Emergency Replacement Heat Pump Water Heater Market Study

Final Report

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Prepared by:

Chris Badger VEIC

Sarabeth Erdman VEIC

Nick Neverisky VEIC

Jake Ahrens VEIC

Sean Parker VEIC

Cole Shea VEIC

Kieran Yater VEIC

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Executive Summary

This report assesses the key factors and decision-making processes of residential customers and contractors in emergency water heater replacement scenarios and analyzes the technical solutions that best support heat pump water heater (HPWH) adoption in these situations. The report examines two potential solutions to increase HPWH adoption in no-heat scenarios; 1) by loaning a gas water heater to customers at no cost until a 240v HPWH can be installed, and 2) by installing a new 120V plug-in HPWH. Both options offer plumbing contractors a faster alternative for restoring hot water service by either postponing or eliminating electrical upgrades necessary for a 240V HPWH. The report uses a market evaluation, data tracking, customer surveys, and interviews with contractors and manufacturers to inform the mapping of the decision-making process in emergency replacement scenarios and the key decision drivers that affect whether a customer adopts a heat pump.

Summary of Findings

Water Heater Market and HPWH Installation Trends in California

The market evaluation identified the following trends among HPWH installations:

- An estimated 721,000 water heaters are replaced annually in California single-family homes; 87 percent of these replacements are gas water heaters and 13 percent electric water heaters, typically as “like-for-like” replacements.
- At least 75 percent of water heater replacements are reported to take place as the result of a sudden or imminent unit failure, creating additional barriers to HPWH installations associated with the increased installation cost, time, and complexity associated with typical gas conversion opportunities.
- Approximately 1,554 HPWH have been installed through TECH Clean California (TECH) over the last two years, representing 0.2 percent of the total estimated annual water heater replacements in single-family homes in California. HPWHs installed in emergency replacement scenarios represented only nine percent of the total HPWH installations, with proactive replacements making up most of the program participants.
- A heavy concentration of the TECH HPWH installations occurred in the San Francisco Bay Area and Sacramento and 84 percent of the installations were in Pacific Gas & Electric's (PG&E) service territory, in part due to layered incentives exceeding $5,200 per installation. The technology’s popularity in PG&E’s service territory has led to gaps in available funding which can be detrimental to HPWH adoption and broader uncertainty in the technology’s market.
- Higher, stackable incentives in the PG&E gas utility service territory correlated with $2,000 higher project installation costs, compared with other parts of the state. The team hypothesizes that higher rebate levels allow contractors in PG&E’s territory to increase their quotes to customers without having the customer’s cost exceed that of a gas water heater. Estimated homeowner eligibility for federal tax credits range from 25 percent to 50 percent of the maximum $2,000 limit due to the reduced installation cost from California rebates.

- Contractor understanding and calculation of the federal tax credit ranged significantly and its applicability varies, based on whether rebates are provided at the point-of-sale or post-sale.
- The use of gas loaners increased overall HPWH project costs and were less commonly used by contractors as a solution to provide same-day hot water restoration. However, gas loaners were used in targeted applications by some contractors to address delays in rebate availability and the time required for electrical or space remediation needed for gas storage tank to 240V HPWH conversions.
- The utilization of plug-in 120V HPWHs has grown to represent 15 percent of recent HPWH installations and is expected to make up an increasing share of conversions from gas water heaters due to their lower installed cost, installation time, and complexity, as they do not require new electrical service lines and panel upgrades.
- Plug-in 120V HPWHs were installed in 22 percent of emergency replacements reported by TECH contractors. Contractors reported the lower installation rate was due to first-hour ratings for certain 120V models during this period, which has since been resolved. Average plug-in 120V HPWH installation costs were 13 percent lower than 240V installations.

Contractor Predispositions Towards HPWHs

Contractor predisposition is a key factor influencing whether a HPWH is installed in an emergency replacement scenario.

- Seven contractors account for approximately 45 percent of total HPWH installations, comprising a small subset of the nearly 20,000 licensed California C-36 plumbing contractors.
- Emergency replacement HPWH installations represent just nine percent of TECH-tracked HPWH installations with two larger contractors making up two thirds of those emergency replacements.
- Contractors are unlikely to recommend HPWH installations in emergency replacement scenarios without more experience with the technology.
- More than 50 contractors completed HPWH best practice and manufacturer training through the TECH Learn and Earn program, making them eligible for a free HPWH to install in their own home or business.
- Contractors actively promoting HPWHs have significant experience and technician training to support HPWH installations, strategies to increase likelihood of HPWH sales to customers, and robust internal data processes necessary for incentive program reporting and applications.
- The heating, ventilation, and air conditioning (HVAC) and plumbing market in California and nationally has experienced increasing consolidation recently, and this trends in HVAC and plumbing contractor mergers have been highlighted by increased HVAC contractor installations reported through TECH.
- Contractors with in-house electricians reported common same-day gas to HPWH conversions, whereas other contractors described the electrical upgrades, permitting and inspection requirements for HPWH installations as a significant barrier.

- The administrative burden of incentive programs and rebate applications is often prohibitive for smaller contractors and can deter them from HPWH installations.
- Emerging third-party smart phone applications are guiding smaller contractors in customer rebate eligibility, and in streamlining application and reporting requirements to over 23 different HPWH incentive programs in California.

Key Decision Factors Affecting HPWH Installations

The market evaluation identified the following trends among HPWH installations;

- **Restoring hot water** on the same day at the lowest cost possible tends to be the top priority for customers and contractors. Additional complications associated with a HPWH conversion can result in multi-day projects for some contractors and increasingly push the homeowner to install a "like-for-like" gas unit.
- **Temporary gas loaners** are being tested by TECH's Quick Start Grant program and Tri-County Regional Energy Network (3CREN). Gas water heaters are installed until a contractor can perform any necessary home upgrades to increase HPWH adoption. The use of temporary gas loaners was limited primarily to one contractor and the 3CREN program has seen no contractor participation to date.
- **Electric permitting requirements**, post-installation inspections, and the need for engaging a separate electrician can all cause project delays that make it difficult to install a HPWH the same day and make opting for a "like-for-like" replacement more likely.
- **Physical and logistical barriers** such as electrical panel upgrades, water heater relocation, and space constraints can cause further delays and increase the complexity of a HPWH conversion. The typical 240V HPWH installation was located in a garage, replaced a natural gas unit with a storage tank, had an average installation cost under $6,217, and required no other building upgrades during the installation.
- **Replacement of an existing electric water heater** with a HPWH was $1,519 less expensive than the replacement of a gas storage water heater. New electrical wiring and panel upgrades were the most significant additional costs for gas to HPWH conversions, followed by the replacement of a tankless water heater.
- **Rebates** reducing the upfront cost of a water heater replacement and monthly energy savings were the two most important factors resulting in HPWH installations in emergency replacement situations.
- **Trust in contractor recommendations** was the third most important factor resulting in HPWH installations in emergency replacement situations.

Recommendations

- **Ensure continuity of rebate funding for HPWH installations**. Consistent program funding is necessary to sustain retailer, distributor, manufacturer and most importantly, contractor prioritization of HPWH's in emergency replacements. The upfront cost is a primary factor for homeowners in emergency replacements, highlighting the impact of gaps or rapid fluctuations in funding on contractor and customer decisions and the likelihood of a HPWH replacement.
- **Streamline rebate application and reporting processes for contractors and maximize efficiency of point-of-sale rebates.** The overwhelming consensus of contractors was that

participating in more than 23 HPWH rebate programs in California was extremely burdensome, especially during emergency replacements, and a more simplified and coordinated process is desperately needed. The Golden State Rebate Program instant point-of-sale rebates was highlighted as an example of a preferred simplified process, while new third-party solutions have served as a welcome market innovation, reducing the administrative burden on contractors and achieving a fast pathway for determining homeowner eligibility and completing application and reporting requirements of each program.

- **Prioritize "lowest hanging fruit" electric water heater replacement and plug-in 120V HPWH opportunities to rapidly scale contractor adoption and lower installation costs.** The rapid increase in the rate of plug-in 120V HPWH installations demonstrates its success in reducing installation complexity, achieving same-day hot water restoration and reducing homeowner upfront costs, all of which are critical in emergency replacement scenarios. Supporting contractor prioritizing of simpler, "easy win" HPWH opportunities found in electric water heater replacements and smaller households that are "good candidates" for plug-in 120V HPWHs offers a pathway to rapidly scale the HPWH market, increase competition and lower installation costs by eliminating the need for expensive electrical or building upgrades. Reducing installation costs is critical to increase electrification in disadvantaged communities (DAC) and lower income households.
- **Focus financial support for electrical and physical remediation for HPWH and broader electrification improvements in DAC areas and lower income households.** Emergency replacements cost more than proactive replacements and many homes need additional electrical or space remediation work for HPWH installations. The burden of these increased water heater replacement costs is most significant in DAC areas and for lower income households and requires increased financial support for electrical and building remediation work.

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Abbreviations and Acronyms

Acronym	Meaning
3CREN	Tri-County Regional Energy Network
BAAQMD	Bay Area Air Quality Management District
BayREN	Bay Area Regional Energy Network
CARB	California Air Resources Board
CCA	Community Choice Aggregator
DAC	Disadvantaged Communities
HPWH	Heat Pump Water Heater
HTR	Hard-to-Reach
HVAC	Heating, Ventilation, and Air Conditioning
IOU	Investor-Owned Utility
IPMT	Intelligent Power Management Technologies
NREL	National Renewable Energy Lab
PCE	Peninsula Clean Energy
PG&E	Pacific Gas & Electric
REN	Regional Energy Network
SGIP	Self-Generation Incentive Program
SMUD	Sacramento Municipal Utility District
TECH	TECH Clean California

Introduction

Developing targeted solutions for emergency replacements in single-family homes with heat pump water heaters (HPWH) is urgently needed to achieve California's decarbonization goals. Emergency or anticipated water heater failures drive approximately 75 percent of water heater replacements in existing homes (NEEA, 2018), but significantly higher rates (greater than 90 percent) are reported by plumbing contractors. Emergency replacements are typically difficult situations for converting to HPWHs, due to the additional cost, complexity and time required for installation, and permitting. In a 2018 study, the top three drivers for a customer decision process were identified as 1) "like-for-like: a unit similar to what they have" 2) "speed: need it now" and don't want to research alternatives and 3) "low upfront costs: long term savings/efficiency are often ignored" (NEEA, 2018). A household's need for quick hot water service restoration historically has relegated customers and contractors to choose the fastest option, typically replacing a failed water heater with the same fossil fuel-based, inefficient technology.

Developing and adopting new emergency replacement strategies is critical to overcoming these persistent barriers to HPWH adoption. These strategies include offering new low load technology options (e.g. 120V plug-in HPWHs) that reduce critical replacement time and can eliminate additional permitting, costly electrical service upgrades, and scheduling an electrician. Removing the time pressure on contractors and customers for restoring hot water service can be similarly achieved by installing a gas loaner water heater the same day. Gas loaners allow time for the additional service upgrades and permitting required for a higher capacity 240V HPWH to be scheduled to meet the customer and contractor needs.

This report examines the key factors and decision processes of residential customers and contractors related to emergency water heater replacements and assesses technical solutions for emergency water heater replacements that best support HPWH installations. Findings and recommendations in the report provide critical new insights for incentive programs and plumbing contractors to better serve their customers in transitioning to a HPWH technology.

Background

The 2022 CA Heat Pump Residential Market Characterization and Baseline Study estimated that in 2019 there were 12.1 million water heaters in California households, but only one percent were high efficiency electric water heaters (i.e. HPWHs.) In addition, a majority of single-family homes currently have gas water heaters, increasing the complexity, cost and time to retrofit or replace them with a new, electric HPWHs. To accelerate the adoption of HPWHs, significant financial incentives are currently being offered at the federal, state, utility and local levels to address the higher incremental cost of upgrades.

In December 2021, a new statewide initiative, TECH Clean California (TECH), created an incentive clearing house for HPWH and heat pump heating, ventilation, and air conditioning (HVAC) systems for single and multifamily buildings. The clearing house allowed for the layering of multiple existing

and new incentives offered at the point of sale to participating distributors and retailers, as well as through contractor submissions. However, TECH also created a pathway for innovation through a combination of pilots and Quick Start Grant projects, which focused on identifying and addressing key barriers to HPWH installations in the state. In the first cohort of Quick Start Grant projects, two innovative projects evaluated different technology and project process solutions to address barriers associated with emergency replacements:

- In 2022, a Quick Start Grant project awardee initiated a new pilot targeted at customers with failed gas water heaters, offering a free gas loaner water heater to customers committing to the installation of a 240V HPWH. The gas loaner was an elegant solution addressing two conflicting HPWH barriers, the desire by customers for same-day hot water restoration and the potential multi-day schedule to accommodate necessary electrical and plumbing upgrades and permitting process. The pilot was successful, increasing HPWH conversions from below one percent to over 17 percent (Foster, 2023).
- During the same period, a second Quick Start Grant awardee conducted a field evaluation of new 120V plug-in HPWHs in 32 California single family homes. The 120V plug-in solution allows contractors an alternative to existing 240V HPWH models, which typically require additional electrical upgrades (e.g. wiring, panel capacity and electrical service) and associated permitting. Their capability to utilize an existing shared 120V outlet near the water heater location, allows a plumbing contractor to significantly decrease the time and complexity to replace a gas water heater with a high efficiency 120V HPWH (Khanolkar, 2023).

In addition to serving as a clearing house for incentives, the TECH initiative reporting process has served to capture and publicly report key metrics of every HPWH installation (TECH Clean California, 2023). The public dataset recently served as the basis for evaluating cost drivers for heat pump HVAC systems installations and will be utilized in this project to assess the primary cost drivers of HPWH installations in California (Sarkisian, 2023). Additionally, the TECH dataset further allows for evaluating trends in HPWH installations, as well as that of participating contractors.

Previous studies in California and the Northwest have evaluated the supply chain for HPWHs, as well as the primary barriers and best practices for HPWH installations. This report will seek to incorporate the key findings from these studies to map the contractor decision process in evaluating key factors at various stages of an emergency water heater project – and ultimately, the corresponding likelihood for a HPWH installation.

- The CalNEXT report, Market Study of Household Electric Infrastructure Upgrade Alternatives for Electrification, assessed intelligent power management technologies (IPMT) which seek to minimize the cost associated with electrification projects by shutting off circuits when current draws exceed a maximum limit. However, the average cost to install an IPMT is $7,000 and incentives for income qualified customers are $4,000. The report found that the high upfront cost of IMPTs, even after incentives, has limited the technology's adoption, further emphasizing the need to identify other alternatives to electric panel upgrades. This is something 120V HPWH's could address.
- CalNEXT's Residential Housing Characteristics Study examined the electrification readiness of single-family homes in disadvantaged communities (DAC) and hard to reach (HTR)

communities. The study found that DAC/HTR residents typically live in homes with older vintages that have had fewer upgrades overtime when compared with non-DAC/HTR homes. This means that when installing a 240V HPWH, DAC/HTR homes are more likely to require additional plumbing, condensate draining, water heater relocation, and electrical panel upgrades, all of which will increase their costs. Addressing these barriers is necessary to equitably decarbonize California's residential sector.

- The 2022 Midstream Heat Pump Water Heater Study and Field Test assessed stakeholders' knowledge and perceptions of HPWHs and developed recommendations to overcome market behavior barriers to HPWH installations. The top barriers to HPWH adoption as identified by single family contractors interviewed in the study were high upfront costs, lack of a skilled workforce to install HPWHs, space constraints, lack of awareness about product, electrical panel upgrades, and rebate program requirements and availability. Customer surveys corroborated these findings, as customers identified high upfront costs as the most important factor when deciding whether to install a HPWH. Emergency replacements were also a barrier, as just 3 of 70-80 HPWH installations in the market study were emergency replacements and in the field test's customer surveys, 5 of 19 HPWH installations were emergency replacements. These were assumed to be funded by the TECH Quick Start Grant gas loaner. Contractors identified panel upgrades as a barrier to emergency replacements due to the increased time and cost. However, customer surveys showed potential for contractors to influence the customer's decision. More than half of customers who installed a HPWH said they first learned about the benefits from their contractor, nearly three quarters took their contractor's recommendation to upsize the size of their tank, and all customers except one who interacted with their contractor said their contractor was knowledgeable about HPWHs. Still, the largest motivators for customers who decided to install a HPWH were the availability of rebates and the desire to be more sustainable.

Summary of HPWH Technical Solutions for Emergency Replacements

As highlighted above, two new technical solutions were identified through the TECH Quick Start Grant program and were further evaluated for their application in emergency replacements.

Plug-in 120V HPWHs

Plug-in 120V HPWHs share many characteristics with 240V models, but there are key differences which are listed below.

