DIY Heat Pump Water Heater Installation and Market Study

Final Report

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Disclaimer

Executive Summary

Recent estimates indicate that over 50 percent of Californians are taking a do-it-yourself (DIY) approach to installing replacement water heaters in their homes. This represents an estimated 260,000 heat pump water heater (HPWH) installations occurring annually by the DIY "workforce." These Californians are either installing entirely on their own — perhaps with the help of family, friends, or local volunteers — or they are getting assistance from a non-licensed professional, such as a general contractor without a C-36 plumbing license. Motivations for pursuing a DIY approach are diverse, including limited contractor availability, confidence and pride in tackling home repair projects, and a primary driver: significantly reducing project costs by eliminating installation expenses.

The prevalence of DIY installations occurring in the market is an important consideration as state policymakers and program administrators consider how to increase the adoption of HPWHs to meet state decarbonization goals, including the goal of installing six million heat pumps statewide by 2030. By increasing the engagement and support for the over 50 percent of California households with DIY water heater replacement experience, the state can leverage an existing, untapped workforce willing to assess and pursue lower-cost DIY HPWH installations. At a minimum, arming homeowners who are considering DIY approaches with sufficient technical knowledge can increase confidence to either enlist the assistance of a professional contractor or achieve more competitive quotes for HPWH retrofits. A more competitive quote could result from expanding the HPWH installer "workforce" to include DIY installers, thereby driving competition; by recruiting other workforce contingents, such as general contractors, for assisted DIY installations; or by empowering more informed homeowners to negotiate with contractors. Achieving these outcomes will require a suite of policy and programmatic strategies, which are outlined in this report.

The project team evaluated market opportunities, challenges, and technical solutions in this space through primary and secondary research, program data analysis, and interviews with DIY homeowner installers, plumbing contractors, incentive program administrators, city permitting inspectors, and other subject matter experts. Interviews with stakeholders informed findings throughout the report, as well as the creation of customer-facing DIY materials.

Summary of Findings

This DIY Heat Pump Water Heater Installation and Market Study identifies specific findings and associated recommendations for policymakers and program administrators to maximize the support for code compliant, quality, non-professional or DIY HPWH installations. The following findings are informed by a detailed analysis of existing HPWH incentive program data, a literature review of best practices and installation guides for DIY HPWH installations, interviews with expert stakeholders including permitting offices and program administrators, and homeowners completing DIY installations.

Technical Challenges and Opportunities with DIY Installations

While HPWHs can offer energy benefits to homeowners, installing a HPWH can be more complex than installing a gas or electric resistance alternative. This report includes several resources to help

homeowners evaluate the technical barriers to a prospective DIY installation, highlights common installation and permitting challenges, and identifies supporting resources.

The most common barriers identified for DIY HPWH installations include:

- Accessing detailed instructions and guides — written and video — for HPWH installations
- Navigating state, utility, and municipal rebate processes
- Locating specific HPWH models, e.g., plug-in 120V HPWH models, at local home improvement stores
- Assessing installation specifics for a home, including whether electrical upgrades are necessary and how to appropriately size a HPWH to meet household hot water needs
- Identifying and accessing the necessary tools and materials for completing an installation
- Lacking guidance on local codes and permitting requirements impacting a HPWH installation

Although fuel-switching HPWH retrofits from gas water heaters were flagged as one of the most significant concerns by utilities and local permitting offices for DIY installations, homeowners identified working safely with natural gas fuel supply piping and removing venting as some of the simpler steps in a HPWH installation.

This report includes a "Deciding on a Professional or DIY HPWH Installation" guide, a "DIY HPWH Pre- and Post-Installation Steps" guide, an "Inventory of Best Practices and How-To Guides for HPWH Installation," and a detailed "Tools and Materials List for a DIY HPWH Installation." However, one of the best initial steps to support homeowners is to identify and assess the relative complexity of their individual case for a HPWH retrofit of their existing water heater. The best-case scenario for a simplified HPWH replacement avoids complex electrical, plumbing, and mechanical work. This includes using a plug-in 120V HPWH model with top-mount plumbing and an internal mixing valve, ideally located on a concrete floor in a large space like a garage.

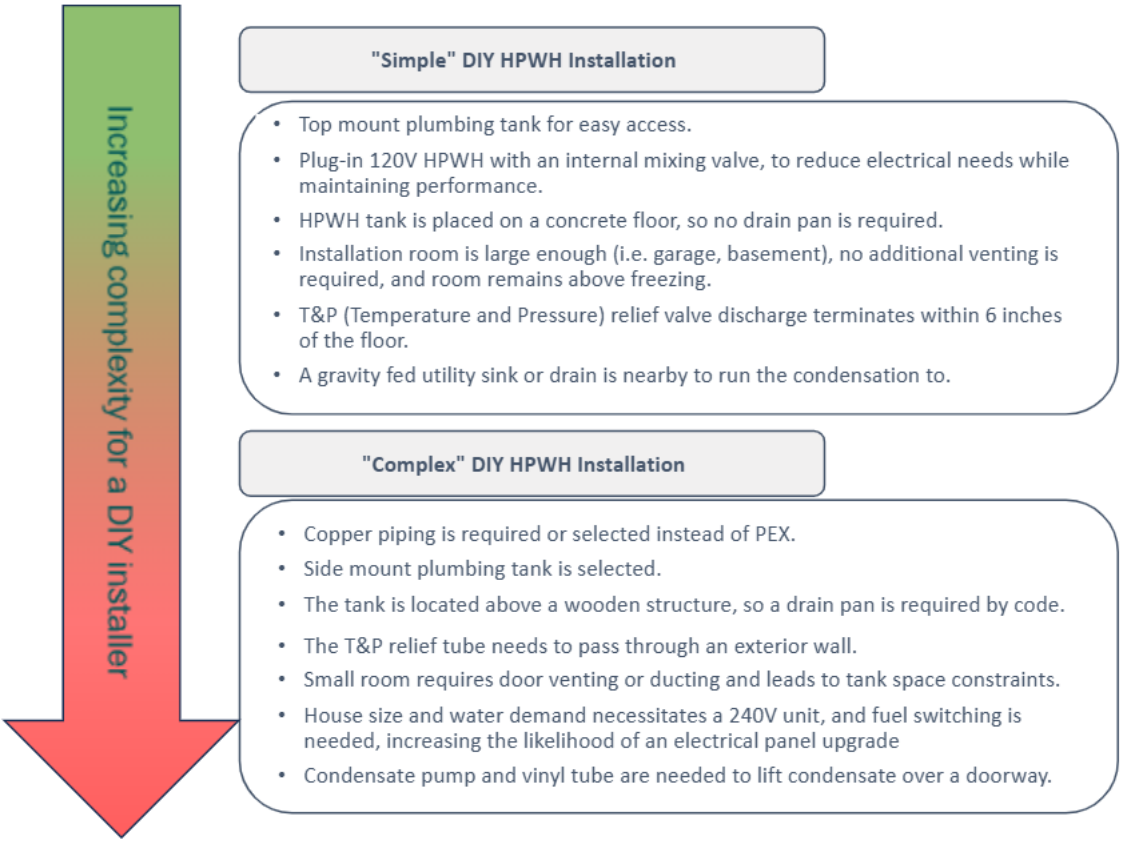

Figure 1: Complexity of a DIY HPWH installation.

DIY HPWH Project Costs and Rebate Availability

The largest rebates currently offered in California — through the statewide Technology and Equipment for Clean Heating (TECH) Clean California and High-Efficiency Electric Home Rebate Act (HEEHRA) Phase I programs — are provided through a contractor network, but several programs are accessible directly to homeowners.

Analysis of program and interviewee data found that **homeowners achieved an average of $3,776 in savings by pursuing a DIY path for a 240V HPWH installation compared to TECH Clean California contractor-led installations**. As reflected in Figure 2 below, for a 120V project, homeowners saw an average of $1,169 in savings with a DIY installation. Savings for DIY projects are largely attributable to the high cost of labor and equipment markup**.** The higher cost for professional installations is a primary driver for homeowners to pursue a DIY HPWH installation, regardless of rebate eligibility.

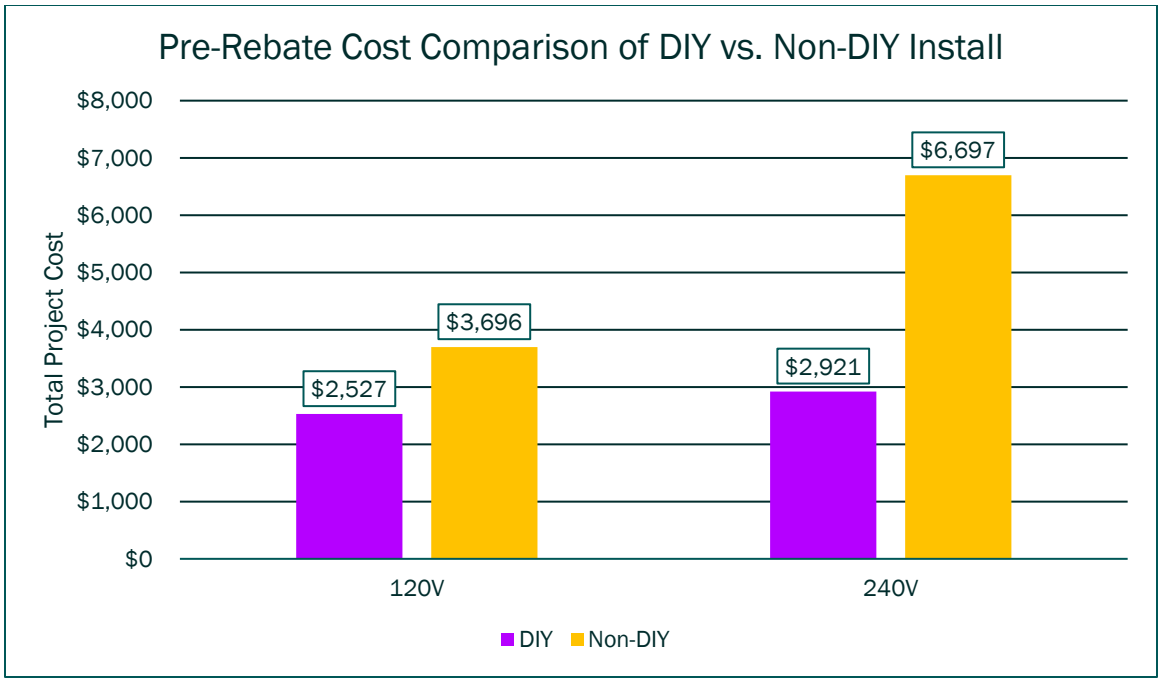

Figure 2: Pre-rebate cost comparison of DIY versus non-DIY install.

Permitting Challenges and Opportunities for DIY HPWH Adoption

Although permitting and inspection are crucial for safe and quality water heater installations, HPWH installations face a disproportionate burden and accountability compared to conventional electric and gas water heaters due to rebate eligibility program requirements. Many rebate and incentive programs require permitting and code compliance, but proof of permits and enforcement vary. **This disproportionate impact not only increases the cost and time burden on all HPWH installations — including professional ones — but can also be a barrier for homeowners attempting to complete a DIY HPWH installation due to lack of experience, knowledge, and comfort navigating the permitting process.**

Simultaneously, permitting and inspection requirements vary between local California jurisdictions. For all installers, it can be challenging to find and navigate area-specific guidance, but this can be particularly challenging for homeowners. Uniformity, simplicity, and accessibility of permitting processes are especially important to DIY installers — who are less likely to have personal knowledge around permitting processes and might be more likely to make mistakes as a result (TECH Clean California, 2024). **Striving toward a standardized, low-cost, and streamlined HPWH permitting process that can be easily communicated to homeowners by rebate program administrators, city officials, and others will be essential to ensuring quality DIY HPWH installations.**

This report includes a summary of case studies in permitting variance and challenges, as well as best practices and recommendations for streamlining permitting and improving accessibility. Findings on the range of permitting ease and accessibility are summarized in Table 1.

Table 1: Difficulty Rating Summary for HPWH Permitting Processes

Permitting "Level of Difficulty"	Common Characteristics, Processes, and Requirements
"Low" — Accessible and Streamlined Process	1. No unique local updates to statewide water heater code requirements. 2. Only one permit is required, as opposed to two permits (plumbing and electrical), or a third additional building permit. 3. Online submittal enabled. 4. As few as zero (instantaneous) days are required for approval. 5. Permit is free or low cost. 6. Information and requirements are synthesized and summarized on a website, making them easy to find. 7. Post-inspection installation updates can be verified without a second inspection visit.
"High" — Cumbersome, Non-Uniform, Inaccessible	1. Unique requirements are added for the jurisdiction that go beyond state code. 2. Multiple permits are required that necessitate understanding plumbing as well as electrical and/or building code. 3. In-person submission is required, no online application. 4. Approval time is long. 5. Permit is expensive. 6. Specific non-standard template is required for load calculations.

Resources and Guidance for DIY HPWH Installations

Interviews with homeowners, program administrators, and other installation experts highlighted that there is a wealth of existing resources and knowledge available to support a HPWH installation. However, most existing resources are not sufficient for guiding a homeowner through a DIY installation, as they are typically highly technical and geared toward a professional installer. In addition, these resources often offer only high-level information regarding site limitations, choosing the right HPWH model, and assessing electrical upgrade and wiring needs, and they rarely include details on the necessary tools and materials for completing an installation. An additional limitation is that many resources are only available in English, posing a barrier for many households in California.

An accessible guide for HPWH installations — that includes everything from HPWH benefits to home and site assessment criteria, to permitting common requirements, to key installation elements — is crucial to supporting DIY HPWH installers. This report includes resources aimed at helping prospective DIY installers understand the relative complexities of a HPWH installation, assess their home's installation requirements, and access the necessary tools and knowledge to safely complete a quality HPWH installation. The following resources are included in Appendix A of this report:

- Deciding on a Professional or DIY HPWH Installation
- DIY HPWH Pre- and Post-Installation Steps
- Inventory of Best Practices and How-To Guides for HPWH Installation
- Tools and Materials List for a DIY HPWH Installation

Recommendations

Increasing support for DIY HPWH installations will require specific actions from a broad group of California stakeholders — including policymakers, permitting and code officials, and incentive and rebate program administrators. Below is a set of recommendations informed by the key findings of this study:

1. Support non-professional DIY installers by disseminating accessible and detailed HPWH retrofit installation guides — including those developed in this report.
2. Design simple and streamlined rebate programs that are accessible directly to a broader base of both professional and non-professional installers to maximize HPWH cost competitiveness and accessibility. Where feasible, create a pathway within existing rebate programs for DIY applicants.
3. Improve the diversity of HPWH models and access to tools to simplify water heater replacements for different building needs. This included improving HPWH product availability in retail stores, investing in market transformation for plug-in 120V HPWH models, and supporting tool rental or volunteer solutions to enable low-cost HPWH installations.
4. Enhance public messaging and contractor training around HPWH benefits and installation requirements — such as offering free energy assessments and planning support for households and continuing to educate both residents and contractors about HPWH installations.
5. Address common friction points and variances in local code and permitting requirements and educate permitting offices about the technical needs and specifications of both 240V and 120V HPWH installations.
6. Incorporate and support the lowest-cost HPWH installation pathways to reach state decarbonization goals, including 120V technologies and safe, quality DIY installations.

Abbreviations and Acronyms

Acronym	Meaning
AEA	Association for Energy Affordability
BAAQMD	Bay Area Air Quality Management District
CARB	California Air Resources Board
CCA	Community choice aggregator
DAC	Disadvantaged communities
DIY	Do-it-yourself
ESMAC	ENERGY STAR® Manufacturer Action Council
HPWH	Heat pump water heater
HVAC	Heating, ventilation, and air conditioning
IOU	Investor-owned utility
NEEA	Northwest Energy Efficiency Alliance
PCE	Peninsula Clean Energy
RCEA	Redwood Coast Energy Authority
RHA	Richard Heath & Associates
SVCE	Silicon Valley Clean Energy
TECH	Technology and Equipment for Clean Heating

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Introduction

The state of California has set a goal of achieving a carbon-neutral economy by 2045, supported by a market transformation goal of installing six million heat pumps by 2030. To meet these goals, California must continue discovering and implementing innovative solutions to lower the cost of heat pump water heater (HPWH) installations and increase access to HPWHs for all utility customers (Office of Governor Gavin Newson, 2022). The state's heat pump market transformation program, TECH Clean California, as well as market studies by firms such as Opinion Dynamics, continue to highlight that upfront costs remain a primary concern and challenge for HPWH adoption. The difference in upfront cost between a conventional gas-fueled water heater like-for-like replacement and a HPWH fuel-switching replacement is particularly challenging and problematic for low-income households.

Meanwhile, a study conducted by the Northwest Energy Efficiency Alliance (NEEA) suggests that do-it-yourself (DIY) HPWH installations can save homeowners between $500 and $750 in contractor labor costs (NEEA, 2018). Additional analysis in this report, using TECH Clean California and other California rebate program data, shows cost differentials between DIY and non-DIY installations ranging from $2,000 to $4,000. Specifically, analysis of program and interviewee data found that homeowners achieved an average of $3,776 in savings by pursuing a DIY path for a 240V HPWH installation compared to TECH Clean California contractor-led installations. For a 120V project, homeowners saw an average of $1,169 in savings with a DIY installation. In California specifically, a recent Opinion Dynamics survey and study found that 52 percent of respondents who replaced their water heater did so themselves or used an unlicensed friend or family member, citing cost and time savings as the primary drivers (Opinion Dynamics, 2024). This represents a large portion of DIYers who will be looking to replace their water heaters but lack a clear and viable path for installing a HPWH as the replacement technology. For the purposes of this study, DIY is defined as self-installation by a homeowner or an assisted installation completed with the help of a general contractor or handyperson, but without the involvement of a licensed plumber or electrician.

