Increasing Heat Pump Water Heater (HPWH) Deployment

Final Report

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Disclaimer

Executive Summary

Heat pump water heaters (HPWHs) are a crucial technology for California's efforts to electrify both new and existing buildings. However, residential contractors have been slow to adopt this emerging technology due to skepticism regarding its performance and concerns about installation complexity. To address these barriers, the CalNEXT Increasing HPWH Deployment project collaborated with Energy Solutions program Technology and Equipment for Clean Heating (TECH) Clean California to test tactics to increase contractor adoption of HPWH.

The primary tactic tested in the Increasing HPWH Deployment project was to boost customer adoption by familiarizing contractors with 120-volt (120V) HPWHs, which do not require the additional electrical upgrades typically needed for most 240V HPWH installations, thereby reducing installation costs and time. By providing training to contractors and offering firsthand experience with the installation and use of 120V units in their own homes, the project aimed to build trust among contractors and alleviate uncertainties regarding the units' performance, particularly, concerns about their capacity to produce sufficient hot water. It was anticipated that this approach would increase contractors' willingness to recommend these units to their customers, thereby accelerating HPWH adoption.

The outreach efforts of the Increasing HPWH Deployment project successfully engaged 400 contractors through distributor channels and direct contractor outreach activities. From this group, 51 contractors completed the two-stage process to earn the HPWH unit of choice (120V). For the first stage, the contractors were required to enroll in TECH Clean California. Second, they undertook training with the HPWH manufacturer they worked with to train on the unit selection, installation, and maintenance processes and considerations specific to that manufacturer's units. After completing the manufacturer-specific training, 67 percent of attendees reported that they were fairly or completely confident in installing HPWHs. All of them stated they would recommend the 120V units to customers.

Upon completion of training and submission of training certifications to TECH, TECH Clean California-participating contractor firms could request up to six HPWH units for installation in their employees' homes. Although the project aimed to purchase approximately 50 free 120V HPWH units for installation in homes served by contractors in low-income/disadvantaged communities (LI/DACs), only 25 units were confirmed to have been installed. To encourage prompt installation and survey response times, the project also provided participation fees of up to $1,000 for each unit to contractors upon receipt of installation verification data ($500 for completing this step) and feedback surveys ($500 for completing this step), which was paid to the contracting company and expected to be passed down to the recipient.

The project team sought feedback from diverse stakeholders in the development and implementation of this project, including multiple manufacturers, a consulting group, program implementation firms, a national energy initiative, and a residential electrification advocacy organization.

Upon installation, TECH Clean California requested post-installation data from recipients, including unit data, installation information, and recipient opportunities and challenges. However, the project's

current data indicates that contractors participating in the Increasing HPWH Deployment program did not utilize TECH incentives at a higher rate than non-program participants.

The contractors who participated in the program significantly impacted their communities by demonstrating the feasibility and benefits of 120V HPWH units. Their positive experiences and willingness to recommend these units to customers helped build trust and awareness, potentially accelerating broader adoption of this energy-efficient technology. By overcoming installation barriers and providing reliable hot water solutions, these contractors contributed to increased energy savings and reduced installation costs for many households. TECH recommends the following strategies to overcome barriers and establish best practices for contractor training and engagement:

- **Increase implementation time:** Similar contractor engagement and training programs should plan an implementation stage extend at least 18 months, depending on scale. Extending the implementation time allows for thorough training, sufficient time to install the units, sufficient time for contractors to gain experience with the units, and the opportunity to collect comprehensive post-installation data. This will enhance the effectiveness of a program and ensure robust data for analysis.
- **Leverage established relationships with distributors and manufacturers:** To enhance the HPWH deployment program, project teams should leverage established relationships with distributors and manufacturers. Engaging these partners streamlines the contractor enrollment, and contractors are key to the adoption and advocacy of 120V HPWHs. This collaboration speeds up the ordering process and enables contractors to conveniently pick up units at the nearest distributor location. Maintaining and leveraging these strategic partnerships in other IOU programs promotes wider acceptance and adoption of 120V HPWHs, leveraging the credibility and influence of these early adopters and their extended networks.
- **Incorporate 120V HPWHs in income-eligible programs:** To further the accessibility of energy-efficient technologies in low-income households, IOUs should accelerate the integration of 120V HPWHs into income-eligible programs. These units less expensive and easier to install, particularly in disadvantaged communities (DACs) with older electrical infrastructures that might otherwise necessitate costly upgrades for 240V units; and they also demonstrate robust performance and reliability. Post-installation surveys indicate a low percentage of issues concerning water heater performance and hot water availability, underscoring their suitability for widespread use. By promoting 120V units, it is possible to significantly reduce installation barriers and costs, advancing electrification efforts in DACs.
- **Emphasize comprehensive training:** The study team found that manufacturer training on new unit technologies improved contractor comfort with HPWHs. IOUs should incorporate manufacturer-specific training into HPWH programs to ensure contractors are well-prepared and confident in installing and maintaining these units. Comprehensive training has led to higher-quality installations, greater contractor satisfaction, and more reliable performance of the units.
- **Integrate data collection and operations:** Program designers should integrate data collection needs into operations during planning. Implementing data collection from the outset streamlines the process and ensures the efficient collection of critical information.

To reinforce this and emphasize the importance of post-installation data, program designers should consider mechanisms to recoup the costs of incentivized units from contractors if they do not provide the required post-installation data.

- **Implement quality-control measures**: We suggest establishing a quality-control program to verify proper installation by contractors and to ensure the accuracy and completeness of post-installation data. Quality-control checks can help identify and address any installation issues early, ensuring high standards are maintained and that the data collected is reliable and useful for evaluating the program's success and areas for improvement.

Abbreviations and Acronyms

Acronym	Meaning
AEA	Association for Energy Affordability
AWHI	Advanced Water Heating Initiative
CSLB	California State Licensing Board
DAC	Disadvantaged communities
EMH	Electrify My Home
ESA	Energy Savings Assistance
ESMAC	ENERGY STAR® Heat Pump Water Heating Manufacturers Action Council
HPWH	Heat pump water heater
HVAC	Heating, ventilation, and air conditioning
IOU	Investor-owned utility
LMI	Low- or moderate-income
NEEA	Northwest Energy Efficiency Alliance
PG&E	Pacific Gas and Electric Company
PLA	Plug Loads and Appliances, a CalNEXT program
RHA	Richard Heath and Associates, Inc.
SCE	Southern California Edison
SGIP HPWH	Self-Generation Incentive Program, Heat pump water heater
TECH	Technology and Equipment for Clean Heating
V	Volt
WH	Water heater

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Introduction

Heat pump water heaters (HPWHs) are a critical technology for California to electrify new and existing buildings. But residential contractors are slow to adopt this emerging technology because of their skepticism about its performance, their uncertainty of the value proposition to customers, the potential complexity of installation, and future impact of electric rate increases (TECH Clean California Low-Income Advisory Board, 2023). The CalNEXT Increasing HPWH Deployment project teamed with Technology and Equipment for Clean Heating (TECH) Clean California to overcome barriers to adoption. TECH Clean California is a statewide initiative approved as part of Senate Bill 1477 to accelerate the adoption of clean space and water heating technology across California homes to help California meet its goal of being carbon-neutral by 2045.

