TECH CLEAN CALIFORNIA

GAS BASELINE INCREMENTAL COST STUDY

SEPTEMBER 25, 2025

CONTENTS

TABLES & FIGURES

I. EXECUTIVE SUMMARY

The Technology and Equipment for Clean Heating (TECH) Initiative was created by Senate Bill 1477, passed in 2018. The TECH Initiative, publicly known as TECH Clean California, is designed to advance the state's market for low-emission space and water-heating equipment for existing residential buildings. As stated in D. 20-03-027[1], the decision "Establishing Building Decarbonization Pilot Programs," the Initiative is a building decarbonization pilot program "intended to raise awareness of building decarbonization technologies and applications, test program and policy designs, and gain practical implementation experience and knowledge necessary to develop a larger scale approach in the future."

Opinion Dynamics is the independent evaluator for TECH Clean California, researching program impacts, market effects, policy developments, and technology advances. We use our Whole Independent Systems Evaluation (WISE™) framework. The WISE approach allows us to maintain our third-party independent voice as we walk alongside Energy Solutions, the prime implementer for the Initiative, and its team of subcontractors, so that we can infuse real-time evaluation insights into every step of program design and implementation. This approach creates effective feedback loops to help all parties better understand complex market adoption patterns, program strategies' effectiveness, and course correction opportunities.

The WISE framework consists of four pillars: the Program Watch, which looks at program processes and impacts; the Technology Watch, which looks at technology performance and advancements; the Policy Watch, which examines policy developments; and the Market Watch, which assesses the California market for heat pump technologies. This Incremental Cost Study falls under both the Market Watch and the Technology Watch and sought to assess how the cost of space-conditioning and water-heating heat pumps compares to gas-powered alternatives. Total project costs included expenses for equipment, labor, and services, as well as any contractor-recommended home modifications, supplies, permitting, and electrical work performed by the contractor. This study also investigated how contractors discussed the heat pump option with customers, including benefits and drawbacks, incentives and financing, along with any required electrical work needed to accommodate the heat pump equipment.

1.1 METHODS

We executed the Incremental Cost Study in three phases. **Phase 1** was conducted in December 2023 and was a rapid turnaround survey to estimate project costs across six scenarios for HVAC equipment (findings in Appendix A). **Phase 2** was conducted in June and July of 2024 and involved mystery shopping visits at 30 single-family homes in California with existing gas space-heating (n=20) or water heating equipment (n=10). With our staff posing as homeowners, we collected bids for gas like-for-like replacements and heat pump options from 107 contractors. We also gathered qualitative data from the "kitchen table conversations" about contractors' recommended equipment, attitudes toward heat pump equipment, contractors' approach to equipment sizing, their assessment of any required electrical work needed, and any permits, incentives, or financing discussed. The homes were in all climate regions, were split on whether they had rooftop solar, and 11 of the 30 homes had electrical panels with no open slots. Twelve of the 20 HVAC homes had prior central air conditioning.

Phase 3 was conducted in April and May of 2025 and consisted of an online survey with a different sample of contractors to collect bids for gas like-for-like replacements and heat pump options for the same 30 homes used in Phase 2. One goal of the Phase 3 survey was to gauge whether we could provide sufficient information in the survey to solicit accurate project bids in an online environment. To do this, we created packages of information for each of the mystery shopping homes. The "packages" contained the home's characteristics and layout, specifications of its existing

[1] https://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M331/K772/331772660.PDF

gas equipment, its electrical panel capacity, and accompanying photos. An example of these packages is included in Appendix D. Seventeen contractors submitted 114 HVAC and 45 water-heating project bids after reviewing these packages.

1.2 RESEARCH OBJECTIVES

TECH's midstream design means that the incentive goes to the contractor who passes it onto the homeowner. Yet, the homeowner is the one who must make the decision to purchase the heat pump equipment over other alternatives, and the contractor's advice and talking points influence the homeowner's decision. Therefore, we sought to understand not just how much more expensive a heat pump might be compared to a gas like-for-like replacement, but also the way the contractor discussed equipment options with the homeowner. Our main research questions were:

- How do equipment and labor costs differ between like-for-like replacements and heat pump retrofit projects in the following scenarios?
  - HVAC
    - Single-family homes with a central ducted gas furnace with no cooling
    - Single-family homes with a central ducted gas furnace with central cooling
  - Water heating (WH)[2]
    - Single-family homes with a gas storage water heater
- How do contractors discuss any needed electrical work? Who do they suggest conduct this work?
- What does the "kitchen table conversation" entail when discussing heat pumps?
- What data are critical to informing survey-based cost studies in the future?

1.3 KEY FINDINGS

PHASE 2

The results from our mystery shopping study demonstrate that there is substantial variability in how contractors assess a home, discuss equipment options with customers, and determine what additional work should occur in the home to accommodate the heat pump. All contractors selected for the study marketed that they offered heat pumps, but about a quarter of the contractors did not offer the mystery shopper an electric option (18% for HVAC and 22% for water-heating). Of the HVAC contractors, half of those who offered a heat pump only did so after the mystery shopper mentioned they had rooftop solar or were considering adding it in the near future. This suggests that contractors view heat pumps as suitable for customers with rooftop solar, and either because they will not be paying the full cost of electricity, or able to spend more on the project.

Based on the way contractors talked about heat pumps, our mystery shoppers characterized HVAC contractors as having more favorable attitudes toward heat pumps than water-heating contractors. The majority of HVAC contractors (59 of 79; 75%) mentioned at least one benefit associated with heat pumps, while half (40 of 79; 51%) mentioned at least one concern. Water-heating contractors' sentiments, on the other hand, were flipped. Half discussed a benefit (18 of 37; 49%) while a majority raised concerns (29 of 37; 78%). Cons across HVAC and water heating heat pumps

[2] There was one home in our sample with an existing gas tankless water heater for which we received like-for-like replacement bids. Additionally, we received other gas tankless water heater bids for homes with a gas storage water heater. This allowed us to incorporate the gas tankless water heater-related costs into our analysis.

included that the heat pumps can be noisy, larger, and not heat the air or water as fast as traditional equipment. Advantages of heat pumps contractors highlighted included their energy efficiency, compatibility with solar PV systems, and improved thermal comfort (the cooling effect of HPWH in indoor areas and the fact that HVAC heat pumps offer both heating and cooling).

Since all homes had gas-powered equipment, a contractor who is serious about installing a heat pump as a replacement should investigate whether there is an appropriate electrical outlet and electrical panel space for it. Just over half of water-heating contractors (21 of 37; 57%) inspected the homes' wiring, electrical panel, and/or service capacity during their visit, while more HVAC contractors did (57 of 79; 72%). Contractors with favorable attitudes were more likely to inspect the adequacy of the electrical system and discuss the electrical panel with mystery shoppers than contractors who had "skeptical" attitudes toward heat pumps. It is unclear whether the contractors who did not investigate the electrical panel did not know they should, or if based on their conversation, they did not think the mystery shopper would seriously consider a heat pump, and therefore did not need to investigate if there was a breaker or outlet available for it.

Additional electrical work to accommodate the heat pump was more common in water-heating projects than space-heating projects. About three-quarters of water-heating contractors (28 of 37; 76%) said that the home would need electrical upgrades such as wiring, outlets, or panel upgrades to accommodate a HPWH, while 43% of HVAC contractors (34 of 79) did. Despite the greater need among HPWH projects, few water-heating contractors could perform the necessary electrical work themselves: 38% (10 of 26). HVAC contractors, in contrast, were more equipped to conduct the necessary electrical work, as 83% (35 of 42) said they could do it themselves. Nearly half of HVAC contractors also recommended non-electrical modifications when installing the heat pump (36 of 79; 46%), which were mostly about ductwork (24 of 36, or 66%). Ductwork modifications added an average of about $1,850 to the total average cost of all-electric heat pump projects.

Consistent with industry guidance, contractors often suggested larger capacities for HPWH compared to the gas water heater it was replacing. Most homes with a 40-gallon water heater were recommended to upgrade to a 50-gallon water heater (11 of 17 bids), and most homes with a 50-gallon water heater were also recommended to get equipment of higher capacity (8 of 14 bids).

Most, if not all, jurisdictions in California require permits to install HVAC heat pumps and HPWHs. About half of the HVAC contractors (43 of 79; 54%) mentioned permits or Home Energy Rating System (HERS) raters. HERS testing and permit costs for HVAC projects varied by city, with average prices ranging from $633 to $1,200. A minority of water-heating contractors (11 of 37; 30%) discussed permits and HERS testing with mystery shoppers. Very few included costs of permits on their bids; for the four did, permit costs ranged from $450 to $590.

Contractors enrolled in TECH Clean California were more likely to mention heat pump incentives and tax credits than those who were not enrolled in TECH. Almost three-quarters of TECH-enrolled HVAC contractors (31 of 44; 71%) brought up electric incentives on their own, while about half of non TECH-enrolled HVAC contractors (17 of 35; 49%) did not. On the water-heating side, 78% (7 of 9) of TECH-enrolled contractors mentioned electric or gas incentives, compared to 33% (9 of 27) of non TECH-enrolled contractors.

We found that HVAC heat pump projects are more expensive than gas like-for-like replacements, though there was no correlation between a home's square footage and total HVAC project costs identified in this study.[3] When compared to the average cost of a like-for-like gas furnace replacement, an all-electric heat pump costs on average about $10,800 more. That incremental cost goes down substantially if the homeowner replaces a gas central furnace *and* central air conditioning (CAC) system, to $2,400. Contractors priced single-speed and variable-speed heat pumps similarly, with

[3] While no relationships between square footage and HVAC project costs was found in this study with 20 homes, Energy Solutions reports they observed a correlation in the larger TECH Clean California project database.

average costs for each type roughly $19,000. Contractors enrolled in TECH priced their heat pump projects slightly higher than contactors who were not enrolled, though TECH contractors' average price of a furnace and CAC replacement was lower than non-TECH contractors.

On the water-heating side, we found that the cost of gas tankless water heaters was very comparable to HPWHs, both of which cost about $4,000 more than gas storage water heaters. There was also a large range in HPWH costs: the lowest HPWH bid was $3,800 and the highest was $14,700, which was for a large, 83 gallon HPWH. Contractors enrolled in TECH Clean California priced HPWHs a little bit lower than contractors not enrolled in TECH: their average total HPWH project costs were $7,246.63 and $9,169.04 respectively.

PHASE 3

We conducted the Phase 3 online survey because it provided an opportunity to ground-truth the mystery shopping contractor quotes collected in Phase 2, while increasing the volume of contractor bids. Furthermore, while it is notoriously difficult to gather cost information from contractors using traditional approaches such as surveys and in-depth interviews, using the Phase 2 home details to create a "home package" contractors could respond to, along with a generous incentive, was expected to generate accurate cost information from contractors. It also provided an opportunity to hear from contractors about how to improve survey-based cost studies moving forward by detailing the critical information necessary to include in scenario descriptions.

In the Phase 3 survey, we asked contractors how sufficient the information provided was for them to provide an accurate project bid. Contractors scored our HVAC home packages as a 2.5 on a scale from 1 to 5, where 1 is "Completely sufficient," and 5 is "Not at all sufficient." As such, on average, the information we provided on each HVAC home's webpage could be described as "somewhat" to "mostly" sufficient. Contractors scored the water-heater home packages better, at an average of 1.9 which equates to "mostly" sufficient.

We found some differences between the bids provided in Phases 2 and 3. In the online environment, contractors' bids for replacing a gas central furnace were about $1,750 more expensive than bids received during the mystery shopping exercise. In Phase 2, the average cost of a dual-fuel heat pump system is not statistically different from the average cost of replacing a gas furnace and CAC system. However, according to Phase 3, a dual-fuel heat pump replacement (with a new furnace, instead of leaving the old furnace as a backup) costs about $2,500 more than the average cost of a new gas furnace and CAC system, representing a 13% cost increment.

The findings for water heaters showed a different trend, in that 45 online bids tended to be less expensive than bids received during the mystery shopping exercise. Specifically, bids received through the online contractor survey for replacing a gas storage water heater were about $1,500 cheaper than those offered on-site. Similarly, the average cost of gas tankless water heaters collected through the survey was lower than that collected during the mystery shopping exercise. However, the average cost of HPWHs collected in the survey was higher than that collected in Phase 2. We also observed that in Phase 3, total water heating project costs were more positively correlated with the number of bathrooms in the home than in Phase 2, although this was still not a strong relationship.

Given the discrepancies between project bids in Phases 2 and 3, and the lack of a uniform direction in project costs between the phases, we have opted to present the more robust, Phase 2 mystery shopping data in this report. The data from Phase 3 is available in Appendix F. We do present some Phase 3 data below in the executive summary where findings aligned closely between the two phases.

1.3.1 HVAC PROJECTS

General Findings

- **We received 188 valid HVAC-related bids in Phase 2,** Of those, 93 were for all-electric heat pump systems.
- **Over half of HVAC contractors (44 of 79; 56%) voluntarily offered both gas-powered and electric equipment to replace the home's existing HVAC equipment.** Of all equipment options discussed between HVAC contractors and mystery shoppers, heat pumps were discussed most frequently (68 of 79; 86%), followed by gas furnaces (50 of 79; 63%). Three-quarters of contractors (59 of 79; 75%) brought up heat pumps first without being prompted by mystery shoppers, with half of them (31 of 59; 53%) bringing up heat pumps after the mystery shopper mentioned they were considering adding rooftop solar to the home in the near future.
- **Overall, most contractors had favorable attitudes toward HVAC heat pumps, with mystery shoppers characterizing 41% as "big champions" (32 of 79) and 20% as "supportive" (23 of 79) of heat pumps based on their interactions. The majority of contractors (59 of 79; 75%) mentioned at least one benefit associated with heat pumps,** including thermal comfort, energy efficiency, or supporting home electrification. Seventeen contractors (22%) pointed out that the benefits of electrification and energy efficiency are greatly enhanced when combined with solar power.
- **About half of contractors (40 of 79; 51%) mentioned at least one concern about HVAC heat pumps, including performance in cold temperatures, space requirements, and reliability.** The most common concern among contractors was related to challenges with the heating performance of HVAC heat pumps (24 of 79; 30%), specifically mentioning their slower heating times, limited output of hot air, and effectiveness in colder climates.
- **Most HVAC contractors (57 of 79; 72%) inspected the adequacy of the wiring, electrical panel capacity/space, and/or service capacity during their visit.**
- **Less than half of HVAC contractors (34 of 79; 43%) discussed the electrical panel with mystery shoppers during their visit.** Contractors with supportive and neutral attitudes towards heat pumps are more likely to discuss the adequacy of the electrical panel capacity than contractors who are skeptical of heat pumps.
- Contractors recommended electrical work at all but one of the HVAC homes. Two of these homes were recommended to have panel upgrades while the rest were incidental electrical work on wiring and outlets.
- **When electrical wiring or panel upgrades were discussed, over half of the HVAC contractors (35 of 42; 83%) indicated that they were able to complete the necessary work themselves.** A minority (6 of 42; 14%) required the homeowner to hire someone to do the work, while a few (2 of 42; 5%) indicated they would subcontract to an electrician.
- **Almost half of the contractors (36 of 79; 46%) recommended non-electric modifications when installing a heat pump with mystery shoppers. Most of these modifications focused on ductwork (24 of 36; 66%).** Other non-electrical upgrades mentioned by contractors included modifying refrigerant lines, building envelope improvements, and modifications associated with changing the expected location of the new system.
- **Over two-thirds of contractors (51 of 79; 65%) determined the size of their suggested HVAC equipment based on the home's existing system, while one-fifth (16 of 79; 20%) performed load calculations.**
- **During Phase 2, 16 contractors (20%) recommended hybrid systems that combined a new heat pump and a gas furnace as a backup heating system.** Several contractors recommended leaving the gas furnace as backup heating due to energy cost considerations (6 of 79; 8%) and climate factors (i.e., effectively heating in the winter) (4 of 79; 5%). Additionally, contractors recommended the gas furnace as back-up heating over installing an electric heat strip in the heat pump.
- **When it comes to incentives, rebates, or tax credits for electric equipment, more than half of HVAC contractors (48 of 79; 61%) mentioned them without any prompting from the mystery shopper. Over one-third of HVAC contractors (31 of 79; 39%) did not mention any incentives, rebates, or tax credits at all.** TECH-enrolled contractors were more likely to bring up incentives, rebates, or tax credits for electric equipment compared to non TECH-enrolled

contractors. The two most common types of incentives mentioned by contractors were tax credits (48 of 69; 70%) and TECH Clean California (34 of 69; 49%).

- **About half of the HVAC contractors (43 of 79; 54%) mentioned permits or Home Energy Rating System (HERS) raters, and a similar proportion (45 of 79; 57%) offered financing options to the mystery shopper.** About half of the contractors who offered financing options (24 of 45; 53%) offered payment plans between 6 and 36 months with zero interest.
- **Half of the contractors who provided bids for HVAC projects in Phase 3 (5 of 10) stated that having additional information or photos of the home's ductwork would have helped them provide more accurate project bids.** Other pieces of information that would have helped them provide accurate bids in the online survey were the Manual J load calculation[4] (3 mentions), information on wall or attic insulation levels (2 mentions), information on homeowners' heating and cooling habits (2 mentions), additional information about the setback of the home relative to the property line, as well as information about the roof, attic, and windows (2 mentions), additional photos of wiring (1 mention), and whether the home's appliances were electric (1 mention).

Cost-related Findings:

- **The HVAC cost data we collected varied widely across both phases of our study. The all-electric heat pump was among the equipment types that showed the most variation in costs.** According to the mystery shopping Phase 2 data, total project costs were relatively similar within the same equipment type between the hot-dry and marine climate regions; however, the Phase 3 online survey cost data showed total project costs being consistently higher in the marine climate region.
- **There is no evident correlation between home square footage and total HVAC project costs in this study.** According to the Phase 2 cost data, the average project cost of a gas central furnace is significantly higher for homes less than 2,000 square feet than for homes 2,000 square feet and above.
- **HERS testing and permit costs for HVAC projects varied by city, with average prices ranging from $633 to $1,200 in Phase 2.** Most Phase 2 HVAC bids (83%) listed a HERS and/or permitting cost of less than $1,000, with an average cost of $831.
- **The incremental costs of a dual-fuel heat pump (HVAC heat pump with a new furnace) and an all-electric heat pump are very similar, compared to the average cost of a gas furnace.**
- **In Phase 2, we found that when compared to the average cost of a like-for-like gas furnace replacement, an all-electric heat pump, on average, costs about $10,800 more, which represents a 129% cost increment.** Phase 3 findings show this incremental cost at about $12,500, representing a 125% cost increment for an HVAC heat pump over the average cost of a gas central furnace like-for-like replacement.
- **In the replacement scenario of a gas central furnace and CAC system, an all-electric heat pump replacement costs about $2,400 more than a like-for-like replacement of the system based on the Phase 2 cost data analysis, and about $2,000 more based on the Phase 3 cost data analysis. This represents a 14% and 10% cost increment, respectively.** Therefore, the incremental cost of an HVAC heat pump replacing an existing heating *and* cooling system is much smaller than replacing a heating system only.
- **In the aggregated cost data across Phase 2 and Phase 3, we found no statistically significant difference between the average cost of a dual-fuel heat pump system and that of a gas furnace and CAC system replacement, consistent with Phase 1.** While in Phase 2 the average cost of a dual-fuel heat pump system was not statistically different from the average cost of replacing a gas furnace and CAC system, Phase 3 showed that a dual-fuel heat pump costs about $2,500 more than the average cost of a new gas furnace and CAC system, representing a 13%

[4] A Manual J load calculation is a formula used to determine a home's precise heating and cooling requirements to ensure optimal HVAC performance and sizing. (https://precisioncomfort.com/what-is-manual-j-load-calculation/)

cost increment. **However, according to the cost data collected during Phase 3, a heat pump replacement, regardless of whether it is all-electric or a dual-fuel system, is a more expensive option than a gas central furnace and CAC system replacement.**

- **We found that heat pump projects with ductwork modifications recommended by the contractor were significantly more expensive than all-electric heat pump projects without ductwork.** Ductwork modifications added an average of about $1,850 (10%) to the total average cost of all-electric heat pump projects.
- **Phase 2 HVAC contractors' opinions on the cost of heat pumps compared to traditional gas furnaces and the combination of a gas furnace and CAC systems were mixed.** While the equipment cost was not a major concern for contractors, nearly one-quarter of contractors (18 of 79; 23%) noted that the heat pump's upfront costs could be higher than traditional gas systems, depending on upgrades required for installation, which could add thousands to the overall cost. Contractors felt that the potential savings on heat pump operating costs depended on several factors, including electricity rates, solar availability, and system configuration.

1.3.2 WATER-HEATING PROJECTS

General Findings:

- **We received 75 WH-related bids in Phase 2.** Of those, 31 were for HPWHs.
- **Over half of the WH contractors (21 of 37; 57%) in Phase 2 voluntarily offered the mystery shopper both gas-powered and electric WH equipment to replace their water heating equipment.** Of all equipment options discussed between WH contractors and mystery shoppers, HPWHs were discussed most frequently (31 of 37; 84%), followed by gas tankless water heaters (23 of 37; 62%), and gas storage water heaters (21 of 37; 57%). While HPWHs were discussed most commonly, only one-third of contractors (12 of 37; 32%) brought up this technology first, with most of them (10 of 12; 83%) bringing them up after the mystery shopper mentioned they were planning to add rooftop solar in the near future.
- **WH contractors viewed HPWHs less favorably than HVAC contractors viewed heat pumps.** While the majority of HVAC contractors (55 of 79; 70%) were either strong champions (32 of 79; 41%) or supportive (23 of 79; 23%) of heat pumps, only about one-third of WH contractors (14 of 37; 38%) were strong champions (4 of 37; 11%) or supportive (10 of 37; 27%) of HPWHs.
- **About half of WH contractors (18 of 37; 49%) discussed benefits associated with HPWHs and highlighted a variety of advantages, particularly in relation to energy efficiency, cost savings, and compatibility with solar energy systems.**
- **Most Phase 2 WH contractors (29 of 37; 78%) raised concerns about HPWHs when discussing them with the mystery shoppers. The most frequently mentioned issues were space requirements and hot water supply.** Other challenges included difficulties accessing rebates, reliability concerns, and noise or vibration issues.
- **About half of WH contractors (21 of 37; 57%) inspected the homes' wiring, electrical panel, and/or service capacity during their visit.**
- **About three-quarters of contractors (28 of 37; 76%) in Phase 2 said that the home's electrical systems would need to be upgraded to accommodate a HPWH.** Contractors with supportive and neutral attitudes towards HPWHs were more likely to discuss potential electrical panel upgrades than skeptical contractors.
- **More than one-third of WH contractors who investigated the home's electrical condition or indicated that electrical upgrades would be necessary (11 of 26; 42%) required the homeowner to hire someone to do this electrical work, while a similar proportion of contractors (10 of 26; 38%) stated they could complete the work themselves.** A few contractors (7 of 26; 27%) indicated that they would subcontract to an electrician.

- **Overall, 13 of 37 WH contractors (35%) mentioned that some non-electrical upgrades would be needed to install a HPWH, especially related to the location of the new unit and additional components** (e.g., a thermostatic mixing valve to regulate water temperature or a condensate drain for moisture removal from the system). Other modifications mentioned were regarding ventilation, gas lines, and flues.
- **When talking about incentives, rebates, or tax credits for electric water-heating equipment, about two-fifths of contractors (15 of 36; 42%) mentioned them without any prompting from the mystery shopper. Over half of WH contractors (20 of 36; 56%) did not bring up any incentives, rebates, or tax credits at all.** TECH-enrolled contractors were more likely to bring up any incentives on their own; specifically, 78% (7 of 9) of TECH-enrolled contractors mentioned electric or gas incentives, compared to 33% (9 of 27) of non TECH-enrolled contractors. Similar to HVAC, the most commonly discussed types of incentives for electric water-heating equipment were tax credits (12 of 25; 48%) and TECH Clean California (6 of 25; 24%).
- **A minority of WH contractors (11 of 37; 30%) discussed permits and HERS testing with mystery shoppers, and a similar proportion (12 of 37; 32%) offered financing options to them.** Nearly half of the WH contractors who offered financing options (5 of 12; 42%) offered payment plans between 12 and 24 months with zero interest.
- For water heating projects in the Phase 3 online survey, the pieces of information that would have helped contractors better estimate their project costs included the dimensions of the water heater location (3 mentions), information about ventilation in the water heater location (3 mentions), the location of the gas meter (2 mentions), information on piping routes through the home (1 mention), and images of the pathway from the street to the water heater location (1 mention).

Cost-related Findings:

- **HPWHs consistently showed large variation in costs across both the mystery shopping exercise and the online contractor survey.**
- **Total water heating project costs showed no strong correlation with the number of bathrooms in the home**, which was used as a proxy for how many people lived in the home, and therefore, gave a sense of the home's hot water demand. We hypothesized that greater hot water demand would equate to larger capacity water heaters, which are often more expensive.
- **Most homes with a 40-gallon water heater were recommended to upgrade to a 50-gallon water heater** (11 of 17 bids that specified tank capacity). For homes with a 50-gallon water heater, most bids that specified tank capacity either recommended the same or a higher tank capacity (8 of 14 bids).
- **In Phase 2, we found that when compared to the average cost of a gas storage water heater replacement, the incremental costs of a gas tankless water heater and a HPWH were very similar, both costing about $4,000 more on average (a 94%-95% cost increment).**
- **Several Phase 2 contractors (8 of 37; 22%) stated that HPWHs have higher upfront costs compared to gas storage or tankless water heaters.** In addition to the cost of the unit itself, contractors highlighted the additional installation expenses, such as electrical upgrades, which can substantially increase the total upfront investment. While some contractors believed that the operating savings might eventually offset the higher upfront cost of HPWHs, opinions on the long-term financial benefits were mixed.

1.4 CONCLUSIONS AND RECOMMENDATIONS

Based on the findings of this Incremental Cost Study, we offer the following conclusions and recommendations:

Conclusion 1: Contractor variability is high. California contractors approach single-family heat pump projects very differently. Bids for the same home varied by several thousand dollars, and practices around permitting, electrical inspections, and additional upgrades were inconsistent. This variability creates opportunities for contractors with strong heat pump expertise to differentiate their business by highlighting their acumen and know-how with heat pump equipment.

Conclusion 2: Participation in incentive programs matter. Contractors enrolled in TECH Clean California were significantly more likely to raise heat pumps as an option, emphasize their benefits, assess whether the home's electrical system could support the equipment, and proactively present available incentives. In contrast, non-TECH contractors often failed to do so, underscoring the importance of program participation in ensuring homeowners receive accurate information and viable pathways to adoption.

Conclusion 3: The water-heating heat pump market lags behind space-conditioning heat pump market. Contractors' attitudes and sales practices differ sharply between the water-heating and space-conditioning markets. Consistent with Opinion Dynamics' prior assessments, the HPWH market continues to lag behind HVAC heat pumps. In this study, water-heating contractors emphasized drawbacks of HPWHs more often than benefits, while HVAC contractors highlighted benefits of heat pumps more frequently than concerns.

Recommendation: Prioritize HPWH incentives. Because contractors communicate fewer perceived benefits of HPWHs to customers, incentives play a disproportionately important role in driving adoption. If programs must target limited incentive dollars, we recommend prioritizing the water-heating market, where incentives are likely to carry greater weight in shaping homeowner decisions and overcoming contractor skepticism.

Conclusion 4: HVAC heat pumps have not yet reached commodity status in California. Unlike gas furnaces—which show relatively consistent pricing—heat pump project costs vary dramatically, ranging from roughly $10,000 to $40,000. This wide spread indicates that heat pumps remain in an early stage of market development, with limited availability and significant contractor discretion in pricing. As adoption grows and more contractors enter the market, we expect price variability to decline and project costs to converge toward greater consistency.

Recommendation: Continue to train and expand contractor base to reduce price variability. While HVAC heat pumps remain in an early, non-commodity phase with wide cost variability, programs should focus on expanding contractor participation, improving price transparency, and supporting trade ally and consumer education. These efforts can accelerate market maturity, reduce pricing disparities, and help ensure that homeowners receive fair, competitive bids as the technology becomes more widely available.

Conclusion 5: Ancillary costs are significant. Non-electrical modifications add an average of $3,600 to HVAC heat pump project costs. Unlike furnace replacements, heat pump installations often require ancillary upgrades—such as ductwork modifications—that drive up total costs. These additional expenses increase the incremental cost of heat pumps and may place them out of reach for low- to moderate-income households.

Recommendation: Support ancillary costs to expand access. To address the burden of ancillary costs, programs should consider offering targeted incentives or financing to cover common non-electrical modifications such as ductwork, permitting, or site preparation. Bundling these supports into heat pump incentive programs can reduce financial barriers for low- and moderate-income households and make projects more accessible and equitable.

Conclusion 6: Gas storage water heaters remain the lowest cost option. On average, gas storage water heaters cost about half as much as HPWHs, while HPWHs were priced comparably to gas tankless systems. Given this price gap and contractors' strong tendency to recommend like-for-like replacements, gas storage water heaters are likely to remain the default choice for most California homeowners absent strong drivers such as rooftop solar or adequate incentives.

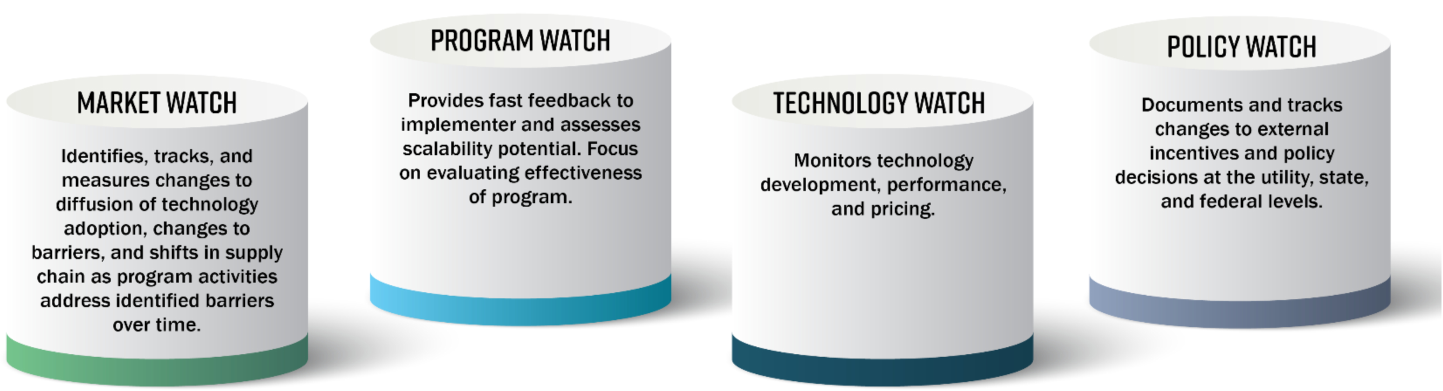
2. INTRODUCTION

The Technology and Equipment for Clean Heating (TECH) Initiative was created as part of Senate Bill 1477, passed in 2018. The TECH Initiative, publicly known as TECH Clean California, is designed to advance the state's market for low-emission space and water-heating equipment for existing residential buildings. As stated in D. 20-03-027[5], the Initiative is a building decarbonization pilot program "intended to raise awareness of building decarbonization technologies and applications, test program and policy designs, and gain practical implementation experience and knowledge necessary to develop a larger scale approach in the future."

Opinion Dynamics is the independent evaluator for TECH Clean California, researching program impacts, market effects, policy developments, and technology advances. We use our Whole Independent Systems Evaluation (WISE™) framework. The WISE approach allows us to maintain our third-party independent voice as we walk alongside Energy Solutions, the prime implementer for the Initiative, and its team of subcontractors, so that we can infuse real-time evaluation insights into every step of program design and implementation. This approach creates effective feedback loops to help all parties better understand complex market adoption patterns, program strategies' effectiveness, and course correction opportunities.

The WISE framework consists of four pillars (Figure 1). The Market Watch assesses the California market for heat pump technologies; the Program Watch focuses on evaluating the effectiveness of the programs' processes, as well as its impacts; the Technology Watch monitors technology performance and advancements; and finally, the Policy Watch examines policy developments at various levels. This Incremental Cost Study falls under both the Market Watch and the Technology Watch.

Figure 1. WISE Pillars



This study's main goal was to assess the cost of space-conditioning and water-heating heat pumps compared to gas-powered alternatives in the California market. We executed the Incremental Cost Study in three phases:

- **Phase 1** was conducted in December 2023 and was a rapid turnaround survey to estimate project costs across six HVAC scenarios. Sixty-four contractors completed an online survey, where they were presented with the same home and six equipment upgrade scenarios. All scenarios assumed a 1,700-square-foot, single-story home with no need for equipment relocation, no panel upgrades, and no ductwork. Contractors provided cost estimates for

[5] https://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M331/K772/331772660.PDF

equipment, labor, and miscellaneous costs. We specified code-minimum (14 SEER) heat pumps. The findings from Phase 1 are included in Appendix A because they were presented and finalized in 2024.

- **Phase 2** was conducted in June and July of 2024 and included mystery shopping visits at 30 single-family homes in California with 107 contractors. All homes had existing gas heating or water heating equipment. We asked contractors to provide bids for gas like-for-like replacements and a heat pump option (ducted air source heat pump and heat pump water heaters [HPWH]). Some contractors also provided other equipment bids, such as dual-fuel heat pumps. Contractors specified the efficiency and tonnage of the equipment based on their recommendation. We received 263 bids in total in Phase 2. Our mystery shopping staff posed as homeowners and took qualitative notes to record how contractors discussed the heat pump option and their attitude toward heat pump equipment in general. This included who mentioned a heat pump or HPWH first, what benefits and drawbacks of heat pump equipment the contractor mentioned, their approach to equipment sizing, their assessment of any required electrical work needed to accommodate the heat pump equipment, any permit considerations, and whether the contractor discussed incentives or financing. We refer to these discussions as the "kitchen table conversation" because it is common for contractors to sit down with the homeowner at the kitchen table to discuss the project budget, offer advice, and consider the different equipment options.
- **Phase 3** was conducted in April and May of 2025 and consisted of an online survey with a separate sample of 17 contractors to collect bids for gas like-for-like replacements and heat pump options for the same 30 homes used in Phase 2. We compiled each home's characteristics, including specs and condition of its existing gas equipment, its electrical panel capabilities, and home layout, and created "packages" for each home with this information and associated photos. These packages of information were presented to contractors—who had not participated in Phase 2—through an online survey. Contractors were then asked to review the packages for three homes and upload project bids for specific equipment options we requested. The survey also asked contractors whether the information provided was sufficient for them to provide accurate project bids and, if not, what additional information they would have liked to receive. We received 159 bids in Phase 3.

This report covers findings from Phases 2 and 3 of our Incremental Cost Study. The key research questions for Phases 2 and 3 of this study were:

- How do equipment and labor costs differ between like-for-like replacements and heat pump retrofit projects in the following scenarios?
  - HVAC
    - Homes with a central ducted gas furnace with no cooling
    - Homes with a central ducted gas furnace with central cooling
  - Water heating (WH)[6]
    - Homes with a gas storage water heater
- How do contractors discuss any electrical work needed? Who do they suggest conduct this work?
- What does the "kitchen table conversation" entail when discussing heat pumps?
- What data are critical to informing survey-based cost studies in the future?

[6] There was one home in our sample with an existing gas tankless water heater for which we received like-for-like replacement bids. Additionally, we received other gas tankless water heater bids for homes with a gas storage water heater. This allowed us to incorporate the gas tankless water heater-related costs into our analysis.

3. METHODS

3.1 PHASE 2: MYSTERY SHOPPING

We aimed to find 30 single-family homes across the state of California (20 HVAC and 10 WH homes) to represent our sample for this research study. We sought homes in a variety of climate zones and geographic areas with diverse sociodemographic populations to capture as accurate a representation of the market as possible and gather data from a diverse representation of contractors. Below, we discuss the recruitment process we implemented and its limitations regarding our ability to execute this objective.

3.1.1 HOMEOWNER RECRUITMENT

We utilized a convenience sampling method to find homeowners who were willing to allow us to use their homes and pose as homeowners in exchange for a $250 incentive. Opinion Dynamics staff leveraged their professional and social networks to distribute a homeowner recruitment email and survey (see Appendix B) to California residents who might be interested in participating in the study. The recruitment email informed them of the purpose of the study, the eligibility criteria, and how to indicate interest. The recruitment survey asked potential participants about their homes and home equipment to determine eligibility. To qualify for the study, homes had to be single-family detached homes equipped with gas-fired furnaces or water-heating systems. If the home had an HVAC heat pump, it could still be eligible based on its gas water heater, and vice versa—if it had a HPWH.

Thirty-four homeowners responded to our survey. One was excluded because the home lacked the required equipment for the study. Of the remaining 33 eligible homes, three homeowners did not respond to scheduling attempts for a screening interview and site visit, leaving a final sample of 30 homes. Each homeowner was interviewed to answer additional questions regarding their gas-powered equipment, home characteristics, and availability for scheduling the mystery shopping visit. Additionally, homeowners received a Participation Agreement at the time of the mystery shopping visit as an additional source of information about the study, which also included contact information for the study lead in case any questions arose later.

Every home selected had either a gas-powered forced air furnace or a gas storage water heater. Respondents reported the age of their equipment in the initial survey and described any issues during the phone interview. Based on this information, we prioritized homes with older equipment—where contacting a contractor for replacement was most reasonable—and assigned each home to either the HVAC or WH sample stratum. The assignments resulted in 20 HVAC homes and 10 WH homes. The homes were spread across 12 of California's 16 climate zones, representing all three climate regions.[7] Three of the homes were in disadvantaged communities (DAC; Table 1).

