Midstream Heat Pump Water Heater (HPWH) Study and Field Test

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ABBREVIATIONS AND ACRONYMS

AB	Alpha Beta
CCA	Community Choice Aggregator
CCE	Community Choice Energy
CEC	California Energy Commission
CEU	Continuing Education Units
CPUC	California Public Utilities Commission
CTA-2045	Modular communications interface (MCI) to facilitate communications with residential devices for applications such as energy management
DPA	Distributor Participation Agreement
DR	Demand Response
EE	Energy Efficiency
ERWH	Electric Resistance Water Heater
GHG	Greenhouse Gas
HP HVAC	Heat Pump Heating, Ventilation and Air Conditioning
HPWH	Heat Pump Water Heater
JA13	Joint Appendix 13
NBI	New Building Institute, Inc.
PG&E	Pacific Gas & Electric Company
POS	Point-of-sale
TECH	Technology and Equipment for Clean Heating
TMV	Thermostatic Mixing Valve

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EXECUTIVE SUMMARY

This report presents the results from the Heat Pump Water Heater (HPWH) Supply Chain Market Study (referred to herein after as "Midstream Market Study") that informed the Midstream Financial Inducement Field Test (referred to herein after as "Midstream Field Test") that tested a solution for engaging midstream market actors to accelerate the adoption of connected HPWHs for load shifting. This project builds on the knowledge gained during the WatterSaver beta test, another PG&E Emerging Technology Project (ET20PGE1231) which tested connected technologies and solutions for overcoming implementation hurdles before the full-scale launch of WatterSaver, a behind-the-meter-thermal storage program.

The HPWHs studied in this project were compliant with California Energy Code Title 24, Part 6, Joint Appendix (JA13) and capable of load shifting. When HPWHs are installed with load shifting enabled, customers can shift their energy use from peak to off-peak periods, helping to reduce overall energy demand on the grid. The report reviews barriers to adoption of HPWHs as identified by the Midstream Market Study and the results of the Midstream Field Test to provide recommendations for future PG&E HPWH programs.

PROJECT GOAL

One goal of this project was to identify barriers and solutions to the adoption of HPWHs across midstream actors through research and direct market interviews. The second goal was to determine the effectiveness of a distributor HPWH equipment incentive to overcome the major adoption barrier of high installation costs that limit demand and therefore, motivation to stock readily available HPWHs at distributor locations.

PROJECT DESCRIPTION

The Midstream Market Study can be found in Appendix A and documents results from 44 interviews across different types of HPWH supply chain stakeholders to assess knowledge, perceptions, and barriers to increasing adoption of connected HPWHs. Stakeholders included local government building department staff, single and multifamily contractors, distributors, retailers, Community Choice Aggregation (CCA) and Community Choice Energy (CCE) staff, and multifamily property managers, owners, and staff. Based on these interviews, implementation and incentive strategies were proposed to influence market behavior to overcome the identified barriers to HPWH installations.

The Project Team then designed the Midstream Field Test to evaluate one of the strategies identified in the Midstream Market Study, a financial inducement (referred to herein after as "incentive") offered to distributors to stock and upsell connected HPWHs and thermostatic mixing valves (TMVs). The Midstream Field Test also worked with distributors to develop collateral to help educate sales staff on the benefits of connected HPWHs and TMVs to help them successfully sell to their customers.

Both the Midstream Market Study and Field Test focused on four specific geographic regions with a specific mix of the characteristics of incentive offerings, permit office support and workforce development that created three different use cases. This allowed for comparing the success of market interventions to increase the adoption of connected HPWHs across the three use cases and determining if the characteristic of that specific region impacted the

results. These regions were the San Francisco Bay Area North Bay, San Francisco Bay Area South Bay, Central Valley, and Central Coast.

PROJECT RESULTS

The main results from the Midstream Market Study collected from the interviews were the documentation of the top three barriers for increasing adoption of connected HPWHs. These barriers are organized by supply chain stakeholder and are in Table 1.

TABLE 1. MIDSTREAM MARKET STUDY: TOP BARRIERS PER STAKEHOLDER GROUP

STAKEHOLDER	BARRIER 1	BARRIER 2	BARRIER 3
Local Gov't Building Department staff	Lack of contractor familiarity with HPWH technologies	Lack of building department staff knowledge of code requirements related to HPWHs	Building department business practices and workflows lead to slow and inconsistent permitting practices for HPWHs
Single Family Contractors	High cost of unit and for installation (especially compared to like-for-like replacement)	Difficulty in convincing the customer to purchase a HPWH	Lack of skilled workforce to install HPWHs driven by lack of workers and unique skills to install a new, complex technology requiring venting kit, condensation, etc.
Multifamily Contractors	Lack of experience to sell, size, engineer and install HPWHs	Higher first cost of HPWH installation compared to like-for-like water heater replacement. This is especially important in multifamily situations that commonly go out to bid for water heater installation with the lowest cost bid winning.	Increased complexity of HPWH installations due to needing electrical infrastructure upgrades and building modifications such as external ducting and/or installing the ability for condensate discharge
Distributors	Lack of motivation to stock HPWHs due to low customer demand	Lack of training for residential sales staff on HPWHs	Residential HPWH sales are focused on first cost instead of lifecycle cost, and have a quick sales cycle
Retailers	Insufficient customer demand to justify using additional storage space to stock HPWHs	Lack of contractor's knowledge and comfort to sell HPWH	Higher first cost of HPWH units resulting in low consumer demand
CCAs/CCEs	Lack of stock of HPWHs	Increased electricity bill after installing a HPWH due to lack of rate-based incentives for HPWHs	Lack of skilled workforce and training
Multifamily Property Managers and Owners	Higher first cost of HPWH equipment and installation compared to like-for-like water heater replacement	High soft costs due to lack of HPWH knowledge create a higher time commitment from the project owner to gain the needed knowledge and/or share the HPWH knowledge to complete the water heater project	Funding opportunities and HPWH incentive models do not align with the financing processes for the different types of upgrades e.g., acquisition rehabilitation, 15-year syndication, capital improvements, refinancing, emergency replacements

Stakeholder	Barrier 1	Barrier 2	Barrier 3
Multifamily Maintenance Staff	HPWH retrofits for emergency replacement take too long due to installation complexities and permitting. A permit is not usually pulled in a like-for-like replacement.	Perception that HPWH retrofits add complexity (during installation and future maintenance), which adds to staff workload and is outside of job scope	Maintenance staff are not receiving upper management directive to prioritize HPWH installations

The Midstream Field Test ran from September 2021 to November 16, 2022, and enrolled two distributors, who were active in submitting incentive applications from July 2022-Novemeber 2022. The structure of residential sales, delayed introduction of connected HPWHs to the market, as well as supply chain slowdowns caused by COVID-19 are all factors that impeded distributor participation. Frequent touch points helped engage distributors, and access to HPWH products motivated participation in the final quarter of the Field Test. The Field Test paid a total of $162,000 toward distributor sales of 139 connected HPWHs and 115 TMVs. Both distributors were located in Region 3, the San Francisco Bay Area South Bay, resulting in 97 percent of incentives being paid in that region. With incentive application data limited to one region, the field test results were not able to answer the research questions from the three use cases.

Data collection was completed for the Midstream Field Test through a customer survey with a 24 percent response rate and distributor interviews. These results in combination with the incentive application data showed the following observations in Table 2:

Table 2. Midstream Field Test: Observations from Data Collection Sources

HPWH Adoption Barrier	Observation
High First Cost	Cost for customers remains a consideration across the supply chain
	There is not always a strong correlation between increased tank size and increased unit or project cost
	Project complexity that may increase price have various levels of impact
Lack of HPWH Stock	Participating distributors appreciated the Field Test
	Product availability does not seem to be a major issue for the participating distributors anymore but originally was a major issue
	Most HPWH installations were early retirement
Lack of HPWH Knowledge and Need for Additional HPWH Training	Perceived slow HPWH first hour recovery, especially in the wintertime
	Mixed assessment of realized and perceived energy and cost savings after installation of a HPWH
	Contractors are a key source for providing customers information about HPWHs
Load Shifting Insights	Most HPWH models require additional hardware to enable connectivity
	Separate purchase of a TMV suggests that programmatic intervention and tracking is better at the contractor level, to confirm it is installed
	Most customers use features on their HPWH to control equipment energy use

Contrary to Midstream Market Study interview findings conducted a year earlier, distributors did not indicate availability of HPWHs from manufacturers as a barrier to stocking and selling HPWHs and instead focused on the need for reliable contractor demand and training. The more successful distributor made all their HWPH sales for which they submitted incentives applications to, to one contractor that was a recipient of a TECH Clean California

Quick Start Grant that provided HPWH incentives. Distributor feedback about motivations to participate in the Field Test highlight the importance of a reliable contractor demand.

PROJECT RECOMMENDATIONS

Supply chain slowdowns and equipment shortages due to COVID-19 impacted connected HPWH product availability for the majority of the Field Test, though this had started to lessen during the last four months. Therefore, the impacts of the distributor incentive were inconclusive as Distributors did not apply for incentives due to lack of equipment over the full year allotted. It is recommended that a distributor incentive be extended so that it can be tested during 12 to –24-month period when qualifying equipment is available market wide, and the market is not impacted by COVID-19 supply chain issues. Given the positive correlation between contractor demand and distributor participation, it is recommended that midstream distributor incentive programs also include educational HPWH materials for contractors to learn about and market the benefits of connected HPWHs to their customers

INTRODUCTION

Accelerating the deployment of connected, load shifting HPWHs is an essential part of California achieving its climate change goals and ambient air quality standards, while offering ratepayer benefits, as outlined in California's 2016 Assembly Bill 2868 (AB 2868).[1] Currently, 25 percent of California's greenhouse gas (GHG) emissions are generated from the building sector, two-thirds of which can be attributed to space and water heating.[2] HPWHs use energy at a rate that is up to four times more efficient than conventional water heaters, thereby having the potential to reduce annual California household emissions by 46-54 percent statewide.[3] Further, with HPWHs customers enjoy increased safety without the risk of carbon monoxide or nitrogen oxide leaks and also benefit from the longer lifespan of HPWHs (up to 13-15 years as compared to conventional units that require replacement every eight to 12 years).[4] In addition, connected HPWHs have load shifting capability that also helps balance energy demand on the grid.

Realizing these HPWH benefits and reaching California's goal to install six million heat pumps by 2030 will require a significant increase in scale. The California Public Utilities Commission (CPUC) estimates that around 800,000 water heaters are replaced annually in California,[5] yet HPWHs account for as little as 2.2 percent of the water heating market nationally, with less than half possessing load shifting capabilities, according to New Buildings Institute (NBI). The California market for water heating grew 5 percent between 2009 and 2019, and in 2019 HPWH units accounted for only 1 percent of the total water heating installs that took place.[6] Furthermore, in California, 80 percent of subjects interviewed in a "California Heat Pump Market Characterization and Baseline Study" conducted by Opinion Dynamics "described the current market for HPWHs in their service territories as somewhere in the range between small and non-existent."[7] Even with the adoption of the California Energy Code Title 24, Part 6, Joint Appendix (JA13) that provides

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[1] *California AB 2868, (*Sabin Center for Climate Change Law, 2022*).* https://lpdd.org/resources/california-ab-2868/

[2] *Building Decarbonization,* (California Air Resources Board, 2022) https://ww2.arb.ca.gov/our-work/programs/building-decarbonization

[3] Pierre, Delforge. (2018). "Electric Heat Pumps Can Slash Emissions in California Homes." NRDC (Expert Blog). https://www.nrdc.org/experts/pierre-delforge/electric-heat-pumps-can-slash-emissions-california-homes

[4] *Are Heat Pump Water Heaters Worth the Cost?,* . (Consumers Unified LLC, 2022). https://www.consumeraffairs.com/homeowners/heat-pump-water-heater-value.html

[5] *CPUC Provides Additional Incentives and Framework for Electric Heat Pump Water Heater Program.* (CPUC, 2022). https://www.cpuc.ca.gov/news-and-updates/all-news/cpuc-provides-additional-incentives-and-framework-for-electric-heat-pump-water-heater-program

[6] *California Heat Pump Residential Market Characterization and Baseline Study.* (Opinion Dynamics, 1000 Winter Street, Waltham, MA, 2022). https://pda.energydataweb.com/api/view/2625/OD-CPUC-Heat-Pump-Market-Study-Report_Final.pdf

[7] *California Heat Pump Residential Market Characterization and Baseline Study.* (Opinion Dynamics, 1000 Winter Street, Waltham, MA, 2022). https://pda.energydataweb.com/api/view/2625/OD-CPUC-Heat-Pump-Market-Study-Report_Final.pdf

a credit for water heater load shifting, connected HPWH market growth has remained low in new construction as well.