The project's goal was to install 25 120-volt (120V) HPWHs into the homes of contractors already licensed to install water heaters. The 120V HPWHs could vastly increase customer adoption by reducing installation costs and time. The 120V units plug directly into existing shared or dedicated circuits at the water heater (WH) location, eliminating the need for electrical wiring and/or electrical panel upgrades. Electrical wiring is one of the most substantial barriers to HPWH installation, as it adds significant cost to the customer and upgrade scheduling and implementation can delay HPWH installation (NBI 2023). California State Licensing Board (CSLB) rules can compound delays; CSLB requires electrical work be performed by a C-10 licensed contractor, rather than the contractors traditionally allowed to install WHs (C-20 and C-36). Since C license contractors cannot subcontract (only B license contractors can), the customer must hire two different contractors to complete a HPWH installation. The CSLB has since clarified their rules to allow C-20 and C-36 contractors to add additional wiring without a C-10 license (but not upgrade a service panel), however this rule change is not widely known or publicized, and the barrier remains.

This project sought to show contractors, through training and first-hand experience, the benefits of 120V HPWHs: the ease of installation, and their capability to deliver adequate hot water without requiring a second contractor to upgrade electrical infrastructure.

This report provides the following findings from this project. The report covers these findings through the following sections:

- **Background**: An overview of the challenges with and status of HPWH adoption, including the problem, technical insights, and the market landscape.
- **Objectives**: The specific outcomes this project sought to achieve.
- **Methodology and Approach**: The activities to recruit and train contractors, install HPWHs, and capture data to achieve the project's objectives.
- **Findings**: The results from the project include data on progress against objectives, key observations, and challenges encountered.
- **Recommendations**: Recommended strategies and tactics for future similar programs, based on the project's results.

Background

Problem Statement

The workforce needed to achieve the California Carbon Neutrality Roadmap goal of installing six million heat pumps, including HPWHs, by 2030 does not yet exist (CARB 2022). Contractors lack experience with and willingness to sell HPWHs to customers. As a result, HPWH adoption to date lags behind heat pump heating, ventilation, and air conditioning (HVAC), largely because the plumbing market tends to be more conservative as a whole and is not accustomed to the kinds of continuous technology advances that are seen in HVAC (Lebrasseur 2023). Experience by other implementers, such as Northwest Energy Efficiency Alliance (NEEA) and Efficiency Maine, suggests that contractors' first-hand home experience with the product significantly increases their willingness to recommend it. Given that 85 percent of California's residential water heaters are fueled by gas, those buildings likely lack the electrical connections and panel capacity necessary for another 240V appliance (Khanolkar 2022). Installing 240V appliances requires at least a new circuit to the WH location and potentially an electrical panel upgrade. Additionally, the added load may also trigger a service upgrade from the local utility. The installation of 240V HPWHs, therefore, requires a customer to hire both an electrician and a plumber, adding to the project cost. Depending on the project's effect on the electrical panel and wiring, the customer may even need to involve their utility, further lengthening the process of installation. Because most HPWHs currently available on the market are 240V models, the added cost of electrical work presents prohibitive cost barriers to much of the market.

In a California Heat Pump Residential Market Characterization and Baseline Study (Opinion Dynamics 2022), it was reported that approximately eight percent of water heaters are replaced each year, often due to sudden failures requiring immediate replacements. This statistic highlights a significant opportunity for increasing the adoption of energy-efficient water heating technologies such as HPWHs during these replacement events. When water heaters fail, homeowners typically need immediate replacements, often opting for the most readily available and familiar options, which are usually conventional electric or gas models.

This replacement-on-burnout scenario presents a critical barrier to the wider adoption of HPWHs. Homeowners may not have the time to research or wait for more efficient models like HPWHs, leading to missed opportunities for energy savings and reduced environmental impact. To address this barrier, it is essential to increase the availability of HPWHs and ensure that contractors are well-equipped to install these units quickly and efficiently, even in emergency situations.

The barriers that are effectively eliminated by using 120V rather than 240V HPWH technology include:

- A reduced or eliminated need for a C-10 electrical contractor,
- A reduced potential load increase on the local electrical utility,
- A reduced/eliminated need for electrical panel upgrade, and

- Faster installation for customers.

Technical Insights

The Increasing HPWH Deployment CalNEXT project utilizes 120V models instead of the 240V models. Whereas 240V HPWHs often require the complicated and expensive installation processes described above, 120V HPWHs only require plumbers to change the fittings on the plumbing fixtures, size the unit to the building, and plug the unit into a wall outlet. In homes with WHs located in a garage or other indoor space, this is a simple process. For customers with WHs in exterior closets, a new circuit will still need to be run, since those units rarely have existing electricity. This advantage cuts both the time and cost of the installation process in most cases.

For customers, 120V HPWHs offer different benefits and drawbacks from 240V units. 120V HPWHs are up to five times more efficient than standard gas water heaters. While electric HPWHs capture significant efficiency gains over fossil fuel water heaters, HPWHs draw on the grid at peak times but can be programmed to shift water heating to off-peak hours. Additionally, HPWH units with an EcoPort (CTA-2045 port) can connect to utility programs for additional energy cost savings. Lastly, customers can adjust the temperature and track energy usage, enabling them to change settings to Away/Vacation mode remotely. These features will enable more granular demand-side management capabilities, including load shifting and demand response.

The drawbacks of the 120V units include slower recovery times, which can and should be offset by increasing tank size, installing a thermostatic mixing valve, and raising the temperature to 140 degrees. Adding 15 more gallons of hot water for the customer to use offsets the longer recovery period.

Current Market Landscape

Distributors across California carry 120V HPWHs. The main distributors that stock HPWHs include Ferguson, Pace, Hajoca, Hirsch, and Heating and Cooling Supply. They act as the primary intermediaries to pass information about HPWHs from manufacturers on to contractors, much of which comes in the form of education and training. Distributors are key actors in advertising HPWHs to contractors, and in encouraging them to transition away from the gas market.

A study conducted by Pacific Gas and Electric Company (PG&E) on the midstream market and field test of HPWHs identified significant barriers to HPWH adoption in California, including a lack of contractor familiarity with the technology. The study stressed the need for more contractor training and education to effectively promote and install HPWHs, which are crucial for the state's clean energy initiatives (PG&E 2022). Contractor unfamiliarity with the technology reinforces skepticism around HPWHs and creates a negative feedback loop in the supply chain leading to greater and greater barriers to growing the HPWH market. Because contractors are cautious about recommending technology with which they are unfamiliar to their customers, the contractors are less likely to advertise HPWHs to customers. Customers, who generally trust their contractors' professional advice, perceive the technology as unreliable, compared with the gas or electric resistance models they currently own and, therefore, demand for HPWHs stagnates. If customers and contractors do not purchase these models, there is no reason for manufacturers to produce more of these models or invest in research to improve them; low supply keeps the price of the HPWHs high and out of reach of the customers.

Overcoming this market pattern was the impetus of the CalNEXT Increasing HPWH Deployment project, which was marketed to contractors as the 120V Heat Pump Water Heater Field Study. This study introduces contractors to the technology and trains them in the installation process. The intended result of the program was to convince contractors to recommend 120V HPWHs for their customers, cultivating market demand and giving manufacturers reason to expand production.

As of June 2024, about 1,024 HVAC and plumbing contractors have enrolled in TECH Clean California, roughly 20 percent of the total population of 5,060 licensed plumbers in California. Notably, only 27 contractors have actively engaged in the CalNEXT Increasing HPWH Deployment project by installing 120V units. This underscores a considerable opportunity for the expansion in the certification and adoption of HPWHs among contractors within the state.

Relevant Historical Market Trends.

The HPWH market is so new, very little data exists, making market analysis challenging. There are no historical trends from which to learn lessons. Further, the lack of historical market trends and data makes it difficult to overcome hearsay regarding HPWHs among contractors and to provide contractors with facts about the functionality of the technology.