---

[7] The California Energy Commission established 16 climate zones to categorize California's range of climates. See this page for more: https://www.energy.ca.gov/programs-and-topics/programs/building-energy-efficiency-standards/climate-zone-tool-maps-and

Table 1. Incremental Cost Study Homes Details

ODCID	Climate Zone	Climate Region	DAC	Equipment type
ODC001	7	Hot-dry	No	WH
ODC002	13	Hot-dry	No	WH
ODC003	9	Hot-dry	No	WH
ODC004	10	Hot-dry	No	HVAC
ODC005	10	Hot-dry	No	HVAC
ODC006	15	Hot-dry	No	WH
ODC007	3	Marine	No	HVAC
ODC008	12	Hot-dry	Yes	HVAC
ODC009	3	Marine	No	WH
ODC010	3	Marine	Yes	HVAC
ODC012	12	Hot-dry	No	WH
ODC013	3	Marine	No	HVAC
ODC014	6	Marine	No	HVAC
ODC015	2	Marine	No	WH
ODC016	6	Marine	No	HVAC
ODC017	16	Cold	No	HVAC
ODC018	10	Hot-dry	No	HVAC
ODC020	13	Hot-dry	Yes	HVAC
ODC021	10	Hot-dry	No	WH
ODC022	10	Hot-dry	No	WH
ODC023	6	Marine	No	HVAC
ODC024	7	Hot-dry	No	HVAC
ODC025	12	Hot-dry	No	WH
ODC026	12	Hot-dry	No	HVAC
ODC028	7	Hot-dry	No	HVAC
ODC029	3	Marine	No	HVAC
ODC030	6	Marine	No	HVAC
ODC031	11	Hot-dry	No	HVAC
ODC032	8	Hot-dry	No	HVAC
ODC033	2	Marine	No	HVAC

Note: The study included 30 homes in total. The study IDs created for homes 011, 019, and 027 were not used.

During the phone interview, homeowners were also asked if they were interested in receiving the quotes that contractors provided during the mystery shopping exercise. Twenty-nine of the 30 homeowners said that they would like to receive the quotes, with nearly all expressing interest in moving forward with the projects. At the end of the site visits, the homeowners were provided with the contractors' bids and a $250 gift card.

Opinion Dynamics staff were assigned as mystery shoppers for homes based on geographic proximity and staff availability. Sometimes, the real homeowner was home during contractor visits and either described themselves as a roommate or tenant.

3.1.2 CONTRACTOR RECRUITMENT

Each mystery shopper was tasked with finding and scheduling up to four contractor visits for each home site between June and July 2024, depending on homeowner availability. The main criterion for selecting contractors was their offering of heat pump equipment, whether for HVAC or water heating, or both. As such, we selected contractors through various means: via the Switch is On website or, via Google or Yelp.[8] For cases in which we found contractors on Google or Yelp, we also visited their websites to verify that they offered heat pump equipment. As shown in Table 2, the mystery shopping exercise involved 116 contractors (79 HVAC contractors and 37 WH contractors). Among HVAC contractors, over half (56%) were enrolled in TECH Clean California, while nearly three-quarters of WH contractors (73%) were not enrolled in the TECH initiative at the time of scheduling in June and July of 2024. For this analysis, we consider contractors enrolled in TECH Clean California if they offered TECH Clean California incentives for the heat pump equipment type being discussed.

Table 2. Phase 2 Contractors by Equipment Type and TECH Initiative Enrollment Status

Equipment type	TECH-Enrolled	Non TECH-Enrolled	Total
HVAC	44	35	**79**
Water Heating	10	27	**37**
Total	**54**	**62**	**116**

The selection of contractors was also limited based on mutual availability among the homeowner, the mystery shopper, and the contractor. To maintain the integrity of the data, no contractors were repeated across multiple homes. A few contractor businesses were chains, but no two homes were served by the same local office for those businesses. The contractors were located in the same areas as the homes. The homes were spread across 16 counties in California: six counties were in Southern California, five in Northern California, and five in the Bay Area (including Napa and Sonoma counties).

3.1.3 MYSTERY SHOPPERS AND DATA COLLECTED ON-SITE

Mystery shoppers were comprised of Opinion Dynamics staff. There were 13 mystery shoppers with a wide range of ages, varied gender representation, and some variation in racial representation. For the majority of the home visits, mystery shoppers pretended to be the homeowner; however, in certain instances, they pretended to be a landlord with a tenant (the real homeowner) or roommates.

Mystery shoppers attended multiple training sessions to learn about the home visit process. The evaluation team created a handbook providing mystery shoppers with step-by-step instructions and scripts to keep conversations as consistent as possible across home visits and to ensure proper data collection. Each mystery shopper had a checklist that they utilized during each visit to record relevant information while they interacted with contractors without revealing the nature of the study. Prior to the contractor visit, mystery shoppers walked through the home with the homeowner to familiarize themselves with the layout of the home and the location of the equipment. They also took pictures of the equipment, the home's electrical panel, and any other relevant home characteristics.

[8] TECH Clean California uses the Switch is On website as a customer-facing educational website for heat pumps and other home electrification technologies.

After the contractor visit, and once they received the bids from the contractors, mystery shoppers recorded the data into a Mystery Shopping Data Collection online form. The online form collected relevant information about the home and data from the interaction with the contractor, including the fuel options the contractor mentioned for the equipment replacement; if the contractor brought up heat pump equipment without being prompted; the contractor's general attitude towards heat pump equipment; any home upgrades discussed, such as electrical panel upgrades or ductwork replacement for HVAC homes, as well as information about permits, financing, and incentives the contractor may have provided. In addition to this data, mystery shoppers drew schematics of the home, which, along with the pictures, would be utilized to support Phase 3 of the study.

3.1.4 REVEAL TO CONTRACTORS

Once mystery shoppers received all bids from a given contractor, we called that contractor to reveal the nature of the study. Each contractor was either contacted by the relevant mystery shopper they interacted with or by a member of the evaluation team to inform them of their participation in the mystery shopping study. First, we explained the purpose of the study to the contractor and gave them the appropriate information to update their records with the real homeowners' contact information, except in cases where the real homeowner did not want to move forward with replacing their equipment. Each contractor was then offered $250 as a thank-you for their participation in the study and their time and effort, if they were not paid up front for the site visit as part of their regular fees. A small number of contractors were not reachable for the reveal over the phone. In those instances, we emailed the information explaining the nature of the study and steps they could take to receive the compensation. While the large majority of contractors accepted the compensation, some did not follow up on the steps for payment explained in the email, others declined payment, and one opted to donate their incentive to a charitable organization.

3.1.5 ANALYSIS

We analyzed the data collected in Phase 2 of the Incremental Cost Study at the contractor level and at the bid level.

CONTRACTOR-LEVEL DATA

During and after the visits with contractors, mystery shoppers recorded data specific to each contractor interaction. The data collected answered specific single-response and multiple-response questions but also included more descriptive notes about the kitchen-table conversation with the contractor. To analyze this data, we ran descriptive statistics, including frequencies and cross-tabulations, and, where relevant, we compared responses between TECH-enrolled and non TECH-enrolled contractors. We conducted separate analyses for HVAC and WH homes and analyzed trends across key variables such as equipment options discussed, additional work required for heat pump installation, equipment sizing practices, and whether contractors mentioned incentives, financing, or permitting, among other metrics of interest. We also collated the open-ended notes from each individual contractor visit and analyzed this qualitative data in NVivo, using a combination of deductive and inductive coding, applying a codebook with a set of a priori codes while also allowing new themes to emerge from the data.

COST DATA

Equipment bids that contractors provided showed large variability in their details (e.g., cost breakdowns for equipment, labor, home modifications, and any other costs associated with the project) and in terms of format (e.g., PDF, handwritten quotes, bids sent via email, etc.). We extracted all the bid data available from the different files we received and compiled it into a database to facilitate the analysis.

Linear Fixed-Effects Regression Modeling

For the cost data analysis, we used linear fixed-effects regression models to estimate the incremental cost of heat pump upgrades over like-for-like replacements, and we did this by looking at two possible baseline scenarios for each equipment type.

Scenarios for HVAC analysis:

1. Average cost of a gas furnace-only replacement as the baseline, and
2. Average cost of a gas furnace + central air conditioning (CAC) system replacement as the baseline.

Scenarios for WH analysis:

1. Average cost of a gas storage water heater replacement as the baseline, and
2. Average cost of a gas tankless water heater replacement as the baseline.

The linear fixed-effects regression models accounted for home-specific characteristics, such as square footage, to hold them constant when estimating incremental costs. Our model also considered when bids included other costs, such as those associated with electrical panel replacement work, any other electrical work, non-electrical modifications like ductwork, and permit-related costs, among others. See Appendix E for further details on our linear fixed-effects regression modeling methodology. Additionally, we used descriptive statistics (e.g., average, minimum, maximum, etc.) and plots to describe the general composition of the data.

Overall, we received 263 valid bids from 107 contractors. Of those, 188 bids were HVAC-related and 75 bids were WH-related. Three of the HVAC homes in our sample had two HVAC systems (each home had two gas-fired furnaces and two CACs), so their bids represented the cost of replacing both equipment systems at once. For the purposes of our analysis, we ran the regression models on the cost data for homes with one HVAC system and homes with two HVAC systems separately. All WH homes had only one water heater. After compiling all the cost data, we categorized the HVAC bids across five equipment types and the WH bids across three equipment types (Table 3 and Table 4).

Table 3. HVAC Bids Received by Number of HVAC Systems and Equipment Type in Phase 2

Number of HVAC Systems	Equipment Type	Number of Bids Received
1	Gas Central Furnace	39
	Gas Central Furnace + CAC	26
	All-Electric Heat Pump	85
	Heat Pump with New Furnace	12
	Heat Pump with Existing Furnace	2
	Total	**164**
2	Gas Central Furnace	0
	Gas Central Furnace + CAC	8
	All-Electric Heat Pump	8
	Heat Pump with New Furnace	8
	Heat Pump with Existing Furnace	0
	Total	**24**

Table 4. Water Heating Bids Received by Equipment Type in Phase 2

Equipment Type	Number of Bids Received
Gas Storage Water Heater	20
Gas Tankless Water Heater	24
Heat Pump Water Heater	31
Total	**75**

3.2 PHASE 3: CONTRACTOR SURVEY

In Phase 3 of the Incremental Cost Study, we collected additional bids for the same 30 homes in Phase 2 from a different sample of contractors via an online survey. Our goal was to collect cost data from 30 contractors, with each contractor providing bids for three HVAC homes or three WH homes. Their bids would be based on “packages” for each home containing photos and relevant information about the home and equipment characteristics.

The Phase 3 contractor survey provided value in terms of sample size and repeatability when the cost data across the two phases was combined. Additionally, this task served as an opportunity to ground-truth the mystery shopping contractor quotes collected in Phase 2 while increasing the volume of contractor bids. Furthermore, while it is notoriously difficult to gather cost information from contractors using traditional approaches such as surveys and in-depth interviews, this “home package” approach, along with a generous incentive, was expected to generate accurate cost information from contractors. It also provided an opportunity to hear from contractors about how to improve survey-based cost studies moving forward by detailing the critical information necessary to include in scenario descriptions.

3.2.1 HOME PACKAGES AND WEBPAGE DEVELOPMENT

The mystery shopping sites served as the foundation for developing the home packages. During the mystery shopping visits, we documented the layout of the home, took photographs, and documented the configuration of the electrical panel, the location of the HVAC or water heating system, and equipment nameplates, among other relevant information. The evaluation team then created home packages or profiles with a brief description of the home and why it required an equipment replacement, including any issues with the existing equipment. Home packages also included home characteristics, such as the number of stories, bedrooms, and bathrooms, the square footage, the year it was built, and the presence or absence of solar panels and/or batteries. They also displayed information on each home’s relevant existing equipment (e.g., both heating and cooling systems for HVAC homes), such as make and model, size, age, efficiency rating, location in the home, and current condition. Information related to the home’s electrical panel was also included in the home packages, such as panel amperage, location, presence of subpanels, and whether it had any open slots.

To facilitate contractors providing cost estimates in an online environment, we created a website for the survey that provided general information about the study and our company, and included separate webpages for each home.[9] Each webpage contained the home’s package, including all relevant photos. Contractors were able to freely navigate the study’s website but needed a passcode to access a specific home’s webpage. Each home having its own webpage enabled us to create unique links for each home, which, along with the home passcode, ensured that only the assigned contractor could access and provide bids for a given home. The home package was also available as a printable PDF

[9] https://caequipcoststudy.com/

file on the corresponding webpage, in case contractors preferred to work offline. Appendix D provides images of the website's homepage and an example of a home project page.

3.2.2 SAMPLING, OUTREACH, AND HOME ASSIGNMENTS

To develop our sample of contractors for Phase 3, we grouped the homes by geographic area and searched for contractors in those areas, ensuring that they did not participate in Phase 2. We again consulted the Switch is On website, Google, and Yelp to identify HVAC contractors and plumbers in these areas. We aimed to get a balanced sample of TECH-enrolled and non TECH-enrolled contractors. To extend the reach of the study and recruit more potential respondents, the evaluation team asked Energy Solutions, the TECH Initiative implementer, to share the Phase 3 survey opportunity with the network of TECH-enrolled contractors.

Our outreach strategy included an initial email invitation to the full contractor list, followed by a second email to a selected group invited to complete the survey, and 1–3 reminder emails to that group, encouraging participation. The initial email invitation provided information about the study and what contractors' participation would entail. We asked interested contractors to reply to our email indicating their preferred equipment type (HVAC or water heating). Our evaluation team, which had previously grouped the homes by equipment type and geographic area, randomly selected contractors out of those who had expressed interest, and assigned three homes to each contractor depending on the contractors' location. The goal was to have contractors provide bids for homes in their vicinity.

The second email, sent only to selected contractors, included links to the survey and more detailed instructions for participating. Once they accessed the survey, contractors saw links to their assigned homes' webpages and the corresponding passcodes to access them. The survey also included boxes for contractors to upload their bids for each home, the type of equipment for which we requested bids, and a few questions about the sufficiency of the information included in the home packages. Depending on each home's characteristics and existing equipment, contractors were asked to upload 3 to 4 bids per home.

The evaluation team sent the initial email to 75 contractors.[10] Overall, 39 expressed interest in participating in the HVAC component of the survey, 11 indicated they were interested in participating in the WH component, and 16 were interested in participating for either equipment type, for a total of 66 contractors expressing interest in participating in the study. Five additional contractors expressed interest in participating but did not specify which equipment they preferred. We invited a total of 40 contractors to participate (23 for HVAC homes and 17 for WH homes). Of them, 17 contractors responded to the survey and provided valid bids for their respective homes (11 for HVAC homes and 6 for WH homes) (see Table 5).

Table 5. Phase 3 Contractors by Equipment Type and TECH Initiative Enrollment Status

Equipment type	Contractors Selected to Participate			Contractors Who Completed the Survey		
	TECH-Enrolled	Non TECH-Enrolled	Total	TECH-Enrolled	Non TECH-Enrolled	Total
HVAC	14	9	**23**	6	5	**11**
Water Heating	10	7	**17**	4	2	**6**
Total	**24**	**16**	**40**	**10**	**7**	**17**

At the end of the fielding period, the evaluation team emailed the contractors who had expressed interest but were not selected, thanking them for their willingness to participate.

[10] This number does not include those contractors to whom Energy Solutions reached out directly.

3.2.3 SURVEY PRE-TESTING AND FIELDING

We pre-tested the survey with one HVAC contractor to ensure the structure of the survey and the instructions provided in the email invitation and survey language itself were clear and straightforward. We asked the contractor to take the survey (without actually providing bids) while being on the phone with our team, sharing their screen, and walking through their thinking process aloud. Using the feedback from this contractor, we made small adjustments to the survey. For their time and valuable contribution, we offered the contractor a $100 incentive. Our team reached out to several WH contractors to pre-test the survey, but we did not receive any other responses.

The Phase 3 survey was in the field between April and May 2025. Contractors who completed the survey and uploaded valid bids for each requested home project received an incentive of $500.

3.2.4 ANALYSIS

We analyzed the data collected in Phase 3 of the Incremental Cost Study at the contractor, bid, and home level.

CONTRACTOR-LEVEL DATA

In addition to providing information on the bids they uploaded for each of their homes, respondents ranked the level of sufficiency of the information and images provided on each home's webpage. Contractors were also able to write optional comments regarding the data or information about the home that they would have liked to know to provide more accurate bids.

To analyze this data, we ran descriptive statistics, including frequencies and cross-tabulations, and compared responses between TECH-enrolled and non TECH-enrolled contractors where relevant. As in Phase 2, we conducted separate analyses for HVAC and WH homes and analyzed trends across variables, including whether the contractors recommended backup heating with their heat pump bids, and whether additional modifications were required for heat pump installation.

At the home level, we calculated an average sufficiency score for each home to determine whether any homes' webpages lacked sufficient information, hindering contractors' ability to estimate an accurate project cost. We also analyzed open-ended responses collected through the survey to gain further insight into which pieces of information would have been most helpful to include in the homes' packages to increase the accuracy of their bids.

COST DATA

We extracted all the bid data from the files uploaded by contractors through the survey and compiled it into a database to facilitate the analysis and comparison with Phase 2 results. As with the Phase 2 analysis, we primarily analyzed differences in total project costs across equipment types, given that most contractors did not provide itemized bid estimates, splitting out equipment, labor, and other costs.

For the cost data analysis, we employed the same linear fixed-effects regression modeling method as in Phase 2 to estimate the incremental cost of heat pump upgrades over like-for-like replacements. We looked at the same two scenarios for each equipment type and analyzed the Phase 3 cost data on its own and in aggregation with the Phase 2 cost data.[11]

When analyzing the combined cost data from the two phases, we distinguished between bids collected in Phase 2 and Phase 3 in our aggregated regression models to control for the fact that the data were collected using two different methods. In doing so, we were able to compare costs from estimates received in each phase. See Appendix E for further details on our linear fixed-effects regression modeling methodology. Additionally, we used descriptive statistics (e.g., average, minimum, maximum, etc.) and plots to describe the general composition of the data.

Overall, we received 159 valid bids from 19 contractors in Phase 3. Of them, 114 bids were HVAC-related, and 45 bids were WH-related. We categorized the HVAC bids across four equipment types (no Phase 3 contractors provided bids that kept the home's existing furnace), and the WH bids across three equipment types (Table 6 and Table 7). Same as for Phase 2, we analyzed the cost data for homes with one HVAC system and homes with two HVAC systems separately.

Table 6. HVAC Bids Received by Number of Systems and Equipment Type in Phase 3

Number of HVAC Systems	Equipment Type	Number of Bids Received
1	Gas Central Furnace	12
	Gas Central Furnace + CAC	25
	All-Electric Heat Pump	53
	Heat Pump with New Furnace	9
	Total	**99**
2	Gas Central Furnace + CAC	5
	All-Electric Heat Pump	10
	Total	**15**

Table 7. Water Heating Bids Received by Equipment Type in Phase 3

Equipment Type	Number of Bids Received
Gas Storage Water Heater	14
Gas Tankless Water Heater	14
Heat Pump Water Heater	17
Total	**45**

3.3 STUDY LIMITATIONS

The Phase 2 mystery shopping exercise was a valuable method to collect heat pump project costs as well as hear and assess the information California customers hear from contractors in real time. We aimed to collect data across different climate zones and geographic regions in California to cover diverse sociodemographic populations of customers and contractors and capture as accurate a representation of the market as possible. However, with this type of study come some limitations. The convenience sample meant that the homes selected for the study were, in some cases, concentrated in the same geographic region, with similar climate conditions (e.g., eight homes were located in

[11] HVAC: (1) average cost of a gas furnace-only replacement as the baseline, (2) average cost of a gas furnace + CAC system replacement as the baseline; WH: (1) average cost of a gas storage water heater replacement as the baseline, (2) average cost of a gas tankless water heater replacement as the baseline.

San Diego County). Additionally, because of timing, budget, and staff availability considerations, we had multiple mystery shoppers in our study, 13 in total, instead of just one or two. We provided training materials and scripts to all mystery shoppers to standardize interactions to the greatest extent possible; however, having multiple staff interacting with contractors may have impacted the consistency across those interactions, which could be reflected in the bids we received.

Our Phase 3 study had different limitations. This was an online survey with links to a separate website, which included images and other materials. This meant that contractors needed a reliable internet connection to access the survey. To mitigate this limitation, our team included a printable PDF containing all the information for a given home inside the home's webpage, which meant that contractors could print out that document and didn't need to be online the whole time while preparing the bids. Finally, as with similar surveys trying to collect cost data, it is challenging to provide all the information contractors need to provide accurate cost estimations. To attenuate this limitation, we provided photos and schematics of the home to help contractors visualize the physical characteristics of the site. Better understanding the type of information contractors need to provide accurate bids was precisely an objective of this survey.

In terms of the cost data collected across these two phases, the fielding timeline for each effort was separated by several months (~nine months). This timing means that the differences in costs identified could not only be influenced by the data collection method, but also by changes in the market in those nine months.

4. HVAC FINDINGS

In this section, we discuss detailed findings related to the 20 HVAC homes from Phase 2 of the Incremental Cost Study.

4.1 HOMES CHARACTERIZATION

The 20 HVAC homes we used for Phase 2, and which supported Phase 3, were spread throughout the state—10 homes were in the hot-dry climate region, nine were in the marine climate region, and one was in the cold climate region. Most homes were between 1,000 and 3,000 square feet, with only one home larger than 3,001 square feet. We prioritized homes with older equipment to make the replacement scenario realistic, and most of the homes had systems older than 15 years. Homes were split on whether they had solar photovoltaic (PV) systems, and five homes had electrical panels with no open slots. Table 8 summarizes HVAC homes' characteristics (see Appendix C for additional details for each home).

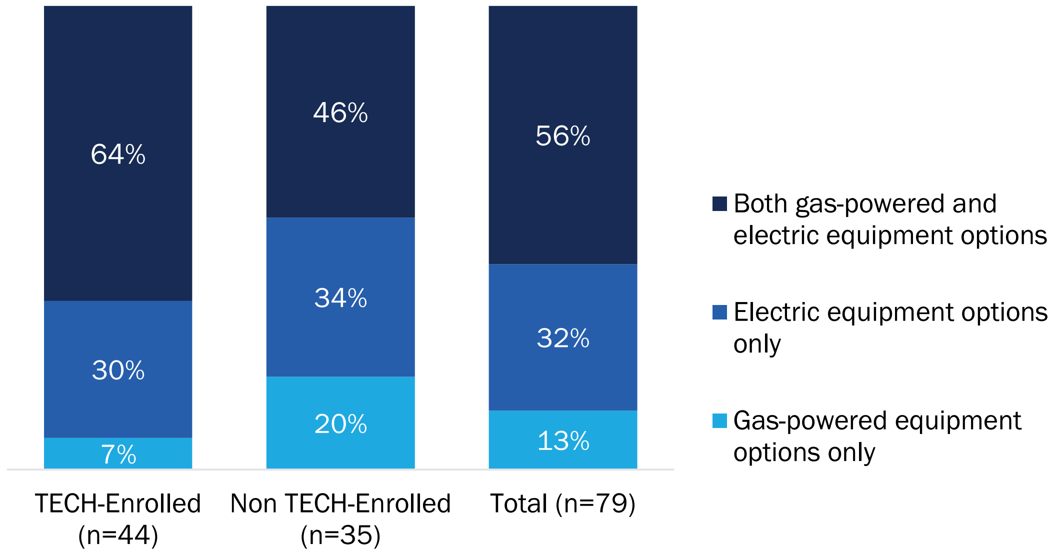
Table 8. HVAC Homes' Characteristics (n=20)

Category	Count of Homes
Square Footage	
501 to 1,000 sq. ft	0
1,001 to 2,000 sq. ft	11
2,001 to 3,000 sq. ft	8
3,001 to 4,000 sq. ft	1
Age of HVAC Equipment	
Under 5 years old	2
5-9 years old	0
10-14 years old	2
15 years or older	16
Number of Systems	
One	17
Two	3
Electrical Panel Status	
With any open slots	15
No open slots	5
Presence of Air Conditioning	
Yes	12
No	8
Presence of Solar PV	
None	11
PV (no battery)	8
PV + battery	1
Climate Zone and Region	
2 (Marine)	1
3 (Marine)	4
6 (Marine)	4
7 (Hot-Dry)	3
8 (Hot-Dry)	1
10 (Hot-Dry)	3
12 (Hot-Dry)	2
13 (Hot-Dry)	1
16 (Cold)	1

4.2 EQUIPMENT OPTIONS DISCUSSED

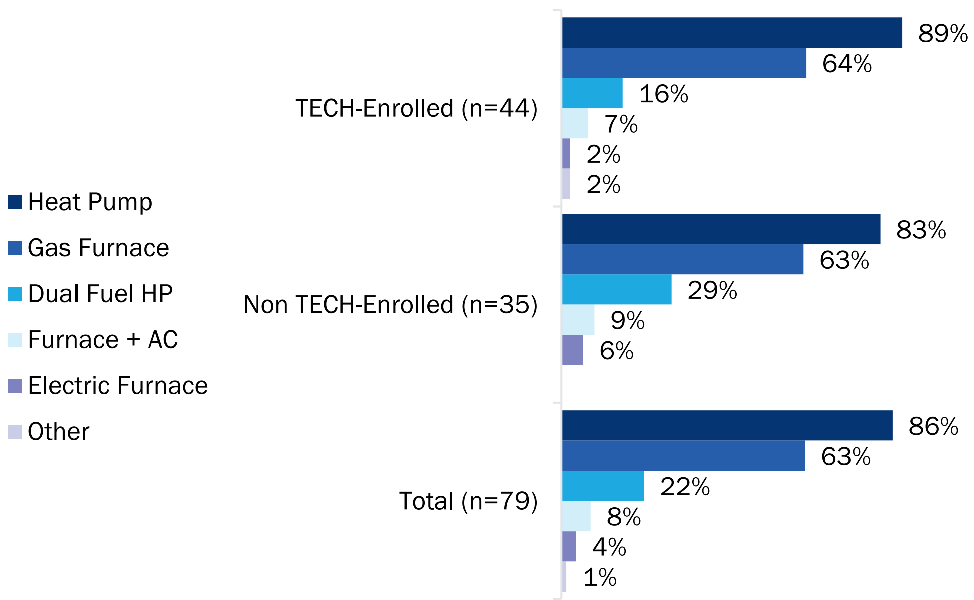
More than half of HVAC contractors (44 of 79; 56%) voluntarily offered both gas-powered and electric equipment to replace the home's existing heating system (Figure 2). About a third of contractors (25 of 79; 32%) recommended only electric equipment without being prompted, while fewer contractors (10 of 79; 13%) offered only gas-powered equipment options. TECH-enrolled contractors are more likely to recommend both gas-powered and electric equipment as replacement options, while non-TECH-enrolled contractors are more likely to offer gas-powered equipment options only.

Figure 2. Fuel Options Contractors Voluntarily Offered to Replace HVAC Equipment



Of all equipment options discussed between HVAC contractors and mystery shoppers, heat pumps were discussed most frequently (68 of 79; 86%), followed by gas furnaces (50 of 79; 63%) (Figure 3). Contractors were similarly likely to discuss these two equipment options regardless of their enrollment in the TECH Initiative. Dual fuel heat pumps were the third most common equipment type mentioned by contractors, with about one-fifth (17 of 79; 22%) discussing these hybrid heat pump and gas furnace systems. Contractors not enrolled in the TECH Initiative mentioned these dual fuel heat pump systems about twice as often (10 of 35; 29%) as TECH-enrolled contractors (7 of 44; 16%).

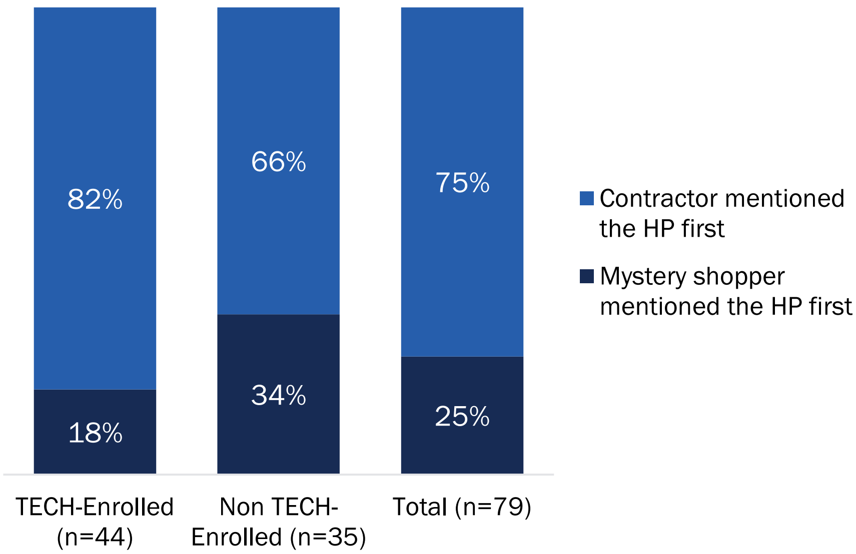
Figure 3. All HVAC Equipment Options Discussed Between Mystery Shoppers and Contractors



Note: Multiple responses were allowed.

Three-quarters of contractors (59 of 79; 75%) brought up HVAC heat pumps first before the mystery shopper mentioned them. TECH-enrolled contractors were more likely to mention HVAC heat pumps voluntarily, on their own (36 of 44, 82%) compared to their non-enrolled counterparts (23 of 35, 66%) (Figure 4).

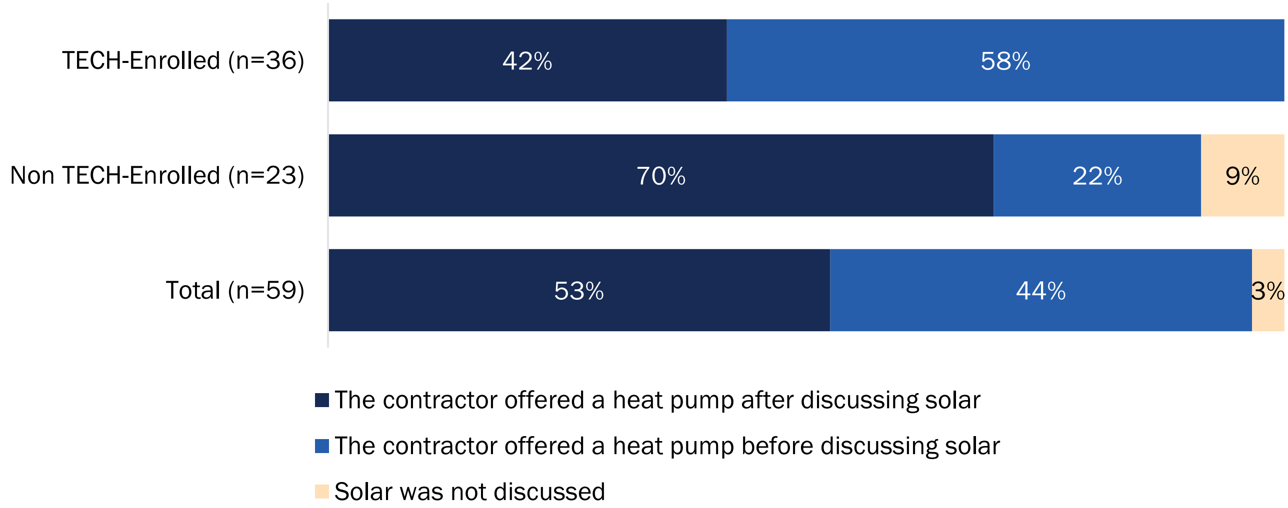
Figure 4. Who Brought Up a Heat Pump as an Option First?



Among HVAC contractors who brought up heat pumps first, about half (31 of 59; 53%) brought them up after discussing the presence of rooftop solar or the homeowner's intention to install it (Figure 5).[12] A greater proportion of non-TECH contractors (16 of 23; 70%) mentioned the heat pump only after discussing solar, compared to TECH-enrolled contractors (15 of 36; 42%). Given that heat pumps run on electricity, a customer's interest in adding solar should make this option more appealing. Since the non-TECH contractors required more prompting to suggest heat pumps, this suggests that TECH Clean California participation may influence contractor recommendations toward cleaner technologies.

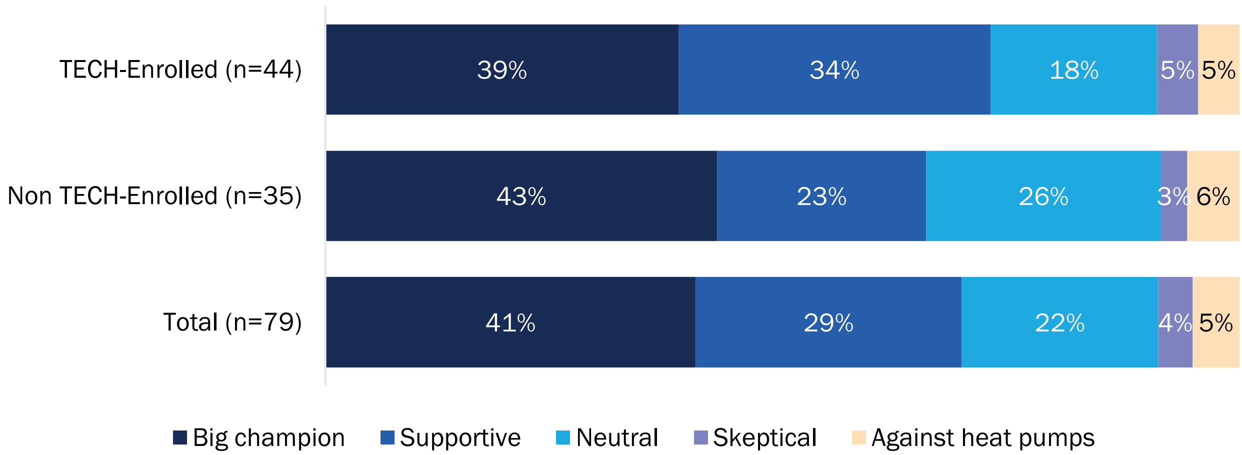
[12] Mystery shoppers were told to express an interest in installing solar in the home if the home did not already have it to see if that mention prompted the contractor to offer a heat pump option. In two cases, the mystery shopper did not have an opportunity to mention solar during the interaction with the contractor.

Figure 5. Did the Contractor Bring Up a Heat Pump Before or After Discussing Solar?



Most HVAC contractors were big champions (32 of 79; 41%) or supportive (23 of 79; 29%) of heat pumps based on their interactions with mystery shoppers. Only 9% of contractors (7 of 79) were skeptical or against heat pumps; while the remaining 22% of contractors seemed to be neutral when it came to this technology (Figure 6). The mystery shoppers judged the contractors' attitudes based on whether the contractor tried to steer the mystery shopper away from heat pumps, presented pros and cons equally, or promoted the technology. We discuss further details about the benefits and concerns contractors mentioned to mystery shoppers in later sections of the report.

Figure 6. Contractors' Attitudes Towards HVAC Heat Pumps



4.3 ADDITIONAL WORK FOR HEAT PUMPS

Installing an HVAC heat pump sometimes requires additional work in the home to accommodate it. This additional work can be related to the home's electrical panel, involve other electrical modifications, or involve the ductwork and flue.

In the sample of 20 HVAC homes, contractors indicated that some type of modification was needed in every home as part of the HVAC heat pump installation. For 16 of the 20 homes (80%), at least one contractor reported that electrical upgrades such as wiring and adding outlets would be necessary before installing a heat pump. A panel upgrade or replacement was necessary in three homes (15%). Additionally, at least one contractor recommended non-electrical modifications in 19 of the 20 homes (95%). We explain the home modifications in more detail below.

4.3.1 ELECTRICAL PANELS AND OTHER ELECTRIC WORK

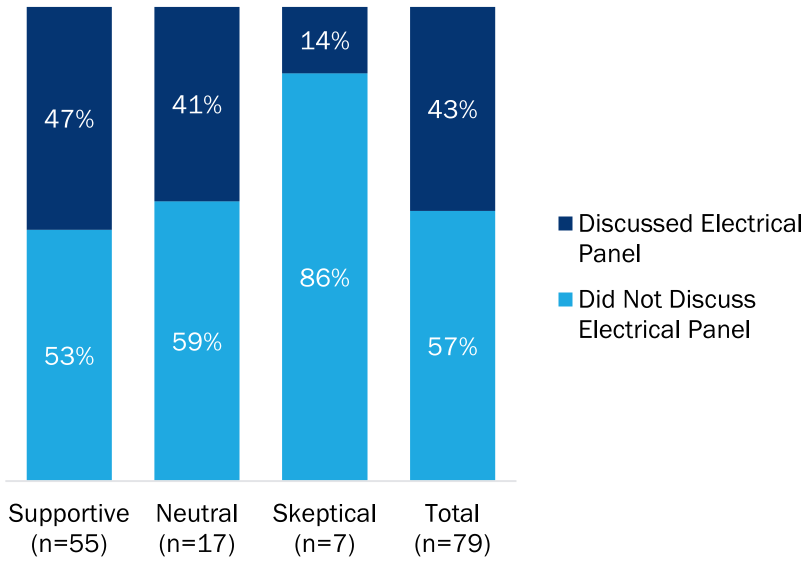
Most HVAC contractors (57 of 79; 72%) inspected the adequacy of the wiring, electrical panel capacity/space, and/or service capacity during their visit. Nearly half of the HVAC contractors (34 of 79; 43%) indicated that the home would need electrical upgrades to accommodate a heat pump, such as wiring, outlets, or panel upgrades. About one-quarter (18 of 79; 23%) said they would need to install new wiring, such as running 220V lines from the electrical panel to the heat pump's indoor or outdoor units or replacing damaged wiring.