- **120V models plug in.** This is the most significant difference between 120V HPWHs and 240V HPWHs. Their lower voltage allows 120V HPWHs to be plugged into standard 15-amp electric outlets, while 240V models typically require the additional space and electrical capacity for a new two-pole 30-amp breaker in the electrical panel and installation of new high amperage wiring from the panel to the HPWH. This plug-in option allows for much easier installations and lower costs by potentially avoiding electric infrastructure upgrades.
- **Reduced or no backup heating.** The 120V HPWHs lower their power demand by operating either entirely in heat pump with no electric resistance backup or using a backup with a dramatically reduced size. While this lack of backup increases efficiency, the performance of the 120V HPWH and lower first hour recovery rate is significantly affected by

environmental factors that impact the compressor performance such as incoming water temperature and ambient air temperature.

- **Integrated thermostatic mixing valve.** The thermostatic mixing valve provides additional hot water capacity by decoupling the tank temperature (e.g. allowing storage up to 140°F) from the delivered hot water delivery temperature (e.g. 120°F). Plug-in 120V models utilizing either integrated or external electronic mixing valves can reduce the risk of hot water run outs by effectively increasing the stored energy in the tank, which can further allow for limiting operation during peak electricity periods through control optimization based on time-of-use rates and demand response program signals.
- **Tank size.** Because 120V HPWHs have no or reduced electric resistance backup options, plumbers typically install larger storage tanks to achieve similar first hour ratings to the previous water heater. The first hour ratings for 50-gallon 120V models range from 45 to 74 gallons compared with 67 to 94 gallons for 50-gallon 240V models.

Gas Loaners

The utilization of a temporary gas loaners addresses several barriers to HPWH installations in emergency replacements, but also come with their own limitations.

- **Enable conversions from gas to 240V HPWHs.** The increased complexity of removing existing gas piping and ventilation, as well as adding necessary electrical wiring and possible panel upgrades, can significantly affect the likelihood of conversions. Providing temporary gas loaner water heaters can provide sufficient time to complete the home remediation requirements for the HPWH installation.

- **Reduced hot water restoration time.** In emergency replacements, gas loaners can significantly reduce the time required to restore hot water to the household, decoupling from the time (up to two weeks) for necessary electrical permitting and upgrades to be completed for the HPWH installation.

- **Increased cost to customer and technician time for contractor.** The installation of a gas loaner involves additional installation time for the service technician, as well as a separate site visit for the additional electrical work and HPWH installation. Due to these requirements, the overall project cost to the customer and staff time for the contractor increase correspondingly. These costs and increased burden on the contractor can limit adoption of gas loaners in absence of program incentives.

The introduction of gas water heater loaners as a technical solution received additional visibility following the TECH Quick Start Grant project and has since been developed into a rebate offer through the Tri-County Regional Energy Network (3CREN), in the counties of San Luis Obispo, Santa Barbara and Ventura. A few contractors interviewed reported using targeted applications of gas loaner, even in the absence of supplemental incentives in cases where slow electrical upgrades, permitting or product availability prevent same or next day restoration of hot water.

Alternative Technical Solutions

In addition to gas loaners, some contractors have developed other temporary solutions including direct external temporary wiring to the HPWH location and installation of a plug-in 120V to 240V

inverter to operate a HPWH in low power (heat pump only mode). Development of new 120V/240V HPWH models to allow for temporary plug-in use is a potential solution for these applications.

Objectives

The primary objectives of this study were to 1) define and quantify the potential market opportunity for emergency water heater replacement in California, 2) investigate plumbing contractors' decision processes guiding customer choices related to emergency water heater replacement, 3) assess technical solutions for emergency water heater replacements that best support HPWH installations and 4) deliver actionable recommendations for contractors and program administrators.

Determine Market Opportunity

The project examined the potential opportunity of targeted HPWH solutions for emergency replacement scenarios in California and to scale participation in energy efficiency and demand-side management programs. The project team reviewed the growing knowledge about customer and contractor barriers, new HPWH technology solutions, as well as leveraged findings from the CalNEXT "Increasing Heat Pump Water Heater Deployment" project (ET22SWE0056), CalNEXT ET22SWE0022 "Residential Housing Characteristics Study", national and other state-wide initiatives and California programs such as TECH, Self-Generation Incentive Program (SGIP), and the CA Market Transformation Program.

Investigate Decision Processes

The project assessed the decision processes of residential customers and contractors related to emergency water heater replacement.[1] The project team investigated what priorities drive both contractor recommendations and customer choices. The project then assessed the tradeoffs of customers' preference for in-kind replacements, upfront incremental costs, importance and impact of state and federal incentives, as well as site specific limitations (e.g. location, space, electrical service upgrades, noise, etc.), as part of emergency replacements.

Assess Technical Solutions

The project evaluated the technical solutions for emergency water heater replacements that best support HPWH installations. This was done through research of two options for replacing hot water heaters: a) a low load, plug-in 120V HPWH model and, b) a larger capacity 240V model with the option for the installation of a temporary gas loaner water heater to provide same day hot water service.

Deliver Actionable Recommendations

Based on customer, contractor and manufacturer interviews, and installation data, the market study identifies the key barriers, customer and contractor decisions, as well as provides recommendations for boosting acceptance of HPWHs for emergency replacements. In addition, the project investigated

[1] Differences in single-family customer type (e.g. owner or landlord) could potentially approach emergency water heater replacements differently, but this delineation is not reflected in the available data sets. Any insights as to the differences in customer types identified during contractor interviews will be captured.

participating contractor awareness and planned approaches for leveraging SGIP rebates, new federal tax credits and regional specific rebates offered by municipalities, Regional Energy Networks (RENs) and Community Choice Aggregation (CCA) organizations, as well as knowledge and use of emerging third-party rebate processing solutions.

Methodology & Approach

This research included both a market evaluation and the mapping of key drivers at the various stages of a water heater replacement to better understand and illustrate the contractor and customer decision making process for installing a HPWH in an emergency replacement scenario. The market evaluation compared various data sources to assess the market opportunity for HPWH conversions during emergency replacements, as well as documented leading influences on customer/contractor decisions. Findings from the market evaluation as well as interviews with and data collected from contractors, manufacturers, and industry stakeholders informed the mapping of the key drivers and stages of an emergency water heater replacement and the effect on a potential HPWH installation.

Market Evaluation

The market evaluation focused on customer demographics, such as income and own/rent status, home characteristics, such as style of home, location of water heater, and exiting system type, as well as an analysis of installation costs, rebates and current installation rates of HPWHs in the state.

Additionally, the project team engaged with the CalNEXT ET22SWE0056 "Increasing Heat Pump Water Heater Deployment" and the CalNEXT ET22SWE0022 "Residential Housing Characteristics Study" project teams and leveraged report findings to gain further insights into the barriers DAC residents face to HPWH installs. The added research complemented an analysis of HPWH installation, building, customer segment and demographic area data for California single-family homes captured through the TECH publicly reported database, National Renewable Energy Lab (NREL) ResStock Building Stock Analysis and by the primary project partner, Barnett Plumbing.

Analysis of Key Decision Drivers and Process

Data analysis, interviews with contractors and manufacturers (listed in Appendix A), and findings from the market evaluation informed the analysis of key decision drivers and process. The project team conducted several interviews with primary project partner, Barnett Plumbing, to understand a typical emergency replacement scenario and to determine the data points collected during the process. Information collected during interviews, as well as in the market evaluation, was synthesized to map an initial matrix of decision points, barriers, and actions. The project team then proceeded to conduct interviews with additional contractors, water heater manufacturers, program managers and other industry stakeholders to assess the decision process for 120V and 240V HPWH emergency replacements.

The project team spoke with plumbing contractors representing the range of predispositions, or business models, regarding HPWHs to understand perspectives, opportunities, and barriers. Contractors were selected for interviews based on their number of installs listed in the TECH HPWH incentive database, as well as familiarity and experience with the technology. Manufacturers were

contacted to better understand opportunity and developments surrounding the 120V technology, as well as contractor feedback and desires from their perspective. Managers of programs offering regional incentives for HPWHs were contacted to further understand the impact of rebates on customer decision, and were able to shed light on additional topics, such as frequency of the DIY 120V install opportunity. The project team captured specific insights regarding barriers and recommended strategies for increasing HPWH installations in emergency replacements and contractor engagement supporting DAC areas and lower income households. Analysis of participation data in the TECH database and "Learn and Earn" program, as well as direct contractor and program manager interviews informed findings and recommendations. To support the development of the decision mapping process, program data from TECH was leveraged to guide a broader statewide comparison of emergency versus proactive HPWH installations. The project team also partnered with Barnett Plumbing to obtain data to track customer emergency replacements from initial call center entry to home service visit to final HPWH installation and customer satisfaction. Metrics included existing and replacement water heater specifications and sizes, assessment of HPWH options, installation time and project cost. Additional site and customer specific details are captured by the contractors in their respective Customer Management Systems offering opportunities for supplemental insights.

In order to accurately capture the current market, a mid-project re-assessment was conducted to determine both successful and unsuccessful strategies and identify any emerging customer and contractor insights, needs, or solutions. Through the mid-project re-assessment, the project team learned that the gas loaner solution was becoming decreasingly popular due to the emergence and adoption of the 120V technology option, aiding in the elimination of barriers associated with the standard 240V technology such as needing direct access to an electrician.

Finally, the project team collected post-installation customer data through more than 500 participant surveys provided by Peninsula Clean Energy (PCE) and more than 1,200 contractor on-site recordings of customer decision factors by Barnett Plumbing. This data informed the mapping and comparison of customer decision factors in emergency and proactive water heater replacements. To further examine the key decision drivers identified and inform process mapping, the project investigated participating contractor awareness and planned approaches for leveraging SGIP rebates, new federal tax credits and regional specific rebates offered by municipalities, RENs and CCA organizations during contractor interviews.

The findings include an evaluation of the California single family water heater market, an overview of the state's HPWH incentive programs & contractor participation, and a discussion of the key drivers and barriers for HPWH installations by contractors, with a focus on the contractor decision process in emergency replacement scenarios.

Findings

This section covers a summary and analysis of the emergency water heater market in California; a review of the existing trade ally and HPWH market studies; and findings and insights from interviews with key market stakeholders including manufacturers, plumbing contractors, and state and utility energy efficiency program administrators.

Evaluation of the California Single Family Water Heater Market

The residential housing stock in California totals approximately 13.8 million units, with single-family residences accounting for nearly 64 percent of the residential housing stock (NREL, n.d.). As seen in Figure 1 below, the majority (86.8 percent) of single-family residences in California built before 2010 use natural gas or propane as the primary fuel source for water heaters. The increased complexity associated with the removal of existing gas piping, as well as the addition of new electrical service for a HPWH installation, requires developing and deploying solutions that simplify gas to HPWH conversions and is critically important for decarbonizing California single-family homes. Typically, electric water heater replacements with HPWHs are less likely to require electrical service upgrades but may still encounter barriers associated with the accommodation of the necessary ventilation and condensation piping.

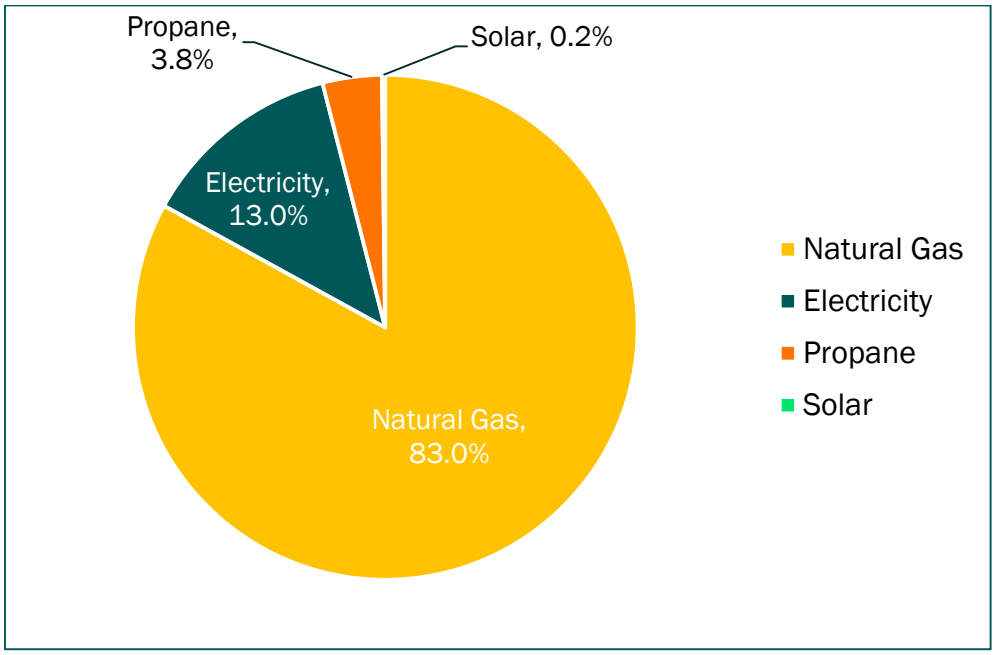

Figure 1: Water heater fuel type in California single-family homes.

Source: NREL ResStock

In water heater replacement scenarios, most homeowners stuck with the fuel type of the previous water heater. In a recent study, only four percent of homeowners surveyed switched from electric to natural gas water heaters, whereas eight percent of surveyed residences switched from natural gas to electric.

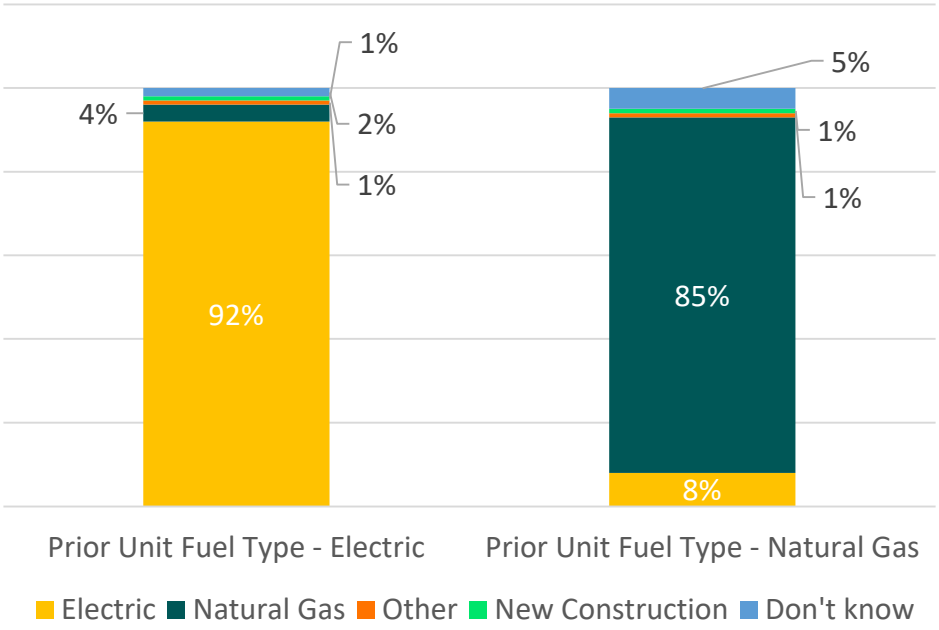

Figure 2: New water heater installation by fuel type.

Source: NEEA Water Heater Market Characterization Report, April 2018

Similar findings were reported in California as part of a 2019 study, which found water heater replacements overwhelmingly were of the existing fuel type but reflect a significant shift from natural gas storage water heaters to tankless models, as well as to a lesser degree increasing replacements with HPWHs (CPUC, 2021).