120V HPWHs are in the nascent stages of market availability, but they will likely advance along the market adoption curve. Currently, only two manufacturers produce 120V units, Manufacturer 1 and Manufacturer 2, and Manufacturer 2 just released its unit in October 2023. The historic growth of the domestic HPWH market was 2.7 percent between 2018 to 2022 (Gupta and Sharma 2023). As of 2022, the market share of HPWHs in the United States is still relatively small, accounting for just under two percent of the overall water heater market. This indicates an emerging but increasing adoption, likely driven by HPWH's energy-efficiency and environmental benefits, compared with traditional water heating methods (Fortune Business Insights 2023, Wachunas 2023). However, the growth of HPWH sales nationwide hit 26 percent year-over-year in 2022 and is projected by the Department of Energy to remain steadfast through 2040 (Wachunas 2023). This jump will be supported as many more manufacturers work to release 120V models soon. TECH anticipates that 120V units will hold an increasing share of the HPWH market.

Industry Standards, Regulations, or Best Practices

Chapter 5 of the California 2022 Building Energy Efficiency Standards contains the industry standards for HPWH installations and California code enforcement permitted through jurisdictions. Jurisdictions can vary in interpretation of the standards. Work is underway to correct differences in code interpretation through training programs implemented by California's Regional Energy Networks.

For example, a lack of clarity remains on the issue of requiring the water heater to be on a pedestal. Gas-fired water heaters must be placed on a pedestal because there is a flame near the ground. However, HPWHs do not combust fuel, nullifying the technical need for this requirement.

Additionally, jurisdictions are requiring the same methods to handle condensates from different types of water heaters that produce condensates with differing compositions. Traditional tankless water heaters produce acidic condensate and, therefore, require a dry well. HPWH condensate contains only water. However, some jurisdictions are unnecessarily requiring HPWHs to have dry wells, too.

Another jurisdictional code issue has become an issue with 120V HPWH units, which are largely designed to be on shared circuits (unless designed explicitly for dedicated circuit). Some jurisdictions are requiring all 120V HPWH units to be on dedicated circuits, thus defeating the purpose of 120V HPWH unit.

Lastly, some jurisdictions require a full diagram layout of a home, showing the location of the HPWH to be prepared even if the new appliance is not moving from the original appliance's location. This requirement unnecessarily increases the workload involved in the installation process of the HPWHs, especially when the new appliance remains in the original appliance's location. The publication, "Best Practices for the Retrofit Installation of Heat Pump Water Heaters," which was developed under a TECH Clean California Quick Start Grant project completed by Richard Heath & Associates, Inc. (RHA), TECH developed the "Heat Pump Water Heater Best Practices and Field Guide" (Richard Heath & Associates and TECH Clean California 2023). The guide is aimed at standardizing HPWH training in California. It includes a checklist for instructors creating new training curricula; a guide for those developing the guidelines, standards, and certifications and a resource guide for installers. However, it is not an instruction manual for HWPH installations. The publication of this guide is intended to ensure the safe and efficient installation of HPWHs in California.

In March 2023, the Bay Area Air Quality Management District adopted Regulation 9, Rules 4 and 6, which prohibits residential and commercial space and water heating appliances that emit nitrogen oxides, e.g., natural gas furnaces and water heaters. The regulation will phase in beginning in 2025. The regulations also call for detailed examination and reporting about market readiness, equipment costs, and impacts of the standards, prior to their effective date.

The CalNEXT Increasing HPWH Deployment project follows TECH Clean California's workforce standards, which include an approved HPWH installation training. Contractors must be CSLB C-20 or C-36 licensed. CalNEXT's Increasing HPWH Deployment project uses TECH Clean California's workforce standards to mitigate the duplication of work and processes that could slow the installation process. Contractors must follow Title 24 requirements, specifically the Energy Code for water heaters, Part 6, 2022 version.

Training for existing workforce contractors is delivered by three TECH Clean California Program Partners: Association for Energy Affordability (AEA), Electrify My Home (EMH), and the National Comfort Institute. HPWH specific training is offered by AEA, EMH, and through the TECH Clean California partnership with the ENERGY STAR® Heat Pump Water Heating Manufacturers Action Council (ESMAC).

Overview of TECH

Authorized by Senate Bill 1477, TECH Clean California is a market transformation initiative designed to increase the adoption of high-efficiency, low-emissions space and water heating technologies that put the state on a path to zero-carbon homes by 2045. The TECH Clean California team was selected following a competitive proposal process and the program launched in 2021.

In July 2022, Governor Newsom announced a goal of installing six million heat pumps by 2030, with 50 percent of benefits flowing to low-income households and disadvantaged communities. TECH Clean California focuses on supporting heat pump market transformation, with a dedicated focus on supporting adoption in low-income and disadvantaged communities (DACs) — 40 percent of program

funding targets equity customers. Inspired by the California Solar Initiative's successful market transformation model, TECH Clean California's program strategy is based on three strategic pillars that will help California meet its heat pump goals:

- **Pillar One**: Spur the clean heating market through statewide incentives, training, and consumer engagement.
- **Pillar Two**: Address adoption barriers and create scalable models through regional pilots.
- **Pillar Three**: Leverage TECH program data to inform California's long-term building decarbonization framework and future investment (Energy Solutions, 2023).

Collaboration with TECH Clean California

The Increasing HPWH Deployment project was intended to augment TECH's Learn and Earn program, which focuses on 240V units. Funds from CalNEXT were used solely for purchasing 120V HPWH units for delivery through the TECH Learn and Earn program. As part of this project, TECH provided opportunities to educate contractors on training around customer incentives available from TECH, as well as those from the Self-Generation Incentive Program HPWH (SGIP HPWH program), the investor-owned utility (IOU) Plug Load and Appliance (PLA) program, and other resources, to aid in their sales process to their customers. The project was coordinated with stakeholders in the Plug Loads and Appliances (PLA) and SGIP HPWH programs for project planning input.

Objectives

The objectives for this project were:

1. Ensure contractors have the knowledge to choose the best equipment type for the customer (240V vs 120V).
2. Expand contractor experience with 120V HPWH installations to remove electric service barriers to adoption and increase HPWH adoption.
3. Collect bill impact analysis and contractor satisfaction results will inform future program designs for disadvantaged community (DAC), low- or moderate-income (LMI), small commercial, and multifamily customer applications.
4. Seek to answer questions such as:
    a. Do the CalNEXT participants utilize TECH incentives at greater rates than average TECH contractors?
    b. Do they install more 120V units than average?
    c. Do these contractors prefer installing the 120V units over the 240V units?
    d. Do they have to complete complimentary measures (i.e., panel upgrades) in order to complete installation?
    e. Do they have to do any remediation more than a 240V unit installation (e.g., space concerns)?

f. Were there unforeseen barriers that could have been mitigated prior to installation?

Methodology and Approach

Conceptual Framework

As identified in CalNEXT's 2022 Water Heating Technology Priority Map, a lack of contractor knowledge and willingness to recommend HPWHs has been a key barrier in the adoption of this technology. The Increasing HPWH Deployment project aimed to test whether exposing contractors to HPWHs and providing them with training could increase HPWH adoption. By installing 25 HPWHs into the homes of plumbing contractors within electric IOU territory (SDGE, PG&E, SCE) so that they experience the process of installation and using 120V HPWHs, the study aimed to alleviate uncertainty about the units' performance, specifically that they do not produce enough hot water. By approaching contractors living in DACs first, the program placed special emphasis on contractors living in and serving DAC communities, where panel upgrades and additional electrical work constitute a significant financial burden and barrier to HPWH adoption. The project team hypothesized that with new, first-hand experience with HPWHs, contractors would be more willing to recommend these units to their customers, ultimately accelerating HPWH adoption. The study sought to perform a time series analysis to compare the satisfaction of contractors with HPWHs and installation rates of contractors that participated in this program against the installation rates of contractors that did not participate.