While not always a preferred or feasible path for all homeowners, this report aims to research and understand the technical, practical, and market factors that impact the viability of DIY installations in owner-occupied, single-family homes in California. The recent introduction of new HPWH technologies, notably the plug-in 120V HPWH, offers a potentially lower-cost and simpler option for converting from the common natural gas water heaters found in California homes. The 120V technology also offers potential cost and energy savings when replacing existing electric resistance water heaters, due to the reduced electrical load. Plug-in 120V HPWHs have grown to represent 15 percent of HPWH installations in California and 22 percent of emergency replacements by TECH Clean California contractors in the past year and offer an attractive solution for DIY installations. On average, costs for plug-in 120V HPWH installations were 13 percent lower than those for 240V installations through TECH Clean California contractors because they are less complex, eliminating the cost of wiring and panel upgrades often required for 240V HPWHs (VEIC, 2024).

Permitting, building code, and rebate program requirements are often unique for a HPWH installation, and add a layer of complexity even for professional installers (TECH Clean California, 2024). Interviewees highlighted that this can be an even greater barrier for less experienced DIY

installers. Assessing challenges related to permitting, building code, and program requirements will be critical not only to expand the opportunity for DIY HPWH installations, but also to increase adoption by professional installers and accelerate California's progress toward achieving its market transformation goals.

This study provides a foundation for program administrators on how to best support DIY installers by offering detailed, step-by-step installation procedures, guidance on navigating associated permitting and code requirements, and identification of necessary installation materials and tools. The report also documents the stages of the DIY installation journey, technical solutions, and guidance for simplified DIY-homeowner led or homeowner-assisted replacement of existing electric and gas water heaters with HPWHs in California homes. Based on the research and findings, the report outlines the potential size of the DIY HPWH market in California and provides actionable recommendations for program administrators and policymakers to engage this underutilized workforce in decarbonizing residential water heating across California.

Background

HPWH Market Background

In California, most households — approximately 78 percent — have natural gas water heaters (Opinion Dynamics, 2024) (VEIC, 2024). The prevalence of gas water heaters in single family homes poses a challenge to California's transition to using clean energy for water heating, as replacing these gas units with electric HPWHs involves increased complexity, cost, and time relative to a like-for-like or same-fuel replacement. Analysis by consulting firm E3 shows ranges in upfront capital costs for HPWHs across California climate zones between $4,000 and $5,000, which is $1,000 to $2,000 more than the average gas water heater (Energy and Environmental Economics, 2019). Rocky Mountain Institute (RMI) estimates that nationwide, the net upfront costs of replacing an existing gas water heater with a HPWH are double those of selecting another like-for-like gas water heater (RMI, 2024). This cost differential presents a particular challenge when considering fuel-switching to a HPWH at the time of failure of an existing water heater, and urgency often lends itself to a lower-cost and simpler upfront replacement. A recent CalNEXT report indicated that at least 75 percent of water heater replacements in California occur in an emergency replacement scenario (VEIC, 2024).

Additionally, HPWH installations are still relatively new to California's residential plumbing sector. with the majority — 53 percent — of plumbers in a recent study reporting that they began installing HPWHs in or after 2019 (Opinion Dynamics, 2024). Other common challenges to HPWH adoption include physical and logistical barriers such as space constraints, electrical panel capacity and permitting requirements, and a lack of homeowner and contractor familiarity and comfort with a new water heating technology (VEIC, 2024).

State and local regulations that require or incentivize heat pump installation are expected to dramatically increase demand for California's already limited plumbing and electrical professional workforce in the coming years. Starting in 2027, households within the Bay Area Air Quality Management District (BAAQMD) will be prohibited from replacing a failed gas water heater tank

model with another similar gas unit, due to new air quality standard requirements (Bay Area Air Quality Management District, 2023). The California Air Resources Board (CARB) plans to extend this requirement statewide in 2030 (State of California Air Resources Board, 2022).

This rapid timeline poses challenges, particularly for lower-income households, unless more cost-effective options for HPWH installations are developed. Making a HPWH accessible for a low-income household requires ensuring that installing a HPWH is the most cost-effective option at the time of failure of an existing water heater, which is more likely to be a gas water heater compared to non-low-income households (Krishpinovich, et al.) This requires either supporting incentive programs for HPWHs and related installation needs to drive down total project cost — inclusive of other home remediation or repair work to accommodate the HPWH — or supporting direct install programs that cover the entire cost of a HPWH installation. The TECH Clean California Low-Income Pilot has found that, at present, incentive and rebate programs are not sufficient to cover the full cost of a HPWH installation for most low-income households, given the prevalence of older homes that require costly remediation (Pickrell, 2024) Additionally, low-income direct install programs are also very expensive on a per-household basis. Early analysis relayed via interview from the TECH Clean California team estimates that the average remediation cost for an Energy Savings Assistance-eligible household participating in the TECH Clean California low- income direct install programs was just under $7,000 per household, and the average total project cost was over $20,000 per household. Finding scalable solutions for low-income electrification will be critical in the lead-up to upcoming regulations.

Additionally, it can and will also be a challenge for people in rural and traditionally hard-to-reach geographies, such as tribal areas, to meet these appliance standards requirements; lower contractor availability in such areas adds pressure to both timelines in emergency replacement scenarios and cost. As one example, TECH Clean California found that HVAC installation projects in counties served by more than 100 TECH Clean California contractors cost, on average, $1,000 less than projects in counties served by only 10 TECH Clean California contractors (TECH Clean California, 2023). Additionally, of the nearly 20,000 licensed California C-36 plumbing contractors, 7 contractors account for approximately 45 percent of all HPWH installations that received incentives through the TECH Clean California program (VEIC, 2024). This highlights the limitations for homeowners in finding and receiving support from existing licensed contractors who are proactively and competently installing HPWHs.

California homeowners have access to substantial rebates for HPWH installations through various state, utility, and municipal programs, such as TECH Clean California and the Statewide Midstream Water Heating Program. These programs can help offset the higher incremental costs of HPWH upgrades. In some areas, these layered incentives have exceeded $5,200, significantly reducing installation costs (The Switch Is On). Many of these incentives are exclusively available through participating contractors, though, meaning they are inaccessible to homeowners directly who might be interested in a DIY installation. However, a subset of incentive programs — including the investor-owned utility (IOU) Golden State Rebates program, Peninsula Clean Energy's (PCE's) HPWH rebate program, Silicon Valley Clean Energy's (SVCE's) HPWH rebate program, Redwood Coast Energy Authority's (RCEA's) HPWH rebate program, and others — are accessible to homeowners. By evaluating participation data and installation costs across California's various HPWH programs, this study documents insights into the benefits, potential cost reductions, and barriers associated with DIY homeowners and assisted DIY HPWH installations.

Market Size Analysis

Based on the 2020 Census, California has over 5 million owner-occupied housing units and, assuming an average useful life of 10 years for water heaters, approximately 500,000 water heaters are replaced annually in the state (CA eTRM, 2023).

TECH Clean California reports 1,700 HPWHs installed annually, representing approximately 0.3 percent of annual water heater replacements. This data includes only installations that are led by licensed contractors and professionals, and does not include DIY or assisted installations, or unpermitted installations that aren't applying for and receiving the TECH Clean California rebate. Data collected from PCE, which administers a program that accommodates DIY projects, indicates that just over 2 percent of HPWH projects that received rebates between June 2021 and April 2024 were DIY installations (34 out of 1,292 HPWH projects). This only represents projects where a HPWH installation was confirmed and does not capture DIY installations of gas water heaters, electric resistance water heaters, or unpermitted HPWHs.

An analysis conducted by NEEA found that 28 percent of water heater replacements annually in the Northwest were DIY installations — defined as a non-professional installation by the homeowner themselves, a friend, or a family member (NEEA, 2018). Comparatively, a recent survey completed by Opinion Dynamics in California found that 52 percent of water heater replacements in a representative sample size were DIY installations. This estimate is based on a sample size of 149 thoroughly screened California homeowners who had replaced their water heater in the past two years. The data are representative of trends statewide, as they reflect the experiences of households across the state and suggest a sizable portion of annual water heater replacements is occurring as DIY installations in California, as well as in the Northwest.

The Opinion Dynamics survey also found that, of the 149 households surveyed, 72 percent were like-for-like replacements and 28 percent were change-of-type replacements (largely gas to electric conversions). Within those buckets, 55 percent of like-for-like water heater replacements were DIY installations, and 46 percent of change-of-type replacements were DIY installations (Opinion Dynamics, 2024). Applying the surveyed findings on DIY replacements to the estimated statewide water heater replacements, California has the potential for up to 260,000 HPWH installations annually utilizing the existing DIY workforce.[1]

[1] Table 2 captures the range of estimates for DIY HPWH replacements annually in California, applying the estimated percentages for DIY installations reported in both the NEEA Hot Water Market Characterization Report and the Opinion Dynamics Water Heater Market Study to the annual water heater replacement estimate reported by the California electronic Technical Reference Manual (eTRM). It then applies to these numbers the Opinion Dynamics findings around the percentage of water heater replacements that are like-for-like or change-of-type, and the relative portion of each that were DIY.

Table 2: Estimated Statewide DIY Water Heater Replacement Market Size (Annual)

Total Annual Statewide Water Heater Replacements	500,000	(CA eTRM, 2023)
DIY Water Heater Replacements	Between 140,000 and 260,000	(NEEA, 2018) (Opinion Dynamics, 2024)
DIY Like-for-Like Water Heater Replacements	Up to 64,400	(Opinion Dynamics, 2024)
DIY Change-of-Type Water Heater Replacements	Up to 198,000	(Opinion Dynamics, 2024)

Source: (CA eTRM, 2023), (Opinion Dynamics, 2024), (NEEA, 2018)

The sample size for the Opinion Dynamics survey is not intended to be representative of the entire state or DIY water heater market. However, the above estimates highlight the likely scale of the opportunity for increasing HPWH installations by improving awareness with homeowners and providing supporting technical information and program processes for quality and safe DIY installations.

Innovative HPWH Technical Solutions

DIY installations of HPWHs are not unlike installations of conventional gas and electric water heaters, requiring the necessary knowledge, skill sets, and adherence to electrical, plumbing, and building code requirements to safely complete a quality installation. This report focuses on the opportunity for DIY installations of both plug-in 120V and hardwired 240V models. However, the benefit of eliminating the potential need for 240V wiring and electrical panel upgrades, offered by the plug-in HPWH models for gas water heater replacements, is especially appealing for DIY installations and is further detailed below.

Plug-In 120V HPWH Overview

The emergence of plug-in 120V HPWHs offers homeowners and installers an alternative to standard 240V HPWH models and can simplify project installation and lower costs. The primary advantage of plug-in 120V HPWH models is their ability to use either a dedicated or existing shared 120V circuit and electrical outlet near the water heater location — making HPWH installations more cost-effective and easier for DIY installation. However, the performance varies between the two model voltage types, so understanding the capability of the technology and the needs of the household is essential to determine when and where this technology is appropriate.

Plug-in 120V HPWHs share many characteristics with 240V models, but there are key differences that provide both simplicity and potential complications to the decision and installation process; they are listed below (VEIC, 2024).

RELATIVE SIMPLICITY OF 120V MODELS

- **120V models plug in.** This is the most significant difference between 120V and 240V HPWHs. The lower voltage of 120V HPWHs allows them to be plugged into standard 15-amp electric outlets, drawing less power, while 240V models require direct wiring from the electrical panel to the HPWH and sufficient space and electrical capacity for a new two-pole, 30-amp breaker

in the electrical panel. The simplicity of the plug-in 120V option allows for much easier, faster installations and lower costs by potentially avoiding electrical infrastructure upgrades.

- **Integrated thermostatic mixing valve.** The thermostatic mixing valve provides an additional 20 percent of 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 (Hot Water Solutions, 2025). Plug-in 120V models using either integrated or external electronic mixing valves can mitigate the reduced recovery rate of 120V units by effectively increasing the stored energy in the tank. This can also allow the homeowner to limit operation during peak electricity periods by optimizing around time-of-use rates and demand response program signals.

ADDITIONAL OPERATIONAL AND INSTALLATION CONSIDERATIONS

- **Reduced or no backup heating.** 120V HPWHs lower their power demand by operating either entirely in heat pump mode with no electric resistance backup heating, or by using a smaller amount of electric resistance backup heating, generally half the capacity of those contained in 240V units. While eliminating or reducing the electric resistance backup heating element increases efficiency, it also reduces the recovery rate of the water heater (NBI, 2023).

- **Tank size.** Because 120V HPWHs have eliminated or reduced electric resistance backup heating options, plumbers typically install larger storage tanks to achieve similar first hour ratings to those of the previously existing 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. A common rule of thumb shared by contractors and manufacturers is to upsize twice from the existing gas tank water heater capacity, whereas 240V models tend to upsize once. For example, replacing an existing 40-gallon gas water heater would likely require a 50-gallon 240V model or 65-gallon 120V model. However, using specific sizing guidelines from manufacturers or from design tools — e.g., the U.S. Department of Energy (DOE) HPWH Installation Tool — is highly recommended to ensure adequate hot water without oversizing (Office of Energy Efficiency and Renewable Energy , n.d.).

Permitting and Code Background

Permitting processes vary across jurisdictions and can be particularly arduous when replacing a gas water heater with an electric HPWH installation where, at times, separate mechanical, electrical, and plumbing permits are required. A study of HPWH permitting costs in San Mateo County found that individual permits can range from $16 to $500 (County of San Mateo Office of Sustainability). Additionally, research by the TECH Clean California program has found that, while building departments commonly allow like-for-like replacements of natural gas water heaters to be permitted over the counter on the same day, the average permitting timeline for a HPWH statewide is 5.9 days (TECH Clean California, 2024). Longer permitting timelines are often driven by building codes, which are intended to address safety concerns, including those associated with increased electrical loads and necessary capping of gas lines and exhaust vents from the existing water heater. Longer timelines are also often driven by insufficient knowledge among contractors and homeowners about additional plumbing and electrical requirements, translating into more inspection challenges and back-and-forth than a like-for-like replacement might entail (TECH Clean California, 2024).

Differences in permitting requirements create challenges for homeowners looking to install a HPWH when trying to find detailed permitting requirements. There are very few checklists or educational resources on HPWH installation that can apply across permitting jurisdictions. This means that most homeowners will have to be proficient in locating, reading, and interpreting building code, or will need to contact their jurisdiction's permitting office directly for assistance. This is especially significant in an emergency replacement scenario, where time is a crucial element.

Objectives

This project assessed the market potential for DIY homeowner-led or assisted 120V and 240V HPWH installations in owner-occupied single-family homes in California. Outputs of the project research include instructional materials and installation guidance for DIY HPWH installations, a compilation and easy-to-access reference guide for simplified HPWH kit components, and an analysis of what portions of the residential single family market are best positioned for DIY HPWH installations. These materials are intended to make the installation process more manageable for homeowners and ensure that HPWHs are accessible to households where contractor costs are a barrier.

The project team developed actionable recommendations for stakeholders who are interested in supporting homeowners with a DIY HPWH approach — including California HPWH incentive programs (statewide, utility, community choice aggregator [CCA], municipal, or other), permitting offices, and community-based organizations. Recommendations focus on potential program design enhancements, improvements in customer education around HPWHs and DIY solutions, and technical guidance for DIY installations.

The project team identified successful strategies that enable residential homeowners to complete simplified HPWH installations and that could boost participation rates across California's HPWH programs. Longer-term goals for this research include using the DIY informational materials and findings to support HPWH adoption, especially in disadvantaged communities (DACs) and lower-income households, thereby increasing affordability.

Finally, this research identified opportunities to make HPWH installations more accessible, which can support the development of the substantial and often overlooked DIY workforce — a demographic that is critical to achieving the state heat pump market transformation and decarbonization goals.

Methodology and Approach

The project team assessed the market opportunity for DIY HPWHs in single family homes, existing plumbing code and permitting requirements in California, current incentive program requirements (as of 2024), and best practice installation guides from manufacturers and industry stakeholders. The project team evaluated opportunities and technical solutions in this space through a combination of primary and secondary research, program data analysis, and interviews with homeowners, contractors, incentive program administrators, and city permitting inspectors. This assessment included the development of a process flow for a DIY HPWH project (Figure 7), which details the technical steps involved in a DIY installation, as well as a Deciding on a Professional or

DIY HPWH Installation guide, located in Appendix A. Findings from this research support specific recommendations to increase the rate of quality DIY installations across the state.

Assessment of HPWH Incentive Programs and Project Cost Data

The project team assessed existing HPWH rebate and incentive program data, with a focus on programs that were available direct-to-homeowner. This includes midstream rebates, such as the Golden State Rebates program, where the instant rebate is applied at the point of sale (POS) through participating home improvement retailers, as well as downstream rebates that allow homeowners to apply directly, such as the case with several programs managed by CCAs. Other midstream programs where use of a certified contractor network is required — such as TECH Clean California or High-Efficiency Electric Home Rebate Act (HEEHRA) Phase I — were excluded, as well as many other local or regional programs, including BayREN rebates and rebates from various municipal utilities, CleanPowerSF, and others.

First, the team compiled a list of HPWH rebates available to California homeowners that are applicable to DIY installations versus contractor-only rebates. The team then evaluated available program data from two HPWH rebate programs, offered by Peninsula Clean Energy (PCE) and Silicon Valley Clean Energy (SVCE), which support and track DIY and contractor-led installations. The data used in the analysis include installation costs, project timelines, and customer demographics, where available.

