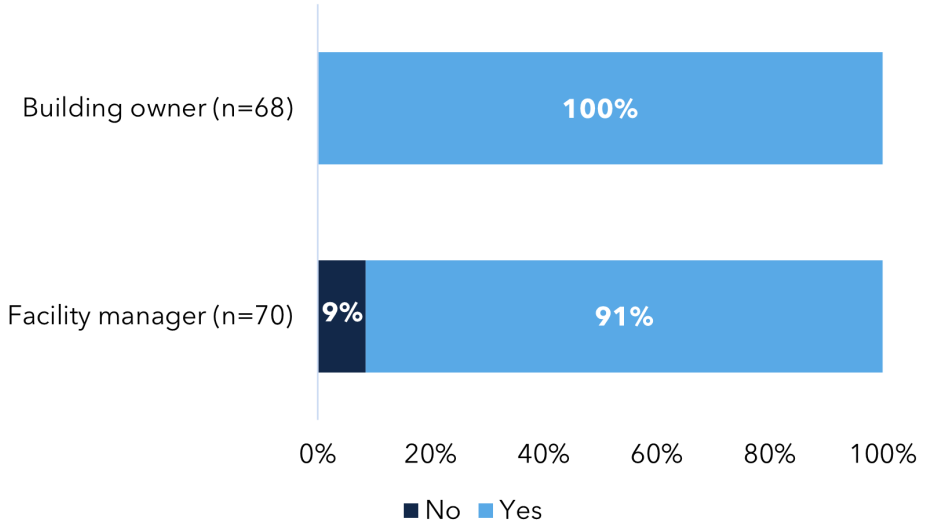
**Figure 403. Desired improvements for next RTU purchase**




Source 40: California RTU Decision-Maker Survey: Thinking about how your current RTUs perform, is there anything you would like to improve with your organization's next RTU purchase? (select all that apply)

As shown in Figure 41, all building owners (100%) and nearly all facility managers (91%) said they would consider Wi-Fi-connected RTUs for their next purchase. However, the small group of facility managers (6 out of 70) who would not consider these models raised concerns. Three respondents indicated the reliance on continuous internet connectivity as a major drawback, particularly in areas with unreliable internet. Two cited the complexity of installation and operation. They noted that Wi-Fi-enabled RTUs often require advanced infrastructure and are better suited for large-scale applications. One respondent reported high upfront costs.

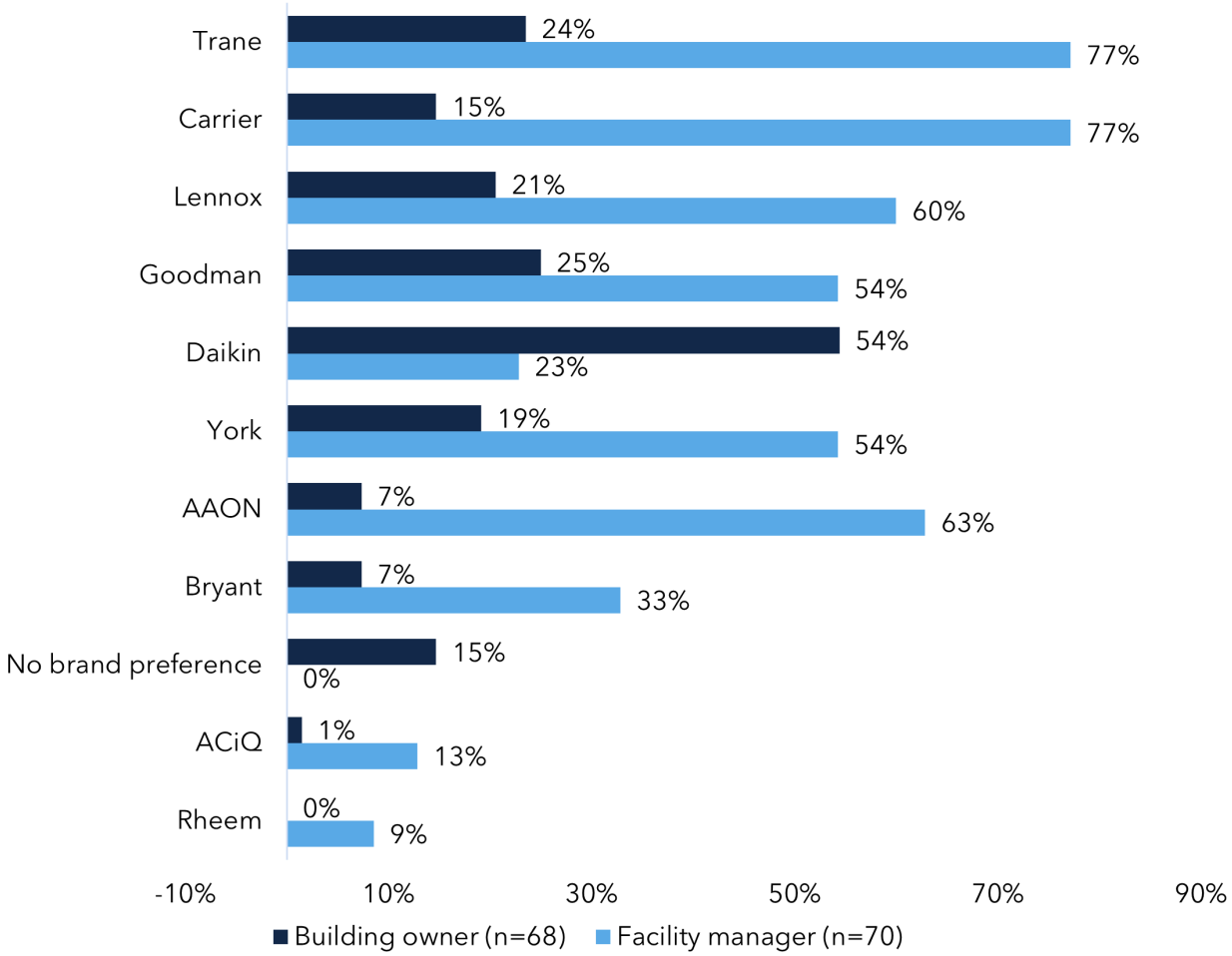
**Figure 414. Willingness to consider Wi-Fi/internet-connected RTUs**




Source 41: California RTU Decision-Maker Survey: For your next RTU purchase, would you consider a Wi-Fi or internet-connected model?

**Brand preferences.** When asked about their preferred RTU brands, most facility managers mentioned Trane, Carrier, Lennox, and AAON (illustrated in Figure 42). Owners mentioned Daikin more often, followed by Goodman and Trane. Additionally, 15% of building owners reported having no brand preference, compared to none of the facility managers.

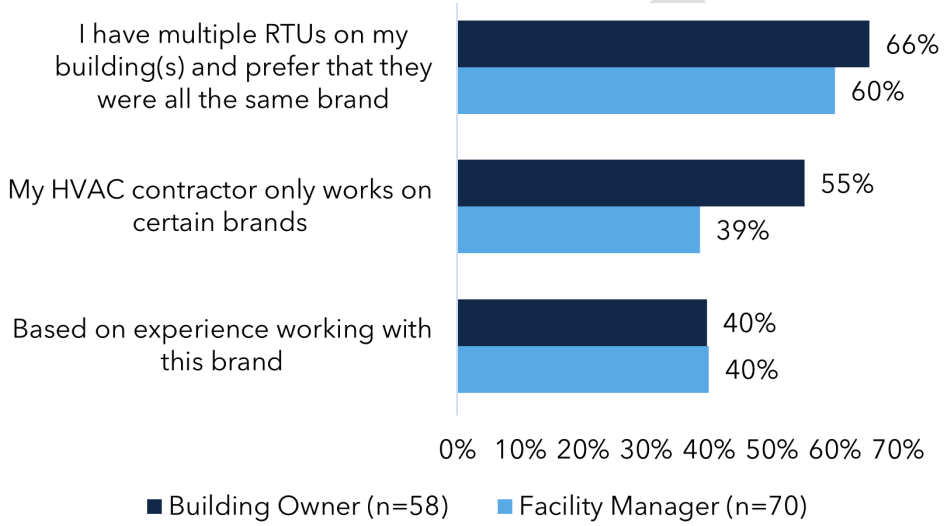
**Figure 425. RTU brand preference**




Source 42: California RTU Decision-Maker Survey: Do you have a preferred brand when purchasing RTUs? Select all that apply.

The survey asked respondents what drives their brand preference. As shown in Figure 43, both groups prioritized consistency, with 60% of facility managers and 66% of building owners preferring all RTUs in their buildings to be the same brand. However, their reasons for brand loyalty differed. Building owners were more likely to rely on the expertise of HVAC contractors, while facility managers were slightly more likely to rely on their own past experiences with a brand. Note that 10 building owners were excluded from this question as they indicated they did not have a brand preference.

**Figure 436. Drivers of brand preference**

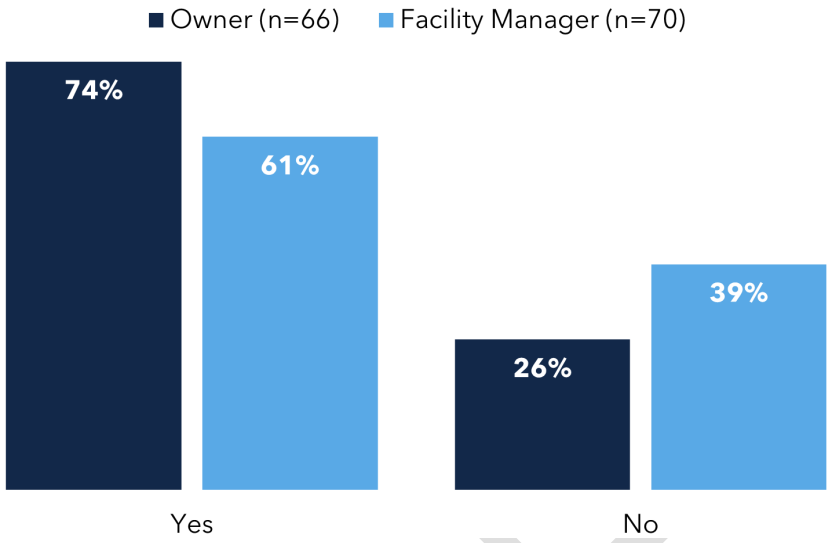



Source 43: California RTU Decision-Maker Survey: What Drives Your Brand Preference? Select all that apply.