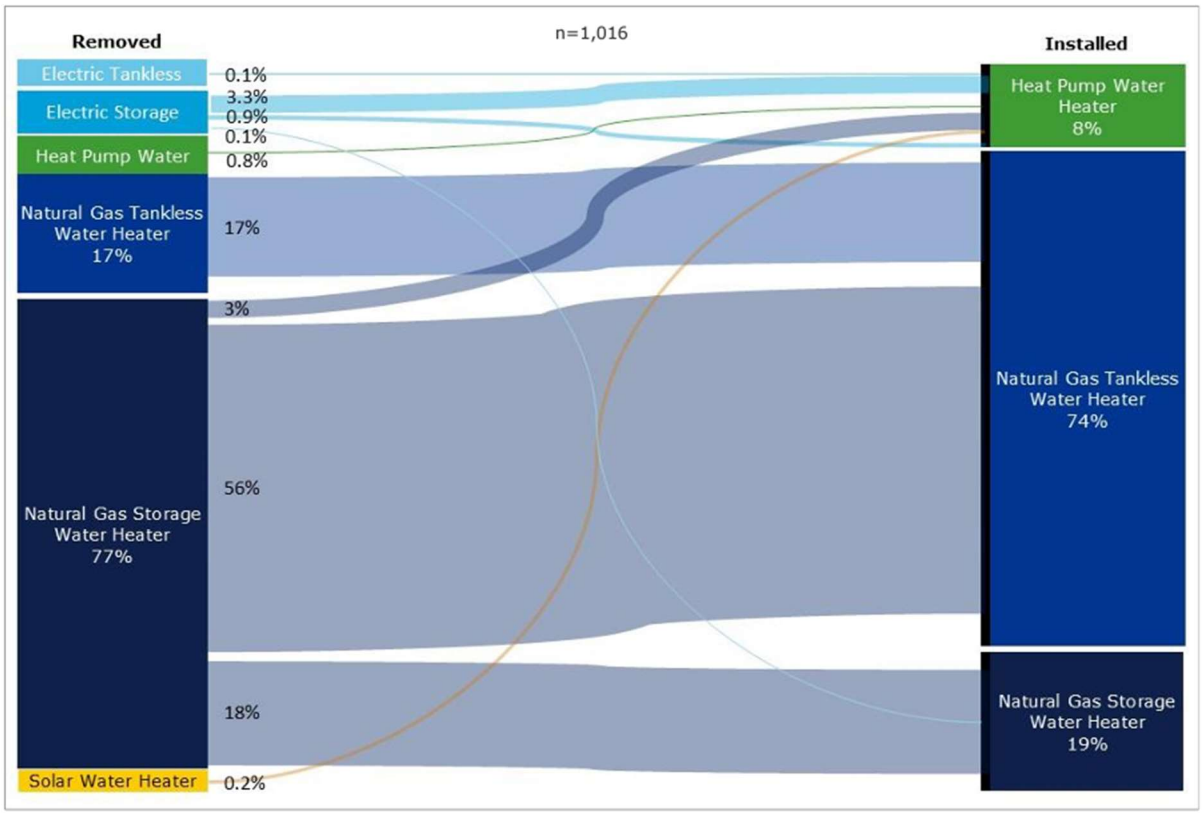

Figure 3: Water heater replacement trends between existing and newly installed.

Source: CPUC Impact Evaluation of Water Heating Measures (June 2021)

An analysis of the primary reasons for water heater replacements highlights that the majority (75 percent) are a direct result of a unit failure, either imminent (32 percent) or sudden emergency (37 percent) failures (NEEA, 2018).[2] In both cases, time constraints and increased complexity and cost raise the level of burden on both customers and contractors to support HPWH conversions in water heater failures.

[2] A similar national market characterization released in 2010 by the EPA, suggested nearly identical purchase motivators for emergency and planned replacements. (EPA 2010)

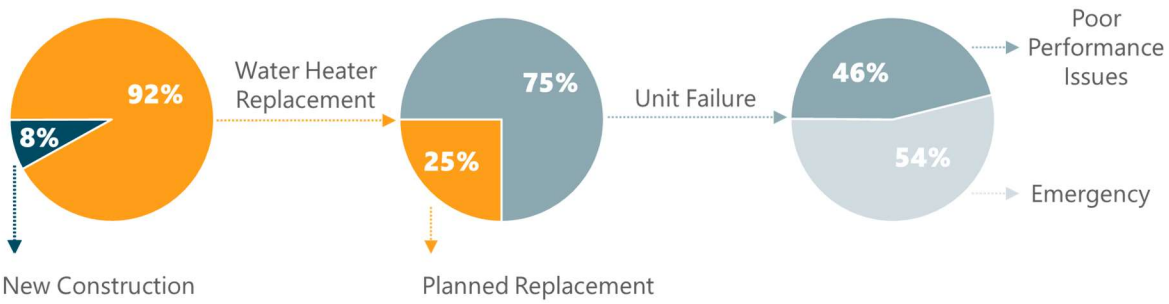

Figure 4: Primary reasons for water heater replacement.

Source: NEEA Water Heater Market Characterization Report, April 2018

However, by analyzing the current state of the water heater market in California and understanding trends in purchase motivators, the data can provide a programmatic roadmap for targeted customer outreach, intervention, and engagement to support HPWH conversions during emergency replacements. The cross-section between single-family residence vintage and age of existing water heater is depicted in Table 1 below. The average age of water heaters in single-family residences in California is 8.3 years. Approximately 37 percent of existing water heaters are more than ten years old, increasing the likelihood of failure based on average equipment lifespan in California.[3] In addition, nearly 20 percent of the water heaters in homes built during the 1990s are 20 years or older, indicating that they are likely original to the home and provide an ideal target market for an emergency replacement water heater program.

Table 1: Reported Water Heater Age by Decade of Home Construction (1950–2020)

Vintage	Less Than 2 Years Old	2 to 4 Years Old	5 to 9 Years Old	10 to 14 Years Old	15 to 19 Years Old	20 or More Years Old
Before 1950	17%	13%	34%	27%	5%	4%
1950 to 1959	13%	16%	34%	24%	6%	7%
1960 to 1969	16%	13%	36%	20%	7%	9%
1970 to 1979	13%	24%	38%	11%	5%	9%
1980 to 1989	16%	12%	32%	25%	7%	7%
1990 to 1999	13%	12%	30%	18%	8%	19%
2000 to 2009	15%	19%	11%	34%	11%	9%
2010 to 2015	5%	14%	62%	19%		
2016 to 2020	17%	67%	17%			
Overall	14%	17%	32%	22%	7%	8%

Source: EIA RECS 2020

[3] Ten years is the effective useful life determined by the prescriptive water heating savings characterization in the California eTRM. (CA eTRM 2023)

Contractors play a critical role in the ecosystem for water heater replacements in California and nationally, serving not only as installers for water heater replacements (71 percent), but also in being the primary source for recommending (84 percent) a replacement water heater type or model. As this is a survey across all water heater replacements, it is likely a conservative estimate for both respective roles during an emergency replacement scenario.

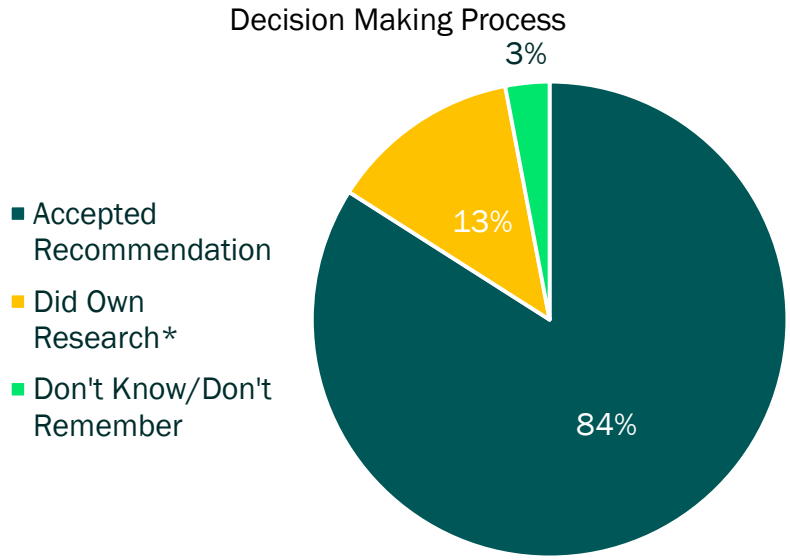

Figure 5: Customer decision process and installer type for water heater replacements.

*Researched before accepting recommendation / installation or made decision for themselves (DIY installation)

Source: NEEA Water Heater Market Characterization Report, April 2018

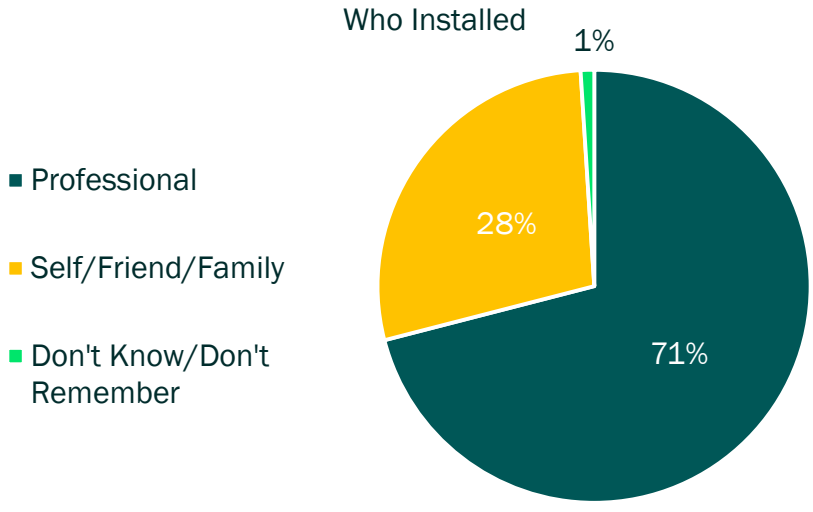

Figure 6: Customer decision process and installer type for water heater replacements.

Source: NEEA Water Heater Market Characterization Report, April 2018

Based on the identified customer purchase motivators and available market data listed in Table 2, an estimated 364,000 gas water heaters are replaced annually in California single-family homes by contractors in cases of emergency or imminent failures. These replacements provide potential opportunity for HPWH installations. Table 2 provides a summary of the factors contributing to the estimate of the emergency replacement HPWH market opportunity.

Table 2: Technical Emergency Replacement Market Potential Estimate for California

Technical Emergency Replacement Market Potential Estimate for California	
1.1 million water heaters	AHRI's historical data estimates that 9.24 million consumer water heaters were sold nationally in 2020. Assuming an equitable per capita allocation across state populations, based on 2021 U.S. Census Data, there was an estimated 1.1 million water heaters sold in California.
67 percent single family homes	Percentage of homes in California that are single family residences (NREL n.d).
2.2 percent new construction homes	Percentage of residential housing stock in California that is designated new construction (NREL n.d). Homes constructed on or after 2016 are assumed to fit into this category for the purposes of this market potential estimate. Water heaters in these residences were removed from contention for emergency replacement, as their effective useful life would exclude them from potential replacement.
Existing single-family water heaters	Calculated ~ 721,000 water heaters replaced annually in California single-family homes.
75 percent water heater emergency replacements in existing homes[4]	Percentage of all water heater replacements that are at, or nearly at, imminent failure. Based on a recent survey, 69 percent of water heater replacement scenarios are a result of an emergency or imminent water heater failure. Other reasons for water heater replacement include: renovation or remodel that required a new water heater (ten percent); efficiency improvement (eight percent); upgraded water heater after moving/buying a new home (eight percent); desired different type of water heater (three percent); other (three percent) (NEEA, 2018).
One percent efficient saturation	Percentage of water heaters sold that are high efficiency electric units. This suggests that one percent of homeowners would not benefit from participation in a HPWH program as they've already installed an electric high efficiency option (Opinion Dynamics, 2022).
71 percent contractor installation	Percentage of water heaters that are installed by contractors and/or plumbers. The majority of water heater installations are conducted by third party trained professionals. Homeowners or property owners are estimated to install water heaters 28 percent of the time (NEEA, 2018). This suggests that an emergency replacement water heater program would benefit from targeted engagement with contractors.

[4] The removal of the percentage of new home replacements increases the proportional unit failure from 69 percent to 75 percent.

Technical Emergency Replacement Market Potential Estimate for California	
85 percent like-for-like natural gas water heater replacements and 92 percent for electric water heater replacements	Percentage of natural gas water heater installations that are similar to the unit being replaced. This suggests a high likelihood that homeowners remain consistent in their water heater purchasing habits and that a baseline in an emergency replacement water heater situation can assume a unit similar to the existing water heater.
364,591 water heaters	Total annual market for emergency water heater replacement for single-family residences in California. Calculated from the market characterization detailed in this table, this value reflects the opportunity for contractor installed HPWH conversions in emergency replacement situations.

Sources: NEEA 2018, Opinion Dynamics 2022

Overview of HPWH Incentive Programs & Contractor Participation

Contractors and households in California have access to and must navigate a myriad of overlapping HPWH incentive programs with different incentive levels, eligibility and reporting requirements, and geographical limitations across the state.

Below is a list of the twenty-three currently available incentives in California, of which twenty-one are accessible or only accessible by contractors. The Golden State Rebate is offered either as an instantaneous point-of-sale rebate with distributors or as a redeemable coupon for an instant point-of-sale discount with participating retailers. Other California program rebates require a mix of online or mail-in submissions for rebate reservations and claims.

Table 3: California HPWH Rebates at the Statewide, Regional and Local Utility Level

California HPWH Rebates at the Statewide, Regional and Local Utility Level		
Statewide / IOU	Federal Tax Credits*	30 percent up to $2000 for HPWH installations[5]
	TECH	$3,100 to $7,300 (Pass-thru incentive with kickers)
	Golden State Rebate	$500 to $900 (Point-of-sale distributor or retailer)
Regional, County, RENs	Electrify Marin	$1,000
	3CREN	$920 to $3,680 (50 percent upfront / 50 percent performance)
	3CREN	$1000 gas loaner
	BayREN **	$250 to $400

[5] The federal tax credit is available for products purchased and installed between January 1, 2023, and December 31, 2032, but is only available to individuals installing the HPWH in an existing home that is their primary residence and not used as a rental property.

California HPWH Rebates at the Statewide, Regional and Local Utility Level		
Local Utility	SMUD **	$500 to $3,000 (Varies by type and capacity)
	Silicon Valley Clean Energy*	$1,000 to $2,000
	Peninsula Clean Energy	$500 to $3,000 (0 percent financing up to $10,000)
	13 Other Local Utilities	Downstream incentives ranging from $150 to $2,000

* Federal Tax Credits and Silicon Clean Energy rebates are only accessible to individuals

** Bay Area Regional Energy Network (BayREN), Sacramento Municipal Utility District (SMUD) and five other rebates are accessible through the TECH Clean California rebate platform (IRIS)

Source: The Switch is On (October 2023)

As highlighted earlier, the TECH initiative launched a new, statewide incentive clearinghouse in December 2021 and included a significant incentive of $3,100,[6] layered with a subset of other existing statewide and regional HPWH incentives. The popularity of the higher incentives offered through the TECH initiative resulted in the single and multifamily general incentives being suspended in May 2022 in most of the state (TECH Clean California, n.d.). However, the TECH incentive clearing house continued to operate after the suspension of statewide incentives, capturing and reporting in a publicly available dataset key aspects of every HPWH installation (TECH Clean California, n.d.). The public dataset recently served as the basis for evaluating cost drivers for heat pump HVAC systems installations and serves to help evaluating trends in HPWH installations, incentive levels and contractor participation across the state (Sarkisian, 2023).

Table 4 below includes the breakdown of HPWH installations across California's four major gas investor-owned utility (IOU) territories since 2021 and the launch of TECH incentives accessible by contractors. A majority (84 percent) of the installations occurred in Pacific Gas and Electric's (PG&E) territory, which is primarily located in central and northern California. Most of the installations were concentrated in only a couple of counties in and around the Bay Area.

Table 4: TECH HPWH Installations, Installed Cost and Contractor Incentives by Natural Gas IOU Territory

IOU Territory	HPWH Installed	Average Project Costs per Unit	Average Contractor Incentive	Average Costs to Customer	Eligible Federal Tax Credit	Final Customer Cost
Pacific Gas & Electric	3,361 (84%)	$7,138	$4,013	$3,227	$968	$2,259
Southern California Gas	577 (14%)	$5,233	$3,649	$1,941	$582	$1,359
San Diego Gas & Electric	66 (2%)	$5,696	$3,125	$2,637	$791	$1,846

[6] Additional $700 TECH Clean California incentive provided for larger capacity HPWHs.

IOU Territory	HPWH Installed	Average Project Costs per Unit	Average Contractor Incentive	Average Costs to Customer	Eligible Federal Tax Credit	Final Customer Cost
Southwest Gas	6 (0.1%)	$5,184	$3,669	$1,389	$417	$972

Source: Tech Clean California (July 2021 thru January 2024)

The average project cost reported for customers in IOU service territories would be net of the Golden State Rebate, as it is provided upstream to the contractor at the point of sale by participating distributors and retailers. The effect would be to increase the actual project cost by $900 for any gas to HPWH installations in IOU service territories. The additional significant and stackable incentives, notably from SMUD, BayREN, PCE, Electrify Marin and Silicon Valley Clean Energy, and available in PG&E's gas utility service territory, can exceed $5,000 in total and likely serve as one of the primary drivers for the higher rate of installations. The higher incentives available in the PG&E gas utility service territory correlated with nearly $2,000 more in average project costs than installations in other parts of the state. The average incentive received by the contractor in Table 4 only reflects those received through the TECH rebate clearing house and does not capture rebates received directly from eligible local and municipal programs, which would further reduce the out-of-pocket costs to the customer. As the 30 percent federal tax credit applies to the final cost to the customer, the impact of increasing layered rebates effectively reduce the corresponding realized financial benefit of the tax credit to California households. Identifying opportunities to maximize the federal tax credit, while minimizing rebate program costs and out of pocket cost and longer-term benefit for homeowners, warrants additional evaluation.