The program carried out the following:

1. Outreach and recruitment
2. Training
3. Installation of free HPWH units (by contractors)
4. Data collection

Outreach and Recruitment

The project team conducted a coordinated outreach campaign to recruit contractors, reaching more than 400 contractors through channels, including phone calls, distributor emails, and in-person events.

The project's initial goal was to distribute 75 to 80 free 120V HPWH units for contractor sales teams and installers serving LMI or DAC communities to install in their homes. We revised this goal to 25 120V HPWHs due to limited contractor uptake of the free 120V HPHW offer. Most contractors opted for 240V HPWHs because of an early negative review of 120V units, which is discussed in the findings section. The Increasing HPWH Deployment project advertised the opportunity to contractors through distributors and manufacturers. In response, contractors either connected directly with the program or through the distributors or manufacturers. Because one manufacturer was the only one with commercially available 120V HPWH models, most of the contractors were already affiliated with this manufacturer and possessed C-36 licensing. Some contractors were already enrolled in TECH Clean California and had previously installed 240V products from the same manufacturer. These

contractors already had experience and training from the manufacturer, making them a quick start option for the program. The other contractors were encouraged to join the TECH Clean California program and to participate in SGIP as that program launched. Some were Energy Savings Assistance (ESA) contractors who install water heaters for low-income programs. The program did not approach subcontractors or affiliates of TECH to partake in the pilot.

Due to initially low recruitment numbers, the team conducted additional outreach by directly contacting contractors from the TECHs Learn and Earn pipeline. When dealing with smaller contractor companies, the owner often served as the main point of contact and typically responded positively. However, larger companies frequently required communication through administrative personnel, which sometimes complicated securing timely participation from the owner. Additionally, contact with one installer proved challenging due to that individual's limited availability amidst work commitments. These interactions underscored that contractors represent a diverse group, necessitating a flexible approach to outreach methods. This is particularly crucial during peak seasons and for companies managing both HVAC and HPWH installations. The program team individually called and emailed contractors who expressed interest in the CalNEXT Increasing HPWH Deployment project to inform them about the opportunity to receive 120V HPWHs. Upon expressing interest, they completed a survey form (Appendix A), and upon satisfying program requirements, they were provided with an order form to proceed with the acquisition process.

Training

To receive the free HPWHs, contractors needed to complete an individual training by the manufacturer. The training component of the CalNEXT Increasing HPWH Deployment project was central to this study because the trainings were how contractors became familiar with both the business and technological aspects of HPWHs and built enthusiasm for the equipment. Additionally, this component of the project gave the project team the opportunity to evaluate how training affects the development of the HPWH market.

Individual training by manufacturers was dedicated to specific training on their products and the 120V units. It was either live and/or pre-recorded and often delivered by local distributors. In trainings, the manufacturer confirmed that the participant understood unit sizing, use of thermostatic mixing valves, location considerations, and CTA-2045 ports. If a contractor completed the training online, the contractor was required to follow up in-person with a manufacturer representative for the opportunity to ask questions. The manufacturers tested contractors on their knowledge before the free 120V units were distributed to verify retention of training. Certification from either manufacturer was a requirement for the receipt of free HPWH units.

Training for 120V HPWHs is essential due to the unique characteristics and installation requirements of this technology:

1. Specialized technical knowledge: The 120V HPWH operates differently from higher voltage models and traditional water heaters. Training ensures that installers understand these specific operational differences and the technology's unique aspects, enhancing efficiency and performance.
2. Installation precision: Given that 120V units may be more suited for settings with existing electrical constraints, training helps installers properly assess and prepare the installation

site, including understanding the electrical load and compatibility with existing infrastructure. This is crucial for avoiding overloads and ensuring that the unit functions correctly without requiring significant electrical upgrades.

3. **Regulatory compliance**: Training provides up-to-date knowledge on local regulations and standards specific to 120V systems, including safety standards and electrical codes. This knowledge is critical for ensuring that installations are compliant and secure.
4. **Customer assurance**: Installers trained specifically in 120V HPWH technology are better equipped to address customer concerns regarding the adequacy and efficiency of lower-voltage units, compared with traditional models. This can help in building customer confidence and satisfaction.
5. **Market readiness**: As energy-efficiency standards become more stringent and consumer preference shifts towards more sustainable technologies, having specific expertise in 120V HPWH installations positions contractors to meet these evolving demands effectively.

Provision of Free 120V Units

After completing training, contractors conducted the entire retrofit process with a free HPWH to install in their own home. The contractors thus gained practical experience in selecting an appropriate model, sizing the units properly, and installing the units in their own homes following manufacturer guidelines, thereby increasing their comfort in installing units. This stage was also crucial to removing the workforce barriers to HPWH adoption because the contractors live with the units, they know how to navigate the selection process, are comfortable with the installation process, and know how to maintain the units. This stage solidifies contractors' trust and enthusiasm for HPWHs.

Recipient contractors submitted an order through TECH, with the contractors specifying unit sizes to be installed and their preferred distributor. The program required the teams to sign a terms and conditions waiver that forbade resale of the units. TECH notified the contractors when the units were ready for pick up.

Data Collection

TECH Clean California created unit replacement and data collection procedures that followed TECH/SGIP guidelines to standardize data format (TECH Clean California 2023). We sought to collect the following data:

- Address where the unit was installed
- Previous unit fuel, type, and capacity
- Photos of installations for verification

One month after the installation, recipients were sent a survey to learn about their experience with their water heater. The survey included questions on how well the heater delivered expected hot water capacity, any issues with recovery times, and the recipients' comfort in recommending the 120V product to their customers. Four months after installation, a follow-up survey was conducted with contractors to gather data on bill impact and continued satisfaction. Additionally, contractor

performance on customer installations was tracked through customer surveys on both TECH and SGIP programs.

Contractor recruitment, enrollment, and training on 120V HPWHs included the following:

1. Contractors enrolled in TECH Clean California got an account and were assigned an account manager with TECH Clean California partner, Frontier Energy.
2. Frontier confirmed contractors' CSLB (Contractors State License Board) number for eligibility: Contractors must have a C-36, C-20, and/or General B license. Frontier set up an automatic daily check on CSLB and investigated expired licenses.
3. Contractors signed up for manufacturer training.
4. Contractors took manufacturer training and received a certificate.
5. Manufacturers sent certificates of completion to TECH Clean California; we verified certificates.
6. TECH Clean California sent emails to contractors requesting HPWH model and employee recipient information and providing terms and conditions.
7. Contractor replied to an email with HPWH information.
8. TECH Clean California issued purchase orders and sent requests to distributors.
9. Distributors sent confirmation/order details to TECH Clean California.
10. TECH Clean California sent confirmation to contractor.
11. TECH Clean California received invoice, made notes in purchase order logs, and sent to accounts payable.
12. Contractor installed HPWH.
13. TECH Clean California requested post-install data immediately following installation, and then once again 30 days later.
14. Contractor sent post-install data to TECH Clean California.
15. TECH Clean California logged post-install data and verified program data points.
16. TECH Clean California confirmed all data as accurate and closed contractor interaction.

Findings

Distributors emerged as a crucial leverage point in marketing this opportunity, acting as trusted messengers within their existing networks. They were motivated to support the project due to its potential to accelerate technology adoption and develop future market opportunities. Email communications facilitated by distributors proved more effective in capturing contractor attention than standalone energy efficiency programs. Similarly, distributor-hosted events provided an

excellent platform for engaging contractors, with the project being invited to participate in weekly discussions. These events offered opportunities to address questions and guide contractors through the sign-up process, which was particularly beneficial for those with limited online presence. By engaging with distributors directly, the team streamlined the ordering process, making it more efficient for contractors to acquire the necessary equipment quickly.