## 6.4 Willingness to switch to a heat pump

The survey asked respondents who indicated they had a gas pack if they would consider switching their current natural gas RTUs to a heat pump RTU in the future. As shown in Figure 44, the majority of both of these groups were willing to consider a heat pump when it came time to replace their existing gas pack, though more building owners (74%) were willing to switch to a heat pump system than facility managers (61%). An important caveat to this result is that there was no mention of price or incentives related to making a switch. Thus, it appears that decision-makers are at least willing to consider a new heat pump system before factoring in cost.

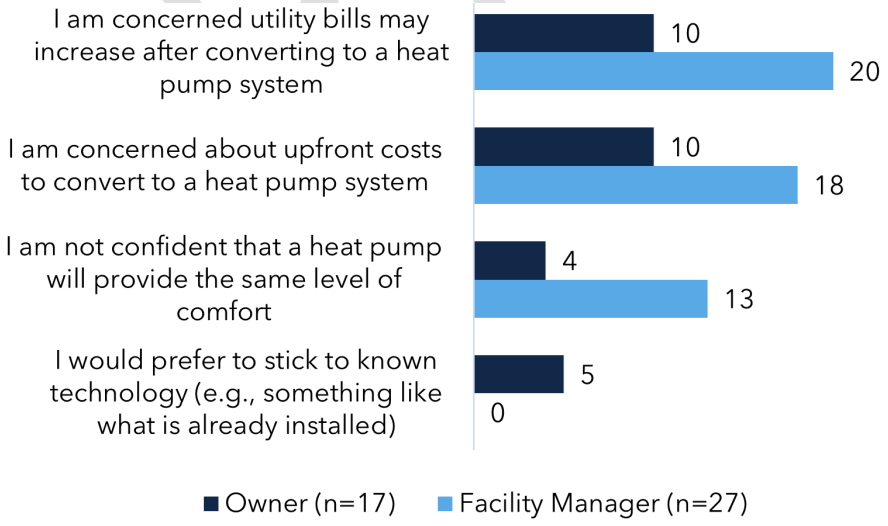
**Figure 447. Willingness to consider heat pump replacement**




Source 44: RTU Decision-Maker Survey: Would you consider replacing the furnace system with a heat pump system?

The survey then asked respondents who would not consider switching to a heat pump to indicate their concerns (Figure 45). The most common concerns were related to upfront costs and utility bill increases.

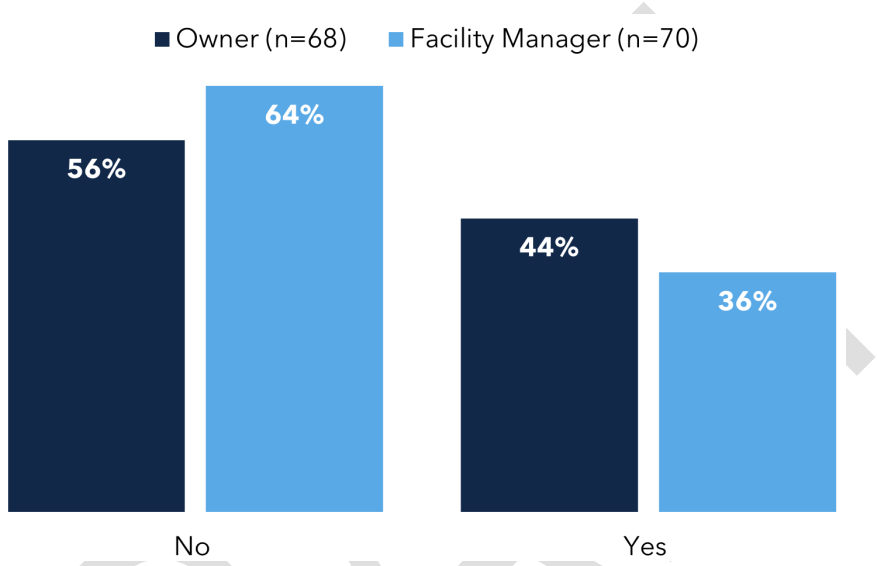
**Figure 458. Concerns with switching to a heat pump system**




Source 45: RTU Decision-Maker Survey: You indicated that you would not consider replacing your natural gas furnace RTU(s) with a heat pump RTU(s). Please select all reasons that apply.

Although decision-makers had an open mind about heat pumps, they were less inclined to purchase a higher efficiency RTU if the price were higher (Figure 46). Those who were willing to pay more for a high-efficiency unit were asked how much more they would be willing to pay. On average, Building Owners (n=29) reported a willingness to pay 7.28% more, while Facility Managers (n=25) reported a willingness to pay 2.44% more.

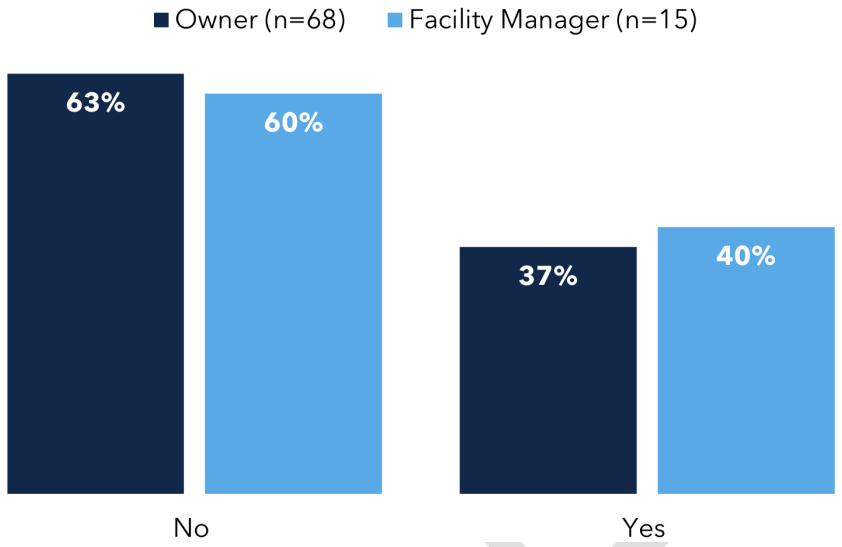
**Figure 469. Willingness to purchase higher efficiency unit at higher price**




Source 46: RTU Decision-Maker Survey: Would you be willing to purchase a high-efficiency RTU if the purchase price were higher?

In addition to capital costs, decision-makers also reported reluctance to switch to a heat pump if it meant increased energy costs (Figure 47).

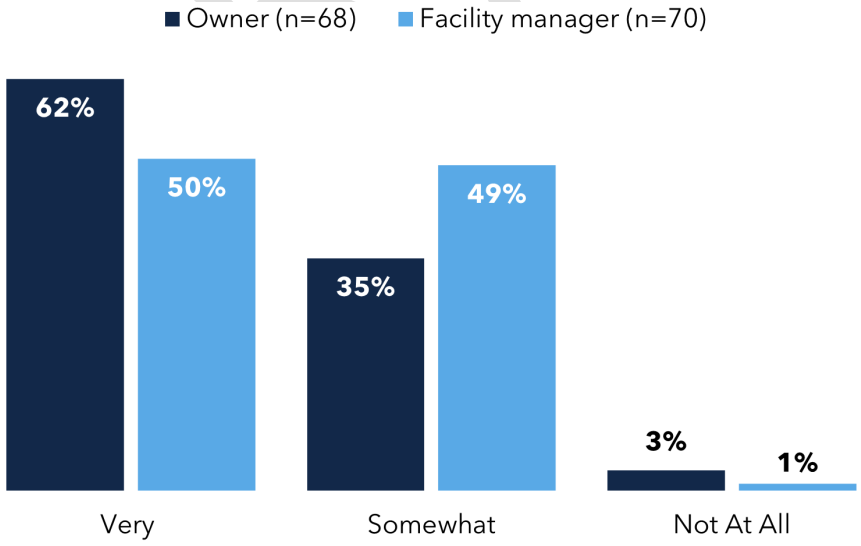
**Figure 4710. Willingness to switch to heat pump with increased energy costs**




Source 47: RTU Decision-Maker Survey: In owner-occupied units, are you willing to switch to a heat-pump RTU if it means energy costs may increase?

Figure 48 illustrates decision-makers' respective levels of concern about increased energy costs. Most building owners and half of the facility managers said they would be very concerned. Increased fuel costs are typically a concern of the tenant; however, tenant complaints are something that owners would generally like to avoid.

**Figure 4811. Level of concern about increased costs for leased buildings**




Source 48: RTU Decision-Maker Survey. In leased units, how concerned are you that switching to a heat pump RTU could increase energy costs?

## 6.5 Barriers to adopting efficient RTUs

CalMTA was able to draw insights from multiple sources to understand the range and scope of factors that present obstacles to the uptake of efficient RTUs to end users. Qualitative data from interviews with manufacturers, contractors, and distributors, as well as representatives from MT programs, program implementers, and industry trade associations, combined with quantitative survey results from decision-makers (i.e., building owners and facility managers), revealed several barriers, including upfront cost, split incentives, product availability, existing conditions, concerns about increased complexity and challenging installations, energy-related costs, and generally low awareness, as key contributors preventing widespread adoption.