Figure 7 below highlights the rapid growth to approximately 200 to 300 monthly HPWH installations reported through the TECH initiative, starting in January 2022 and ending in May 2022 with the sunsetting of the incentives. The following year saw a drop to approximately 50 HPWH installations on average per month. As other incentive programs across the state continued to be available during this period and were not required to be reported through the clearing house, it is likely that HPWH installations were higher. The tailing off of HPWH installations in August and September 2023 was in advance of the anticipated relaunch of incentives supported through the SGIP funding for HPWH program incentives. With the resurgence of high incentives with the reopening of the program on October 31, 2023, contractors and customers likely held back HPWH applications in the preceding months.

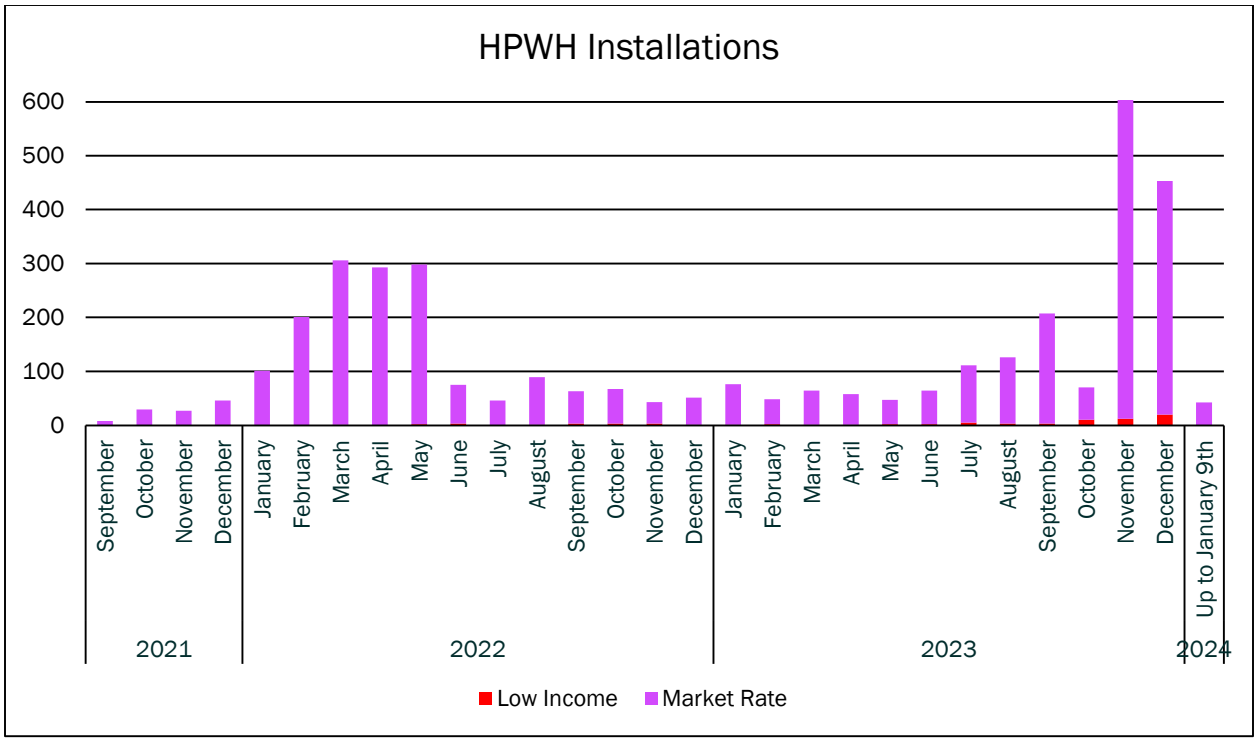

Figure 7: TECH HPWH installations between July 2021 and early January 2024.

Source: Tech Clean California (January 2024)

The total number of single-family HPWH installations reported during the two-year period between September 2021 and early January 2024 was 3,755. Average annual rebates exceeded $6.2 million to achieve 1554 HPWH installations each year, which is approximately 0.24 percent of the total estimated annual water heater replacements in California. Achieving higher rates of conversions will be critical to decarbonizing water heating in single-family homes in the coming years.

Although HPWH installations were reported across the majority of California counties, the heavy concentration of HPWH installations in Alameda (approximately 20 percent) and Sacramento (approximately 25 percent) counties is likely attributed to a series of factors including additional regional rebates, higher concentration of higher performing contractors and density of single-family housing.

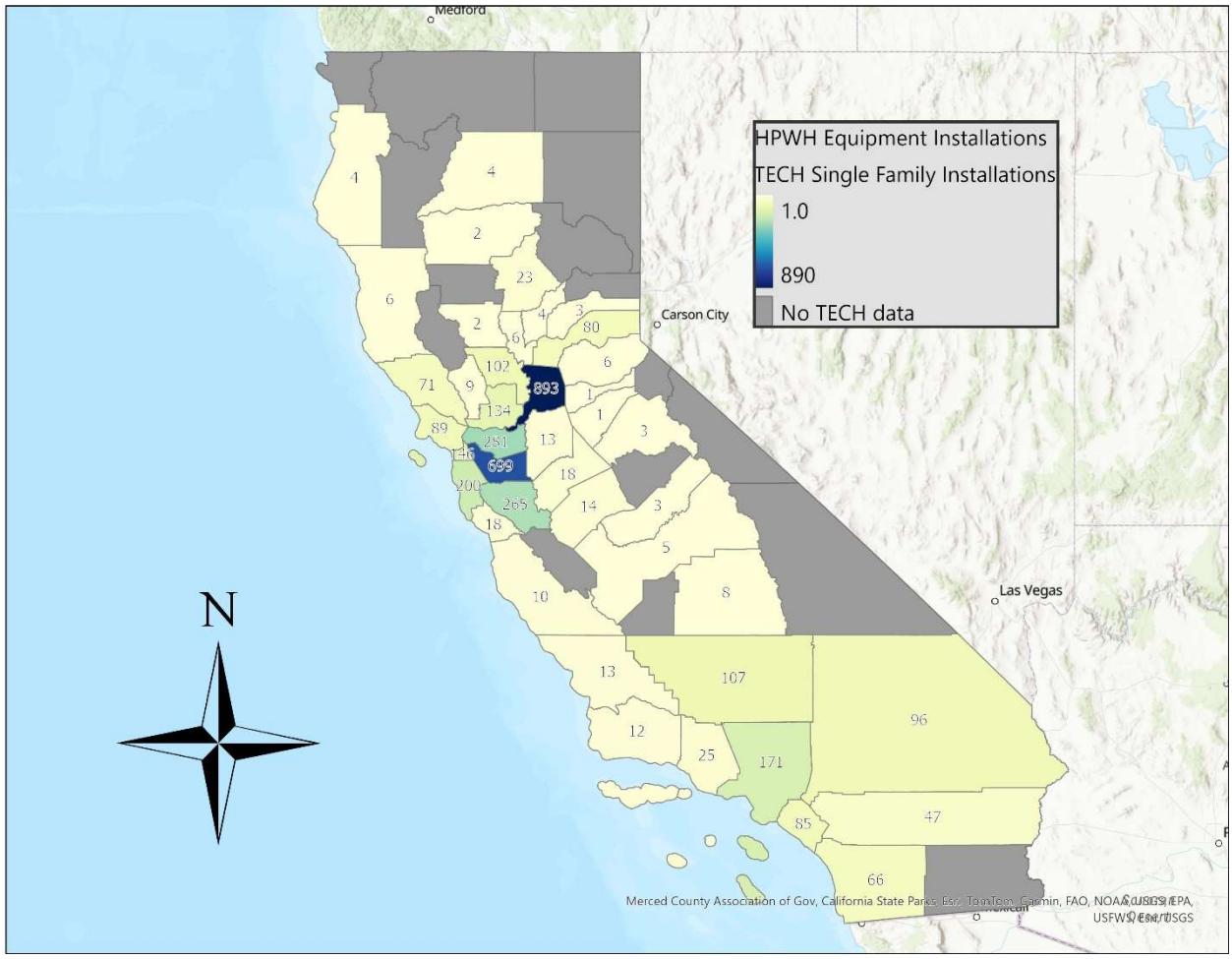

Figure 8: TECH HPWH installations by county.

Source: Tech Clean California 2024

Although not a focus of this report, recent updates to the California Title 24 building code require that all newly constructed single-family homes that do not have a HPWH installed must make HPWH-ready space, condensate drain and electrical service available (Energy Code Ace, 2022). Additionally, the Bay Area Air Quality Management District (BAAQMD) adopted new regulatory standards for water heater emissions. Beginning in 2027, water heaters sold or installed in the Bay Area may not emit nitrogen oxides. This regulation effectively mandates HPWH installations beginning 2027, which will significantly impact Bay area contractors and customers and their water heater replacement decision factors. In addition, the California Air Resources Board (CARB) has released a similar proposal to establish a new "Zero-Emission Standard for Space and Water Heaters" set to be effective in 2030 (CARB 2022). Mandates to require zero-emission or HPWH ready installations in single family homes will place increasing pressure for developing simpler, lower cost HPWH solutions, as well as developing targeted strategies and incentives for emergency replacements.

Evaluating Primary HPWH Cost Drivers

The TECH clearing house public data set provides a relatively detailed source for evaluating the impact of a wide range of site-specific installation or equipment factors that drive the cost of the installation of a HPWH. Below is an analysis comparing the difference in incremental cost between a baseline HPWH installation and installations with key potential cost drivers. One factor highlighted earlier is the correlation of nearly $2,000 higher HPWH installation costs with layerable rebates available in PG&E gas IOU service territory. The project team hypothesizes that higher rebate levels allow "all-in" contractors to increase their quotes to customers while remaining competitive with gas water heaters. The baseline or typical HPWH installation reported over the past two years reflects the following characteristics to best represent an emergency replacement scenario:

- Replaced with 240V integrated HPWH
- Replaced a natural gas storage tank;
- Average installation Cost of $6,217
- No other building upgrades performed during installation

Several factors reduce the average cost of the HPWH installation but the most significant are installations in homes replacing an existing electric water heater (-$1,519). It stands to reason that removing the need for a new electrical service to the water heater and utilizing contractors with increased experience and efficiency in completing projects can reduce an overall project cost.

Table 5: Primary Cost Drivers for HPWH Installations

Cost Driver	Average Cost	Quantity	Percentage	Incremental Cost
Baseline	$6,217	2429	100%	N/A
Non-PG&E Service Territory	$5,371	391	16%	-$1,767
Replace Electric WH	$4,698	44	2%	-$1,519
Replacing Propane WH	$5,640	35	1%	-$577
120 Volt HPWH	$6,097	485	20%	-$120
Non-garage Locations	$6,221	660	27%	$4
Top Three Contractors	$6,401	1147	47%	$184
Installation ≥ Two Days	$6,403	361	15%	$186
Replacing Tankless	$6,688	84	3%	$471

Cost Driver	Average Cost	Quantity	Percentage	Incremental Cost
Panel Upgrade	$7,020	233	10%	$803[7]

Source: Tech Clean California (January 2024)

However, several factors increased the average cost of the HPWH installation on average and the most significant are installations in homes requiring a panel upgrade ($803) and installations replacing an existing tankless water heater ($471). It is more common for tankless water heaters to be located in more confined or interior home locations, which require additional remediation steps to accommodate a larger integrated storage HPWH.

The introduction of the plug-in 120V HPWH in the latter part of 2022 as an alternative solution to a 240V HPWH is likely, according to one leading contractor, to represent an increasingly higher proportion of future conversions of gas water heaters. Prior to the relaunch of the HPWH TECH incentives at the end of October 2023, 120V HPWH represented only four percent of all reported installations. However, the prevalence of plug-in 120V models increased to 15 percent following the relaunch of the incentives at the end of October 2023 and an even higher 22 percent in emergency water heater replacements. Avoiding the cost, time and complexity of running new 240V electrical service to the existing gas water heater location and the potential need for a panel upgrade is a huge advantage for plumbing contractors, who otherwise might have to enlist a separate electrical contractor for the job. It also expands the range of options for water heater locations outside of the garage, simplifies and expedites HPWH installations, and correspondingly, reduces the cost. The additional scope for installing a mixing valve or condensate pump showed little correlation to increasing overall costs.

Out of 318 projects where panel upgrades were completed, 313 used natural gas or propane as the previous fuel type, which reinforces the assumption that homes with existing electrically heated water heaters will usually not require panel upgrades. Also, and somewhat to be expected, only seven projects required panel upgrades for converting to 120V HPWH's, which in all cases were replacing natural gas units.

For projects not requiring panel upgrades, 120V units had the lowest average cost at $6,140 (491 projects) and split-system installations had the highest at $12,915 (30 projects).

Comparing the reported $6,317 median HPWH installation cost in single-family homes (TECH Clean California 2023) with an estimated $3,908 project costs for a standard gas to HPWH conversion (Opinion Dynamics, 2022) suggests an increase of $2,409 of marginal revenue for the contractors. This increase may reflect several factors, including a reported significantly higher labor burden for backend processes (e.g. training, permitting, customer education, rebate and data reporting, etc.),

7 The analysis used to support insights on cost, utility, installation, and previous water heater information reflect a subset of HPWH installations based on factors most representative of typical or emergency replacement installations. Specifically, this subset includes projects serving single family homes, where HPWH's were the only upgrade completed during installation, and in certain cases, only capturing projects costing less than $10,000, or having been completed on or after Oct 1st 2023.

and a combination of limited competition and potentially risk adverse contractor project estimates to customers, as well the relatively high incentives across California. The potentially higher profit margin for a contractor for a HPWH installation over a "like-for-like" natural gas storage or tankless unit without increasing the customer costs is a potential strong influence for shifting business models. However, this will likely require sustained increases in customer demand, contractor awareness, streamlining of rebate processes, and sustained high levels of program funding.

Additional details on the primary factors increasing the complexity and installation time for HPWH conversions are reviewed in the following sections.

The Impact of Increased Complexity in HPWH Installations

In 2023 a TECH Quick Start Grant project released its Best Practices Manual and HPWH Job Aids, recognizing the complexity of HPWH installations and shining a light on best practices for high quality HPWH installations (RHA, 2023). The guides cover important installation barriers including homeowner knowledge, as well as installation challenges related to the HPWH location, ventilation and noise, electrical and other site requirements.

These same installation challenges are highlighted in a separate report (Moran, Starkey, & Suzuki, 2023), emphasizing the importance of location of a HPWH, notably garages and basements, to minimize the likelihood of any negative occupant experiences and reduce complicated installation scenarios.

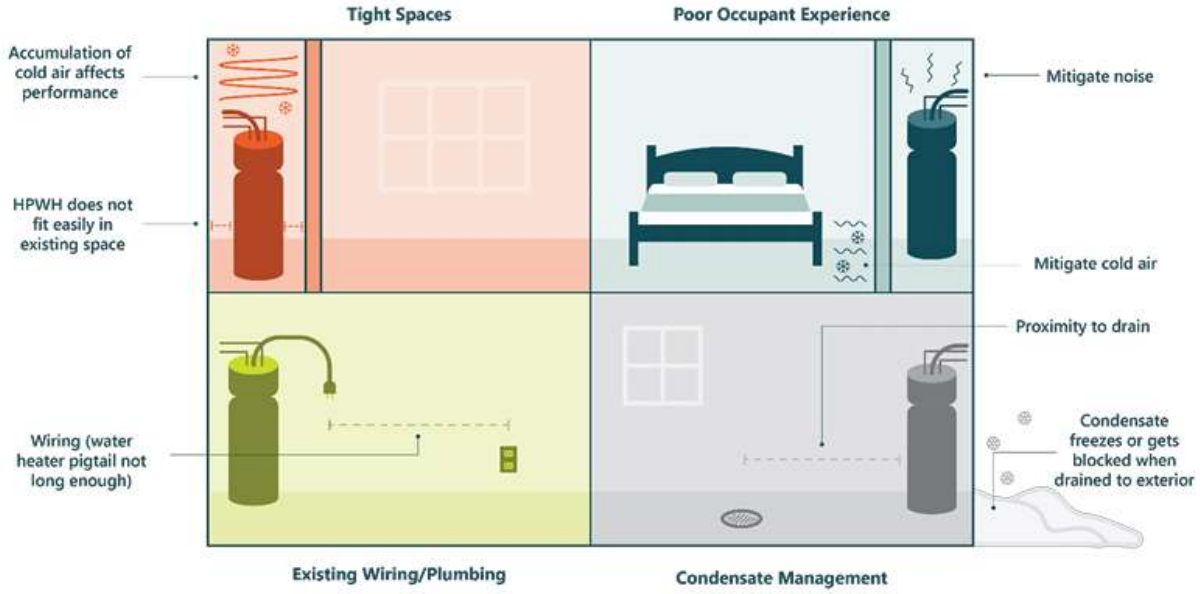

Figure 9: Illustration of installation challenges for HPWH.