Initial outreach efforts recruited eight contractors, and additional outreach led to a total recruitment of 26 contractor companies, all of which were retrofit-focused. Among these, nine were based in rural areas, and 17 were in Disadvantaged Communities (DACs). These initial units in DACs help ensure that the project's 120V HPWHs were equitably distributed, while also building capacity for future installations in these areas under other energy-efficiency programs.

Although the total outreach led to the distribution of 56 120V HPWHs, challenges within the project prevented the fulfillment of the original goal of distributing 75 to 80 units, as detailed in the Post-Installation Data Collection section below. Of the distributed units, 25 were successfully installed and post installation data recorded. Distribution details are summarized in Table 1, with a breakdown by service territory provided in Table 2.

During the CalNEXT field study, 11 out of 26 participating contractors submitted applications through TECH before participation. However, participation levels remained unchanged for these contractors after receiving their free 120V HPWH although it should be noted that funding for HPWH through TECH Clean California was exhausted far more rapidly than expected, and the recipient contractors may simply not have had enough time to adapt sales processes. Longer incentive runways would have alleviated these concerns.

Data from TECH's Learn and Earn Program revealed contractor preferences for 240V units as compared with 120V units, despite manufacturer-specific training. Contractor employees across 93 companies ordered a total of 239 240V units compared to 25 120V units. This preference likely stems from perceived functional defects in previous versions of 120V units, as reported anecdotally by other contractors. According to the New Buildings Institute, "we heard a few complaints from installers and customers about manufacturing defects and malfunctioning units. Examples include an oversensitive sensor, a leaky tank, and a missing control panel. While most of these are not 120V technology-specific, special attention is required to eradicate manufacturing defects from HPWHs" (New Buildings Institute Staff 2023).

Some contractors faced challenges in installing units due to workload constraints and the competing priority of paid jobs, resulting in lower-than-expected survey participation. This issue was particularly pronounced among contractors who installed both HVAC systems and HPWH units. The summer season, being a high-demand period for HVAC work, required these contractors to focus on their primary, revenue-generating activities. Consequently, they could not prioritize the free 120V HPWH installations. Based on the team's findings, it appears that 88 percent of contractors involved in CalNEXT did not submit additional applications after completing the study. This underscores the need for project timelines and expectations to account for seasonal workload fluctuations and the prioritization of paid work.

Table 1: 120V HPWH Distribution

Tank Size	Number Distributed
50 Gallon	5
40 Gallon	1
66 Gallon	11
65 Gallon	23
80 Gallon	16
Total	**56**

Source: Increasing HPWH Deployment project tracking data

Table 2: 120V HPWH Distribution by Service Territory

Electric IOU	Number Distributed
Pacific Gas & Electric	24
Southern California Edison	31
San Diego Gas & Electric	1
Total	**56**

Source: Increasing HPWH Deployment project tracking data

Contractor Training Results

Contractor training played a pivotal role in the project, deepening the understanding of this emerging technology among installers. As part of the training requirements, staff from all participating contractor companies underwent training facilitated by manufacturers. Although the team did not receive feedback from all units delivered, the training program still promoted significant uptake and engagement.

Feedback on the training was insightful. One distributor manager noted, "Our 120V HP sales remain small. We feel that our product is superior to competition from a performance perspective, but we are at a disadvantage with some rebate programs like the Golden State rebate. We'll need to wait to 2025 and beyond to make an assessment on contractor comfortability."

The project also garnered positive anecdotal feedback from contractors about the training's impact on their own understanding and comfort with 120V HPWHs:

"*The heat pump was a smooth installation, and we were able to test out some of the venting options for the unit, which was a great learning experience for understanding how we can get these units into more homes. The program has definitely helped us better understand the different tiers, from 120V builder model to 240V with leak guard, and ways to install these into different sections of the home. Thank you for the great opportunity*."
— Participating Contractor

"*Our family business started nearly 75 years ago, and we might be among the most conservative and traditional plumbers around! Your program has created quite a buzz here and we are steadily coming on board with hybrid water heater replacements for customers*."
— Participating Contractor

Post-Installation Data Collection and Analysis

One of the key challenges in this project was gathering post-installation data from contractors, despite increased efforts since the Preliminary Findings Report. We received feedback from 25 contractors and compared results between TECH contractors who participated in the Increasing HPWH Deployment project and those who did not.

Comparison of TECH Contractor Participation Rates

Since the project team aimed to determine whether Increasing HPWH Deployment contractors utilized TECH incentives at greater rates than average TECH contractors, we applied the following filters to the dataset:

- TECH HPWH claims only
- Closed Paid status only
- Submitted 2/27/2024 or later

Preliminary data suggested that Increasing HPWH Deployment contractors did not utilize TECH incentives at greater rates than average TECH contractors. Only seven claims were submitted by Increasing HPWH Deployment contractors, representing just three unique contractors. This small sample size should be considered when reviewing the following data points:

- **TECH Incentives**: Contractors who participated in the Increasing HPWH Deployment project received a much smaller average TECH incentive than other TECH contractors: $2,977 vs. $4,292. This difference is likely due to the HPWH Deployment contractors installing fewer HPWHs and submitting fewer claims.
- **Equipment Type**: All equipment installed by the Increasing HPWH Deployment contractors were 240V (no 120V equipment was installed), whereas general TECH contractors installed about 20 percent 120V equipment.
- **Claims Submitted**: Only 2.6 percent of HPWH claims within the filtered data set were submitted by Increasing HPWH Deployment contractors.

Adoption of 120V HPWH Units

Increasing HPWH Deployment contractors are not more likely to install 120V HPWHs than other TECH contractors. Several factors may contribute to this slow adoption rate, including the limited project duration, the availability of only one manufacturer for 120V units at the time, and other unidentified factors.

Structural Challenges

The project faced structural challenges that hindered the collection and analysis of all planned post-installation data. These challenges primarily involved contractor incentives and implementation time, which together prevented sufficient unit distribution and data collection from contractors. These lessons will be valuable for future water heating and electrification projects, as detailed in the Recommendations section.

Barriers to Collecting Feedback

To increase contractor participation, the project was designed with a low barrier to entry, requiring contractors to complete manufacturer training to receive free 120V HPWH units. However, this low barrier resulted in weak motivation for contractors to provide post-installation data. To address this, the project scope was revised to include a $1,000 participation fee (broken into two payments to match data collection plans) to encourage post-install feedback per installed unit. Although this fee did help motivate some feedback, challenges remained.

Project Timeline and Contractor Feedback

The project, initially approved in December 2022 with a completion deadline of December 2023, was extended to June 2024 to allow adequate time for start-up, recruitment, training, distribution, and data collection. Contractors agreed to install units within 30 days of receipt, however some requested extensions. Feedback was ultimately collected from 20 contractors who met the installation conditions:

- **First-month feedback**: Collected by Opinion Dynamics, focusing on home usage and contractors' willingness to recommend the 120V product.
- **Four-month follow-up survey**: Assessing contractor satisfaction and bill impact.

Survey Results

Figure 1 presents feedback from contractors regarding their experiences with the 120V HPWH units installed as part of the Increasing HPWH Deployment project.

Almost all the contractors (24 out of 25) did not require any panel or electrical upgrades to install the 120V HPWH units. Similarly, additional construction work was generally unnecessary, with only 4 out of 25 contractors needing to perform such tasks.