CalMTA notes that most of these barriers are more relevant to the larger two-minute replacement market than to the high-end custom market.

### 6.5.1 Product availability

Manufacturers indicate product availability determines what the 2-minute market adopts. Most building owners indicated they buy what is available when purchasing an RTU. Long lead times are a significant barrier for RTUs with features that are not typically stocked. Contractors prefer products that are reliably stocked, which enables same-day or next-day delivery. For special orders, delivery times can range from one week to 16 weeks. Special orders are more commonly required for efficient features such as ERV, HRV, and products that provide remote monitoring services. Because most replacements occur under urgent and unplanned circumstances, end users are going to purchase what is available with a short turnaround.

NEEA staff commented that in an emergency where the original system fails, buyers will pay anything to get a unit installed quickly. If only high-efficiency units were stocked, buyers may be willing to upgrade from a baseline unit. However, in most cases, standard equipment is more readily available than efficient products. Comfortably California staff also identified this as a barrier to heat pump RTU adoption, noting that heat pumps are often not stocked, meaning they would primarily be installed in planned scenarios.

### 6.5.2 Upfront cost

It is well documented in the literature that upfront cost is a major barrier to purchasers selecting more efficient RTUs. Primary research also confirms this. SCE and NEEA staff interviewed by CalMTA agreed this was one of the most significant barriers to the adoption of high-efficiency RTUs. NEEA explained that building owners are motivated to spend as little as possible, unless there are corporate sustainability goals they need to address. Unless regulations force building owners to buy more efficient units, they will always go with baseline. Interviews with contractors and distributors also revealed that upfront cost is a key factor driving customers to replace failed RTU systems with similar or identical replacements, thus minimizing installation-related costs. They note that customers generally decline efficient features, such as ERVs, HRVs, or remote monitoring services, to save on cost. Though owner-occupants are more likely to spend more on

efficiency if they benefit from the reduced energy costs, contractors said most RTU purchasers are not interested in spending more money on perceived extras.

### 6.5.3 Existing conditions

RTUs are restricted by the existing duct configuration and size, electric supply, structural strength, and curb size. This limits the type of product that can be installed at minimal expense. An example NEEA provided was units with an ERV are heavier and could trigger a structural evaluation to ensure the roof can support the extra weight. Manufacturers also say high-efficiency units tend to weigh more than standard units, which may require additional steps and materials to ensure a safe installation.

With these considerations in mind, design engineers and contractors, as well as end-users, tend to prefer equipment that they are confident will work and do not require expensive and time-consuming renovation or alterations.

Multiple contractors and manufacturers noted that one of the biggest potential problems when considering switching to a heat pump RTU is related to the electrical panel. Older buildings may not have the capacity required to accommodate such products, and the additional costs required for electrical or panel upgrades would turn away building owners.

### 6.5.4 Split incentives

Mentioned by multiple market actors, split incentives occur in leased buildings when tenants are responsible for utility bills, but building owners are responsible for capital improvements. SCE staff elaborated that split incentives can also manifest with spec developers who do not hold real estate long-term.[54] A spec developer forms an LLC, builds a strip mall or office building with the lowest possible material and labor costs, sells it off, and then dissolves the LLC. In this scenario, there is no incentive to invest in high efficiency. Split incentives can also occur when institutional owners have separate staff working on capital investments and operations and maintenance (O&M). Operational savings from buying a more expensive and efficient unit or using a higher quality installer cannot be included when determining capital expenditure, even though the O&M staff would prefer a higher quality product.

### 6.5.5 Product complexity and proper installation

Installation of certain features is done in the field as opposed to in the factory. Installing components in the field (such as a bolt-on ERV) increases the risk of improper installation compared to when it is factory installed.

SCE noted that many RTUs have not lived up to their efficiency rating in the field, with the quality of installations posing a barrier to achieving savings. The ideal RTU serves a single zone per unit, but in practice, units often serve multiple zones that may have different temperatures (for

[54] Spec developers build structures on land they own without a specific buyer or tenant in mind.

example, due to windows facing different directions). Good air circulation, proper filtration and ventilation, and ensuring economizers work properly are key to a high-quality installation.

Additional features installed by insufficiently trained HVAC workers can complicate the installation process of efficient RTU equipment. In many cases, flawed installation defeats the purpose of an efficient RTU, such that standard equipment that is properly installed can be more efficient than improperly installed high-efficiency equipment. For example, one manufacturer noted that premium features such as ERVs add complexity to the design and installation process, making it less attractive for buyers.

### 6.5.6 Relative energy prices and power quality

For electrification projects, an additional barrier is the relatively high cost of electric heating compared to natural gas heating. High electricity costs, combined with familiarity with existing products, help perpetuate buyers' preference for gas-fueled units. Additionally, many features included in efficient electric-based products make equipment even more sensitive and vulnerable to the local power grid's power quality and voltage spikes.

### 6.5.7 Low awareness

The lack of awareness about the available technology and its benefits is a systematic supply chain issue that filters down from manufacturers to consumers. Distributors will not order equipment that does not sell quickly. Contractors will not recommend technology that is not readily available and thus do not gain experience installing and operating advanced equipment. These factors result in end users having little familiarity with efficient technology. One manufacturer interviewed by CalMTA noted that worker shortages prevent HVAC employees from learning about new technology. Contractors may have difficulty explaining the value of new products and may perceive that recommending such products will result in delays or add unnecessary secondary costs, potentially causing the customer to award the work to another installation vendor.

# 7 Light commercial HVAC workforce characteristics

CalMTA conducted secondary research and stakeholder interviews to assess the dynamics of the California workforce that supports or could potentially support commercial packaged RTU installations. This chapter examines several related topics, including the HVAC workforce outlook, pathways to becoming an HVAC technician, supply and demand for HVAC workers, awareness of high-efficiency features, and notable employer challenges.

## 7.1 HVAC workforce and businesses

The California Employment Development Department projects annual employment between 2020 and 2030 to increase from 31,220 to 35,400 HVAC workers. Building equipment contractors

will employ the majority (88%) of these workers, with the remaining workers employed by schools, federal and local government, lodging, hospitals, and durable goods wholesalers.[55,56]

HVAC installation businesses in California must have a C-20 license before a company can charge any customer $500 or more for HVAC-related work.[57,58] The California Department of Consumer Affairs Contractors State License Board maintains a list of all active C-20 license holders, which includes over 11,300 businesses in California and other states. Nearly all (98%) businesses are based in California, and 43% are businesses located in disadvantaged communities.[59] While most (59%) contractors only have a C-20 license, some C-20 holders also have other types of licenses as well, with B (general contractor), C36 (plumbing), and C10 (electrical) being the most common. Table 9 shows the most common combinations of C-20 and other licenses.

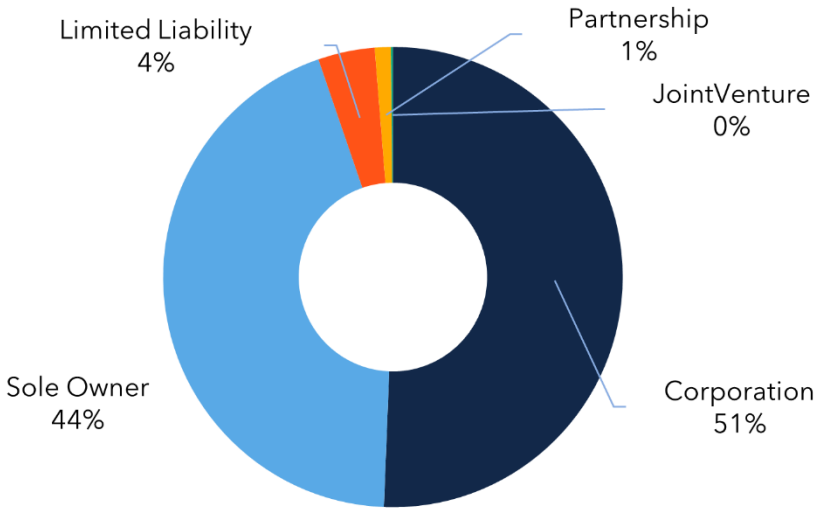
**Table 9. Common C-20 license combinations**

| License type | Proportion of organizations |
|---|---|
| C-20 Only | 59% |
| C-20 and B General Contractor | 20% |
| C-20 and C36 Plumbing | 16% |
| C-20 and C10 Electrical | 12% |

Most HVAC businesses are either corporations or sole owners, as shown in Figure 49. On average, sole owners with C-20 licenses have 4.5 employees, while corporations with C-20 licenses have 22.7 employees.[60] C-20 licenses are typically held at the organizational level rather than the individual level – not every contractor on a given job will have a C-20 license; rather, their employer holds the license. One college interviewee said 90% of students would never get a C-20 license.

[55] Building equipment contractors (NAICS code 2382) primarily install or service building equipment that is part of a building's mechanical system (such as electricity, water, heating and cooling).
[56] Occupation Code 49-9021 Heating, Air Conditioning, and Refrigeration Mechanics and Installers.
[57] Contractors State License Board. September 30, 2024. "Before Applying for a License When No Exam is Required." https://www.cslb.ca.gov/contractors/applicants/contractors_license/no_exam_application/Before_Applying_For_License.aspx
[58] Contractors 2024, *op. cit.* "C-20 - Warm-Air Heating, Ventilating and Air-Conditioning Contractor." https://www.cslb.ca.gov/about_us/library/licensing_classifications/Licensing_Classifications_Detail.aspx?Class=C20
[59] Disadvantaged communities are identified through CalEnviroScreen.
[60] CalMTA analysis of C-20 data joined with purchased data from Data Axle.