The research team acknowledges that both PCE and SVCE serve similar geographic territories and customer demographics within the Bay Area, resulting in very similar data for each program. Many program administrators — including the Golden State Rebates program and Redwood Coast Energy Authority (RCEA) — do not yet collect data on whether a homeowner self-installed or used a licensed plumber or electrician. However, qualitative data was gathered via interviews with RCEA and other stakeholders on the likely cost savings of a DIY versus non-DIY project, to confirm that the findings in PCE and SVCE data reflected similar trends. The research team also collected cost data from interviewees, which is reflected in the report's findings.

Next, to supplement the program data analysis, the project team reviewed data from low-income programs, such as the Energy Savings Assistance (ESA) programs, as well as findings from the recent CalNEXT Residential Housing Characteristics Study (Project # ET22SWE0022). The goal was to assess the potential market opportunities within low-income households and DACs for supporting DIY projects, with an eye toward information on unique HPWH barriers, project costs, electric upgrade prevalence, and more.

Assessment and Review of Existing DIY Installation Resources and Technical Guides

The project team collected and reviewed existing training materials for DIY HPWH installations through research, interviews, and subject matter expert referrals. These included technical assessments of current HPWH solutions, recommended DIY HPWH installation materials and tools, and additional elements needed to achieve quality HPWH installations. The research also involved documenting and referencing manuals and best practice guides for installation and maintenance to support continuous high-efficiency operation and product longevity, including an assessment of their

accessibility to homeowners. These resources were sourced through interviews with expert advisors from Barnett Plumbing and the Ortiz Group; program administrators at PCE, SVCE, and TECH Clean California; researchers on DIY HPWH solutions at NEEA; and homeowners completing DIY installations. The goal was to collect a sufficient range of resources that served multiple purposes and formats, including videos, tutorial-style step-by-step guides, and technical installation manuals. Factors used to evaluate accessibility include the availability of non-English language versions, free or fee-based accessibility, and the technical complexity of the content. These resources informed the development of a Public-Facing DIY Digital Fact Sheet and Guide (Appendix A), which consists of the following four resources:

1. Deciding on a Professional or DIY HPWH Installation
2. DIY HPWH Pre- and Post-Installation Steps
3. Inventory of Best Practices and How-To Guides for HPWH Installation
4. Tools and Materials List for a DIY HPWH Installation

The Deciding on a Professional or DIY HPWH Installation guide outlines what makes a HPWH installation relatively simple or complex for someone considering a DIY approach. The two page guide provides a summary of site-specific limitations for homeowners, informing them of the level of difficulty of their installation and where licensed contractors would be required for either 240V or 120V HPWH installations. It also maps a customer's journey through a DIY HPWH installation, identifying tips and potential challenges throughout the process. The Inventory of Best Practices and How-To Guides offers a detailed overview of existing materials to support homeowners during the DIY installation process — from YouTube videos to step-by-step guides and more. The Tools and Materials List for a DIY HPWH Installation details all commonly used tools and materials for a DIY HPWH installation, specifying what is needed in certain installation scenarios and what might be optional. On all customer-facing materials, the team consulted with a plumbing contractor, Barnett Plumbing, and a volunteer-led HPWH installer and trainer, SunWork, to get input from a technical installation perspective. The team also worked with incentive program administrators and homeowner interviewees to gather input on customer education and outreach needs.

Homeowner and Stakeholder Interviews and Feedback

The research team conducted robust outreach to stakeholders, alongside a series of interviews with homeowners who had completed DIY HPWH installations. Leveraging relationships with PCE, SVCE, and RCEA, opportunities for paid interviews were distributed to customers who had confirmed they had self-installed a HPWH. Additional outreach was conducted via the California Building Decarbonization Listserv, a service list managed by the Building Decarbonization Coalition. Several of the listed stakeholder groups also served as advisors and reviews on the report deliverable. Stakeholder interviews informing this research are presented in Table 3.

Table 3: DIY HPWH Stakeholder Interviews

Interviews	Description
Fifteen interviews with DIY HPWH homeowner installers	These spanned the Bay Area — specifically customers of Peninsula Clean Energy and Silicon Valley Clean Energy; rural Humboldt County customers of Redwood Coast Energy Authority; and VEIC colleagues.
Seven interviews with HPWH rebate program administrators	Included the San Diego Gas & Electric (SDG&E) team administering the Golden State Rebate program, Peninsula Clean Energy, Silicon Valley Clean Energy, Redwood Coast Energy Authority, Truckee Tahoe Public Utilities District, the City of Palo Alto, and TECH Clean California.
Four interviews with local permitting and city officials and experts	Included the City of Palo Alto Utilities, City and County of San Francisco, the TECH Clean California team that convened a Building Department Working Group over a year as part of a permitting streamlining pilot project, and the SunWork organization which shared early results from a collaboration they are a part of with San Francisco Bay Area Planning and Urban Research Association (SPUR) collecting permitting requirement data across all 657 Bay Area cities and towns (spanning nine counties).
Five subject matter expert interviews	Included Barnett Plumbing (a leading HPWH installer in Northern California); Reuben Veek (Executive Director for volunteer-led HPWH installer organization SunWork); Tom Kabat (DIY installer as well as BAAQMD Board Member and SunWork volunteer); the Ortiz Group (CalNEXT partner and low-income expert); and VEIC's Lead Emerging Opportunities Manager and HPWH expert, Jake Marin.

Interviews with the above stakeholders informed the findings throughout this report. Feedback was directly incorporated into the creation of the Public-Facing DIY Digital Fact Sheet and Guide (Appendix A). Through interviews and follow-on engagements, the team gathered stakeholder feedback on:

- DIY installation motivations for homeowners
- DIY HPWH project costs, rebate availability, and time duration
- DIY technical installation challenges and recommendations
- Useful and accessible installation-guiding resources and best practices guides
- Permitting and inspection requirements and challenges
- Recommendations for additional resources and market needs

Findings

This section covers findings from the project team's research. These findings can support the DIY HPWH installation customer journey for single family owner-occupied homes — and are included in an order that reflects that process and journey.

Findings from research encompass:

1. Technical steps and evaluation of DIY HPWH installations
2. DIY HPWH installation costs and rebate program analysis
3. Permitting and code requirements for DIY HPWH installations
4. DIY HPWH Installation Guides, Process Flow Chart, and Fact Sheet

1. Technical Steps and Evaluation of DIY HPWH Installations

This section provides an overview of the technical steps and factors a homeowner must consider for a DIY HPWH installation. The evaluation steps provide insights regarding any upgrades the homeowner will need to make, tools they will need to complete the project, and any professional assistance that might be required, as well as general feasibility of the project. This includes a specific focus on electrical upgrades related to wiring and panel capacity, HPWH sizing, and necessary tools and materials — all areas that homeowners and interviewees highlighted as primary technical challenges for homeowners to assess the relative complexity of a DIY installation.

Motivation for a DIY Approach

The most common motivation interviewees cited for taking a DIY approach was cost savings, but homeowners also identified several other reasons for pursuing a DIY installation, including:

1. Lower Cost: This was particularly salient in more complex installations and with 240V installations, where homeowners reported receiving quotes as high as $12,000 to $14,000 for a HPWH installation from plumbing contractors. All 15 interviewees cited that this cost differential with a DIY installation was sufficient motivation for pursuing a DIY installation, despite the lack of accessibility to large incentives and rebates through TECH Clean California and HEEHRA.
2. DIY Technical Proficiency: Several homeowners cited that they were highly technically proficient based on past experience, such as construction or engineering work, and expressed pride in doing as much DIY work as possible on their home. The interviewees appreciated the opportunity to better understand the operations and maintenance of a HPWH gained through a more involved DIY installation experience.
3. Existing Solar Systems or Electrification Appliances: Some homeowners were motivated by the fact that they already had solar. This was a motivation for selection of a HPWH versus a gas alternative, as opposed to a DIY versus a non-DIY consideration. However, multiple homeowners who had solar systems were also more comfortable with the technical aspects of a HPWH installation.

4. Expediency and Timing: In rural areas of RCEA's territory in particular, homeowners typically opted for DIY installations of new appliances given long time frames for getting a licensed contractor who has HPWH experience out to a site. This was particularly prevalent for short-timeline replacements, such as when equipment fails.

Complexity of a DIY Installation

The project team identified the core characteristics of a complex DIY HPWH installation, listed below, based on interviews with DIY homeowner installers, plumbing contractors, city permitting offices, and other expert stakeholders.

- **Panel Capacity Considerations:** A plug-in 120V model simplifies a HPWH installation, though some jurisdictions require a dedicated circuit for a 120V HPWH, even if they are designed for a shared circuit. Additionally, for existing dwelling retrofits, electrical code allows manual load estimates based on square footage and appliance wattage, or meter interval data-based calculations. Though meter-based calculations are more accurate, and often reveal more electrical capacity, some jurisdictions do not allow them anymore, including if a household has solar. Upgrading an electrical panel and adding new circuits is possible to DIY, but it can be challenging.
- **Identifying Water Heater Size and Location Constraints:** Properly sizing a new HPWH tank is critical to ensure the new equipment meets the home's hot water needs, especially when using a 120V model. The physical space available and the equipment's location in the home should also be considered, due to the HPWH's additional height clearance, noise levels, and proximity to a drain. Homeowners may be unaware of these considerations, or unsure how to adequately size the new storage tank.
- **Plumbing Materials:** In some jurisdictions, crosslinked polyethylene (PEX) is not allowed for piping, and homeowners must use copper piping instead, necessitating soldering/sweating copper pipes or purchasing pricier flexible copper.
- **Gas Capping:** Although it's technically uncomplicated, some jurisdictions disallow DIY gas capping due to gas leak safety or emissions reasons. Homeowners should have inspectors check that the gas line is safely capped. The venting for the gas water heater will also need to be capped with a sheet-metal cap.
- **Vehicle Protection:** Some jurisdictions only require a bollard in a garage if the HPWH is front and center, while others require it in any garage location.

These characteristics were incorporated into Figure 3, capturing the key elements of a "simple" installation relative to a "complex" installation. They are also represented graphically in the report's customer-facing materials, included in the Deciding on a Professional or DIY HPWH Installation guide in Appendix A.

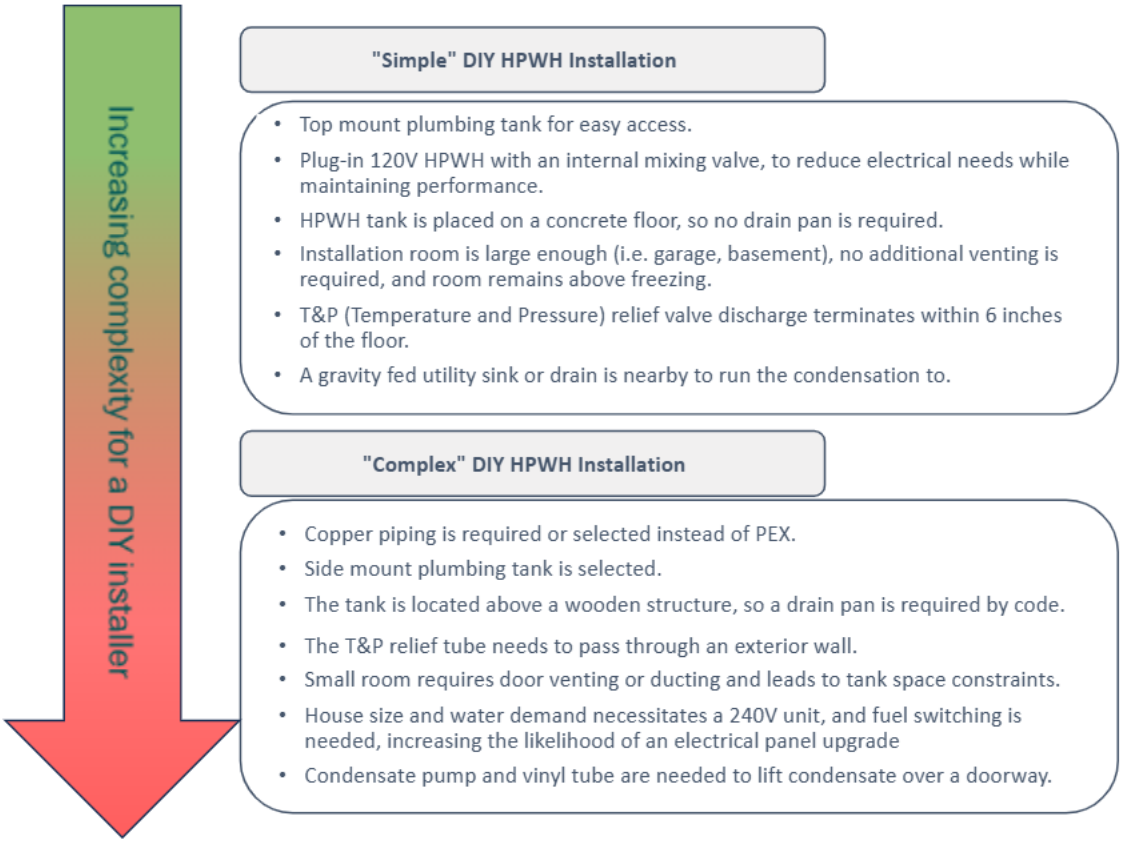

Figure 3: Complexity of a DIY HPWH installation.

Electrical Wiring and Panel Capacity

The capacity of a home's electrical panel is typically a determining factor in the level of complexity for a homeowner to complete a DIY HPWH installation. Unless the new HPWH is replacing an existing 240V electric water heater, a homeowner will need to assess electrical system layout options for running a new 240V circuit to the water heater location or alternatively consider a 120V plug-in model. In addition, limitations on electrical panel capacity, i.e., amperage rating, or lack of sufficient space in the panel for a 30-amp breaker, make a project more challenging and will likely require working with an electrician to upgrade the electrical panel to allow for the HPWH installation. The Pacific Northwest National Laboratory (PNNL) has developed a Heat Pump Water Heater Installation Tool that includes an Electric Panel Calculator as shown in Figure 4 below, helping homeowners evaluate whether their existing electrical infrastructure is sufficient for a HPWH (Pacific Northwest National Lab, 2024). Use of this tool requires developing an estimate of the home's electrical load with the following inputs:

1. The amperage rating of the existing panel, often listed on the main breaker of the electrical panel
2. The square footage of the living area in the home

3. The number of kitchen countertop circuits serving small appliances and the number of laundry circuits as a base indicator of the total number of circuits and electrical loads in the home2
4. A list of all electrical appliances in the house — including ovens; stovetops; electric vehicle (EV) chargers; and heating, ventilation, and air conditioning (HVAC) equipment — and optionally, the specific wattage of each appliance, which is typically listed on the nameplate rating for a larger appliance

The tool then calculates the home's estimated electrical load and provides one of three outputs regarding the panel capacity to help guide and inform the homeowner's decision:

- Panel capacity is sufficient for 240V/30-amp circuit.
- Panel capacity is sufficient for 120V/15-amp circuit.
- Recommend panel size: 200 amps. With the provided values, the panel does not have enough capacity for an added circuit.

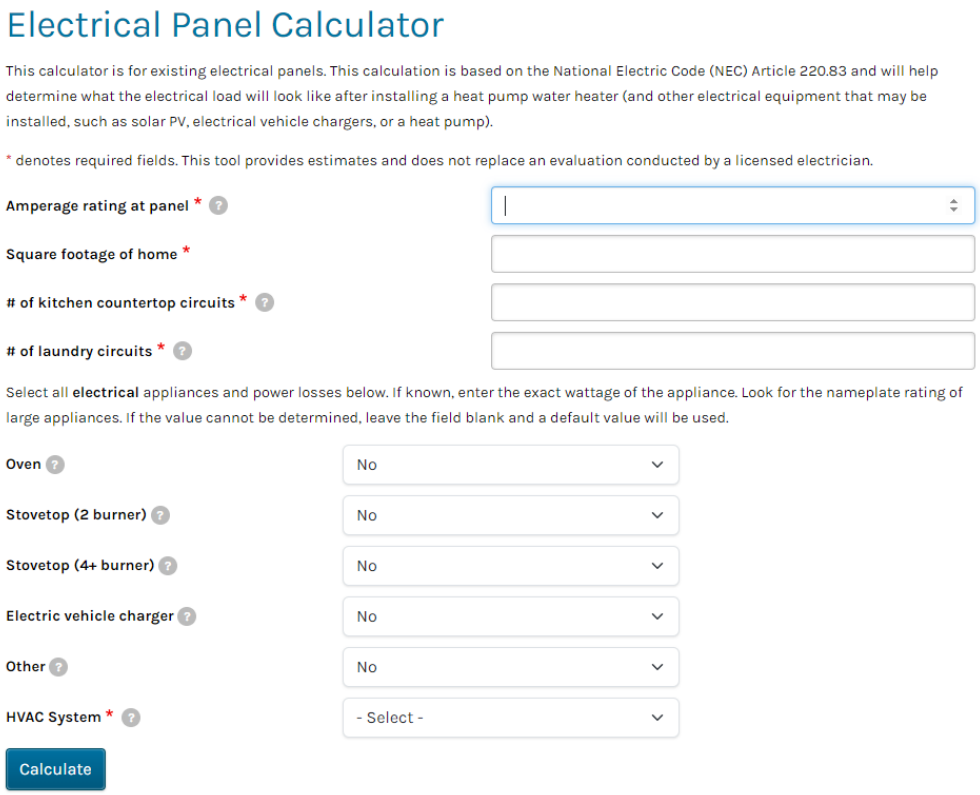

Figure 4: Sample of PNNL electrical panel calculator.