Coordinated connected HPWH efforts like WatterSaver, WatterSaver beta test and this Midstream Market Study and Field Test are needed to increase the quantity of connected HPWHs and to realize the load shift potential of HPWHs. WatterSaver is a behind-the-meter load shifting program that dynamically controls water heaters to shift energy usage off the evening peak. The Midstream Market Study and Field Test were designed to build upon knowledge gained during the WatterSaver beta test, another PG&E Emerging Technology Project (ET Project Number: ET20PGE1231), which answered research questions to inform the full-scale WatterSaver pilot program.[8] Like the Midstream Market Study, the beta test revealed that the lack of availability and stock of HPWHs at distribution centers is a potential barrier to widespread adoption. Therefore, the Midstream Field Test explored ways to remove this barrier to increase the readily available inventory of HWPHs.

MIDSTREAM FOCUS

The Midstream Project provided an opportunity to learn about and leverage the position of distributors to increase the installation rate of HPWHs and TMVs. Midstream actors can be an optimal point of intervention given their influence with contractors, as well as their general awareness of the latest products available. Offering incentives at the midstream level can help lower the cost difference between conventional and higher efficiency products. Lowering the cost of new products can give distributors greater confidence that shifting their stocking practices will result in sales. In turn, manufacturers are more likely to build these connected HPWHs knowing distributors are purchasing and selling them. Together, these motivations help overcome the barrier of costs to sufficiently stock HPWHs as identified in the Midstream Study found in Appendix A.

Additional reasons for targeting midstream actors for market transformation:

- Educating distributors can help educate other market actors about the benefits of this new technology as distributors may use incentive spend toward educating their sales staff and contractors, who then educate customers.
- Incentives can influence distributors to increase their stock of connected HPWHs and TMVs, and therefore have units on hand to meet the needs of same-day emergency replacement, which drives the majority of residential water heater sales.[9]
- Coordination with a small number of distributors can influence widescale market impacts across an entire territory, at a relatively low program cost.[10]

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[8] *WatterSaver Beta Test Final Report,* (Richard Health & Associates, Inc., 2020).

[9] *Why it works: Understand how the market chain benefits when incentives* target distributors, Energy Star. https://www.energystar.gov/products/retailers/midstream_programs/why_it_works

10 *Why it works: Understand how the market chain benefits when incentives target distributors,* Energy Star.

https://www.energystar.gov/products/retailers/midstream_programs/why_it_works

- Distributors may be more likely than customers to participate in incentive programs for new and expensive technologies as they are often concerned with product quality and performance characteristics versus "first cost."[11]

- Distributors often prefer to sell the more efficient products for the higher profit margins and are often willing to cooperate with incentive programs and provide feedback for study purposes.[12]

EMERGING TECHNOLOGY

While HPWHs were first introduced over 20 years ago, General Electric was the first manufacturer to introduce the technology in a significant way in 2009.[13] Rheem, AirGenerate, Stiebel Eltron, and A.O. Smith then introduced HPWH models that same year. These manufacturers produce models that now qualify for ENERGYSTAR certification and are eligible today for program incentives and a federal tax credit.

Unlike other types of water heating technologies that generate heat to increase water temperature, HPWHs use heat pump technology to heat water by transferring heat from the surrounding air to the water in the HPWH storage tank. A fan draws in ambient air, and heat in the air is absorbed by refrigerant in the unit's evaporator coil. Refrigerant then moves through the unit's compressor where refrigerant temperature is further increased. Then the hot refrigerant is circulated through heat exchange coils where heat is transferred to the water in the tank. This heat transfer process also cools and dehumidifies the air surrounding the HPWH from which the heat is absorbed.

By transferring rather than generating heat, HPWHs are up to three times more efficient than conventional water heaters such as electric resistance water heaters (ERWHs) and those that burn natural gas, propane, or oil. The uniform energy factor (UEF) metric is used to report the energy efficiency of water heaters – a higher UEF indicates higher efficiency. HPWHs typically have a UEF between 2.2 and 3.5, compared to a typical UEF range of 0.6 to 0.95 for conventional water heaters.[18] Since they absorb heat from the ambient air and release cooler air, HPWHs operate most efficiently when stored in a space with excess heat as opposed to a cooler environment.[19]

In addition to their higher energy efficiency, connected HPWHs have advanced features that offer benefits to customers and the grid. Connected HPWHs can have native Wi-Fi controls, add-on Wi-Fi capabilities, integrated or add-on support for communication modules like the EcoPort, or other after-market control solutions. These controls can receive signals from utilities or aggregators to direct water heaters to change their operation in response to demand response events or to shift daily operations to times of lower electricity demand.

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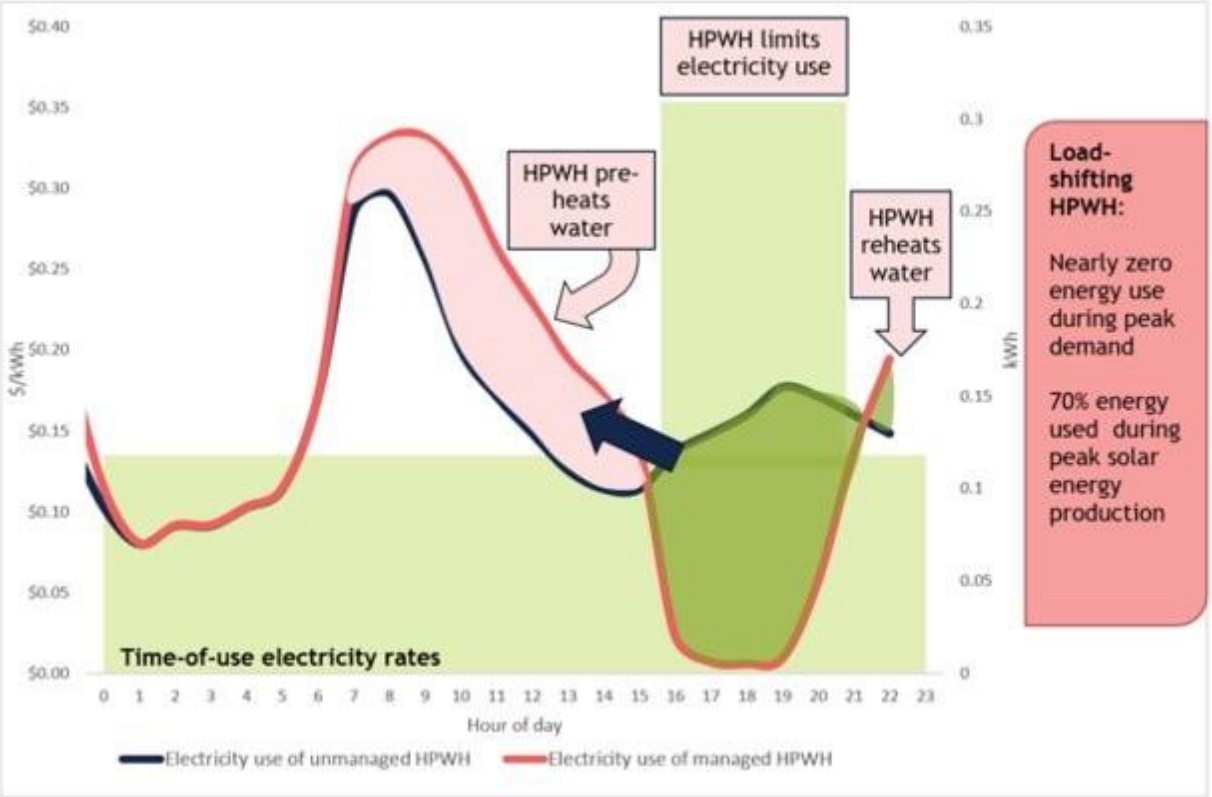
11 *Why it works: Understand how the market chain benefits when incentives target distributors,* Energy Star.
https://www.energystar.gov/products/retailers/midstream_programs/why_it_works

12 *Why it works: Understand how the market chain benefits when incentives target distributors,* Energy Star.
https://www.energystar.gov/products/retailers/midstream_programs/why_it_works

13 Franco H.V., Lekov A.B., Meyers S., Letschert V., Heat Pump Water Heaters and American Homes: A Good Fit? (2010)

For example, connected HPWHs can receive signals to automatically heat water during off-peak hours when renewable generation is abundant. This limits the need to heat water in the evening when electricity demand is high, reducing electricity demand on the grid. This can also reduce the need for higher-polluting generation sources to meet evening electricity peaks.

HPWH load shifting is possible because electric water heaters can store energy by acting as a thermal battery that uses energy to heat water at optimal times and storing that energy in the form of hot water for later use. A thermostatic mixing valve (TMV) is a valve that mixes cold and hot water to provide consistent and safe water outlet temperatures and prevent scalding. Connected HPWHs with a TMV installed can heat water to temperatures higher than the common set point of 120°F to temperatures as high as 140°F, so customers can enjoy higher thermal storage capacity without an increased risk of scalding. The ability to preheat and store water at a higher temperature increases usable hot water and can reduce the need to upsize a storage tank.



Source: NRDC 2020

FIGURE 1. VISUAL OF HPWH WITH LOAD SHIFTING

Figure 1 depicts water heater energy usage, with and without shifting electricity usage to off-peak hours. The black line is what a water heater's electricity consumption would look like without load shifting. The red line shows water heater operation with load shifting. With load shifting, water heater electricity use increases between 8:00 a.m. and 3:00 p.m., when solar is abundant, and then dramatically decreases during the late afternoon and evening

hours when electricity prices are higher. This graphic helps illustrate how load shifting capabilities can help reduce energy strain on the grid.

The U.S. Department of Energy's Pacific Northwest National Laboratory (PNNL) conducted a study titled "Heat Pump Water Heaters Achieve Significant Peak Reduction and Energy Savings," that compared connected HPWHs with ERWHs and found that 90 percent of a consumer's evening peak load could be reduced with a connected HPWH.[20] By taking advantage of the increased product efficiency and the ability to shift load by preheating water during off-peak hours, customers that upgrade to a connected HPWH can reduce their operating costs by up to 50 percent compared to a traditional ERWH, resulting in average savings of $200-$400/year.[21] Though in California, the majority of customers upgrading to a connected HPWH have an existing natural gas water heater.

California policy developments continue to support connected HPHWs. JA13 requires that HPWHs possess load shifting capabilities and include a TMV installation to be eligible for an optional building code compliance credit. Additionally, the Self Generation Incentive Program (SGIP) HPWH Program approved in CPUC decision 19-09-027 will require incentivized HPWHs to be installed along with a TMV and be enrolled in a demand response program.

METHODOLOGY

This section provides an overview of the methodology used to complete the Midstream Market Study and Midstream Field Test. It also includes an overview of region selection with full details found in Appendix A.

REGION SELECTION

The HPWH Project focused on four different regions across PG&E territory, each with unique characteristics, to gain a greater understanding of HPWH installation barriers. The regions were selected based on a methodology that allowed for testing the impacts of a midstream incentive across multiple use cases. Regions varied based on county locations, distributor incentives, and the TECH Clean California contractor and/or permit training. Three use cases for research were identified across the four regions.

FIGURE 2. MIDSTREAM PROJECT: HPWH REGION SELECTIONS

Characteristic	REGION 1 BayREN North Bay	REGION 2 Central Valley	REGION 3 BayREN South Bay	REGION 4 Central Coast
Geographic Coverage	Contra Costa, Marin, Napa, Solano, and Sonoma County	San Joaquin, Stanislaus, Merced and Fresno County	San Francisco, San Mateo, Santa Clara, and Alameda County	Monterey, San Benito, and Santa Cruz County
TECH Clean California Components	Monthly trainings per region; Ongoing contractor coaching; Permit office training	None	Monthly trainings per region; Ongoing contractor coaching; Permit office training	None
TECH Clean California Incentives	Statewide contractor incentives			
Midstream HPWH Study	None	Distributor + thermostatic mixing valve (TMV)*	Distributor	Distributor + TMV*

*The TECH Regional Pilot, Market Readiness for HPWH Load Shifting, will provide a contractor TMV incentive in the BayREN region. To allow for testing the impacts of a distributor TMV inducement the HPWH project will not overlap with the distributor TMV inducement in regions with a TECH Contractor TMV incentive.