Despite most investigating the electrical system, less than half of HVAC contractors (34 of 79; 43%) discussed the electrical panel with mystery shoppers during their visit. Of these 34 contractors, ten (29%) were at homes with no open slots in the panel, while the remaining 24 (70%) were at homes that had available panel capacity. These discussions did not necessarily indicate that an upgrade was needed; in many cases, contractors noted that the existing electrical panel had sufficient capacity. In fact, only three contractors who discussed electrical panels (9%) mentioned that the existing panel would need to be optimized to accommodate the additional load from the heat pump system. Only one contractor (3%) noted that a full electrical panel replacement would be necessary due to insufficient electrical capacity. All four of these contractors were at homes where the panel had no open slots. A few other contractors (3 of 34; 9%) suggested that the homeowner should consider upgrading their electrical panel in the future because it was either old or small—two contractors were at homes with available panel capacity, while one contractor was at a home without any open slots in the electrical panel.

Contractors with supportive and neutral attitudes towards heat pumps were more likely to discuss the electrical panel with mystery shoppers than contractors who were skeptical of heat pumps (Figure 7).[13] Over two-fifths of contractors who were supportive of heat pumps or neutral toward them discussed electrical panel upgrades (47% and 41%, respectively), compared to 14% of contractors who were skeptical of heat pumps.

[13] For this analysis, we collapsed the previously presented categories describing contractors' attitudes towards heat pumps as follows: "supportive" and "big champion" are collapsed within "supportive"; "skeptical" and "against" are collapsed into "skeptical"; "neutral" remains unchanged.

Figure 7. Electrical Panel Discussions by Contractor Attitude Toward Heat Pumps

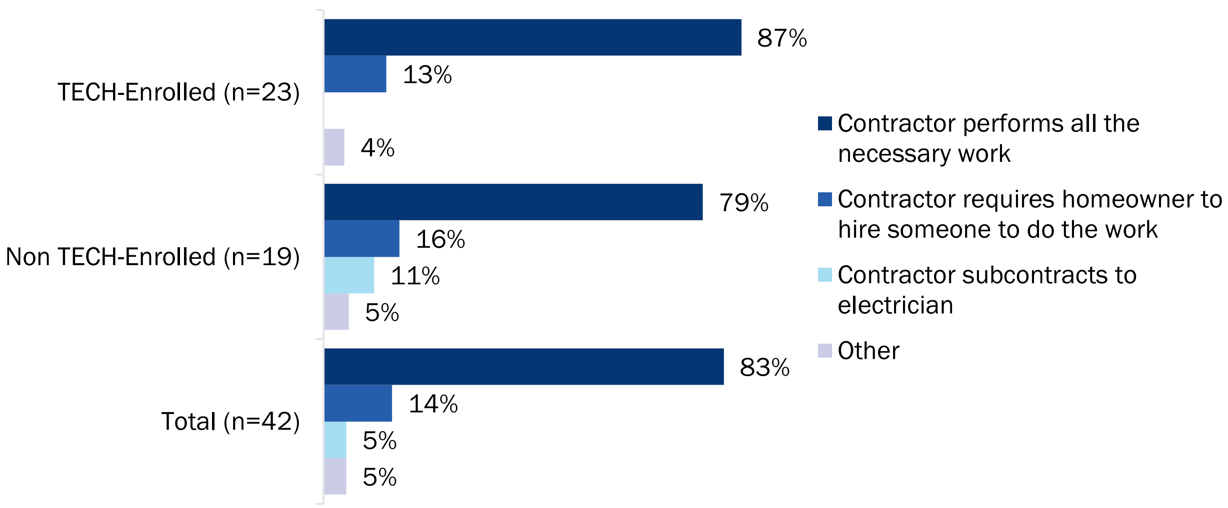


When electrical modifications were needed in the home in order to install a heat pump, mystery shoppers asked if the heat pump contractor could perform those upgrades or modifications, or if the homeowner would need to hire an electrician. We investigated this component of heat pump projects because of the way the California Contractor State Licensing Board (CSLB) authorizes different trades to perform incidental electrical work. Specialty contractors, such as C-20 HVAC contractors and C-36 plumbers, may only perform incidental or supplemental work in other trades, not work that requires a separate license classification. For example, incidental/supplemental electrical work may include running new wiring or installing an additional outlet, but it does not extend to replacing or upgrading an electrical service panel. So, a heat pump installation that requires replacing or upgrading an electrical service panel can only be completed under a single contract by one of the following: (1) a B-General Building Contractor; (2) a contractor holding multiple specialty licenses, including the appropriate heat pump license and a C-10 Electrical Contractor license; or (3) two specialty contractors operating under a CSLB-issued Joint Venture License. Importantly, a specialty contractor cannot subcontract with another specialty contractor; for example, a C-20 HVAC contractor cannot subcontract with a C-10 electrical contractor. Given these regulations, we examined how contractors navigate and comply with these rules.

A majority of the HVAC contractors who investigated the home's electrical condition or mentioned needed electrical upgrades (35 of 42; 83%) indicated they were able to complete the necessary work themselves. A minority (6 of 42; 14%) required the homeowner to hire someone to do the work, while two (5%) indicated they would subcontract to an electrician (Figure 8).[14]

[14] 15 contractors did not specify who would do the electrical work, and were excluded from the analysis.

Figure 8. Who Completes the Necessary Electrical Work?



Note: Some contractors offered the mystery shopper more than one option, which is why the numbers in each group do not sum to 100%. Responses in this analysis represent the 42 contractors who investigated the home's electrical condition or mentioned that electrical upgrades were needed.

4.3.2 Other Home Modifications

Almost half of the contractors (36 of 79; 46%) discussed with mystery shoppers non-electric modifications they recommended for the home to accommodate the heat pump. Most of these modifications focused on ductwork (24 of 36, or 66%), which three-quarters of all contractors (58 of 79; 73%) inspected. Five contractors (6%) expressed concerns about making changes to the ductwork due to the potential presence of asbestos. They noted that older homes might have asbestos in the ducts, which could complicate repairs or replacements. In these cases, some contractors recommended leaving the ducts undisturbed to avoid the costs and regulatory issues associated with asbestos removal. When the existing ducts were deemed inadequate, some contractors suggested replacing or rerouting the ductwork to ensure optimal performance, particularly in the upper levels of the home. Several contractors also mentioned that mini-split systems were often a more suitable alternative when the ductwork was poorly configured or difficult to upgrade.

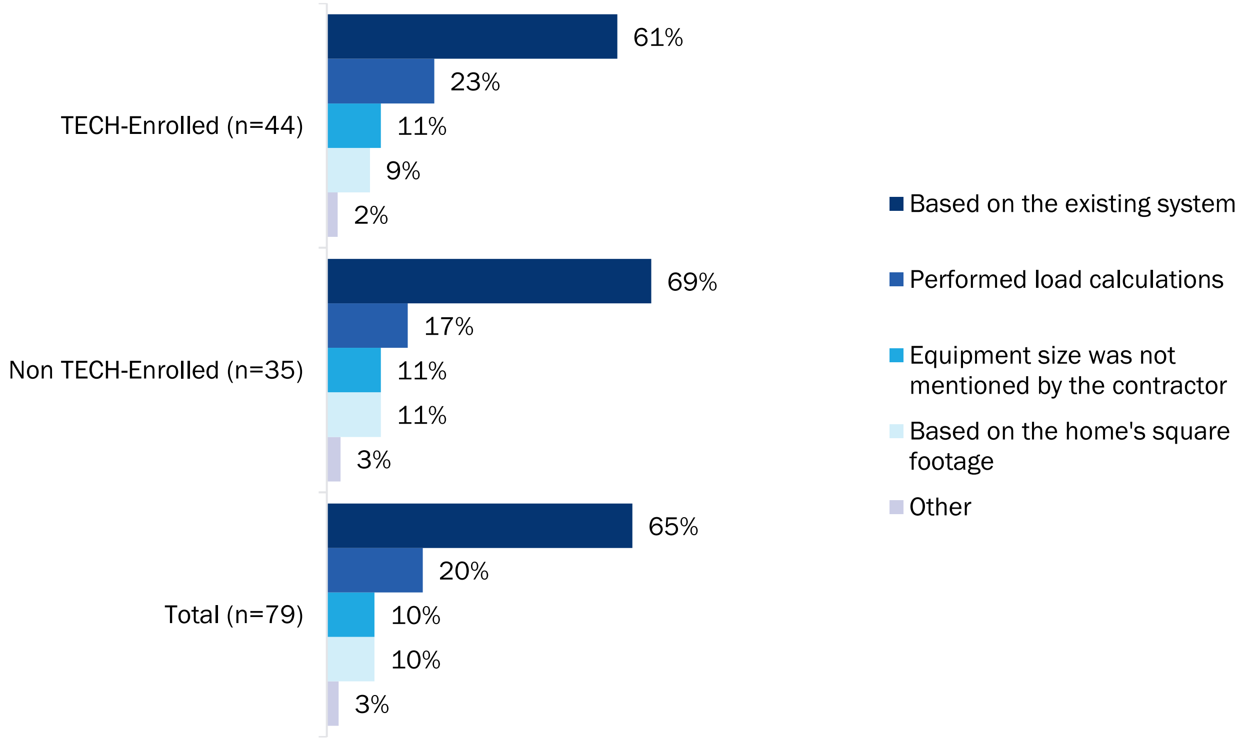
Other non-electrical upgrades mentioned by contractors included modifying refrigerant lines (7 of 79; 9%), building envelope improvements, and modifications associated with relocating the new system. Some contractors indicated that the existing refrigerant lines could be reused as long as they did not leak, but if repairs were necessary, the cost would be around $350. Five contractors (6%) stressed the importance of building shell upgrades, especially insulation and air sealing, to enhance system efficiency, warning that without proper insulation, the heat pump's effectiveness could be compromised. Finally, three contractors (4%) noted that altering the indoor or outdoor unit locations might be necessary, potentially involving work like opening walls, replastering, and painting.

4.4 CONTRACTOR SIZING PRACTICES

As part of the contractors' assessment of the adequacy of the current systems, most contractors (71 of 79; 90%) asked the mystery shopper about any issues with the existing heating system, and nearly all contractors (76 of 79; 96%) inspected it. By inspecting existing systems, contractors gather useful context for replacement decisions, such as equipment sizing. Proper sizing of HVAC heat pump systems is essential to ensure occupants receive the expected thermal comfort and that the systems deliver the energy performance specified by manufacturers. Manual J load calculations are the recognized method for sizing HVAC heat pumps because they systematically estimate heating and cooling loads based on building characteristics. In practice, however, they can be time-consuming, sensitive to input assumptions, and prone to oversizing when contractors add safety margins or use simplified approaches. The mystery shopping visits offered an opportunity to assess contractor sizing practices, to see if they used the robust Manual J protocol or if they used a quicker approach, sizing the new system off of the existing system.

Two-thirds of contractors (51 of 79; 65%) determined the size of their suggested equipment based on the home's existing system, while one-fifth (16 of 79; 20%) performed load calculations (Figure 9). A few contractors (8 of 79; 10%) based the size of the recommended equipment on the home's square footage, while the same proportion did not discuss equipment size with the mystery shopper. Several contractors (9 of 79; 11%) noted limitations on the size of new equipment beyond simply matching the existing system, with some citing tight duct systems (6 of 79; 8%). In one instance, a contractor observed that the ducts could accommodate a larger system than the current one, but such an upgrade would require an upgrade to the electrical panel.

Figure 9. Method Contractors Used to Determine Sizing of Suggested Equipment



Note: Multiple responses were allowed.

4.5 BACKUP HEATING

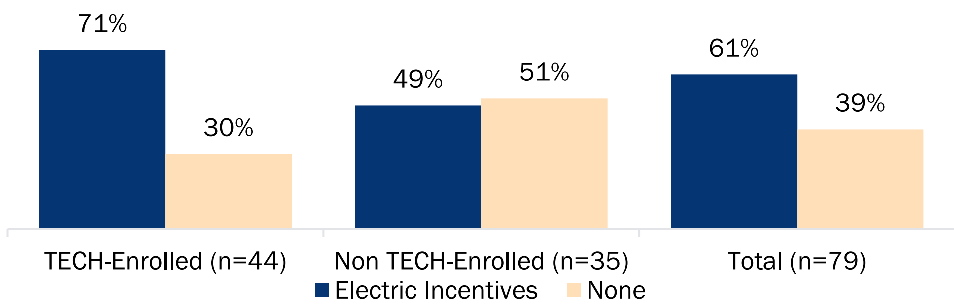
Heat pumps may require supplemental heating to adequately warm a home on very cold days. Some models include built-in electric resistance heat strips, while others allow them to be added, and contractors may also recommend retaining the existing furnace as backup. However, based on both the mystery shopping visits and the contractor survey, only 20% of contractors recommended supplemental heating in their heat pump bids. All but one of those contractors recommended keeping the original gas furnace, while one contractor recommended a new high-efficiency gas furnace as backup. **Several of these contractors recommended leaving the gas furnace as backup heating due to energy cost considerations (6 of 79; 8%) and climate factors (4 of 79; 5%).** Given high electricity rates, four contractors (5%) emphasized that using a heat pump for heating and cooling until a specific temperature was reached, after which the gas furnace kicked in, could be more cost-effective. Three contractors (4%) also mentioned that dual fuel systems are a good way to take advantage of fluctuating energy prices.

During the mystery shopping visits, contractors recommended the gas furnace as back-up heating over installing an electric heat strip in the heat pump. While several contractors (7 of 79; 9%) discussed installing a heat strip in the heat pump as backup heating in cold climate conditions, they also generally expressed hesitation about it due to high costs and technical challenges. Of those seven contractors, five noted that installing the necessary 220V circuits to power the electric heat strip would require significant electrical work, such as running new wiring to the attic of the home, making it an expensive and cumbersome project. Two contractors also mentioned that using a heat strip as backup heating can be inefficient, particularly when it activates during temperature swings.

4.6 INCENTIVES

Just over half of the contractors offered the mystery shopper electric incentives, rebates, or tax credits (48 of 79; 61%) without any prompting (Figure 10). No contractors offered incentives for gas equipment options. TECH-enrolled contractors were more likely to bring up incentives, rebates, or tax credits for electric equipment compared to non TECH-enrolled contractors. Almost three-quarters of TECH-enrolled contractors (31 of 44; 71%) brought up electric incentives on their own, while about half of non TECH-enrolled contractors (17 of 35; 49%) did the same.

Figure 10. Did Contractors Mention Incentives on Their Own?



After being prompted by the mystery shopper, an additional 23 contractors, 11 TECH-enrolled (25%) and 12 non TECH-enrolled (34%), mentioned electric incentives. Still, no contractors mentioned gas incentives. **The two most common**

types of incentives mentioned by contractors were tax credits (48 of 71; 68%) and TECH Clean California (34 of 71; 48%) as shown in Table 9.

Table 9. Incentives Discussed by Contractors for HVAC Equipment (n=71)

Incentive Discussed	Number of Contractors Who Discussed Each Incentive	Percent
Tax credits (Electric)	48	68%
TECH Clean California	34	48%
Los Angeles Department of Water and Power (LADWP)	3	4%
Manufacturer	4	6%
Sacramento Municipal Utility District (SMUD)	4	6%
Pacific Gas and Electric (PG&E) (Electric)	3	4%
Peninsula Clean Energy (PCE)	2	3%
Comfortably CA	3	4%
Inflation Reduction Act (IRA)	1	1%
Bay Area Regional Energy Network (BayREN)	1	1%
Other (Electric)	8	11%
Mystery Shopper Unsure about Specific Incentive	5	7%

Note: Responses among contractors who discussed incentives at all. Multiple responses were allowed.

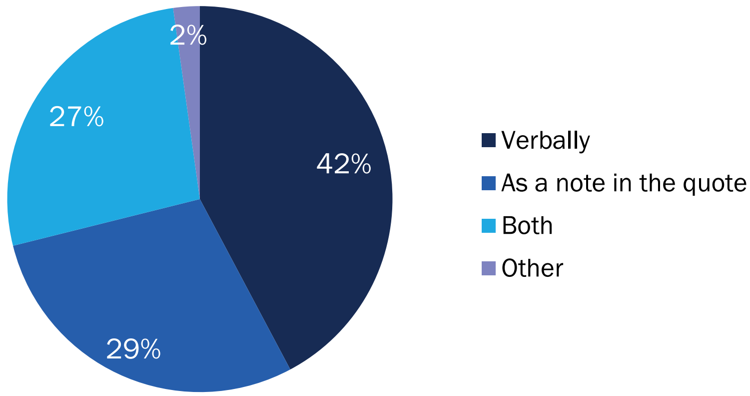
4.7 PERMITS

About half of the HVAC contractors (43 of 79; 54%) mentioned permits or HERS raters when discussing the project with mystery shoppers. The quotes for permits and HERS/energy testing varied widely in Phase 2, with contractors offering prices ranging from $320 to $1,500. There was also variability in contractors' messaging around permit requirements. Some contractors (6 of 79; 8%) indicated that permits were not required. In contrast, 14 contractors (18%) stated that permits were necessary, and another four (5%) specified that permits were needed to qualify for incentives or rebates. One contractor mentioned that they do not recommend pursuing an incentive through the TECH Initiative because it requires extensive testing, permits, and inspections, which could cost up to $2,500, depending on the home's needs. Another contractor mentioned that about half of their customers go through the permit process, quoting $1,500 for inspections, testing, city involvement, and related services. Additional quotes from contractors about permits indicated that the contractor typically "assumed the homeowner is getting the permit, but wink wink, they don't always do that" or that the homeowner should not get a permit, as it could "trigger a whole slew of house renovations to bring it to code."

4.8 FINANCING

Over half of the HVAC contractors (45 of 79; 57%) offered financing options to the mystery shopper. Among contractors who offered financing options (45 in total), about half (24; 53%) provided zero-interest payment plans ranging from 6 to 36 months. Five contractors (11%) mentioned financing through a "Go Green Home" loan, with interest rates of 4–6% depending on loan length. Financing options were most often discussed verbally with the mystery shopper (19; 42%), though nearly one-third (13; 29%) included details in their written quotes (Figure 11). About one-quarter (12; 27%) both discussed financing verbally and included it in their quotes.

Figure 11. How Did Contractors Offer Financing Options? (n=45)



Note: Responses among contractors who offered financing options.

4.9 KITCHEN TABLE CONVERSATION

During contractors' visits, mystery shoppers recorded contractors' attitudes toward HVAC heat pumps, including details about the benefits and concerns they bring up when discussing this technology.

4.9.1 HVAC HEAT PUMP BENEFITS

The majority of contractors (59 of 79; 75%) mentioned at least one benefit associated with heat pumps, including thermal comfort, energy efficiency, or home electrification. Over one-third of contractors (31 of 79; 39%) highlighted the indoor comfort benefits of heat pump systems, particularly in terms of both thermal comfort and quiet operation. When it comes to thermal comfort, 11 contractors (14%) emphasized that heat pumps provide both heating and cooling, making them a good option for year-round comfort, with four contractors (5%) specifically mentioning the added benefit of cooling over a central gas furnace. Several contractors (6 of 79; 8%) noted that heat pumps offer more even temperatures throughout the home, reducing fluctuations common in traditional natural gas or electric resistance systems. Additionally, 2 contractors (3%) also pointed out that heat pumps maintain a more comfortable humidity level, avoiding the dry air often associated with gas heating. In terms of its quiet operation, 13 contractors (16%) mentioned that heat pumps operate more quietly than older systems, creating a more relaxing environment.

Many contractors emphasized the energy efficiency benefits of heat pumps, with one-third of contractors (24 of 79; 30%) highlighting how they outperform traditional gas systems. One contractor noted that heat pumps are three times more efficient than gas furnaces, and others pointed out the added efficiency of variable-speed heat pumps, which offer more precise temperature control and use less energy than conventional gas systems. These units can achieve SEER ratings as high as 18, compared to the typical 13.4 SEER of traditional air conditioners, leading to lower energy consumption and reduced utility bills.

Several contractors (6 of 79; 8%) also noted that heat pumps are an efficient all-electric option, aligning with the growing trend of moving away from gas-based systems. While one contractor described people aiming for zero carbon emissions as a small, "extreme" group, others emphasized the broader appeal of electric systems, particularly for homeowners concerned about indoor air quality. Two contractors (3%) specifically highlighted the benefits for individuals with respiratory concerns like asthma. Additionally, five contractors (6%) noted that recent regulations require all new gas furnaces to be ultra-low NOx, a feature they described as “unreliable” and “rushed to market,” further strengthening the case for switching to all-electric heat pumps. Four contractors (5%) also framed heat pumps as a “clean” or “green” option, contributing to sustainability trends.

Finally, seventeen contractors (22%) pointed out that the benefits of electrification and energy efficiency are greatly enhanced when combined with solar power. Of these contractors, the majority (12 of 17; 71%) visited homes without existing solar and they often framed heat pumps as a worthwhile investment only when paired with solar. One of these contractors told the mystery shopper that a heat pump would be a “no brainer” if they were considering installing solar in the future. Heat pumps are particularly advantageous for homeowners who already have or plan to install solar systems, as solar energy can offset the heat pump’s energy usage and significantly lower operational costs.

4.9.2 HVAC Heat Pump Concerns

Fewer contractors (40 of 79; 51%) mentioned concerns about HVAC heat pumps, which included performance in cold temperatures, space requirements, and reliability. The most common concern among contractors was related to challenges with the heating performance of HVAC heat pumps (24 of 79; 30%), specifically their slower heating times, limited output of hot air, and effectiveness in colder climates. Nine contractors (11%) noted that heat pumps take longer to heat a home compared to traditional gas furnaces. Gas furnaces can quickly blast hot air into the home, while heat pumps rely on extracting heat from the outside air, which can be a slower process, especially in colder weather. As a result, five contractors (6%) noted that heat pumps often deliver cooler air than gas furnaces, which may feel less comfortable to individuals accustomed to higher supply-air temperatures. Additionally, several contractors (4 of 79; 6%) highlighted that heat pumps may struggle to provide sufficient warmth when temperatures fall below 30 degrees Fahrenheit, and some contractors even cautioned against relying solely on heat pumps as a heating source in such conditions. One mystery shopper shared that even after they brought up cold-climate heat pumps, the contractor said he “wouldn’t install a heat pump as the sole heating source.”

Eleven contractors (14%) also expressed concerns about the placement of heat pump units and their space requirements. Some contractors cited concerns about placing the indoor unit in areas with limited space, which could necessitate additional work and installation costs. Contractors also highlighted challenges with outdoor unit placement, particularly related to permitting issues in areas with special jurisdiction rules that limit expanding the home’s footprint. As a result, the outdoor unit may need to be placed in less-than-ideal locations, such as under a deck with insufficient vertical clearance or near a neighbor's home, where the noise could be problematic. Four contractors (5%) mentioned concerns with noise, and one said that the mystery shopper’s specific location had a noise ordinance that no heat pump unit compressor could pass.

Finally, five contractors (6%) raised concerns about the reliability of heat pumps, citing their perceived shorter lifespan and higher maintenance needs compared to traditional systems. One contractor noted that heat pumps typically last 10-12 years, whereas gas furnaces and air conditioners can last 15-20 years. Another contractor explained that this reduced longevity is because heat pump compressors are used year-round for both heating and cooling, unlike gas furnaces and CAC systems, which are seasonal. Additionally, one contractor highlighted the complexity of heat pump systems, suggesting that their increased maintenance requirements and lower reliability could be a concern, particularly for those looking for a more dependable, low-maintenance option.

4.9.3 Contractors’ Perspectives on Cost

Contractors’ opinions on the cost of heat pumps compared to traditional gas furnaces and the combination of a gas furnace and CAC systems were mixed. While one-third of contractors (25 of 79; 32%) identified heat pump costs as a benefit, nearly the same proportion (22 of 79; 28%) identified heat pump-associated costs as a concern. While opinions were mixed on the operating and installation costs for heat pumps, contractors were neutral on the upfront equipment cost. One contractor said, "A heat pump is only $750 more than a gas furnace in terms of upfront costs, but it's really gas rates and electric rates that I need to be concerned about." Other contractors said that the equipment costs between a heat pump and a gas furnace were "comparable," and that rebates and incentives made the cost of heat pumps the same or even less than gas systems.

While the equipment cost was not a major concern for contractors, nearly one-quarter of contractors (18 of 79; 23%) noted that the heat pump's upfront costs could be higher than traditional gas systems, depending on upgrades required for installation, which could add thousands to the overall cost. These contractors often emphasized the additional electric work required to install a heat pump, such as running 220V power lines or upgrading the electrical panel. One contractor noted that one-third to half of the cost of a heat pump installation would be from the electrical work alone. Another contractor said that electrical work alone could cost up to $1,200, while a third contractor highlighted that upgrading to a larger electrical panel could cost an additional $8,000 and take several months to complete. Additionally, non-electrical upgrades such as ductwork or insulation also add to the installation costs. One contractor noted that the indoor air quality improvements needed, including replacing duct boards, would be about $800-$1,500. One of our mystery shoppers shared, "[the contractor] mainly focused on the cost of the system. Overall, it felt like he was trying to steer me away from a HP after he saw the ducts, which was surprising. I had to insist that I wanted to go electric to get him to give me the all-electric HP option."

Contractors felt that the potential savings on heat pump operating costs depended on several factors, including electricity rates, solar availability, and system configuration. Over one-quarter of contractors (23 of 79; 29%) highlighted that heat pumps can lead to lower operating costs when paired with solar power. Furthermore, several contractors (7 of 79; 9%) warned that without solar, electricity costs for heating could actually be significantly higher than the cost of gas heating, and a few (5 of 79; 6%) noted that this was particularly true in regions with high electricity rates, such as PG&E service territory. Three contractors recommended that a backup system, such as a gas furnace, could mitigate this issue, noting that the homeowner could choose between electric or gas power depending on which is more cost-effective at the time.

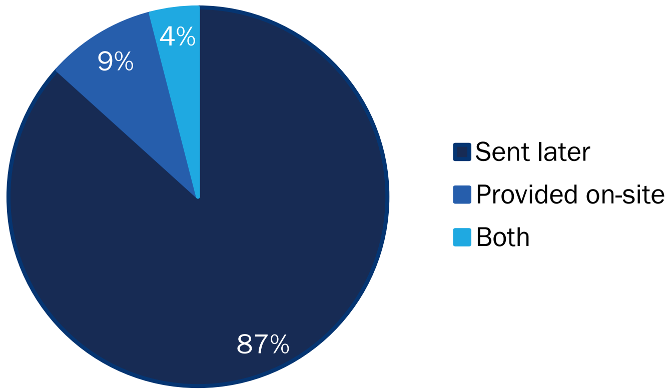
4.9.4 TIME AT SITE AND QUOTE DELIVERY

About two-thirds of HVAC contractors (47 of 78; 60%) were on site for less than an hour, while one-third of contractors (25 of 78; 32%) spent 1-2 hours on-site, and six contractors (8%) spent more than two hours on site.[15] We did not identify a driver of the time spent on site. We hypothesized that contractors performing Manual J calculations may have spent more time on site, but that is not the case: about half (7 of the 16 HVAC contractors who did Manual J) spent less than an hour on site, and another seven stayed between 1 and 2 hours, while the final 2 contractors stayed between 2 and 3 hours. Most contractors (68 of 75; 91%) sent the quote to mystery shoppers later, while a smaller proportion (7 of 75; 9%) only provided the quote on-site (Figure 12).[16]

[15] Analysis excludes one contractor for whom information about the duration of the on-site visit was missing.

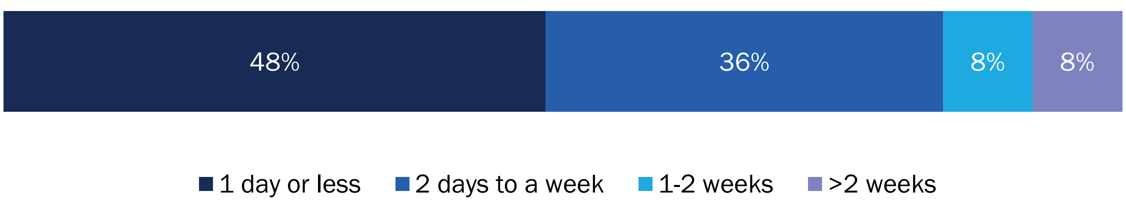
[16] Analysis excludes four contractors who did not end up providing bids.

Figure 12. When Did the Contractor Provide the Quote(s)? (n=75)



Among those contractors who sent quotes later, nearly half (30 of 62; 48%) provided them within a day or less (Figure 13).[17] The remaining 32 contractors (52%) provided quotes within two days to more than two weeks, with some mystery shoppers reporting that they had to follow up with contractors several times before receiving their quotes. Nearly all contractors (69 of 72; 96%) sent quotes electronically, while four (6%) contractors provided a printed quote.[18]

Figure 13. How Much Time Elapsed Between the Contractor's Visit and Receiving the Quote (n=62)



Note: Responses among contractors who sent project bids later.

4.10 COST-RELATED FINDINGS

As mentioned before, equipment bids that contractors provided across both phases of our study showed large variability in terms of the details included in the bid (e.g., cost breakdowns for equipment, labor, home modifications, and any other costs associated with the project) and in terms of format (e.g., PDF, handwritten quotes, bids sent via email, etc.). For our analysis, we used the total cost of each project without accounting for discounts or incentives. This allowed us to compare costs across bids and ensure that wide-ranging discounts, promotions, and rebates provided by contractors did not skew our results. We provide information about incentives and financing options offered in subsequent sections of our report.

Additionally, while most homes had a single HVAC system, three of the 20 HVAC homes had two systems. For the purposes of our cost analysis, we looked at homes with one HVAC system and homes with two HVAC systems separately

[17] Analysis excludes six contractors for whom information about when the bids were provided was missing.

[18] Analysis excludes four contractors who did not end up providing bids and three contractors for whom information about the format of the bid was missing.

to avoid artificially inflating costs in the aggregate. We present findings related to homes with a single HVAC system in this section; see Appendix G for findings specific to homes with two HVAC systems.

Overall, average project costs across equipment types and average incremental costs of heat pump systems varied among bids collected in Phase 2 and Phase 3. We opted to present the Phase 2 and Phase 3 cost data separately because of the differences in data collection mode (in-person, at the house, compared to online) and because of the time elapsed between the two phases.

4.10.1 DESCRIPTIVE SUMMARY OF HVAC PROJECT COSTS

PHASE 2 HVAC PROJECT COST DATA

Mystery shoppers solicited bids for gas like-for-like replacements—either a gas central furnace only or a gas central furnace and CAC system—and heat pump options. Contractors also provided bids for dual-fuel heat pumps, either with a new gas furnace or with the existing gas furnace as backup.

Table 10 summarizes the average, median, minimum, and maximum total HVAC project costs by equipment type. The average cost for a gas furnace was about $8,400, while the average cost of a gas furnace and CAC system was about $17,500. Additionally, the average cost of an all-electric heat pump was over $19,400, which was more expensive than both dual-fuel heat pump options. Contractor bids included both single-speed and variable-speed heat pumps, with average costs for each type being similar at roughly $19,000.

Table 10. Phase 2 HVAC Project Costs Summary by Equipment Type

Bid Equipment Type	Average	Median	Minimum	Maximum
Gas Central Furnace (n=39)	$8,415	$7,884	$3,456	$17,938
Gas Central Furnace + CAC (n=26)	$17,588	$15,834	$9,567	$36,360
All-Electric Heat Pump (n=85)	$19,410	$18,500	$10,608	$39,688
Heat Pump with Existing Furnace (n=2)	$12,604	$12,604	$10,972	$14,235
Heat Pump with New Furnace (n=12)	$16,973	$15,178	$11,651	$26,140
Heat Pump Speed				
Single-Speed Heat Pump (n=37)	$19,354	$18,500	$10,608	$39,688
Variable-Speed Heat Pump (n=62)	$18,752	$17,982	$10,972	$37,577

When examining the minimum and maximum costs by equipment type, we noticed a **large variation in the project cost data received.** Figure 14 depicts a visual representation of the range of total project costs both among and within equipment types, with the presence of a few outliers (represented by dots). **The all-electric heat pump project represented the greatest variation in costs.**

Figure 14. Phase 2 HVAC Project Costs by Equipment Type

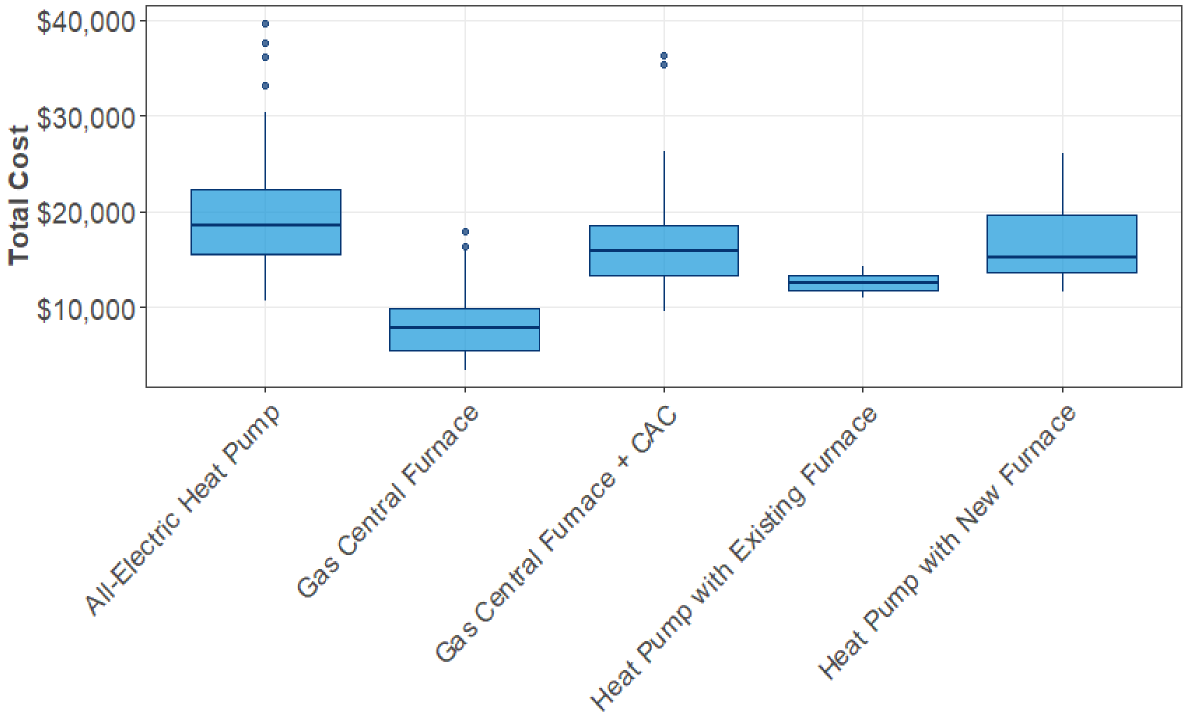


Table 11 summarizes the average, median, minimum, and maximum total costs for HVAC projects by climate region and equipment type. As mentioned before, we only had one home in a cold climate region in our sample, so the number of bids we received for that climate region is limited. Additionally, there are no all-electric HVAC heat pump bids for the cold climate region because no contractor was confident installing a heat pump as the sole heating source. **Total project costs are relatively similar within the same equipment type in hot-dry and marine climate regions.** The highest project cost overall was for an all-electric heat pump system in a hot-dry climate region ($39,688). The lowest total project cost overall was for a gas central furnace ($3,456.38), also in a hot-dry climate region.

Table 11. Phase 2 HVAC Project Costs Summary by Climate Region and Equipment Type

Climate Region	Average	Median	Minimum	Maximum
Gas Central Furnace				
Cold (n=5)	$13,168	$14,920	$8,500	$17,938
Hot-Dry (n=20)	$6,650	$6,046	$3,456	$13,681
Marine (n=14)	$9,238	$9,618	$3,860	$16,272
Gas Central Furnace + CAC				
Cold (n=2)	$35,904	$35,904	$35,448	$36,360
Hot-Dry (n=20)	$16,039	$15,520	$9,567	$26,233
Marine (n=4)	$16,172	$15,338	$11,514	$22,500
All-Electric Heat Pump				
Hot-Dry (n=43)	$19,464	$18,500	$10,608	$39,688
Marine (n=42)	$19,354	$18,359	$11,486	$37,577
Heat Pump with Existing Furnace				
Hot-Dry (n=1)	$10,972	$10,972	$10,972	$10,972
Marine (n=1)	$14,235	$14,235	$14,235	$14,235
Heat Pump with New Furnace				
Cold (n=1)	$18,272	$18,272	$18,272	$18,272
Hot-Dry (n=11)	$16,855	$14,355	$11,651	$26,140

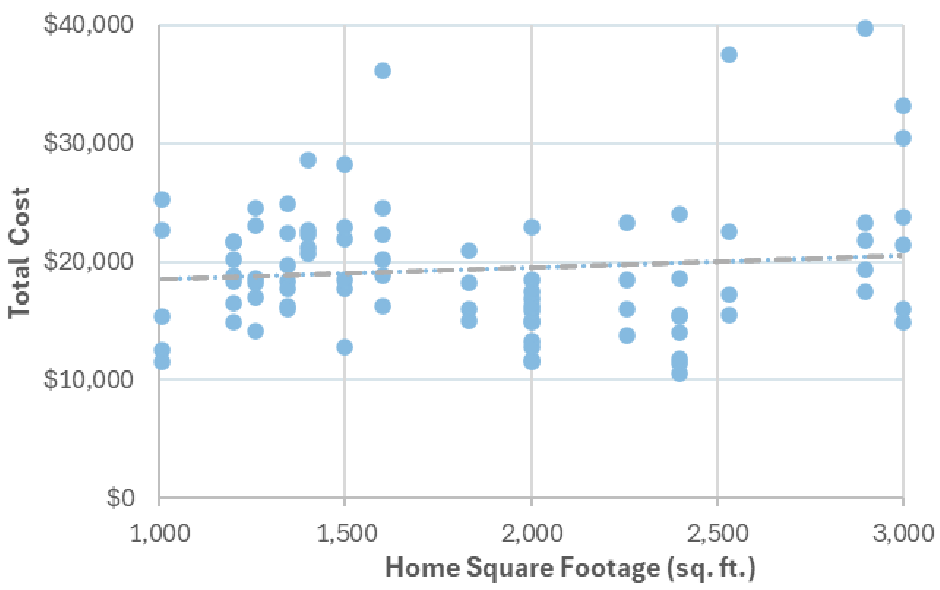
Additionally, we investigated differences between total HVAC project costs (excluding incentives) given by contractors who were TECH-enrolled and those who were not. Table 12 below presents the cost breakdowns between TECH-enrolled contractors and non TECH-enrolled contractors by bid equipment type. There is no statistically significant difference in average project costs between these two groups across all equipment types. On average, non TECH-enrolled contractors offered higher project costs for a gas central furnace and CAC system and lower project costs for dual-fuel heat pumps—especially when keeping the existing furnace—compared to their TECH-enrolled counterparts.