Sizing and Location of the HPWH Tank

Properly sizing a new HPWH storage tank is crucial to ensure the new equipment meets the home's water heating needs. When conventional gas or electric tank or tankless water heaters are replaced

[2] The current 2023 National Electrical Code requires a minimum of two kitchen countertop circuits and one laundry circuit.

with HPWHs, it is often necessary to install a larger tank than the original to account for reduced electric resistance backup and longer recovery times. This is especially true for 120V models because they have no backup or reduced power backup elements (NBI, 2023). Beyond evaluating sizing for hot water needs, space limitations should be considered by the installer, to ensure there is adequate room for a larger storage tank where the water heater is located.

To assist homeowners through the decision-making process for HPWH selection and installation, the PNNL HPWH Installation Tool also works to determine the right fit of HPWH model and tank size based on data provided by the user regarding the home's existing water heater, hot water usage, occupancy, and space constraints (Pacific Northwest National Lab, 2024). To provide a recommended HPWH model and tank capacity, the following data is required:

1. The location of the existing water heater, whether indoors or outdoors, in the garage, attic, basement, or elsewhere
2. The physical space available in the new HPWH location to support common requirements of six feet and six inches of height clearance to account for air filter clearance, a three-foot diameter to provide ease of access to all fittings and control panel, and positioning to allow the exhaust outlet to be at least eight inches from a wall, door, or ceiling
3. Distance greater than eight feet from any thermostat
4. Proximity of the water heater location to living or bedroom spaces where sound and vibration at similar levels to a dishwasher or dehumidifier might be unacceptable
5. Proximity of a drain available near the existing water heater for condensate, ideally directly adjacent or in an adjacent room
6. The existing water heater type, i.e., fuel type, storage, or tankless
7. The existing water heater tank size, found on the nameplate or Energy Guide label;
8. The existing water heater input rate, found on the nameplate or Energy Guide label.

While sizing and location issues are not always deciding factors, they are crucial to consider for a successful installation. According to feedback from interviews, improper sizing due to a lack of knowledge on how to account for water heating needs is one of the most common mistakes made by DIY installers. Interviewees noted that when DIY installation was their first experience with HPWH models, they encountered unexpected issues such as difficulties transporting the larger tanks within the home and operational noise.

Tools for DIY Installations

To be technically prepared for a safe, effective, and high-quality installation, there are several tools and materials that a homeowner will need. A commonly cited and in-depth resource covering necessary tools and materials is the NEEA Hot Water Solutions DIY installation guide (NEEA, undated).

Interviewees suggested that, while lists such as NEEA's (Table 4), are a great starting point for homeowners, it is useful to familiarize oneself with local permitting office and code requirements in advance of installation, to ensure specific materials are allowed. One homeowner shared that an

inspector stated that he could not use PEX (a popular plastic alternative to copper piping) for the hot water outlet piping in his installation, and instead required more expensive copper piping and different installation methods. Interviewees confirmed that some jurisdictions require copper piping for water heater installation, largely because of comfort with copper, it's known durability, and performance longevity.

Additionally, several interviewees cited that it would be helpful if some of the more expensive tools were rentable, either from existing tool libraries, local appliance retailers like Lowe's or Home Depot, or other tool rental facilities.

Table 4: DIY Kit Components, Tools, and Materials

Tools	
Commonly Used	**Site-Specific**

• Pipe cutter or hacksaw
• Measuring tape
• Plumbers pipe wrench
• Step ladder
• Crescent wrench
• Garden hose to drain existing tank
• Gloves (optional)
• Level (optional)
• If installing a 240V:
  o Electrical current tester or voltmeter
  o Basic electrical tools (e.g., wire stripper, pliers, screwdrivers)
	• Hand truck to simplify removal of the existing tank and HPWH replacement.
	• Duct crimper
	• If using copper pipe:
	  o Pro press tool (makes copper fittings easier, but expensive. Prime candidate to rent.)
	  o Tubing cutter (hand or cordless) (optional)
	  o Reaming pen (optional — for "deburring" copper tubing)
	  o Brass wire brush (optional — to prep copper pipe for sweat)
	• Propane torch (optional — for sweating copper pipe. Requires the most skill.)

Materials	
Commonly Used	**Site-Specific**
• Water supply pipes • Pipe and fittings for temperature/pressure relief valve (SharkBite fittings are common for DIY plumbing jobs) • Shutoff valve • PVC pipe and accessories for condensate lines • PVC connectors, threaded for condensate outlet connection (both 45˚ and 90˚ elbows) • Pipe hangers • PVC glue • Pipe insulation • Earthquake straps	• Condensate pump (optional) • Clear vinyl tubing, sized for condensate pump and of sufficient length to reach drain or to tie into existing condensate line (optional) • Tubing hangers (optional) • Drain pan to sit beneath unit (new unit may have a larger circumference than the existing tank, optional) • Thermal expansion tank (required for closed plumbing systems and/or local code) • Stand (if required by local code) • Strut channel or wood blocking (for wall clearance if required by manufacturer; check installation instructions) • Bollard or wheel stop block (if in a garage and required by local code) • If using copper pipe:

- Shims
- Rags or old towels to wipe up any water spills
- If replacing a gas water heater:
    - Brass gas valve outlet cap
    - Yellow Teflon tape on gas pipe threads
- If installing a 240V:
    - Electrical tape
    - Wire nuts
    - Lead-free solder and flux (optional if using copper pipe — for copper pipe sweating)
- Thermostatic mixing valve (example of an easy-to-install version being the AM300 DirectConnect Series Mixing Valves kit) (optional — many 120V HPWHs have an integrated thermostatic mixing valve)

Source: (NEEA, undated), SunWork, Interviews

Call Out Box: DIY HPWH Retrofits as an Opportunity for Low-Income Households

As a low-cost alternative to professional installations, DIY HPWH installations can be a good fit for households facing financial constraints. While the cost savings of a DIY approach might resonate with some low-income households, many of the known major barriers to heat pump adoption for low-income Californians might be exacerbated in a DIY scenario.

The CalNEXT DAC HTR Statewide Single-Family Housing Characteristics Study (Krishpinovich, et al., 2024) surveyed 300 single family homes across California, highlighting some of the key challenges faced by households in DACs. Additionally, the CalNEXT Residential Housing Characteristics Study (Solorio, et al., 2023) identified several demographic and building stock characteristics for low-income communities and residences that might make a DIY installation more challenging. Findings from these two studies include:

- Nearly two-thirds of homes in DACs had an electrical panel size of 100-amps or less, which may necessitate a circuit splitter or a costly panel upgrade for an electrification retrofit.
- Language barriers and lack of internet access can reduce awareness of electrification programs. This might reduce the likelihood that a homeowner would proactively seek out a HPWH solution, let alone decide to undertake a DIY installation.
- Low-income households have relatively high energy-cost burdens and are more likely to have natural gas appliances, making the concern around bill impacts of fuel substitution more prevalent.
- Low-income residences are about 20 percent smaller than the general population at 1,311 square feet compared to 1,643 square feet, which may introduce space constraints when upsizing a water heater tank size for a HPWH installation, as well as potential noise and ventilation issues.

Similar challenges appear in data from the TECH Clean California Low-Income Direct Install Pilot, which cofunded 433 electrification projects with the ESA program. These projects targeted households with incomes below 80 percent of the area median income (AMI) that faced remediation and minor home repair cost barriers. While the projects were intentionally selected for this pilot due to higher remediation costs and complications, the pilot highlights the significant remediation needs of low-income households. The average cost of remediation and minor home repair costs for participating households was $6,290. This work could make DIY HPWH installations more complicated and expensive compared to replacing like-for-like systems.

As discussed in the report's Background section, California needs robust solutions for scaling heat pump deployment in low-income households, including for residents who are not able to copay for a HPWH retrofit (Pickrell, 2024). Given the low cost of a DIY project relative to a contractor-led project, one potential solution could be supporting DIY or assisted DIY installations where it's possible — acknowledging that many low-income homeowners are potentially well acquainted with DIY work in their own home. Targeted interventions and support for pre-electrification work and remediation could help eliminate or reduce major barriers and could be paired with support for low-cost DIY HPWH installations, for example. At a minimum, supporting lower-cost DIY projects could open up incentive and rebate program budgets to more effectively support low-income households.

Finally, educating consumers about electrification health, safety, and non-energy benefits in culturally relevant manners, and solving for policy challenges such as electric rate reform, will continue to be crucial for both DIY and non-DIY solutions for low-income heat pump adoption (Krishpinovich, et al., 2024)

2. DIY HPWH Installation Costs and Rebate Program Analysis

This section provides an overview of DIY installation costs, compares them with non-DIY project data, and reviews the HPWH rebate landscape in California and various programs' accessibility to homeowners to compare DIY versus non-DIY project cost differentials. The project costs among DIY and contractor-led installations of both 120V and 240V HPWHs can differ due to several variables, including equipment costs, installation complexity, and rebate availability. While some rebates are only accessible through contractors, potentially increasing the total achievable rebate amount, there are several cost savings associated with DIY installations that may help the homeowner ultimately achieve greater savings overall.

Given that some incentives are only available to contractors for contractor-executed installations — which offer the potential to drive the cost to the consumer low enough to make up for the higher installation prices — the objective was to understand the cost differentials between non-DIY and DIY installations for both 120V and 240V HPWH models. This included an analysis of how those various cost differentials shift between pre-rebate total project costs and post-rebate out-of-pocket costs to the homeowner. The project team also investigated the key drivers for a lower or higher cost installation of a 240V unit.

Comparison of DIY and Non-DIY Project Costs

Through interviews with DIY installers, the project team collected data on typical project costs, including the HPWH unit, installation supplies and tools, and permitting fees. The team also collected data on contractor quotes that some DIY installers received prior to undertaking their DIY project and analyzed TECH Clean California contractor project cost data to compare average non-DIY project costs. The figures below display the cost differentials between DIY and non-DIY installations, using DIY interviewee cost data compared to average contractor project cost data from the TECH Clean California program.

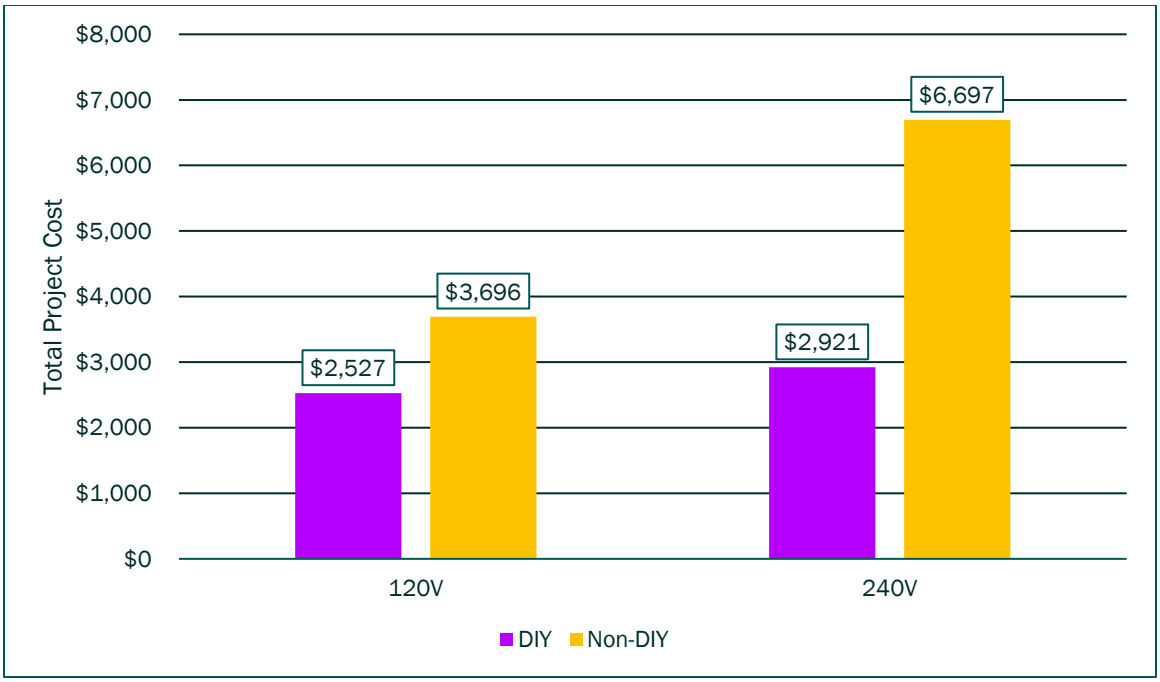

Figure 5: Pre-rebate cost comparison of DIY versus non-DIY installation for 120V versus 240V units.

As shown in Figure 5, homeowners achieved an average $3,776 lower total cost for a 240V HPWH installation by pursuing a DIY path compared to TECH Clean California contractor-led installations. This was primarily due to the time and cost of additional plumbing and electrical work, as well as the markup from the contractor on materials. While installation costs are already high when professionally installed, there is a risk of cost inflation in part due to large contractor-accessible incentives, such as the TECH Clean California rebate (VEIC, 2024). Several DIY homeowners interviewed expressed their frustration with the high quotes they received from contractors, ranging from $4,500 to $12,000, which were often double or even triple the pre-rebate total costs of their DIY installations — including tools, permits, and materials — which ranged from $1,100 to $4,000. It is notable that the average cost of the quotes received by these homeowners, who did not pursue them and opted for the DIY route, was higher than the average contractor-led TECH Clean California project cost. The average project quote was likely driven up by the complexity of the projects, several of which required extensive home upgrades and modifications, such as upgrading electrical panels and adding ventilation and ducting.

Through interviews, homeowners shared information about the details of their specific projects. For example, a project that was originally quoted at $12,000 was complex and involved the replacement of an existing gas water heater that was located in a small utility closet in the center of the home. This required extensive home modifications, including the addition of ventilation, ducting, a condensate line, and new 240V wiring. While it took the homeowners an estimated 30 hours, they were able to install the HPWH and complete the project themselves for $3,500 in total, resulting in approximately $8,500 in cost savings. Additionally, the homeowners noted that they had recently installed a 120V combination washer and heat pump dryer unit in their nearby laundry room, which freed up the 240V outlet from the previous dryer. This simplified the installation, as they were able to repurpose the 240V outlet wiring and breaker from the electrical panel. The homeowners then received a $2,000 Peninsula Clean Energy (PCE) rebate, leaving their final costs at $1,500. On the

other end of the spectrum, another homeowner was quoted $4,500 for a relatively simple installation, which included running a new 240V wire and adding breakers into the electrical panel. The homeowner opted for the DIY route, ultimately spending two days and $2,800 in total, including $2,400 for the HPWH, $200 for plumbing supplies, and $200 for electrical supplies. Once all available rebates were applied, the total project cost was fully covered, and the homeowner was left with no remaining out-of-pocket costs.

While the greatest savings are often seen with 240V HPWH models, the cost analysis shows an average savings of $1,169 with a DIY 120V installation as well. On average, 120V units cost a few hundred dollars more than 240V units due to the integrated thermostatic mixing valve and the frequent need for a bigger tank (NBI, 2023). Even with these additional costs, given the simplicity of installation, a homeowner will likely still save money with a DIY installation.

As mentioned above, while total project cost comparisons show significant savings through a DIY approach, the project team set out to evaluate the rebate options and availability for both project types, and how those incentives ultimately affect remaining homeowner costs. Figure 6 shows an analysis of the rebate options and levels for an average cost of both DIY and non-DIY installations of a 240V HPWH model.

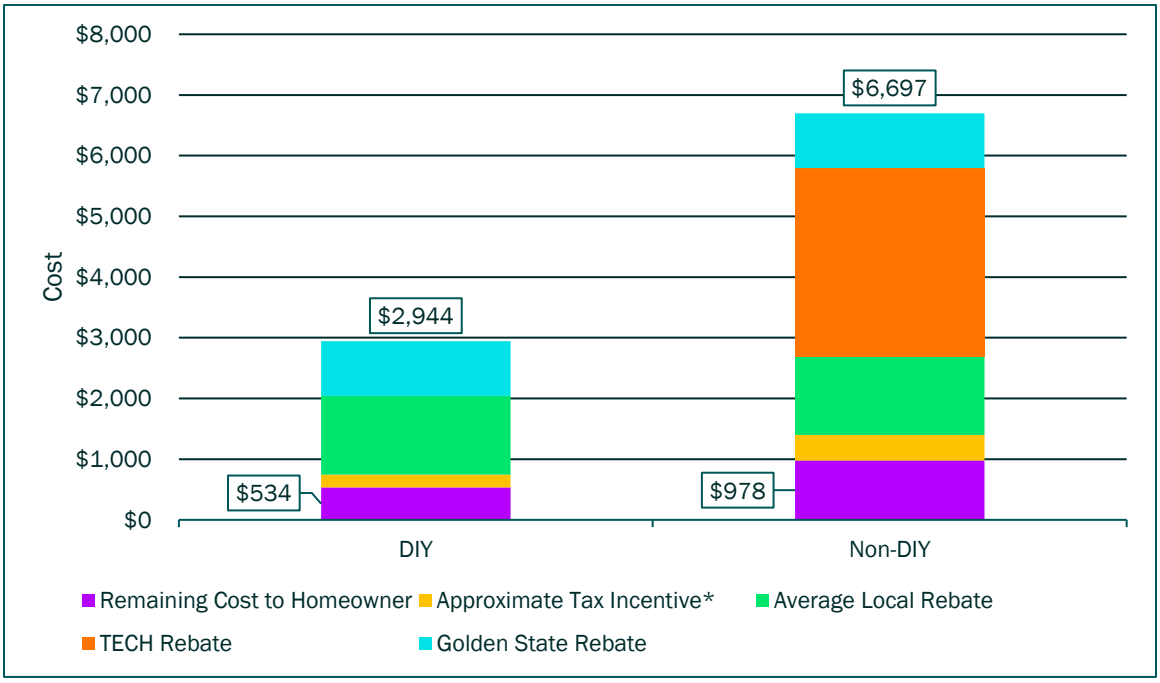

Figure 6: Post-rebate cost comparison of DIY versus non-DIY install.