The combination of characteristics and regional differences resulted in a plan to test three different use cases:

- **Use Case 1**: Comparing results from Region 1 and Region 3 to determine the impact of the distributor incentive in a region with existing workforce development, permit office support, and contractor incentives
- **Use Case 2**: Comparing Region 2 and Region 3 to determine the impact of workforce development and permit office training in regions with both contractor and distributor incentives
- **Use Case 3**: Comparing Region 2 and Region 4 to determine the impact of geographic differences in areas that both had a distributor and contractor incentive but did not have workforce development nor permitting office support

However, during the HPWH Project, multiple changes took place with TECH Clean California that changed the three different use cases.

- Initially Use Case 3 was planned to test the impact of a distributor incentive in Region 4, an "clean slate" area without any other incentives or training, but TECH Clean California adjusted their incentive eligibility and in December 2021 expanded the contractor HPWH incentives to all of California. Therefore, Use Case 3 was adjusted to determine the impact of geographic characteristics as Region 4 is coastal and Region 2 is inland.
- Use Case 1 and 2 were developed to test the impact of layering a distributor and contractor incentive but the budget for TECH Clean California was fully reserved in May 2022 and could only be tested as running concurrent for a shorter period.

MIDSTREAM MARKET STUDY

The first step of the Midstream Market Study that was completed was a literature review to identify common HPWH adoption barriers and collect program design key insights that would inform subsequent project activities. This included reviewing 28 HPWH reports written between 2015 and 2021 that focused on electrification, load shifting, decarbonization efforts, policy changes, retrofits, midstream programs, peak demand, and market barrier insights. The report review methodology involved extracting and organizing common barriers and key insights from existing HPWH reports to gain a high-level understanding of the industry's current knowledge. In addition to the review of industry reports, interviews were conducted with Richard Heath & Associates (RHA) and Demand Side Analytics (DSA) regarding their experiences implementing and evaluating the WatterSaver beta test. These interviews provided a deeper understanding of challenges and lessons from a real-world program example. Learnings from both efforts were considered when developing future program design concepts to overcome barriers to increasing the adoption of connected HPWH programs.

The literature review provided a summary of existing reports and research. The next step was for Energy Solutions, along with partners Frontier Energy and Associate for Energy Affordability (AEA), to conduct market interviews to confirm the most current barriers to increasing the adoption of connected HPWHs. The Project Team performed 44 interviews across different market stakeholder types and four different geographic regions to understand current HPWH installation and replacement practices. The specific areas of interest for each stakeholder group are summarized in Table 3.

TABLE 3. MIDSTREAM MARKET STUDY: STAKEHOLDER INTERVIEW DETAILS

STAKEHOLDER TYPE	NUMBER INTERVIEWED	SUBJECT OF INTERVIEW
Local government building and department staff	6	Current water heating permitting, and inspection requirements related to HPWH installations
Single family and multifamily contractors	15	Practices for replacing gas water heaters and any insights on the impact of transitioning to HPWH installations
Distributors	4	Familiarity with HPWHs, existing equipment stocking practices, and the potential to increase the require regular stocking of HPWHs
Retailers	4 (and 2 manufacturers)	Stocking practices for and impacts of HPWHS, as well as their experience with, and sales process and purchase considerations for HPWHs
CCAs/CCEs	4	Existing outreach, education, and incentive programs. This information would be issued to help determine gaps and strategies for how these gaps can be addressed
Multifamily Property Managers and Owners	5	Unique concerns and structures that impact water heater planning, such as timing and funding for capital improvements
Multifamily Maintenance Staff	4	Burnout replacement and particularly emergency replacement, as that typically falls to on-site maintenance personnel

Based on the results from the interviews, installation barriers were identified, prioritized, and organized by stakeholder groups. Then implementation strategies were developed to overcome the three most impactful barriers per stakeholder and incentive strategies were developed to overcome the top barrier per stakeholder group. Of the strategies developed, the Project Team selected the HPWH incentive to distributors as the most impactful option and tested it in the Field Test portion of the HPWH project.

MIDSTREAM FIELD TEST

The Midstream Field Test tested the HPWH incentive to distributors and took place from September 2021 to November 2022. The distributor incentive aimed to overcome the main barrier to HPWH adoption, as identified by stakeholder interviews, which is the overall high cost of HPWH in replacement installations that limit demand and therefore, motivation to stock HPWHs.

The Midstream Field Test was designed to research the impact of a distributor incentive in areas with a contractor incentive being offered through TECH Clean California. Also, the distributor incentive was processed with the same platform paying the TECH Clean California contractor incentive as Energy Solutions was the implementor for both efforts. This structure provided a unique opportunity to increase data collection opportunities as contractors can capture additional information about a HPWH installation that a distributor may not be able to as the contractor works directly with the customer and is onsite for installation. Requiring distributors to report customer and site information added complexity and is a barrier to distributor participation as typically distributors do not request this information when they make a sale. The contractor incentive offered through TECH Clean California was fully subscribed in May 2022, prior to the conclusion of the Midstream Field test, resulting in layered data only being available for about 50 percent of the incentive applications.

The distributor incentive was a $1,000 reimbursement for the sale of a connected HPWH that would be installed in retrofit projects. Also, an additional amount of $200 was available if the sale also included a qualifying ASSE 1017 TMV since TMVs increase the load shift potential of each HPWH and provide safety benefits by reducing the chance of scalding. These incentive rates were chosen as they represented the average cost difference between a HPWH and a gas water heater of the same size and the cost of including a TMV at installation. These two incentives were predicted to help decrease concerns contractors or customers have about purchasing a higher cost product along with a TMV.

TABLE 4. MIDSTREAM FIELD TEST: INCENTIVE PROGRAM OFFERINGS

MEASURE CATEGORY	INCENTIVE RATE
Per HPWH	$1000.00
Per TMV	$200.00

Equipment that was eligible for the Field Test was unitary HPWH that meets the criteria defined by JA13. JA13 compliance requires that HPWHs are load shifting capable and are installed with a TMV conforming to the ASSE 1017 standard. The Field Test Distributor Participation Agreement (DPA) included a list of qualifying models that adhere to the JA13 standards. HPWH manufacturers Rheem, A.O. Smith, and Bradford White were considered eligible due to their load-shifting capabilities.

The distributor incentive was offered in regions 2, 3 and 4 which includes the South Bay area around San Francisco, the Central Valley, and the Central Coast as displayed in Figure 3. Site qualification was based on the site zip code.

FIGURE 3. MIDSTREAM FIELD TEST: COUNTIES ELIGIBLE FOR DISTRIBUTOR INCENTIVE APPLICATION SUBMISSION

To receive an incentive, the distributor completed an incentive application through an online platform that contained the information found in Table 5.

TABLE 5. MIDSTREAM FIELD TEST: INCENTIVE APPLICATION INPUTS

QUALIFYING EQUIPMENT INFO	QUALIFYING CUSTOMER INSTALLATION SITE INFO	QUALIFYING SALES INFO
Manufacturer	Site Address	Total Units Sold
Model Information	Site City	Invoice Number
Unit Serial Number(s)	Site Zip Code	
Uniform Efficiency Factor (UEF)		

To support the success of the Field Test, the Project Team provided training on the incentive application submission process, conducted meetings to answer questions and review any requests for resources to aid in the sale of HPWHs. The below resources were provided to distributor sales staff to inform on the incentive opportunity, educate about the benefits of connected HPWHs and increase confidence selling connected HPHWs to contractors:

- One-page overview and digital presentation of the midstream incentive for outreach to enroll distributors in the Field Test
- DPA that was signed by enrolled distributors that outlined the terms and conditions of the Field Test
- Sales flyer that provided an overview of the benefits of connected HPWHs and TMVs to aid in the sale of these products

RESULTS

Cross-stakeholder group interviews conducted through the Midstream Market Study revealed education, training, and program incentives as the key solutions to addressing top barriers. This Midstream Field Test demonstrated the importance of steady contractor demand in motivating distributor participation in an incentive program. This test collected and evaluated incentive application data, survey replies collected from customers and interview responses the participating distributors.

MIDSTREAM MARKET STUDY

The literature review identified the following program design considerations as most important to include in future programs dedicated to the advancement of HPWH market adoption:

- **Education, Training, and Tools:** Education at the customer and contractor levels is essential for growing consumer awareness of and demand for HPWHs. Additional training and tools for contractors will help them sell the benefits of HPWHs to customers and feel comfortable performing the installations. Contractor training will also help lower the time and cost required for the permitting process and installation.
- **Program Incentives:** Substantial HPWH incentives to reduce the high unit and installation costs will help customers gain value from upgrading their water heater. The Field Test will help identify where along the supply chain additional incentives can increase market adoption of connected HPWHs.

Following the literature review, the results from the supply chain interviews documented the barriers to adoption unique to each stakeholder group interviewed. The major barriers found are provided in Table 6 through Table 13 with the top three barriers listed in the first three rows.

The interviews were conducted with stakeholders in each of the different regions if possible and the barriers are also organized based on regions to determine whether geography or regional differences influenced the types of barriers stakeholders report. Figure 2 show the regions that were selected. A blank box in specific column of that row means the barrier was not brought up in that region or the team was not able to locate a stakeholder willing to participate in the interview in that region. The most common barriers found included the higher first cost of HPWH installations as compared to like-for-like replacements, and the lack of experience with HPWH installations and technical knowledge across all supply chain actors. The majority of barriers were mentioned across all four regions, with Region 2 having the lowest number of interviews.

TABLE 6. BARRIERS IDENTIFIED BY LOCAL GOVERNMENT BUILDING DEPARTMENT STAFF

BARRIER	REGION 1	REGION 2	REGION 3	REGION 4
*Lack of contractor familiarity with HPWH technologies	X		X	X
*Lack of building department staff knowledge of code requirements related to HPWHs	X		X	X
* Building department business practices and workflows lead to slow and inconsistent permitting practices for HPWHs	X		X	X
Lack of coordination between in-field and building department staff				X

*Top three barriers

TABLE 7. BARRIERS IDENTIFIED BY SINGLE FAMILY CONTRACTORS

BARRIER	REGION 1	REGION 2	REGION 3	REGION 4
*High cost of unit and for installation (especially compared to like-for-like replacement)	X	X	X	X
*Difficulty in convincing the customer to purchase a HPWH	X	X	X	X
*Lack of skilled workforce to install HPWHs driven by lack of workers and unique skills to install a new, complex technology requiring venting kit, condensation, etc.	X	X	X	X
Not enough space in the home to install the HPWH	X	X	X	X
Long delays in receiving new equipment or supplies due to supply chain constraints from the pandemic	X	X	X	X
Permitting and inspection is complex and not consistent across permitting jurisdictions.	X	X	X	X
Lack of awareness of what the product is, reliability, and energy saving potential	X	X	X	X
High cost of electrical panel upgrades	X			
Rebate programs that require bringing the whole building up to code			X	
No rebate program in the area				X
Hard to convince customer to get rid of gas appliances		X		
Customer information and education on HPWH			X	

*Top three barriers

TABLE 8. BARRIERS IDENTIFIED BY MULTIFAMILY CONTRACTORS

BARRIER	REGION 1	REGION 2	REGION 3	REGION 4
Lack of experience to sell, size, engineer and install HPWHs	X	X	X	X
Higher first cost of HPWH installation compared to like-for-like water heater replacement. This is especially important in multifamily situations that commonly go out to bid for water heater installation with the lowest cost bid winning.	X	X	X	X
Increased complexity of HPWH installations due to needing electrical infrastructure upgrades and building modifications such external ducting and/or installing the ability for condensate discharge	X	X	X	X

TABLE 9. BARRIERS IDENTIFIED BY DISTRIBUTORS

BARRIER	REGION 1	REGION 2	REGION 3	REGION 4
*Lack of motivation to stock HPWHs due to low customer demand	X	X	X	X
*Lack of training for residential sales staff on HPWHs	X	X	X	X
*Residential HPWH sales are focused on first cost instead of lifecycle cost, and have a quick sales cycle	X	X	X	X
Lack of stock of HPWHs and grid connected HPWHs	X	X	X	X