Source: Moran, 2023.

Data from the TECH clearing house reflects the importance of location as a factor for a high (73 percent) rate of HPWH installations in garages over other locations (27 percent). The data reflects both conditioned and unconditioned garages, which may affect the performance of HPWHs, as well

as in reducing project costs. All other locations include the basement, closet, and other unknown locations.

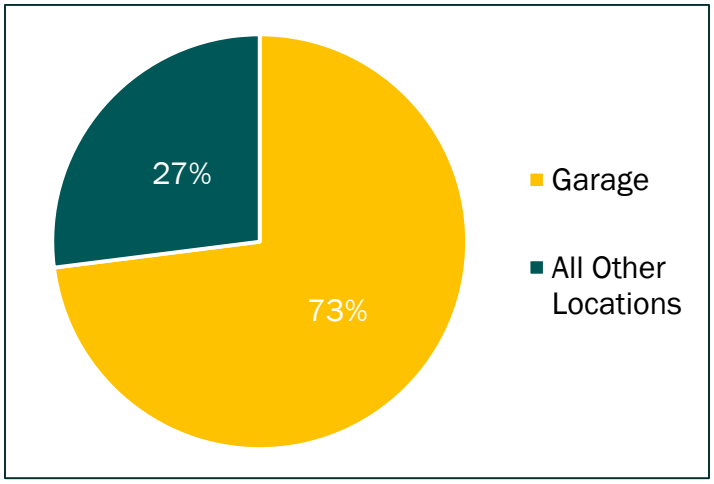

Figure 10: Location of HPWH installation in building.

Source: Tech Clean California (January 2024)

However, the prevalence of HPWH installations in garage locations is higher than expected from the general market opportunity for water heater replacements. In single family residences in California, approximately 52 percent of water heaters are located in the garage. The second most common location for water heaters is exterior to the home, where 22.1 percent of water heaters are installed. Comparatively, this is three times more than the national average for water heaters located outside, which is seven percent (EIA RECS n.d). The prevalence of HPWH installations in garages reflects generally simpler and lower cost installations due to the proximity to electrical panels, condensate drains, and, for that reason, a lower threshold for emergency replacement opportunities.

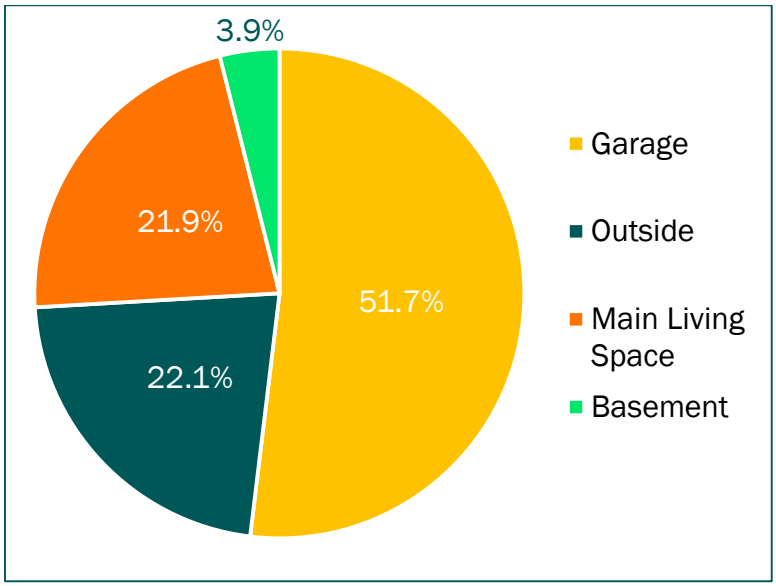

Figure 11: Water heater location in California single-family homes.

Source: EIA RECS 2020

Additional insights from the clearing house data reflect the disproportionate likelihood of HPWH installations to replace natural gas storage water heaters, not tankless models. This reflects a combination of factors, including the prevalence of older storage tanks, space limitations of tankless locations, the increased complexity for relocation of the water heater, as well as lower costs and potential contractor or customer perceived valuation of "continuous" hot water from tankless water heaters over that of HPWHs. As tankless water heaters are increasing in popularity and not subject to the initial roll out of air quality mandates related to zero emission water heaters, reducing cost and complexity of HPWH installations becomes increasingly important for emergency replacements.

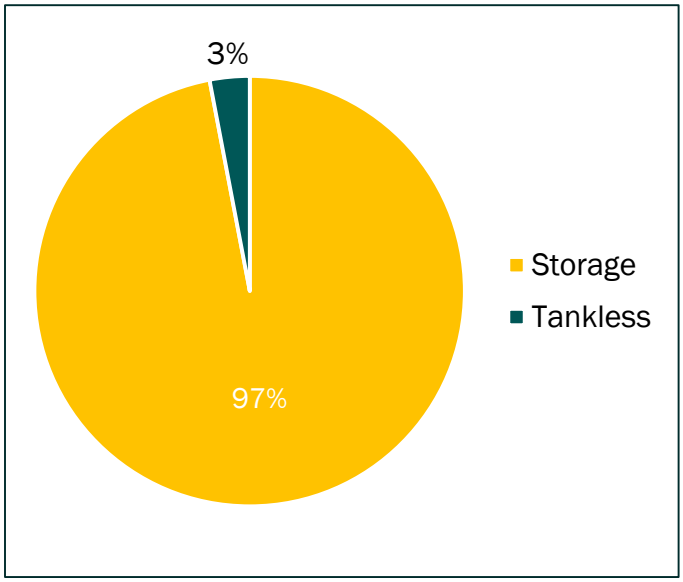

Figure 12: Previous water heater type.

Source: Tech Clean California (February 2024)

Somewhat surprisingly, HPWH replacements of electric resistance water heaters represent only two percent of reported installations, much lower than the 13 percent of single-family homes identified in the market characterization (NREL ResStock). This in part may reflect the significantly higher incentives being offered for natural gas conversions, but considering the lower average incremental installed cost (-$1,519) and reduced complexity of installations, it is an opportunity for improvement and further research.

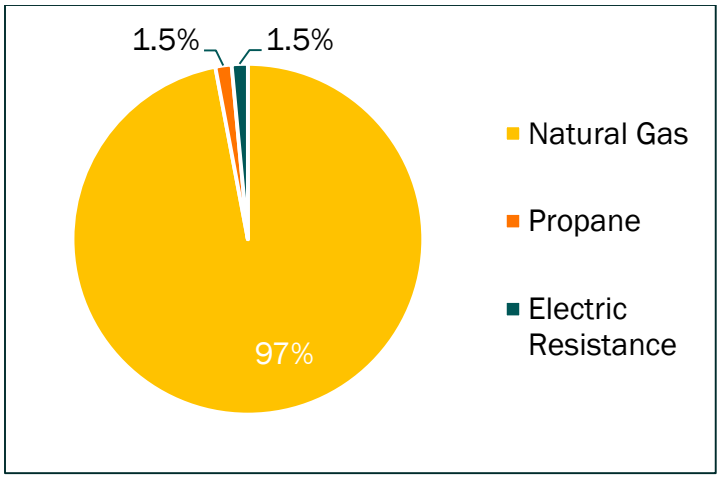

Figure 13: Previous water heater fuel type.

Source: Tech Clean California (February 2024)

The Impact of HPWH Installation Time in Emergency Replacements

Many of the identified installation challenges for HPWHs above come with increases in complexity and installation time, which correspondingly increase the cost of an emergency replacement. However, increases in the time required for a HPWH installation, especially during emergency replacement scenarios, can also directly impact a customer's and contractor's decision to move forward. The figure below reflects guidance from contractors as to the incremental time required to address common tasks for a quality HPWH installation.

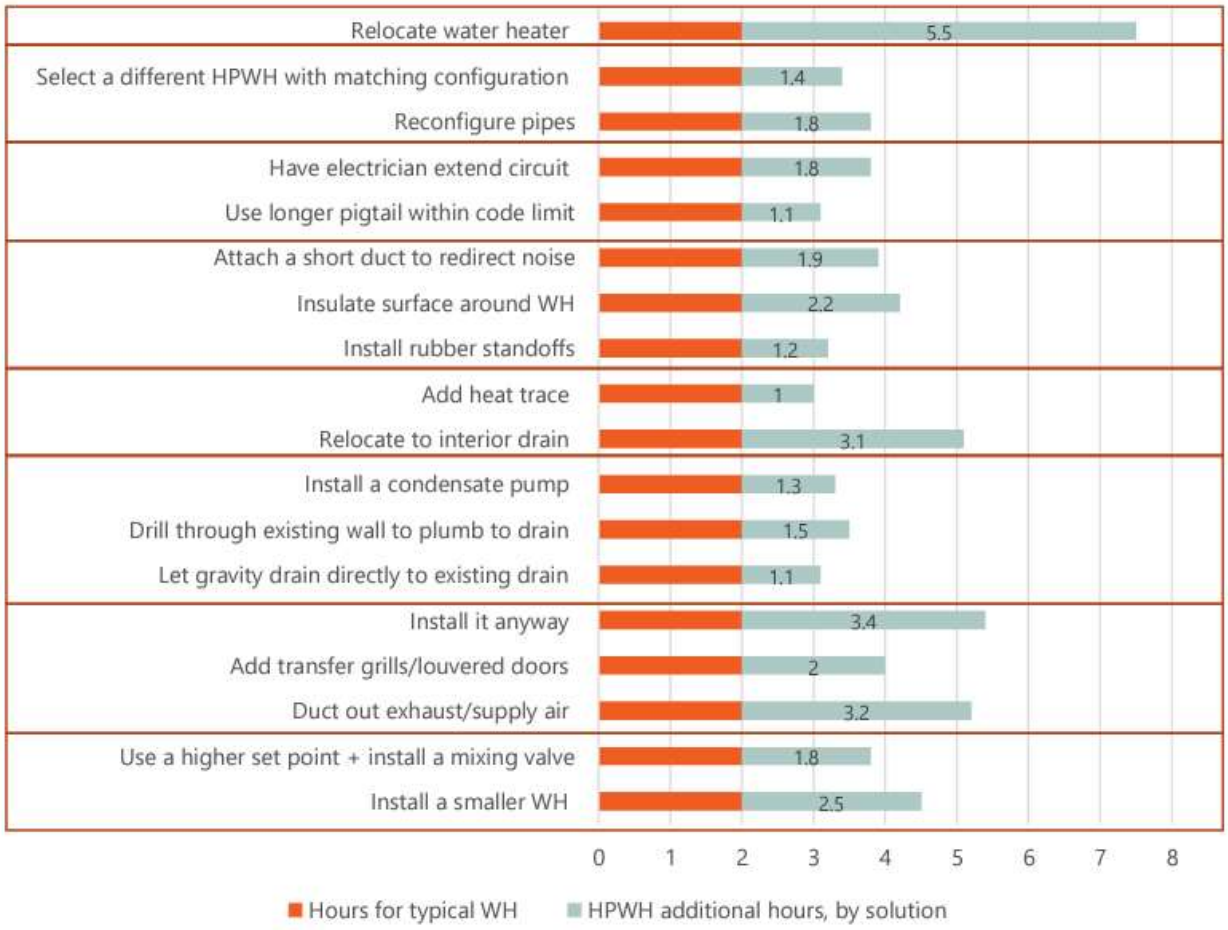

Figure 14: Total hours estimated for HPWH installation actions.

Source: NEEA Challenging Installation Scenarios, 2023

HPWH installations reported in the TECH database suggest that roughly half are completed in a single day. As most installations were in the garage, projects may be self-selected for viability by the contractor or customer, based on the level of increased complexity, cost and installation time. For each additional day of installation duration, the number of installations dropped precipitously.

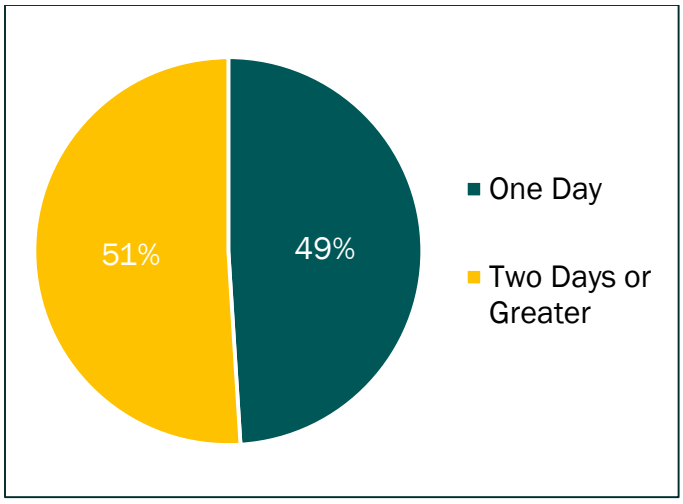

Figure 15: HPWH installation duration.

Source: Tech Clean California (February 2024)

Whether a HPWH installation was an emergency replacement as a result of a water heater failure has only recently been captured in reported TECH project data, and, as such, participation may reflect more planned replacements versus emergency replacements. Planned HPWH installations would likely afford contractors and customers the ability to orchestrate the timing of any necessary electrical upgrades or mechanical remediations in advance of or in coordination with the single day for onsite work. However, as reflected in the data, restoring hot water service the same day is a high priority for customers and contractors, directly limiting the opportunity for more complicated HPWH conversions.

Tracking Key Performance Metrics in Emergency Replacements

In October 2023 TECH began tracking the type of HPWH installations to identify whether they were emergency or non-emergency (i.e. proactive) replacements. Since the restart of the TECH program incentives for HPWHs in October 2023, only nine percent of installations were identified as emergency replacements. However, the three leading contractors, each of whom has completed more than 150 installs during the four-month period, reported 2 percent, 15 percent, and 29 percent respectively of HPWH installations as emergency replacements. Absent these three contractors, the emergency replacement rate drops to below three percent, highlighting that many contractors may be primarily targeting proactive replacements or that only leading contractors are able to successfully sell HPWHs in emergency replacements.

Table 6: Emergency Replacement Metrics

TECH Emergency Replacements	Results	Additional Findings
Total HPWH installations[8]	1058	Emergency replacements represented only 9% of total HPWH installations
Emergency replacements with HPWHs	96	Top two contractors completed 66% of emergency replacements with HPWHs
Contractors completing emergency replacements	18	Contractors completing emergency replacements represent only 8% of all HPWH installation contractors
Emergency replacements with panel upgrade	17%	Only 1 out of 6 emergency replacements required a panel upgrade
HPWH installation location in garage	89%	Basements were the second most common installation location in only 6% of homes
Previous water heater fuel type (natural gas)	98%	Contractors reported electric water heater replacements to be extremely uncommon
Average total project cost	$7,128	Total project costs were on average $223 more than non-emergency replacements
Average total project cost after rebates	$2,130	Emergency replacement HPWH installations received nearly $5,000 in rebates
HPWH equipment type (120V plug-in models)	22%	Emergency replacements had a slightly higher rate of plug-in 120V HPWH installations than non-emergency replacements (15%)

Source: Tech Clean California (January 2023)

The combination of tracking emergency replacements, along with HPWH technology type (e.g. 240V, 120V and split), allows for gathering additional trends in HPWH installations.[9] The reported 26 plug-in 120V HPWH in emergency replacements cost an average of 13 percent more than non-emergency, proactive replacements and only replaced water heaters less than 50 gallons in

[8] Emergency replacement data is based on the period between October 2023 and January 2024, following the addition of the TECH Clean California rebate reporting requirement as to the type of replacement.

[9] TECH Clean California does not currently track the use of gas loaners and the one contractor currently utilizing gas loaners to support HPWH installs tracks their use as a separate project cost.

capacity.[10] Of note, all of the plug-in 120V installations in emergency replacements provided same day hot water restoration.

Charting Contractor and Customer Decision Processes: Factors and Barriers Affecting a HPWH Installation During an Emergency Replacement Scenario

Several recent evaluations have assessed the primary drivers for the installation of HPWHs in residential homes from both the customer and contractor perspectives. These key drivers can be amplified during an emergency water heater replacement and arise at different stages along the contractor journey for a potential HPWH installation. Defining these stages, as well as the specific drivers and barriers for each stage, provides a better understanding of the necessary programmatic or market mechanisms that would result in increased HPWH installations during emergency replacement scenarios.

For example, the incremental cost between a "like for like" gas replacement and a HPWH is often identified as one of the most significant factors or barriers in emergency replacements. However, other key factors, like installation complexity and duration, for example, can both independently influence a customer or contractor decision towards a HPWH installation, as well as indirectly influence other important factors, like the incremental cost driver.