**Figure 4912. C-20 license holders by business type**




Source 49: Contractors State License Board C-20 data

At mid- to large-sized residential and light commercial HVAC companies, workers either specialize in installation or service. Installers set up new HVAC systems while the service side conducts preventative maintenance and troubleshooting on existing systems. In addition to these core staff, there are office and sales/estimator staff who provide quotes. Smaller companies often have staff performing a wider range of duties than a larger company.

## 7.2 Pathways to become an HVAC technician

There are a variety of opportunities to enter the HVAC workforce in California. The most common pathway into HVAC without education or experience is via warehousing. According to one interviewee, anyone with basic mechanical aptitude can be hired to install warehouse HVAC systems. It is also usual to break into the industry as an HVAC helper to obtain on-the-job training. With experience and self-driven learning, a helper can advance to roles in service or installation.

Individuals can choose a certificate or degree program through a community college, trade school, or technical school. Once they have completed their educational program, graduates usually go into the workforce, which could be with HVAC companies or as in-house maintenance staff.

An alternative pathway is via union apprenticeships, intensive multiyear programs that serve as springboards to full union memberships. Eligibility requirements for an apprenticeship vary by location but usually require a high school diploma or GED; a valid California driver's license for identification; the ability to read, write, and speak English; a willingness to attend classes while

working as an apprentice; and the ability to take and pass an aptitude test and interview.[61] Completing an apprenticeship is a direct pathway to a job with the union offering the program. Apprenticeships are attractive because they come with employment, hands-on experience, raises, pensions and retirement benefits, and no or low out-of-pocket costs.

Some private companies, nonprofits, schools, and government bodies, including the California Department of Industrial Relations, offer pre-apprenticeship programs. These educational opportunities provide training and instruction in the basic professional skills required to succeed in an apprenticeship and serve as on-ramps to the union apprenticeship track.

Despite the growth in the construction industry workforce, union membership has declined over time. Unionized workers currently make up about 15% of the California construction industry.[62]

Most residential HVAC replacements are non-union jobs.[63] Union workers primarily serve the large commercial sector, according to a manufacturer consultant.

### 7.2.1 California training and education providers

CalMTA identified several training providers and opportunities in California (see Table 10). This is not exhaustive; rather, it represents the types of opportunities that the research uncovered. While California's energy-efficiency portfolio includes a variety of HVAC training programs and partnerships, such as those offered by investor-owned utilities or the Workforce Education and Training (WE&T) program, these are not the focus of this research.

**Table 10. Types of HVAC training available in California**

| Training providers | Quantity |
|---|---|
| Community college or trade/technical school certificate programs | 85 |
| Union apprenticeships | 32 |
| Community college degree programs | 8 |
| Manufacturer training | 7 |
| Trade association training | 4 |
| Distributor training | 3 |

**Schools.** Trade and technical schools offer Career and Technical Training (CTE) certificates, which do not result in a degree. Some community colleges also offer CTE-driven certificate programs in

[61] California Apprenticeship Coordinators Association. September 30, 2024. "Air Conditioning & Refrigeration Apprenticeship." http://www.calapprenticeship.org/programs/air_conditioning_apprenticeship.php

[62] California Workforce Development Board. January 5, 2024. *High Road Training Partnership: Resilient Workforce Program (RWP).* https://cwdb.ca.gov/wp-content/uploads/sites/43/2024/05/1_WSCSMW-Narrative_ACCESSIBLE.pdf

[63] CA Workforce Board 2024, *op. cit.*

addition to Associate degree programs in HVAC or HVAC-related fields. Certificate programs are shorter, usually less than one year; degree programs usually take two to four years. Typically, certificate programs train students in a specific skill set, while degree programs require students to learn a broader set of skills and can incorporate certificate programs as part of the curriculum. Both certificate programs and degree programs can lead to different entry points into the HVAC field. Certificates are usually used as an entry or to strengthen a skill, and degree programs are useful for more advanced jobs in the HVAC field, such as an HVAC design engineer. Students in this type of program are often in their mid-thirties and retraining for a new industry.

There are many schools with HVAC programs across California offering a variety of program options, from full-time to part-time evenings. There is typically a hands-on component that must be completed in person, but online classwork may also be an option at some schools. Technical education programs typically require a year of full-time study.

**Apprenticeships.** Unions get their training curricula from a national body that constantly updates the material to stay on top of the newest equipment and trends. These programs combine related technical instruction, which is usually typical classroom-style learning, with on-site training to make sure apprentices have all the skills they need. Additionally, union partnerships enhance training. Many unions partner with equipment manufacturers to bring in manufacturer representatives for training sessions. This ensures that the workforce is learning directly from the source of the equipment, gaining the necessary knowledge to install and work with new technology. Unions also may partner with schools, allowing their apprentices to earn degrees through the apprenticeship program.

There are five main components of apprenticeships:

- Related technical instruction
- Direct business involvement
- Structured on-the-job training
- Regular increases in pay
- Certification (in HVAC, this is a Journeyman's License)[64]

Apprenticeships approved by the California Department of Industrial Relations' Division of Apprenticeship Standards (CADIR-DAS) last between one and five years and use an earn-while-you-learn training model. These programs can be offered by employers, unions, schools, manufacturers, or intermediary agencies but are most often provided by unions in the HVAC industry.

[64] United States Department of Labor. September 30, 2024. *A Quick-Start Toolkit: Building Registered Apprenticeship Programs.* https://www.apprenticeship.gov/sites/default/files/apprenticeship_toolkit.pdf

**Manufacturers and distributors.** All major RTU manufacturers also offer training programs, such as Lennox Learning Solutions, Daikin University, and Carrier University. These courses include various tracks, such as HVAC system design, servicing HVAC systems (installing and troubleshooting), and controls. There are also courses on how to use manufacturers' proprietary software more effectively. Manufacturer training may be online or in person at their training centers. One manufacturer also noted that manufacturers donate equipment to schools to better train students using their products. They also partner with industry organizations, such as HARDI, ACCA, and RSES, to facilitate training to contractors.

Of the 15 HVAC distributors surveyed by CalMTA, most said they do not offer training and instead rely on manufacturers to train installers on their equipment. Some of the distributors who do offer trainings, focus on more complicated products, such as energy recovery or variable refrigerant flow systems, or on familiarizing contractors with the models they sell. Distributors also noted they rely on manufacturers to stay current on their products and associated regulations.

Although not included in Table 10 since it is not advertised, some HVAC companies offer internal training to new hires. One company maintains a classroom equipped with all the equipment needed for installers to continue their training and relies on manufacturers to conduct these trainings, especially for new products with increasing complexity.

### 7.2.2 Economic and workforce development boards

Economic development organizations and workforce development boards generally do not offer HVAC training directly, instead providing funding or other support for industry partners to do so.

Economic development organizations typically focus on a wide variety of areas within the business landscape, including promoting tourism, agriculture, manufacturing, or other industries that contribute heavily to the area in which they operate. These organizations assist business leaders in many aspects of business development, such as navigating tax credits, applying for grants or other funding, and recruiting businesses to specific areas.

CalMTA reached out to several economic development boards who said their work is not closely related to workforce development; they declined to participate in interviews due to a lack of relevant knowledge. Workforce development boards, on the other hand, were willing to discuss the HVAC WE&T landscape in California.

Workforce development organizations focus specifically on topics such as developing and funding training programs, connecting employees with potential employers, and providing training materials for certification exams or other industry requirements. Workforce boards and panels can work closely with funding recipients (called partners) to tailor the format, content, and focus of the training. In other cases, workforce boards simply provide funding and program guidelines, allowing their partners – or the third-party training organizations

working with their partners – to develop the curricula themselves. There are 45 workforce boards across California.[65,66]

All four workforce development boards interviewed focus on recruiting trainees from disadvantaged communities or underrepresented communities.

### 7.2.3 California's funding for HVAC

The State of California's Labor and Workforce Development Agency oversees various departments, boards, and panels. Those relevant to this research are the Employment Training Panel (ETP) and the California Workforce Development Board.

ETP is funded by a tax on employers and distributes funding to employers and contractors to offset "the cost of employer-driven training for incumbent workers."[67] The panel receives between $95 and $110 million annually. In addition to training reimbursement, ETP provides contractors with program monitoring and support as well as operational and invoicing assistance. It also conducts regular audits to ensure compliance and adequate record-keeping.

*"Research links technical illiteracy with economic drag."*

*-State Agency Employee*

ETP provides funding across a broad spectrum of industries; most of their HVAC-related work supports apprenticeships, community colleges, and other programs focused on occupation-specific training for careers that do not require four-year degrees. It also provides language and workforce literacy skills education and, in the past, has worked with partners that train refugees for careers in HVAC.

ETP does not cover legally mandated training or training that is generic to a field (for instance, professional skills or resume building); instead, it focuses on specific skills required to pursue a career in a given field. However, ETP does fund self-paced instruction (such as LinkedIn Learning courses or other online instruction) at a reduced reimbursement rate. Twenty-five percent of ETP's funding is earmarked for apprenticeships, 50% for employers, and the remaining 25% for small businesses and multi-employer contracts (as a means for multiple small businesses to collectively train their employees with state reimbursement).