*Top three barriers

TABLE 10. BARRIERS IDENTIFIED BY RETAILERS

BARRIER	REGION 1	REGION 2	REGION 3	REGION 4
*Insufficient customer demand to justify using additional storage space to stock HPWHs	X	X	X	X
*Lack of contractor's knowledge and comfort to sell HPWH	X	X	X	X
*Higher first cost of HPWH units resulting in low consumer demand	X	X	X	X
Low incentives, no motivator to stock HPWHs				X

*Top three barriers

TABLE 11. BARRIERS IDENTIFIED BY CCAS/CCES

BARRIER	REGION 1	REGION 2	REGION 3	REGION 4
*Lack of stock of HPWHs	X		X	X
*Increased electricity bill after installing a HPWH due to lack of rate-based incentives for HPWHs	X		X	X
*Lack of skilled workforce and training			X	X
Customers and contractors not aware of the benefits of connected HPWHs as marketing focuses on the health and safety benefits	X		X	
Lack of targeted marketing to MF owners			X	

*Top three barriers

TABLE 12. BARRIERS IDENTIFIED BY MULTIFAMILY PROPERTY MANAGERS AND OWNERS

BARRIER	REGION 1	REGION 2	REGION 3	REGION 4
*Higher first cost of HPWH equipment and installation compared to like-for-like water heater replacement	X	X	X	X
*High soft costs due to lack of HPWH knowledge create a higher time commitment from the project owner to gain the needed knowledge and/or share the HPWH knowledge to complete the water heater project	X	X	X	X
*Funding opportunities and HPWH incentive models do not align with the financing processes for the different types of upgrades e.g., acquisition rehabilitation, 15-year syndication, capital improvements, refinancing, emergency replacements	X	X	X	X
Lack of adequate capital to cover higher costs of HPWH replacements	X	X	X	X
Typical lending options do not assume reduced operational costs for energy efficiency and do not reward electrification in lending determinations.	X	X	X	X
Standard property needs assessments and capital needs assessments which guide upgrade investments are based on efficiency rather than values of electrification of end uses for cleaner and more efficient appliances	X	X	X	X
Lack of adopted organizational prioritization for electrification including HPWHs	X	X	X	X
If tenants are paying the utility costs, owners' investment is more of a challenge because there is not direct payback for investment.	X	X	X	X
Unknown operational costs due to variations in predicting future rate structures	X	X	X	X

*Top three barriers

TABLE 13. BARRIERS IDENTIFIED BY MULTIFAMILY MAINTENANCE STAFF

BARRIER	REGION 1	REGION 2	REGION 3	REGION 4
HPWH retrofits for emergency replacement take too long due to installation complexities and permitting. A permit is not usually pulled in a like-for-like replacement.	X	X	X	X
Perception that HPWH retrofits add complexity (during installation and future maintenance), which adds to staff workload and is outside of job scope	X	X	X	X
Maintenance staff are not receiving upper management directive to prioritize HPWH installations	X	X	X	X

In alignment with PG&E goals of cross department collaboration, the results of the Midstream Market Study were discussed with staff from the BayREN Codes and Standards training team. It was determined that there were three main myths that single family contractors mentioned in their interviews as barriers that would be helpful to overcome to increase HPWH adoption.

- Myth #1: TMVs are not worth installing, do not work and/or may cause scalding and other performance issues
- Myth #2: Customers need to have a garage to install a HPWH
- Myth #3: HPWHs are impractical for emergency replacement scenarios

To dispel these myths, the team developed new content that will be included in future BayREN's HPWH Training for Contractors and available to those taking the training.

MIDSTREAM FIELD TEST

The results of the Midstream Field Test include a summary of distributor participation and key observations about industry barriers.

DISTRIBUTOR PARTICIPATION

Four distributors were successfully engaged on the incentive offering, three signed the DPA, and two successfully participated by submitting incentive applications. Between July 2022 and November 16, 2022, the Midstream Field Test incentivized 139 HPWH and 115 TMV distributor sales and received around nine incentive applications per week.

TABLE 14. MIDSTREAM FIELD TEST: DISTRIBUTOR PARTICIPATION

PARTICIPATION DETAILS	
Total HPWH Incentive Applications Submitted	139
Total HPWH Incentive Spend	$139,000
Total TMV Incentive Applications Submitted	115
Total TMV Incentive Spend	$23,000
Total Incentive Spend	$162,000
Top Install Location(s)	Alameda County (71% of installs) Santa Clara County (15% of installs) San Mateo, San Benito, and San Joaquin Counties combined (14% of installs)

While the Midstream Field Test was open to distributor participation starting in September of 2021, incentive application was not received until July of 2022. The impact of COVID-19 on the HPWH supply chain was the major reason for this delayed participation. Technical issues were another cause of participation setbacks. One distributor who enrolled was unable to submit incentive applications without a built-in way to automatically flag eligible products in their sales system. This capability was important as sales staff needed a way to quickly identify and then market qualifying equipment. System specific issues, low equipment supply, and low contractor/customer demand during COVID-19 delayed and likely dissuaded distributors from participating altogether. By following a distributor outreach approach that included frequent touch points and exchange of marketing material, the Project Team was able to motivate participation in the final quarter of the Field Test.

TABLE 15. MIDSTREAM FIELD TEST: HPWH INCENTIVES BY REGION

	REGION 1	REGION 2	REGION 3	REGION 4
Regional characteristics	TECH workforce development		TECH workforce development	
	TECH contractor incentive - planned	TECH contractor incentive - planned	TECH contractor incentive - planned	TECH contractor incentive - planned
		Distributor incentive	Distributor incentive	Distributor incentive
Incentives	0%	1%	97%	2%
Distributor Location	0%	0%	100%	0%
Contractor Location	0%	0%	100%	0%

The Field Test incentives were available across three different Regions to potentially expand the learnings across three different use cases, repeated below for convenience. While the distributor enrollment outreach did span all regions, those that participated were all in Region 3. Therefore, all distributor sales were made to contractors located in Region 3 and 97 percent of installations occurred at customer addresses also located within Region 3.

- **Use Case 1**: Comparing results from Region 1 and Region 3 to determine the impact of the distributor incentive in a region with existing workforce development, permit office support, and contractor incentives.

- **Use Case 2**: Comparing Region 2 and Region 3 to determine the impact of workforce development and permit office training in regions with both contractor and distributor incentives
- **Use Case 3**: Comparing Region 2 and Region 4 to determine the impact of geographic differences in areas that both had a distributor and contractor incentive but did not have workforce development nor permitting office support

Use Case 1

Comparison of the impact from a distributor incentive between Regions 1 and 3 could not be evaluated given unexpected changes to expected regional characteristics. The main factor was the lucrative HPWH incentives provided by regional programs available in Region 3 as compared to Region 1 that drove contractor awareness and customer demand for HPWHs. Additional changes from the original framework was although permit office support and contractor coaching were listed as components of workforce development, neither ended up being offered in Regions 1 and 3 due to TECH Clean California program changes. The workforce development offered was online contractor training webinars covering an introduction to HPWHs and the installation process. Region 3 did not offer both the distributor and contractor incentive at the same time, given that TECH Clean California contractor funding ran out before the distributor incentive was utilized for the Field Test.

Use Case 2

In total, 82 percent of incentivized distributor HPWH sales were to one contracting company in Region 3 that was also the recipient of a 2021 TECH Clean California Quick Start Grant (QSG). The TECH QSG provides a temporary gas water heater to customers in need of emergency replacement and covers up to $2,100 of contractor labor costs to install the HPWH. Due to the result of this QSG, the contractor recipient was able to provide steady demand, which motivated this distributor's participation. The presence of a contractor incentive in Region 3 increased contractor demand and, therefore, distributor willingness to participate. The same contractor who purchased from the participating distributor was also in the top three of TECH participating contractors. The existence of a distributor incentive in addition to a contractor incentive in this Region may have influenced the contractor to purchase and install more HPWHs. Without the expected characteristics of permit office support and contractor coaching available in either Region 1 or 3, the Field Test was unable to evaluate whether these would have increased HPWH sales in either Region.

Use Case 3

There was only one HPWH unit that received an incentive in Region 2 and only two units in Region 4. Those limited results in combination with participating distributors located only in Region 3 eliminated the ability to develop learnings from Use Case 3.

Key Observations about Industry Barriers

The data collection for the Field Test included details from incentive applications, a customer survey and distributor interviews which provide insights regarding the field test's effectiveness as well as insights that could inform future programs. Below are key highlights from that data. Highlights are organized by barriers – primary barriers defined by supply

chain stakeholder interviews, as well as key observations from each, particularly regarding the adoption of load-shifting capable HPWHs.

Supporting examples for each takeaway are sourced from the following data collection activities:

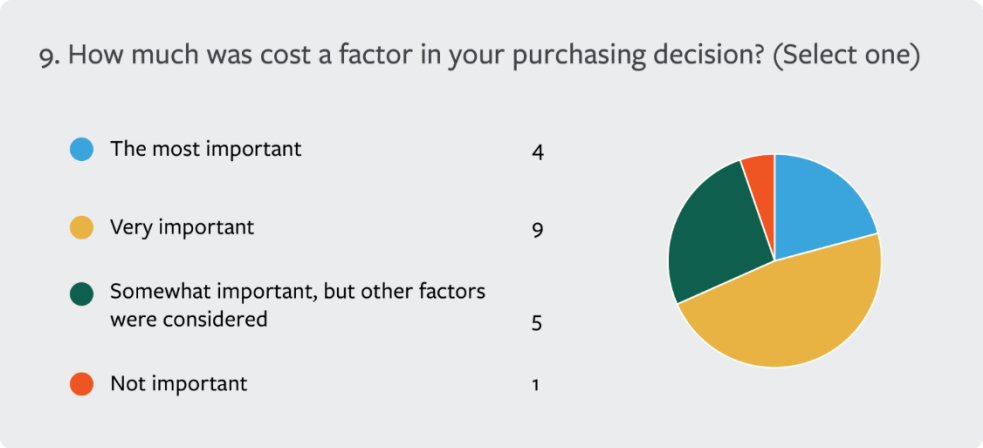
- Interview responses from participating distributors (2): findings from interviews conducted with the two participating distributors during the last two weeks of the Field Test
- Customer survey responses (19): data from the responses received from the 19 customers who completed the customer survey. The survey was sent to the 79 customers who received HPWH installations that were incentivized by both the distributor and TECH Clean California contractor incentive because customer contact information was only available to be collected from the TECH contractor incentive
- Midstream Field Test distributor / TECH Clean California contractor incentive applications (79): data collected from the Midstream Field Test applications that overlap with the TECH Clean California contractor applications for HPWH installations based on customer address. TECH Clean California contractor applications provided additional data fields such as total project cost for the contractor, the previous tank size and fuel type and whether a panel upgrade or permit request was made.
- All Midstream Field Test distributor incentive applications (139): all Midstream incentive applications for HPWH and TMV installations collected by the Midstream Field Test

Barrier 1: High First Cost

Multifamily contractors, multifamily property managers and owners, and distributors identified high first costs associated with installing a HPWH versus a like-for-like replacement as a top barrier to HPWH adoption in the Midstream Market Study interviews. The participating distributors of the Midstream Field Test as well as the Midstream and TECH customers who responded to the customer survey, reinforced that high first cost of HPWHs is an impediment to market adoption.

Observation 1: Cost for customers remains a consideration across the supply chain

- Example A from customer survey



- Example B from distributor survey
  - *"Main problem is that no one wants to put a HPWH in unless it's cheaper than a gas WH replacement, so it's got to be close to free to take a working gas WH and go to a HPWH"*

Observation 2: There is not always a strong correlation between increased tank size and increased unit or project cost

Although on average, for HPWH units that received a Midstream incentive, the unit and project cost increased as the tank size increased the correlation coefficient between those variables is low. A positive correlation coefficient confirms there is a relationship between two variables and the closer to 1 the coefficient is the stronger the relationship. In this situation, the correlation coefficient between tank size and unit price is .25 while the correlation coefficient between tank size and project cost is .15 confirming a weaker relationship.