Table 12. Phase 2 HVAC Project Costs Summary by TECH Initiative Enrollment and Equipment Type

Contractor Type	Average	Median	Minimum	Maximum
Gas Central Furnace				
TECH-Enrolled (HVAC) (n=18)	$8,732	$8,497	$3,860	$16,272
Non TECH-Enrolled (n=21)	$8,143	$6,248	$3,456	$17,938
Gas Central Furnace + CAC				
TECH-Enrolled (HVAC) (n=16)	$15,821	$15,050	$9,567	$22,500
Non TECH-Enrolled (n=10)	$20,414	$16,747	$12,108	$36,360
All-Electric Heat Pump				
TECH-Enrolled (HVAC) (n=52)	$19,653	$18,571	$11,486	$39,688
Non TECH-Enrolled (n=33)	$19,027	$17,200	$10,608	$37,577
Heat Pump with Existing Furnace				
TECH-Enrolled (HVAC) (n=1)	$14,235	$14,235	$14,235	$14,235
Non TECH-Enrolled (n=1)	$10,972	$10,972	$10,972	$10,972
Heat Pump with New Furnace				
TECH-Enrolled (HVAC) (n=5)	$17,814	$18,272	$13,711	$23,388
Non TECH-Enrolled (n=7)	$16,373	$13,872	$11,651	$26,140

In our preliminary exploration of the data, we also looked at any correlation between the home size and the total project costs. Figure 15 below illustrates that **there is no evident correlation between home square footage and total HVAC project costs identified in this study.** One of our theories to explain this lack of relationship is that older homes are often smaller, which could influence the total project cost due to the necessity for non-electrical upgrades like ductwork when replacing or upgrading an HVAC system. From our sample of homes, 81% of homes built before 1980 were less than 2,000 square feet, and 76% of all HVAC bids that included duct replacement were for homes built before 1980. As such, ductwork may be a factor contributing to higher total project costs for smaller homes.

Figure 15. Phase 2 HVAC All-Electric Heat Pump Project Costs by Home Square Footage



$R^2 = 0.0108$

We further analyzed project costs for homes under 2,000 square feet and homes that were 2,000 square feet and above by equipment type (Table 13). Once again, no correlation between home size and total project costs emerged from the data we collected. **However, when it comes to the average project cost of a gas central furnace replacement, the average project cost is statistically higher for homes less than 2,000 square feet than for homes 2,000 square feet and above.** No other statistically significant differences in project costs were found between small and large homes.

Table 13. Phase 2 HVAC Project Costs Summary by Home Size and Equipment Type

Bid Equipment Type	Average	Median	Minimum	Maximum
Homes less than 2,000 sq. ft.				
Gas Central Furnace (n=14)	$12,106*	$11,609	$8,341	$17,938
Gas Central Furnace + CAC (n=9)	$20,528	$16,979	$14,500	$36,360
All-Electric Heat Pump (n=46)	$19,916	$19,261	$11,500	$36,129
Heat Pump with Existing Furnace (n=1)	$14,235	$14,235	$14,235	$14,235
Heat Pump with New Furnace (n=4)	$20,418	$20,005	$18,272	$23,388
Homes 2,000 sq. ft. and above				
Gas Central Furnace (n=25)	$6,348	$5,734	$3,456	$13,681
Gas Central Furnace + CAC (n=17)	$16,031	$14,034	$9,567	$26,233
All-Electric Heat Pump (n=39)	$18,813	$16,800	$10,608	$39,688
Heat Pump with Existing Furnace (n=1)	$10,972	$10,972	$10,972	$10,972
Heat Pump with New Furnace (n=8)	$15,251	$13,808	$11,651	$26,140

*Statistically significant at the 95% confidence level.

When it comes to the different components included in the total costs, very few bids showed a detailed breakdown. Table 14 below shows the average costs of various components of the projects (equipment, labor, and electrical and non-electrical modifications) based on bids where contractors provided an itemized cost breakdown. Non-electrical modifications included ductwork, smart thermostats, condensate drains and pumps, in addition to any specific modifications each home needed according to the contractor. All-electric heat pump bids often showed the cost associated with non-electrical modifications separately, compared to other project-related costs. The average cost for non-electrical modifications in all-electric heat pump projects was about $3,600 (n=28).

Table 14. Phase 2 Itemized HVAC Project Costs Summary by Equipment Type

Bid Equipment Type	Average Total Cost	Average Equipment Cost		Average Labor Cost		Average Electrical Modification Cost		Average Non-Electrical Modification Cost	
Gas Central Furnace (n=39)	$8,415	n=2	$5,073	n=2	$2,820	n=3	$334	n=6	$2,911
Gas Central Furnace + CAC (n=26)	$17,588	n=0	N/A	n=0	N/A	n=2	$1,250	n=8	$4,569
All-Electric Heat Pump (n=85)	$19,410	n=5	$7,425	n=5	$3,878	n=10	$1,919	n=28	$3,690
Heat Pump with Existing Furnace (n=2)	$12,604	n=0	N/A	n=0	N/A	n=0	N/A	n=0	N/A
Heat Pump with New Furnace (n=12)	$16,973	n=1	$10,510	n=1	$7,200	n=0	N/A	n=2	$2,550

Note: n values reflect the number of bids that included each cost, not the number of unique contractors providing each cost. Average total costs were calculated using the total n of each equipment type.

Lastly, we investigated costs for HERS testing and permitting for HVAC projects across all cities represented in our sample of homes. After the installation of a permitted piece of equipment in California, the Authority Having Jurisdiction (usually the city) usually requires a HERS rater to test it to ensure the new equipment meets California Title 24 building code specifications. The TECH Clean California Initiative requires that projects receiving incentives demonstrate HERS compliance. Since HERS testing is triggered by getting a permit, contractors specified this cost in the project bids as either permitting costs or HERS testing compliance costs. Table 15 summarizes these costs by city and includes all HVAC equipment types. As shown, **HERS testing and permit costs quoted by contractors varied by city, with average prices ranging from $633 to $1,200**. The lowest HERS testing and permit cost recorded was $320 in El Cerrito, while the highest was $1,500 in Rancho Palos Verdes.

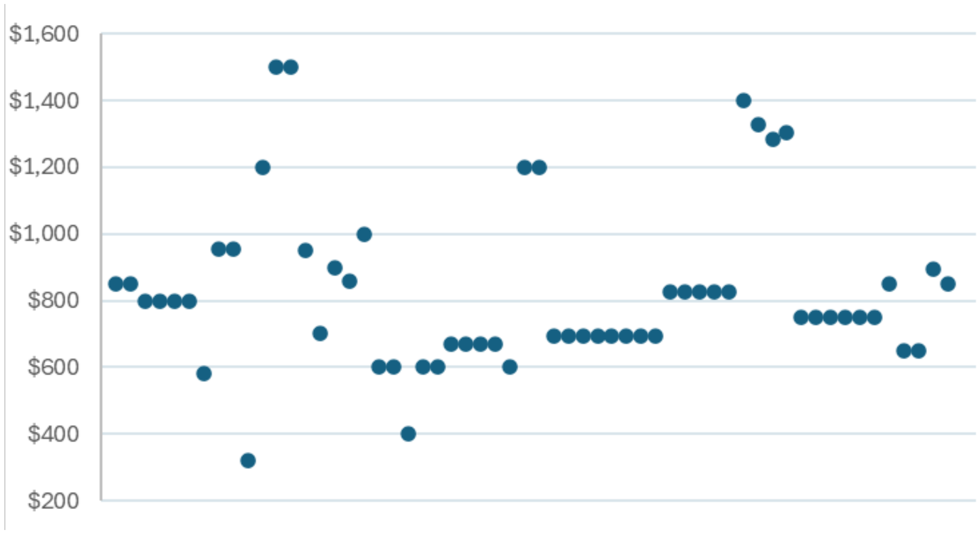
Table 15. Phase 2 HVAC Project HERS/Permitting Costs Summary by City

City [a]	Average	Median	Minimum	Maximum
Carlsbad (n=8)	$695	$695	$695	$695
Concord (n=5)	$825	$825	$825	$825
Culver City (n=2)	$873	$873	$850	$895
El Cerrito (n=2)	$760	$760	$320	$1,200
Long Beach (n=2)	$879	$879	$859	$900
Oakland (n=6)	$817	$800	$800	$850
Oceanside (n=10)	$982	$750	$750	$1,400
Poway (n=5)	$656	$670	$600	$670
Rancho Palos Verdes (n=4)	$1,163	$1,225	$700	$1,500
Redondo Beach (n=2)	$1,200	$1,200	$1,200	$1,200
Rocklin (n=2)	$650	$650	$650	$650
Sacramento (n=1)	$582	$582	$582	$582
San Mateo (n=2)	$955	$955	$955	$955
Seal Beach (n=1)	$850	$850	$850	$850
Truckee (n=6)	$633	$600	$400	$1,000

[a] n values represent the number of bids that included HERS/permit costs. As such, n values do not represent unique contractors' HERS/permit pricing.

Figure 16 shows the distribution of HERS testing and permitting costs listed across the 58 bids collected in Phase 2 that included a HERS and/or permitting cost line item. **Most bids (83%) listed a HERS and/or permitting cost of less than $1,000.**

Figure 16. Phase 2 HVAC Project HERS/Permitting Costs (n=58)



Note: Dots in the figure denote individual project bids.

4.10.2 INCREMENTAL COST FINDINGS

PHASE 2 FINDINGS

As mentioned previously, the evaluation team developed a series of fixed-effects linear regression models to estimate the incremental costs associated with a like-for-like gas system replacement and a heat pump upgrade for homes with a gas central furnace and homes with a gas central furnace and CAC system. Each model isolates the effect of specific project components on total project costs, such as electrical panel upgrades, installation by a TECH-enrolled contractor, or contractors with HERS permits. To account for unobserved household-level differences (e.g., size, age, or location), the models include fixed effects for each home, effectively comparing cost differences within the same household across different equipment types.

The incremental costs of a dual-fuel heat pump (with a new furnace) and an all-electric heat pump are very similar compared to the average cost of a gas furnace (Table 16). When compared to the average cost of a gas furnace replacement, an all-electric heat pump, on average, costs about $10,800 more, which represents a 129% cost increment. Similarly, a dual-fuel heat pump with a new gas furnace as backup heating costs, on average, nearly $10,000 more than a gas furnace replacement, which is a 118% cost increment. However, a dual-fuel heat pump with the existing gas furnace (that is, only the outdoor condenser unit) costs about $7,500 more than a new gas furnace replacement, which is a 90% cost increment. Therefore, leaving the existing furnace translates to a more affordable project.

Table 16. Phase 2 HVAC Project Incremental Costs Findings by Home Scenario

Replacement Equipment	Incremental Cost Estimate (Over Baseline)	% Incremental Cost (Over Baseline)
Baseline Scenario: Gas Central Furnace Replacement; Baseline Average Cost: $8,415		
All-Electric Heat Pump (n=85)	$10,869*	129%
Heat Pump with Existing Furnace (n=2)	$7,594*	90%
Heat Pump with New Furnace (n=12)	$9,915*	118%
Baseline Scenario: Gas Central Furnace + CAC; Baseline Average Cost: $17,588		
All-Electric Heat Pump (n=85)	$2,456*	14%
Heat Pump with Existing Furnace (n=2)	($640)	(4%)
Heat Pump with New Furnace (n=12)	$982	6%

* Statistically significant at the 95% confidence level

When compared to the average cost of replacing a gas central furnace and central air conditioning (CAC) system, installing an all-electric heat pump costs about $2,400 more on average—a 14% increase. By contrast, installing only a new heat pump while keeping the existing furnace (i.e., replacing just the outdoor condenser unit) costs about $600 less than a new gas furnace and CAC system—a 4% decrease. A new heat pump paired with a new gas furnace averages about $1,000 more than a gas furnace and CAC system, or a 6% increase. **Overall, our analysis finds that the average cost of a dual-fuel heat pump system is not statistically different from the cost of replacing a gas furnace and CAC system.**

In terms of project components and their influence on overall costs, we found that the **inclusion of ductwork increases the total average cost of heat pump projects by about $1,850 (10%),** a statistically significant effect at the 95% confidence level. Additionally, in the case of the impact of HERS testing or permit costs on total average costs across bids, we observed that for either a gas central furnace replacement or a gas central furnace and CAC system replacement, projects that include HERS testing or permit costs are, on average, about $4,000 ($3,946 and $4,681, respectively) more expensive than bids for like-for-like replacements that do not include HERS/permit costs (holding all other terms constant and statistically significant at the 95% confidence level).

Aggregated Findings

We combined the cost data across both phases of our study to estimate incremental costs associated with a like-for-like replacement and a heat pump replacement using a larger number of observations. As described in the Methods section, when running our regression models on the combined data, we created a flag to distinguish bids from each phase and account for the fact that the data were collected using two different methods (i.e., mystery shopping and online survey). The incremental cost findings from the combined cost data from Phases 2 and 3 are presented in Table 17 below.

Table 17. Phase 2 & 3 Aggregated HVAC Project Incremental Costs Findings by Home Scenario

Replacement Equipment	Incremental Cost Estimate (Over Baseline)	% Incremental Cost (Over Baseline)
Baseline Scenario: Gas Central Furnace Replacement; Baseline Average Cost: $8,777		
All-Electric Heat Pump (n=138)	$11,080*	126%
Heat Pump with Existing Furnace (n=2)	$5,868*	67%
Heat Pump with New Furnace (n=21)	$10,574*	120%
Phase 3 (n=99)	$1,749^	20%
Baseline Scenario: Gas Central Furnace + CAC; Baseline Average Cost: $18,463		
All-Electric Heat Pump (n=138)	$2,087*	11%
Heat Pump with Existing Furnace (n=2)	($3,896)*	-21%
Heat Pump with New Furnace (n=21)	$1,283	7%
Phase 3 (n=99)	$1,632	9%

* Statistically significant at the 95% confidence level

^ Statistically significant at the 90% confidence level

Similar to what we observed when we analyzed the cost data for each individual phase, the aggregated data showed that the incremental costs of a dual-fuel heat pump (with a new furnace) and an all-electric heat pump are very similar compared to the average cost of a gas furnace. Replacing a gas central furnace with an all-electric heat pump costs, on average, about $11,000 more than replacing it with a like-for-like equipment, which represents a 126% cost increment. Additionally, replacing a gas central furnace with a dual-fuel heat pump (with a new furnace) costs about $10,500 more than replacing it with the same equipment (a 120% cost increment). These incremental costs fall somewhat in the middle between those found in Phase 2 and those found in Phase 3.

Overall, our model estimated that when it comes to replacing a gas central furnace, bids received through the online contractor survey were about $1,750 more expensive than bids received during the mystery shopping exercise.

The incremental cost of an all-electric heat pump project is almost negligible when the homeowner would otherwise be replacing their gas furnace and CAC system: the heat pump costs an average of about $2,000 more, an 11% cost increment. Additionally, replacing the gas central furnace and CAC system with a dual-fuel heat pump, but keeping the existing furnace, costs nearly $4,000 less on average than replacing the whole system with a like-for-like system (a 21% cost decrease). Furthermore, similar to what we found in Phase 2, but unlike what we observed in Phase 3, **the average cost of a dual-fuel heat pump system with a new furnace is not statistically different from the average cost of replacing a gas furnace and CAC system.**

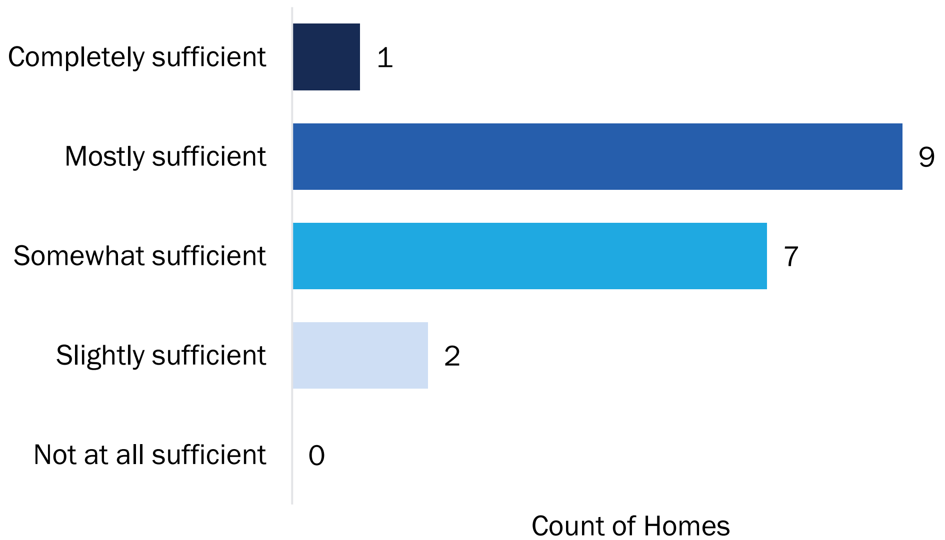
Although our model estimated that bids received through the online contractor survey for replacing a gas central furnace and CAC system were about $1,630 more expensive than bids received through the mystery shopping exercise, that cost increase was not statistically significant.

In terms of project components and how they influence average project costs in the aggregate data, we observed that for like-for-like gas furnace replacements with or without a CAC, projects that include HERS testing or permit costs are, on average, about $3,900 ($3,386 and $3,981, respectively) more expensive than bids that do not include HERS/permit costs (holding all other terms constant and statistically significant at the 95% confidence level).

4.11 INFORMATION CONTRACTORS NEED TO PROVIDE ACCURATE BIDS

As previously mentioned, in the Phase 3 survey, we asked contractors the degree to which the information and images included in each home package and presented on the study's webpage were sufficient to provide accurate cost estimates. Based on their responses, we calculated an average sufficiency score for each home to determine whether any home package particularly lacked information, hindering contractors' ability to accurately estimate HVAC project costs. We found that the average sufficiency score across all HVAC homes was 2.5 on a scale from 1 to 5, where 1 is "Completely sufficient," and 5 is "Not at all sufficient." As such, on average, the information we provided on each HVAC home's webpage could be described as "somewhat" to "mostly" sufficient. Figure 17 shows the number of HVAC homes in each category related to the sufficiency of information included in their home package.

Figure 17. Sufficiency of Information Included in HVAC Homes' Packages Provided in Phase 3 (n=19)



Contractors described the additional information that would have assisted them in providing accurate bid estimates for each home. Their answers allowed us to identify ways to improve the quality of project cost data contractors can provide in online surveys. **Half of the contractors who provided bids for HVAC projects in Phase 3 (5 of 10) stated that photos of the home's ductwork or additional information on ductwork, such as whether it was sized properly, would have helped them provide more accurate project bids.**[19] Other helpful pieces of information that contractors mentioned would have made their bids more accurate were the Manual J load calculation (mentioned by 3 contractors), information on wall or attic insulation levels (mentioned by 2 contractors), information on homeowners' heating and cooling habits (mentioned by 2 contractors), additional information about the setback of the home, as well as information about the roof, attic, and windows (mentioned by 2 contractor), additional photos of wiring (mentioned by 1 contractor), and whether the home's appliances were electric (mentioned by 1 contractor).

[19] One contractor did not provide a response to this question, and was excluded from this part of the analysis.

5. WATER HEATER FINDINGS

In this section, we discuss detailed findings related to the 10 WH homes from Phases 2 and 3 of the Incremental Cost Study.

5.1 HOMES CHARACTERIZATION

The majority of WH homes (8 of 10) were located in the hot-dry climate region, while two were located in the marine climate region. All homes were between 1,000 to 3,000 square feet. The age of the existing water equipment varied, with six of the homes having water heaters less than 7 years old, and the remaining four having water heaters aged 7 years or more. One home had a gas tankless water heater, while the other nine homes had a gas storage water heater. Tanks' capacity ranged between 40 and 75 gallons. Half of the homes had rooftop solar, and six had electrical panels with no available slots. Table 18 summarizes WH homes' characteristics (see Appendix C for additional details for each home).

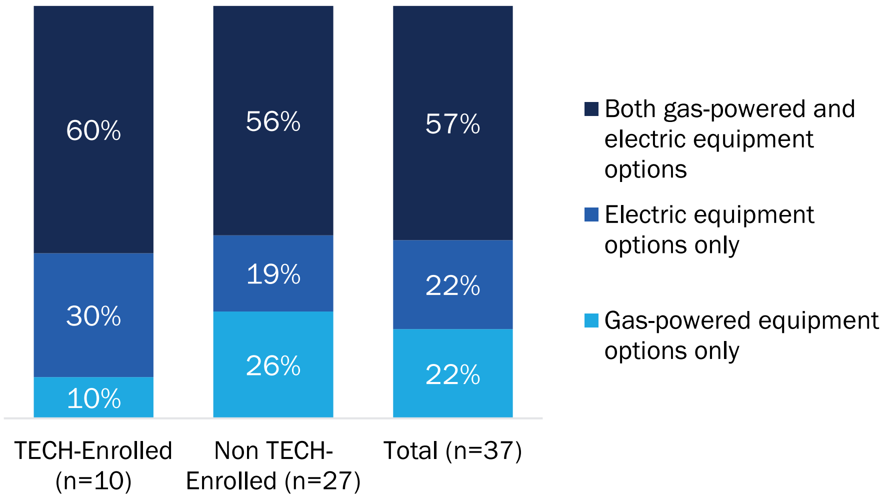
Table 18. Water Heating Homes' Characteristics (n=10)

Category	Count of Homes
Square Footage	
501 to 1,000 sq. ft	0
1,001 to 2,000 sq. ft	4
2,001 to 3,000 sq. ft	6
3,001 to 4,000 sq. ft	0
Age of Water-Heating Equipment	
Under 4 years old	3
4-6 years old	3
7-10 years old	1
Over 10 years old	3
Existing Water Heater Tank Size	
Tankless	1
40 gal	5
50 gal	3
75 gal	1
Electrical Panel Status	
With any open slots	4
No open slots	6
Solar PV	
None	4
PV (no battery)	5
PV + battery	1
Climate Zone and Region	
2 (Marine)	1
3 (Marine)	1
7 (Hot-Dry)	2
9 (Hot-Dry)	1
10 (Hot-Dry)	1
12 (Hot-Dry)	2
13 (Hot-Dry)	1
15 (Hot-Dry)	1

5.2 EQUIPMENT OPTIONS DISCUSSED

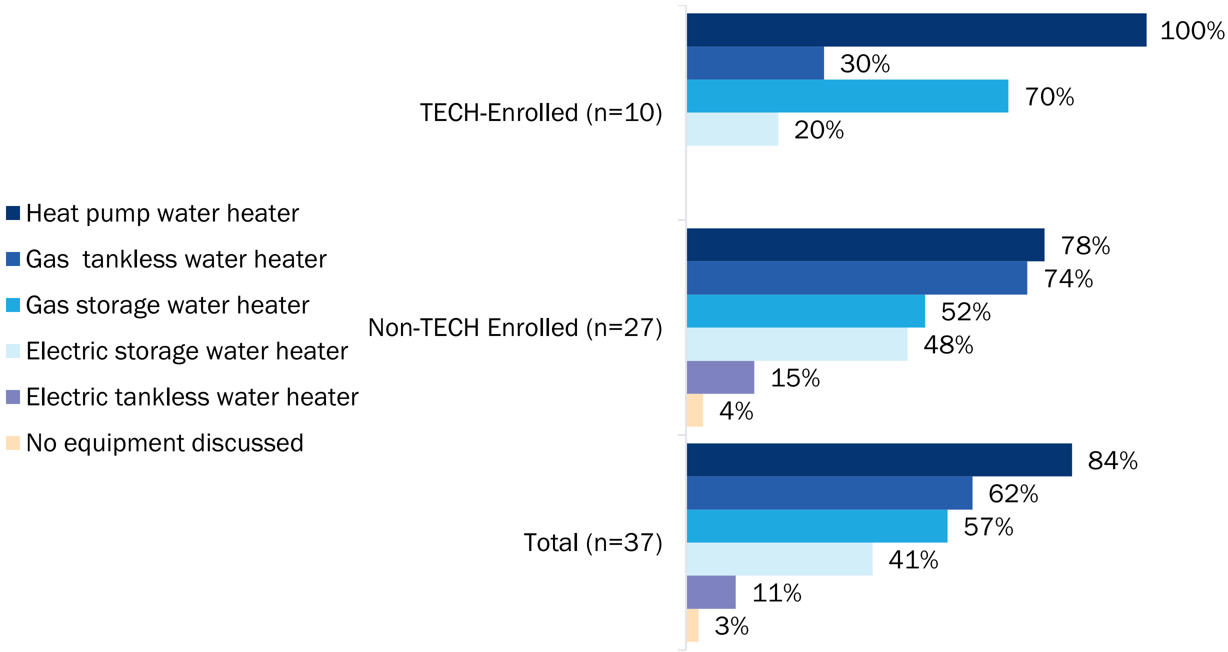
Over half of the WH contractors (21 of 37; 57%) voluntarily offered both gas-powered and electric WH options to mystery shoppers to replace their water heating equipment, and participation in TECH Clean California increased the likelihood they would offer electric options (Figure 18). About one-fifth of WH contractors offered only gas-powered WH equipment (8 of 37; 22%) or only electric WH equipment (8 of 37; 22%) as options without being prompted. Overall, WH contractors are similarly likely to recommend both gas-powered and electric WH equipment regardless of their enrollment status in TECH Clean California. However, contractors not enrolled in TECH Clean California were less likely to voluntarily recommend electric-only equipment options (5 of 27; 19%), compared to TECH-enrolled WH contractors (3 of 10; 30%). Conversely, non TECH-enrolled contractors are more likely to offer only gas-powered WH equipment (7 of 27; 26%) than TECH-enrolled contractors (1 of 10; 10%).

Figure 18. Fuel Options Contractors Voluntarily Offered to Replace Water-Heating Equipment



Contractors discussed a variety of water heater equipment options with mystery shoppers. **Heat pump water heaters were discussed most frequently (31 of 37; 84%), followed by gas tankless water heaters (23 of 37; 62%), and gas storage water heaters (21 of 37; 57%)** (Figure 19). All TECH-enrolled contractors discussed heat pump water heaters, while just over three-quarters of non-TECH contractors (21 of 27; 78%) discussed them. A higher proportion of non TECH-enrolled contractors discussed gas tankless water heaters with mystery shoppers (20 of 27; 74%) compared to TECH-enrolled professionals (3 of 10; 30%); while the latter group more commonly discussed gas storage water heaters (7 of 10; 70%) compared to their non-enrolled counterparts (14 of 27; 52%).

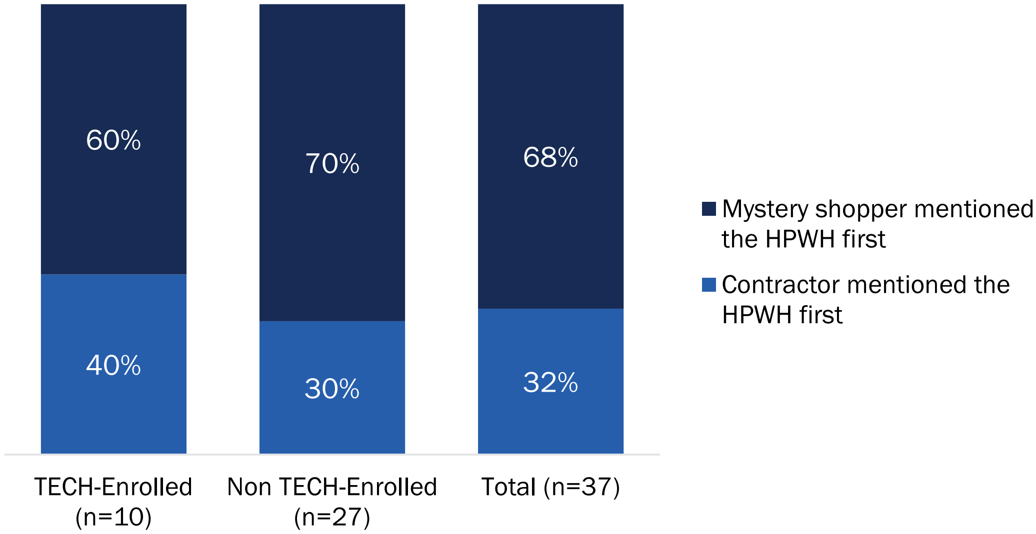
Figure 19. All Water-Heating Equipment Options Discussed Between Contractors and Mystery Shoppers



Note: Multiple responses were allowed.

While HPWHs were discussed most commonly during interactions with contractors, only one-third of contractors (12 of 37; 32%) brought up this technology first (Figure 20). The other two-thirds of the time (25 of 37; 68%), the mystery shopper was the one who introduced the HPWH as an option. Of the twelve contractors who initiated discussions about HPWHs, ten (83%) brought it up only after the mystery shopper expressed interest in getting solar PV, while the remaining two contractors (17%) mentioned the HPWH before solar was discussed.

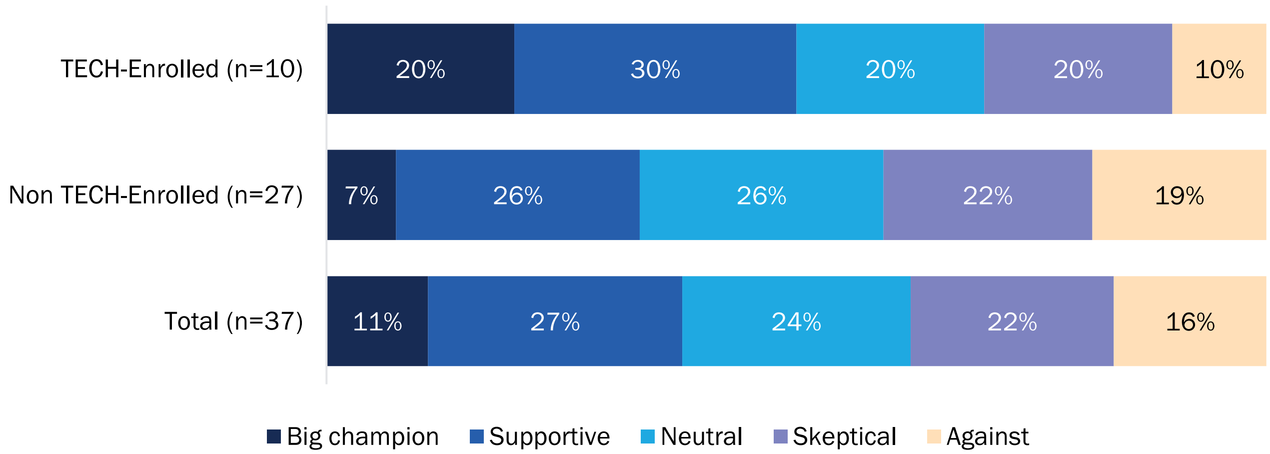
Figure 20. Who Brought Up a Heat Pump Water Heater as an Option First?



Overall, WH contractors viewed HPWHs less favorably than HVAC contractors viewed space conditioning heat pumps. While the majority of HVAC contractors (55 of 79; 70%) were either strong champions (32 of 79; 41%) or supportive (23 of 79; 23%) of heat pumps, only about one-third of WH contractors (14 of 37; 38%) were strong champions (4 of 37;

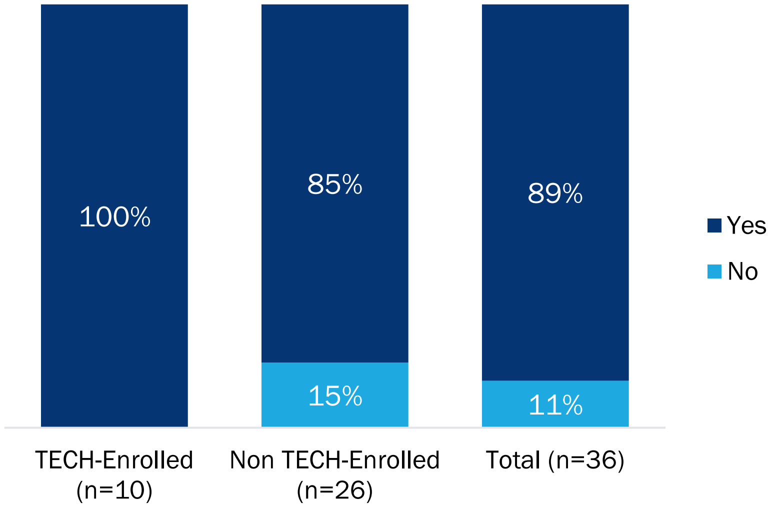
11%) or supportive (10 of 37; 27%) of HPWHs (Figure 21). Over half of WH contractors (52%) were neutral (9 of 37; 24%), skeptical (8 of 37; 22%), or opposed (6 of 37; 16%) to HPWHs. TECH-enrolled contractors are more likely to be big champions of HPWHs (2 of 10; 20%) compared to non TECH-enrolled contractors (2 of 27; 7%). Conversely, non TECH-enrolled contractors are more likely to be against HPWHs (5 of 27; 19%) than TECH-enrolled contractors (1 of 10; 10%).

Figure 21. Contractors' Attitudes Towards Heat Pump Water Heaters



About two-thirds (24 of 36; 67%) of contractors asked the mystery shopper about issues with the existing water heater, while the majority (32 of 36; 89%) also inspected the water heater themselves (Figure 22).

Figure 22. Did the Contractor Inspect the Home's Current Water Heater?



Note: One contractor was excluded from the analysis due to a missing response.

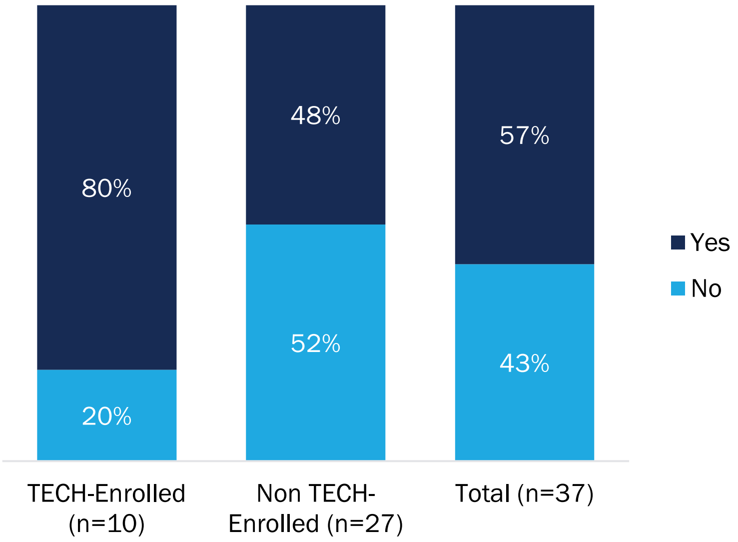
5.3 ADDITIONAL WORK FOR HEAT PUMP WATER HEATERS

HPWHs tend to be taller and bulkier than gas storage water heaters and require a certain amount of air space around them to function properly. Most models on the market at the time of the study in summer 2024 also required a dedicated 220V outlet, though 120V HPWH models had recently become available. When replacing a gas water heater with a 220V HPWH, contractors must add a dedicated circuit, or an outlet for the 120V HPWH, if one is not already available nearby. As a result, installing an HPWH may require relocation or additional work in the home to accommodate it. This additional work can involve upgrades to the home's electrical panel, adding electrical supply or other modifications, or ensuring there is a sufficiently large ambient area for installation.

5.3.1 ELECTRICAL PANELS AND OTHER ELECTRIC WORK

Since all of the homes had gas-powered water heaters, a contractor who is serious about installing a HPWH should investigate whether there is an appropriate electrical outlet and electrical panel space for the HPWH. **About half of WH contractors (21 of 37; 57%) inspected the homes' wiring, electrical panel, and/or service capacity during their visit (Figure 23).** TECH-enrolled contractors were more likely to inspect the home's electrical systems (8 of 10; 80%) than non-TECH-enrolled contractors (13 of 27; 48%), suggesting they were either more knowledgeable about HPWHs or taking the sale and installation of a HPWH more seriously than others.