"State of Mind" or predisposition of the California plumbing contractor

In an emergency replacement scenario, the disposition, or rather predisposition, of a contractor for considering a HPWH as an alternative or even preferred replacement option for a customer is a foundational factor in gas conversions. In a recent California study (Opinion Dynamics, 2022[11]), contractors reported growth of HPWHs in water heater replacements, but this growth varied by region, based on available incentives and the increase in focus on electrification in the state. In comparison, the growth of tankless water heaters in replacing existing gas storage water heaters reflected preconceptions about gas technologies being better and electric water heaters not providing sufficient hot water to customers. Changing these preconceptions, especially if based on previous poor HPWH experiences, requires investments by programs and manufacturers to identify and report on new technologies and solutions that result in improved experiences for both the contractor and their customers.

In the state of California, there were 19,796 licensed C-36 plumbing contractors reported in 2022 (CSLB, 2022). As of May 2024, TECH reports 416 contractors having completed enrollment and additional 324 within the enrollment pipeline. However, only 236 contractors have completed one or more HPWH installations since the launch of the incentive clearing house in December 2021. Further, only 14 contractors have completed more than 50 HPWH installations and only seven contractors have completed more than 100 installations, representing nearly 45 percent of the total HPWH installations tracked by the initiative.

[10] Plug-in 120V installations in proactive water heater replacements tended to have a slightly higher (18 percent) rate of replacing water heaters greater than 50 gallons.

[11] CPUC / Opinion Dynamics, "California Heat Pump Residential Market Characterization and Baseline Study", May, 2022.

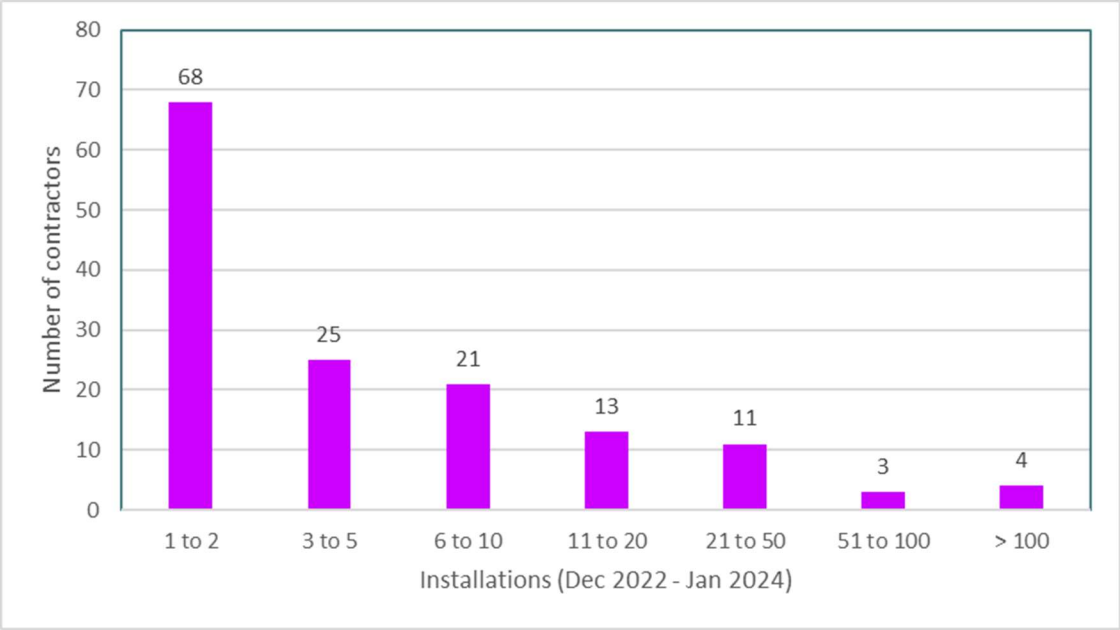

Figure 16: TECH HPWH installations by contractor.

Source: Tech Clean California (January 2024)

Increasing contractor experience, acceptance, and attraction to the increased financial opportunities with HPWH installations has been a core goal of the initiative, by providing incentives, technical and sales training, co-op marketing support, and contractor listing (The Switch is On, 2023). The Learn and Earn program was created to help familiarize TECH-certified contractors with HPWH technology by sponsoring the purchase of units for contractors in areas where there are limited options for customers interested in installing a HPWH. These units are for personal use and contractors must be trained on HPWH installations by a program partner manufacturer to receive them.

To support and further the Learn and Earn initiative, the CalNEXT *Increasing Heat Pump Water Heater Deployment* project (ET22SWE0056), is focusing on accelerating the adoption of 120V units in DAC communities. By installing them in the homes of plumbing contractors who live and work in those areas, the project aims to demonstrate that 120V units can alleviate the financial burden and barrier of panel upgrades and electrical work that often prohibit homes in DAC communities and beyond from installing 240V units. However, the wide disparity between the contractors that are "all-in" on HPWH's and those tending to stick with "like-for-like" gas technologies, raises important questions about what is holding them back and the need for solutions to change the status quo.

HVAC and plumbing trades are increasingly consolidating in California. Stakeholders highlighted that the majority of HPWH training participants currently are from C-20 HVAC contractor firms. Reportedly, HVAC contractors see HPWHs as an opportunity to expand customer base and smooth out the seasonality of HVAC installations. One manufacturer highlighted the benefits of one-stop firms offering capabilities to provide heat pump solutions serving both space conditioning and water heating needs. Stakeholders also highlighted the importance of further expanding firms' electrical capabilities either through consolidation with electrical contractors or developing in-house electrical licenses for technicians. As highlighted earlier, the highest concentration of installations reflects the

proximity of the leading contractors service territory and is not representative of the naturally occurring water heater replacements in residential single-family homes across California counties.

Time is a critical factor in determining whether a HPWH installation will occur during an emergency replacement scenario. It is highlighted by the fact that no reported emergency replacements in TECH took longer than one day. Several other key decision factors, from both the contractor and customer perspectives, were identified through research and interviews with contractors, program managers, and other market stakeholders. This section will review the impact of contractor predisposition, and will define and expand on the decision factors that occur during the various stages of a project journey. It will also assess their effect on the likelihood of replacing a gas water heater with a HPWH in an emergency replacement scenario.

A contractor's predisposition toward HPWHs influences their approach to emergency replacement situations and often guides their interactions and recommendations to customers. Figure 1717 outlines the primary factors affecting the contractor's predisposition, and Figure 1717 further defines three categories that can be used to define most contractors addressing water heater replacements.

Primary Factors Affecting a Contractor's Predisposition or Business Model

- **Cost** - While the sale and installation of HPWHs can be lucrative for some contractors, others struggle with the financial barriers surrounding them.
- **Rebate Landscape** - Significant time and knowledge are necessary to successfully participate in all available rebate programs.
- **Customer Satisfaction** - Contractors' top priority is making sure they feel confident that they installing reliable equipment that will meet their customer's needs.

"All-in on HPWH" Contractor

- **Knowledge and experience** - has significant experience and training for the proper design and installation of HPWHs in a variety of building-specific applications and proactively sells HPWHs.
- **Business processes and financials** – has developed internal processes for efficiently tracking HPWH project data for incentive program reporting, realizing high project margins and able to manage financial gaps between installation and rebate reimbursement from state or regional programs.
- **Staffing** – has sufficient and trained service technicians to support longer and more complex replacements of combustion water heaters with HPWHs.

"Flexible" Contractor

- **Knowledge and experience** - has some experience and necessary training for the installation of HPWHs, but likely more customer-driven requests and limited in their ability to accommodate more complex building applications.
- **Business processes and financials** – has necessary internal processes for tracking HPWH project data for incentive program reporting, but increased risk, lengthier project installations and requirements to bridge gaps between installation and rebate reimbursement limits more proactive HPWH promotions.
- **Staffing** – has limitations on availability of trained service technicians to support longer and more complex replacements of combustion water heaters with HPWHs.

"Like-for-like" Contractor

- **Knowledge and experience** - has had limited or no experience or training for the installation of HPWHs, and due to poor experiences or prejudices against HPWHs will not recommend and may actively dissuade a customer from considering a HPWH.
- **Business processes and financials** – does not have direct experience or the internal processes for tracking HPWH project data for incentive program reporting, or the desire or ability to bridge financial gaps between installation and rebate reimbursement.
- **Staffing** – does not have trained and experienced service technicians to support longer and more complex replacements of combustion water heaters with HPWHs.

Figure 17: Primary factors affecting a contractor's predisposition or business model.

The effect of individual drivers on the likelihood of a HPWH installation in an emergency replacement can vary significantly based on a contractor's predisposition or business model (e.g., "All-in on

HPWH," etc.). An example of "all-in on HPWH" contractor positioning is illustrated in the fact that two contractors installed approximately two-thirds of the HPWHs in emergency replacements.

Several factors identified by multiple contractors that tended to predispose them to not actively promote a gas to HPWH conversion during emergency replacements include:

- Lack of sustained incentives statewide and regionally in California to cover the full incremental cost of a HPWH conversion;
- Lack of familiarity or poor experience with plug-in 120V HPWH or a lack of immediate pressure to shift away from gas technologies;
- Limited technician capacity to support potentially more complex and lengthier HPWH conversions; and
- Concerns about the impact to business processes to navigate incentive program participation, reporting requirements and additional financial risk and burden for providing incentive pass-through to customers.

BUSINESS PROCESS AND FINANCIAL BARRIERS

One key factor keeping contractors in the "like-for-like" category is the complexity and administrative burden associated with accessing rebates and incentives for HPWH installations. Incentives are a key driver of HPWH installations, but not all contractors have equal access to them. Larger companies are able to employ full-time staff to identify and process rebates, but for many smaller companies or individual contractors, the level of effort, financial risk and time required can be prohibitive. One contractor described HPWHs as "the future" but was barely installing any because of the time burden of the rebate process and they worried their business was falling behind because of this. Identifying funding opportunities, navigating eligibility requirements, and filling out incentive paperwork and reporting can take hours which requires companies to hire full time staff or subcontract out the work. For instance, the TECH program requires contractors to fill out data on site and customer information, project information, installation details, demand response and time of use requirements, electrical upgrade details, equity incentives, equipment information, provide photos of installation, and identify additional incentives being applied for. Multiple contractors referred to TECH as the most difficult rebate process they had experienced. In interviews, contractors expressed the desire for a single portal for all rebates with a simplified process. Alternatively, the Golden State Rebate program was repeatedly praised as the best rebate program for its instant discounts.

This administrative barrier has led to the development of third-party rebate processing solutions seeking to properly identify, determine eligibility and streamline the application process for contractors and homeowners. In addition to the third-party solutions, some contractors are receiving support from other contractors with more established rebate fulfillment systems.

Contractors reported significant improvements utilizing third-party services in their ability to identify eligible incentives for HPWH projects; capture necessary reporting requirements for the various rebate programs; and complete same-day rebate submissions and reservations. Contractors reported that the third-party solutions receive a per-project payment for the services but were successful in reducing the administrative hurdles faced by small contractor companies and allowed for a more diverse range of contractors to engage in HPWH installations.

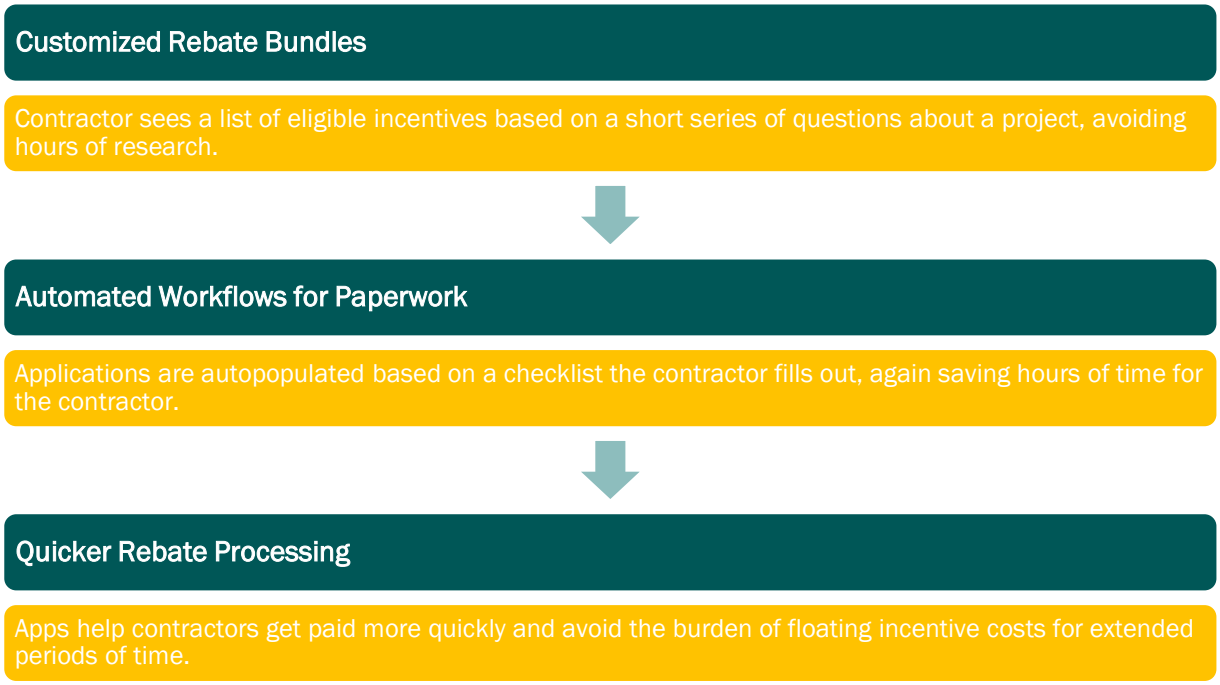

Figure 18: Third party rebate processing advantages.

In addition to the reported burden in the rebate eligibility, application and reporting process, contractors also reported different levels of awareness and understanding of available federal tax credits. This included a general assessment that tax credits had little impact on the customer decision to purchase a HPWH, but also a significant discrepancy in the understanding of the application of the federal tax credit, based on the reduced cost of the installation after rebates. However, the complexity of the federal tax credit guidance is based on whether the rebate is provided at the point-of-sale or post-sale, highlighting the importance of educating contractors on the ITC eligibility and calculation.

Key Decision Factors Affecting HPWH Installations

The project team conducted stakeholder interviews with contractors, program managers, industry experts and an HPWH manufacturer to better understand the contractor experience with HPWH installations in emergency replacement scenarios. The initial framework for the interviews was informed by recent HPWH market studies and evaluations, identifying the key contractor and customer decision factors during the different stages of an emergency replacement scenario and the effect on the likelihood of a HPWH installation.

In emergency replacement scenarios, customers' top concerns are restoring hot water as soon as possible at the lowest out of pocket cost. In the interviews, contractors identified the following factors as having the greatest impact on the cost, complexity and ultimately, customer comfort in choosing a HPWH installation. These factors come into effect at different stages of the project development cycle, including during an initial pre-visit phone call with the customer, during an initial site visit, or when offering a cost estimate and options for the customer.

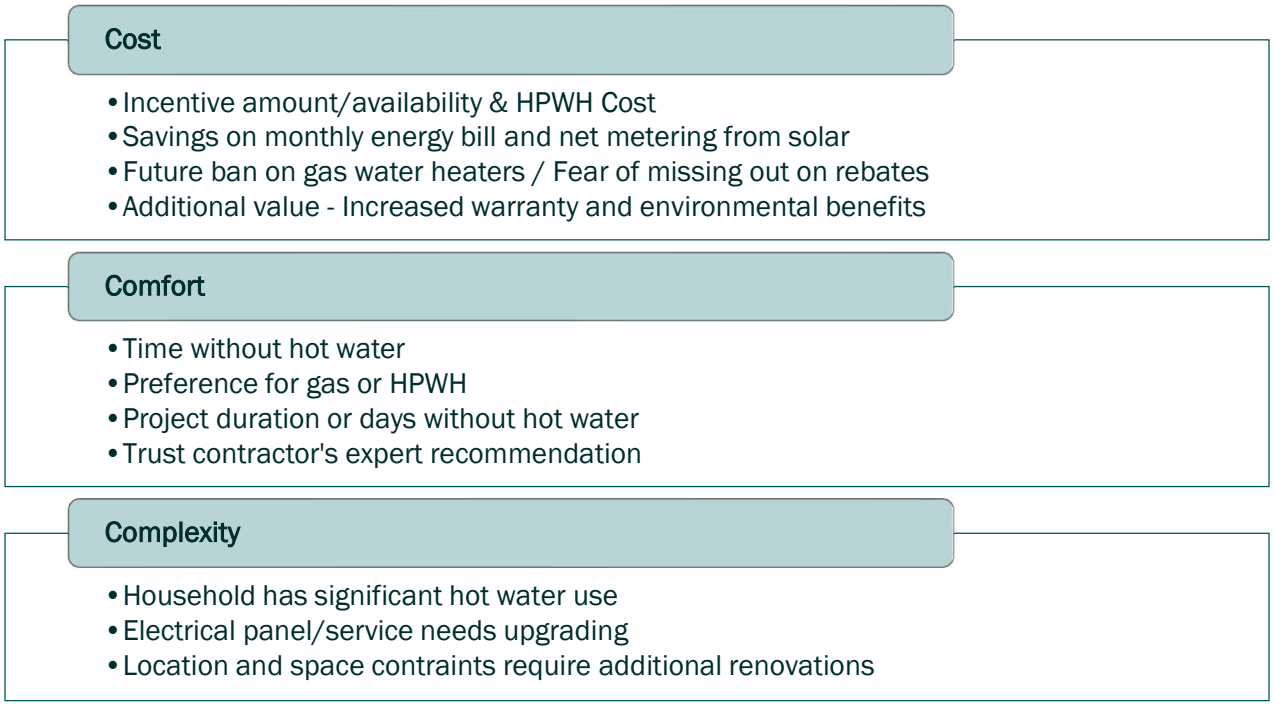

Figure 19: Key factors affecting likelihood of HPWH installations.