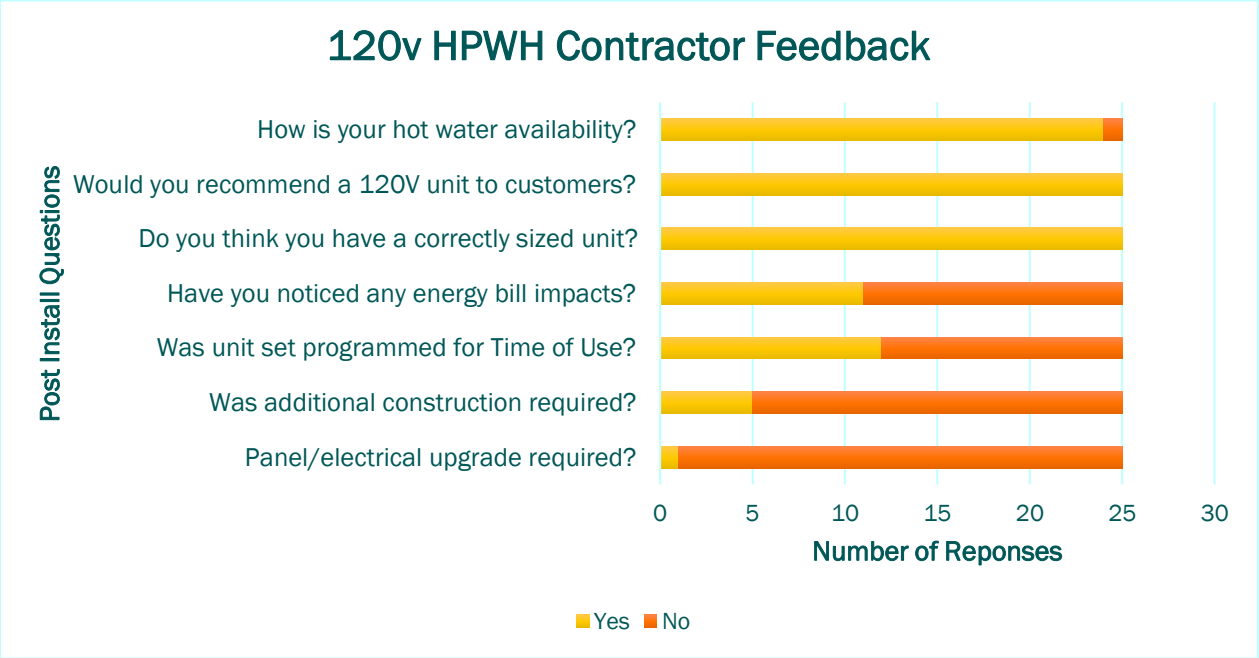
Regarding the programming of units for Time of Use, opinions were divided: 12 contractors programmed the units for Time of Use, 13 did not. When asked about the impact on energy bills regarding the HPWH as a whole, 11 out of 25 contractors reported noticing changes, whereas 14 did not observe any significant impacts.

Contractors were unanimous in their assessment of the unit size, with all 25 respondents agreeing that they had installed correctly sized units. They were also unanimous in their willingness to recommend the 120V HPWH units to customers, demonstrating a high level of satisfaction with the product.

Lastly, hot water availability was not a major issue, with 24 out of 25 contractors reporting no problems. Only one contractor mentioned experiencing occasional problems with hot water availability.

Overall, the feedback reflects a positive experience among contractors, characterized by minimal installation challenges, a general satisfaction with unit performance, and a strong willingness to recommend the product to customers.

Figure 1: 120V HPWH contractor feedback



Source: Increasing HPWH Deployment project tracking data

Select Participant Feedback

“Thank you for the Heat Pump Water Heater. I finally have it installed. I also added a Point-Of-Use hot water recirculating pump. It only comes on when you know that you are going to use hot water by pushing a button on the remote, or through a downloadable app. I have installed around 12 of these Manufacturer 1 HPWH's and finally have one of my own.”

"I have however noticed that this particular model, even though it is marketed to be quietest, is not as quiet as the Ruud. I believe the decibels might be a bit less, but the frequency of the sound is a bit annoying. It makes me wonder how many people I told these are based on the brochure. Their experience would be different because they wouldn’t have had another heat pump water heater in there before."

Barriers

1. **Lead time on unit orders:** Delays in acquiring the units due to manufacturer production and distributor inventory levels slowed study execution.
2. **Requirement to install into employee homes:** The requirement to install units into employee homes presented logistical challenges, especially where these employees live in geographically dispersed areas. Many employees were tenants, so their participation was constrained by factors such as lease agreements or limited authority over property modifications, potentially impacting sample representation.
3. **Concerns about an increase in the electricity bill, not sold on the new technology.** Some contractors were worried about an increase in electricity bills and were not sold on the new technology to be more efficient. “Why would I change my HPWH if there is no problem with the one I have now?
4. **Employee homeowners also likely to have on-demand (tankless) systems that they aren't interested in giving up:** Homeowners among the employee cohort possessed existing on-demand systems, leading to a reluctance to switch to the study-provided units, thereby affecting participation rates.
5. **Concerns about meeting the 30-day deadline for providing feedback:** Participants expressed apprehensions about their ability to adhere to the stipulated 30-day feedback submission deadline, due to time constraints and technical impediments.
6. **Installers may not have enough time to complete the installations or that these installations will take time away from other customer installs:** The installers encountered time constraints in executing installations within prescribed time limits, which led to operational inefficiencies or affected their capacity to fulfill other paid client obligations.

Recommendations

The experience of the Increasing HPWH Deployment project has resulted in recommendations that can benefit other HPWH and electrification programs. These recommendations are:

- **Increase implementation time:** Similar contractor engagement and training programs should plan an implementation stage extend at least 18 months, depending on scale.

Extending the implementation time allows for thorough training, sufficient time to install the units, sufficient time for contractors to gain experience with the units, and the opportunity to collect comprehensive post-installation data. This will enhance the effectiveness of a program and ensure robust data for analysis.

- **Plan around incentive runway**: TECH Clean California exhausted funding for HPWH units through SGIP HPWH in the middle of this study, which impacted potential contractor sales of 120V units. Future projects should ensure that incentives will be available, making it possible to assess the impact of the free units provided to contractors over a longer period of time.
- **Leverage established relationships with distributors and manufacturers:** To enhance the HPWH deployment program, project teams should leverage established relationships with distributors and manufacturers. Engaging these partners streamlines the contractor enrollment, and contractors are key to the adoption and advocacy of 120V HPWHs. This collaboration speeds up the ordering process and enables contractors to conveniently pick up units at the nearest distributor location. Maintaining and leveraging these strategic partnerships in other IOU programs promotes wider acceptance and adoption of 120V HPWHs, leveraging the credibility and influence of these early adopters and their extended networks.
- **Incorporate 120V HPWHs in income-eligible programs:** To further the accessibility of energy-efficient technologies in low-income households, IOUs should accelerate the integration of 120V HPWHs into income-eligible programs. These units less expensive and easier to install, particularly in disadvantaged communities (DACs) with older electrical infrastructures that might otherwise necessitate costly upgrades for 240V units; and they also demonstrate robust performance and reliability. Post-installation surveys indicate a low percentage of issues concerning water heater performance and hot water availability, underscoring their suitability for widespread use. By promoting 120V units, it is possible to significantly reduce installation barriers and costs, advancing electrification efforts in DACs.
- **Emphasize comprehensive training:** The study team found that manufacturer training on new unit technologies improved contractor comfort with HPWHs. IOUs should incorporate manufacturer-specific training into HPWH programs to ensure contractors are well-prepared and confident in installing and maintaining these units. Comprehensive training has led to higher-quality installations, greater contractor satisfaction, and more reliable performance of the units.
- **Integrate data collection and operations:** Program designers should integrate data collection needs into operations during planning. Implementing data collection from the outset streamlines the process and ensures the efficient collection of critical information. To reinforce this and emphasize the importance of post-installation data, program designers should consider mechanisms to recoup the costs of incentivized units from contractors if they do not provide the required post-installation data.
- **Implement quality-control measures**: We suggest establishing a quality-control program to verify proper installation by contractors and to ensure the accuracy and completeness of post-installation data. Quality-control checks can help identify and address any installation issues early, ensuring high standards are maintained and that the data

collected is reliable and useful for evaluating the program's success and areas for improvement.