TABLE 16. MIDSTREAM FIELD TEST: ALL MIDSTREAM HPWH INCENTIVE APPLICATIONS

HPWH UNIT VOLUME (GALLONS)	NO. HPWH UNITS SOLD	AVG. TOTAL UNIT COST W/ TAX (NOT INCLUDING INCENTIVES)
50	23	$1,911
65*	90	$2,082
80	23	$2,219

* 65 and 66 gallon HPWH units were combined into one row due to close similarity in size

TABLE 17. MIDSTREAM FIELD TEST: OVERLAPPING MIDSTREAM & TECH CONTRACTOR INCENTIVE APPLICATIONS

HPWH UNIT VOLUME (GALLONS)	NO. HPWH UNITS SOLD	AVG. OF TOTAL PROJECT COST (LABOR + ANY EXTRA COSTS, NOT INCLUDING INCENTIVES)
50	8	$5,556
65*	57	$6,387
80	14	$6,507

* 65 and 66 gallon HPWH units were combined into one row due to close similarity in size

Observation 3: Project complexity that may increase price have various levels of impact

- Example A from Field Test/TECH incentive applications
  - Panel upgrades: Panel upgrades were not needed for every project
  - Increase of tank size: 78 out of 79 installations were for customers who upsized to a larger tank size with the median increase of 15 gallons. 84 percent of the customers surveyed replied that the contractor influenced selection of tank size.
- Example B from customer survey
  - Only one of 19 customers surveyed replied that the new HPWH is in a new location

BARRIER 2: LACK OF HPWH STOCK

Retailers, distributors, and CCAs/CCEs interviewed in the Midstream Market Study in the Fall of 2021 identified lack of HPWH stock as a top barrier to adoption of HPWHs in the

Midstream Market Study interviews. However, the Distributor interviews that took place as part of the Midstream Field Test in the Fall of 2022 did not mention lack of HPWH supply as a barrier anymore as the supply chain disruptions from COVID-19 had caught up with demand. Since the Field Test did not include CCA/CCE interviews, there is not information as to whether their perception changed as well. Also, each Distributors stocks only one HPWH manufacturer so is dependent on solely that source for equipment.

Observation 1: Participating distributors appreciated the Field Test

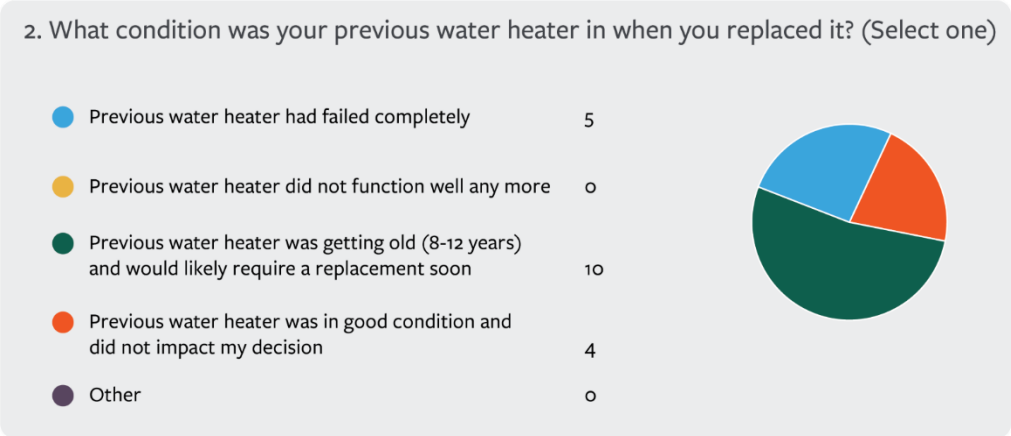
- Example A from distributor interview
  - *"Better than other Golden State Rebate program"*
  - If the pilot continued, *"Six months would equal 50-100 units"*

Observation 2: Product availability does not seem to be a major issue for the participating distributors anymore but originally was a major issue

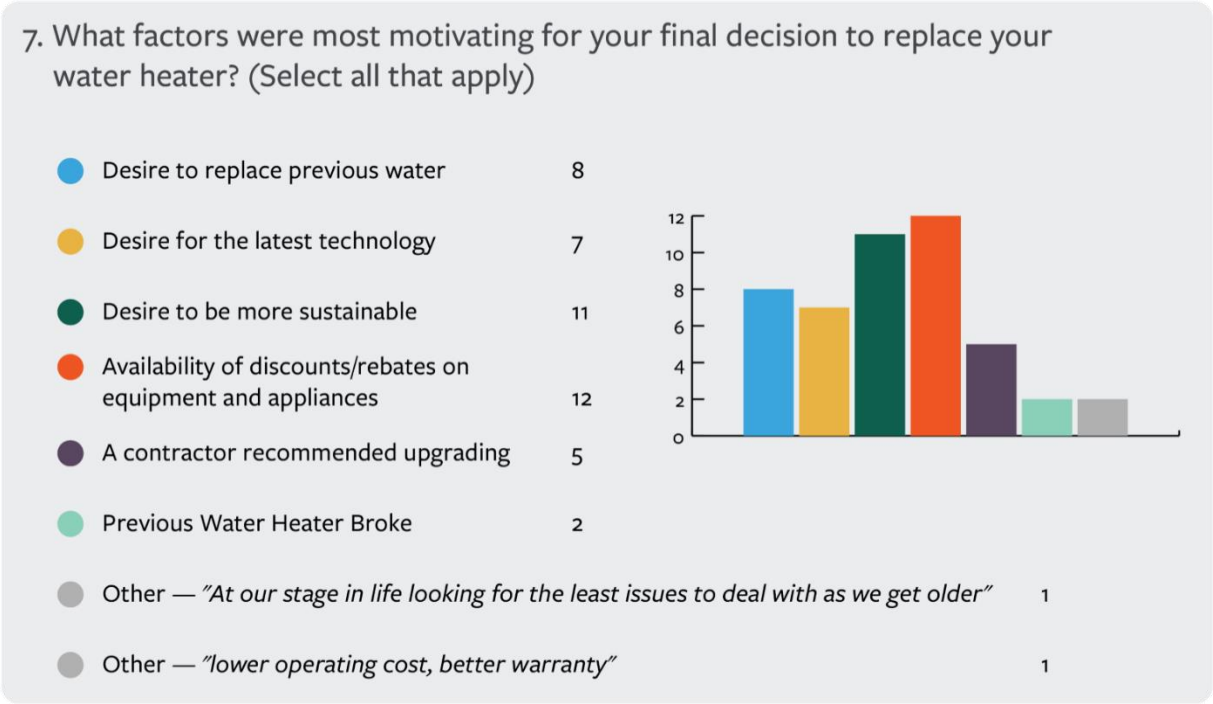
- Example A from distributor interviews
  - Sales for HPWH have increased over the past few years
  - HPWHs are five to ten percent of water heater stock
  - Stock based on whether they think it will sell (stock in low quantity first to see how it does)
  - Similar wait time for gas and heat pump water heaters: *"Takes about two to three weeks to get gas heaters, HPWHs don't seem to require much of a wait."*

Observation 3: Most HPWH installations were early retirement

- Example A from customer survey
  - 14 of 19 customers surveyed indicated water heater replacements were early retirement
  - 10 selected that their previous water heater was "getting old" and four that it was "in good condition."
  - Five responses indicated emergency replacements where the previous water heater had "failed entirely." These replacements were likely funded by the TECH Clean California Quick Start Grant program mentioned above which provides a temporary emergency replacement of the gas water heater and then helps cover the installation costs for a new HPWH.



- Several motivations for replacement (when given multiple choice)



BARRIER 3: LACK OF HPWH KNOWLEDGE AND NEED FOR ADDITIONAL HPWH TRAINING

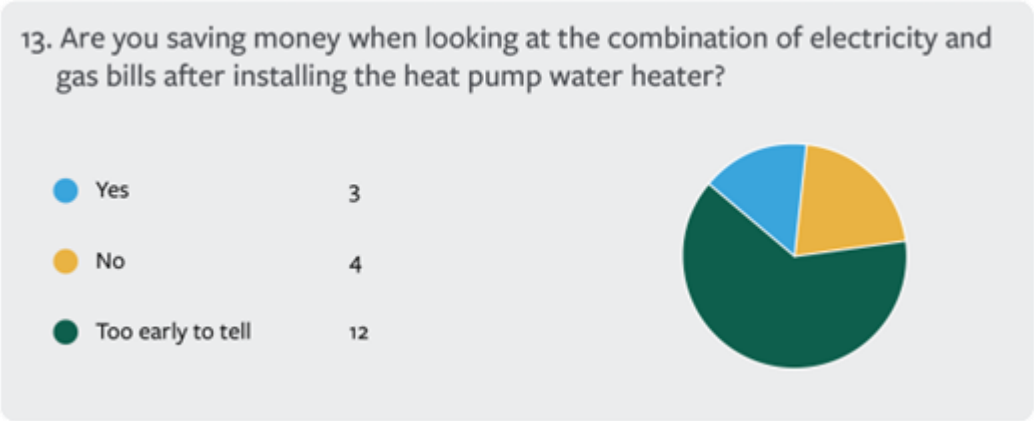
Local Government Building Staff, Single Family Contractors, Multifamily Contractors, Distributors, CCAs/CCEs, as well as Multifamily Property Managers and Owners identified contractor training on, knowledge of an experience with HPWHs as a barrier to market adoption and contribution to higher first costs in the Midstream Market Study interviews. Distributors participating in the Midstream Field Test provided examples of potential knowledge gaps that impede HPWH sales to contractors as well as contractors' ability to sell HPWHs to customers.

Observation 1: Perceived slow HPWH first hour recovery, especially in the wintertime

- Example A distributor interview
  - "*Upsizing is a concern"* for a customer and contractor
  - *"Concerns about when someone wants to have a lot of family over and take a lot of showers"*

Observation 2: Mixed assessment of realized and perceived energy and cost savings after installation of a HPWH:

- Example A from customer survey
  - The majority of customers surveyed suggested more time is needed to determine whether there are energy savings, while also saying they have not experienced higher-than-average utility bills.



- Example B from distributor interviews
  - Main value that HPWHs bring to customers: "*Energy savings and tax incentives*"
  - *"Electric bill will be higher than before and won't outweigh cost. Only way they'll save energy is by operating in HP only mode."*

Observation 3: Contractors are a key source for providing customers information about HPWHs

- Example A from customer survey
  - 10 out of 19 customers shared they first learned about the benefits of the HPWH from a contractor
  - 14 out of 19 customers stated that the contractor influenced their decision to switch to a larger HPWH by presenting and discussing sizing options with them
  - Three other survey questions highlighted positive and informative contractor experiences
    - All customers indicated that the contractor took the time to show them how to use the heat pump water heater
    - 17 of 19 customers said that they thought their contractor was knowledgeable about the heat pump water heater equipment. The one who did not respond this way selected that they did not interact directly with their contractor.
    - All customers who selected that they interacted with the contractor answered that the contractor educated them on some of the benefits associated with their HPWH

18. Did the contractor take the time to show you how to use the heat pump water heater at any point?

Yes	18
No	1

19. Was your contractor knowledgeable about the heat pump water heater equipment? (Select one)

Very knowledgeable	17
Neutral	1
Not knowledgeable	0
I did not interact directly with the contractor	1

20. Did the contractor educate you on any of the benefits associated with your heat pump water heater?

Yes	18
No	0

Load Shifting Insights

The Midstream Field Test provided insight on the implications for connected water heaters and future load shifting programs from the perspective of distributors. The stakeholders in the Market Study did not offer any barriers related to connected technology as they instead focused on heat pump water heaters adoption at-large.

Observation 1: Most HPWH models require additional hardware to enable connectivity

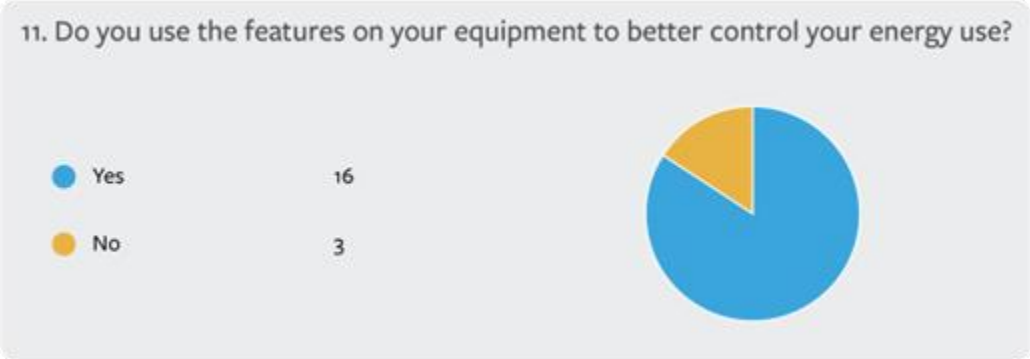
- Example Source A from Midstream Field Test distributor / TECH Clean California contractor applications
    - All of the models sold need an added module to enable load shifting

Observation 2: Separate purchase of a TMV suggests that programmatic intervention and tracking is better at the contractor level, to confirm it is installed

- Example Source A from Midstream Field Test distributor / TECH Clean California contractor applications
    - One of two distributors was able to sell the TMV at the time of HWPH sale. Sales for the two equipment pieces together were all to the same contractor company.
    - One of two distributors was unable to sell a TMV at the time of HPWH sale. They said that the contractor(s) they sell to buy the TMVs in bulk because it is cheaper.