The California Workforce Development Board is responsible for the continuous improvement of the workforce system in California.[68] It manages several grants and initiatives, including a $35 million investment from the EPA's Greenhouse Gas Reduction Fund (GGRF) to invest in training

[65] Training organizations may include nonprofits, community-based organizations, or trade associations.
[66] CA Workforce Board 2024, *op. cit.* "Local Workforce Development Boards." https://cwdb.ca.gov/local_boards/local_workforce_investment_associations/
[67] California Employment Training Panel. September 30, 2024. "About ETP." https://etp.ca.gov/about-us/
[68] CA Workforce Board 2024, *op. cit.* "About Us." https://cwdb.ca.gov/about_us/

partnerships to reduce greenhouse gas emissions.[69] One recipient of the GGRF funds was the Western States Council of Sheet Metal Workers (WSC-SMART), which received a $13 million grant to support a partnership between the WSC-SMART union and the California Association of Sheet Metal and Air Conditioning Contractors. This investment expands the capacity of their Joint Apprenticeship and Training Committees from 2024 to 2026. Currently, there is a backlog of over 2,000 approved applicants waiting to join the sheet metal workforce, so this investment should enable the recipients to address this backlog.[70] There are 12 regional training centers or Joint Apprenticeship and Training Committees throughout California, ranging from San Diego to Livermore. WSC-SMART will also partner with UC Davis' Western Cooling Efficiency Center to develop curricula and invest in new technologies and training equipment, such as a variable refrigerant flow laboratory, to train new and existing workers on heat pump systems.

## 7.3 Supply and demand for HVAC workers

This section describes the current landscape of the HVAC workforce and highlights issues, such as the shortage of experienced workers, which increases the competition for skilled labor. This is followed by an examination of the characteristics that employers seek in candidates, the demand for and availability of training and education programs, and, lastly, an assessment of the challenges that employers face in trying to hire and comply with the changing regulatory landscape.

### 7.3.1 Shortage of experienced workers

**Overall demand.** According to contractor and manufacturer interviewees, the HVAC industry is experiencing a shortage of experienced workers, forcing HVAC companies to work hard to retain their employees. One respondent explained there has been a shortage for a long time, with the challenge exacerbated by many workers aging out. Since most of the work is in uncomfortable locations (i.e., exposed to the elements on a roof), it is not suitable for an aging workforce, and many younger people who go into HVAC do not stay long. There is an even bigger shortage of workers for commercial/industrial jobs because people entering HVAC often do not want to move from residential/light commercial jobs up to commercial/industrial jobs.

**Seasonal demand.** One non-union employer who works primarily with energy-efficiency programs said that HVAC companies struggle to find enough staff to meet demand during the summer season, with all positions in demand, from installation to technical, diagnostics, and repair specialists. Winter demand is quieted with labor availability because furnaces do not break as often as AC systems; sometimes, HVAC workers run out of jobs at the end of the heating season.

[69] CA Workforce Board 2024, *op. cit.* "High Road Training Partnerships." https://cwdb.ca.gov/initiatives/high-road-training-partnerships/

[70] CA Workforce Board 2024, op. cit. *High Road Training Partnership Report.* https://cwdb.ca.gov/wp-content/uploads/sites/43/2024/05/1_WSCSMW-Narrative_ACCESSIBLE.pdf

### 7.3.2 Competition for workers

With a limited talent pool, poaching has become a common issue among non-union employers. For the past two years, one employer noted they had to hire and train entry-level workers on the job. Interviewees also noted that the amount of residential work is increasing with the rise in new subdivision construction, partially due to California's aging building stock, so they have an immediate need for new employees. One employer said their peers face the same challenge as light commercial and residential HVAC jobs compete for the same pool of workers. However, since more complex nonresidential jobs rely on workers with different skill sets, there is not the same competition for workers. Additionally, unions directly compete with private HVAC companies; as one employer commented, they often lose out on opportunities to private companies that do not train their employees as extensively.

### 7.3.3 Employer desired characteristics and certifications

Given current conditions, employers said they cannot afford to be too selective with their workers, and they must keep who they have and train them to get the job done. One said the main challenge is finding people with enough experience. HVAC distributors also said technical school graduates entering the HVAC workforce often have theoretical knowledge but lack hands-on experience. Employers then must spend time and resources to fully train individuals entering the workforce; however, some do not encourage employees to continue further skill development to save time and money, which leads to complacency.

**Certifications.** Aside from experience, one employer primarily looks for Section 608 EPA certification, which allows workers to handle refrigerant gases. Other employers consider the North American Technical Excellence (NATE) certification to be helpful in demonstrating expertise (in the residential market), but it is not typically a requirement for hiring a new employee. An interviewee representing a college said the only certificate students need to find work is the EPA certification.

**Skills gap.** The most prevalent technical skill gap multiple interviewees mentioned is understanding airflow and ductwork sizing, which is essential for installing more efficient units. In addition, the cost of continued education or upskilling is often prohibitive for contractors already in the field, which leads to a lack of knowledge about emerging or advanced technologies.

> *"I asked 16 different private [HVAC] companies what is the #1 thing they look for, and all of them said soft skills."*
>
> *Manager of Workforce Development*

Multiple employers said soft skills were even more important than technical skills and the biggest gap in the entry-level workforce. A student who enters with traditional soft skills is already at a significant advantage, such as knowing how to work with others and communicate with customers, showing up on time, and dressing professionally, which are difficult skills to teach and are highly desirable.

### 7.3.4 Training and retention

Quick training for specific skills may fill short-term needs but will not prepare trainees for a stable career. Contractors must have both broad and deep knowledge—if the industry shifts and HVAC projects decline, professionals must have other skills to stay busy. Unions typically train people in broad portfolios of related skills, such as sheet metal, electrical, and HVAC, so that if one type of project declines, they will be able to fill their time with other work. One interviewee who worked for a workforce board explained, "The goal is addressing climate change in a way that creates stable careers, not just training people up as fast as possible."

One member of an organization that works with labor unions and environmental organizations clarified that, ultimately, "demand-side policy triggers good supply-side dynamics." If demand dictates that everyone on the job needs to be trained in a certain skill set or that equipment must meet certain efficiency standards, the supply side (i.e., distributors and equipment dealers) will adapt. This aligns with one non-union employer, who said they install and will install whatever energy-efficiency programs require.

**Union apprenticeship programs.** In contrast to private employers, unions have significantly more applicants than work opportunities. One union member said their apprenticeship applicant waitlist is consistently around 2,000 people. Unions can only take new apprentices when they have jobs for them to learn on, meaning that the market controls how many apprentices unions can take on, not the unions themselves. A workforce board staff member also mentioned that there is an oversubscription to apprenticeship programs. However, trainees who complete union apprenticeships typically become desirable, specialized industry professionals.

Unions partner with many types of businesses to assist with their trainings and make apprenticeship more enticing. These include manufacturers offering equipment-specific training, often for the newest available technology, as well as technical schools and community colleges, some of which offer apprentice degrees upon completing their program. Additionally, unions will send representatives to schools for career fairs. Unions work with trade associations and workforce development organizations semi-frequently. Union members reported working with non-union contractors on jobs infrequently, depending on the scope and size of the project. A non-union employer also commented that they do not work with unions. Unions occasionally directly subcontract non-union labor, but the general contractor will often be the one to write up and execute the contract.

**AI as a training solution.** Further contributing to the shortage of skilled workers is the learning curve to become a well-rounded and well-trained technician. Some HVAC products are highly complex and require experienced and skilled workers to install; however, not all HVAC workers are willing or required to acquire such skills. A potential solution is through artificial intelligence (AI) to assist workers in the service and installation process. HARDI noted that AI could help distributors efficiently manage warehouses and logistics, while installers could leverage AI tools on site, querying them about appropriate equipment and best installation practices. HARDI explained that a

recurring comment among installers was that getting on the phone to speak to a manufacturer often takes a long time, so having tools to answer their questions in real time would be beneficial.

### 7.3.5 HVAC education demand and curriculum

> *"I've had such a surge in enrollment that we're actually creating weekend courses because our evening courses are full."*
>
> *HVAC Education Professional*

**Student demand.** One interviewee who serves as the chair of the Mechanical-Electrical Department at a city college said there is no shortage of students who are interested in a career in HVAC. This interviewee did not see the industry creating entry-level jobs, with many employers seeking fully trained journeymen. They further explained that not many companies have gotten to the point where they need to start training entry-level workers. This is not consistent with the experience of employers, who said they have no choice but to accept entry-level workers and train them. It is CalMTA's interpretation that most HVAC employers, like those in any other industry, would prefer to hire experienced workers but will do the bare minimum in on-the-job training to get through crunch times.

**Curricula development.** Different types of organizations develop curricula in different ways. Schools, manufacturers, and trade associations develop their training programs internally based on the expertise of their employees, market research, or the types of equipment they make. Unions receive their apprenticeship curricula from national organizations such as North America's Building Trades Unions, which develop apprenticeship standards according to federal and state guidance. While not all distributors offer trainings, when they do, they tend to bring in manufacturers to train their employees on the brands and models they work with most frequently. Interviewed respondents provided several examples of different curricula across the industry:

- *Unions.* Unions are constantly updating their curricula. However, these curricula are approved by the state and developed by instructors and individuals in the field. Union interviewees said the consistency of training centers across the state could be improved and that they need investments to keep up with modern technology.
- *Online.* According to a manufacturer consultant, online training is becoming more common as it is both efficient and scalable. In-person training is harder for HVAC business owners because they pay for training and lose out on time that workers could be completing jobs. However, this consultant said it is more important to emphasize the use of tools and techniques in the field rather than in the classroom, so there will always be a place for in-person training.
- *Certificates.* Utilities and energy efficiency programs such as SCE or Energize Careers have also done HVAC-related training for many years. SCE sees its role as supporting the industry in complying with code, while Energize Careers tries to cross-train HVAC, electrician, heat pump installation, and weatherization contractors and bring those with experience in one or more adjacent fields into HVAC work. The program works with everyone from high school

graduates up through mid-career. Energize Careers staff said it is crucial that employers are part of workforce training curriculum design because if someone takes a six-month class and gets a certificate but does not actually know the right skills, the time and money are wasted.