*Above estimated "Approximate Tax Incentive" is calculated based on remaining out-of-pocket, post-rebate costs, acknowledging there are multiple methods to apply for the 25C tax credit.

The total achievable rebate amount for a HPWH installation varies based on location in California. While some incentives are available statewide, such as the Golden State Rebate and the TECH Clean California rebate, several local agencies have additional rebates available to homeowners that range from $600 to $2,000. A comprehensive list of all single family accessible HPWH rebates is listed

below in Table 5. For the purposes of the comparison in Figure 6, an average local rebate of $1,300 was assumed. Both DIY and contractor-led projects have access to the $900 POS Golden State Rebate, most local rebates, and the federal 25C tax incentive. The key difference in the rebate landscape between DIY and non-DIY projects is the $3,100 TECH Clean California rebate, which is only accessible to contractors. As shown by the data represented in Figure 6, even with the significant TECH Clean California incentives, non-DIY contractor-led projects are, on average, more expensive post-rebate than similar DIY projects.

These findings are supported by an additional case study using data from PCE. PCE provides local incentives that are directly accessible to homeowners and is the only program administrator interviewed that tracks whether the HPWH was installed by a contractor or as a DIY project. PCE's dataset contained nearly 1,300 project installations, split between contractor and DIY installations. Of the total program installations, 34 were DIY and 251 were contractor-led. The project team found that, on average, a DIY HPWH installation without a panel upgrade cost $3,727, with an average incentive of $2,000 offered by PCE. The average project cost of a contractor-led installation without a panel upgrade was $7,961. DIY installations paired with a panel upgrade cost $7,042[3] on average, with an incentive kicker of $1,000, bringing the total incentive to $3,000. Contractor installations with a panel upgrade cost $11,879 on average. In both cases, DIY installations saved homeowners between $4,000 and $5,000 dollars compared to contractor-led installations.

The findings from the cost and rebate analysis above demonstrate that, while both rebate availability and project complexity greatly affect project costs, DIY installations almost always result in lower out-of-pocket costs to the homeowner — despite variance in incentive availability across jurisdictions. In addition, DIY installers' experiences show that as project complexity increases, so does the difference between contractor quotes and total DIY costs.

Sample DIY Installation Cost Analysis

The following analysis reflects data shared by an individual homeowner who documented the cost of all materials associated with the installation and the labor hours required for each step of the installation.[4]

The entire process included listening to webinars, reading installation manuals, applying for rebates, installing the HPWH unit, and following the associated permitting and inspection processes. Excluding the actual installation time, one of the most significant impacts on the homeowner was the permitting and inspection time, which was 24 hours for a 240V HPWH model and 23 hours for a 120V model.[5] While time-intensive, the total project cost averaged just over $2,800. This is a substantial level of cost savings compared to the average project cost for a HPWH installation within the TECH Clean California program of $6,217 to $6,697 for 240V models and $6,097 to $3,696 for 20V models (TECH Clean California).

[3] PCE panel upgrade incentives require panel installation by a licensed electrician.

[4] Specific costs and time associated with electrical wiring and the breaker for the 240V HPWH were not included in the installation documentation. The absence of these costs likely contributed to the small differential in 120V and 240V HPWH costs and installation time.

[5] Example installation time included unique scenarios, such as 1 hour for physical modifications to a doorframe due to HPWH diameter and, separately, 1.5 hours to prep the HPWH and transport it up a set of stairs.

Table 5: Sample Project Cost for DIY HPWH Installation

Cost Category	Average Cost (120V and 240V)
Permit	$77
HPWH Unit Cost	$1,816
Electrical Components (straps, electrical bonding, outlet duct)[6]	$87
Plumbing Components (plumbing supplies, shark bite connectors, copper tubing, hydrostatic valve, condensate trap, duct reducer)	$618
Monitoring and Control, Insulation, Antivibration Pad	$241
Total Estimated Project Cost	**$2,840**
Eligible Rebates – Golden State Rebate ($900), Silicon Valley Clean Energy Rebate ($2,000)	($2,900)
Post-Rebate Cost	**$0**
Cost Category	**Average Hours**
Labor Category	Average labor hours
Preliminary Research	1.5
Order/Pickup, Rebate Application	4
Installation, Permitting/Inspection	18
Total Estimated Hours	**23.5**

Rebate Programs Directly Accessible to Homeowners

Rebates available to single family homeowners were identified using the Switch Is On website (The Switch Is On). The terms, conditions, and rebate application process for each provider were reviewed to confirm whether DIY installations are eligible for the rebate. Table 6 outlines the rebate levels, the

[6] Although typically required for a gas water heater to 240V HPWH conversion, no electrical wiring or 240V breaker were identified in the reported installation costs.

ability to ”stack” with other rebates, i.e., layer and combine for a single measure, eligibility requirements based on regions or service territories, and any specific performance criteria.

Table 6: Single Family Homeowner Accessible HPWH Rebates

Rebate Provider	Standard Rebate	Income-Qualified Rebate	IOU Territory or Territories	Minimum Efficiency Requirement	Stacking Ability
City of Shasta Lake	$350	N/A	Pacific Gas & Electric (PG&E)	2.2 EF	No
Golden State Rebates	$500–$900	N/A	All	3.30 UEF	Yes
Los Angeles Department of Water and Power (LADWP)	$1,500	N/A	N/A (LADWP)	3.30 UEF	Yes
Lassen Municipal Utility District (LMUD)	$350	N/A	N/A (LMUD)	2.2 EF	No
City of Lodi	$200	N/A	N/A (Lodi Energy Center)	N/A	No
City of Moreno Valley	$120–$140	N/A	Southern California Edison	2.0 EF	No
Pasadena Water & Power (PWP)	$400–$450	N/A	N/A (PWP)	N/A	No
Peninsula Clean Energy	$2,000	$3,000	PG&E	N/A	Yes
Plumas-Sierra Rural Electric Co-Op (PSREC)	$150	N/A	N/A (PSREC)	0.93 EF	No
Redding Electric Utility (REC)	$750	N/A	N/A (REC)	2.2 EF	No
Redwood Coast Energy Authority	$600	N/A	PG&E	3.30 EF	Yes

Rebate Provider	Standard Rebate	Income-Qualified Rebate	IOU Territory or Territories	Minimum Efficiency Requirement	Stacking Ability
Silicon Valley Clean Energy	$2,000	$3,000	PG&E	N/A	Yes
Sonoma Clean Power	$700	50% Project Cost up to $10,000	PG&E	N/A	Yes
Turlock Irrigation District Water & Power (TIDWP)	$350	N/A	N/A (TIDWP)	2.0 EF	No
City of San Jose	$1,000	$2,000	PG&E	N/A	Yes
Federal Tax Credit	30% of project cost, up to $2,000	N/A	All	ENERGY STAR® (3.30 UEF)	Yes

Based on this scan, 15 programs across California offer HPWH rebates that are available directly to homeowners pursuing DIY installations, in addition to federal tax credits. At a minimum, every homeowner in an IOU territory — almost 35 million people — has access to rebates for DIY installations through the Golden State Rebate program, which can be stacked with many of the local rebates listed above.

If a DIY installation approach is feasible for homeowners in these program jurisdictions, they could see significant reductions in HPWH installation costs through a combination of rebates and reduced labor costs. To support DIY installers, rebate program administrators and policymakers should assess the accessibility of incentives available directly to homeowners. It is also particularly important to minimize the "application burden" associated with applying for incentives — which can include complex application processes or long processing times to receive post-installation rebates, for example. This challenge exists for many rebate programs, where contractors or customers are forced to float costs for weeks to months while waiting for a reimbursement (VEIC, 2024).

3. Permitting and Code Requirements for DIY HPWH Installations

The project team identified challenges with and variances within HPWH permitting processes through a review of California state and local building, plumbing, and electrical code case studies, as well as interviews with DIY installers and permitting offices. Substantiated by existing research on permitting streamlining, interviewees also identified opportunities to simplify, clarify, and improve accessibility of permitting processes for HPWHs. The interviews sought to surface the common mistakes, challenges, and guidance needed to reduce the burden on homeowners to apply for and

secure a permit, receive eligible rebates, and retrofit existing water heaters — typically gas models — to more efficient electric HPWH models.

Permitting Likelihood and Motivations

The project team's research aimed to understand the scale of how often permits were being pulled for water heater replacements, and the "pain points" that were discouraging HPWH projects from getting permitted. Analysis of permit data indicates that only a small fraction of water heater replacement installations are permitted across five Bay Area cities — San Jose, Palo Alto, Oakland, San Mateo, and Richmond — ranging from 3.3 to 20 percent.[7]

According to project interviewees, the primary motivation for obtaining a permit for a HPWH installation is when proof of permit is required to receive a rebate or incentive. While permitting a project is important to ensure safe and quality installations, numerous interviewees highlighted that requiring a permit places an additional burden on a person installing a HPWH relative to a person installing an alternative water heater model. This can be a deterrent for certain homeowners worried about complexity or cost. For example, information from customers in the Redwood Coast Energy Authority (RCEA) territory relayed that HPWH permits can cost between $300 and $400, which was unexpectedly high for many DIY installers and homeowners, even after the $700 rebate from RCEA and the $700 to $900 rebate from Golden State Rebates were applied at the point of purchase at their local retail store.

To make HPWHs accessible and attractive for the more than 50 percent of Californians who are likely to DIY their water heater replacement, homeowners need to both be motivated to participate in a rebate or incentive program and able to access a simple and transparent permitting process, if required for participating in the program. Several homeowners highlighted that making "common mistakes" or "key considerations" for HPWH installation requirements available on rebate and incentive webpages would be an effective strategy — as captured in the project team's work on customer-facing materials.

Permitting Variance and Challenges

The following case studies highlight learnings from existing research, such as the TECH Clean California Permitting Pilot, as well as interviews with homeowners who completed DIY installations, rebate program administrators who support and oversee permitted projects, and city officials who support permitting processes. This research revealed variance in individual jurisdictions interpretation and implementation of state and local building code, increasing complexity for installers. The variation and common challenges captured in this section are integrated into the Public-Facing DIY Digital Fact Sheet and Guide (Appendix A), specifically the Deciding on a Professional or DIY HPWH Installation two-page guide.

Compiling these common mistakes started with reviewing sample permitting and code requirements, focusing on existing research that had been conducted through TECH Clean California's Permitting Streamlining Pilot and by the San Francisco Bay Area Planning and Urban Research Association (SPUR).

[7] This data is currently being conducted by the San Francisco Bay Area Planning and Urban Research Association (SPUR), shared pre-publication via written correspondence,

TECH CLEAN CALIFORNIA PERMITTING PILOT FINDINGS

The TECH Clean California Permitting Pilot assessed permitting barriers faced by HPWH installers in California and developed strategies to overcome these barriers alongside supplemental resources for HPWH installers and building inspectors (TECH Clean California, 2024). The study also identified specific challenges and site installation requirements that are often included in local jurisdictional codes, and that create challenges for HPWH installations. Examples of variations across local jurisdictions that the Pilot team identified included:

- Natural gas lines must be capped if the original water heater was gas-fueled. In many jurisdictions, you need a permit to cap a gas line, or you may need to hire a professional to oversee or conduct the installation.
- Many HPWHs are required to have a dedicated 240V/30-amp electrical line.[8] Electrical work may be required to accommodate the new electrical load if there is not an existing dedicated 240V/30-amp line near the HPWH location.
- HPWHs must also incorporate condensate waste removal and potentially an overflow basin for a condensate pump, and drainage piping.

Several of these challenges were further investigated through research and interviews. With regard to gas capping, interviewees confirmed that this can be done safely by an individual equipped with good information, though capping a gas line is often seen as a safety hazard and can be disallowed or discouraged by permitting offices without a licensed plumber involved. Additionally, a requirement for a dedicated circuit poses a barrier to DIY installations, particularly in cases where a homeowner is installing a 120V plug-in unit designed specifically for a shared circuit. Multiple 120V plug-in HPWH models are designed to function on a shared circuit. A recent field study by the New Buildings Institute found no issues with circuit tripping for their installations, where each water heater's draw was around 5 amps total — only one-third of the 15-amp circuit capacity. While installing a HPWH on a shared circuit is not contrary to California building code, many inspectors remain uncomfortable with it and require a dedicated circuit. Additional education on the 120V HPWH's shared circuit capabilities will support their proliferation in the market (NBI, 2023).

Condensate drainage for a HPWH is also simpler than for gas water heaters due to the lack of combustion products and acids, allowing condensate to be drained to a sanitary sewer or outside via a hose. Given that the condensate requirements in code are often written for gas water heaters with combustion products and acid, a DIY homeowner will want to make sure they have the right guidance and installation tutorial information on hand, whether from the HPWH manufacturer or elsewhere, to guide their installation process.

One of the results of the TECH Clean California Pilot's research was the creation of the 2022 HPWH Code Assistance Sheet (2019 HPWH Building Code Assistance Sheet, 2022). This resource provides a simplified and centralized overview of code requirements for HPWHs, which can be helpful to any homeowner getting up to speed on water heater replacement options and retrofit requirements (TECH Clean California, 2022). Additional dissemination of the Code Assistance Sheet, particularly

[8] The TECH Permitting Pilot was completed prior to the availability of the 120V plug-in HPWH models.

through rebate programs that allow DIY participation, would help ensure that homeowners can access and use this type of a resource.

SUNWORK AND BARNETT PLUMBING: PERMITTING EXPERIENCE AND RESEARCH

Several stakeholders with experience leading HPWH installations were interviewed — including Barnett Plumbing, SunWork, and DIY homeowner installers themselves. The interview with Barnett Plumbing focused on the permitting challenges and requirements associated with 120V HPWH installations. As their team highlighted, not only do permitting requirements vary based on jurisdiction, but the lack of familiarity with HPWHs sometimes causes misconceptions among permitting officials. SunWork is a volunteer-driven, assisted DIY nonprofit, which uses trained volunteers to install HPWHs in homes throughout the Bay Area and Central Coast of California, with the objective of keeping installation costs lower than traditional contractor services while still delivering quality installations. SunWork has completed over 180 HPWH installations across 10 California counties and 40 to 45 different permitting jurisdictions.

Both SunWork and Barnett relayed four key categories of challenges and variations in HPWH installation based on local jurisdictions' building department requirements that would make a project more complex for a DIYer:

1. **Condensate:** Fewer and fewer jurisdictions require special handling of condensate — though some still require that condensate be routed to the exterior of a home. Roughly half of jurisdictions in the Bay Area allow the temperature and pressure relief valve (T&P line) to terminate on the garage floor, but about half do not and require it to go to the exterior wall. That can create challenges if you need to climb through a crawl space or need to relocate the HPWH to allow for this. Additionally, because codes are often based on HVAC systems, the use of hard pipe for the condensate line can help with inspection, because it is often used for HVAC condensation.
2. **Vehicle Protection:** Many jurisdictions will require a bollard in a garage. This sometimes applies only when the HPWH is front and center and in the direct path of a vehicle, or it might be required in all cases.
3. **Shared Circuit:** Some permitting departments do not allow 120V HPWHs to be on shared circuits and require a dedicated circuit, despite certain 120V plug-in models being designed explicitly for this use.
4. **Electrical Load Calculations:** Electrical code offers several different procedures that a permit applicant can pick from to determine if there's sufficient electrical load capacity. One of the two options for adding load to an existing dwelling unit — spreadsheet-based load estimates — involves uploading load estimates based on appliance wattage per square foot into an Excel spreadsheet. The other option is a meter data analysis approach, which involves interpreting actual measured interval data. Many households see very different outcomes for each, with meter data analysis being the most accurate. However, some cities won't accept meter data analysis calculations. This can result in a higher load estimate and can increase the likelihood that a HPWH installation triggers electrical service upgrades. Additionally, 240V disconnect switches are often required to be mounted no higher than 6 to 7 inches from the floor.

With homeowners, the research team discussed core permitting challenges from a DIY perspective. In addition to reiterating the challenges mentioned by Barnett and SunWork, homeowners emphasized that because their motivation to get a permit was largely driven by rebate program requirements, standardization around a low permitting price would further enhance the incentive. While some interviewees cited permitting costs as low as $100 — two homeowners in Peninsula Clean Energy territory — several interviewees were surprised to face permitting costs as high as $500 — specifically, in Redwood Coast Energy Authority territory.

Many homeowners shared that they experienced a rather straightforward inspection and permitting process. They highlighted that finding information in a single location that included "common mistakes" or "key questions to ask your permitting office" would be very useful to other prospective DIY installers. This recommendation informed the customer-facing materials covered in this report, including the Deciding on a Professional or DIY HPWH Installation two-page guide in Appendix A.

COMMON CHARACTERISTICS, PROCESSES, AND REQUIREMENTS FOR HPWH PERMITTING

In addition to synthesizing data collected via stakeholder interviews and research, SunWork shared results from a collaborative project with SPUR that aims to document HPWH permitting requirements across all Bay Area jurisdictions. Using both sources of information to pull out key case studies, Table 7 summarizes common characteristics, processes, and requirements for HPWH permitting, highlighted with associated case studies. Many of these characteristics were also confirmed and highlighted in the recently introduced legislation Senate Bill (SB) 282, "Residential heat pump systems: water heaters and HVAC: installations."