Observation 3: Most customers use features on their HPWH to control equipment energy use

- Example Source A from customer survey



RECOMMENDATIONS

MIDSTREAM MARKET STUDY

The HPWH Project Team developed the following strategies in the Fall of 2021 to address the largest barriers per stakeholder group to aid in market adoption of connected HPWHs in emergency and replacement scenarios:

1. **Implementation strategies:** The barriers identified from the interviews were narrowed down to the top three most impactful barriers per stakeholder group. Then a strategy was developed to best overcome each barrier. The strategy ranged from education, training, process improvement and financial inducements. The list of top three implementation strategies per stakeholder group interviewed can be found in Appendix B HPWH Supply Chain Market Study Implementation Strategies.
2. **Financial Incentive Structure:** The barriers identified from the interviews were further narrowed to the top barrier across four of the main stakeholders: Local

government building department staff, single family contractor, distributor, and retailer. Recommendations were developed specifically for a financial inducement to overcome the top barrier which is different from the implementation strategies that use education or training as a solution for overcoming barriers. A brief summary of the financial incentive is included Table 18 with a full overview including value proposition and incentive layering is available in Appendix A. This Midstream HPWH Project had resources to move forward with one incentive structure and tested the distributor incentive with the hopes of driving large scale change.

TABLE 18. MIDSTREAM MARKET STUDY: FINANCIAL INCENTIVE STRUCTURE BY STAKEHOLDER GROUP

STAKEHOLDER	BARRIER	INCENTIVE STRUCTURE
Local government Building Department Staff	Lack of education and training	Provide additional no-cost HPWH installation and best practices training that are eligible for continuing education units (CEUs) to motivate participation.
Single Family Contractor	High cost of installation	Provide an electrical panel upgrade incentive to lower the overall cost of installations available to all qualifying PG&E contractors. Note: At the time this was developed TECH Clean California was offering an electrical panel upgrade in the Bay Area as part of a regional pilot.
Distributor	Low customer demand due to the high cost of HPWH replacement installations	Offer a distributor incentive that can be layered with a contractor incentive to help drive customer demand.
Retailer	Lack of storage space to hold HPWHs and need for customer demand to justify it	Give customers an instant point-of-sale (POS) rebate that will allow customers to see valid rebates for the product they are looking at while in the retailer's store.

MIDSTREAM FIELD TEST

COVID-19 disrupted the supply chain and prevented connected HPWHs from being readily available until the end of Q2 2022. Therefore, impacts of the distributor incentive were inconclusive as the Field Test was not able to be run for a full year and was instead limited to about four months. To continue building off the Field Test, two future recommendations were developed.

Recommendation 1: A distributor incentive pilot should be extended to evaluate its impact on HPWH market adoption during a 12–24-month period when qualifying equipment is available market wide, and the market is not impacted by COVID-19 supply chain slowdowns.

- Shortages of raw materials like steel, aluminum, copper, plastics as well as semiconductors (necessary to support HPWH connectivity) slowed the equipment manufacturing process.[14] Supply chain slowdowns due to material shortages

[14] *2021's HVAC Equipment Shortages: Supply Chain Impacts on Consumers*, (J Rescue Air Heating and Cooling, June 22, 2021,. https://www.rescueairtx.com/blog/2021/june/2021s-hvac-equipment-shortages-supply-chain-impa/

impacted the availability of connected HPWHs throughout the first nine months of the program. In addition, commodity prices rose 19% between May 2020 and 2021, which negatively impacted costs.[15] According to one of the participating distributors, higher interest rates during this period further decreased demand as customers preferred to avoid "high capital investment projects" like installing a HPWH. The distributor also said that "residential new construction was almost at a standstill." The combination of supply chain slowdowns and decreased customer demand made it harder for the Field Test to engage and enroll distributors.

- Distributor participation in a residential program for an emerging technology can take four to six months as it can require changing business and stocking practices to support quicker turn residential HPWH sales. This was also a part of why the enrolled participants did not submit applications until the final quarter of the Field Test. There was also one participant that specifically requested an extension of the incentive offering. With additional time to run the Midstream Field Test, there would have been additional distributors that participated allowing, for additional engagement through the creation of market share reports to drive competition between distributors.
- The contractor with the highest number of HPWH purchases from one of the participating distributors, was also one of the top three participating contractors in the TECH Clean California program. It is likely that this distributor incentive contributed to the high level of participation from this contractor. It was also found that contractors in territories with additional HPWH incentive offerings such as SMUD and BayREN, showed higher rates of participation. These instances indicate a correlation between more incentive options and a higher rate of HPWH sales per contractor. Therefore, an extended distributor incentive would likely continue to support participation and an increase in HPWH sales.

Recommendation 2: HPWH training and education in a midstream program should include, in addition to the distributor, the contractor as they have the touch point with the customer making the decision on installing a HPWH

- Survey responses from customers indicated that the contractor helped educate them about the benefits of HPWHs and influenced their decision to install one. In response to the survey question, "Did the contractor educate you on the benefits of your HPWH?" 18 of 19 customers replied "Yes."
- Customer responses to the survey question about their motivations for replacing their water heater revealed that in addition to needing a replacement, the availability of discounts, the desire to be more sustainable, and interest in the latest technology motivated their decision. Providing marketing material and resources to contractors that highlight these benefits to customers will help them sell this newer technology.
- Customer survey responses indicate that some customers understand and/or are interested in learning more about load shifting. This shows that contractors are likely discussing load shifting as one of the benefits associated with HPWHs. Training and educational materials can further help contractors communicate with customers as

[15] Helper S. and Soltas E., Why *the Pandemic Has Disrupted Supply Chains.* (The White House, June 17, 2021). https://www.whitehouse.gov/cea/written-materials/2021/06/17/why-the-pandemic-has-disrupted-supply-chains/

they are the main touch point. Contractors can also leave materials with the customers who are interested in learning more.

- Another important aspect to include in sales collateral is the greater warranty time (up to 10 years) on HPWH products relative to alternative water heaters. This may help customers better understand the lifetime value of HPWHs and look beyond the higher first cost.

APPENDIX A: PG&E MIDSTREAM HPWH STUDY AND FIELD TEST: SUPPLY CHAIN MARKET STUDY

PG&E Midstream HPWH Study and Field Test: Supply Chain Market Study

To: Helen Liu, Kelly Cunningham, Andrew Doeschot, and Thomas Mertens
Pacific Gas and Electric Company

From: Energy Solutions, Frontier Energy and Association for Energy Affordability

Date: March 8, 2022

Energy Solutions

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About Energy Solutions

Energy Solutions is a mission-driven clean energy implementation firm that specializes in programs that align with the market to deliver significant resource impacts. For over 25 years we've been pioneering end-to-end, market-driven solutions that deliver reliable, large-scale and cost-effective savings to our utility, government, and private sector clients across North America. Our passionate, smart employee-owners are committed to excellence and to building long-lasting, trusted relationships with our clients.

Our Partners

Frontier Energy is a professional services firm delivering energy efficiency, market transformation, and transportation solutions through technical consulting, program design and implementation, and technology development. With a team of 140 talented people in eight offices across the U.S., Frontier is committed to a single mission: To provide exceptional programs, services, and tools that encourage the intelligent use of energy.

Association for Energy Affordability (AEA) is a not-for-profit technical services and training organization at the forefront of increasing energy efficiency and green building practices in multifamily buildings. Since 1992 AEA has provided energy audits for thousands of buildings representing hundreds of thousands of dwelling units; delivered energy efficient building operations training to several hundred property management and maintenance personnel; and overseen the construction and installation of measures that address energy and water efficiency, comfort, durability, safety, indoor air quality, and environmental impact.

Overview

The Pacific Gas and Electric Company (PG&E) Midstream Heat Pump Water Heater (HPWH) Study and Field Test (referred to here as "HPWH Project") includes a supply chain market study of stakeholders to assess knowledge and perceptions of HPWHs and to develop implementation strategies aimed at influencing market behavior to overcome barriers for HPWH installations. This report outlines activities completed by the HPWH Project team which includes Energy Solutions and partners, Frontier Energy and Associate for Energy Affordability (AEA).

Region Selection

The HPWH Project focused on four different regions across PG&E territory, each with unique characteristics, to gain a greater understanding of HPWH installation barriers. The regions were selected based on a methodology that allowed for testing the impacts of a midstream inducement across multiple use cases. Regions varied based on county locations, distributor incentives, contractor incentives, and TECH Clean California contractor and/or permit trainings. Initially three distinct use cases were identified across the four regions. However, during the HPWH Project, TECH Clean California expanded its approach from regional to statewide contractor incentives giving Region 4 and Region 2 similar program characteristics but unique geographic characteristics.

Table 1: Selected Geographic Regions

REGION 1 BayREN North Bay	REGION 2 Central Valley	REGION 3 BayREN South Bay	REGION 4 Central Coast
Contra Costa, Marin, Napa, Solano, and Sonoma County	San Joaquin, Stanislaus, Merced and Fresno County	San Francisco, San Mateo, Santa Clara, and Alameda County	Monterey, San Benito, and Santa Cruz County

Stakeholder Feedback

To collect stakeholder feedback, the HPWH Project team interviewed market actors within the four geographic regions to understand the HPWH market within these territories, their existing process for replacing gas water heaters, and installation barriers for HPWH's. The market actors interviewed included local governments, contractors, distributors, retailers, and multifamily stakeholders. The total number of interviews is outlined in Table 2.

Table 2: Market Actors

Stakeholders Interviewed	Interviewer	Number of Interviews
Local government building department staff	Frontier Energy	6
Single-Family contractors	Frontier Energy	10
Multifamily contractors	AEA	5
Distributors	Energy Solutions	4
Retailers	Energy Solutions	4 (and 2 manufacturers)

Stakeholders Interviewed	Interviewer	Number of Interviews
Community Choice Aggregations (CCAs) and CCEs	Energy Solutions	4
Multifamily property managers and owners	AEA	5
Multifamily maintenance staff	AEA	4

Interviews with local government building department staff focused on reviewing current water heating permitting and inspection requirements related to HPWH installations. Single-family and multifamily contractors were interviewed to understand current practices for replacing gas water heaters and any insights on the impact of transitioning to HPWH installations. Distributors were contacted to understand their familiarity with HPWHs, their existing equipment stocking practices, and the potential to increase or require regular stocking of HPWHs. Retailers were selected to provide insight on how to influence their stocking practices. Community choice aggregators (CCAs) were targeted to understand their existing outreach, education, and incentive programs to determine gaps and how the gaps can be addressed. Multifamily owners and property managers were selected to understand the unique concerns and structures that impact water heater planning, such as timing and funding for capital improvements. Finally, multifamily maintenance staff were interviewed to understand burnout replacement and particularly emergency replacement, as that typically falls to on-site maintenance personnel.

Installation Barriers

The HPWH Project team conducted email and phone interviews with specific market actors and stakeholders within four geographic regions to understand current water heater installation practices. From those interviews, the team identified the major barriers per stakeholder and per region preventing greater adoption of HPWHs.

Implementation Strategies

The HPWH Project team developed implementation strategies and inducement structures aimed at influencing market behavior to overcome the three most impactful barriers per stakeholder. These strategies and inducement structures were designed to influence the market to favor HPWHs for replacements under all use cases, including emergency circumstances. The outcomes of this task are:

1. Implementation strategies to overcome the three major barriers were identified including a description, rationale, resources needed, education required, an explanation of how and why strategies vary in each region, key metrics, and key indicators of success.
2. Financial inducement structures were created to overcome the most impactful barrier for each stakeholder category. The inducement strategy developed to overcome the main barrier for distributors was selected to be tested in the Field Test portion of the HPWH Project.