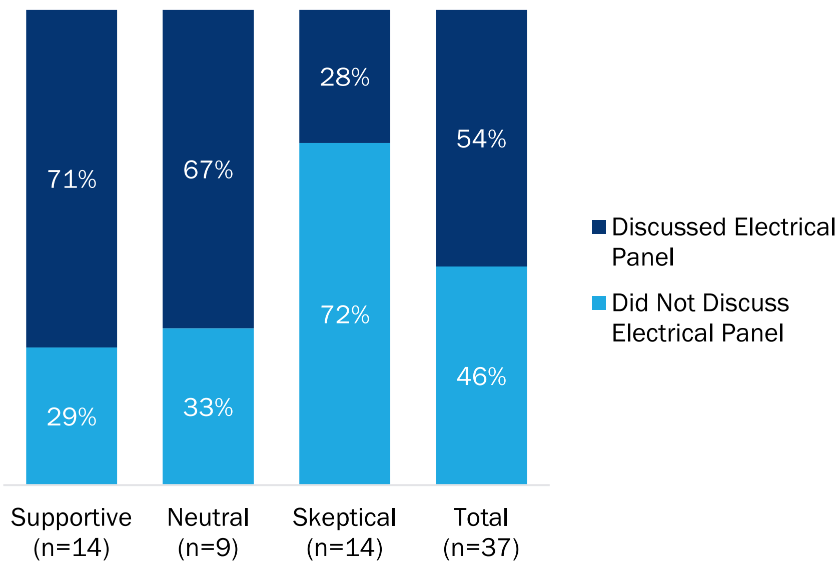
Figure 23. Did Water Heating Contractors Inspect the Home's Electrical System?



About three-quarters of contractors (28 of 37; 76%) said that the home would require electrical work to accommodate a HPWH. This typically involved ensuring the home's electrical panel could support the increased load and installing new circuits and wiring. In some cases (4 of 28; 14%), these contractors mentioned that the home would require a complete panel upgrade to handle the new system, especially if the existing panel was outdated or overloaded. Other contractors (14 of 28; 50%) emphasized the importance of adding a dedicated 220V circuit and/or wiring from the panel to the location of the new HPWH, with additional costs for hiring an electrician. Several contractors (4 of 28; 14%) also mentioned 120V HPWHs, which could plug into existing outlets, but two of those contractors recommended against them because they take even longer to heat water.

Contractors with supportive and neutral attitudes towards HPWHs were more likely to discuss potential electrical panel upgrades, including adding a dedicated circuit, than skeptical contractors, even in instances where they determined an electrical panel upgrade was not necessary (Figure 24).[20] Over two-thirds of contractors who were supportive of HPWHs (71%) or neutral towards them (67%) discussed electrical panel upgrades with mystery shoppers, compared to 28% among contractors who were skeptical of HPWHs. It seems contractors who recommend gas water heaters and mention drawbacks of HPWHs are unlikely to spend time investigating whether the home's electrical panel can accommodate a HPWH, expecting the homeowner to proceed with a gas like-for-like water heater replacement or move to a gas tankless system.

Figure 24. Electrical Panel Discussions by Contractor Attitude Toward HPWHs



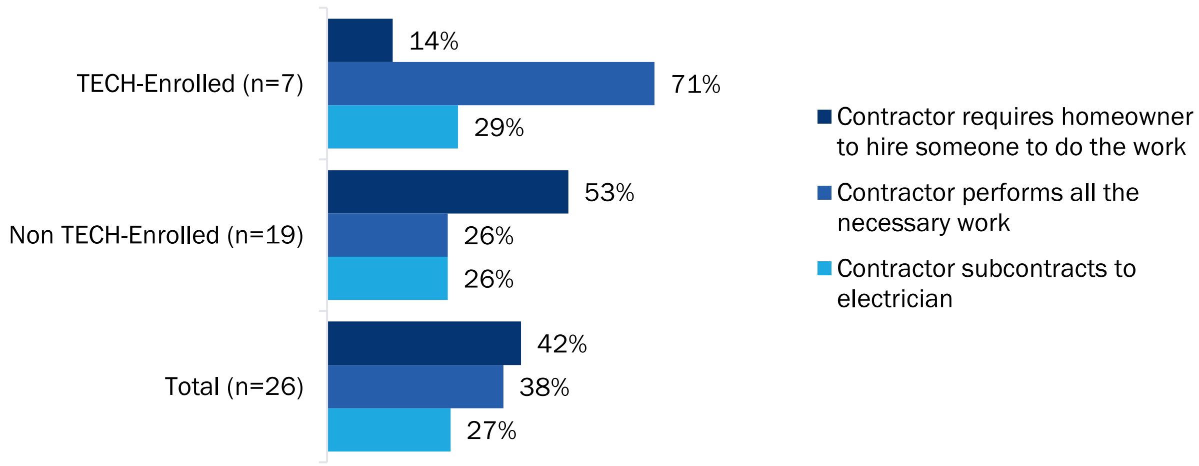
More than one-third of contractors who discussed electrical modifications with the mystery shopper (11 of 26; 42%) required the homeowner to hire someone to do this electrical work (Figure 25). A similar proportion of contractors (10 of 26; 38%) stated they could complete the work themselves, while fewer (7 of 26; 27%) indicated that they would subcontract to an electrician. Contractors enrolled in the TECH initiative were more likely to perform all the electrical work themselves (5 of 7; 71%) compared to non TECH-enrolled contractors (5 of 19; 26%).[21] These findings slightly contrast with the HVAC findings, where a minority of contractors (8 of 42; 19%) either subcontracted an electrician or advised the homeowner to hire one on their own.

---

[20] For this analysis, we collapsed the previously presented categories describing contractors' attitudes towards heat pumps as follows: "supportive" and "big champion" are collapsed within "supportive"; "skeptical" and "against" are collapsed into "skeptical"; "neutral" remains unchanged.

[21] Seven contractors did not mention who would do the electrical work and were excluded from the analysis.

Figure 25. Who Completes the Necessary Electrical Work?



Note: Some contractors offered the mystery shopper more than one option and that is why the numbers in each group do not sum to 100%. Responses among contractors who investigated the home's electrical condition or mentioned that electrical upgrades were needed.

5.3.2 OTHER HOME MODIFICATIONS

In addition to electrical upgrades, non-electrical modifications are sometimes necessary when installing a HPWH, especially related to its location and additional components. Overall, 13 of 37 contractors (35%) mentioned that some non-electrical upgrades would be needed to install a HPWH. Four contractors (11%) noted that due to the large size of HPWHs, the new unit may need to be relocated to a different area (e.g., a garage) to ensure sufficient clearance and ambient air space. Other common upgrades included installing a thermostatic mixing valve to regulate water temperature and ensure compliance with local codes, as well as adding a condensate drain. Ventilation was another key requirement mentioned by two contractors, while three contractors indicated that old gas lines and flues would need to be capped and secured. One contractor mentioned that they see HPWHs more commonly installed in new buildings due to the numerous modifications required for installation.

5.4 SIZING PRACTICES

HPWHs have a slower recovery rate than gas storage water heaters, and therefore, contractors may recommend moving to a larger tank size when upgrading to a HPWH. **Several contractors (7 of 37; 19%) recommended upsizing HPWHs to compensate for the slower recovery rates.** These contractors thought larger units were necessary to ensure a sufficient hot water supply, especially in households with higher demand. However, the ability to upsize was often constrained by available space, as HPWHs are bulkier than traditional models and require more room for installation and airflow.

We looked at the instances where contractors may have upsized the new water heating equipment they recommended. Table 19 summarizes the tank capacity of homes' existing water heaters compared to the capacity of the water heaters recommended by contractors in the bids we received. **Most homes with a 40-gallon water heater were recommended to upgrade to a 50-gallon water heater (11 of 17 bids contained equipment of higher capacity). For homes with a 50-gallon water heater, most bids also contained water heaters with higher capacities (8 of 14 bids).**

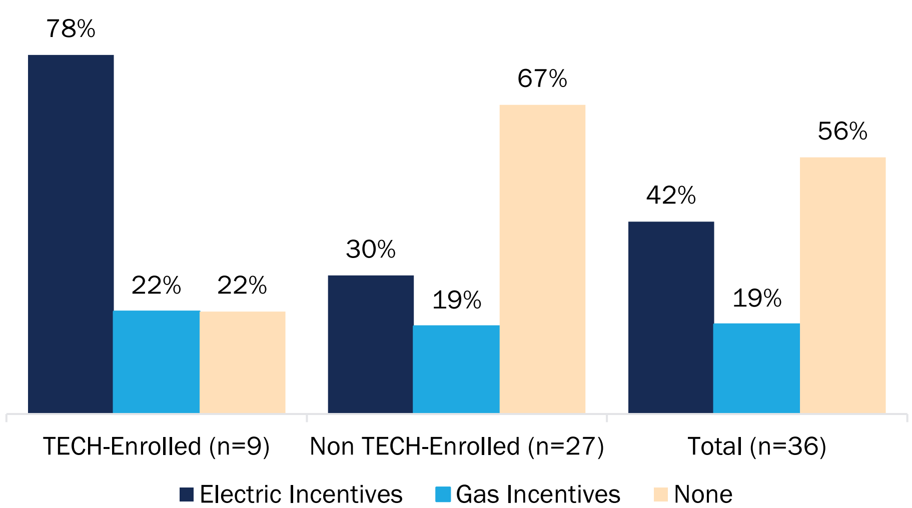
Table 19. Phase 2 Number of Bids Received for Water-Heating Equipment by Tank Capacity

Existing Water Heater Tank Capacity (Gallons)	New Water Heater Tank Capacity (Gallons)						
	40	50	65	66	75	80	83
40	6	10	0	0	0	0	1
50	0	6	4	0	0	4	0
75	0	1	0	0	5	1	0
N/A	0	1	2	0	0	0	0

5.5 INCENTIVES

When talking about incentives, rebates, or tax credits for electric water-heating equipment, about two-fifths of contractors (15 of 36; 42%) mentioned them without any prompting from the mystery shopper (Figure 26). About half as many contractors (7 of 36; 19%) mentioned incentives, rebates, or tax credits for gas water-heating equipment. **Over half of WH contractors (20 of 36; 56%) did not bring up any incentives, rebates, or tax credits at all.** TECH-enrolled contractors were more likely to bring up any incentives on their own; specifically, 78% (7 of 9) of TECH-enrolled contractors mentioned electric or gas incentives, compared to 33% (9 of 27) of non TECH-enrolled contractors. Both groups more commonly mentioned electric incentives than gas incentives.

Figure 26. Did Contractors Mention Water Heater Incentives On Their Own?



Note: Contractors could mention both electric and gas incentives. One TECH-enrolled contractor was excluded from this analysis due to a missing response.

After the mystery shopper specifically asked about available rebates or tax credits, an additional 12 contractors discussed them. In total, 25 contractors (68%) discussed electric incentives, while eight contractors (22%) mentioned gas incentives. **Similar to HVAC, the most commonly discussed types of incentives for electric water-heating equipment were tax credits (12 of 25; 48%) and TECH Clean California (6 of 25; 24%).** SoCalGas rebates were the most commonly mentioned option for gas water-heating equipment (5 of 8; 63%; Table 20).

Table 20. Electric and Gas Incentives Discussed by Contractors for Water-Heating Equipment

Fuel Type	Incentive Discussed	Contractors Who Discussed Each Incentive	Percent
Electric (n=25)	Tax credits	12	48%
	TECH Clean California	6	24%
	Inflation Reduction Act (IRA)	2	8%
	Sacramento Municipal Utility District (SMUD)	2	8%
	Pacific Gas and Electric (PG&E)	2	8%
	Bay Area Regional Energy Network (BayREN)	1	4%
	Other (Electric)	3	12%
	Mystery Shopper Unsure about Specific Incentive	3	12%
Gas (n=8)	SoCalGas	5	63%
	Pacific Gas and Electric (PG&E)	1	13%
	Manufacturer Discount	1	13%

Note: Responses among contractors who discussed incentives at all. Multiple responses were allowed.

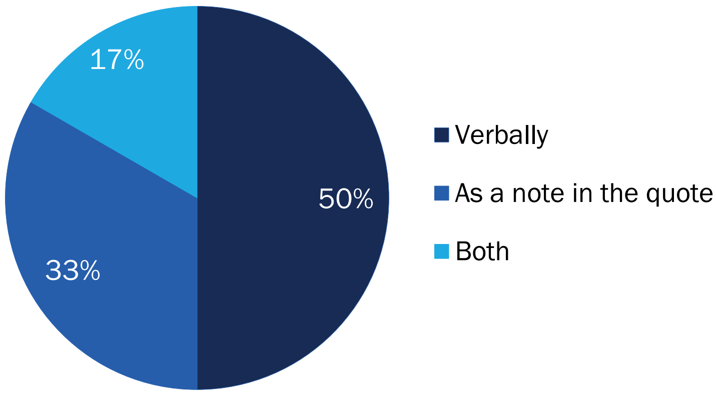
5.6 PERMITS

A minority of WH contractors discussed permits and HERS testing with mystery shoppers (11 of 37; 30%). Two of those contractors said that permits were optional, depending on whether the homeowner wanted one, while the remaining nine contractors said a permit would be required. One contractor mentioned that permits have become more expensive, at about $350. As mentioned before, most WH bids received in Phase 2 did not include a cost line item for permits and HERS/energy testing. Among the four quotes that did include this component, contractors quoted prices ranging from $450 to $590.

5.7 FINANCING

Similarly, a minority of WH contractors (12 of 37; 32%) offered financing options to the mystery shopper. Of these contractors, five offered payment plans between 12 and 24 months with 0% interest rate. Two contractors mentioned interest rates between 10% and 15%, while one contractor offered a lower interest rate of 6.49% for PG&E customers. Among contractors who offered financing options, the most common method to offer these options was to only discuss them verbally with the mystery shopper (6 of 12; 50%; Figure 27). About one-third of the contractors who offered financing options (4 of 12; 33%) included the details in the quote they provided; while the remaining contractors (2 of 12; 17%) both discussed these options verbally and included them in the quote they provided later.

Figure 27. How Did Contractors Offer Financing Options? (n=12)



Note: Responses among contractors who offered financing options.

5.8 KITCHEN TABLE CONVERSATION

During contractors' visits, mystery shoppers recorded contractors' attitudes toward HPWHs, including details about the benefits and concerns they bring up when discussing this technology.

5.8.1 HEAT PUMP WATER HEATER BENEFITS

About half of WH contractors (18 of 37; 49%) discussed benefits associated with HPWHs. Contractors who discussed the benefits of HPWHs highlighted a variety of advantages, particularly in relation to energy efficiency, cost savings, and compatibility with solar energy systems.

The most frequently cited benefit was the compatibility of HPWHs with solar power. Eleven contractors (30%) noted that HPWHs are well-suited for homes with existing PV systems, with five of these contractors (14%) noting that the cost of heating water with electricity is often offset by the savings from solar, particularly in areas with high utility rates.

Additionally, a few contractors (3 of 37; 8%) mentioned that the HPWHs can support future electrification goals and help homeowners transition away from gas systems entirely. For instance, two contractors highlighted that electrifying a home is a forward-thinking strategy, particularly in California, where there are ongoing efforts to phase out gas equipment. These contractors framed this shift as "investing in the future," noting that moving to all-electric systems aligns with broader environmental goals and governmental incentives. Another contractor did not view electrification as a clear benefit of HPWHs but instead said that HPWHs were not worth it unless the homeowner planned to completely electrify their home. This contractor said: "If you are keeping gas for cooking, clothes drying, etc., then don't switch your water heater to electric".

Contractors also highlighted both the energy efficiency and reliability of HPWHs as key benefits. A few contractors (5 of 37; 14%) emphasized the significant energy savings, with one noting that HPWHs use only 10%-12% of the energy required by traditional gas or electric storage water heaters. Several of these contractors also pointed out that this efficiency often translates into noticeable savings on monthly utility bills. Alongside energy savings, a similar number of contractors (4 of 37; 11%) also highlighted the reliability and low maintenance needs of HPWHs. One contractor referenced the generous 10-year warranties offered by many models and manufacturers' support when any issues arise.

Finally, a few contractors (3 of 37; 8%) mentioned that the cooling effect of HPWHs is an added benefit in hot climates. They explained that during operation, the heat pump expels cool air, which can lower the temperature near the HPWH. This cooling effect can increase comfort levels in areas like garages, where many HPWHs are installed. While one contractor noted the cooling effect as a drawback, saying the garage could get "very cold," homeowners may actually view this as a benefit.

5.8.2 HEAT PUMP WATER HEATER CONCERNS

Most contractors (29 of 37; 78%) raised concerns about HPWHs. Contractors generally perceived as "skeptical" of or "against" HPWHs tended to focus primarily on concerns, while those with a "supportive" or "big champion" attitude toward HPWHs tended to discuss both the benefits and concerns associated with the technology. **The most frequently mentioned drawbacks were installation space requirements and ensuring a sufficient hot water supply. Other challenges included difficulties accessing rebates, reliability concerns, and noise or vibration issues.**

Space limitations were the most common concern among contractors, with twelve contractors (32%) noting that HPWHs were larger than the existing water heaters and would take up more space in the home. Contractors noted that HPWHs are usually sized larger to accommodate the slower recovery rate, necessitating additional clearance around the unit. This added space requirement is especially problematic in homes with tight configurations, and several contractors mentioned that the unit would need to be relocated if the homeowner decided to switch to a HPWH. For example, two contractors suggested that the HPWH would need to be relocated to the garage to accommodate its larger size.

Another key concern was the hot water recovery rate. Ten contractors (27%) expressed concerns that HPWHs have slower recovery times than traditional gas or electric models. This slower recovery rate, which can take several hours to heat water to a usable temperature, could be particularly problematic for households with high hot water demand, such as homes with larger families. One contractor warned the mystery shopper that they could risk going without hot water for the entire day if they installed a HPWH. In some cases, contractors recommended opting for a larger unit, such as an 80-gallon model, to ensure there was sufficient hot water available. However, opting for a larger unit presented its own set of challenges, including higher costs and the need for more space, which not all homes could accommodate.

In addition to concerns about space requirements and recovery rates, contractors also highlighted issues related to accessing rebates, reliability, and noise/vibration. Six contractors (16%) expressed uncertainty about the availability of rebates for HPWHs, citing pauses or shortages in funding, with one contractor describing the rebates as "unstable." Five contractors (14%) raised concerns about the reliability of HPWHs, mainly due to their uncertainty about the long-term performance of the technology. Finally, four contractors (11%) noted potential noise and vibration issues, warning that the sound generated by HPWHs could transmit through walls and disrupt living spaces, including bedrooms.

5.8.3 CONTRACTORS' PERSPECTIVES ON COSTS

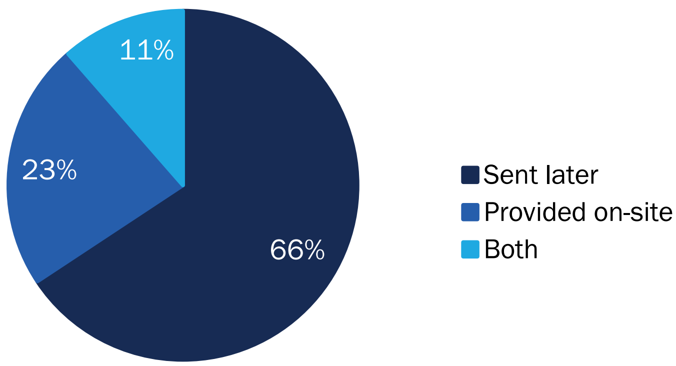
Several contractors (8 of 37; 22%) noted that HPWHs carry significantly higher upfront costs compared to gas storage or tankless water heaters. For example, one contractor pointed out that a HPWH typically costs around $6,500, while a standard gas water heater might only cost about $3,000. Another contractor mentioned that a solar water heater could run as high as $11,000. **In addition to the cost of the unit itself, contractors highlighted the additional installation expenses, such as electrical upgrades, which can substantially increase the total upfront investment.** Estimated costs for electrical work ranged from $1,500 for new wiring to as much as $9,000 for a full electrical panel upgrade. Even with rebates that can reduce the upfront cost, contractors pointed out that these incentives often have specific eligibility criteria, and some funding was currently on hold, making it harder for consumers to rely on them.

While some contractors believed that the operating savings might eventually offset the higher upfront cost of HPWHs, opinions on the long-term financial benefits were mixed. A small group of contractors (5 of 37; 11%) noted that HPWHs could lead to operational savings over time, with four of them emphasizing that these savings would be most significant when paired with solar energy. One contractor told the mystery shopper that it would not be worth it to install a HPWH unless the home had solar. Many contractors also cautioned that the payback period could be lengthy. For example, one contractor estimated it could take at least five years to recoup the additional costs of a HPWH compared to conventional gas water heaters. Given the newness of the technology, several contractors also expressed concerns about the reliability and lifespan of HPWHs, questioning whether the energy savings would justify the steep upfront cost in the long run. Two contractors further pointed out that, while HPWHs are more efficient than traditional electric water heaters, the operational savings might not be as substantial as other energy upgrades, such as replacing HVAC systems.

5.8.4 SITE VISITS AND QUOTES

Regarding contractor home visits, most WH contractors (29 of 37; 78%) were on site for less than an hour, while six contractors (16%) spent 1-2 hours on-site, and two contractors (5%) spent 2-3 hours on-site. About three-quarters of contractors (27 of 35; 77%) sent their quotes to mystery shoppers after their visit, while the rest (8 of 35; 23%) only provided their quotes on-site (Figure 28).[22]

Figure 28. When Did Contractors Provide Quote(s)? (n=35)



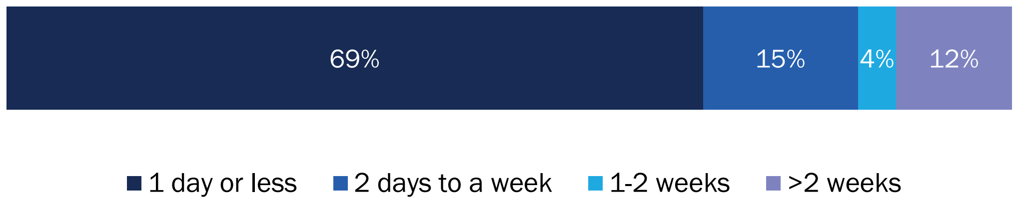
Among those contractors who sent quotes later, about two-thirds (18 of 26; 69%) provided them within a day or less (Figure 29).[23] Nearly all contractors (29 of 30; 97%) sent quotes electronically, while one contractor provided a printed quote.[24]

[22] Analysis excludes one contractor who did not end up providing bids and another contractor for whom information about when the bids were provided was missing.

[23] Analysis excludes one contractor for whom details about when the bids were provided were missing.

[24] Analysis excludes five contractors who did not end up providing bids and two contractors for whom information about the format of the bid was missing.

Figure 29. How Much Time Elapsed Between Contractors' Visit and Receiving The Quote(s) (n=26)



Note: Analysis among contractors who sent project bids later.

5.9 COST-RELATED FINDINGS

As with HVAC, water-heating equipment bids that contractors provided across both phases of our study showed variability in terms of the details included (e.g., cost breakdowns for equipment, labor, and any other costs associated with the project) and in terms of format (e.g., PDF, handwritten quotes, bids sent via email, etc.). For the purposes of our analysis, we used the total cost of each project without accounting for discounts or incentives, which allowed us to compare costs across bids and ensure that any discounts, promotions, and rebates provided by contractors did not skew our results. We provide information about incentives and financing options offered in subsequent sections of our report.

Overall, average project costs across equipment types and average incremental costs of heat pump systems varied among bids collected in Phase 2 and Phase 3, which is further detailed in this section.

5.9.1 DESCRIPTIVE SUMMARY OF WATER HEATER PROJECT COSTS

PHASE 2 WATER HEATER PROJECT COST DATA

Mystery shoppers solicited bids for HPWHs and for gas like-for-like replacements—a gas storage WH and, in the case of one home, a gas tankless WH. Additionally, some contractors provided bids for gas tankless water heaters beyond the one home that had one to begin with.

Table 21 summarizes the average, median, minimum, and maximum total WH project costs by equipment type. The average cost of a HPWH was about $8,500, while the average cost of a gas storage WH was half that price (about $4,200). Surprisingly, the average cost of a gas tankless WH was slightly higher than that of a HPWH at around $9,000.

Table 21. Phase 2 Water Heating Project Costs Summary by Equipment Type

Bid Equipment Type	Average	Median	Minimum	Maximum
Gas Storage Water Heater (n=20)	$4,264	$3,626	$2,010	$7,488
Gas Tankless Water Heater (n=24)	$9,011	$6,986	$5,500	$17,000
Heat Pump Water Heater (n=31)	$8,549	$7,846	$3,800	$14,700

When looking at the minimum and maximum costs by equipment type, **we see large variation in the cost data received, specifically for gas tankless WHs and HPWHs.** The lowest HPWH bid was $3,800 and the highest was $14,700. Figure

30 visually depicts the range of total project costs by equipment type, and shows this variation in costs, with the presence of a couple of outliers.

Figure 30. Phase 2 Water Heating Project Costs by Equipment Type

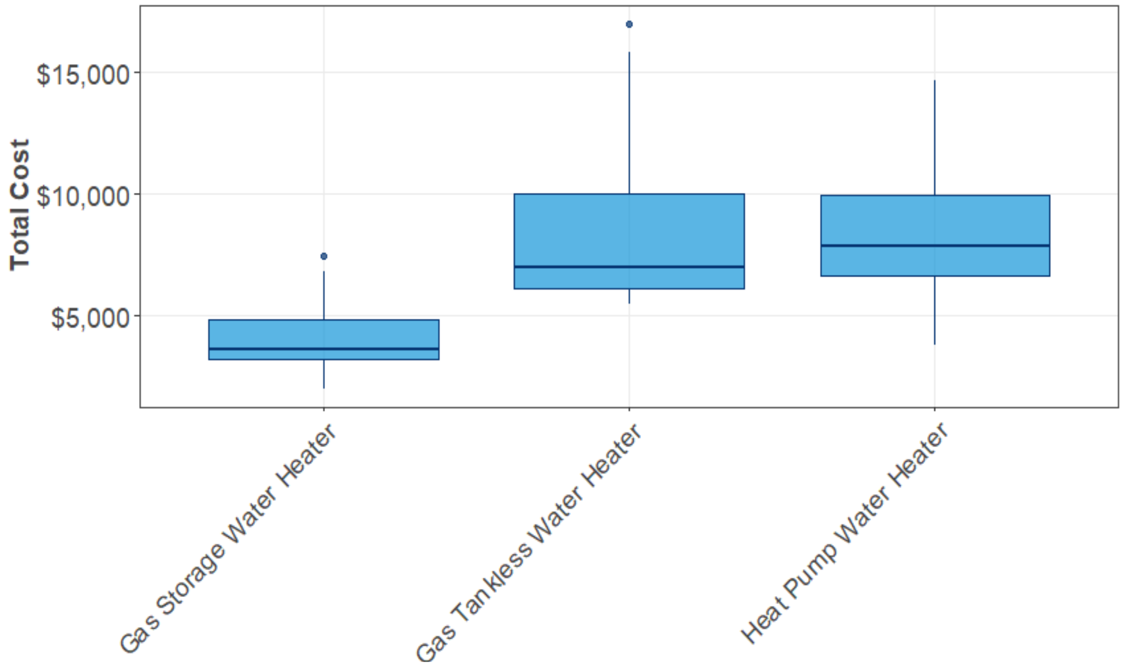


Table 22 below presents the cost average, median, minimum, and maximum for water heating equipment by climate region. As mentioned before, all our WH homes were located in a hot-dry or a marine climate region. **When it comes to water-heating equipment, total project costs are relatively similar within the same equipment type in hot-dry and marine climate regions**, consistent with costs received for HVAC equipment. In other words, **we found no relationship between total WH project costs and climate region.**

Table 22. Phase 2 Water Heating Project Costs Summary by Climate Region and Equipment Type

Climate Region	Average	Median	Minimum	Maximum
Gas Storage Water Heater				
Hot-Dry (n=14)	$4,402	$3,626	$2,500	$7,488
Marine (n=6)	$3,942	$3,713	$2,010	$6,777
Gas Tankless Water Heater				
Hot-Dry (n=17)	$8,355	$6,935	$5,500	$17,000
Marine (n=7)	$10,606	$8,324	$6,000	$15,563
Heat Pump Water Heater				
Hot-Dry (n=23)	$8,104	$7,846	$3,800	$13,225
Marine (n=8)	$9,829	$8,063	$4,938	$14,700

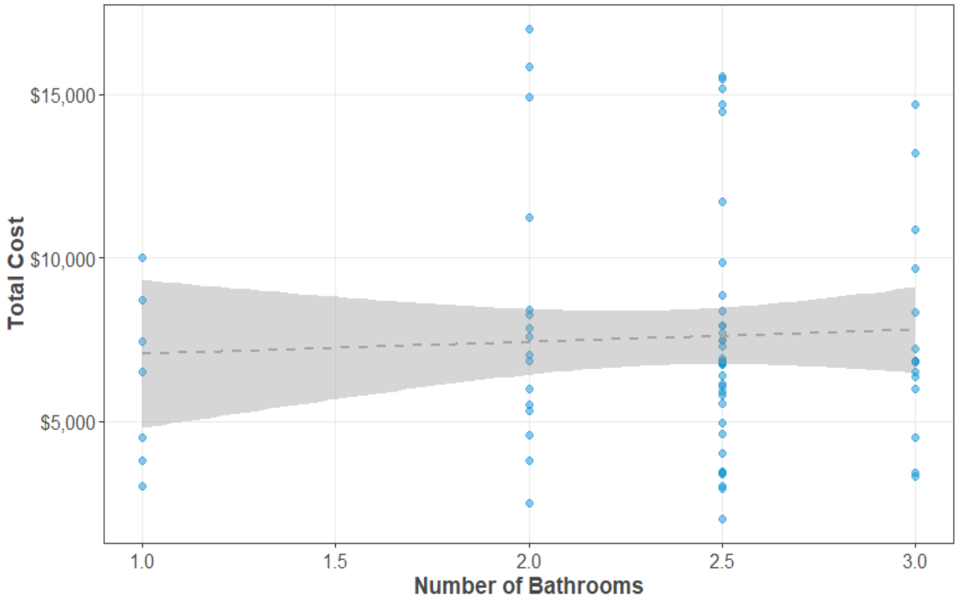
Additionally, we investigated cost differences between WH project costs provided by contractors who were enrolled in TECH Clean California versus those who were not. As Table 23 shows, TECH-enrolled contractors offered slightly lower WH project costs on average than non TECH-enrolled contractors for all equipment types, though the difference is not statistically significant.

Table 23. Phase 2 Water Heating Project Costs Summary by TECH Initiative Enrollment and Equipment Type

Contractor Type	Average	Median	Minimum	Maximum
Gas Storage Water Heater				
TECH-Enrolled (HPWH) (n=9)	$3,530	$3,395	$2,010	$5,553
Non TECH-Enrolled (n=11)	$4,864	$4,493	$2,500	$7,488
Gas Tankless Water Heater				
TECH-Enrolled (HPWH) (n=4)	$6,191	$6,014	$5,800	$6,935
Non TECH-Enrolled (n=20)	$9,575	$7,463	$5,500	$17,000
Heat Pump Water Heater				
TECH-Enrolled (HPWH) (n=10)	$7,247	$6,800	$4,938	$9,875
Non TECH-Enrolled (n=21)	$9,169	$8,273	$3,800	$14,700

We also explored the potential relationship between total water heater project costs and the number of bathrooms in a home, recognizing that some installers commonly use bathroom count as a rule of thumb when sizing water heaters. We used the number of bathrooms in the home as a proxy for how many people lived in the home, and therefore, have a sense of the home's water demand. We hypothesized that greater hot water demand would equate to larger capacity water heaters, which might be more expensive. As represented in Figure 31, the data from this sample of 10 homes showed **no correlation between total project costs and the number of bathrooms in the home.**

Figure 31. Phase 2 Water Heating Project Costs by Number of Bathrooms in the Home



We also looked at any potential differences in equipment costs by tank capacity, specifically for HPWHs. Table 24 breaks down the HPWH equipment cost statistics by tank capacity and shows a modest increase in average equipment costs as tank capacity increases. However, since most contractors did not provide itemized costs nor tank capacities in their quotes, we had a limited number of observations for each tank capacity category.

Table 24. Phase 2 Heat Pump Water Heater Equipment Costs Summary by Tank Capacity

Tank Capacity (Gallons)	Average	Median	Minimum	Maximum
50 (n=9)	$7,130	$6,500	$1,712	$10,633
65 (n=4)	$7,439	$7,147	$4,587	$10,875
66 (n=1)	$8,273	$8,273	$8,273	$8,273
80 (n=4)	$8,519	$7,026	$6,800	$13,225

Note: Average costs listed in the table reflect only the itemized price of the water-heating equipment in the bids provided by contractors.

In relation to the different components included in the total project costs (equipment, labor, and electrical and non-electrical modifications), very few contractors provided labor costs or electrical work costs as separate line items in their bids. Table 25 summarizes the average cost of various project components by equipment type. Equipment costs and non-electrical modification costs were more commonly specified, particularly in gas tankless WH and HPWH bids. The average cost for non-electrical modifications (such as installing a thermostatic mixing valve, adding a condensate drain, ventilation, and capping gas lines) in HPWH projects was about $990 (n=9).

Table 25. Phase 2 Itemized Water Heating Project Costs Summary by Equipment Type

Bid Equipment Type	Average Total Cost	Average Equipment Cost		Average Labor Cost		Average Electrical Modification Cost		Average Non-Electrical Modification Cost	
Gas Storage Water Heater (n=20)	$4,264	n=10	$3,994	n=0	N/A	n=0	N/A	n=4	$591
Gas Tankless Water Heater (n=24)	$9,011	n=13	$7,867	n=0	N/A	n=2	$1,830	n=7	$3,860
Heat Pump Water Heater (n=31)	$8,549	n=23	$8,024	n=1	$2,758	n=2	$757	n=9	$993

Note: N values reflect the number of bids that included each cost, not the number of unique contractors providing each cost. Average total costs were calculated using the total n of each equipment type.

When looking into costs for HERS testing and permitting for WH projects, we noted that most bids received in Phase 2 did not include them as a separate itemized cost. Four of 75 bids contained a permit cost averaging $566 across all equipment types. The itemized permit costs are summarized by city in Table 26 below.

Table 26. Phase 2 Water Heating Project HERS/Permitting Costs Summary by City

City [a]	Average	Median	Minimum	Maximum
La Quinta (n=3)	$589	$589	$589	$589
Oakland (n=1)	$450	$450	$450	$450

[a] n values represent the number of bids that included HERS/permit costs. As such, n values do not represent unique contractors' HERS/permit pricing.

5.9.2 INCREMENTAL COST FINDINGS

PHASE 2 FINDINGS

As mentioned previously, we used fixed-effects linear regression models to estimate incremental costs of a like-for-like replacement and a HPWH replacement for homes with a gas storage water heater and homes with a gas tankless water heater. Each model isolates the effect of specific project components, such as electrical upgrades or installation by a

TECH-enrolled contractor, on total project costs. To account for unobserved household-level differences (e.g., size, age, location, number of bathrooms), the models include fixed effects for each home, effectively comparing cost differences within the same household across different equipment types. Table 27 shows our incremental costs findings for the two scenarios of interest.

Table 27. Phase 2 Water-Heating Project Incremental Cost Findings by Upgrade Scenario

Replacement Equipment	Incremental Cost Estimate (Over Baseline)	% Incremental Cost (Over Baseline)
Gas Storage Water Heater (Baseline Average Cost: $4,264)		
Gas Tankless Water Heater (n=24)	$4,036*	95%
Heat Pump Water Heater (n=31)	$3,990*	94%
Gas Tankless Water Heater (Baseline Average Cost: $9,011)		
Heat Pump Water Heater (n=31)	($181)	(2%)

* Statistically significant at the 95% confidence level

A HPWH costs about the same as a tankless water heater, making their incremental costs over a gas storage water heater very similar. On average, both cost nearly double a gas storage water heater (about $4,000 more), representing a 95% cost increment.

In terms of project components and how they influence average project costs, we found that for a gas storage water heater replacement, projects that include electrical work are, on average, about $2,300 ($2,321) more expensive than those that do not include this type of work (holding all other terms constant and statistically significant at the 95% confidence level). Additionally, our analysis showed that in the case of a gas storage water heater replacement, projects that are completed by TECH-enrolled contractors are, on average, about $2,500 ($2,586) cheaper than those completed by non TECH-enrolled contractors (holding all other terms constant and statistically significant at the 95% confidence level). For a gas tankless water heater replacement project, that difference is slightly bigger, with projects completed by a TECH-enrolled contractor being about $3,000 ($3,121) cheaper, on average, than projects completed by their non-enrolled counterparts (holding all other terms constant and statistically significant at the 95% confidence level).

Aggregated Findings

We combined the cost data across both phases of our study to estimate incremental costs associated with a like-for-like replacement and a HPWH replacement based on a larger number of observations. As described in previous sections, when running our regression models on the combined data, we created a flag to distinguish bids from each phase and account for the fact that the data were collected using two different methods (i.e., mystery shopping and online survey). The incremental cost findings from the combined cost data from Phases 2 and 3 are presented in Table 28 below.