Table 7: Difficulty Rating for HPWH Permitting Common Characteristics, Processes, and Requirements

Permitting "Level of Difficulty"	Common Characteristics, Processes, and Requirements
"Low" — Accessible and Streamlined Process	• No unique local updates to statewide water heater code requirements. • Only one permit is required, as opposed to two permits (plumbing and electrical), or a third additional building permit. • Online submittal enabled. • As few as zero (instantaneous) days are required for approval. • Permit is free or low cost. • Information and requirements are synthesized and summarized on a website, making them easy to find. • Post-inspection installation updates can be verified without a second inspection visit.

Permitting "Level of Difficulty"	Common Characteristics, Processes, and Requirements
	Case Studies: • The City of Los Altos Hills adopted the TECH Clean California Permitting Pilot streamlined HPWH permit. This includes use of an information guide, with specific callouts in the document address condensate and ventilation. There are no additional requirements beyond state code, and both in-person and online submission is allowed. Post-inspection updates can be submitted via photos. There is a one-day lead time for approval. • Multiple jurisdictions have instantaneous permit processes, such as the Cities of Berkeley, Fremont, Mountain View, Palo Alto, Pleasonton, San Jose, Sunnyvale, and San Mateo.
"High" — Cumbersome, Non-Uniform, Inaccessible	• Unique requirements are added for the jurisdiction that go beyond state code. • Multiple permits are required that necessitate understanding plumbing as well as electrical and/or building code. • In-person submission is required, no online application. • Approval time is long. • Permit is expensive. • Specific non-standard template is required for load calculations.
	Case Studies: • While the City of Palo Alto has a streamlined and instantaneous heat pump permit process, multiple interviewees cited that the process can be challenging for homeowners to navigate. It includes a load calculation on unique city templates, understanding and application of plumbing, electrical, and building codes, and some unique requirements such as bollard protection. • Similarly, while the city of San Francisco has an instantaneous permit option, it is only open to licensed contractors, and the city requires both a Plumbing and Electrical permit, which need to be separately inspected with a contractor present. For a self-installation, homeowners are required to submit a fillable PDF. Anecdotally, the city is stringent on electrical requirements — disallowing any flexible conduit, for example.

Source: (TECH Clean California, 2024) (Los Altos Hills)

4. DIY HPWH Installation Guides, Process Flow Chart, and Fact Sheet

Throughout customer and stakeholder interviews, it was frequently repeated that there was a gap in existing HPWH resources that could meaningfully, accessibly, and comprehensively walk a homeowner through a DIY installation. Several interviewees stated that they wished they had a step-by-step guide to HPWH installation that went beyond what might be covered in a manufacturer's installation manual and included information on how to determine if, and what type of, a HPWH might be right for them; if their home can accommodate a HPWH, and how; and, most commonly, what the "common mistakes" are that homeowners make. For example, while the Switch Is On website hosted by the Building Decarbonization Coalition provides a great overview for homeowners in California about eligible rebates and incentives, it doesn't provide information on aspects like how

to select a water heater or what your local jurisdictional code requirements might be. Manufacturers' installation manuals and YouTube how-to videos can walk a homeowner step-by-step through a successful installation, but they don't often include or cite "common mistakes" from a permitting perspective or provide advice on how to size your HPWH model.

Leveraging feedback from interviews and research, this section strives to coalesce resources for prospective DIY HPWH installers in a single place. This section will cover:

1. A review of installation guides and training resources
2. A synthesis of homeowner knowledge gathering, home assessment, and installation steps for a DIY HPWH project
3. A public-facing DIY HPWH installation fact sheet

Review of Installation Guides and Training Resources

There are numerous training materials available to assist individuals seeking to install a HPWH. However, the training materials vary in their accessibility. Existing guides related to HPWH installations were assessed for their accessibility to homeowners based on the languages the training was available in, the length of the training, whether the training had a paywall, and the target audience of the training as a proxy for its technicality.

The initial "ratings" of accessibility to a homeowner — Low, Medium, High — focus on how technical the material is, and how close it is to a step-by-step guide. This is only one lens through which to evaluate accessibility. There are, of course, other factors, including whether the materials are tailored to different learning approaches — such as written, use of pictures and media, video, interactive formats, and others — and whether they are available in multiple languages.

In addition to the resources listed below, individuals can seek guidance and answers to questions regarding the installation by contacting the store where the appliance was purchased, their local permitting office or building code department, or the manufacturer for technical assistance with the installation.

Table 8: Inventory of Best Practices and How-To Guides

Resource Title and Link	Author	Audience	Language	Duration	Accessibility Rating
Hybrid Water Heater Professional Installation Guide (Link to video; Link to web page; Link to Manual)	Energy Trust of Oregon	General Public	English	24 min + web guide	High — comprehensive step-by-step how-to guide with accompanying video (electric-to-electric)

Resource Title and Link	Author	Audience	Language	Duration	Accessibility Rating
Heat Pump Water Heater DIY Installation Guide (Link)	Hot Water Solutions, NEEA	General Public	English, Spanish	5 min+ guide	High — comprehensive step-by-step how-to guide (electric-to-electric)
How to Install an Electric Heat Pump Water Heater | Ask This Old House (Link)	This Old House (YouTube)	General Public	English	6.5 min	High — detailed step-by-step guide and shopping list in comments, "case study" HPWH installation (electric-to-electric)
Manufacturers Manual (Link to sample: **AO Smith 66 gallon 120 V**)	Manufacturer	Public, Contractor	TBD	TBD	High/Medium — comprehensive and critical resources to review and be familiarized with for a DIY HPWH installation, though often lengthy and technical
How To Install a HPWH Yourself (Link)	Corey Wilson (YouTube)	General Public	English	1 hour 8 min	Medium — detailed step-by-step video, "case study" in electric HPWH installation (does not include gas decommissioning)
Best Practices for the Retrofit Installation of Heat Pump Water Heaters (Link)	RHA	Contractor, Instructors	English	28 pages	Medium — comprehensive but technical; includes checklist
Heat Pump Water Heater Installation Best Practices Guide (Link)	Hot Water Solutions, NEEA	General Public	English	3 minutes	Medium — not a step-by-step guide, but a thorough best practices reference

Resource Title and Link	Author	Audience	Language	Duration	Accessibility Rating
Heat Pump Water Heater Guidelines (Link)	PCE	General Public	English	1 web page	Medium — not an installation guide, but a thorough resource to select and prepare for a HPWH; includes specific recommendations for reducing noise and vibration, and circulation/venting in a small space (<700 ft^2)
HPWH Best Practices Guide for Informed Customers, DIY Installers, and Curious Contractors (Link)	SVCE	General Public	English	13 pages	Medium — not a step-by-step installation guide, but a thorough overview of key installation elements such as airflow and ventilation, electrical capacity, and others
Heat Pump Water Heater Checklist (Link)	PNNL	General Public	English	10 min	Medium — not a step-by-step installation guide, but a thorough overview of key pre-installation, installation, and commissioning steps
Heat Pump Water Heater Installation Tool (Link)	PNNL	General Public	English	10 min	Medium — a helpful tool to select a HPWH size and model
Heat Pump Water Heater Permitting and Inspection Checklist (Link)	PNNL	General Public	English	19 pages	Medium — a helpful checklist for permitting requirements based on national cost
YouTube Research of Individual Steps (Link to example: **How to Solder a Pipe**)	YouTube	General Public	English	TBD	Medium/Low — a helpful step-by-step video of one potentially important component of an installation, though of only that one step

Resource Title and Link	Author	Audience	Language	Duration	Accessibility Rating
The Basics: Heat Pump Water Heater (Link)	SVCE	General Public	English	1 page	Low — a high-level fact sheet on the basics of why, when, and what to do if interested in a HPWH
Pre-Retrofit Assessment of Crawlspaces and Basements (Link)	PNNL	General Public	English	10 min	Low — a helpful overview of one component of preparation for an install, reviewing specific common needs in a crawlspace or basement installation of a HPWH or HVAC system
High Performance Buildings and Electrification (Link)	AEA	Contractor Course	English	6 hours 15 min	Low — geared toward contractors, exam required
TECH Clean California & ESMAC Heat Pump Water Heater Education (Link)	AEA, TECH, ESMAC	Contractor	English	2 hours	Low — geared toward contractors, exam required

Synthesis of DIY HPWH Installation Evaluation Steps

A customer's journey to installing a HPWH in their own home has many drivers. As cited earlier in the Motivation for a DIY Approach section, motivations for a DIY installation vary and include saving money on labor costs, contractor schedule and availability, and interest in understanding the technical components of a HPWH.

The following resources aim to summarize the steps for a DIY installation project and process, with an eye toward what makes a DIY project unique. They include citations and excerpts from specific resources covered in Table 8. The evaluation steps reflect a process flow that embodies the necessary steps for choosing a HPWH, receiving rebate or incentive funding for an installation, permitting the HPWH installation, and ensuring it is safely installed and functioning properly. Specific to a DIY installation, steps were clustered into three phases:

1. Pre-installation Knowledge Gathering

Rather than relying on a professional plumber, electrician, or contractor recommendation, a homeowner pursuing a DIY installation needs to be able to independently source information on what a HPWH is, what the benefits are, and what options exist for different HPWH models. In interviews to date, homeowners and program administrators emphasized that a homeowner was

most often driven to choose a HPWH because their contractor recommended it, or because of awareness through local rebate and incentive program outreach. An estimated 84 percent of homeowners make decisions based on their contractor's recommendation (NEEA, 2018). Lack of general consumer awareness of HPWHs as a product choice is consistently cited as a top barrier to HPWH adoption (VEIC, 2024). This was affirmed by interviewees, who cited their own challenges with finding detailed information on HPWH product choice and a lack of awareness among family and friends. Additional research has found that water heaters are typically low priority appliances and not top of mind for homeowners, other than in failure and emergency replacement scenarios — though HPWHs as a product are growing in consumer awareness (Northwest Energy Efficiency Alliance, 2023). Ensuring homeowners who are curious about a DIY installation have easy access to resources to guide their decision toward choosing a HPWH is critical.

2. Pre-Installation Home Assessment

Once a prospective DIY water heater installer is interested in a HPWH, the second step is to conduct a basic pre-installation home assessment. For a DIY installer, this can be more challenging depending on the homeowner's existing level of technical knowledge. The pre-installation home assessment is the critical "go/no-go" step for evaluating whether or not a home is a good potential fit for a DIY installation — depending on whether there is electrical or other work that needs to be completed that would necessitate a licensed professional. These steps are also important to inform the model and size of the water heater a homeowner purchases. Multiple stakeholders and homeowner interviews, as well as market research conducted, indicate that a common mistake made by homeowners is not sufficiently sizing their water heater for their household's needs (NEEA, undated). The resources included in Table 8 can help guide a homeowner through this pre-installation home assessment.

3. Post-Installation Process

Finally, once a homeowner has decided to purchase and self-install a HPWH, Table 8 includes resource guides for the HPWH installation process. For a DIY installation, a homeowner might assume the responsibility for obtaining a permit and applying directly for any eligible rebates.

Informed by research and interviews, the chart in Figure 7 captures the essential steps and process flow for a DIY installation.

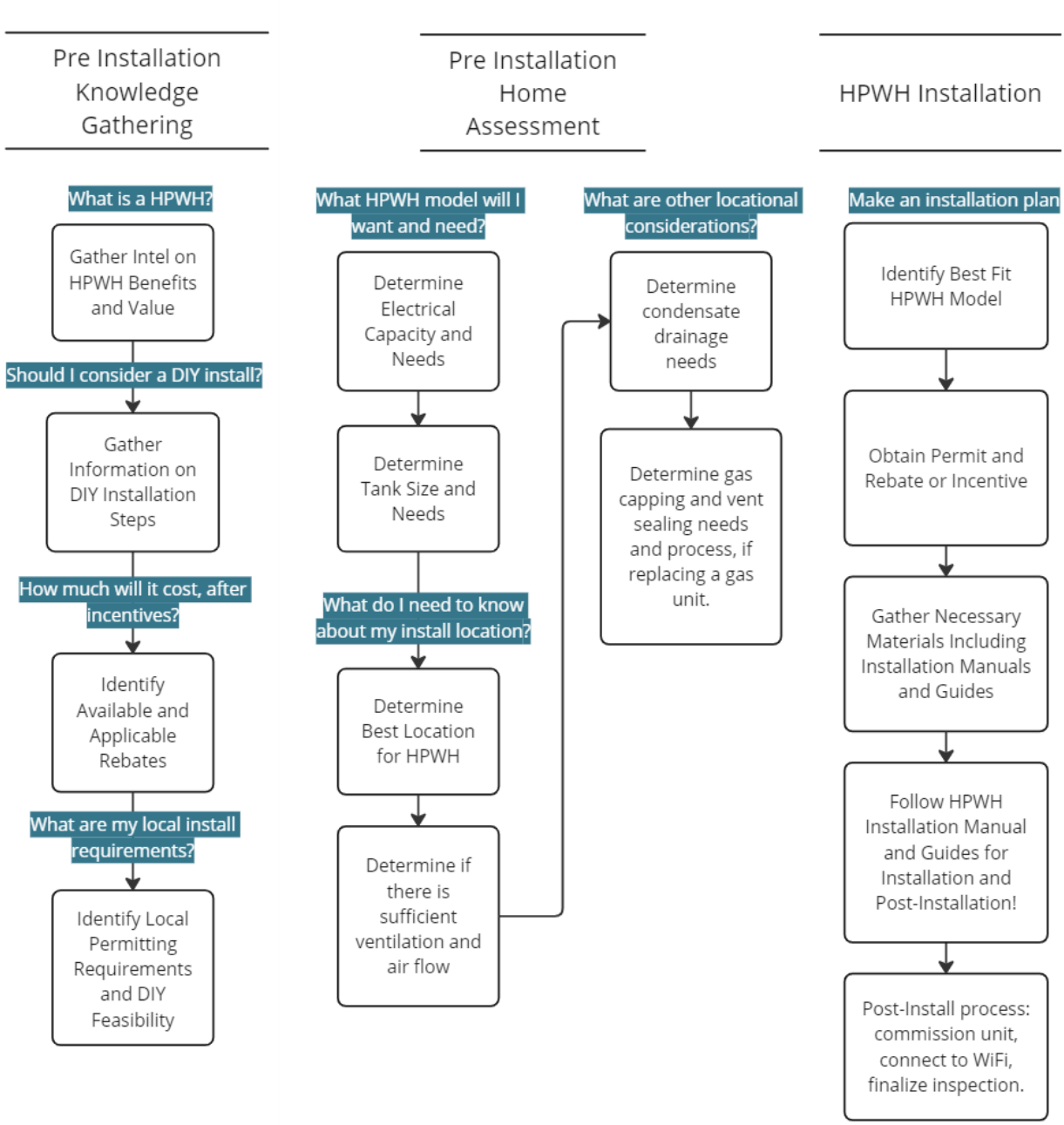

Figure 7: Process flow for a DIY HPWH project.

Table 9 captures variables that make a DIY installation more or less feasible. It includes key points for consideration by a customer in deciding whether they want to pursue a DIY installation specifically. Some of these evaluation steps are true "go/no-go" decisions — such as if a HPWH is affordable for the homeowner (including based on rebate eligibility), if the homeowner has adequate existing electrical capacity, and if local permitting or code requirements enable non-professional installations. The rest of the evaluation steps may result in a homeowner becoming aware of

additional or specific work that needs to occur but that is still workable for a DIY installation. Resources on how to answer these evaluation questions are cited for each step.

Importantly, this is not meant to serve as a "yes/no" checklist for whether a homeowner can or should pursue a DIY HPWH installation. Table 9 relays commonly cited challenges with HPWH installations that might present a unique challenge for a DIY installer, informed by interviews and research.

Table 9: DIY HPWH Installation Evaluation Steps

Pre-Installation Knowledge Gathering		
Question	**Guidance**	**Resources and More Information**
1. Do I know the benefits of a HPWH, and of a DIY installation?	Familiarize yourself with the benefits, characteristics, and reasons to purchase and install a HPWH — and why to consider a DIY solution!	See: (Peninsula Clean Energy, 2020), (NEEA, undated)
2. Do I have the resources, knowledge, and how-to guides on hand to support me in a DIY installation?	If so, great! If not, reference step-by-step how-to guides as examples.	See: (Energy Trust of Oregon, 2021), (NEEA, undated), (RHA, Inc., 2023)
3. Can I access rebates and incentives if I do a DIY installation?	Certain rebate and incentive programs are not accessible for DIY installations, as they are "mid-stream" incentives distributed through licensed contractors and installers, i.e., the TECH Clean California program. You can check what rebates might be accessible to you on *The Switch Is On* website, and in Appendix A.	See: (The Switch Is On) filtered by Homeowners" in the "Who Can Apply" field.