### 7.3.6 HVAC employer challenges

**Regulatory changes.** Several industry interviewees said that constant regulatory changes, such as refrigerants and updates to Title 24, are a burden to manufacturers, distributors, and installers. The constant regulation changes require re-training, new tools, and time spent interpreting what practices meet regulations.

**Lack of oversight.** Another industry challenge is the lack of enforcement, which puts larger organizations at a disadvantage. As one larger employer explained, "There are a few big players and lots of little installation companies who think they can run a bigger business but are operating without licensing, and the state isn't sorting those out." In other words, the overhead costs of applying for permits and staying up to date with training can cause organizations that "do everything by the book" to get outbid. Then, when the work done by unscrupulous contractors gets flagged by inspectors, customers are upset that they must spend more money to hire proper installers. This employer said the backlog to get jobs approved by building departments (in the Bay Area) is so long that using one-off contractors, often from outside the local area, to install equipment without permits is more appealing. One HVAC manufacturer estimated a project would be 15% more expensive if following the proper permitting process and would not be surprised if unpermitted installations occurred. These findings are consistent with CalMTA's analysis of permit application data.

**Non-local workers and cheap labor.** One union member was also concerned about non-local workers. He said many workers come from other states that do not have state-approved apprenticeship programs, which reduces the opportunity for the local union workforce. This union could bring all their applicants off the waitlist if out-of-state workers were not present.

Additionally, according to an interview with the statewide WE&T program provider, there is a lot of pressure on contractors to provide the fastest and cheapest work possible because usually the lowest bidder wins the job. This leads to employers pushing staff to work harder and faster, leading to turnover. The lowest bidder paradigm also affects wages. A consulting engineer at SCE further elaborated that firms do not compete on a level playing field: whoever can offer the lowest upfront price can probably get away with a subpar installation. There has not been much pressure to improve quality when building owners do not know how to differentiate between well-trained installers and those without the proper skills.

**Shortage of skilled workers.** Lack of experienced workers means employers are hiring HVAC graduates and forced to provide training because new graduates may not have hands-on experience, only theoretical knowledge and classroom experience. However, one smaller employer told CalMTA the company values consistency with their installers, so they make everyone complete their internal training.

**Diversifying workforce.** Finally, while HVAC is seen as a stable and well-paying industry, a WE&T program provider commented that the HVAC industry is primarily white/Latino and male. This provider said getting people of color or women into these jobs can be difficult because it is not known as a diverse or welcoming field for those who do not fit the status quo.

### 7.3.7 Awareness of and experience with high-efficiency features

**Popularity and familiarity with technology.** Interview respondents reported that non-union contractors have little experience with remote monitoring systems because other organizations, such as a manufacturer's remote monitoring center, usually monitor the equipment. One employer thought it was low (10% to 20%) but growing in popularity. Industry respondents reported mixed estimates for skilled labor installing heat pump packaged RTUs, ranging from 10% of HVAC workers to most HVAC workers, highlighting the lack of clarity regarding estimates among the HVAC community. One employer said it was becoming more popular and estimated that about a quarter of workers were familiar with the technology. However, some respondents said 25% or less were skilled at installing and maintaining packaged RTUs with heat recovery. Union respondents said their workers can install and maintain RTUs with ERV/HRVs, dual-fuel, or all-electric heat pump RTUs, and while they do not train much in remote monitoring systems, they do train their workers in controls.

**Limited experience with new technologies.** One manufacturer consultant said the worker shortage prevented employees from learning about new technologies. With existing workers busy with basic jobs and limited time for training or upskilling, employers keep selling the same equipment because their employees do not know how to use new technology. Another manufacturer said that the management at HVAC companies does not like to innovate or embrace new technology, so this dismissive attitude toward high-efficiency equipment gets passed down to the workers. However, a distributor said that in the commercial sector, they prioritize "super cheap units," so the HVAC workers are not getting experience with high-performance units.

*Simplifying HVAC Installations.* When asked what can be done to make HVAC installations easier, one employer explained that packaged units come in two configurations, side discharge versus downdraft, and that side discharge units are easier to install since all the connections are on the side and roof work does not need to be done. Downdraft units require roofing work to replace the curb and seal around the new curb. In a prior interview with CalMTA, SCE noted that downdraft units are more efficient.

# 8 CRTU pricing

The total price to install an RTU is affected by many factors, including location, cooling and heating capacity, number of units purchased and installed, curb adaptor(s), crane boom size,

efficiency level, and other features.[71] Generally, larger capacity equipment has a higher total price but lower per-ton price, and there are economies of scale when ordering multiple units, including better per-unit pricing from vendors and the ability to spread certain costs (such as crane rental) over more units. Pricing includes these components:

- Equipment (RTU) and delivery costs (ground transportation and crane rental)
- Labor (including installation of new equipment and removal of old equipment, commissioning, required permitting and acceptance testing)
- Building modifications to enable installation of the new RTU (curb adapters, duct and roof work, electrical capacity)

CalMTA asked manufacturers whether the installation of high efficiency RTUs differed from standard efficiency RTUs. Most did not expect efficiency level to impact the installation process much unless there were field-installed components, such as an ERV kit. High efficiency products may have more complex controllers that could take longer to program, and integration into building management systems could also take additional time. Since CalMTA assumes the features of interest are factory installed, the incremental labor cost is zero.

It is unclear how often building modifications are needed to install CRTUs compared to a standard RTU, and the cost of those modifications.

Most HVAC suppliers and manufacturers do not sell to the public, especially for commercial products. As such, RTU pricing must be gathered by a licensed contractor from their suppliers. Contractors use that information to generate an estimate for RTU buyers that includes equipment plus markup, labor, and other services.

## 8.1 Challenges in collecting pricing data

CalMTA attempted to collect incremental pricing using baseline and high-efficiency RTU quotes from HVAC installers for a 3-ton and 10-ton HP RTU. CalMTA offered participating contractors that provided price data and model specifications a $500 incentive. Cold calling and even using team member HVAC contractor referrals was ultimately ineffective at generating bona fide RTU quotes. Feedback from several contractors when they first learned of CalMTA's study suggested they intended to participate. Despite conducting outreach to over 50 contractors, CalMTA only obtained two quotes from contractors who had a connection with a CalMTA team member. One contractor who completed the worksheet provided pricing for the code minimum and high cooling efficiency 3-ton heat pump RTU. Their reason for not providing pricing for a10-ton unit is because such a product is not offered by the brand they work with. The other quote was not usable because it was for a residential RTU using R-410A refrigerant. This contractor's supplier did not yet have an A2L product that could meet the cooling efficiency requirement of 16 SEER2.

[71] Accessed 4/30/2025. https://atlasacrepair.com/cost/commercial-hvac-cost/#rtucost

Another contractor referred by a CalMTA team member provided insight on the bid process, but ultimately did not provide any of the requested RTU pricing data. This contractor works with a variety of brands and sales representatives. They noted that they had spoken with a sales representative about getting pricing for the items on the worksheet, but indicated that placing an order for a single 3-ton or 10-ton RTU was uncommon because the costs would be much higher than for a bulk order. Additionally, they mentioned that manufacturers or distributors tend not to want to share pricing on certain equipment because they face significant uncertainty regarding the quantity they need to manufacture, how many will actually be purchased, and other market uncertainties such as tariffs.

The limited response by contractors combined with feedback from the few contractors who did engage with CalMTA suggests that:

- Products meeting the CalMTA specifications may have limited availability
- Contractors' suppliers are unwilling to provide pricing data for a theoretical project

## 8.2 Incremental equipment price

This section contains results from CalMTA's secondary and primary research efforts to collect incremental equipment pricing by feature of interest: high cooling efficiency, inverter-driven heat pump RTUs, and connected controls and commissioning (CCC).

### Cooling efficiency

The cooling efficiency specification for CRTUs under 5.4 tons is a SEER2 of 16 or greater. The cooling efficiency for CRTUs from 5.4 tons to under 11.25 tons is an IEER of 16.9 or greater.

Using data from the U.S. Department of Energy's Technical Support Document for air-cooled commercial unitary air conditioners and commercial unitary heat pumps (table 5.8.4) for a 7.5 ton capacity system, CalMTA calculated the incremental price between a baseline efficiency (14.1 IEER) and CalMTA's proposed efficiency (16.9 IEER) air cooled unitary heat pump using linear regression. CalMTA found an incremental price of $73.90 per ton. For a 10-ton unit, this translates to an incremental price of $739 total. The team assumes no incremental labor costs associated with the measure based on manufacturer interview feedback.

An analysis from a recent study found an average incremental measure cost of $650/ton between a code minimum and highest-efficiency HP RTU between 5.4 and 11.2 tons.[72] This study's highest efficiency heat pump achieved an IEER rating of 19.4.

[72] Supply Chain Engagement for HP RTUs Focused Pilot, Table 13. Accessed 4/30/2025 https://calnext.com/wp-content/uploads/2025/04/ET23SWE0073_Supply-Chain-Engagement-for-Increasing-Packaged-Unitary-Heat-Pump-System-Adoption_Final-Report.pdf.

In a quote gathered in April 2025 from a mechanical contractor in Southern California, we found that the incremental price of a 3-ton heat pump RTU is $705 total, or $235 per ton.[73] Although CalMTA requested pricing for 3-ton and 10-ton systems, the incremental price of a 10-ton unit was not available from this contractor as the manufacturer does not produce a heat pump model that meets the minimum cooling efficiency criteria of 20% better than code in this capacity.

CalMTA examined availability of high cooling efficiency heat pumps from Lennox and found few models meet the minimum required cooling efficiency proposed by CalMTA (Figure 50, compliant models highlighted). Looking at high-efficiency heat pumps from Trane (Precedent line shown in Figure 51), CalMTA observed similar gaps in availability of models that meet the proposed cooling efficiency. Carrier's heat pump RTU data shows AHRI ratings for only four sizes out of 10, of which only three sizes would meet CalMTA's minimum required cooling efficiency.