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Appendix A: Marketing and Outreach Materials

Figure 2:TECH x CalNEXT HPWH 120V field study flyer

TECH CLEAN CALIFORNIA

120V Heat Pump Water Heater Field Study

What you receive

- A free 120V heat pump water heater to install in your home
- A $1,000 installation participation fee once the details and photos have been submitted
- Lots of hot water!

Who can participate

- Installers of water heaters for a TECH Clean California enrolled contractor company
- Other employees of the TECH Clean California enrolled contractor company

What you need to do

- On the order form, complete pre-installation details on existing water heater.
- Sign participant agreements.
- Sign an electronic disclosure to allow research team access to energy consumption data.
- Replace the existing gas water heater with a new 120V heat pump water heater at no cost to the participant, **within 30 days of receiving the unit**.
- Submit pictures of the installed unit and provide details of the installation.
- Share your experience with the equipment through periodic satisfaction surveys.

All personally-identifying information provided by the participant to the field study team will be strictly confidential. Field study data will be aggregated and anonymized prior to results publication.

Eligibility

- ✓ Existing gas or propane water heater (any gas provider)
- ✓ Utility electric customer of: Pacific Gas & Electric (PG&E), Southern California Edison (SCE), or San Diego Gas & Electric (SDG&E)
- ✓ Small households (maximum four people) with low to medium hot water demand
- ✓ Single family and multifamily homes up to four units