Our analysis of the aggregated data showed that **a gas tankless water heater replacement costs about $3,300 more, on average, than a gas storage water heater replacement, which represents a 78% cost increment. Even more expensive would be replacing a gas storage water heater with a HPWH, which costs about $4,000 more than a like-for-like equipment replacement, representing a 96% cost increment.** Consistent with what we found in Phase 2, **when compared to the average cost of a gas tankless water heater replacement, models showed that the average cost of a HPWH is not statistically different.**

Table 28. Phase 2 & 3 Aggregated Water Heating Project Incremental Cost Findings by Upgrade Scenario

Replacement Equipment	Incremental Cost Estimate (Over Baseline)	% Incremental Cost (Over Baseline)
Gas Storage Water Heater (Baseline Average Cost: $4,279)		
Gas Tankless Water Heater (n=38)	$3,337*	78%
Heat Pump Water Heater (n=48)	$4,129*	96%
Phase 3 (n=45)	($1,537)*	-36%
Gas Tankless Water Heater (Baseline Average Cost: $8,313)		
Heat Pump Water Heater (n=48)	$844	10%
Phase 3 (n=45)	($1,453)*	-17%

* Statistically significant at the 95% confidence level

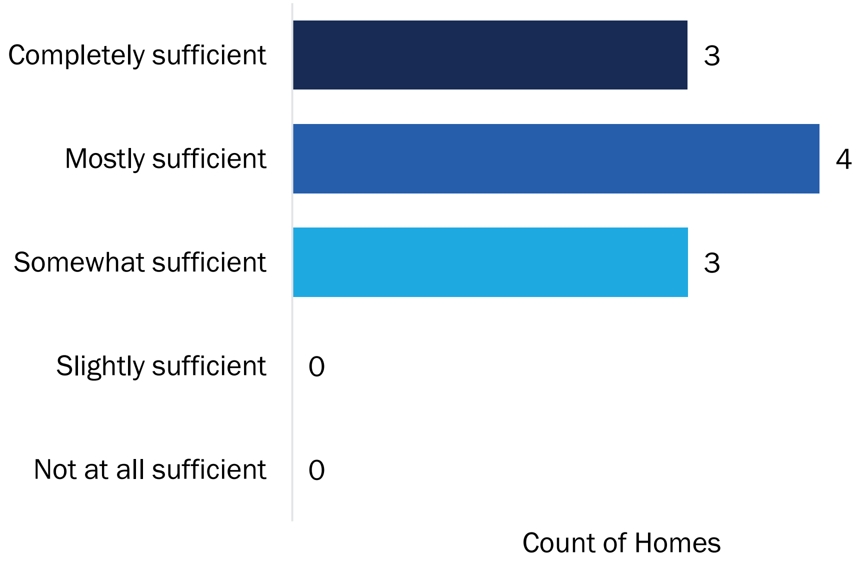
Additionally, we found that for a gas tankless water heater replacement, projects that include electrical work are, on average, about $2,600 more expensive than projects that do not include this type of work (holding all other terms constant and statistically significant at the 95% confidence level). Lastly, in the case of a like-for-like gas storage water heater replacement, we had one Phase 3 project where the contractor recommended electrical panel work for safety reasons, which added $5,642 to the water heater-only project cost.

Overall, our model estimated that when it comes to replacing either a gas storage water heater or a gas tankless water heater, bids received through the online contractor survey were about $1,500 less expensive than bids received during the mystery shopping exercise.

5.10 INFORMATION CONTRACTORS NEED TO PROVIDE ACCURATE BIDS

We asked contractors the degree to which the information and images included in each home package and presented on the study's webpage were sufficient to provide accurate cost estimates. Based on their responses to the Phase 3 survey, we then calculated an average sufficiency score for each home to determine whether any home package particularly lacked information, hindering contractors' ability to estimate accurate water heating project costs. We estimated that the average sufficiency score across all WH homes was 1.9 on a scale from 1 to 5, where 1 is "Completely sufficient," and 5 is "Not at all sufficient." As such, on average, the information we provided on each WH home's webpage could most closely be described as "mostly" sufficient, a slight improvement compared to the average score of HVAC homes. Figure 32 shows the number of WH homes in each category related to the sufficiency of information included in their home package.

Figure 32. Sufficiency of Information Included in WH Homes' Packages Provided in Phase 3 (n=10)



For water heating projects, the most mentioned pieces of information that would have facilitated the cost estimation process were the dimensions of the water heater location (mentioned by 3 contractors), additional information about ventilation in the water heater location (mentioned by 3 contractors), the location of the gas meter (mentioned by 2 contractors), information on piping routes through the home (mentioned by 1 contractor), and images of the pathway from the street to the water heater location (mentioned by 1 contractor).

6. CONCLUSIONS AND RECOMMENDATIONS

Based on the findings of this Incremental Cost Study, we offer the following conclusions and recommendations:

Conclusion 1: Contractor variability is high. California contractors approach single-family heat pump projects very differently. Bids for the same home varied by several thousand dollars, and practices around permitting, electrical inspections, and additional upgrades were inconsistent. This variability creates opportunities for contractors with strong heat pump expertise to differentiate their business by highlighting their acumen and know-how with heat pump equipment.

Conclusion 2: Participation in incentive programs matter. Contractors enrolled in TECH Clean California were significantly more likely to raise heat pumps as an option, emphasize their benefits, assess whether the home's electrical system could support the equipment, and proactively present available incentives. In contrast, non-TECH contractors often failed to do so, underscoring the importance of program participation in ensuring homeowners receive accurate information and viable pathways to adoption.

Conclusion 3: The water-heating heat pump market lags behind space-conditioning heat pump market. Contractors' attitudes and sales practices differ sharply between the water-heating and space-conditioning markets. Consistent with Opinion Dynamics' prior assessments, the HPWH market continues to lag behind HVAC heat pumps. In this study, water-heating contractors emphasized drawbacks of HPWHs more often than benefits, while HVAC contractors highlighted benefits of heat pumps more frequently than concerns.

Recommendation: Prioritize HPWH incentives. Because contractors communicate fewer perceived benefits of HPWHs to customers, incentives play a disproportionately important role in driving adoption. If programs must target limited incentive dollars, we recommend prioritizing the water-heating market, where incentives are likely to carry greater weight in shaping homeowner decisions and overcoming contractor skepticism.

Conclusion 4: HVAC heat pumps have not yet reached commodity status in California. Unlike gas furnaces—which show relatively consistent pricing—heat pump project costs vary dramatically, ranging from roughly $10,000 to $40,000. This wide spread indicates that heat pumps remain in an early stage of market development, with limited availability and significant contractor discretion in pricing. As adoption grows and more contractors enter the market, we expect price variability to decline and project costs to converge toward greater consistency.

Recommendation: Continue to train and expand contractor base to reduce price variability. While HVAC heat pumps remain in an early, non-commodity phase with wide cost variability, programs should focus on expanding contractor participation, improving price transparency, and supporting trade ally and consumer education. These efforts can accelerate market maturity, reduce pricing disparities, and help ensure that homeowners receive fair, competitive bids as the technology becomes more widely available.

Conclusion 5: Ancillary costs are significant. Non-electrical modifications add an average of $3,600 to HVAC heat pump project costs. Unlike furnace replacements, heat pump installations often require ancillary upgrades—such as ductwork modifications—that drive up total costs. These additional expenses increase the incremental cost of heat pumps and may place them out of reach for low- to moderate-income households.

Recommendation: Support ancillary costs to expand access. To address the burden of ancillary costs, programs should consider offering targeted incentives or financing to cover common non-electrical modifications such as ductwork, permitting, or site preparation. Bundling these supports into heat pump incentive programs can reduce financial barriers for low- and moderate-income households and make projects more accessible and equitable.

Conclusion 6: Gas water heaters remain the lowest cost option. On average, gas storage water heaters cost about half as much as HPWHs, while HPWHs were priced comparably to gas tankless systems. Given this price gap and contractors' strong tendency to recommend like-for-like replacements, gas water heaters are likely to remain the default choice for most California homeowners absent strong drivers such as rooftop solar or adequate incentives.

APPENDIX A. PHASE I COST STUDY FINDINGS

The presentation of findings from Phase 1 of the study is attached below.

TECH Incremental
Cost Study - FINAL Ph

APPENDIX B. DATA COLLECTION INSTRUMENTS

PHASE 2

Homeowner Recruitment Survey Instrument

Homeowner Recruitment Survey .p

PHASE 3

Contractor Survey Instrument

Phase III Contractor Survey.pdf

APPENDIX C. DETAILED HOME CHARACTERIZATIONS

Below we provide additional information about each HVAC and WH home including home size, details about their existing equipment, condition of the electrical panel, and their electric and gas utility, among other information. Several homes received service from Small and Multi-Jurisdictional Utilities (SMJUs), which operate across multiple states and/or serve relatively few customers, often in rural areas. To help protect the identities of homeowners in these smaller service territories, we have labeled these utilities as SMJUs in the tables below.

HVAC HOMES

Table 29 details home characteristics for all 20 HVAC homes. Several homes had multiple HVAC systems, and some did not have central air conditioning (CAC).

Table 29. HVAC Home Detailed Characteristics

Home #	Utility	Climate Zone	Number of bedrooms	Number of bathrooms	Conditioned Square Footage	Year built	Presence of solar panels or batteries	Number of Systems	Furnace Age (years)	Furnace Location	CAC Presence	Main Panel Amps	Number of open slots
ODC004	SDG&E	10 (Hot-Dry)	5	3.5	3,100	2003	None	2	21	Attic	Yes	200A	2
ODC005	SDG&E	10 (Hot-Dry)	4	3	2,871	2003	PV (no battery)	2	21	Attic/Garage	Yes	200A	1
ODC007	PG&E	3 (Marine)	3	2	1,600	1950	None	1	24	Bedroom closet	No	200A	3 (main) 0 (sub)
ODC008	SMJU (electric) PG&E (gas)	12 (Hot-Dry)	2	1	1,260	1928	None	1	15	Basement	Yes	100A	1
ODC010	PG&E	3 (Marine)	4	3	1,793	1912	PV and battery	1	Unknown (old)	Crawlspace	Yes	200A	3
ODC013	PG&E	3 (Marine)	3	2	1,400	1942	PV (no battery)	1	21	Crawlspace	No	200A	2 (main) 7 (sub)
ODC014	SCE (electric) SoCalGas (gas)	6 (Marine)	5	3	2,534	1961	None	1	14	Hallway closet	Yes	200A	0 (main) 7 (sub)
ODC016	SCE (electric) SoCalGas (gas)	6 (Marine)	4	2	1,832	1945	PV (no battery)	1	3	Closet in playroom	Yes	200A	3 (main) 0 (sub)
ODC017	SMJU(electric) Southwest Gas Corporation (gas)	16 (Cold)	2	2	1,600	1979	None	1	22	Crawlspace	No	125A	0

Home #	Utility	Climate Zone	Number of bedrooms	Number of bathrooms	Conditioned Square Footage	Year built	Presence of solar panels or batteries	Number of Systems	Furnace Age (years)	Furnace Location	CAC Presence	Main Panel Amps	Number of open slots
ODC018	SDG&E (both)	10 (Hot-Dry)	4	2.5	2,259	1985	PV (no battery)	1	4	Garage	No	100A	0 (main) 1 (sub)
ODC020	PG&E (both)	13 (Hot-Dry)	3	3.5	2,900	1958	None	2	>30	Rooftop	Yes	200A	0
ODC023	SCE (electric) SoCalGas (gas)	6 (Marine)	3	3	2,014	1969	None	1	31	Upstairs interior closet	No	100A	1 (main) 0 (sub)
ODC024	SDG&E	7 (Hot-Dry)	5	3	3,000	1997	PV (no battery)	1	30	Attic	Yes	125A	0 (main) 3 (sub)
ODC026	PG&E	12 (Hot-Dry)	3	2	1,343	1961	None	1	26	Exterior closet	Yes	125A	4
ODC028	SDG&E	7 (Hot-Dry)	4	3	2,400	1993	PV (no battery)	1	30	Garage	No	125A	0
ODC029	PG&E	3 (Marine)	4	3	1,735	1953	None	1	15	Garage	No	110A	6 (main) 2 (sub)
ODC030	SCE (electric) SoCalGas (gas)	6 (Marine)	3	2	1,008	1943	None	1	20	Attic	No	125A	2 (main) 2 (sub)
ODC031	PG&E	11 (Hot-Dry)	4	2	2,400	2007	PV (no battery)	1	17	Attic	Yes	175A	0
ODC032	SCE (electric) SoCalGas (gas)	8 (Hot-Dry)	2	1.5	1,200	1940	PV (no battery)	1	12	Attic	Yes	200A	0
ODC033	PG&E	2 (Marine)	3	2.5	2,000	1991	None	1	33	Upstairs interior closet	Yes	100A	0 (main) 1 (sub)

WATER HEATING HOMES

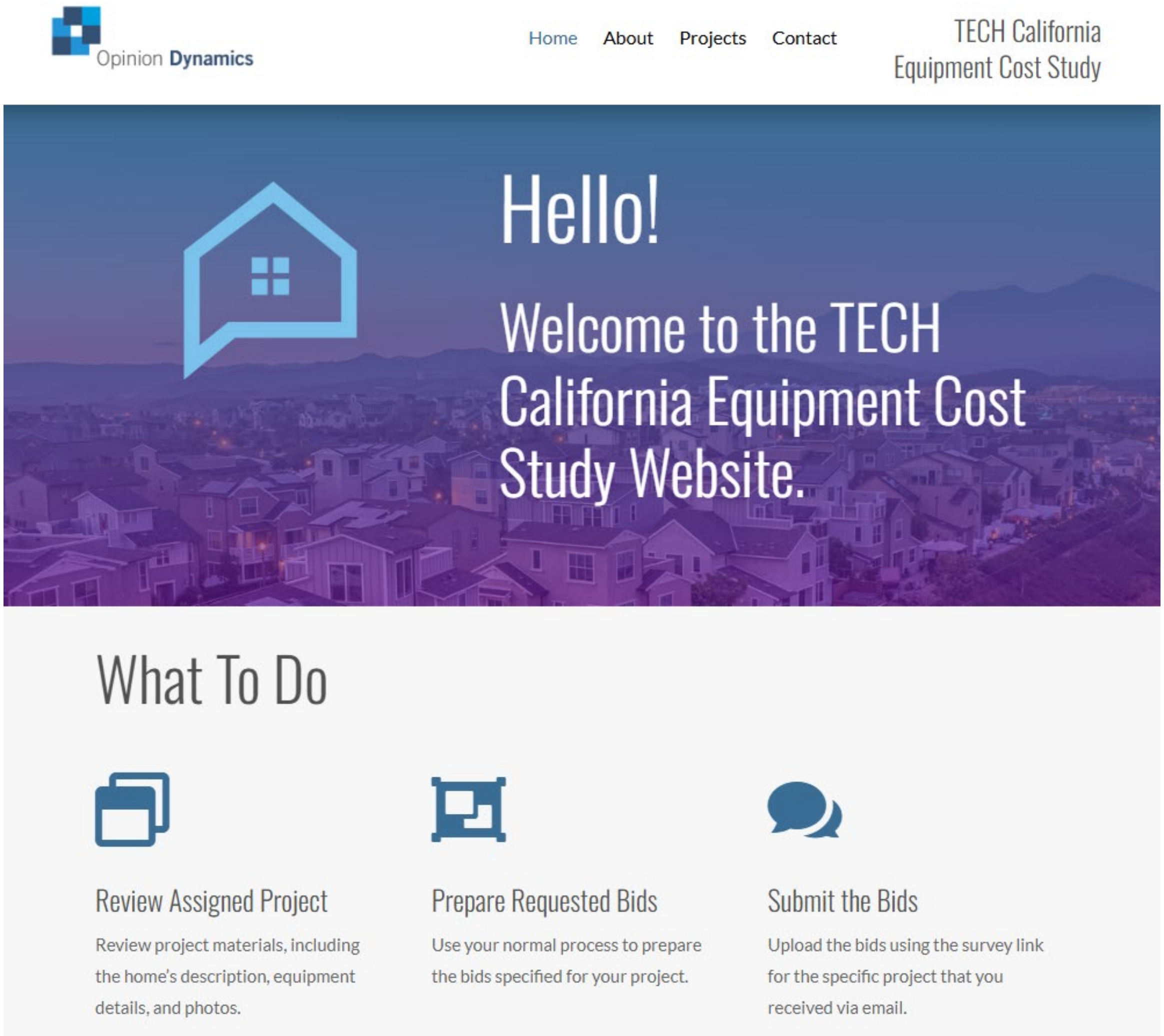
Table 30 includes key characteristics for all ten WH homes. While these homes varied in several aspects, all were between 1,200 and 2,700 square feet in size. Most had water heaters located in unconditioned garages, with the exceptions of one in a basement and another in an outdoor closet.

Table 30. Water Heating Homes Detailed Characteristics

Home #	Utility	Climate Zone	Number of bedrooms	Number of bathrooms	Conditioned Square Footage	Year built	Presence of solar panels or batteries	Water Heater Age	Water Heater Location	Main Panel Amps	Number of open slots
ODC001	SDG&E	7 (Hot-Dry)	3	2	1,216	1948	None	2	Unconditioned garage	100A	0
ODC002	PG&E	13 (Hot-Dry)	4	2.5	2,250	2023	PV (no battery)	<1	Unconditioned garage	200A	11 (main) 3 (sub)
ODC003	SCE (electric) SoCalGas (gas)	9 (Hot-Dry)	3	2	1,791	1962	PV (no battery)	17	Unconditioned garage	200A	0
ODC006	SMJU (electric) SoCal Gas (gas)	15 (Hot-Dry)	3	2.5	2,611	2002	None	22	Unconditioned garage	200A	0
ODC009	PG&E	3 (Marine)	4	3	2,200	1922	PV + battery	4	Unconditioned basement	200A	13 (main) 12 (sub)
ODC012	SMJU (electric) PG&E (gas)	12 (Hot-Dry)	4	3	2,166	1989	PV (no battery)	4	Unconditioned garage	200A	3 (main) 0 (sub)
ODC015	PG&E	2 (Marine)	3	2.5	1,909	1971	None	16	Unconditioned garage	100A	0
ODC021	SDG&E	10 (Hot-Dry)	4	2.5	2,538	2003	PV (no battery)	7	Unconditioned garage	200A	0
ODC022	SDG&E	7 (Hot-Dry)	3	1	1,250	1959	PV (no battery)	3	Outdoor closet	100A	0
ODC025	PG&E	12 (Hot-Dry)	4	3	2,158	2004	None	4	Unconditioned garage	100A	8 (main) 5 (sub)

APPENDIX D. STUDY WEBSITE AND HOME PACKAGE WEBPAGE

For the Phase 3 contractor survey, we created a website with a brief description of the study's protocol, an instructional video for participants, and separate webpages for each home project. Below is an image of the website's home page.



As mentioned, each home had a separate webpage with information and imagery about the home and the relevant equipment. Sample images of the webpages for one HVAC home and one WH home are shown below.

Single-Family Home #008: Sacramento, California

Project Details:

The family in this two-story home, built in 1928, has a gas forced-air furnace and a central air conditioner (split system). Both systems are 15 years old, and the family is looking to replace them. The furnace is functioning well, but the family also uses a space heater. At the end of last summer, their central AC system started switching off randomly, pushing out air, but air that was not cool. They currently have a 100 amp electrical panel with one open slot.

Please prepare bids for the following equipment systems:

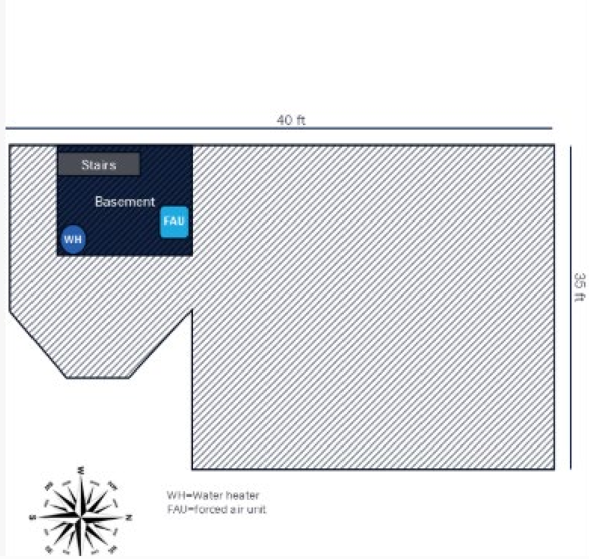
1. Standard heat pump
2. Inverter-driven heat pump
3. Gas central furnace + central AC

Home Characteristics and Layout:

Number of stories	Number of bedrooms	Number of bathrooms	Conditioned square footage	Year built	Presence of solar panels or batteries
2	2	1	1,260	1928	None

First Floor

Second Floor



Existing Space Heating Equipment:

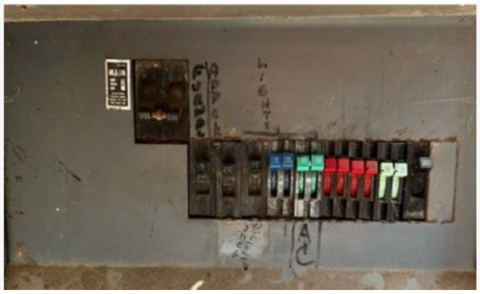
Space heating equipment type	System #	Location	Make/ Model	Heating capacity (Btuh)	Efficiency (AFUE)	Age (years)	Area served	Current condition
Gas forced-air furnace	1	Basement	Amana AMV90704 CXB	70,000	95.5%	15	Whole home	Functioning

FAU

Electrical Panel & Additional Information:

Electric and Gas utility provider	Power lines overhead or underground?	Location & accessibility	Main panel (Amps)	Any subpanels?	Number of open/availabl e breaker slots	Approximate distance from panel to forced air furnace location
SMUD (electric) PG&E (gas)	Overhead	Exterior	100 A	No	1 available	Basement= 40 ft

Outdoor Panel



In addition to having the ability to view the information on a webpage, contractors could also view the information and imagery in a printable format.

WH HOME

Single-Family Home #015: Santa Rosa, California

Project Details:

The family in this single-story home, built in 1971, has a 40-gallon gas storage water heater. It is 16 years old, and they are looking to replace it. The system is functioning, but it takes a while to get hot water. It is in the home's unconditioned garage and does not have a recirculation pump. The homeowner is interested in installing rooftop solar and would consider converting to a heat pump water heater to use more of the PV generation. There are two adults living in the home. They currently have a 100-amp Zensco electrical panel with no open slots.

Please prepare bids for the following equipment systems:

1. Gas storage water heater
2. Gas tankless water heater
3. Heat pump water heater

Existing Water Heater Equipment:

System type	Location	Storage capacity (gallons)	Make/ Model	Input heating capacity (Btuh)	Age (years)	Home has a water softener?	120V outlet close to WH?	Recirculation pump present & operational?	Type of room adjacent to WH location
Gas storage water heater	Unconditioned garage	40 gal	State Select GS640YOCTG	40,000	16	No	Yes	No	Dining room

Water Heater

Electrical Panel & Additional Information:

Electric and Gas utility provider	Power lines overhead or underground?	Location & accessibility	Main panel (Amps)	Any subpanels?	Number of open/available breaker slots	Approximate distance from panel to water heater location
PG&E	Underground	Left front of house, behind a fence, easy access	100 A	No	0 (none)	60 ft

Outdoor Panel

APPENDIX E. PHASE 2 & 3 INCREMENTAL COST DETAILED METHODS

This appendix provides further detail on our linear fixed-effect regression modeling.

The evaluation team developed a series of fixed-effects linear regression models to estimate the incremental cost of heat pump upgrades over like-for-like replacements for each phase of our study. We looked at homes with one HVAC system and homes with two HVAC systems separately. Each model isolated the effect of specific project components, such as electrical panel upgrades, non-electrical modifications, installation by a TECH-enrolled contractor, HERS testing/permits on total project costs. To account for unobserved household-level differences (e.g., size, age, or location), the models include fixed effects for each home, effectively comparing cost differences within the same household across different installation types. Our analysis looked at two possible baseline scenarios for each equipment type.

Scenarios for HVAC analysis:

1. Average cost of a gas furnace-only replacement as the baseline, and
2. Average cost of a gas furnace + central air conditioning (CAC) system replacement as the baseline.

Scenarios for WH analysis:

1. Average cost of a gas storage water heater replacement as the baseline, and
2. Average cost of a gas tankless water heater replacement as the baseline.

We tested a wide range of model specifications to identify the most robust and interpretable results. While our modeling initially considered a broader set of technical and home characteristics, we retained only variables with sufficient data and statistically significant effects. The models presented in the report represent the final, validated specifications selected for their explanatory power, reliability, and alignment with available data. The table below lists the variables we investigated during the modeling process.

Table 31. Variables of Interest Investigated during Regression Modeling

Variable Description
HERS testing and/or permitting costs included in bid
Electrical panel replacement cost included in bid
Electrical work costs included in bid
Square footage of home
Duct replacement cost included in bid
Non-electrical modification costs included in bid
Contractor is enrolled in TECH Initiative
Presence of solar panels in the home
Climate region
Number of bathrooms in the home
New Equipment efficiency*
New Equipment capacity*
Furnace blower type*
Heat Pump type (standard vs. inverter-driven)*

*There were not enough observations to estimate a relationship with total project cost.

The next sections provide details of the final regression models used to estimate incremental costs for each phase of our study.

HVAC

PHASE 2

Equation 1 compares the cost of installing a gas furnace to the cost of alternative technologies, such as installing an electric heat pump alone or in combination with a gas furnace. It also evaluates how additional project elements, such as electrical panel upgrades and permit-related costs, affect the total project cost of installing a gas furnace.

Equation 1. Gas Furnace Cost Model

$$Gas\ Furnace\ Cost_i = \beta_{Electric\ Heat\ Pump} * Electric\ Heat\ Pump_i + \beta_{Heat\ Pump\ and\ Existing\ Furnace} * Heat\ Pump\ and\ Existing\ Furnace_i + \beta_{Heat\ Pump\ and\ New\ Furnace} * Heat\ Pump\ and\ New\ Furnace_i + \beta_{Electric\ Panel\ Work} * Electrical\ Panel\ Work_i + \beta_{HERS\ Permit\ Work} * HERS\ Permit\ Work_i + \alpha_i + \varepsilon_i$$

Where:

$Gas\ Furnace\ Cost_i$ = Total gas furnace installation cost for home i.

$Electric\ Heat\ Pump_i$ = Dummy variable is 1 if the project includes an all-electric heat pump, 0 otherwise.

$Heat\ Pump\ and\ Existing\ Furnace_i$ = Dummy variable is 1 if the project includes a heat pump paired with the existing gas furnace, 0 otherwise.

$Heat\ Pump\ and\ New\ Furnace_i$ = Dummy variable is 1 if the project includes both a heat pump and a new gas furnace, 0 otherwise.

$Electrical\ Panel\ Work_i$ = Dummy variable is 1 if the project required upgrades to the home's electrical panel, 0 otherwise.

$HERS\ Permit\ Work_i$ = Dummy variable is 1 if the project includes HERS testing or permit costs, 0 otherwise.

α_i = Fixed effect for each home (controls for home-level differences).

ε_i = Error terms for home i.

Results:

Term	Estimate	Std.Error	Statistic	P.Value
All-Electric Heat Pump	10,869*	1428.59	7.61	0.00
Heat Pump and Existing Furnace	7,594*	2037.82	3.73	0.00
Heat Pump and New Furnace	9,915*	1434.26	6.91	0.00
Electrical Panel Work	- 2,374*	296.94	-7.01	0.00
HERS Permit Work	3,946*	1395.17	2.83	0.01

*Statistically significant at the 95% confidence level.

Equation 2 compares the total project cost of installing a gas furnace and central air conditioner system to the cost of installing an all-electric heat pump or a dual-fuel heat pump system. It also measures the effect of HERS testing/permit-related costs on total project costs of installing a gas furnace and central air conditioner system.

Equation 2. Gas Furnace and CAC Cost Model

$$Gas\ Furnace\ and\ CAC\ Cost_i = \beta_{Electric\ Heat\ Pump} * Electric\ Heat\ Pump_i + \beta_{Heat\ Pump\ and\ Existing\ Furnace} * Heat\ Pump\ and\ Existing\ Furnace_i + \beta_{Heat\ Pump\ and\ New\ Furnace} * Heat\ Pump\ and\ New\ Furnace_i + \beta_{HERS\ Permit\ Work} * HERS\ Permit\ Work_i + \alpha_i + \varepsilon_i$$

Where:

$Gas\ Furnace\ and\ CAC\ Cost_i$ = Total project cost for installing a gas furnace and CAC system for home i.

$Electric\ Heat\ Pump_i$ = Dummy variable is 1 if the project includes an all-electric heat pump, 0 otherwise.

$Heat\ Pump\ and\ Existing\ Furnace_i$ = Dummy variable is 1 if the project includes a heat pump paired with the existing gas furnace, 0 otherwise.

$Heat\ Pump\ and\ New\ Furnace_i$ = Dummy variable is 1 if the project includes both a heat pump and a new gas furnace, 0 otherwise.

$HERS\ Permit\ Work_i$ = Dummy variable is 1 if the project included HERS testing or permit costs, 0 otherwise.

α_i = Fixed effect for each home (controls for home-level differences).

ε_i = Error terms for home i.

Results:

Term	Estimate	Std.Error	Statistic	P.Value
All-Electric Heat Pump	2,456*	721.05	3.41	0.00
Heat Pump and Existing Furnace	- 640	1878.86	-0.34	0.74
Heat Pump and New Furnace	982	1731.44	0.57	0.58
HERS Permit Work	4,681*	1623.68	2.88	0.01

*Statistically significant at the 95% confidence level.

Equation 3 compares the total project cost of installing a gas furnace and central air conditioner system to the cost of installing an all-electric heat pump or a dual-fuel heat pump system. It also measures the effect of HERS testing/permit-related costs. It is worth mentioning that the estimated values were statistically significant due to the small sample size (n=18 bids).

Equation 3. Gas Furnace and CAC Cost Model for Two-HVAC Systems Homes

$$Gas\ Furnace\ and\ CAC\ Cost_i = \beta_{Electric\ Heat\ Pump} * Electric\ Heat\ Pump_i + \beta_{Heat\ Pump\ and\ New\ Furnace} * Heat\ Pump\ and\ New\ Furnace_i + \beta_{HERS\ Permit\ Work} * HERS\ Permit\ Work_i + \alpha_i + \varepsilon_i$$

Where:

$Gas\ Furnace\ and\ CAC\ Cost_i$ = Total project cost for installing a gas furnace and CAC system for home i.

$Electric\ Heat\ Pump_i$ = Dummy variable is 1 if the project includes an all-electric heat pump, 0 otherwise.

$Heat\ Pump\ and\ Existing\ Furnace_i$ = Dummy variable is 1 if the project includes a heat pump paired with the existing gas furnace, 0 otherwise.

$Heat\ Pump\ and\ New\ Furnace_i$ = Dummy variable is 1 if the project includes both a heat pump and a new gas furnace, 0 otherwise.

$HERS\ Permit\ Work_i$ = Dummy variable is 1 if the project included HERS testing or permit costs, 0 otherwise.

α_i = Fixed effect for each home (controls for home-level differences).

ε_i = Error terms for home i.

Results:

Term	Estimate	Std.Error	Statistic	P.Value
All-Electric Heat Pump	2,762	5516.60	0.50	0.67
Heat Pump and New Furnace	- 7,037	7135.48	-0.99	0.43
HERS Permit Work	4,123	10149.33	0.41	0.72

Note: Results were not statistically significant.

PHASE 3

Equation 4. Gas Furnace Cost Model

$$Gas\ Furnace\ Cost_i = \beta_{Electric\ Heat\ Pump} * Electric\ Heat\ Pump_i + \beta_{Heat\ Pump\ and\ New\ Furnace} * Heat\ Pump\ and\ New\ Furnace_i + \beta_{TECH\ Contractor} * TECH\ Contractor_i + \alpha_i + \varepsilon_i$$

Where:

$TECH\ Contractor_i$ = Dummy variable is 1 if the contractor was enrolled in the TECH Initiative, 0 otherwise.

Results:

Term	Estimate	Std.Error	Statistic	P.Value
All-Electric Heat Pump	12,489*	1405.16	8.89	0.00
Heat Pump and New Furnace	12,903*	2107.47	6.12	0.00
TECH-enrolled Contractor	- 3,431*	937.32	-3.66	0.00

*Statistically significant at the 95% confidence level.

Equation 5. Gas Furnace and CAC Cost Model

$$Gas\ Furnace\ and\ CAC\ Cost_i = \beta_{Electric\ Heat\ Pump} * Electric\ Heat\ Pump_i + \beta_{Heat\ Pump\ and\ New\ Furnace} * Heat\ Pump\ and\ New\ Furnace_i + \beta_{TECH\ Contractor} * TECH\ Contractor_i + \alpha_i + \varepsilon_i$$

Results:

Term	Estimate	Std.Error	Statistic	P.Value
All-Electric Heat Pump	1,965*	605.04	3.25	0.01
Heat Pump and New Furnace	2,559*	1137.11	2.25	0.04
TECH-enrolled Contractor	- 2,961*	1114.08	-2.66	0.02

*Statistically significant at the 95% confidence level.

Equation 6. Gas Furnace and CAC Cost Model for Two-HVAC Systems Homes

$$Gas\ Furnace\ and\ CAC\ Cost_i = \beta_{Electric\ Heat\ Pump} * Electric\ Heat\ Pump_i + \beta_{TECH\ Contractor} * TECH\ Contractor_i + \alpha_i + \varepsilon_i$$

Results:

Term	Estimate	Std.Error	Statistic	P.Value
All-Electric Heat Pump	5,360*	424.23	12.63	0.01
TECH-enrolled Contractor	- 6,175	2708.87	-2.28	0.15

*Statistically significant at the 95% confidence level.

AGGREGATED DATA

Equation 7. Gas Furnace Cost Model

$$Gas\ Furnace\ Cost_i = \beta_{Electric\ Heat\ Pump} * Electric\ Heat\ Pump_i + \beta_{Heat\ Pump\ and\ New\ Furnace} * Heat\ Pump\ and\ New\ Furnace_i + \beta_{Heat\ Pump\ and\ Existing\ Furnace} * Heat\ Pump\ and\ Existing\ Furnace_i + \beta_{Electric\ Panel\ Work} * Electrical\ Panel\ Work_i + \beta_{HERS\ Permit\ Work} * HERS\ Permit\ Work_i + \beta_{Phase\ III} * Phase\ III_i + \alpha_i + \varepsilon_i$$

Where:

$Phase\ III_i$ = Dummy variable is 1 if the bid was received from the contractor survey, 0 if it was received from the mystery shopping.

Results:

Term	Estimate	Std.Error	Statistic	P.Value
All-Electric Heat Pump	11,080*	1027.62	10.78	0.00
Heat Pump and Existing Furnace	5,868*	1529.58	3.84	0.00
Heat Pump and New Furnace	10,574*	1410.45	7.50	0.00
Electrical Panel Work	- 3,578*	364.66	-9.81	0.00
HERS Permit Work	3,386*	1236.12	2.74	0.01
Phase III	1,749^	1021.15	1.71	0.10

*Statistically significant at the 95% confidence level.

^Statistically significant at the 90% confidence level.

Equation 8. Gas Furnace and CAC Cost Model

$$Gas\ Furnace\ and\ CAC\ Cost_i = \beta_{Electric\ Heat\ Pump} * Electric\ Heat\ Pump_i + \beta_{Heat\ Pump\ and\ New\ Furnace} * Heat\ Pump\ and\ New\ Furnace_i + \beta_{Heat\ Pump\ and\ Existing\ Furnace} * Heat\ Pump\ and\ Existing\ Furnace_i + \beta_{Electric\ Panel\ Work} * Electrical\ Panel\ Work_i + \beta_{HERS\ Permit\ Work} * HERS\ Permit\ Work_i + \beta_{Phase\ III} * Phase\ III_i + \alpha_i + \varepsilon_i$$

Term	Estimate	Std.Error	Statistic	P.Value
All-Electric Heat Pump	2,087*	576.25	3.62	0.00
Heat Pump and Existing Furnace	- 3,896*	1258.52	-3.10	0.01
Heat Pump and New Furnace	1,283	1185.13	1.08	0.29
Electrical Panel Work	- 2,696*	432.27	-6.24	0.00
HERS Permit Work	3,981*	1348.72	2.95	0.01
Phase III	1,632	1165.20	1.40	0.18

*Statistically significant at the 95% confidence level.

Equation 9. Gas Furnace and CAC Cost Model for Two-HVAC Systems Homes

$$Gas\ Furnace\ and\ CAC\ Cost_i = \beta_{Electric\ Heat\ Pump} * Electric\ Heat\ Pump_i + \beta_{Heat\ Pump\ and\ New\ Furnace} * Heat\ Pump\ and\ New\ Furnace_i + \beta_{HERS\ Permit\ Work} * HERS\ Permit\ Work_i + \alpha_i + \varepsilon_i$$

Term	Estimate	Std.Error	Statistic	P.Value
All-Electric Heat Pump	3,346	2154.56	1.55	0.26
Heat Pump and New Furnace	-3,039	3099.80	-0.98	0.43
HERS Permit Work	4,003	5164.09	0.78	0.52
Phase III	-5,589	4349.54	-1.28	0.33

*Results are not statistically significant.

WATER HEATER

PHASE 2

Equation 10 assesses how the cost of installing a gas storage water heater compares to the cost of other water heating technologies, such as a gas tankless water heater and a heat pump water heater. It also evaluates the added cost of electrical panel work and whether using a TECH-enrolled contractor affects total project cost of installing a gas storage water heater.

Equation 10. Gas Storage Water Heater Cost Model

$$Gas\ Storage\ Water\ Heater\ Cost_i = \beta_{Gas\ Tankless\ Water\ Heater} * Gas\ Tankless\ Water\ Heater_i + \beta_{Heat\ Pump\ Water\ Heater} * Heat\ Pump\ Water\ Heater_i + \beta_{Electric\ Panel\ Work} * Electrical\ Panel\ Work_i + \beta_{TECH\ Contractor} * TECH\ Contractor_i + \alpha_i + \varepsilon_i$$

Where:

$Gas\ Storage\ Water\ Heater\ Cost_i$ = Total gas storage water heater installation cost for home i

$Gas\ Tankless\ Water\ Heater_i$ = Dummy variable is 1 if the installed system is a gas tankless water heater, 0 otherwise.

$Heat\ Pump\ Water\ Heater_i$ = Dummy variable is 1 if the installed system is a heat pump water heater, 0 otherwise.

$Electrical\ Panel\ Work_i$ = Dummy variable is 1 if the project required upgrades to the home's electrical panel, 0 otherwise.

$TECH\ Contractor_i$= Dummy variable is 1 if the contractor was enrolled in the TECH Initiative, 0 otherwise.