**Figure 50. Lennox Enlight RTU R-454B cooling performance**

| | | | COOLING DATA | |
|---|---|---|---|---|
| TYPE | NOMINAL TONNAGE | MODEL | EER (EER2*) | SEER2 OR IEER |
| HEAT PUMP | 3 | LHT036H5E | 12.2 | 16.0 |
| | 4 | LHT048H5E | 12.0 | 15.6 |
| | 5 | LHT060H5E | 11.8 | 15.2 |
| | 6 | LHT072H5E | 11.0 | 15.5 |
| | 6.5 | LHT078H5E | 12.7 | 17.0 |
| | 7.5 | LHT092H5E | 12.3 | 16.8 |
| | 8.5 | LHT102H5E | 12.1 | 16.8 |
| | 10 | LHT120H5E | 12.0 | 16.6 |
| | 12.5 | LHT152H5E | 11.1 | 15.2 |
| | 13 | LHT156H5M | 12.1 | 15.4 |
| | 15 | LHT180H5M | 11.1 | 15.5 |
| | 20 | LHT240H5M | 11.1 | 15.5 |

Source 50: Lennox Enlight Rooftop Units brochure https://www.lennox.com/dA/130669be49/file1/37J51_Enlight%20Brochure%20454B.pdf

[73] Models quoted include a baseline unit with 14 SEER2 and efficient unit with a 16.4 SEER2 rating.

## Figure 51. Trane Precedent high efficiency heat pump RTU cooling performance

**Table 7. General data — high efficiency — heat pump**

| | 3 Tons | 4 Tons | 5 Tons | 6 Tons | 7.5 Tons | 8.5 Tons | 10 Tons | 12.5 Tons | 15 Tons | 17.5 Tons | 20 Tons |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | WHK036 | WHK048 | WHK060 | WHK072 | WHK090 | WHK102 | WHK120 | WHK150 | WHK180 | WHK210 | WHK240 |
| **Cooling Performance[a]** | | | | | | | | | | | |
| Gross Cooling Capacity | 36700 | 50000 | 61300 | 77000 | 90000 | 108000 | 121000 | 152000 | 181000 | 210000 | 245000 |
| EER[b] / EER2[c] | 13.6/12.8 | 13.6/12.8 | 13.6/12.8 | 12.8 | 12.0 | 12.1 | 11.4 | 12.1 | 11.7 | 11.3 | 10.9 |
| Nominal cfm/AHRI Rated cfm | 1200/1200 | 1600/1600 | 2000/2000 | 2400/2400 | 3000/3000 | 3400/3400 | 4000/4000 | 5000/5000 | 6000/5250 | 7000/7000 | 8000/8000 |
| AHRI Net Cooling Capacity | 36000 | 49000 | 60000 | 76000 | 88000 | 106000 | 118000 | 150000 | 178000 | 206000 | 240000 |
| IEER[d] (2-Speed) / SEER[b]/ SEER2[c] | 16.8/16.2 | 16.8/16.2 | 16.4/15.8 | 16.3 | 15.5 | 17.0 | 16.1 | 16.8 | 16.8 | 16.2 | 16.4 |
| IEER (SZVAV/MZVAV) | — | — | — | 16.8/16.8 | 16.0/16.0 | 17.5/17.5 | 16.6/16.6 | 17.2/17.2 | 17.3/17.3 | 16.7/16.7 | 16.9/16.9 |

Source 51: Source: Trane Product Catalog, Precedent™ Packaged Rooftop Units https://elibrary.tranetechnologies.com/public/commercial-hvac/Literature/Product%20Catalog/PKGP-PRC023C-EN_02212025.pdf

**Figure 5213. Carrier WeatherMaster Puron Advance RTU cooling performance**

| Nominal Cooling Ton Size | Cooling Stages | AHRI Efficiency (SEER2) IEER |
|---|---|---|
| 3 | 2 | - |
| 4 | | - |
| 5 | | - |
| 6 | | 17.4 |
| 7.5 | | 17.0 |
| 8.5 | | |
| 10 | | 16.8 |
| 12.5 | | - |
| 15 | | - |
| 20 | | - |

Source 52: Carrier WeatherMaster® Puron Advance™ Single-Packaged Heat Pump Rooftop Units with EcoBlue™ Technology 50GEQ

https://www.carrier.com/commercial/en/us/products/packaged-outdoor/outdoor-packaged-units/50geq/

### Inverter-driven heat pump RTUs

Data from the eTRM for measure ID SWHC043 - Multiple Capacity Unitary Air-Cooled Commercial Air Conditioners Between 65 and 240 kBtu/hr, provides an incremental cost of $456.63 per ton between a base efficiency system and one meeting the measure criteria. Labor costs in the eTRM were identical for base and measure cases.

Inverter-driven compressors are available in custom built RTUs. CalMTA found inverter-driven RTUs are uncommon in the mass-produced heat pump RTU market. It is commercially available in Lennox and Trane's highest efficiency tier of RTUs, the Model L or Precedent. However, these products are gas packs.

Working with UC Davis facility staff, CalMTA obtained quotes from a distributor for a 3-ton and 10-ton RTU with and without an inverter. The price premium ranged from $2,430 to $5,120 per ton. However, the model with the inverter also includes other features, so this price premium represents an upper bound.

### Connected commissioning and controls (CCC)

CRTU team members indicated the brands and systems listed below meet the product specifications. Based on feedback from a manufacturer, incremental costs for CCC is expected to be small relative to the cost of an RTU. Another manufacturer commented that CCC may not be available for code minimum efficiency equipment and may be standard on high or ultra-high efficiency equipment.

**Table 11. CCC products**

| Manufacturer | Product | Pricing |
|---|---|---|
| CaptiveAire | CAS-Link | No extra charge according to the product website |
| Trane | Symbio Service and Installation App | Comes standard in certain product lines and sizes |
| Trane | Symbio 700 controllers | Comes standard in certain product lines and sizes (high efficiency or larger sizes typically) and optional on others |
| Lennox | CORE Controller | According to manufacturer, relatively small incremental cost, exact cost not disclosed<br>Standard on premium models, not available in lower efficiency units |
| Daikin | iLINQ Controller | $700 |

### All CRTU efficiency features

CalMTA identified a commercially available product that met all CRTU criteria, CaptiveAire's Paragon RTU. The price of this equipment (including 7.5 ton heat pump, electric heat, economizer, transition curb, and startup) is estimated at $5,900 per ton based on a sample quote gathered at the end of 2024. The incremental equipment price compared to a baseline RTU (7.5 ton heat pump or gas pack with economizer, no transition curb needed) is $3,800 per ton.

# 9 Methodology

The RTU Market Characterization summarizes findings from a variety of secondary and primary research. This section provides details about the specific sources and methods used in CalMTA's research.

## 9.1 Literature review and secondary research

CalMTA completed a thorough literature review of studies related to the light commercial HVAC market. The research included an examination of energy efficiency programs in California and across the United States that support or could support high-efficiency RTUs. CalMTA analyzed various data sources to characterize the RTU market in California, including these:

- **ComStock:** A U.S. Department of Energy model of the commercial building stock developed and maintained by the National Renewable Energy Laboratory. CalMTA analyzed data specific to California.
- **2022 California Commercial End-Use Survey:** A study completed for the California Energy Commission that examines commercial building characteristics.
- **Virtual Compliance Assistant and EnergyPro database:** A database developed and maintained by the Statewide Codes & Standards Compliance Improvement Subprogram. CalMTA worked with the database manager to create customer filters and analyze mechanical system data.
- **Data Axle Business List:** CalMTA purchased a list of mechanical contractors in California from Data Axle. The list contained business-specific contacts, titles, standard industrial classification codes, number of employees, etc.
- **AHRI:** AHRI publishes annual U.S. shipments by product type as reported by its members.

## 9.2 Interviews

CalMTA conducted numerous interviews, as detailed in Table 12.

**Table 12. Interviews completed by CalMTA 2024-2025**

| Type | Number completed | Purpose |
|---|---|---|
| RTU stakeholder | Seven staff from:<br>• A California IOU (SCE)<br>• Statewide HVAC Program (Comfortably California)<br>• Statewide Workforce Education and Training Program (Energize Careers)<br>• Statewide Codes & Standards Compliance Improvement Subprogram<br>• CalNEXT, NEEA, and HARDI | Understand what other programs working in the commercial HVAC industry are promoting, assess the general RTU landscape, and identify data sources to inform market characterization |
| Workforce Interviews | 16 interviews with these types of organizations:<br>• HVAC installation companies<br>• Schools with HVAC program<br>• Workforce boards and nonprofits that support training and education<br>• Unions<br>• HVAC manufacturer<br>• HVAC equipment distributor<br>• HVAC consultant<br>A short survey with 15 distributors on what types of industry trainings they offer | Understand the current state of the light commercial HVAC workforce and the educational needs of the industry that would support the installation of high-efficiency RTUs |
| Contractor and Distributors | • 18 HVAC contractors<br>• 5 HVAC distributors | Characterize recent RTU sales, understand how purchase decisions are made, and identify lead times for various RTUs and features |
| Manufacturers | Several professionals from five commercial RTU manufacturers, including staff from regulatory affairs and product development | Characterize the California market, identify opportunities and challenges to promote efficient RTUs, understand RTU decision-making, and identify education and training opportunities |

CalMTA initiated market research by conducting RTU stakeholder interviews in March 2024, completing them in May 2024. The purpose of these exploratory interviews was twofold: (1) to quickly come up to speed by gathering knowledge from experienced industry professionals and

(2) to identify data sources and opportunities for collaboration to inform the market characterization. CalMTA invited staff from all IOUs for interviews but only SCE participated.