Get started at qrco.de/120vHPWH

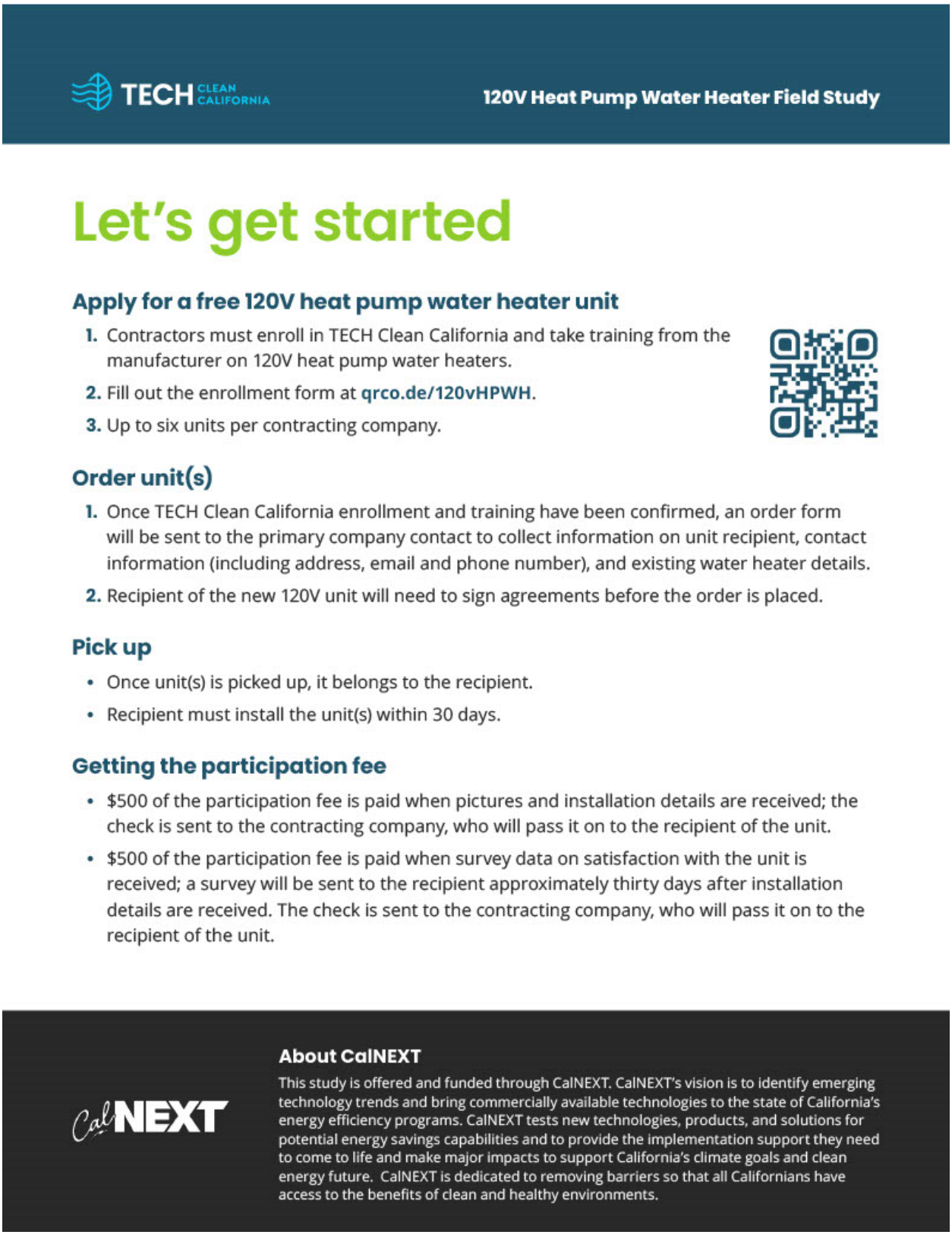


Figure 3: Enrollment form for the 120V HPWH field study

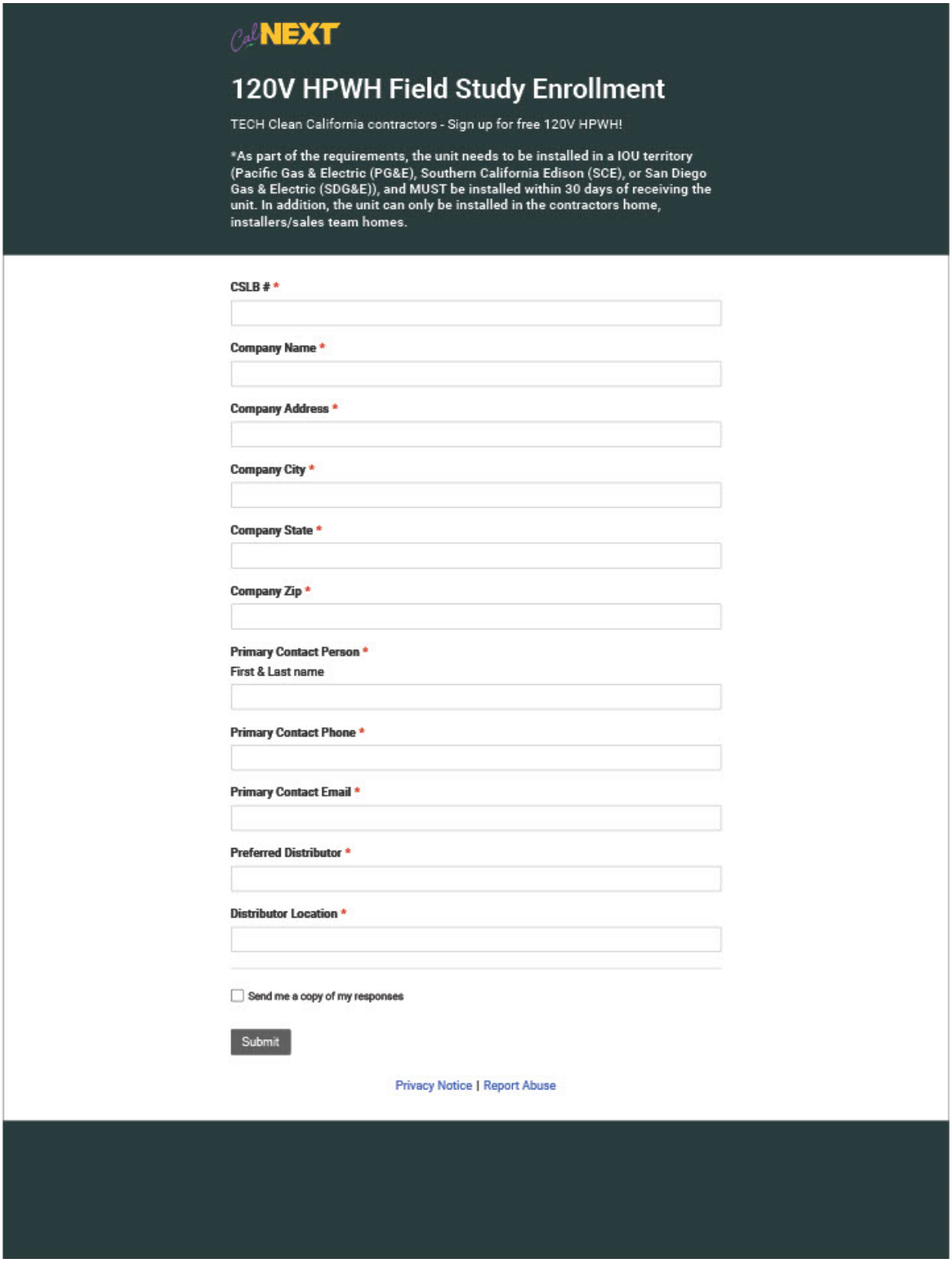
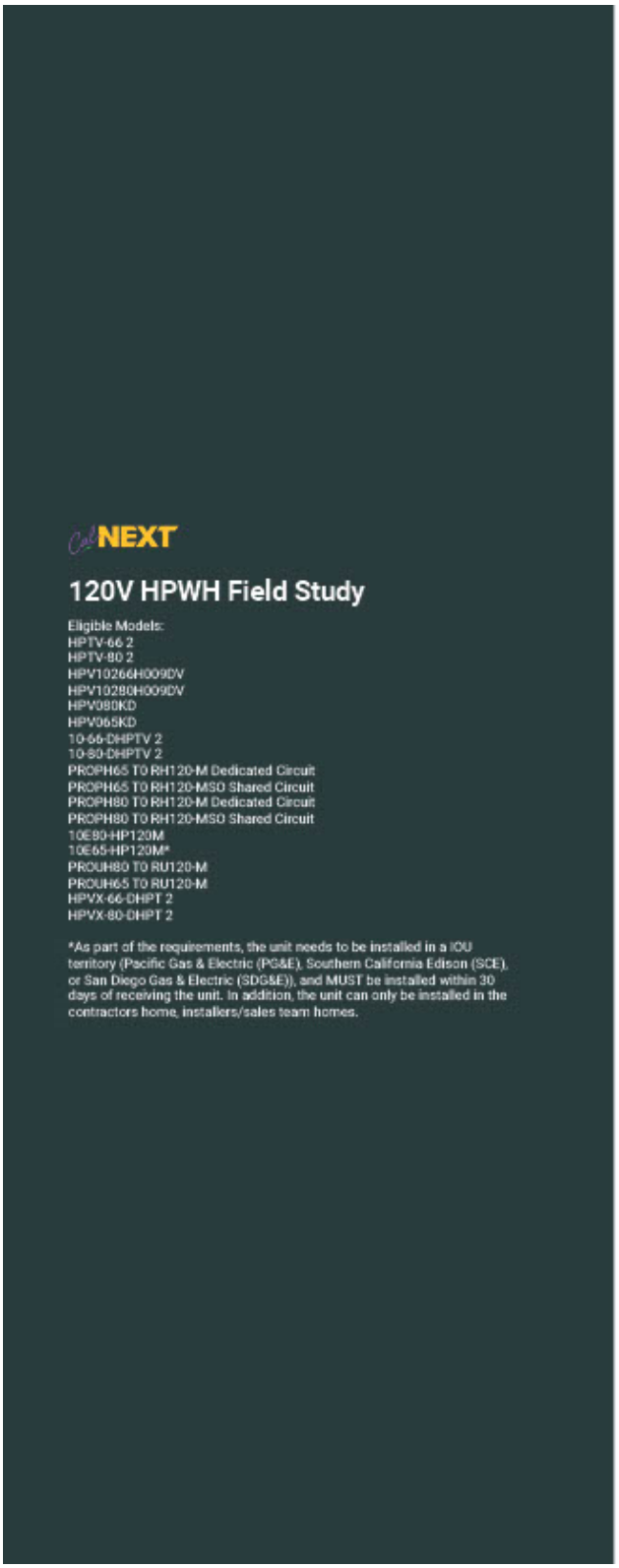


Figure 4: HPWH order form


CalNEXT
120V HPWH Field Study
Eligible Models:
HPTV-66 2
HPTV-80 2
HPV10266H009DV
HPV10280H009DV
HPV080KD
HPV065KD
10-66-DHPTV 2
10-80-DHPTV 2
PROPH65 T0 RH120-M Dedicated Circuit
PROPH65 T0 RH120-MSO Shared Circuit
PROPH80 T0 RH120-M Dedicated Circuit
PROPH80 T0 RH120-MSO Shared Circuit
10E80-HP120M
10E65-HP120M*
PROUH80 T0 RU120-M
PROUH65 T0 RU120-M
HPVX-66-DHPT 2
HPVX-80-DHPT 2
*As part of the requirements, the unit needs to be installed in a IOU territory (Pacific Gas & Electric (PG&E), Southern California Edison (SCE), or San Diego Gas & Electric (SDG&E)), and MUST be installed within 30 days of receiving the unit. In addition, the unit can only be installed in the contractors home, installers/sales team homes.


Terms & Conditions *
1. Participating Trade Professional may install in their own residence, employee's residence, or their place of business. Under no circumstances is the Participating Trade Professional allowed to re-sell the units to other entities. To ensure compliance, the program team is collecting serial numbers of the installed equipment to track installations.
2. Recipient agrees that CalNEXT and TECH Clean California may track energy consumption changes related to the installation of this equipment as part of participation for up to two years after installation.
3. All equipment warranties and ownership pass to the recipient upon taking possession from the distributor.
CSLB *
Company *
Manufacturer *
Select or enter value
Model *
New Unit Gallons *
Recipient Name *
First & Last name
Recipient Email *
Recipient Phone
Recipient Address *
Recipient City *
Recipient State *
Recipient Zip *
Electric Utility Provider *
Old WH Unit Gallons (put tankless for tankless) *
Old WH Unit Type *
Select or enter value
Old Unit Fuel Type *
Select or enter value
Old Unit Location *
Select or enter value
Send me a copy of my responses
Submit
Powered by smartsheet
Privacy Notice | Report Abuse