4. Does my local building code and permitting process enable DIY installations?	Unfortunately, local building code and permitting processes vary across jurisdictions and over time. When you are seeking out a permit for a HPWH retrofit project, you can browse your local permitting office's website or call them directly. Some things to keep an eye out for or ask about to determine if a DIY HPWH installation is feasible include: - Does the permitting office require floor plans drawn to scale, completed/signed by a professional? - Does your permitting office require electrical line diagrams, completed/signed by a professional? - Does the permitting office require electric load calculations, completed/signed by a professional? - Does the permitting office require an invoice or proof of service from a licensed professional?	See: (Sustainable Energy Action, 2023) for a list of potential permitting requirements (p. 6) and a draft checklist (p. 7-12); next section, "HPWH Permitting and DIY Installation Common Mistakes."
Pre-Installation Home Assessment		
Question	**Guidance**	**Resources and More Information**
5. Do I have adequate electrical capacity?	Certain jurisdictions have minimum electrical capacity requirements in their local building code for HPWH installations. Some also required on-site inspection or detailed electrical drawings. The electrical capacity required is dependent on the Volts of the HPWH unit (120V or 240V) and the amperage. If not, or if you are unsure, you will likely want to consult an electrician	See: (RHA, Inc., 2023) for recommendations on types of HPWHs and evaluating if you have sufficient available electrical capacity (p. 20-21).
6. Do I know what HPWH tank size I need?	Certain jurisdictions required upsizing of water heater tanks in retrofits. Luckily, many resources can help you determine what size WH you need. If possible, install a thermostatic mixing valve to increase storage potential and energy savings.	See: (RHA, Inc., 2023) for guidance on determining tank size. (p. 12); See: (Idronics), Retrofit – Tank Size (Idronics), Retrofit – Tank Size

7. Do I have a location with the right air temperature?	Ensure your HPWH location will remain above freezing at all times. If you do not have access to a basement or garage, you might need to consider solutions for interior placement.	See: (RHA, Inc., 2023) for installation locations per CA Climate Zone (p. 14).
8. Do I have adequate ventilation and airflow for the HPWH?	Most tanked systems need to be installed in a room of 700 cubic feet or more. If you do not have 700 cubic feet of space, you might need to duct the water heater to a larger space or outdoors.	See: (RHA, Inc., 2023) for Small Space Ventilation Strategies (p. 17) See: (Idronics) Retrofit – Water Heater Location, Airflow
9. Do I have a plan for condensate drainage?	Determine a suitable location for the condensate to drain — whether a direct gravity drain to a sink or washer drain line port, to the outdoors (if it will not freeze), or via a condensate pump.	See: (RHA, Inc., 2023) for Condensate-Handling Strategies (p. 15) See: (Idronics) – Retrofit – Condensate
10. If replacing a gas water heater, do I need to cap a gas line?	If so, you should determine if doing so DIY is feasible. Many jurisdictions require involving a licensed professional to cap a gas line and require verification through the permitting process. Many rebate and incentive programs also ask for this verification.	See: (RHA, Inc., 2023) for Capping a Gas Line (p. 23)
Installation Processes		
Question	**Guidance**	**Resources and More Information**
11. Have I identified the "best fit" HPWH model for my home?	Identify the right HPWH model for you based on various considerations — including hot water draw, occupancy, space constraints, and more.	See: (Pacific Northwest National Lab, 2024)
12. Have I successfully compiled and submitted the relevant materials for my permit and rebate?	Ensure that you have filled out the application on your local permitting office's website for a permit and incentive administrator's website for a rebate or incentive, and submitted the needed information	See: (The Switch Is On) filtered by Homeowners" in the "Who Can Apply" field.

13. Have I identified the step-by-step resources and checklist I would like to follow and use?	If so, great! If not, revisit the step-by-step how-to guides and resources to identify the best checklist to ensure a safe and effective installation.	See: (Energy Trust of Oregon, 2021) the (NEEA, undated), and the (RHA, Inc., 2023)

Public-Facing DIY Digital Fact Sheet and Guide

The DIY HPWH Installation Guide and materials were developed to capture and elevate key considerations for homeowners considering a DIY HPWH installation. They are intended to distill the information gathered in a manner that is concise and digestible for a customer — and that could be used in multiple targeted use cases or publication, including:

1. On a rebate program's website
2. In a retailer's store for interested customers
3. On an informational web page, such as *The Switch Is On*

The Fact Sheet, included in full as Appendix A: Public-Facing DIY Digital Fact Sheet and Guide, was further refined based on homeowner interviews. It includes the following core materials:

1. Deciding on a Professional or DIY HPWH Installation
2. DIY HPWH Pre- and Post-Installation Steps
3. Inventory of Best Practices and How-To Guides for HPWH Installation
4. Tools and Materials List for a DIY HPWH Installation

Recommendations

As highlighted earlier in the report, an estimated 500,000 water heaters are replaced each year in California, up to 50 percent of which are by non-professional or DIY installers. This non-professional segment of the workforce represents a critical yet underutilized portion of the installer base that could be instrumental in rapidly scaling the rate of HPWH installations, reducing installed costs, and creating a pathway toward achieving the state's electrification and decarbonization goals. Opportunities to better support non-professional DIY installers include: 1) developing accessible and detailed HPWH retrofit and installation guides; 2) providing accessible, streamlined rebates that reduce upfront costs; 3) increasing diversity of HPWH models and access to tools to simplify water heater replacements for different building needs; 4) improving public messaging around HPWH benefits, alongside educating and training contractors on their advantages and installation requirements; and 5) addressing common friction points for HPWHs in local code and permitting requirements.

1. **Support non-professional DIY installers by disseminating accessible and detailed HPWH retrofit installation guides.**

Audience: Program Administrators, Retail Stores, City Permitting Offices

There is a large amount of content in written or video form on HPWH retrofits, however, these materials vary in their ability to guide a homeowner through a high-quality, non-professional installation. Many existing materials don't cover the entire process start to end, including knowledge gathering, home assessment, and installation. Often, they are intended for specific use cases, such as electric-to-electric replacements, and don't cover the array of electrical, plumbing, and mechanical skills, knowledge, and tools required for many installation types.

Interviews with DIY installers, contractors, and permitting officials informed the development of new materials to support DIY installers in their evaluation, planning, and installation steps. These include: 1) Deciding on a Professional or DIY HPWH Installation; 2) DIY HPWH Pre- and Post-Installation Steps; 3) Inventory of Best Practices and How-To Guides for HPWH Installation; and 4) Tools and Materials List for a DIY HPWH Installation.

Making these materials available to homeowners could help guide DIY installers in ensuring their HPWH projects meet important safety and quality installation needs, while also equipping all Californians with information to better understand the components of a HPWH installation, whether they pursue a DIY approach or not. These materials could be distributed through partnerships with retail stores, rebate and incentive program administrators' websites, city permitting offices, and more. Outreach could also be targeted in rural areas, where contractor availability is more limited. Materials could be included as hand-outs or linked to when a homeowner participates in a free home energy assessment or audit, submits an inquiry about a HPWH incentive or rebate, or when a customer visits a retail store, for example.

Finally, interviewees also recommended engaging with contractors around assisted or partial installation opportunities. In rural areas and emergency replacement scenarios, many customers still go to a retail store first and purchase their own equipment. These customers might then want to hire a contractor for installation or seek technical support. Making contractors aware of the prevalence of

such installations could create opportunities for them to proactively advertise and provide market assisted installation services. Efficiency Maine has shared best practices regarding DIY customer acquisition and program participation, including in-store marketing and instant rebates, Google search and YouTube ads, and efforts that strive for price parity. For early retirement replacements, they have found success offering limited time discounts, as well as aiming marketing efforts at customers not currently in the market for a HPWH by running ads to the general public through radio, digital displays, and mail or email (Wachunas, 2025).

2. **Design simple and streamlined rebate programs to maximize HPWH cost competitiveness and accessibility.**

Audience: Program Administrators, Policymakers

Many rebate programs are inaccessible directly to homeowners. Ensuring that the 50 percent of Californians who are non-professionally replacing water heaters have access to incentives will support them in making the switch to HPWHs. This will include making rebates available not simply through approved and certified contractor networks — such as those required by TECH Clean California and HEEHRA Phase I, as well as some local and regional programs — but also expanding existing programs to include a DIY participation channel. It will also require ensuring that rebate and incentive programs are accessible and simple to apply for, and do not necessitate long wait times for reimbursement in cases where a homeowner needs to float that cost.

Increasing rebate access to DIY installers — whether homeowners directly, or general contractors without a C-36 plumbing license — has the potential to increase the size of the workforce capable of completing HPWH installations. This expanded workforce can increase competition, which in turn can contribute to HPWH installation and project cost compression. It can also mitigate some of the cost inflation that occurs when rebate and incentive programs offer high incentives exclusively to a small subset of the contractor workforce.

To ensure safe and quality installations, permits can still be required. The process should be a low-cost and straightforward component of a rebate process, and program administrators should provide technical advising and customer support to help applicants understand local jurisdictional requirements.

3. **Improve diversity of HPWH models and access to tools to simplify water heater replacements for different building needs.**

<u>Improve Retail Store Product Availability for HPWHs</u>

Audience: Retailers, Manufacturers, Program Administrators

In California, statewide HPWH rebates are accessible either through contractors or through participating distributors and retailers. The large, local DIY retailers were the most commonly identified source for homeowner installations. However, several interviewees cited that product availability at their local retailer was a challenge and not always assured, particularly for newer 120V plug-in models. Particularly in emergency replacement scenarios, homeowners need not only informational support to guide the proper selection and installation of HPWHs, but also quick access to HPWH models that fit their needs. It is important that program administrators partner and coordinate with local retailers to understand local stocking practices and encourage the stocking of a

greater number of diverse HPWH models where feasible, offering data to retailers on the growing scale of both professional and non-professional installer demand for HPWHs. This can focus on plug-in 120V models, which are increasingly prevalent and important to support DIY installations and emergency replacements. Program administrators can also provide materials to support the training of retailers' sales staff on the basic materials and tools required for an installation by their customers.

Support Market Transformation for 120V HPWHs and Easy-to-Install HPWH Features

Audience: Program Administrators, Policymakers, Manufacturers

Increasing awareness about the benefits, use cases, and installation requirements for 120V HPWHs among both residents and homeowners, as well as contractors, will be crucial to meeting state heat pump deployment goals in an energy efficient manner. Avoiding unnecessary electrical upgrades significantly reduces the cost of a HPWH installation, while also reducing strain on the electric grid. Program administrators and policymakers should focus on investing in consumer awareness, contractor training, and market transformation for 120V HPWHs. Simultaneously, manufacturers should work with policymakers to advance the supply chain and increase the availability of 120V models among retailers statewide, including models with an integrated thermostatic mixing valve. Multiple interviewees cited the value and ease of installing a HPWH with an integrated thermostatic mixing valve.

Support Tool Rental Services for DIY Installations, or Volunteer-Led Solutions

Audience: Program Administrators, City Officials

Several interviewees stated that they would have, or did, benefit from rental services for the more expensive and less common plumbing tools that supported their DIY installation. This could include a dolly for transporting a water heater in and out of a home, or a Pro Press Tool if it is being used on copper pipes and fittings. Some moving companies such as U-Haul rent out dollies, and searching online community blogs showed that Home Depot has rented Pro Press Tools in other jurisdictions at certain times. To better support homeowners considering a HPWH installation, program administrators and city officials could consider supporting a rental program for some tools.

Additionally, the project team interviewed SunWork, which supports volunteer-led HPWH and solar installations in the Bay Area and Central Coast. They equip their volunteers with all necessary tools for installation, including tools and materials that might be too expensive for a DIY homeowner to buy individually — such as a $2,000 compression pipe crimper, compression fittings, and flexible piping. Expansion of a volunteer-led model could be another option worth exploring by program administrators or local city officials.

4. **Improve public messaging and contractor training around HPWH benefits and installation requirements.**

Audience: Program Administrators, Policymakers, City Officials

Support Home Energy Audits and Free Home Electrical Assessments

One of the most commonly cited challenges by interviewees and broader research conducted on HPWH market transformation is a lack of knowledge among homeowners about whether a HPWH is

a good fit and, if so, what model and size they should choose. Additionally, research in California has found that at least 75 percent of water heater replacements are reported to take place as the result of a sudden or imminent unit failure. Providing free, early, and accessible home energy audits to allow homeowners to plan for an emergency replacement supports them in making a transition to a HPWH. If that home assessment or audit includes load calculations, it also presents an opportunity to evaluate whether a home can avoid an electric service upgrade, and save money, with a 120V plug-in model. Several CCAs statewide already offer free home assessments or energy advising — including SVCE, PCE, and RCEA (No-Cost Home Energy Assessment, n.d.). Both SVCE and PCE offer additional guarantees that they will replace a failing water heater within 48 hours. Interviews with these program administrators highlighted the value of these home assessments and pre-planning, emphasizing that many folks in an emergency replacement scenario voice that they plan or anticipate replacing their water heater with a like-for-like option — either a gas water heater or an electric resistance water heater — due to unfamiliarity with HPWHs.

Educate Contractors on HPWH Installations

In addition to supporting homeowners in their own electrification planning, work is also needed to continue to grow contractor's knowledge about HPWH installations for those homeowners and households that do not go down a DIY pathway. Educating contractors is relevant in the DIY context because many homeowners who already have or plan to DIY a water heater replacement might not be equipped to DIY a more complex HPWH installation, as opposed to a like-for-like gas water heater replacement. It's important to make sure that this subset of the 50 percent of Californian DIYers can be readily supported by a contractor who is knowledgeable about HPWHs instead. Several interviewees who did choose to go down a DIY path cited that when they met with contractors, they were often mis-informed. Interviewees mentioned confusion or a lack of understanding around venting requirements, recommendations for oversizing of the new HPWH, or an over-reliance on electric service upgrades when they might not be needed (or a plug-in 120V with a large enough tank could suffice). Program administrators, policymakers, and local officials should continue to invest in education and training of the California contractor workforce to support efficient, cost-effective, and quality HPWH installations.

5. **Address common friction points and variances in local code and permitting requirements and educate permitting offices about the technical needs and specifications of both 240V and 120V HPWH installations.**

Audience: Program Administrators and Policymakers

When permits are required for incentive and rebate program participation, educating local permitting officials and building inspectors about the needs of a HPWH installation is crucial. Interviewees and stakeholders cited multiple priority areas for the necessary education of permitting and code officials, including:

- Condensate drain requirements: While some jurisdictions allow pressure relief valve (PRV) piping to terminate on the garage floor, others still require it to go through an exterior wall to avoid interior water damage. This was often cited as a more challenging or costly part of an installation — for example, if you need to run additional piping through a crawl space or relocate a water heater to allow for this. These requirements can be based on condensation

termination codes written for HVAC systems with combustion and acidity concerns, which do not apply to HPWHs. Consistent code interpretation can simplify and streamline the process for homeowner installers. In cases where water damage is not a unique or particularly high concern in a home, e.g., no major history of water damage, allowing PRV piping to terminate on a garage floor is simpler, less costly, and allows for ease-of-access for regular inspection and maintenance.

- Electrical requirements: Updating local jurisdictional interpretation of code to accept "smart" methods for calculating load, e.g., meter-based, will help homeowners optimize to avoid upgrading electric service and will maximize opportunities for 120V plug-in models.
- Piping materials and fittings: The use of plastic water piping, e.g., PEX, and quick-connect fittings, e.g., SharkBite, has dramatically decreased the complexity and skill set required for non-professionals to replace water heaters. However, some permitting offices require the use of copper piping for some applications due to familiarity with the material and its known longevity, which requires a somewhat advanced skill set for soldering pipe connections. Statewide guidance on interpretation of code related to the use of plastic piping and quick connect fittings for HPWH installations could remove a barrier for non-professional installers.
- Gas capping: Local jurisdictions' interpretation of code should recognize that gas capping needs to be done correctly to mitigate safety and environmental hazards. However, that interpretation should also acknowledge that this is a technical step that DIY installers can perform themselves if adequately informed and their work is inspected.

Permitting and code officials should also learn from other experiences in streamlining and improving permitting accessibility, looking to the list of HPWH Permitting Common Characteristics and Processes in Table 7, which highlights common characteristics of an accessible permitting process. Many of the characteristics of a simple permitting process are included in recently introduced legislation in California, SB 282, which attempts to address standardized requirements, permit simplicity, low-cost and expedient permit issuance, and a pathway for DIY installations.[9] While this bill has not passed as of the publication of this report, it serves as an example of potential progress toward an improved permitting process.

6. **Incorporate and support lowest-cost HPWH installation pathways to reach state decarbonization goals, including 120V technologies and safe, quality DIY installations.**

DIY HPWH installations will not be a solution or good fit for many homeowners, and additional support, training, and resources should be provided to ensure that those who pursue a DIY approach are installing their HPWH safely and meeting high-quality standards. DIY installations are a more cost-effective option than contractor installations and will continue to be a pathway pursued by Californians who are financially constrained, who live in areas without expedient or sufficient contractor availability, and more. A DIY pathway should be particularly supported within households with lower water usage demands where a 120V plug-in unit is a good fit. As California continues to plan for a long-term transition to HPWHs, including a shift to zero-nitrous oxide (NOx) water heater appliance standards, policymakers and program administrators will need to find cost-effective

[9] See: https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=202520260SB282

solutions to scale HPWH installations. Proactive support for DIY installations should be a part of that market transformation strategy and planning.

Appendix A: Public-Facing DIY Digital Fact Sheet and Guide

Below is a select set of proposed customer- and public-facing materials that could serve as a DIY Digital Fact Sheet and Guide for use or reference by various stakeholders — program administrators, policymakers, contractors, volunteer-led assisted DIY organizations, and others.