COST BARRIERS

Contractor interviews confirmed that the upfront cost is the single most important factor as to whether a HPWH gets installed during emergency replacements. Based on the availability of incentives, contractors reported being able to sell HPWHs to customers for a lower price than a conventional tank gas water heater and for the same price as a tankless unit. The impact of rapid changes in rebate availability, most recently experienced with the TECH initiative in February 2024, can have an outsized impact on customer's receptivity to a proposed higher cost HPWH alternative during a sudden unplanned expense of an emergency replacement. Rapid changes in rebate funding can create significant operational challenges for contractors, as well impacting continuity of growth of the HPWH industry in California.

One point of confusion among some contractors was when the federal tax credits would be applied to the HPWH. In interviews, some contractors believed customers could install HPWHs at no cost, but the federal tax credits can only cover up to 30 percent of the final cost paid by the customer, indicating a potential need for additional guidance and clarification around federal tax credit application.

Contractors also pointed to the added cost of panel upgrades as a significant barrier for homeowners and the reason they are most likely to opt out of a HPWH conversion. This is an even greater problem when the plumbing contractor does not have an electrician readily available, which can lead to higher labor costs.

Another difficulty contractors experience is the lag in rebate processing on the program side. Delayed payments require contractors or their customers to float costs for weeks to months. Larger companies may be able to absorb these costs, but smaller companies or standalone contractors with

smaller margins may not be able to sustain their business without prompt payments. This can lead them to ask customers to pay the full cost upfront and wait for the rebate to process. However, this can similarly burden the homeowner, especially if they are lower income. Many smaller contractor companies do not see the payoffs as worth the financial risk, and instead opt to continue with like-for-like gas water heater replacements that still offer good margins.

COMPLEXITY BARRIERS

An emergency replacement puts time-pressure on contractors, so any delays associated with switching to a HPWH make a like-for-like replacement more attractive. Some contractors reported being able to install a HPWH on the same day as a unit failure, while others said it could take up to a week. Whether a plumbing company has an in-house electrician or partners with an electrical contractor dramatically impacts if same-day HPWH installations are possible. One plumber, whose company had an electrician on staff, reported being able to install a HPWH within a maximum of four hours. Another plumber, whose company did not have an in-house electrician, said they used to be able to do same-day HPWH installations, but said that it now takes four to seven days because of electrical permit requirements, coordination with external electricians, and post-installation inspections. The contractor also blamed new reporting requirements to access rebates as an additional burden. The emerging application of 120V HPWHs for smaller households increased to 22 percent of emergency replacements recently, offering contractors an alternative solution, typically eliminating the additional cost and need for electrical upgrades.

Interviewees mentioned various physical barriers that can prevent HPWH installations. These barriers include space constraints, primarily related to the current water heater location being in interior closets or in close proximity to living spaces. These scenarios typically require a relocation of the water heater to the garage, or somewhere where the residents cannot hear the noise. Contractors also mentioned the complexity associated with running electrical wiring within the home for 240V HPWH models and possibility of panel upgrades. Even when these physical barriers can be addressed, they can lead to increased costs and longer timelines for installations.

COMFORT BARRIERS AND ADOPTION OF GAS LOANERS & 120V PLUG-IN MODELS

Gas loaners offer an opportunity to address a customer's desire for same day hot water without permanently installing a gas water heater. Loaners allow contractors to coordinate the logistical hurdles of an HPWH installation without the time pressure. However, one contractor expressed hesitance towards the solution as they worried about the time spent by the contractor performing two installations without any more revenue. This indicates that gas loaners may require extra incentives to be more widely used.

Still another contractor said they had used a gas loaner once despite no additional incentives. However, they said that was a rare case and they only used it because it was during the peak demand for the TECH rebates and there was a shortage of the product they planned to install. They said that they never needed it in other situations because they were able to install a HPWH within one day because they have an electrician on staff. This sentiment was shared by another interviewee. The most prevalent user of the gas loaner was from a single contractor that does not have an electrician on staff, so the loaner allows them time to coordinate with external electricians and fulfill permitting requirements. Additionally, the gas loaner has also allowed for a bridge in emergency replacements in cases where there have been gaps in incentive funding for HPWHs.

Plug-in 120V HPWHs reportedly solve many of the logistical problems faced by 240V HPWHs according to most contractors for select applications. The ability to avoid panel upgrades, additional permitting and coordinating with electricians while installing a new HPWH is appealing to plumbers. However, some still had concerns about the ability of 120V HPWHs to meet customer hot water needs. Contractors felt the need to increase the size of the tank to feel confident customers would be satisfied. One contractor said they would not install a 120V HPWH in any house larger than a two-bedroom one bathroom. This sentiment was validated by TECH data which indicated that 120V HPWHs did not replace a single gas water heater with 50+ gallons of capacity.

Multiple contractors also expressed concerns over products' first-hour ratings and their ability to qualify for TECH incentives. However, these first-hour ratings were recently updated, which should alleviate that concern for the models and even increase their adoption in some larger homes. Still, these models provide an electric, efficient, and simple solution for HPWH conversions in small homes.

Key HPWH Installation Drivers Reported by Homeowners

An analysis of data from a participating contractor captured the primary reasons cited by customers for either opting for a conversion to a HPWH or opting for a "like-for-like" gas water heater replacement since 2022.[12] In cases where a HPWH sale was completed, the primary reasons given in both proactive and emergency replacement scenarios highlight key similarities related to the importance of upfront and operational cost savings and trust in the contractor recommendations, but also significant disparities related to preference for the HPWH technology, impact of the forthcoming ban on gas water heaters, and associated environmental benefits. Figure 20 below shows these key drivers and their varying levels of impact.

[12] Data provided for analysis by a California contractor as part of a custom project sales tracking system.

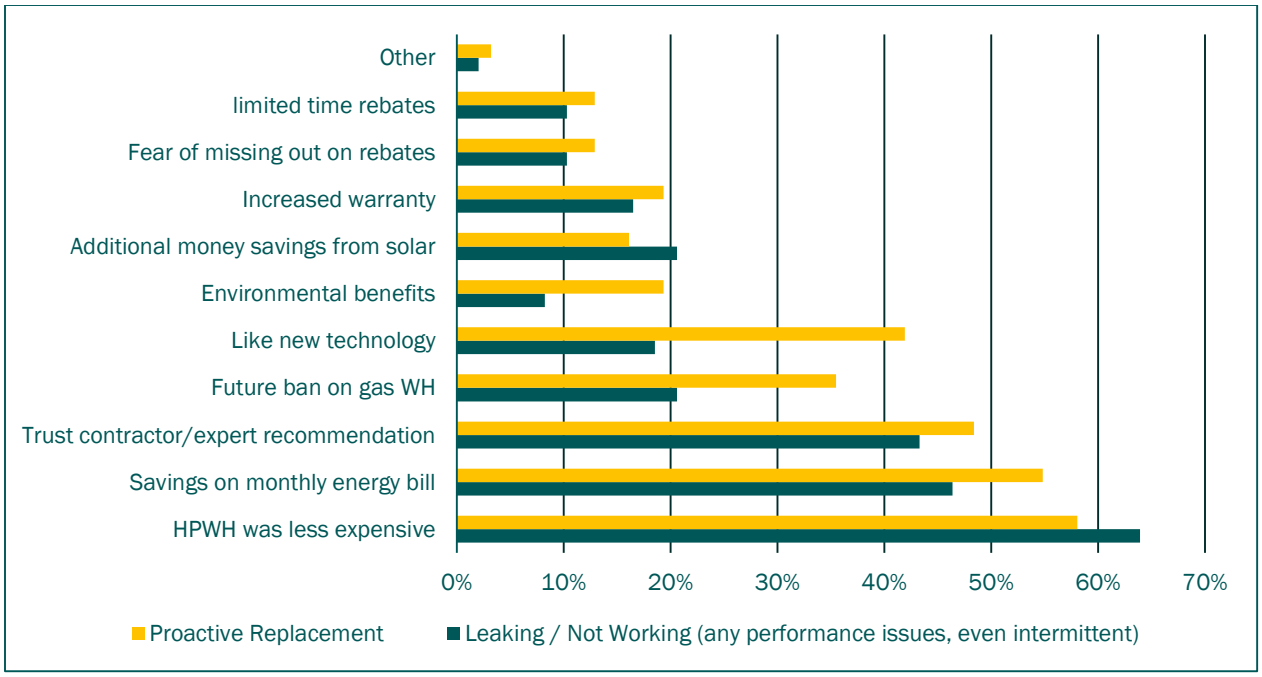

Figure 20: Key drivers of HPWH sales cited by customers.

Source: Project Team

A significant majority of homeowners, 68 percent for emergency replacements, and 85 percent for proactive replacements, remained undecided after the initial site visit. For emergency replacements, the reasons cited for this indecision were categorized into primarily wanting to discuss with the "decision maker" or to a slightly lesser degree seeking to do more research. In seeking to do more research, most often this included receiving quotes from other contractors. In proactive replacements, the primary reason cited was seeking to do more research and a much lesser degree to discuss with the "decision maker".

In cases where the customer opted for a gas "like-for-like" replacement, customer preference for gas technology and additional cost, complexity (e.g. space, location and electrical issues) and time were all cited as important factors in their decision, as shown in Figure 21.

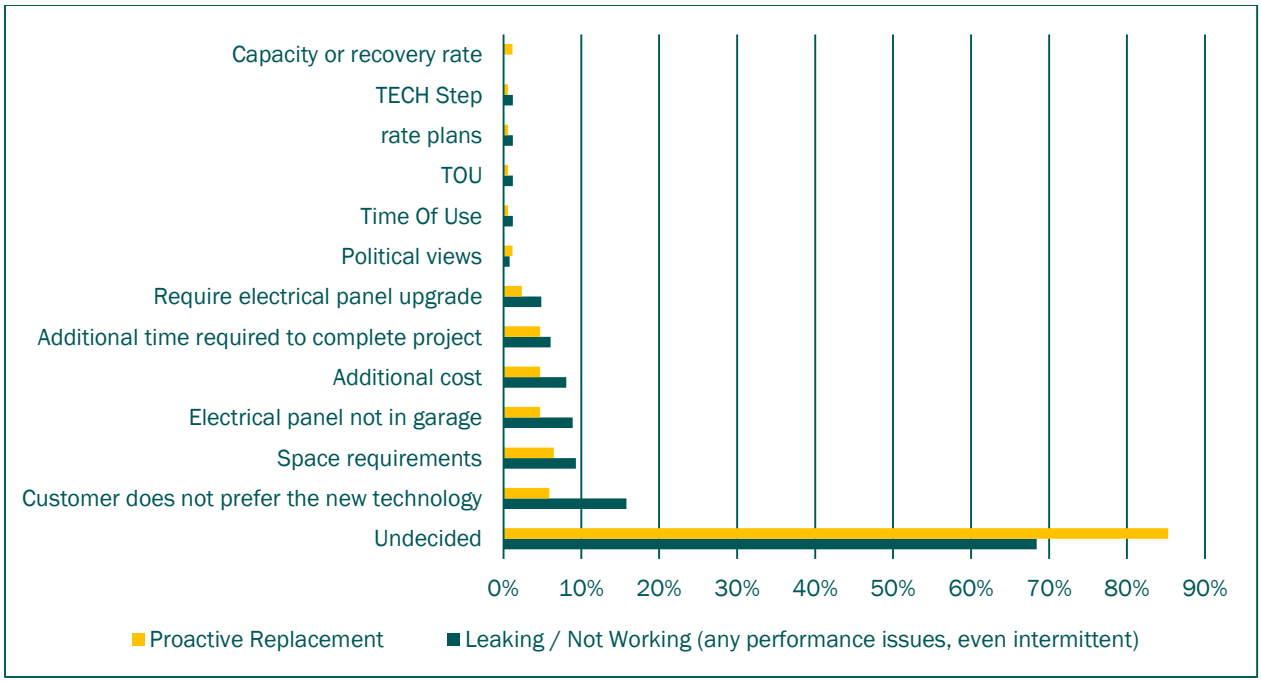

Figure 21: Key drivers of gas "like-for-like" sales cited by customers.

Source: Project Team

A similar analysis of post-installation survey data from PCE[13] captured details and decision factors behind HPWH installations that received rebates from the program from 2022-2023. Out of 228 installations, just over a quarter occurred when the water heater was broken or not functioning well. Of those 59 homeowners installing a HPWH during an emergency replacement scenario, 97 percent reported the rebate being "very important" or "crucial" in their decision to install the equipment.

The most common motivating factors reported for choosing to install a HPWH when an existing unit failed included:

- Reduce greenhouse gas emissions
- Incentives/rebates
- Energy efficiency

While most motivating factors were similar among all circumstances leading to HPWH installations, solar on the home was identified as a significantly more common factor among proactive replacements.

In addition to the rebate, the PCE program offers a zero-interest loan for projects, which is more often utilized during proactive replacements. While ten percent of homeowners with a failing unit reported accessing a loan through the incentive provider, 19 percent of homeowners with a proactive installation utilized the loan. While 26 different plumbing contractors installed 54 of the emergency replacements, the distribution of those installations among participating contractors was

[13] Peninsula Clean Energy. February 20, 2024.

not even, reflecting a similar pattern, as the TECH data showcased in Figure 1616, of a select few "All-in" contractors accounting for the majority of the HPWH installation market. Five homeowners reported a DIY installation.

MAPPING KEY HPWH DECISION FACTORS IN EMERGENCY REPLACEMENTS

The effect of individual drivers on the ultimate likelihood of a HPWH installation can be visualized through a mapping of the key HPWH decision factors with relative percentages of HPWH and "like-for-like" water heater installations in emergency replacement scenarios. Figure 22 is a representation of the flow of a water heater replacement project and the identified decision factors, where HPWH installations represent a percentage of typical emergency replacements, and the relative effect of the primary drivers are reflected in the width of the individual pathways.

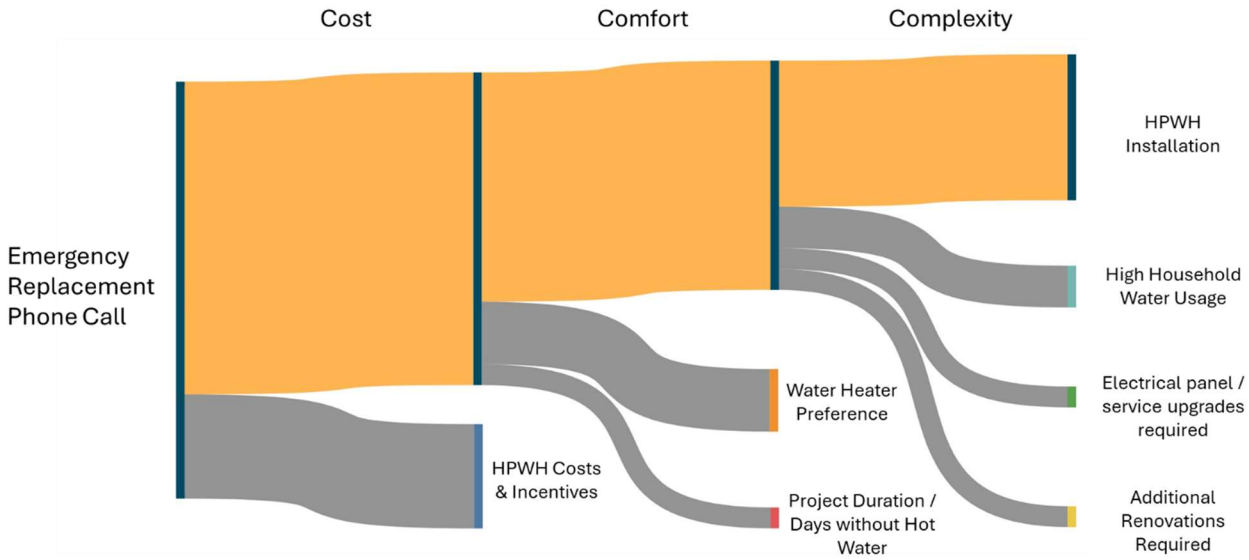

Figure 22: Key decision factors in emergency replacement scenarios in single-family homes.