Next, CalMTA conducted interviews to characterize the light commercial HVAC workforce, completing them by September 2024. The interviews aimed to supplement the workforce characterization, understand the supply and demand for HVAC workers, and identify training opportunities and challenges in workforce development.

CalMTA interviewed California RTU contractors and distributors through November 2024. These interviews gathered characteristics of recent RTU sales, along with identifying business practices related to RTUs and influences in the purchase process. Most contractors represented businesses with fewer than 20 employees, although two respondents worked at companies with over 150 employees. CalMTA recruited interviewees from a randomly selected sample of businesses holding C-20 licenses from the list maintained by the California's Contractors State License Board. The team also recruited from personal referrals by team members to HVAC businesses. To qualify for the interview, the business had to serve nonresidential customers in California and the respondent had to be involved in RTU sales.

Through March 2025, CalMTA interviewed five RTU manufacturers about their high-performance RTU products, business decision-making, education and training, future plans, and opportunities for improving the adoption of RTUs with higher efficiency. CalMTA offered incentives to contractors, distributors, and workforce representatives who participated in the interview.

## 9.3 Decision-maker survey

CalMTA surveyed two groups of RTU decision-makers in California: building owners and facility managers overseeing nonresidential buildings with RTUs. The survey addressed the following research objectives:

- Understand barriers to efficient RTU purchases
- Determine standard practices for RTU purchases
- Understand the key considerations and sources that influence decision-makers when selecting an RTU

From November 21 to December 10, 2024, CalMTA conducted an online survey of RTU decision-makers in California, targeting facility managers and building owners responsible for operating and purchasing RTUs in their buildings.

### 9.3.8 Survey administration

To recruit facility managers and building owners, the survey team used Qualtrics' sample services, which uses a network of over 20 online sample providers to ensure a diverse and reliable respondent pool. Respondents were randomly invited to take the survey based on qualification criteria, though Qualtrics applies exclusions for factors like category eligibility (ensuring

respondents fit the target audience, such as commercial facility managers or nonresidential building owners) and participation frequency (limiting how often individuals take surveys to reduce bias and maintain data quality). Qualtrics also provided incentives to respondents.

CalMTA also screened facility managers through Computer-Assisted Telephone Interviewing (CATI) to ensure they met the qualification criteria, directing approved participants to complete the survey online. This method combined the accuracy of phone-based recruitment with the flexibility and efficiency of an online survey for data collection. Because a panel of building owners was readily available, CalMTA conducted the building owner survey entirely as a web-based survey. Table 13 provides detailed descriptions of each survey.

**Table 13. Overview of survey methodology**

| Target population | Recruitment method | Sample size | Length of survey | Screening criteria |
|---|---|---|---|---|
| Facility manager | CATI | 70 | 30 minutes | Facility managers in California managing at least one building with packaged RTUs who were involved in the RTU decision-making process. |
| Building owner | A panel of nonresidential building owners | 68 | 30 minutes | California nonresidential building owners with packaged RTUs who were involved in the RTU decision-making process. |

### 9.3.9 Screening and quality assurance

The survey screening process included two criteria. First, respondents had to confirm whether they own or manage a nonresidential property in California equipped with RTUs for heating, cooling, and ventilation. Those answering "no" or "don't know" did not proceed with the survey. Second, only respondents who confirmed their role in RTU decision-making were eligible to continue with the survey.

CalMTA implemented the following QA/QC steps:

- **Soft launch:** A soft launch collected approximately 10% of the sample. CalMTA reviewed the soft launch data and made minor adjustments to the survey questions (i.e., adding descriptions to tables) before proceeding with the remaining data collection.
- **Attention checks:** Respondents were required to correctly answer a quality control question (i.e., "Select disagree for this question") to proceed.
- **Speeding:** Responses completed in less than half the median survey time were flagged and replaced.
- **Response review:** CalMTA reviewed responses and had the option to flag and request replacements for any responses identified as having quality concerns.

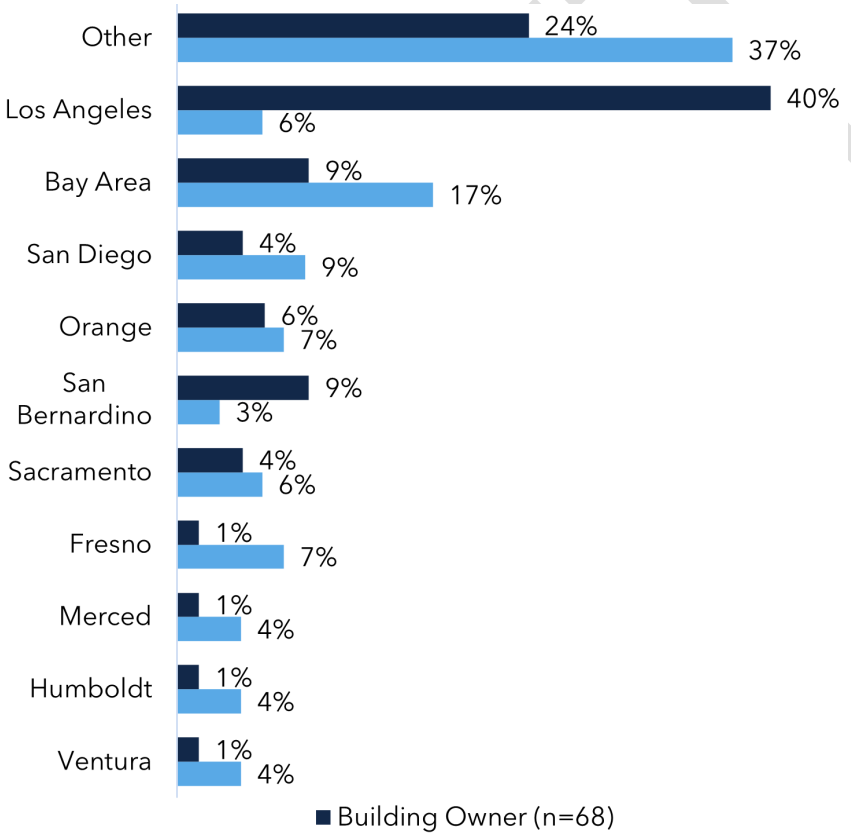
### 9.3.10 Survey Sample Characteristics

The survey sample consisted of 68 building owners who reported owning a total of 2,694 buildings and 70 facility managers who reported overseeing a total of 749 buildings.

#### *Respondent Location*

Figure 53 shows survey respondents are distributed throughout the state. CalMTA assigned respondents to the "Other" category if they were in areas with less than 5% combined responses from both owners and managers (i.e., Butte and El Dorado counties), including combining the nine San Francisco Bay area counties into one region.

**Figure 53. County/Region of residence**




Source 53: RTU Decision-Maker Survey: What county do you currently live in?

## 9.4 Product price research

To research the incremental price for CRTUs, CalMTA combined primary and secondary data.

#### Primary data

In spring of 2025, CalMTA conducted cold calls to HVAC installation companies in California and outreach to referrals from team members to collect bids for 3 and 10 ton RTUs. CalMTA designed a data collection worksheet to be completed by contractors, which was emailed after

a meeting with CalMTA staff to explain the desired equipment features and installation assumptions (i.e., existing curb is sufficient). The worksheet asked contractors to complete a table (14) with current pricing.

**Table 14. Data collection table**

| | **Baseline** | **Tier 1** | **Tier 2** |
|---|---|---|---|
| **RTU size (cooling capacity)** | **Installed Price (markup, installation, permits, commissioning)** | **Installed Price (markup, installation, permits, commissioning)** | **Installed Price (markup, installation, permits, commissioning)** |
| 3 ton RTU | Enter equipment price | Enter price for 16 SEER2 equipment | Enter price for 16 SEER2 + inverter equipment |
| 3 ton RTU w/ RMS factory installation | Enter equipment price | Enter price for 16 SEER2 equipment | Enter price for 16 SEER2 + inverter equipment |
| 10 ton RTU | Enter equipment price | Enter price for 16.9 IEER equipment | Enter price for 16.9 IEER + inverter equipment |
| 10 ton RTU w/ RMS factory installation | Enter equipment price | Enter price for 16.9 IEER equipment | Enter price for 16.9 IEER + inverter equipment |
| RMS subscription cost (1-year) | Enter Subscription price for RMS | Enter Subscription price for RMS | Enter Subscription price for RMS |

Tier 1 is a minimum of 16 SEER2 for the 3-ton RTUs and 16.9 IEER for the 10-ton RTUs. For Tier 2, the worksheet specified the same metrics as Tier 1 and added an inverter (variable speed). The worksheet also provided pricing assumptions (such as excluding taxes and assuming re-use of existing curb) and examples of qualifying remote monitoring systems (RMS) by manufacturer. Other requirements were that the new RTU is compliant with Title 24 and uses an A2L refrigerant.

CalMTA conducted outreach between February and April 2025 through a combination of emails and phone calls. The outreach included a brief description of the research and the types of information that would be requested. It also made clear that participants who submitted both the completed worksheet and provision of supporting materials would receive a $500 financial incentive. Of the 50+ original outreach attempts, CalMTA sent the workbook to six contractors who had agreed to participate in the research in exchange for the financial incentive. Out of those six contractors who agreed to participate, only two provided pricing information, despite multiple follow-up attempts. One contractor who did provide information to CalMTA took nearly a month to provide the completed worksheet and supporting materials. Another contractor engaged with CalMTA in discussions about the worksheet and ultimately submitted a set of quotes for products that did not meet the requested criteria because it was not available through their supplier.

### *Secondary data*

CalMTA conducted a literature review to determine if incremental costs for features of interest were available and qualifying product availability. Using data from the literature, CalMTA conducted analysis to estimate incremental costs for products meeting CalMTA's specifications.