These materials will be downloadable on the CalNEXT website for stakeholders to use openly, at: Approved Projects - CalNEXT. If you have questions about use or distribution of these materials, you can reach out to:

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Chris Badger (cbadger@veic.org)

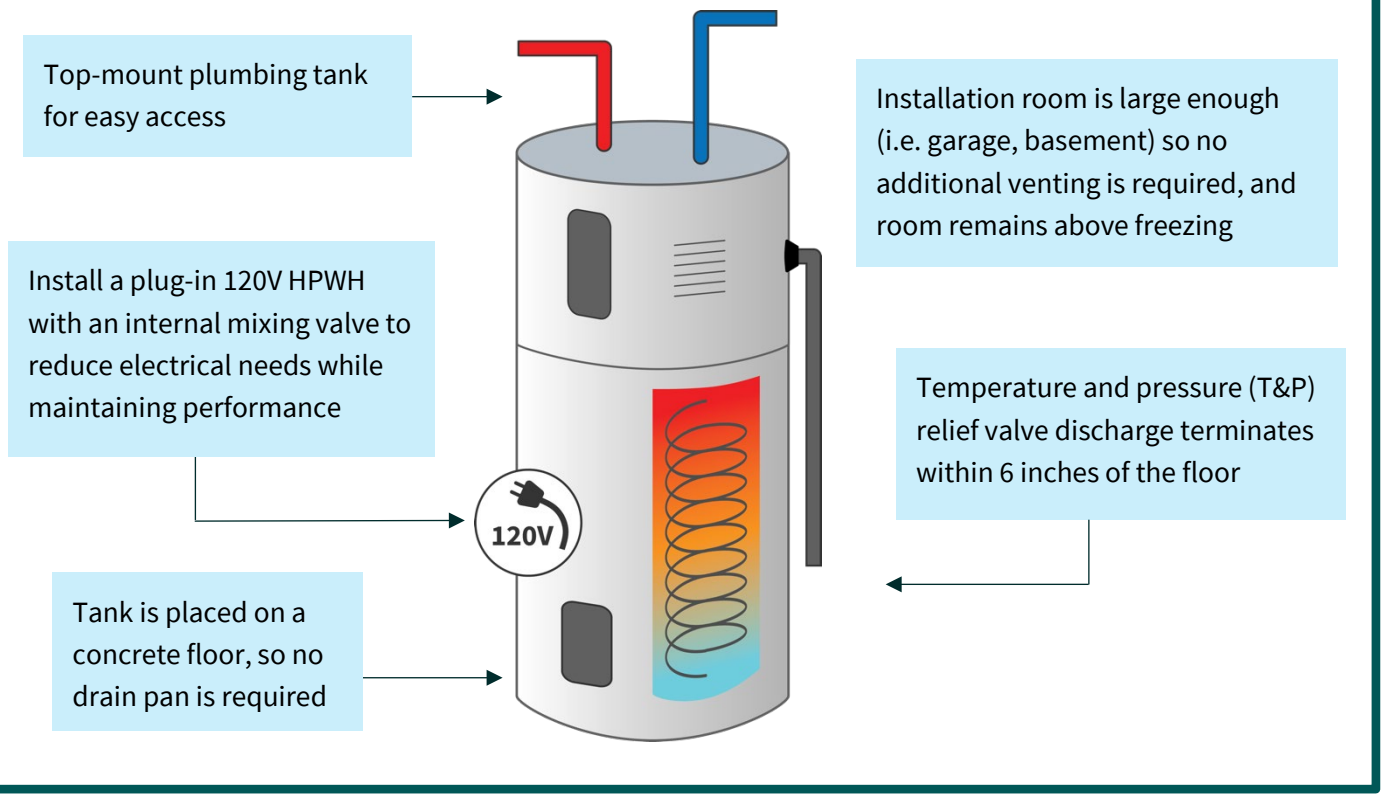
Can I install my own Heat Pump Water Heater?

Deciding on a Professional or DIY HPWH Installation

Heat pump water heaters (HPWH) are a new, high efficiency alternative to conventional gas or electric water heaters. As their operation and installation is more complex, it is recommended that a homeowner consider using the services of a professional contractor. However, a handy homeowner can self-install, or work assisted by a contractor or a friend/family member with plumbing and electrical experience. This guide aims to help homeowners find technical resources and guides to better understand the steps for completing a quality HPWH installation.

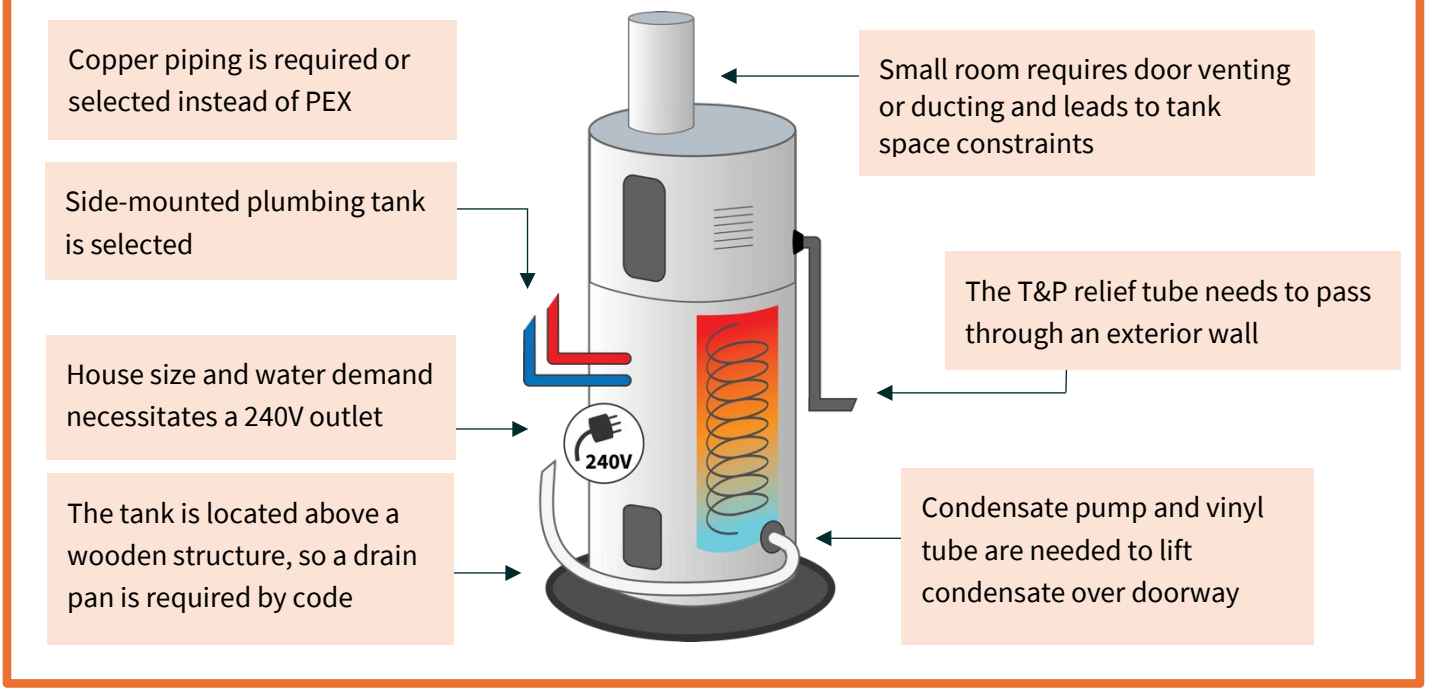
The two pages below explore examples of "simple" and "complex" HPWH installations, to assist you in deciding if you want to DIY or hire a professional contractor.

Key Elements of a "Simple" HPWH Installation



Can I install my own Heat Pump Water Heater?

Key Elements of a "Complex" HPWH Installation



Additional Impacts on Installation Complexity

- **Permit Type and Cost:** Many jurisdictions require only a plumbing permit for a HPWH install, but some require both a plumbing and electrical permit. Varied local requirements can impact cost.
- **Ventilation:** Project costs increase if additional ducting for ventilation is required.
- **HPWH Weight and Labor:** HPWH's can weigh over 200 pounds, necessitating renting a dolly or getting additional help.
- **Condensate:** Varying jurisdictional requirements for handling condensate impact price and complexity. Plumbing to a utility sink nearby is straightforward and low-cost, while running through a wall to the exterior or installing a condensate pump is more costly. Some jurisdictions allow a pressure relief valve (PRV) to terminate on the garage floor, and some require it to go through an exterior wall. Additionally, installing PRV's or water supply lines might require soldering or sweating copper, if copper pipe is used.
- **Panel Capacity Considerations:** A plug-in 120V model simplifies an installation, though some jurisdictions require a dedicated circuit for a 120V HPWH, even if they are designed for a shared circuit. Additionally, for existing dwelling retrofits, electrical code allows manual load estimates or meter interval data-based calculations. Though meter-based calculations are more accurate, some jurisdictions do not allow them anymore, including if a household has solar. A panel upgrade and adding new circuits is possible to DIY but can be challenging.
- **Plumbing Materials:** In some jurisdictions PEX is not allowed for piping and homeowners must use copper piping, necessitating soldering/sweating copper pipes or purchase pricier flexible copper.
- **Gas Capping:** An uncomplicated technical step, some jurisdictions disallow DIY due to gas leak safety or emissions reasons. Homeowners should have inspectors check that the gas line is safely capped. The venting for the gas water heater will also need to be capped with a sheet-metal cap.
- **Vehicle Protection:** Some jurisdictions will only require a bollard in a garage if the HPWH is front and center while others require it in any garage location.

Can I install my own Heat Pump Water Heater?

DIY Heat Pump Water Heater Pre- and Post- Installation Steps

Pre-Installation Knowledge Gathering	
1.What are the benefits of a HPWH and DIY Installation?	Familiarize yourself with the benefits, characteristics, and reasons to purchase and install a HPWH. A DIY HPWH installation can save on costs but can be a complex replacement project. The "Inventory of Best Practices and How-To Guides" includes robust information on benefits and operation of HPWHs.
2.Where can I find helpful DIY HPWH resources?	Scan the inventory of best practices and how-to guides for HPWH installation to familiarize yourself with the process and available resources.
3. Are rebates available for a DIY installation?	Many rebates are only offered through licensed contractors. However, there are some rebates available to homeowners. Find rebates available in CA at https://www.switchison.org/.
4.What is the permit process like for a HPWH install?	Local building code and permitting processes vary across jurisdictions. When seeking a permit for a HPWH installation, check your local permitting office's website or call them directly for details of what is required and whether a DIY installation is advisable. You can also consider working with a contractor post-installation to inspect and review for quality and safety.
Pre-Installation Home Assessment	
5.Do I have adequate electrical capacity and service to the water heater?	Minimum electrical capacity requirements, on-site inspection and detailed electrical drawings may be required by local building code and to support the electrical needs of a specific HPWH model. Plug-in 120V HPWH models can be a potential solution for reducing electrical upgrade and permitting needs. However, it is best to consult an electrician for any electrical upgrades.
6.Do I know what HPWH tank size I need?	Manufacturer guidelines and design resources can help you determine the best size HPWH for your household based on hot water draw, occupancy, space constraints, and more. Consider installing a thermostatic mixing valve for increased hot water delivery and safety.
7.Do I have a location with the right air temperature? Is it near a bedroom?	Ensure your HPWH location will remain above freezing at all times. If you do not have access to a basement or garage, consider locating within the finished area of your home. Ideally, locating the HPWH so that it does not share a wall with a bedroom will avoid noise sensitivity.
8.Is there adequate ventilation for the HPWH?	Most tanked systems need to be installed in a room of 700 cubic feet or more to meet ventilation requirements. Alternatively, duct the HPWH to a larger space or outdoors.
9.Do I have a plan for condensate drainage?	Determine a suitable location for the condensate to drain – whether a direct gravity drain to a sink or washer drain line port, to the outdoors (if it will not freeze), or via a condensate pump.
10.If replacing a gas water heater, do I need to cap a gas line?	If so, you should determine if doing so DIY is feasible. Some jurisdictions require a licensed professional to cap a gas line and require verification through the permitting process. Some rebate and incentive programs also ask for this verification.
Post-Installation Process	
12.Have I successfully compiled and submitted the relevant materials for my permit and rebate?	Ensure that you have filled out the permit application and completed an inspection required by your local permitting office. Submit any required rebate forms with the needed HPWH installation information.

Can I install my own Heat Pump Water Heater?

Inventory of Best Practice and How-To Guides

Resource Title and Link	Author	Audience	Language	Length	Accessibility Rating
Hybrid Water Heater Professional Installation Guide (Link to video; Link to web page; Link to Manual)	Energy Trust of Oregon	General Public	English	24 min + web guide	High – comprehensive step-by-step how-to guide with accompanying video. (electric-to-electric)
Heat Pump Water Heater DIY Installation Guide (Link)	Hot Water Solutions, NEEA	General Public	English, Spanish	5 min+ guide	High – comprehensive step-by-step how-to guide (electric-to-electric).
How to Install an Electric Heat Pump Water Heater | Ask This Old House (Link)	This Old House (YouTube)	General Public	English	6.5 min	High - Detailed step-by-step guide and shopping list in comments, "case study" HPWH installation (electric-to-electric).
Manufacturers Manual (Link to sample: AO Smith 66 gallon 120 V)	Manufacturer	Public, Contractor	English	TBD	High/Medium – a comprehensive and critical resources to review and be familiarized with for a DIY installation of a HPWH, though oftentimes lengthy and technical.
How To Install a HPWH Yourself (Link)	Corey Wilson (YouTube)	General Public	English	1 hour 8 min	Medium – Detailed step-by-step video, "case study" in electric HPWH installation (does not include gas decommissioning).
Best Practices for the Retrofit Installation of Heat Pump Water Heaters (Link)	RHA	Contractor, Instructors	English	28 pages	Medium – comprehensive but technical. Includes checklist.
Heat Pump Water Heater Guidelines (Link)	PCE	General Public	English	1 web page	Medium – not an installation guide but thorough resource to select and prepare for a HPWH. Includes specific recommendations for reducing noise and vibration, and circulation/venting in a small space (<700 sq ft).
HPWH Best Practices Guide for Informed Customers, DIY Installers, and Curious Contractors (Link)	SVCE	General Public	English	13 pages	Medium – not a step-by-step installation guide, but a thorough overview of key installation elements (airflow and ventilation, electrical capacity, etc.)
Heat Pump Water Heater Checklist (Link)	PNNL	General Public	English	10 min	Medium – not a step-by-step installation guide, but a thorough overview of key pre-install, installation, and commissioning steps.

Can I install my own Heat Pump Water Heater?

Heat Pump Water Heater Installation Tool (Link)	PNNL	General Public	English	10 min	Medium – a helpful tool to select a HPWH size and model.
Heat Pump Water Heater Permitting and Inspection Checklist (Link)	PNNL	General Public	English	19 pages	Medium – a helpful checklist for permitting requirements based on national cost.
YouTube Research of Individual Steps (Link to example: How to Solder a Pipe)	YouTube	General Public	English	TBD	Medium/Low – a helpful step-by-step video of one potentially important component of an install, though of only that one step.
The Basics: Heat Pump Water Heater (Link)	SVCE	General Public	English	1 page	Low – a high-level fact sheet on the basics of why, when, and what to do if interested in a HPWH.
Pre-Retrofit Assessment of Crawlspaces and Basements (Link)	PNNL	General Public	English	10 min	Low – a helpful overview of one component of preparation for an install, reviewing specific common needs in a crawlspace or basement installation of a HPWH or HVAC.
High Performance Buildings and Electrification (Link)	AEA	Contractor Course	English	6 hours 15 min	Low - geared toward contractors, exam required.
TECH & ESMAC Heat Pump Water Heater Education (Link)	AEA, TECH, ESMAC	Contractor	English	2 hours	Low - geared toward contractors, exam required.

Can I install my own Heat Pump Water Heater?

Tools and Materials List for a DIY HPWH Installation

Tools

Commonly Used

- Pipe cutter or hacksaw
- Measuring tape
- Plumbers pipe wrench
- Step Ladder
- Crescent wrench
- Garden hose to drain existing tank
- Gloves (optional)
- Level (optional)
- If installing a 240V:
    - Electrical current tester or voltmeter
    - Basic electrical tools (wire stripper, pliers, screwdrivers, etc.)

Site-Specific

- Hand truck to simplify removal of the existing tank and new HPWH.
- Duct Crimper
- If using copper pipe:
    - Pro Press Tool (makes copper fittings easier, but expensive. Prime candidate to rent.)
    - Tubing Cutter (Hand, or Cordless) (Optional)
    - Reaming Pen (Optional - for "deburring" copper tubing)
    - Brass Wire Brush (Optional– to prep copper pipe for sweat)
- Propane torch (Optional – for sweating copper pipe. Requires the most skill.)

Materials

Commonly Used

- Water supply pipes
- Pipe and fittings for temperature/pressure relief valve (SharkBite fittings are common for DIY plumbing jobs)
- Shutoff valve
- PVC pipe and accessories for condensate lines
- PVC connectors, threaded for condensate outlet connection (both 45˚ and 90˚ elbows)
- Pipe hangers
- PVC glue /primer
- Pipe insulation
- Earthquake straps
- Shims
- Rags or old towels to wipe up any water spills
- If replacing a gas water heater:
    - Brass gas valve outlet cap
    - Yellow Teflon tape or other approved thread sealant for gas pipe threads
- If installing a 240V:
    - Electrical tape, wire nuts

Site-Specific

- Condensate pump (optional)
- Clear vinyl tubing, sized for condensate pump and of sufficient length to reach drain or to tie into existing condensate line (optional)
- Tubing hangers (optional)
- Drain pan to sit beneath unit (new unit may have a larger circumference than the existing tank, optional)
- Thermal expansion tank (required for closed plumbing systems and/or local code)
- Stand (if required by local code)
- Strut channel or wood blocking (for wall clearance if required by manufacturer; check installation instructions)
- Bollard or wheel stop block (if in a garage and required by local code)
- If using copper pipe:
    - Lead-free solder and flux (Optional if using copper pipe – for copper pipe sweating)
- Thermostatic mixing valve (example of an easy-to-install version being the AM300 DirectConnect Series Mixing Valves kit) (Optional – many 120V HPWHs have an integrated thermostatic mixing valve)

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