Region Selection

The HPWH Project team identified four unique geographic regions and primary partners in those regions to test strategies across varying conditions. The four unique regions initially selected are outlined in Table 3. During the course of the HPWH Project, TECH Clean California expanded from offering regional to statewide incentives resulting in Region 2 and Region 4 having the same characteristics. The selection methodology was completed in August 2021 and considered the following characteristics:

a. HPWH incentive programs targeting contractors include Community Choice Aggregator (CCA) efforts
b. Coordination with TECH Clean California including TECH Regional Pilots
c. Use cases to be tested
d. Territory applicability and resident demographics
e. Under-represented communities
f. Contractor education programs
g. Permit office trainings
h. Existing distributor market regions

Table 3: HPWH Project Region Selection

Characteristic	REGION 1 BayREN North Bay	REGION 2 Central Valley	REGION 3 BayREN South Bay	REGION 4 Central Coast
Geographic Coverage	Contra Costa, Marin, Napa, Solano, and Sonoma County	San Joaquin, Stanislaus, Merced and Fresno County	San Francisco, San Mateo, Santa Clara, and Alameda County	Monterey, San Benito, and Santa Cruz County
TECH Clean California Components	Monthly trainings per region; Ongoing contractor coaching; Permit office training	None	Monthly trainings per region; Ongoing contractor coaching; Permit office training	None
TECH Clean California Incentives	Statewide contractor incentives			
Midstream HPWH Study	None	Distributor + thermostatic mixing valve (TMV)*	Distributor	Distributor + TMV*

*The TECH Regional Pilot, Market Readiness for HPWH Load Shifting, will provide a contractor TMV incentive in the BayREN region. To allow for testing the impacts of a distributor TMV inducement the HPWH project will not overlap with the distributor TMV inducement in regions with a TECH Contractor TMV incentive.

HPWH Project Use Cases

A driving factor in the geographic region selection was to optimize the number of use cases the HPWH Project could test. To do that the four regions selected had overlapping and unique characteristics to create three discrete use cases.

USE CASE 1: Distributor inducement in a region with workforce development and permit office support

The first use case determined for the HPWH Project focused on the impact of a distributor inducement in regions with existing workforce development, permit office support, and contractor incentives. Therefore, Region 3 - BayREN North Bay, would have a distributor inducement applied while Region 1 - BayREN South Bay, would not have a distributor inducement. Table 4 provides a breakdown of the characteristics for Use Case 1.

Table 4: Distributor Inducement in a Region with Workforce Development and Permit Office Support

Characteristic	REGION 1 BayREN North Bay	REGION 2 Central Valley	REGION 3 BayREN South Bay	REGION 4 Central Coast
Geographic Coverage	Contra Costa, Marin, Napa, Solano, and Sonoma County	San Joaquin, Stanislaus, Merced and Fresno County	San Francisco, San Mateo, Santa Clara, and Alameda County	Monterey, San Benito, and Santa Cruz County
TECH Clean California Components	Monthly trainings per region; Ongoing contractor coaching; Permit office training	None	Monthly trainings per region; Ongoing contractor coaching; Permit office training	None
TECH Clean California Incentives	Statewide contractor incentives			
Midstream HPWH Study	None	Distributor + TMV	Distributor	Distributor + TMV

USE CASE 2: Impact of workforce development and permit office support in regions with contractor and distributor incentives

The second use case for the HPWH Project focused on the impact of a workforce development and permit office in regions with both contractor and distributor incentives. The HPWH technology is considered new, and the initial market feedback is that it is important to develop the workforce to truly overcome HPWH adoption barriers. So, this use case will aim to test that. Therefore, Region 2 – Central Valley, will not have workforce development and permit office support but will have a contractor and distributor inducement while Region 3 - BayREN South Bay, will have workforce development and permit office support and also a contractor and distributor incentive. See Table 5 for a detailed breakdown for this second use case.

Table 5: Impact of Workforce Development and Permit Office Support in Regions with Contractor and Distributor Inducements

Characteristic	REGION 1 BayREN North Bay	REGION 2 Central Valley	REGION 3 BayREN South Bay	REGION 4 Central Coast
Geographic Coverage	Contra Costa, Marin, Napa, Solano, and Sonoma County	San Joaquin, Stanislaus, Merced and Fresno County	San Francisco, San Mateo, Santa Clara, and Alameda County	Monterey, San Benito, and Santa Cruz County
TECH Clean California Components	Monthly trainings per region; Ongoing contractor coaching; Permit office training	None	Monthly trainings per region; Ongoing contractor coaching; Permit office training	None
TECH Clean California Incentives	Statewide contractor incentives			
Midstream HPWH Study	None	Distributor + TMV	Distributor	Distributor + TMV

USE CASE 3: Distributor inducement in region without contractor incentives, workforce development or permit office support

The third use case was planned to test a pathway to increase HPWH adoption in a "clean slate" region which is an area without existing incentives, workforce development or permit office support. There are many areas in California that match these criteria so it is useful to understand if only offering a distributor inducement will drive meaningful change. However, with the expansion of TECH Clean California contractor incentives from regional to statewide as of December 7, 2021, there are not "clean slate" regions available. Table 6 displays the details of the initially planned "clean slate" use case.

Table 6: Distributor Inducement in Region Without Contractor Incentives, Workforce Development or Permit Office Support

Characteristic	REGION 1 BayREN North Bay	REGION 2 Central Valley	REGION 3 BayREN South Bay	REGION 4 Central Coast
Geographic Coverage	Contra Costa, Marin, Napa, Solano, and Sonoma County	San Joaquin, Stanislaus, Merced and Fresno County	San Francisco, San Mateo, Santa Clara, and Alameda County	Monterey, San Benito, and Santa Cruz County
TECH Clean California Components	Monthly trainings per region; Ongoing contractor coaching; Permit office training	None	Monthly trainings per region; Ongoing contractor coaching; Permit office training	None

Characteristic	REGION 1 BayREN North Bay	REGION 2 Central Valley	REGION 3 BayREN South Bay	REGION 4 Central Coast
TECH Clean California Incentives	Statewide contractor incentives			
Midstream HPWH Study	None	Distributor + TMV	Distributor	Distributor + TMV

Stakeholder Feedback

The HPWH Project team identified specific market actors and interviewed multiple representatives of each stakeholder type to determine the current processes for water heater replacements and HPWH installation barriers. Stakeholders included local government building department staff, single family and multifamily contractors, distributors, retailers, CCAs, and multifamily stakeholders.

Local Government Building Department Staff

Frontier Energy engaged with local government building departments across three of the four geographic regions. The general perspectives from building department staff are included below. Overall, the general trend was that building department staff view their role as enforcing code, and not educating permit applicants about how new technologies need to be installed to meet code. HPWHs are not only a new technology, but also require new contractor skills, business models, and licensing compared to traditional water heaters, given both plumbing and electrical expertise is required to install a HPWH. Helping permit applicants navigate and document this required expertise is not the building department's responsibility, although the department is uniquely positioned to provide, or at least introduce, a permit applicant to that type of information.

Summary of Interview Results

Frontier Energy conducted six phone interviews with building department staff. Outreach to Region 2 was attempted, but ultimately unsuccessful. The jurisdictions engaged by region and building department role (example – Chief Building Official) are included below:

- Role
  1. Chief Building Official
  2. Plan Check Supervisor
  3. Building Inspection
  4. Building Inspection Division Manager
- Region 1: (BayREN North Bay – Contra Costa, Marin, Napa, Solano, Sonoma)
  1. Pleasant Hill
  2. Mill Valley

- Region 3: (BayREN South Bay – San Francisco, San Mateo, Santa Clara, Alameda)
  1. Berkeley
  2. San Jose
- Region 4: (Monterey, San Benito, Santa Cruz)
  1. Santa Cruz
  2. Salinas

While each building department services different populations and needs, a few key considerations were brought up throughout the interview process that include: (1) lack of public and contractor familiarity with HPWHs, (2) challenges associated with integrating an electrical and plumbing permit, and (3) adoption rates are unknown because water heaters are often installed without a permit.

LEVEL OF FAMILIARITY WITH HPWH TECHNOLOGIES

Respondents from all the building departments interviewed had some familiarity with HPWH technologies and a defined process to replace natural gas water heaters with HPWHs. Additionally, respondents expressed that their building departments had staff familiar with HPWH technologies and associated code requirements to troubleshoot questions asked by contractors. In most cases, either building inspectors or plan check examiners had the most knowledge related to the code requirements of HPWHs.

However, familiarity differed by jurisdiction. In some jurisdictions, knowledge of HPWH technologies and associated code requirements was spread across a team of plan check examiners or building inspectors. In other jurisdictions, the knowledge related to HPWH technologies and associated code requirements was concentrated in fewer individuals.

All staff interviewed expressed a need for further targeted trainings in HPWH technologies among building department staff. Notably, those interviewed had a stated interest in targeting building inspectors and plan check examiners for HPWH trainings. Respondents expressed the need to diversify the knowledge of HPWH permitting requirements across a larger team. Those interviewed had general awareness of BayREN and some awareness of Energy Code Ace code trainings.

Respondents specifically referenced a lack of familiarity with HPWH technologies, both from the public and contractors. Building department staff referenced how the public is generally unaware of HPWH technologies as compared to more traditional electrification technologies, notably solar. Additionally, building department staff referenced that the typical contractor is more familiar with natural gas water heaters. Local building department staff suggested offering targeted HPWH trainings with contractors to increase HPWH adoption.

INTEGRATED ELECTRICAL AND PLUMBING PERMIT

Respondents from several building departments referenced difficulties related to permitting. In some instances, depending upon local building department business practice, a contractor or homeowner installing a HPWH may have to apply for two permits – electrical and plumbing. Navigating two separate permit processes is cumbersome and adds complexity, cost, and time. Some jurisdictions, notably San Jose and Berkeley, have overcome this barrier by integrating the plumbing and electrical

permits for HPWH installations.[1] The combination of permits has not been done as plumbing and electrical are traditionally different permits and with the limited uptake of HPWHs has not driven building departments to investigate a need to combine permits.

UNKNOWN HPWH ADOPTION RATES

Respondents from all building departments referenced a lack of insight into how widely HPWHs are being adopted within their jurisdictions. Building department staff only have insight into permitted projects. All respondents mentioned that contractors often complete water heater replacements without applying for a permit. Respondents were cautious about offering a solution that tries to induce higher permitting rates for fear that additional permitting processes for HPWHs may deter contractors.

Documentation of Existing Water Heater Replacement Processes

All building departments interviewed had a general permitting process for replacing a gas water heater with a HPWH. However, the process for submitting and obtaining a permit and resources provided by each jurisdiction vary dependent on a variety of factors. While it is not the building department's responsibility to educate permit applicants about how new technologies need to be installed to meet code, departments in general are uniquely positioned to provide, or at least introduce, a permit applicant to that type of information and it's in the industry's best interest if those information resources are aligned across multiple jurisdictions.

RESOURCES & PROCESS

Jurisdictions that are invested in the transition towards HPWHs provide permit applicants with a set of resources detailing the benefits of electrification technologies. Berkeley passed a natural gas ban ordinance on December 2, 2019, and to support that they have dedicated educational materials and a detailed process for replacing a natural gas water heater with an HPWH. Berkeley has a dedicated webpage detailing the environmental and energy efficiency benefits of HPWHs and gives users access to virtual trainings, incentive programs, and links to apply for a permit. Most jurisdictions, however, provide only general resources for approving natural gas to HPWH replacements. Some have no information. For instance, Mill Valley provides a resource on its website detailing what is needed for a natural gas water heater replacement but doesn't mention HPWHs.

ONLINE PERMIT SUBMITTALS

All jurisdictions interviewed have an online process for contractors or residents to submit permits. The shift to digital submittals aligns with the general shift to virtual business practices in response to the COVID-19 pandemic. Santa Cruz, Salinas, and Mill Valley use the digital platform eTRAKIT to manage permit submittals. eTRAKIT is a third-party provider leveraged to help building departments simplify the permit process. Contractors or residents navigate to an online portal and submit a permit application. After submittal through the online portal, building department staff review the application through the eTRAKIT platform. Similarly, Berkeley, Monterey, and San Jose use custom web tools to manage permit submittals. These jurisdictions have created a customized online portal for contractors or

[1] Berkeley Permit Application

residents to submit applications. Local building department staff did not have a stated preference for a particular permit review software.