α_i = Fixed effect for each home (controls for home-level differences).

ε_i = Error terms for home i.

Results:

Term	Estimate	Std.Error	Statistic	P.Value
Gas Tankless Water Heater	4,036*	1370.82	2.94	0.02
Heat Pump Water Heater	3,990*	601.80	6.63	0.00
Electrical Panel Work	2,321*	786.13	2.95	0.02
TECH-enrolled Contractor	- 2,568*	1123.96	-2.28	0.05

*Statistically significant at the 95% confidence level.

Equation 11 compares the total project cost of installing a gas tankless water heater to the cost installing a heat pump water heater. It also captures whether the fact that the contractor was enrolled in the TECH Initiative or not affects the total project costs of installing a tankless water heater.

Equation 11. Gas Tankless Water Heater Cost Model

$$Gas\ Tankless\ Water\ Heater_i = \beta_{Heat\ Pump\ Water\ Heater} * Heat\ Pump\ Water\ Heater_i + \beta_{TECH\ Contractor} * TECH\ Contractor_i + \alpha_i + \varepsilon_i$$

Where:

$Gas\ Tankless\ Water\ Heater\ Cost_i$ = Total gas tankless water heater installation cost for home i.

$Heat\ Pump\ Water\ Heater_{i,t}$ = Dummy variable is 1 if the installed system is a heat pump water heater, 0 otherwise.

$TECH\ Contractor_{i,t}$= Dummy variable is 1 if the contractor was enrolled in the TECH Initiative, 0 otherwise.

α_i = Fixed effect for each home (controls for home-level differences).

$\varepsilon_{i,t}$ = Error terms for home i at time t.

Results:

Term	Estimate	Std.Error	Statistic	P.Value
Heat Pump Water Heater	- 181	1027.88	-0.18	0.86
TECH-enrolled Contractor	-3,121^	1453.29	-2.15	0.06

^Statistically significant at the 90% confidence level.

PHASE 3

Equation 12. Gas Storage Water Heater Cost Model

$$Gas\ Storage\ Water\ Heater\ Cost_i = \beta_{Gas\ Tankless\ Water\ Heater} * Gas\ Tankless\ Water\ Heater_i + \beta_{Heat\ Pump\ Water\ Heater} * Heat\ Pump\ Water\ Heater_i + \beta_{Electric\ Work} * Electric\ Work_i + \beta_{TECH\ Contractor} * TECH\ Contractor_i + \beta_{HERS\ Permit\ Work} * HERS\ Permit\ Work_i + \alpha_i + \varepsilon_i$$

Where:

$Electric\ Work_i$ = Dummy variable is 1 if the project included electric work-related costs, 0 otherwise.

Results:

Term	Estimate	Std.Error	Statistic	P.Value
Gas Tankless Water Heater	1,035*	250.17	4.14	0.00
Heat Pump Water Heater	3,174*	809.39	3.92	0.00
Electric Work	3,213*	942.98	3.41	0.01
TECH-enrolled Contractor	2,032*	603.67	3.37	0.01
HERS Permit Work	2,956*	817.09	3.62	0.01

*Statistically significant at the 95% confidence level.

Equation 13. Gas Tankless Water Heater Cost Model

$$Gas\ Tankless\ Water\ Heater_i = \beta_{Heat\ Pump\ Water\ Heater} * Heat\ Pump\ Water\ Heater_i + \beta_{HERS\ Permit\ Work} * HERS\ Permit\ Work_i + \alpha_i + \varepsilon_i$$

Results:

Term	Estimate	Std.Error	Statistic	P.Value
Heat Pump Water Heater	2,733*	907.25	3.01	0.01
HERS Permit Work	4,275*	1315.65	3.25	0.01

*Statistically significant at the 95% confidence level.

AGGREGATED DATA

Equation 14. Gas Storage Water Heater Cost Model

$$Gas\ Storage\ Water\ Heater\ Cost_i = \beta_{Gas\ Tankless\ Water\ Heater} * Gas\ Tankless\ Water\ Heater_i + \beta_{Heat\ Pump\ Water\ Heater} * Heat\ Pump\ Water\ Heater_i + \beta_{Electric\ Panel\ Work} * Electrical\ Panel\ Work_i + \beta_{Electric\ Work} * Electric\ Work_i + \beta_{TECH\ Contractor} * TECH\ Contractor_i + \beta_{Phase\ III} * Phase\ III_i + \alpha_i + \varepsilon_i$$

Results:

Term	Estimate	Std.Error	Statistic	P.Value
Gas Tankless Water Heater	3,337*	739.99	4.51	0.00
Heat Pump Water Heater	4,129*	290.41	14.22	0.00
Electrical Panel Work	2,807*	725.75	3.87	0.00
Electric Work	2,354*	209.39	11.24	0.00
TECH-enrolled Contractor	- 707	760.23	-0.93	0.38
Phase III	- 1,537*	394.07	-3.90	0.00

*Statistically significant at the 95% confidence level.

Equation 15. Gas Tankless Water Heater Cost Model

$$Gas\ Tankless\ Water\ Heater_i = \beta_{Heat\ Pump\ Water\ Heater} * Heat\ Pump\ Water\ Heater_i + \beta_{Electric\ Work} * Electric\ Work_i + \beta_{TECH\ Contractor} * TECH\ Contractor_i + \beta_{Phase\ III} * Phase\ III_i + \alpha_i + \varepsilon_i$$

Term	Estimate	Std.Error	Statistic	P.Value
Heat Pump Water Heater	844	647.08	1.30	0.22
Electric Work	2,658*	379.24	7.01	0.00
TECH-enrolled Contractor	-1,274	1033.17	-1.23	0.25
Phase III	-1,453*	433.77	-3.35	0.01

*Statistically significant at the 95% confidence level.

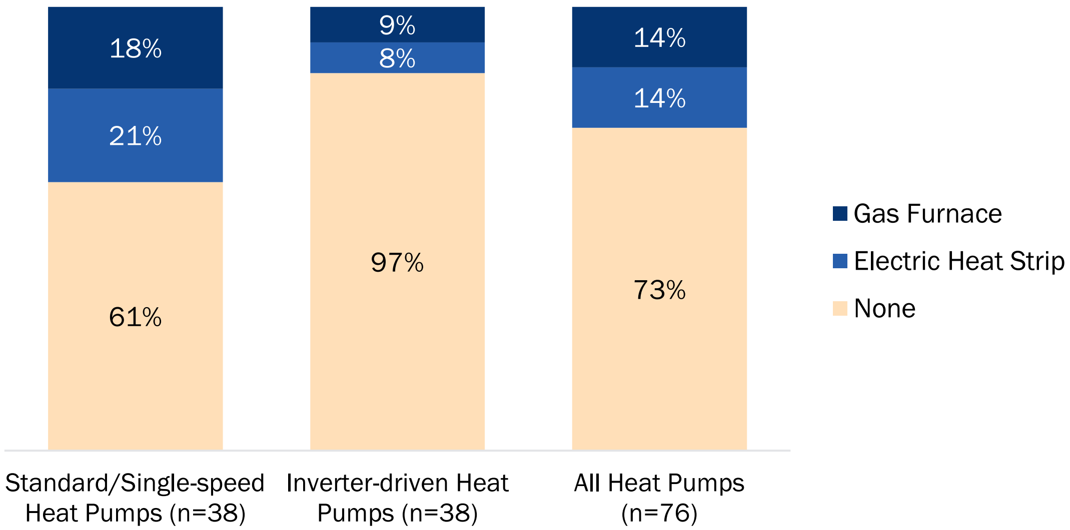
APPENDIX F. PHASE 3 RESULTS

This appendix includes findings from the Phase III online survey.

HVAC FINDINGS

In the Phase 3 contractor survey, we asked contractors to specify the type of backup heating they recommended for each of their heat pump-related bids, with “none” being an option. **Most HVAC contractors (9 of 11; 82%) recommended no backup heating. Contractors did not recommend any backup heating for nearly three-quarters of all HVAC heat pumps we received bids for in Phase 3 (55 of 76; 73%) (Figure 33).** When comparing bids for standard/single-speed and variable-speed/inverter-driven heat pumps, we observed that, as expected, **contractors more commonly recommended backup heating for standard/single-speed heat pumps.** Unlike for Phase 2, contractors equally recommended a gas furnace and an electric heat strip as backup heating during Phase 3.

Figure 33. Backup Heating Recommended for Heat Pumps in Phase 3



Note: The figure represents the number of individual heat pumps (not bids) in Phase 3, since for homes with two HVAC systems, one single bid would include two heat pump systems.

PHASE 3 HVAC PROJECT COST DATA

In the Phase 3 contractor survey, we requested that contractors assigned HVAC projects provide bids for a like-for-like replacement of the home’s system (including a CAC if they had one), a standard/single-speed heat pump, and an variable-speed heat pump. Contractors also provided bids for dual-fuel heat pumps with a new gas furnace as backup. For homes with only a gas furnace, we requested an additional bid for a gas central furnace and CAC system.

Table 32 summarizes the average, median, minimum, and maximum total HVAC project costs by equipment type from Phase 3. The average cost for a gas furnace was about $10,000, while the average cost of a gas furnace and CAC system was about $19,400. Additionally, the average cost of an all-electric heat pump was about $22,000, which was about $1,000 higher than the average cost of the dual-fuel heat pump option. The average cost of inverter-driven heat pumps (about $23,400) was slightly higher than that of standard/single-speed heat pumps (about $20,000).

Table 32. Phase 3 HVAC Project Costs Summary by Equipment Type

Bid Equipment Type	Average	Median	Minimum	Maximum
Gas Central Furnace (n=12)	$9,956	$8,650	$6,000	$19,905
Gas Central Furnace + CAC (n=25)	$19,374	$17,803	$14,705	$33,467
All-Electric Heat Pump (n=53)	$21,892	$20,604	$15,000	$34,302
Heat Pump with New Furnace (n=9)	$20,998	$21,303	$14,273	$28,842
Heat Pump Speed				
Single-Speed Heat Pump (n=30)	$19,995	$19,070	$14,273	$34,302
Variable-Speed Heat Pump (n=32)	$23,419	$23,250	$15,430	$32,650
Total (n=99)	**$19,728**	**$19,189**	**$6,000**	**$34,302**

When examining the minimum and maximum costs by equipment type, we noticed **a large variation in the cost data received.** Figure 34 is a visual representation of the range of total project costs both among and within equipment types, with the presence of a few outliers**. The all-electric heat pump was among the equipment types that showed more variation in costs.**

Figure 34. Phase 3 HVAC Project Cost by Equipment Type

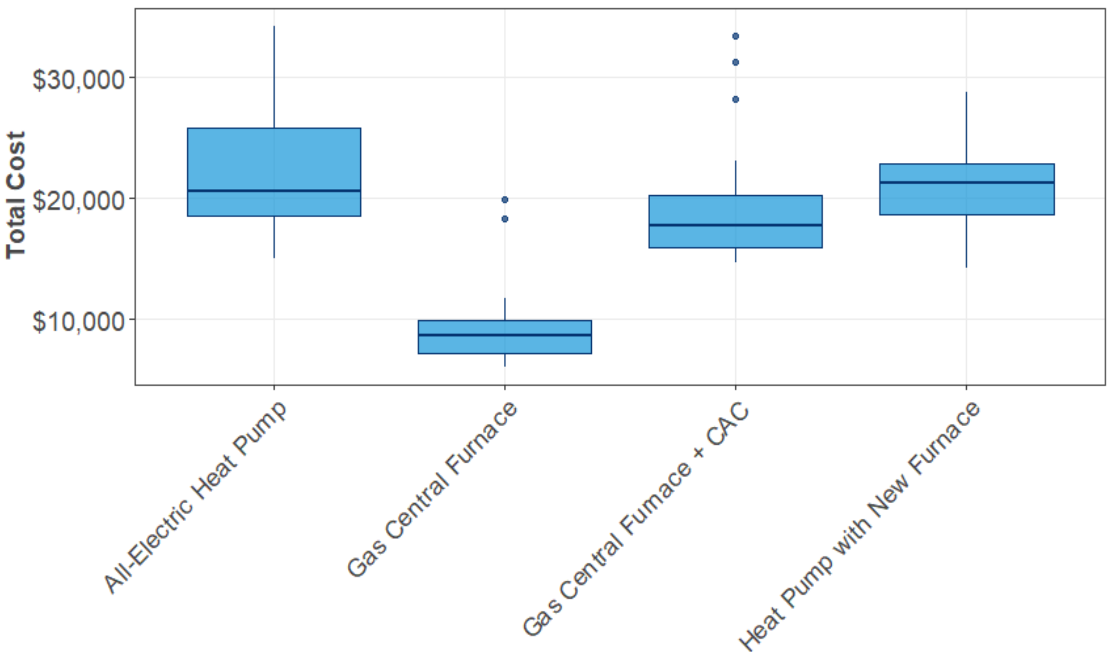


Table 33 summarizes the average, median, minimum, and maximum total costs for HVAC projects by climate region and equipment type for Phase 3. The all-electric heat pump system in a cold climate showed the largest average cost; however, this is based on only one bid. Total project costs are consistently higher in the cold climate compared to the other climate regions for the same equipment type, except when it comes to the dual-fuel HP. **When comparing average project costs for the same equipment type across the hot-dry and marine climate regions, we observed that they are consistently higher in the marine climate.** The highest project cost overall was for an all-electric heat pump system in a marine climate region at $34,302, which included a full duct replacement. The lowest total project cost overall was for a gas central furnace ($6,000), also in a marine climate region.

Table 33. Phase 3 HVAC Project Costs Summary by Climate Region and Equipment Type

Climate Region	Average	Median	Minimum	Maximum
Gas Central Furnace				
Cold (n=1)	$11,690	$11,690	$11,690	$11,690
Hot-Dry (n=3)	$8,358	$8,900	$6,900	$9,273
Marine (n=8)	$10,338	$7,982	$6,000	$19,905
Gas Central Furnace + CAC				
Cold (n=1)	$22,250	$22,250	$22,250	$22,250
Hot-Dry (n=12)	$17,267	$16,900	$14,705	$23,127
Marine (n=12)	$21,240	$18,927	$15,630	$33,467
All-Electric Heat Pump				
Cold (n=1)	$30,760	$30,760	$30,760	$30,760
Hot-Dry (n=20)	$19,096	$18,700	$15,000	$26,965
Marine (n=32)	$23,362	$23,250	$15,170	$34,302
Heat Pump with New Furnace				
Cold (n=1)	$25,145	$25,145	$25,145	$25,145
Hot-Dry (n=7)	$19,285	$18,855	$14,273	$22,905
Marine (n=1)	$28,842	$28,842	$28,842	$28,842

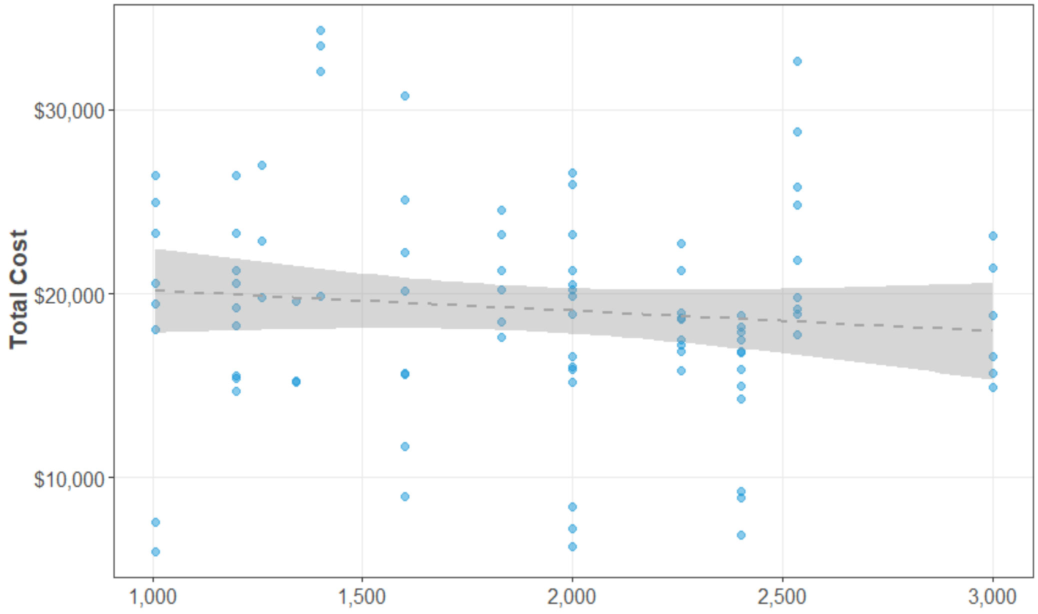
Furthermore, we investigated differences in HVAC project costs estimated by contractors who were TECH-enrolled versus those who were not. Table 34 below presents the cost breakdowns between TECH-enrolled contractors and non TECH-enrolled contractors by equipment type for Phase 3. Once again, we did not find any statistically significant difference in average project costs provided by TECH-enrolled and non TECH-enrolled contractors across all equipment types.

Table 34. Phase 3 HVAC Bid Project Costs Summary by TECH Initiative Enrollment and Equipment Type

Contractor Type	Average	Median	Minimum	Maximum
Gas Central Furnace				
TECH-Enrolled (HVAC) (n=8)	$11,335	$9,087	$6,900	$19,905
Non TECH-Enrolled (n=4)	$7,198	$6,907	$6,000	$8,980
Gas Central Furnace + CAC				
TECH-Enrolled (HVAC) (n=18)	$20,424	$19,025	$14,705	$33,467
Non TECH-Enrolled (n=7)	$16,673	$16,600	$15,180	$18,053
All-Electric Heat Pump				
TECH-Enrolled (HVAC) (n=28)	$21,755	$20,250	$15,000	$34,302
Non TECH-Enrolled (n=25)	$22,044	$20,604	$15,170	$32,650
Heat Pump with New Furnace				
TECH-Enrolled (HVAC) (n=8)	$20,018	$20,079	$14,273	$25,145
Non TECH-Enrolled (n=1)	$28,842	$28,842	$28,842	$28,842

We also looked at any evident correlations between the home size and the total project costs for Phase 3. Figure 35 shows the distribution of total project costs overall across the homes' square footage. **We observed no evident correlation between home size and total HVAC project costs from our sample.**

Figure 35. Phase 3 HVAC Project Cost by Home Square Footage



We further compared project costs for homes under 2,000 square feet and those 2,000 square feet and above by equipment type (Table 35). **We found that the average project cost of an all-electric heat pump replacement is statistically higher for smaller homes than for larger homes.** We found no statistically significant difference in average project costs between homes less than 2,000 square feet and homes greater than 2,000 square feet across the other equipment types.

Table 35. Phase 3 HVAC Project Costs Summary by Home Size and Equipment Type

Bid Equipment Type	Average	Median	Minimum	Maximum
Homes less than 2,000 sq. ft.				
Gas Central Furnace (n=6)	$12,083	$10,335	$6,000	$19,905
Gas Central Furnace + CAC (n=12)	$21,229	$19,040	$14,705	$33,467
All-Electric Heat Pump (n=28)	$23,261	$23,277	$15,260	$34,302
Heat Pump with New Furnace (n=2)	$24,025	$24,025	$22,905	$25,145
Homes 2,000 sq. ft. and above				
Gas Central Furnace (n=6)	$7,829	$7,825	$6,250	$9,273
Gas Central Furnace + CAC (n=13)	$17,661	$16,900	$14,900	$23,127
All-Electric Heat Pump (n=25)	$20,358	$18,950	$15,000	$32,650
Heat Pump with New Furnace (n=7)	$20,133	$18,855	$14,273	$28,842

*Statistically significant at the 95% confidence level.

Most contractors who participated in Phase 3 did not provide itemized costs in their project bids. As such, when looking at the different components included in the total project costs (e.g., equipment, labor, and electrical modifications) based on bids where contractors provided an itemized cost breakdown, sample sizes are low when estimating average costs for these individual components. Table 36 summarizes the average cost of various project components by equipment type. No contractors provided itemized equipment costs in their bids for Phase 3. Conversely, all-electric heat pump bids often showed the cost associated with non-electrical modifications separately, and to a lesser extent, the cost associated with electrical modifications. The average cost for non-electrical modifications in all-electric heat pump projects was about $4,500 (n=22).

Table 36. Phase 3 Itemized HVAC Project Costs Summary by Equipment Type

Bid Equipment Type	Average Total Cost	Average Equipment Cost		Average Labor Cost		Average Electrical Modification Cost		Average Non-Electrical Modification Cost	
Gas Central Furnace (n=12)	$9,956	n=0	N/A	n=0	N/A	n=0	N/A	n=4	$5,754
Gas Central Furnace + CAC (n=25)	$19,374	n=0	N/A	n=0	N/A	n=2	$1,653	n=8	$4,872
All-Electric Heat Pump (n=53)	$21,892	n=0	N/A	n=2	$1,750	n=16	$897	n=22	$4,550
Heat Pump with New Furnace (n=9)	$20,998	n=0	N/A	n=1	$1,500	n=1	$2,500.00	n=3	$5,533

Note: n values reflect the number of bids that included each cost, not the number of unique contractors providing each cost. Average total costs were calculated using the total n of each equipment type.

For Phase 3, we again explored HERS testing and permitting costs by city, as shown in Table 37 below. Unsurprisingly, **HERS testing and permit costs vary by city, with average prices ranging from $320 to $3,500.** This range was wider than the HERS testing and permitting costs range we collected in Phase 2. The lowest HERS testing and permit cost recorded was $320 in Concord, Napa, and Oakland, while the highest was $3,500 in Rancho Palos Verdes.

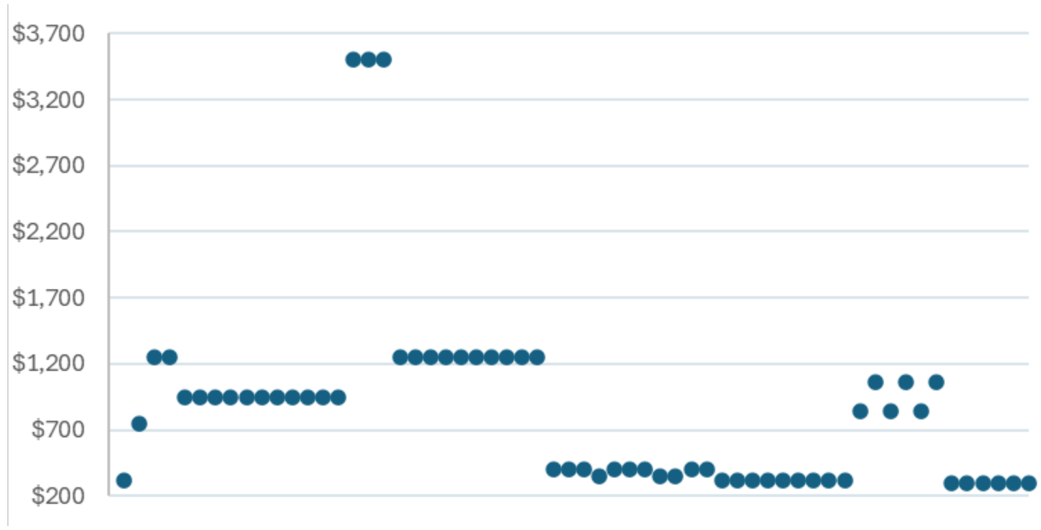
Table 37. Phase 3 HVAC Project HERS/Permitting Costs Summary by City

City [a]	Average	Median	Minimum	Maximum
Concord (n=3)	$320	$320	$320	$320
Culver City (n=6)	$1,100	$1,100	$950	$1,250
Daly City (n=4)	$375	$375	$350	$400
El Cerrito (n=4)	$388	$400	$350	$400
Long Beach (n=3)	$1,250	$1,250	$1,250	$1,250
Napa (n=3)	$320	$320	$320	$320
Oakland (n=4)	$320	$320	$320	$320
Rancho Palos Verdes (n=3)	$3,500	$3,500	$3,500	$3,500
Redondo Beach (n=8)	$1,100	$1,100	$950	$1,250
San Mateo (n=3)	$400	$400	$400	$400
Seal Beach (n=4)	$950	$950	$950	$950

[a] n values represent the number of bids that included HERS/permit costs. As such, n values do not represent unique contractors' HERS/permit pricing.

Figure 36 shows the distribution of HERS testing and permitting costs listed across 72 bids collected in Phase 3 that included a HERS and/or permitting cost line item. **About two-thirds of bids (63%) listed a HERS and/or permitting of less than $1,000, compared to 83% in Phase 2. Notably, the overall average cost of HERS testing and/or permitting in bids received in Phase 3 was higher compared to that in bids collected in Phase 2 ($924 versus $831).**

Figure 36. Phase 3 HVAC Project HERS/Permitting Costs (n=72)



Note: Dots in the figure represent project bids.

PHASE 3 INCREMENTAL COST FINDINGS

To analyze the cost data collected through the contractor survey, we used the same linear fixed-effects regression modeling process as with Phase 2 to estimate the incremental costs associated with a like-for-like replacement and a heat pump replacement for homes with a gas central furnace and homes with a gas central furnace and CAC system. The incremental cost findings from the Phase 3 cost data are summarized in Table 38 below, with all results significant at a 95% confidence level.

Table 38. Phase 3 HVAC Project Incremental Costs Findings by Home Scenario

Replacement Equipment	Incremental Cost Estimate (Over Baseline)	% Incremental Cost (Over Baseline)
Gas Central Furnace Replacement (Baseline Average Cost: $9,956)		
All-Electric Heat Pump (n=53)	$12,489*	125%
Heat Pump with New Furnace (n=9)	$12,903*	130%
Gas Central Furnace + CAC (Baseline Average Cost: $19,374)		
All-Electric Heat Pump (n=53)	$1,965*	10%
Heat Pump with New Furnace (n=9)	$2,559*	13%

* Statistically significant at the 95% confidence level

In Phase 3, we found that the incremental costs of a dual-fuel heat pump (with a new furnace) and an all-electric heat pump were nearly identical when compared to a gas furnace replacement. On average, replacing a gas central furnace with an all-electric heat pump cost about $12,500 more—a 125% increase over like-for-like gas equipment. Similarly, installing a heat pump with a new furnace cost about $12,900 more, representing a 130% increase.

In the replacement scenario of a gas central furnace and CAC system, an all-electric heat pump costs about $2,000 more than a like-for-like replacement of the system, which represents a 10% cost increment. Similarly, we observed that **a dual-fuel heat pump replacement (with a new furnace) costs about $2,500 more, representing a 13% cost increment. Overall, according to the cost data collected during Phase 3 of our study, a heat pump replacement, regardless of whether it is all-electric or a dual-fuel system, is a more expensive option than a like-for-like replacement.**

Lastly, our analysis showed that HVAC projects for either a gas central furnace replacement or a gas central furnace and CAC system replacement, which are completed by a TECH-enrolled contractor are, on average, about $3,000 ($3,431 and $2,961, respectively) cheaper than bids for like-for-like replacements completed by non TECH-enrolled contractors (holding all other terms constant and statistically significant at the 95% confidence level).

HPWH FINDINGS

PHASE 3 WATER HEATER PROJECT COST DATA

Via the contractor survey, we requested that contractors who were assigned water heating projects provide bids for a like-for-like replacement of the home's system, a gas tankless water heater, and a heat pump water heater.

Table 39 summarizes the average, median, minimum, and maximum total water heating project costs by equipment type. The average cost of a HPWH was about $9,800, while the average cost of a gas storage water heater was less than half that price ($4,300), and that of a tankless water heater was also lower ($7,100).

Table 39. Phase 3 Water Heating Project Costs Summary by Equipment Type

Bid Equipment Type	Average	Median	Minimum	Maximum
Gas Storage Water Heater (n=14)	$4,300	$3,300	$1,950	$12,200
Gas Tankless Water Heater (n=14)	$7,116	$6,900	$4,200	$11,982
Heat Pump Water Heater (n=17)	$9,821	$8,447	$5,900	$16,200

When looking at the minimum and maximum costs by equipment type, **we see a large variation in the cost data received, specifically for gas storage water heaters and HPWHs.** Figure 37 depicts the range of total project costs by equipment type and shows the variation in costs with the presence of a couple of outliers. The outlier of $12,200 for the gas storage water heater is due to electrical panel work recommended by the contractor for fire and safety reasons that effectively doubled the cost of the water heater replacement.

Figure 37. Phase 3 Water Heating Project Costs by Equipment Type

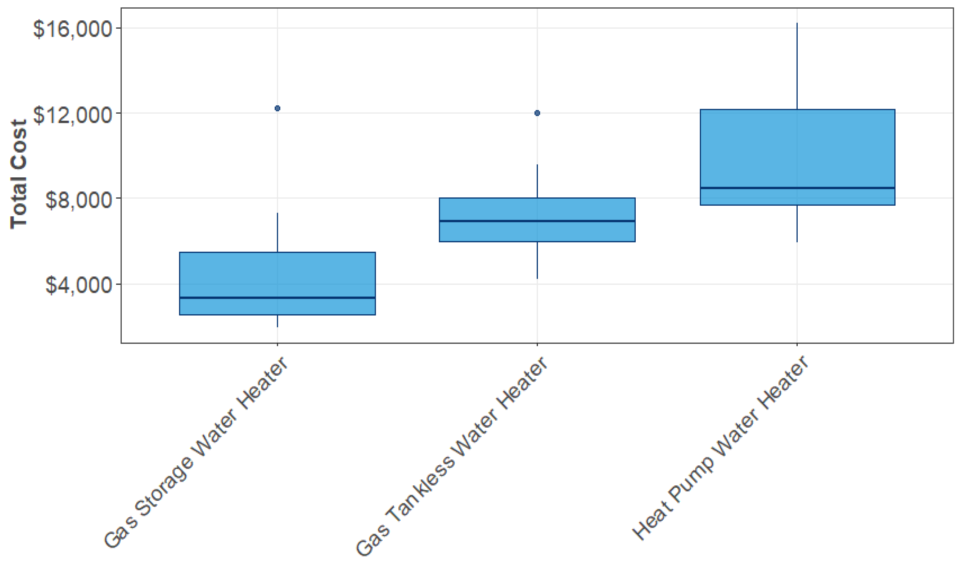


Table 40 below presents the cost average, median, minimum, and maximum for water heating equipment by climate region. **We observed that total project costs are relatively similar within the same water heating equipment type in hot-dry and marine climate regions.** The highest water heating total project cost received in Phase 3 was for a HPWH in the marine climate region ($16,200), while the lowest total project cost was for a gas storage water heater in the hot-dry climate region ($1,950).

Table 40. Phase 3 Water Heating Project Costs Summary by Climate Region and Equipment Type

Climate Region	Average	Median	Minimum	Maximum
Gas Storage Water Heater				
Hot-Dry (n=8)	$3,304	$2,975	$1,950	$6,278
Marine (n=6)	$5,627	$4,513	$2,500	$12,200
Gas Tankless Water Heater				
Hot-Dry (n=8)	$6,254	$6,369	$4,200	$8,100
Marine (n=6)	$8,264	$7,845	$5,863	$11,982
Heat Pump Water Heater				
Hot-Dry (n=11)	$9,447	$8,200	$5,900	$15,900
Marine (n=6)	$10,505	$10,010	$6,200	$16,200

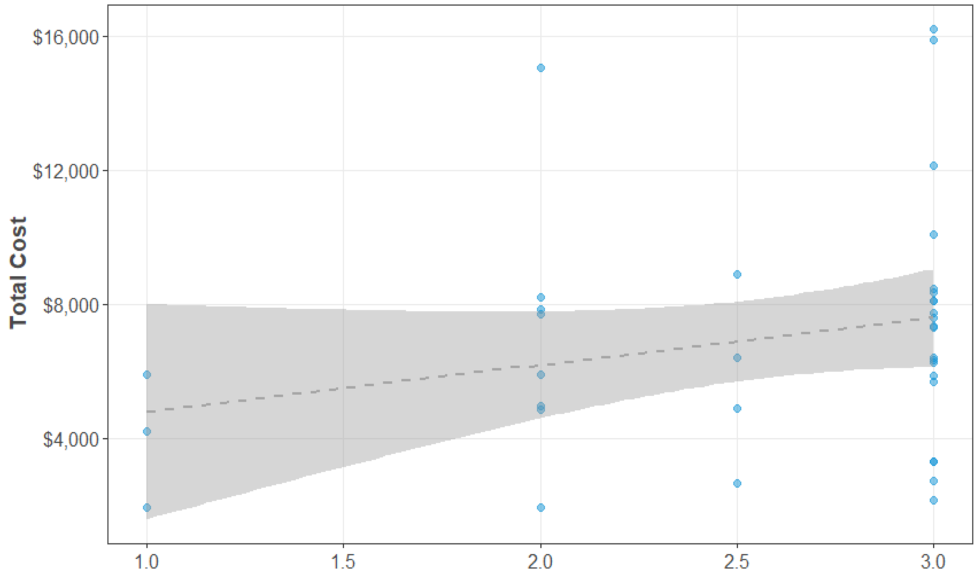
Further, we investigated potential differences in average costs for each equipment type based on whether the contractor who provided the bid was enrolled in the TECH initiative for HPWHs or not. Table 41 shows the average, median, minimum, and maximum project costs for water heating equipment by contractors' TECH enrollment status. We found that average costs are statistically similar for the same equipment type across TECH-enrolled contractors and those who are not enrolled in the TECH initiative.

Table 41. Phase 3 Water Heating Project Costs Summary by TECH Initiative Enrollment and Equipment Type

Contractor Type	Average	Median	Minimum	Maximum
Gas Storage Water Heater				
TECH-Enrolled (HPWH) (n=10)	$4,716	$3,300	$1,950	$12,200
Non TECH-Enrolled (n=4)	$3,260	$3,018	$2,150	$4,856
Gas Tankless Water Heater				
TECH-Enrolled (HPWH) (n=10)	$6,996	$6,900	$4,200	$11,982
Non TECH-Enrolled (n=4)	$7,414	$7,123	$5,863	$9,548
Heat Pump Water Heater				
TECH-Enrolled (HPWH) (n=13)	$9,496	$8,365	$5,900	$16,200
Non TECH-Enrolled (n=4)	$10,875	$10,346	$7,746	$15,061

In terms of any possible relationship between water heating total project costs and the number of bathrooms in the home, as depicted in Figure 38, we observed that in Phase 3, **total water heating project costs were positively correlated with the number of bathrooms in the home. However, this is still not a strong relationship.** One possible explanation for this is that through the online survey, contractors provided bids for several homes, which could have made them more prone to compare their assigned homes' characteristics and make adjustments to the project costs accordingly. In this case, cost adjustments could be related to the number of bathrooms and/or the number of people living in the home, which in turn could indicate the home's water demand.

Figure 38. Phase 3 Water Heating Project Costs by Number of Bathrooms in the Home



We also investigated any potential differences in equipment costs, specifically for HPWHs related to tank capacity. Table 42 breaks down the Phase 3 HPWH equipment cost statistics by tank capacity and shows no clear trend in average equipment costs. However, since most contractors did not provide itemized cost summaries for their water heater projects and many did not list the capacity of the water heaters in their bids, we had a limited number of observations for each tank capacity category.

Table 42. Phase 3 Heat Pump Water Heater Equipment Costs Summary by Tank Capacity

Tank Capacity (Gallons)	Average	Median	Minimum	Maximum
50 (n=1)	$4,000	$4,000	$4,000	$4,000
66 (n=3)	$2,667	$2,500	$2,500	$3,000
80 (n=2)	$3,425	$3,425	$3,250	$3,600

Note: Average costs listed in the table reflect only the itemized price of the water-heating equipment in the bids provided by contractors.

When examining the instances in which Phase 3 contractors upsized the new water-heating equipment they recommended, **we observed that most homes with a 40-gallon water heater were recommended to upgrade to a 50-gallon water heater (13 of 21 bids contained equipment of higher capacity). For homes with a 50-gallon water heater, most bids either recommended the same (3 of 7 bids) or a higher tank capacity (3 of 7 bids).** Table 43 summarizes the tank capacity of homes' existing water heaters compared to the capacity of the water heaters recommended by contractors in the 29 bids we received during Phase 3 that specified tank capacities.

Table 43. Phase 3 Number of Bids Received for Water-Heating Equipment by Tank Capacity

Existing Water Heater Tank Capacity (Gallons)	New Water Heater Tank Capacity (Gallons)				
	40	50	65	66	80
40	8	4	3	1	5
50	1	3	2	1	0
75	0	0	0	0	1

Table 44 below shows the average cost of various project components included in the total project costs (equipment, labor, and electrical and non-electrical modifications) by equipment type based on bids where contractors provided an itemized cost breakdown. A limited sample of contractors provided itemized costs in their project bids, which explains the small sample sizes (i.e., number of bids) represented in the table below. Of those bids that provided different line items for project component costs, HPWH bids most commonly showed equipment, labor, and electrical modification costs compared to the other equipment types.

Table 44. Phase 3 Itemized Water Heater Project Costs Summary by Equipment Type

Bid Equipment Type	Average Total Cost	Average Equipment Cost		Average Labor Cost		Average Electrical Modification Cost		Average Non-Electrical Modification Cost	
Gas Storage Water Heater (n=14)	$4,300	n=3	$800	n=3	$2,667	n=1	$2,580	n=4	$694
Gas Tankless Water Heater (n=14)	$7,116	n=3	$1,700	n=3	$4,933	n=3	$1,193	n=3	$567
Heat Pump Water Heater (n=17)	$9,821	n=6	$3,142	n=6	$6,400	n=6	$983.	n=4	$731

Note: N values reflect the number of bids that included each cost, not the number of unique contractors providing each cost. Average total costs were calculated using the total n of each equipment type.