Source: Project Team

A broader statewide analysis of contractors and customers would provide additional insights as to the scale of the effect of each key driver, which may shift dramatically based on changes at the state or local level with respect to availability of rebates, appliance related air quality legislation and contractor/customer comfort with HPWH technologies.

Developing a Prioritization Framework for HPWH Emergency Replacements

Several recent guidance tools and training courses have been developed for contractors to support quality HPWH installations. The Best Practices for the Retrofit Installation of Heat Pump Water Heaters (RHA 2023), Heat Pump Water Heater Decision Tool[14] and individual manufacturer product training serve as excellent guides for the proper selection and installation of HPWHs. However, reinforcement for contractors and program managers on the prioritization of HPWH opportunities,

[14] Set to be released by PNNL in 2024.

especially to support HPWHs targeting emergency replacements, is needed. Guidance from one manufacturer and feedback from contractors are reflected in the following prioritization framework for emergency replacements, focusing on the easiest opportunities initially and then expanding to include more complex installations, based on a contractor's relative HPWH experience or availability of incentives to offset or mitigate the out-of-pocket cost for a homeowner.

The prioritization framework in Figure 23 tracks the increasing cost and complexity of a HPWH conversion, starting with a simpler electric resistance water heater to HPWH replacement to progressively more complex gas storage and tankless water heater to HPWH conversions. The electric resistance to HPWH conversion reduces the installed cost by more than $1,500 on average due to the existing 240V wiring to the water heater location. While other prerequisites such as space, ventilation, and noise need evaluation and affect the likelihood of HPWH replacements of electric water heaters, the only consistent addition is the necessity to provide a condensate drain for the new HPWH.

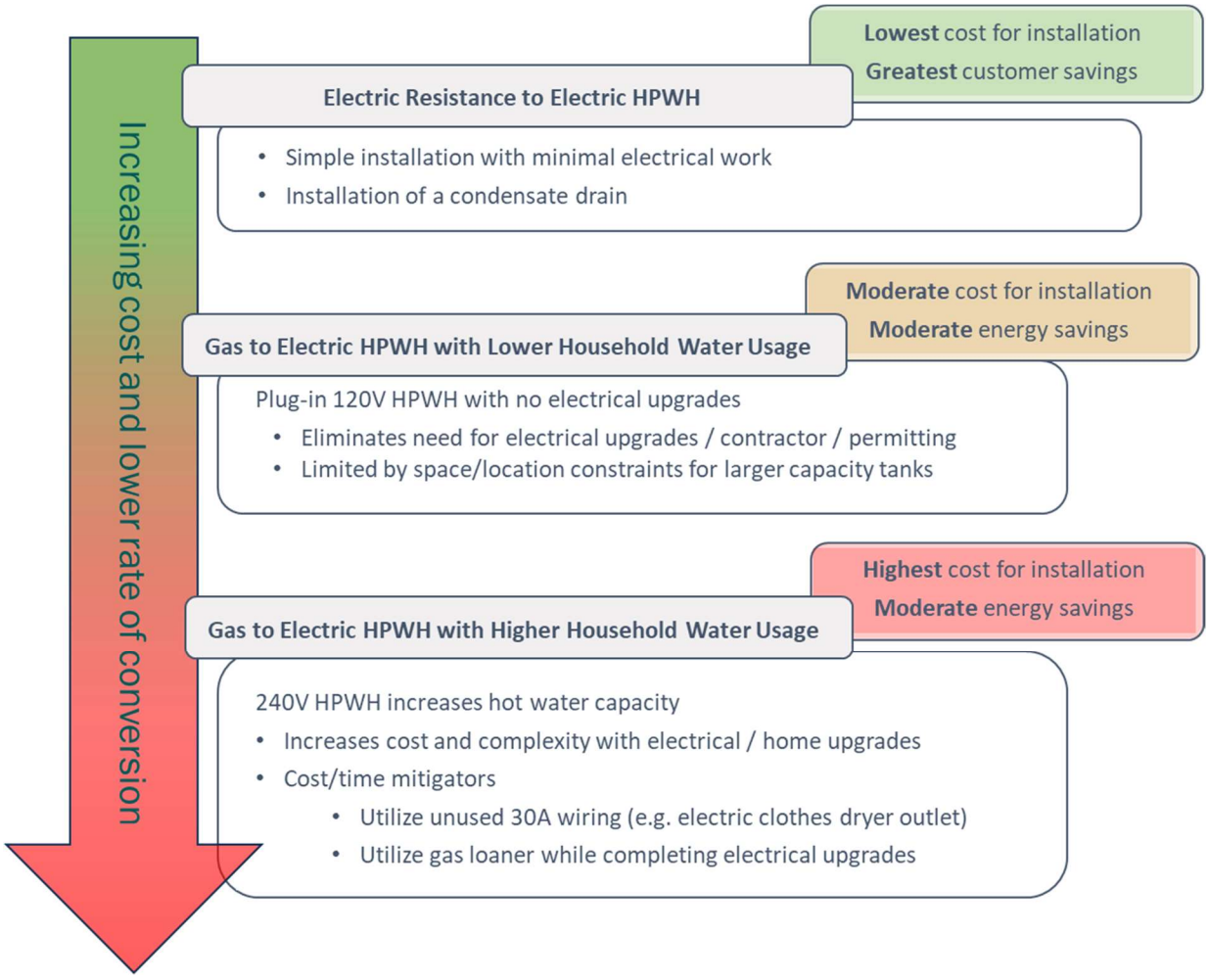

Figure 23: Prioritization Framework for HPWHs in Emergency Replacements.

However, as most existing water heaters in California single-family homes are natural gas storage water heaters, it is important for contractors and programs to prioritize solutions to best meet

individual homeowner needs and contractor capacity. The first and most cost-effective opportunity for gas replacements is to target households with lower hot water needs with new plug-in 120V HPWH models. In addition to cost savings from avoiding the expense of a new 240V service at the water heater location, opting for the plug-in option can enable plumbing contractors to bypass the additional complexity and time required for the electrical upgrades and permitting. This approach may also eliminate the need to schedule an external electrical contractor.

Although a good solution for smaller households or those with lower hot water usage, the limited recovery rates of plug-in models, as well as large physical size for increasing tank capacity, requires additional 240V HPWH solutions for gas conversions. One solution identified by a manufacturer and contractor is to utilize unused 240V clothes dryer outlets and repurpose them for the HPWH, eliminating the need for electrical upgrades. Clothes dryers and water heaters are frequently located in similar locations (e.g. garages and basements), and accessing the existing clothes dryer outlet can be a simpler solution compared with running new wiring from the electrical panel. However, in cases where more substantial modifications are necessary, such as relocating the HPWH, installing new electrical wiring or panel upgrades, or undertaking other home remediation measures, such as employing a temporary gas loaner, can serve as a practical solution to restore same-day hot water to the household. This approach also accommodates the extended timeframe needed for the additional work.

Utilizing a prioritization framework can serve as an important guide for contractors and service technicians, as well as for rebate programs seeking to increase HPWH conversions with funding constraints. For contractors, determining the optimal balance between cost and complexity in emergency replacements can help gauge their ability to align their internal staff's experience and capacity to the job. It also enables contractors to prioritize opportunities that effectively minimize homeowner out-of-pocket expenses. For incentive program managers and market transformation enthusiasts, rapidly scaling the HPWH market through a "lowest hanging fruit" approach can lead to increased HPWH sales, increased competition and ultimately cost-compression. By achieving cost compression in HPWH equipment and installations, it makes the more complex and expensive gas to 240V HPWH conversions more attainable, which will ultimately support market transition to zero-emission water heater regulations. Such a transition is further facilitated by consistent and sustainable rebate funding.

Recommendations

Based on the results of the market evaluation, emergency replacements are the most common time for customers to replace their water heater, but also the situations in which they are least likely to install a HPWH. This indicates the importance of addressing the barriers to HPWH adoption that arise during emergency replacements, if California hopes to decarbonize its residential sector. For licensed general, plumbing, electrical and HVAC contractors, replacing broken water heaters in emergency replacement situations is a representatively small portion of their current business. If the installation of a HPWH is too difficult; the incremental cost is too high; or the rebate process is too burdensome, they are much more likely to simply make a like-for-like replacement. The need for a program addressing emergency water heater replacements is becoming even more pressing with

upcoming BAAQMD and CARB regulations effectively banning standard gas water heaters starting in 2027.

Rebate Program Recommendations

Rebate programs need to reduce the reporting and administrative burdens placed on contractors and shift to more streamlined, market-aligned distributor and retailer point-of-sale rebates whenever feasible. The current requirements of the more than 23 separate rebate processes were so burdensome that many smaller contractors felt unable to participate in the programs, and therefore in the HPWH market as a whole. This is likely one of the reasons for the consolidation of the market among a few "all-in" contractors who have developed more robust internal systems for applying for rebates. The combination of a consolidated market and higher rebate levels in PG&E's territory is hypothesized to be one of the reasons for the increased cost of installations in that territory. The large amount of incentive dollars available for HPWHs in PG&E's territory, combined with a consolidated market, allows these select few contractors to increase their quotes to customers without exceeding the cost of a gas water heater and without the fear of being undercut by other contractors. This is supported by the cost driver analysis which found installations by the most experienced contractors had a higher cost. Helping smaller contractors participate in these rebate programs is critical to enable them sell HPWHs and to increase competition in the market to drive down the cost for customers. Contractors expressed the desire for a consolidated rebate process where they could apply for all eligible rebates in a single location. Contractors have begun enlisting in a mobile app solution to overcome this complexity and have very positive reviews saying these apps save hours of their time. Participating in rebate programs is critical for contractors to be able to sell HPWHs to customers, so simplifying the process is necessary to continue California's progress towards electrification.

California needs to increase funding for its rebate programs and assess strategies for achieving cost compression of HPWH installations to create sustainable market development in advance of state and local zero-emission appliance standards. Statewide coordination of rebates, financing and federal funding can be maximized through point-of-sale and on-bill incentives to achieve low to no out-of-pocket costs for HPWH installations, lower installed costs and increased leveraged tax benefits. Contractors reported a huge influx of HPWH installations when TECH relaunched in late October. However, the funding ran out in PG&E territory in February. Since then, contractors who had been installing a HPWH every day say they have had no more requests for HPWH installations. Upfront cost is one of the biggest barriers to HPWH installations, and when rebates run out and are no longer able to alleviate that burden, customers stop installing HPWHs. This can particularly impact smaller contractors who restructured their business to emphasize HPWHs and now see dramatically reduced interest in their services. It is vital that rebates remain available, particularly in places with high demand for HPWHs such as PG&E and SMUD territories.

Prioritizing HPWH Opportunities in Emergency Replacements

A new water heater is most likely to be installed when the current unit fails, which is also the most challenging time to install a HPWH. Increasing the likelihood of a HPWH installation in an emergency water heater replacement requires addressing the key decision factors affecting contractor and customers.

As cost and energy savings are two of the most important factors affecting the likelihood of HPWH installations in emergency replacements, increasing focus and prioritizing the 'lowest hanging fruit" opportunities could help California programs achieve significantly greater scale at lower costs to the customer, as well as programs. A broader contingent of contractors would also benefit from tackling simpler installations first, capitalizing on the simpler and lower cost of replacement of an electric water heater or avoidance of electrical upgrades with plug-in 120V HPWHs. Increased scale of installations resulting from this "lowest hanging fruit" approach will achieve greater engagement from a broader segment of contractors, as well as increased awareness of HPWHs by homeowners for potential proactive replacements. This approach of tackling "low hanging fruit", paired with contractor participation in programs like TECH's Learn to Earn, would increase contractors' familiarity with and confidence in the technology. Increasing contractors' experience with the technology is critical, given the influence that a contractor's predisposition has on the likelihood of a HPWH installation.

However, the need for increasing home electrical and building readiness in California single family homes for HPWH conversions will be an ongoing barrier to market transformation. California's water heater stock is old, with an average useful life of ten years and a median water heater age of 8.3 years in single-family homes. A home HPWH readiness program offers an opportunity to reduce the complexity of emergency HPWH conversions. Proactive assessments of a home's readiness to install a HPWH could inform homeowners of the necessary home upgrades they will have to take. Homeowners could then prepare for when a home's water heater fails, and hot water can be restored on the same day with a HPWH, avoiding a drawn-out installation process or a like-for-like installation. A home upgrade program should target DAC/HTR communities in particular, as these communities are the most likely to live in older homes that need further upgrades to electrify. Proactive home upgrades that enable electrification are critical to prepare for the upcoming regulations from BAAQMD and CARB. When these regulations take effect, all water heater installations will be HPWHs, and a proactive program can help alleviate any workforce pressures that result from this increased demand.

Still, additional programs may be necessary to help contractors install HPWHs in homes that have not yet undergone the necessary upgrades. Utilities could offer incentives for the installation of gas loaners. 3CREN currently runs a rebate program for gas loaners modeled off TECH's Water Heater Loaner Quick Start Grant. The Quick Start Grant found that the option of a gas loaner in emergency replacement scenarios increased the adoption rate of HPWHs from less than one percent to greater than 17 percent. One contractor expressed concern that gas loaners require them to make two site visits and perform two installations, eating into their revenue margins. An incentive that covers this cost could make the option to install a gas loaner more appealing, especially as many contractors expressed a concern over staff capacity for installing HPWHs. Utilization of gas loaners provides contractors much needed time to perform home upgrades that may become increasingly necessary as more regulations mandate HPWH adoption.

Plug-in 120V HPWHs also offer an opportunity to overcome the costs and time delays that arise from panel upgrades. Panel upgrades are the largest barrier to 240V HPWH installations. Because 120V HPWHs allow contractors to avoid panel upgrades, they could particularly benefit DAC/HTR homes which are most likely to require additional home upgrades. According to TECH data 120V HPWHs were the cheapest installation option even when compared with all projects that did not require

panel upgrades. The ease of installation and avoided costs make the 120V models appealing products for HPWH installations moving forward. While there had previously been concern over the products first-hour ratings, those were recently resolved with AHRI's recent updates.

The TECH program, utilities, manufacturers, and other stakeholders are developing critically needed training and best practice guides to support contractors with HPWH installations. Developing a simple, streamlined training, and onboarding process for the vast majority of California contractors that are currently not installing HPWHs will be important to achieve the State's goals. Opportunities like the Learn and Earn program should be scaled to encourage contractors to participate in HPWH installation training, as well as gain vital first-hand experience in their own home or business.

To continue to transition California's water heaters to high efficiency HPWHs, it is vital to mitigate the barriers faced in emergency replacement scenarios. A combination of simplified and stable rebates, increased prioritization of "lowest hanging fruit" electric water heater replacements and plug-in 120V HPWHs, and proactively upgrading homes are needed to prepare California for upcoming regulations and preparedness for emergency replacements.

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Appendix A: Stakeholder Interviews

Organization	Stakeholder Type	Participants
3CREN	Consumer Advocate / Program Implementor	April Price
Alligator Plumbing	Contractor	Jason Debonis
Barnett Plumbing	Contractor	Ben Foster
Bradford White	Manufacturer	Gregg Holladay
Discount Plumbing	Contractor	Robert Velazquez
Energy Solutions	Consumer Advocate / Program Implementor	Linda Rodriguez
Excalibur Water Heaters	Contractor	Anthony Achermann
New Buildings Institute	Consumer Advocate / Program Implementor	Joe Wachunas
Pacific Northwest National Laboratory	Consumer Advocate / Program Implementor	Josh Butzbaugh; Alek Parsons
Peninsula Clean Energy	Consumer Advocate/ Program Implementor	Alejandra Posada
QuitCarbon	Contractor	Cooper Marcus
Rock Rabbit	Contractor Advocate / Industry Stakeholder	Aimee Bailey
SunWork	Contractor	Tom Kabat

Appendix B: Additional Stakeholders

Organization	Stakeholder Type	Participants
CalMTA	Industry Stakeholder	Rick Dunn
City of Palo Alto	Program Implementer	Christine Tam
Efficiency Vermont	Program Implementer	Steve Casey
Energy Solutions	Consumer Advocate/ Program Implementor	Dylan Sarkisian
Northwest Energy Efficiency Alliance	Industry Stakeholder	Geoff Wickes
Peninsula Clean Energy	Consumer Advocate/ Program Implementor	Rafael Reyes
Rheem	Industry Stakeholder	Kevin Clark
Rheem	Industry Stakeholder	Allen Cape