Of the 45 water heating bids we received in Phase 3, 27 included itemized permitting costs. As shown in Table 45 below, **HERS testing and permit costs varied by city, with average prices ranging from $561 to $1,581**. The lowest HERS testing and permit cost recorded was $300 in Elk Grove, Oakland, and Tracy, while the highest was $2,000 in Santa Rosa and Tracy.

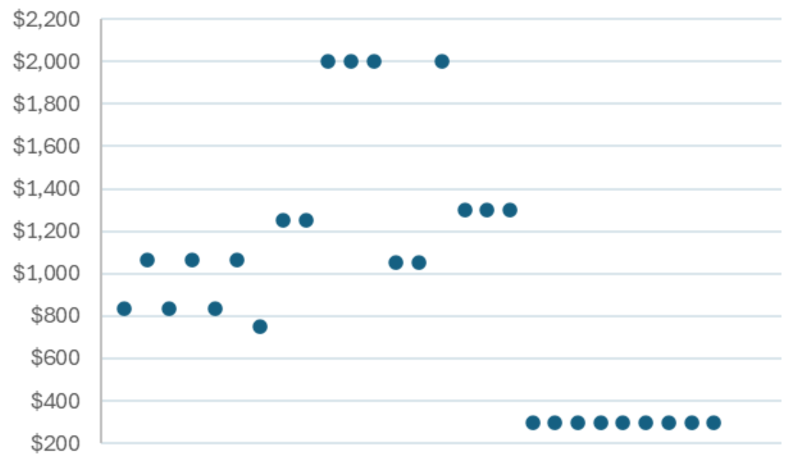
Table 45. Phase 3 Water Heating Project HERS/Permitting Costs Summary by City

City [a]	Average	Median	Minimum	Maximum
Elk Grove (n=5)	$561	$300	$300	$1,066
Fresno (n=1)	$750	$750	$750	$750
La Quinta (n=1)	$1,250	$1,250	$1,250	$1,250
Oakland (n=8)	$838	$952	$300	$1,300
Santa Rosa (n=5)	$1,581	$2,000	$838	$2,000
Thousand Oaks (n=1)	$1,250	$1,250	$1,250	$1,250
Tracy (n=6)	$833	$675	$300	$2,000

[a] n values represent the number of bids that included HERS/permit costs. As such, n values do not represent unique contractors' HERS/permit pricing.

Figure 39 shows the distribution of HERS testing and permitting costs listed across the 27 bids collected in Phase 3 that included a HERS and/or permitting cost line item. **About half of the water heating project bids in Phase 3 included HERS testing/permit costs under $1,000 (48%).**

Figure 39. Phase 3 Water Heating Project HERS/Permitting Costs (n=27)



Note: Dots in the figure represent project bids.

PHASE 3 INCREMENTAL COST FINDINGS

To analyze the cost data collected through the contractor survey, we used the same linear fixed-effects regression modeling process as with Phase 2 to estimate the incremental costs associated with a like-for-like replacement and a HPWH replacement for homes with a gas storage water heater and homes with a gas tankless water heater. The incremental cost findings from the Phase 3 cost data are summarized in Table 46 below, with all results significant at a 95% confidence level.

According to the cost data collected through the contractor survey, replacing a gas storage water heater with a tankless water heater costs about $1,000 more than replacing it with like-for-like equipment, which represents a 24% cost increment. However, replacing a gas storage water heater with a HPWH costs about $3,100 more than replacing it with like-for-like equipment, representing a 74% cost increment. In the replacement scenario of an existing gas tankless water heater, our Phase 3 data analysis showed that a HPWH costs about $2,700 more than a like-for-like replacement, representing a 38% cost increment.

Table 46. Phase 3 Water-Heating Project Incremental Cost Findings by Upgrade Scenario

Replacement Equipment	Incremental Cost Estimate (Over Baseline)	% Incremental Cost (Over Baseline)
Gas Storage Water Heater (Baseline Average Cost: $4,300)		
Gas Tankless Water Heater (n=14)	$1,035*	24%
Heat Pump Water Heater (n=17)	$3,174*	74%
Gas Tankless Water Heater (Baseline Average Cost: $7,116)		
Heat Pump Water Heater (n=17)	$2,733*	38%

* Statistically significant at the 95% confidence level

When referring to project components and their influence on average project costs, we observed that for a gas storage WH replacement, projects that include electrical work are, on average, about $3,200 ($3,213) more expensive than projects that do not include this type of work (holding all other terms constant and statistically significant at the 95% confidence level). Additionally, in the case of a gas storage WH replacement, projects that are completed by TECH-enrolled contractors are, on average, about $2,000 ($2,032) more expensive than those completed by non TECH-enrolled contractors (holding all other terms constant and statistically significant at the 95% confidence level). This contradicts what we found during Phase 2 of our study.

We observed that in the case of both gas storage and gas tankless WH replacements, projects that include HERS testing or permit costs are, on average, between $3,000 and $4,200 more expensive than bids for like-for-like replacements that do not include HERS/permit costs (holding all other terms constant and statistically significant at the 95% confidence level).

APPENDIX G. ADDITIONAL DATA SUMMARY AND TWO-SYSTEM HOMES INCREMENTAL COSTS FINDINGS

ONE-HVAC SYSTEM COST FINDINGS

This section includes additional summaries of the cost data received for homes with one HVAC system that were not presented in the main report.

ADDITIONAL DESCRIPTIVE SUMMARY OF HVAC PROJECT COSTS

PHASE 2 ADDITIONAL HVAC PROJECT COST DATA

Table 47. Phase 2 HVAC Project Costs Summary by Presence of Solar PV and Equipment Type

Bid Equipment Type	Average	Median	Minimum	Maximum
Homes with Solar				
Gas Central Furnace (n=27)	$9,158	$8,500	$3,456	$17,938
Gas Central Furnace + CAC (n=19)	$17,794	$15,600	$9,567	$36,360
All-Electric Heat Pump (n=65)	$19,528	$18,537	$10,608	$39,688
Heat Pump with Existing Furnace (n=2)	$12,604	$12,604	$10,972	$14,235
Heat Pump with New Furnace (n=8)	$14,267	$13,808	$11,651	$18,272
Homes without Solar				
Gas Central Furnace (n=12)	$6,743	$6,000	$3,860	$13,681
Gas Central Furnace + CAC (n=7)	$17,027	$16,068	$12,875	$26,233
All-Electric Heat Pump (n=20)	$19,024	$17,235	$11,486	$33,144
Heat Pump with New Furnace (n=4)	$22,385	$22,028	$19,343	$26,140

Table 48. Phase 2 HVAC Project Costs Summary by System Tonnage and Equipment Type

Tons[a]	Average	Median	Minimum	Maximum
Gas Central Furnace				
3 (n=4)	$14,645	$15,376	$9,889	$17,938
3.5 (n=2)	$11,886	$11,886	$10,365	$13,406
4 (n=1)	$5,844	$5,844	$5,844	$5,844
5 (n=4)	$7,973	$6,857	$4,495	$13,681
6.7 (n=3)	$7,393	$8,341	$5,338	$8,500
7.5 (n=2)	$7,472	$7,472	$5,734	$9,209
8.3 (n=3)	$7,702	$7,884	$6,976	$8,247
9.2 (n=4)	$6,209	$6,099	$4,742	$7,894
10.4 (n=1)	$5,554	$5,554	$5,554	$5,554
All-Electric Heat Pump				
2 (n=3)	$21,135	$22,726	$15,350	$25,330
2.5 (n=5)	$23,043	$21,220	$17,528	$28,633
3 (n=26)	$18,249	$17,996	$11,500	$24,945
3.5 (n=3)	$21,869	$22,267	$18,810	$24,530
4 (n=16)	$18,518	$17,289	$11,486	$37,577
4.5 (n=1)	$12,826	$12,826	$12,826	$12,826
5 (n=16)	$20,029	$16,600	$10,608	$39,688

[a] Capacities given in BTUH were converted to tons by dividing BTUH by 12,000.

Table 49. Phase 2 HVAC Project Costs Summary by Efficiency (SEER) and Equipment Type

SEER	Average	Median	Minimum	Maximum
Single-Speed All-Electric Heat Pumps (n=9)				
15-15.9 (n=3)	$20,349	$21,680	$17,528	$21,840
16-16.9 (n=2)	$12,000	$12,000	$11,500	$12,500
17-17.9 (n=4)	$13,108	$13,412	$10,608	$15,000
Variable-Speed All-Electric Heat Pumps (n=32)				
16-16.9 (n=5)	$19,170	$18,537	$14,128	$22,722
17-17.9 (n=3)	$20,733	$20,660	$16,967	$24,570
18-18.9 (n=16)	$16,736	$16,513	$11,675	$23,320
19+ (n=8)	$25,787	$23,354	$18,323	$37,577
Total All-Electric Heat Pumps (n=41)				
15-15.9 (n=3)	$20,349	$21,680	$17,528	$21,840
16-16.9 (n=7)	$17,121	$18,186	$11,500	$22,722
17-17.9 (n=7)	$16,376	$15,000	$10,608	$24,570
18-18.9 (n=16)	$16,736	$16,513	$11,675	$23,320
19+ (n=8)	$25,787	$23,354	$18,323	$37,577

Note: When the contractor did not specify a heat pump as standard or inverter-driven, but the heat pump had a SEER rating of at least 18, we assumed it to be inverter-driven.

Table 50. Phase 2 HVAC Project Costs Summary by Efficiency (SEER2) and Equipment Type

SEER2	Average	Median	Minimum	Maximum
Single-Speed All-Electric Heat Pumps (n=12)				
< 14 (n=1)	$16,501	$16,501	$16,501	$16,501
14-14.9 (n=2)	$24,667	$24,667	$16,190	$33,144
15-15.9 (n=4)	$17,810	$18,627	$11,486	$22,500
16-16.9 (n=3)	$18,539	$17,669	$16,250	$21,700
17-17.9 (n=1)	$21,386	$21,386	$21,386	$21,386
18-18.9 (n=1)	$15,937	$15,937	$15,937	$15,937
Variable-Speed All-Electric Heat Pumps (n=10)				
16-16.9 (n=2)	$21,633	$21,633	$20,190	$23,075
17-17.9 (n=2)	$21,762	$21,762	$15,344	$28,180
18-18.9 (n=5)	$17,793	$17,200	$15,002	$21,220
19+ (n=1)	$22,893	$22,893	$22,893	$22,893
Total All-Electric Heat Pumps (n=22)				
< 14 (n=1)	$16,501	$16,501	$16,501	$16,501
14-14.9 (n=2)	$24,667	$24,667	$16,190	$33,144
15-15.9 (n=4)	$17,810	$18,627	$11,486	$22,500
16-16.9 (n=5)	$19,777	$20,190	$16,250	$23,075
17-17.9 (n=3)	$21,637	$21,386	$15,344	$28,180
18-18.9 (n=6)	$17,483	$16,569	$15,002	$21,220
19+ (n=1)	$22,893	$22,893	$22,893	$22,893

PHASE 3 ADDITIONAL HVAC PROJECT COST DATA

Table 51. Phase 3 HVAC Project Costs Summary by Presence of Solar PV and Equipment Type

Bid Equipment Type	Average	Median	Minimum	Maximum
Homes with Solar				
Gas Central Furnace (n=9)	$10,841	$8,980	$6,000	$19,905
Gas Central Furnace + CAC (n=20)	$19,749	$17,928	$14,705	$33,467
All-Electric Heat Pump (n=42)	$22,396	$21,250	$15,000	$34,302
Heat Pump with New Furnace (n=7)	$21,241	$21,303	$14,273	$28,842
Homes without Solar				
Gas Central Furnace (n=3)	$7,300	$7,250	$6,250	$8,400
Gas Central Furnace + CAC (n=5)	$17,871	$15,900	$14,900	$23,127
All-Electric Heat Pump (n=11)	$19,964	$19,570	$15,260	$26,608
Heat Pump with New Furnace (n=2)	$20,148	$20,148	$18,855	$21,440

Table 52. Phase 3 HVAC Project Costs Summary by System Tonnage and Equipment Type

Tons[a]	Average	Median	Minimum	Maximum
Gas Central Furnace				
3 (n=1)	$11,690	$11,690	$11,690	$11,690
3.3 (n=1)	$6,000	$6,000	$6,000	$6,000
4 (n=1)	$8,400	$8,400	$8,400	$8,400
5 (n=1)	$8,900	$8,900	$8,900	$8,900
6.7 (n=1)	$6,250	$6,250	$6,250	$6,250
All-Electric Heat Pump				
2.5 (n=6)	$20,488	$20,604	$15,544	$23,304
3 (n=6)	$22,637	$23,858	$15,430	$26,965
3.5 (n=1)	$30,760	$30,760	$30,760	$30,760
4 (n=12)	$20,506	$20,575	$16,000	$24,800
5 (n=11)	$19,507	$18,800	$15,000	$26,608

[a] Capacities given in BTUH were converted to tons by dividing BTUH by 12,000.

Table 53. Phase 3 HVAC Project Costs Summary by Efficiency (SEER) and Equipment Type

SEER	Average	Median	Minimum	Maximum
Single-Speed All-Electric Heat Pumps (n=6)				
15-15.9 (n=3)	$19,032	$19,189	$18,450	$19,456
16-16.9 (n=3)	$17,333	$16,800	$16,600	$18,600
Variable-Speed All-Electric Heat Pumps (n=9)				
16-16.9 (n=3)	$17,233	$17,200	$15,700	$18,800
18-18.9 (n=4)	$25,034	$24,890	$24,567	$25,791
19+ (n=2)	$24,040	$24,040	$15,430	$32,650
Total All-Electric Heat Pumps (n=15)				
15-15.9 (n=3)	$19,032	$19,189	$18,450	$19,456
16-16.9 (n=6)	$17,283	$17,000	$15,700	$18,800
18-18.9 (n=4)	$25,034	$24,890	$24,567	$25,791
19+ (n=2)	$24,040	$24,040	$15,430	$32,650

Note: When the contractor did not specify a heat pump as standard or inverter-driven, but the heat pump had a SEER rating of at least 18, we assumed it to be inverter-driven.

Table 54. Phase 3 HVAC Project Costs Summary by Efficiency (SEER2) and Equipment Type

SEER2	Average	Median	Minimum	Maximum
Single-Speed All-Electric Heat Pumps (n=13)				
14-14.9 (n=1)	$18,950	$18,950	$18,950	$18,950
15-15.9 (n=6)	$17,970	$18,090	$15,170	$20,604
16-16.9 (n=6)	$25,405	$24,792	$15,544	$34,302
Variable-Speed All-Electric Heat Pumps (n=12)				
16-16.9 (n=1)	$19,900	$19,900	$19,900	$19,900
17-17.9 (n=3)	$25,218	$26,465	$22,725	$26,465
18-18.9 (n=6)	$25,802	$26,653	$19,570	$32,061
19+ (n=2)	$28,863	$28,863	$26,965	$30,760
Total All-Electric Heat Pumps (n=25)				
14-14.9 (n=1)	$18,950	$18,950	$18,950	$18,950
15-15.9 (n=6)	$17,970	$18,090	$15,170	$20,604
16-16.9 (n=7)	$24,619	$23,304	$15,544	$34,302
17-17.9 (n=3)	$25,218	$26,465	$22,725	$26,465
18-18.9 (n=6)	$25,802	$26,653	$19,570	$32,061
19+ (n=2)	$28,863	$28,863	$26,965	$30,760

[a] When the contractor did not specify a heat pump as standard or inverter-driven, but the heat pump had a SEER or SEER2 rating of at least 18, we assumed it to be inverter-driven.

TWO-HVAC SYSTEMS COST FINDINGS

ADDITIONAL DESCRIPTIVE SUMMARY OF HVAC PROJECT COSTS

PHASE 2 HVAC PROJECT COST DATA

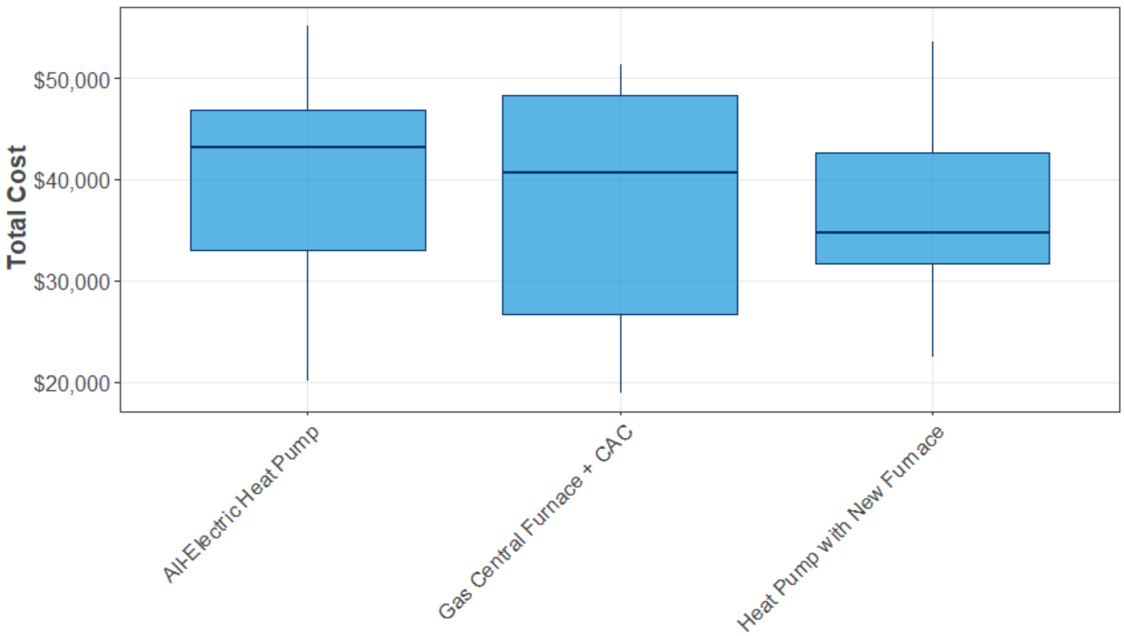
Table 55 summarizes the average, median, minimum, and maximum total project costs for homes with two HVAC systems by equipment type. The average cost for two gas furnace and CAC systems in Phase 2 was about $37,800, while the average cost of two all-electric heat pump systems was about $39,900.

Table 55. Phase 2 Two-HVAC System Project Costs Summary

Bid Equipment Type	Average	Median	Minimum	Maximum
Gas Central Furnace + CAC (n=8)	$37,822	$40,676	$18,895	$51,321
All-Electric Heat Pump (n=8)	$39,899	$43,161	$20,065	$55,176
Heat Pump with New Furnace (n=8)	$36,931	$34,708	$22,435	$53,583
Heat Pump Speed				
Single-Speed Heat Pump (n=4)	$25,061	$26,245	$20,065	$27,690
Variable-Speed Heat Pump (n=13)	$41,530	$42,425	$22,435	$55,176

When examining the minimum and maximum costs by equipment type, we noticed a large variation in the cost data received. Figure 40 displays the range in total project costs by equipment type for homes with two HVAC systems for Phase 2. The gas furnace and CAC system project represented the greatest variation in costs.

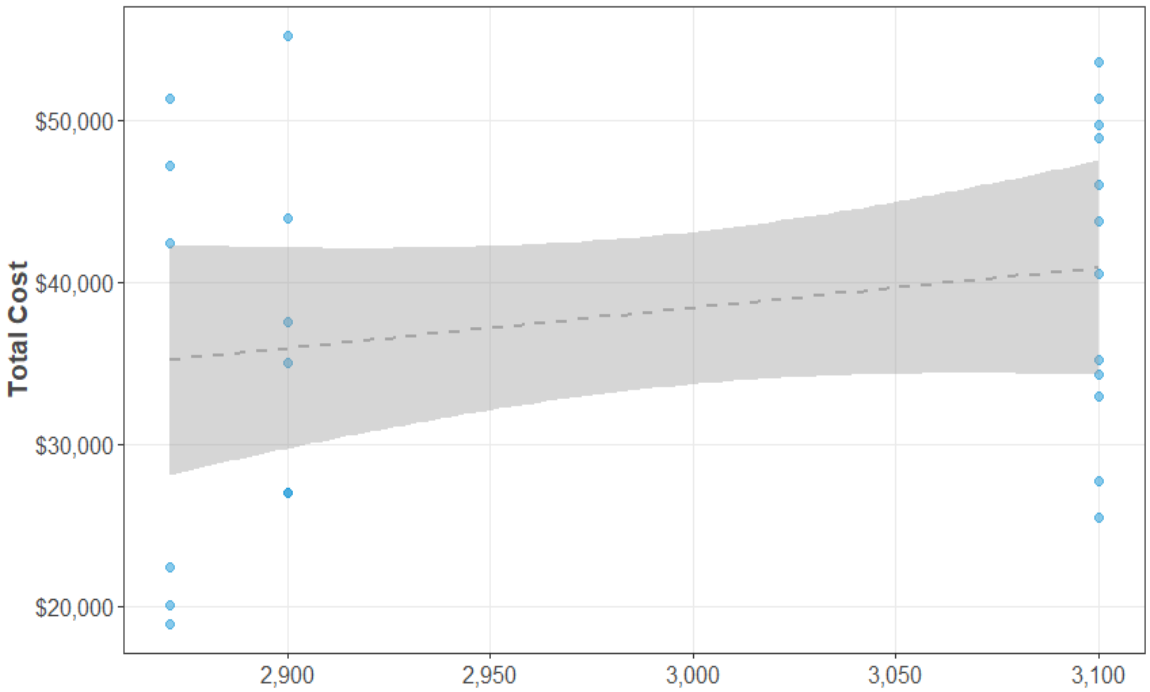
Figure 40. Phase 2 Two-HVAC System Total Project Costs by Equipment Type



All three two-HVAC-system homes were in the hot-dry climate regions and had solar PV, so there were no differences in costs that we could explore around those elements. Furthermore, none of the 24 bids across these 3 homes included costs related to HERS testing or permitting.

These homes were all over 2,000 square feet, which makes sense given that they needed two HVAC systems to properly heat and cool the entire home. Figure 41 below illustrates the slightly positive correlation between home square footage and total project costs for two HVAC systems.

Figure 41. Phase 2 Two-HVAC System Total Project Costs by Home Square Footage



We investigated potential cost differences between HVAC project costs given by contractors who were TECH-enrolled and those who were not. Table 56 below presents the cost breakdowns between TECH-enrolled contractors and non TECH-enrolled contractors by bid equipment type. Given the small sample of bids received for homes with two HVAC systems, we found no statistically significant difference in average project costs between these two groups across all equipment types.

Table 56. Phase 2 Two-HVAC System Project Costs Summary by TECH Initiative Enrollment and Equipment Type

Contractor Type	Average	Median	Minimum	Maximum
Gas Furnace + CAC				
TECH-Enrolled (HVAC) (n=6)	$41,681	$45,498	$18,895	$51,321
Non TECH-Enrolled (n=2)	$26,245	$26,245	$25,490	$27,000
All-Electric Heat Pump				
TECH-Enrolled (HVAC) (n=6)	$42,866	$44,935	$20,065	$55,176
Non TECH-Enrolled(n=2)	$31,000	$31,000	$27,000	$35,000
Heat Pump with New Furnace				
TECH-Enrolled (HVAC) (n=5)	$39,929	$40,485	$22,435	$53,583
Non TECH-Enrolled (n=3)	$31,935	$32,964	$27,690	$35,150

As exhibited in Table 57 and Table 58 below, all-electric heat pump costs for homes with two HVAC systems in Phase 2 increased as efficiency ratings went up. However, due to the limited number of bids that listed the efficiency of the new equipment, we were unable to estimate any statistically significant difference in total project cost based on efficiency. Most Phase 2 bids for homes with two HVAC systems provided SEER ratings instead of SEER2.

Table 57. Phase 2 Two-HVAC System Project Costs Summary by Efficiency (SEER) and Equipment Type

SEER	Average	Median	Minimum	Maximum
Single-Speed All-Electric Heat Pumps (n=2)				
14-14.9 (n=1)	$27,000	$27,000	$27,000	$27,000
15-15.9 (n=1)	$20,065	$20,065	$20,065	$20,065
Variable-Speed All-Electric Heat Pumps (n=4)				
18-18.9 (n=3)	$41,623	$43,898	$35,000	$45,972
19+ (n=1)	$49,659	$49,659	$49,659	$49,659
Total All-Electric Heat Pumps (n=6)				
14-14.9 (n=1)	$27,000	$27,000	$27,000	$27,000
15-15.9 (n=1)	$20,065	$20,065	$20,065	$20,065
18-18.9 (n=3)	$41,623	$43,898	$35,000	$45,972
19+ (n=1)	$49,659	$49,659	$49,659	$49,659

Note: When the contractor did not specify a heat pump as standard or inverter-driven, but the heat pump had a SEER rating of at least 18, we assumed it to be inverter-driven.

Table 58. Phase 2 Two-HVAC System Project Costs Summary by Efficiency (SEER2) and Equipment Type

SEER2	Average	Median	Minimum	Maximum
Variable-Speed All-Electric Heat Pumps (n=2)				
16-16.9 (n=1)	$42,425	$42,425	$42,425	$42,425
18-18.9 (n=1)	$55,176	$55,176	$55,176	$55,176
Total All-Electric Heat Pumps (n=2)				
16-16.9 (n=1)	$42,425	$42,425	$42,425	$42,425
18-18.9 (n=1)	$55,176	$55,176	$55,176	$55,176

Note: When the contractor did not specify a heat pump as standard or inverter-driven, but the heat pump had a SEER or SEER2 rating of at least 18, we assumed it to be inverter-driven.

PHASE 3 HVAC PROJECT COST DATA

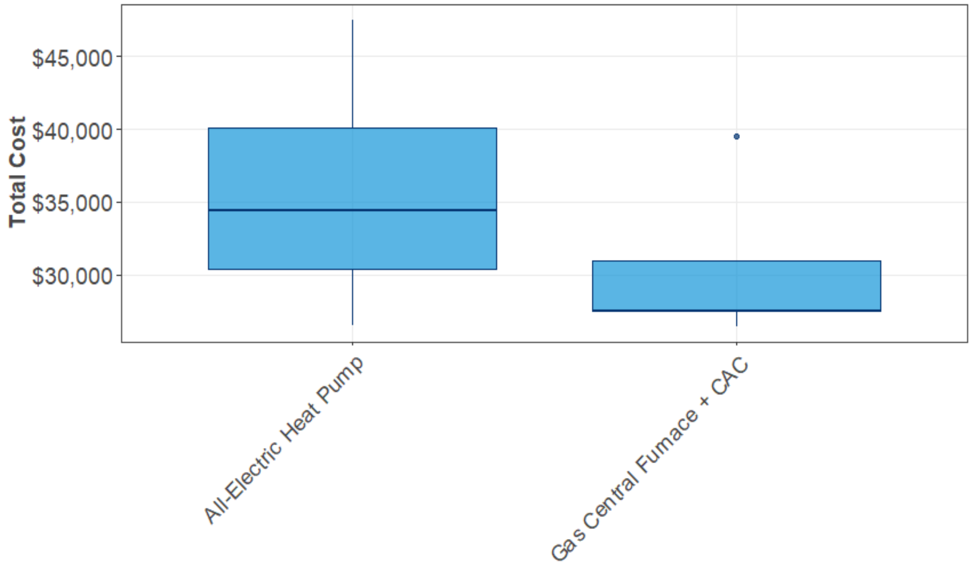
Table 59 below summarizes the average, median, minimum, and maximum total project costs for homes with two HVAC systems by equipment type. The average cost for two gas furnace and CAC systems in Phase 3 was about $30,400, while the average cost of two all-electric heat pump systems was about $35,700.

Table 59. Phase 3 Two-HVAC System Project Costs Summary

Bid Equipment Type	Average	Median	Minimum	Maximum
Gas Central Furnace + CAC (n=5)	$30,370	$27,470	$26,438	$39,510
All-Electric Heat Pump (n=10)	$35,730	$34,384	$26,492	$47,500
Heat Pump Speed				
Single-Speed Heat Pump (n=5)	$33,187	$32,643	$26,492	$40,550
Variable-Speed Heat Pump (n=5)	$38,274	$38,708	$30,358	$47,500

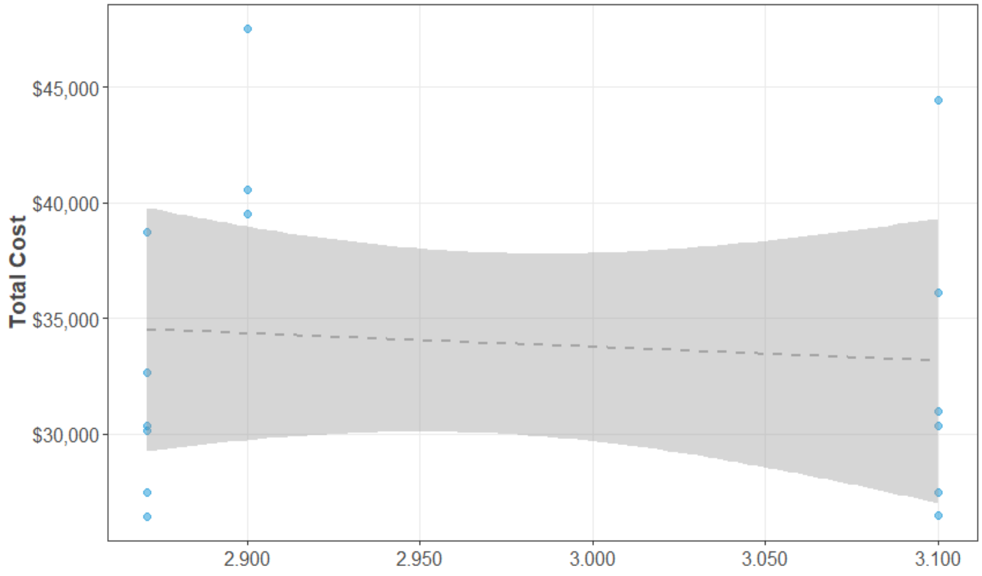
In Phase 3, when examining the minimum and maximum costs by equipment type, we noticed some variation in the cost data received for all-electric heat pumps. Figure 42 displays the range in total project costs by equipment type for homes with two HVAC systems.

Figure 42. Phase 3 Two-HVAC System Total Project Cost by Equipment Type



Additionally, we found no correlation between total project costs and home square footage for homes with two HVAC systems based on the bids received from the contractor survey (Figure 43).

Figure 43. Phase 3 Two-HVAC System Total Project Cost by Home Square Footage



In terms of any potential differences in project costs based on efficiency rating, we observed no clear trend as shown in Table 60 below. Three bids specified a 19+ SEER efficiency rating, with an average project cost of $36,000; all other bids specified SEER2 efficiency ratings.

Table 60. Phase 3 Two-HVAC System Project Costs Summary by Efficiency (SEER2) and Equipment Type

SEER2	Average	Median	Minimum	Maximum
Single-Speed All-Electric Heat Pumps (n=5)				
< 14 (n=1)	$40,550	$40,550	$40,550	$40,550
14-14.9 (n=2)	$34,384	$34,384	$32,643	$36,124
16-16.9 (n=2)	$28,308	$28,308	$26,492	$30,125
Variable-Speed All-Electric Heat Pumps (n=2)				
17-17.9 (n=2)	$41,577	$41,577	$38,708	$44,445
Total All-Electric Heat Pumps (n=7)				
< 14 (n=1)	$40,550	$40,550	$40,550	$40,550
14-14.9 (n=2)	$34,384	$34,384	$32,643	$36,124
16-16.9 (n=2)	$28,308	$28,308	$26,492	$30,125
17-17.9 (n=2)	$41,577	$41,577	$38,708	$44,445

Note: When the contractor did not specify a heat pump as standard or inverter-driven, but the heat pump had a SEER or SEER2 rating of at least 18, we assumed it to be inverter-driven.

INCREMENTAL COST FINDINGS

PHASE 2 FINDINGS

As previously mentioned, the existing HVAC equipment for these three homes was two gas furnace and CAC systems. Therefore, project costs for installing these two HVAC equipment systems were the baseline of our fixed-effects regression models. Table 61 below shows the incremental costs associated with heat pump upgrades. We observed no statistically significant difference among the average project cost of two gas furnace and CAC systems, that of two all-electric heat pumps, and that of two dual-fuel heat pumps. However, given the small sample sizes for these projects, we are unable to draw any conclusions from these findings.

Table 61. Phase 2 Two-HVAC System Project Incremental Costs Findings

Replacement Equipment	Incremental Cost Estimate (Over Baseline)	% Incremental Cost (Over Baseline)
Baseline Scenario: Gas Furnace + CAC; Baseline Cost: $37,822		
All-Electric Heat Pump (n=8)	$2,762	7%
Heat Pump + New Furnace (n=8)	($7,037)	(19%)

Note: Results are not statistically significant.

PHASE 3 FINDINGS

In Phase 3, however, we observed that in the replacement scenario of two gas central furnace and CAC systems, two all-electric heat pumps cost about $5,300 more than a like-for-like replacement of the systems, which represents an 18% cost increment. This finding was significant at the 95% confidence level (see Table 62).

Table 62. Phase 3 Two-HVAC System Project Incremental Costs Findings

Replacement Equipment	Incremental Cost Estimate (Over Baseline)	% Incremental Cost (Over Baseline)
Baseline Scenario: Gas Central Furnace + CAC; Baseline Cost: $30,370		
All-Electric Heat Pump (n=10)	5,360*	18%

* Statistically significant at the 95% confidence level

Aggregated Findings

We combined the cost data across both phases of our study to estimate incremental costs associated with a like-for-like replacement and a heat pump replacement using a larger number of observations. As such, we observed that the average cost of two all-electric heat pumps and the average cost of two dual-fuel heat pump systems with a new furnace are not statistically different from the average cost of two gas furnace and CAC systems (see Table 63).

Table 63. Phase 2 & 3 Aggregated Two-HVAC System Project Incremental Costs Findings

Replacement Equipment	Incremental Cost Estimate (Over Baseline)	% Incremental Cost (Over Baseline)
Baseline Scenario: Gas Central Furnace + CAC; Baseline Cost: $34,956		
All-Electric Heat Pump (n=18)	$2,247	6%
Heat Pump with New Furnace (n=8)	$460	1%

Note: Results are not statistically significant.

Water Heater Findings

This section includes additional ways to summarize the cost data received for water heating projects that were not presented in the report.

Additional Descriptive Summary of Water Heater Project Costs

Phase 2 Water Heater Project Cost Data

Table 64. Phase 2 Water Heater Project Costs Summary by Presence of Solar PV and Equipment Type

Bid Equipment Type	Average	Median	Minimum	Maximum
Homes with Solar				
Gas Storage Water Heater (n=7)	$3,513	$3,433	$2,995	$4,493
Gas Tankless Water Heater (n=6)	$6,547	$6,480	$5,800	$7,430
Heat Pump Water Heater (n=17)	$7,881	$7,592	$4,587	$13,225
Homes without Solar				
Gas Storage Water Heater (n=13)	$4,668	$4,500	$2,010	$7,488
Gas Tankless Water Heater (n=18)	$9,832	$7,713	$5,500	$17,000
Heat Pump Water Heater (n=14)	$9,360	$8,386	$3,800	$14,700

Table 65. Phase 2 Water Heater Project Cost Summary by Home Size

Bid Equipment Type	Average	Median	Minimum	Maximum
Homes less than 2,000 sq. ft.				
Gas Storage Water Heater (n=8)	$3,693	$3,413	$2,010	$6,777
Gas Tankless Water Heater (n=10)	$11,977	$15,062	$5,500	$17,000
Heat Pump Water Heater (n=13)	$8,848	$8,423	$3,800	$14,687
Homes 2,000 sq. ft. and above				
Gas Storage Water Heater (n=12)	$4,644	$3,976	$2,995	$7,488
Gas Tankless Water Heater (n=14)	$6,893	$6,844	$5,800	$8,369
Heat Pump Water Heater (n=18)	$8,333	$7,396	$4,587	$14,700

PHASE 3 WATER HEATER PROJECT COST DATA

Table 66. Phase 3 Water Heater Project Costs Summary by Presence of Solar PV and Equipment Type

Bid Equipment Type	Average	Median	Minimum	Maximum
Homes with Solar				
Gas Storage Water Heater (n=4)	$2,513	$2,400	$1,950	$3,300
Gas Tankless Water Heater (n=4)	$5,900	$5,649	$4,200	$8,100
Heat Pump Water Heater (n=6)	$8,641	$7,723	$5,900	$15,900
Homes without Solar				
Gas Storage Water Heater (n=10)	$5,015	$4,091	$1,950	$12,200
Gas Tankless Water Heater (n=10)	$7,602	$7,445	$4,950	$11,982
Heat Pump Water Heater (n=11)	$10,464	$10,065	$5,900	$16,200

Table 67. Phase 3 Water Heater Project Costs Summary by Home Size

Bid Equipment Type	Average	Median	Minimum	Maximum
Homes less than 2,000 sq. ft.				
Gas Storage Water Heater (n=8)	$4,545	$3,313	$1,950	$12,200
Gas Tankless Water Heater (n=8)	$7,333	$6,900	$4,200	$11,982
Heat Pump Water Heater (n=10)	$9,499	$9,133	$5,900	$15,061
Homes 2,000 sq. ft. and above				
Gas Storage Water Heater (n=6)	$3,973	$3,005	$2,150	$7,328
Gas Tankless Water Heater (n=6)	$6,825	$6,994	$4,900	$8,100
Heat Pump Water Heater (n=7)	$10,280	$8,447	$6,400	$16,200

Opinion **Dynamics**

CONTACT:

Malena Hernandez
Principal Consultant
mhernandez@opiniondynamics.com

Jen Loomis, PhD
Associate Director
jloomis@opiniondynamics.com

Ellen Steiner, PhD
Vice President
esteiner@opiniondynamics.com

BOSTON
PORTLAND
SAN DIEGO
SAN FRANCISCO