Berkeley provides permit applicants with an easy-to-manage process for submitting and obtaining a HPWH permit. Mill Valley uses an online portal for contractors to submit permit applications. For Mill Valley and Berkeley, contractors must submit a site plan, manufacturer specification sheet, existing main panel ratings, documentation demonstrating a new or existing panel with sufficient electrical capacity for the home's electric load, and a wiring diagram including an electrical disconnect to successfully obtain a HPWH permit.

Pleasant Hill uses a monitored email address to manage permits. Applicants must submit site plans, spec sheets, and all other related documentation to a managed inbox. Local building officials from Pleasant Hill remarked that this approach was slow, inconsistent, and unreliable.

Single Family Contractors

The project team asked single family contractors about their experience with HPWHs and accessories, business and sales practices, training and documentation for installing HPWHs, and challenges they face in their work. They were also asked about their process for installing HPWHs and how that process varies from site to site, and according to replacement scenario (emergency vs. planned). This section summarizes the interview results and delivers insights about the contractors' installation processes.

Summary of Interview Results

Frontier Energy conducted 10 interviews with single-family residential contractors across the four study regions. Responses varied widely on some topics yet there were also many similarities across firms and regions. Installation challenges were mentioned by nearly every contractor interviewed. Many residential buildings do not have space for HPWHs unless they have a garage. The responses relating to panel upgrades varied widely across regions, with Region 1 and 2 contractors saying they are rarely or never required, and Region 3 and 4 contractors saying they are often or almost always required. For older buildings, panel upgrades are commonly needed, and contractors indicated this could increase the cost of installation by 50-60%. Contractors cited installation costs ranging from $3,600 in a standard scenario without additional work required (e.g., panel upgrade, additional plumbing, more space needed) up to $8,000 or $9,000 in non-standard scenarios where panel upgrades and other additional work, such as ducting, is required to accommodate the HPWH. In general, costs were cited as a major challenge by nearly every contractor interviewed. Within the last year, HPWH supply shortages and delays have also been a significant challenge for most contractors interviewed. One contractor in Region 1 mentioned that they have inventory of electric resistance water heaters that they can provide to customers in emergency replacement scenarios, to help overcome the challenge of supply chain delays.

Multiple contractors mentioned that planned replacements (as opposed to emergency replacement on equipment burnout) of gas water heaters with HPWHs are becoming more common. Many of the contractors interviewed indicated that planned replacements outnumbered emergency replacements by a large margin, e.g., out of 70-80 HPWH installations, only 3 were in an emergency replacement scenario. Emergency replacement of natural gas water heaters with HPWHs, while not common, were not described as a major challenge by six of the ten contractors interviewed, with several contractors citing

their experience and ability to expedite the process. A few contractors, namely in Regions 3 and 4 where panel upgrades are more commonly required, cited challenges related to supply chain delays and time-consuming paperwork and coordination needed with the utility. One contractor mentioned that in their experience, panel upgrades were needed roughly 25% of the time. In emergency replacement scenarios, the need for a panel upgrade served as a dealbreaker and dissuaded the customer from pursuing a HPWH unless there was a unit available that wouldn't necessitate the panel upgrade. They mentioned that supply chain had an impact on that type of situation when a unit exists in the market that would not necessitate a panel upgrade but is not readily available due to supply issues.

The majority of contractors said they are able to complete a HPWH installation in one day, though they indicated that the process takes longer than a gas water heater replacement and the equipment could be 3-4 times more expensive than a gas water heater counterpart. Permitting was not cited as a significant challenge by most contractors interviewed, however some jurisdictions require separate plumbing and electrical permits, and some only allow a contractor with a general B license to pull a permit. Some firms had an electrician on staff, so they did not have to subcontract; others subcontracted or recommended the customer find their own electrician. Several firms noted that finding a subcontractor for electrical upgrades was a challenge. One firm noted that they plan to hire an electrician for the purpose of handling HPWHs entirely in-house without subcontracting to make the installation process easier for themselves and the customer.

Contractors' anecdotal experiences with the permitting process varied across regions. A contractor in Region 1 mentioned the lack of an online process at one jurisdiction as a source of frustration. In Region 3, a contractor mentioned the significant variation from one jurisdiction to the next, with permit costs ranging $150 - $1,200, and turnaround times ranging from a few days to six weeks. In Region 4, one contractor shared the perspective that permits were fairly straightforward and inexpensive.

The majority of contractors interviewed did not have experience installing accessories for load shifting. One contractor in Region 1 noted that they had experience setting up the wireless module that comes with the Rheem unit, which could be used for remote controlling and load shifting. When asked about how often thermostatic mixing valves were installed, responses varied widely— from 20% of the time to 100% of the time, often based on participation in programs that do or do not require them. One contractor said they wished there was a more standard practice for determining when thermostatic mixing valves are required, as it depends on recovery rate, which varies by manufacturer.

Some contractors had experience with ducting kits for indoor installation, some did not. Nearly every contractor interviewed said that they recommend upsizing units to avoid the potential for customers being dissatisfied with the amount of hot water available. One contractor gave the following details regarding how they upsize when installing HPWHs: for a current 40-gallon natural gas water heater they replace with a 65-gallon HPWH. For a current 50-gallon natural gas water heater they replace with an 80-gallon HPWH. When asked about sizing, another contractor mentioned that Sonoma Clean Power requires an 80-gallon tank. Another contractor said that their firm only installs 80-gallon HPWHs. Space limitations were cited as a consideration by many contractors regardless of sizing. One contractor in Region 4 said, in reference to the required air space around HPWH unit, "make sure it is a 10x10x10 room. Sometimes you can do 750 for smaller units." One firm in Region 3 mentioned challenges associated with rebate programs that require the whole building to be brought up to code. Another contractor in Region 4 cited the challenge that no rebate program was available in their area.

When asked about challenges and ideas to overcome barriers, responses ranged from general requests for more support from utilities to very specific suggestions. At least seven out of 10 contractors interviewed cited customer awareness as a barrier and/or requested PG&E co-branded materials to educate customers and help convince them of the benefits of HPWHs. One contractor requested a simple portal to allow them to assist customers with rebates and incentives. Several requested educational materials for contractors, such as a guide to common installations, a 1-2 minute training video for new installers, or resources to assist with load calculations. One contractor shared that it would be helpful to contractors doing load calculations if PG&E would provide customer usage data in 15-minute increments rather than in 1-hour increments. The contractor stated that building energy codes reference 15-minute increments and their calculations would be easier to calculate and more precise if more granular data were available to them.

Documentation of Existing Water Heater Replacement Processes

All contractors interviewed had a general process for replacing gas water heaters with HPWHs, although their levels of experience with HPWHs varied, with some being relatively new to HWPH technology. Several noted that they do not have specific documentation, tools, or resources they rely on. Others noted that they follow the manufacturer manual as each manufacturer has specific requirements. One contractor described the difficulty of having a defined process due to widely varying sites and city requirements. Several contractors indicated that a guidebook or kit with resources for common scenarios would be helpful for technicians new to HPWH installation. Multiple contractors cited customer reticence to switch away from gas as a barrier to their HPWH sales process and noted that having marketing collateral branded by a utility to explain HPWH value and benefits could help with changing customer mindsets.

Nearly every contractor's overall process was similar, beginning with a phone conversation and site visit to assess customer needs and site characteristics. Contractors assess sizing needs by looking at the number of occupants, number of bathrooms, customer preferences for shower length, and presence of large soaking tubs. They identify and discuss pros and cons of suitable locations for HPWH, concerns such as noise or size, and what will need to be done regarding condensation, conduits, venting, ducting, etc. One contractor indicated they conduct a comprehensive energy assessment and present an environmental study scenario to convince the customer on how the HPWH will address the environmental problems and make their home more energy efficient.

The need for electrical panel upgrades varied between regions. A contractor in Region 1 found that while electrical almost always had to be run from the panel, panel upgrades were not commonly needed; however, contractors in Region 3 and 4 indicated that panel upgrades were almost always needed. One contractor firm interviewed had a unique approach in which they focus only on "easy-to-install HPWHs", i.e., no electric panel upgrade needed. The majority of installations they had done to date (8 out of 9) were in garages, and units they install are generally 15-amp units that don't require a panel upgrade. However, this firm cited that because they are focused on specific types of installations (primarily in garages and with no need for upgraded electric panel or ducting) they seem to turn away a good number of customers, recommending they look for a different contractor. This firm's business practice was unique, and not mentioned by any other contractor interviewed as part of this study.

Multifamily Contractors

Multifamily contractors were asked to respond to questions about their experience with HPWHs, their approach for replacing water heaters of all types, how they influence and make recommendations to multifamily property owners and decision makers, and challenges they face in installing HPWHs. They were also asked about their process for installing HPWHs according to various replacement scenarios (emergency vs. planned), and what changes might be needed to increase the rate of adoption of HPWHs. This section summarizes the interview results and delivers insights about the contractors' installation processes.

Summary of interview results and key insights gathered

Many similar issues and key insights that presented themselves for single family contractors also applied to multifamily contractors, such as lack of stock due to supply chain constraints, installation challenges when space and/or electrical panel capacity is limited, permitting paperwork, and high cost relative to like-for-like replacement[2]. One key insight unique to multifamily contractors is that it's common practice for property owners to request bids from multiple contractors which can make a contractor more reluctant to specify a HPWH, which is generally more expensive. The evaluation criteria of those bids are often focused on cost, construction, and reliability as those are key to the property's ability to operate as cash-flow positive while also maintaining occupant and onsite staff satisfaction. Because of the competitive nature of these bid requests, contractors often feel compelled to focus their proposal on what a property owner requests, which is often a like-for-like replacement, especially in emergency or imminently failing equipment, but even in planned upgrades. As a result, proposing anything that could cost more than business as usual could result in the multifamily contractor losing the bid.

The primary situation where contractors felt comfortable offering an alternative proposal for a HPWH is where incentives are set such that the HPWH is at the same total material and installation cost, or cheaper, than the like-for-like gas option. Contractors need to have confidence in incentives when drafting these proposals and offering incentives to both distributors and contractors can help increase that confidence.

Another complication is that HPWHs can trigger electrical and/or building modifications as compared to like-for-like replacements, which can add cost and complexity to the scope and could deter a property owner. While this has the risk of increasing project cost, which alone can complicate the project feasibility, the added complexity of the construction progress can also serve as an assumed deterrent from the contractors' experience.

Finally, there was a general lack of knowledge and experience around HPWHs and grid connected HPWHs, in particular for those MF contractors who have not yet had any HPWH projects or still have a gas equipment focused sales model. Additionally, the MF contractors interviewed seemed to have less knowledge of HPWH than the SF contractors interviewed. The lack of experience installing HPWHs means that contractors either feel uncomfortable proposing it or sizing and installing it and cannot speak about the long term operational and maintenance benefits when owners ask questions. Contractors

[2] Like-for- like replacement is when an existing water heater is replaced with the same type of water as the original. For example, if the original water heater was natural gas, the replacement would also be natural gas powered.

lacked experience and knowledge about how to sell the savings and non-utility benefits of HPWH (with the exception of properties that already have or planned to install PV). The general feedback from contractors was that they would appreciate training and education opportunities. Their preferred method for increasing their comfort level with proposing and installing HPWHs would be to install more and gain firsthand experience and confidence from actual project installation experience.

Documentation of existing processes for replacement of gas water heaters

In emergency replacement scenarios, typically the contractors install as close to like-for-like as fast as possible. In these situations, it is not unusual for the property to only request one proposal, or to have established relationships with a go-to contractor. For planned replacement scenarios, contractors have a more deliberative opportunity for proposals, but may also be compared to competing proposals under review. The utility bills savings, maintenance impact, or non-bill benefits of replacement gas water heaters is not a key part of the proposal or decision-making process. Although multifamily contractors may add these additional factors into proposals that emphasize higher efficiency gas water heaters, especially in situations where those costs may be incrementally higher than a standard efficiency gas water heater.

Distributors

Distributors were interviewed to understand existing water heater stocking practices, factors limiting HPWH sales, HPWH trainings provided and understanding of HPWH load shift benefits.

Summary of interview results and key insights gathered

The team interviewed staff from distributors who have centers that service all four of the focus regions in the HPWH Project. The concerns shared were related to low customer demand which results in low HPWH sales, supply shortages, and the need for more staff training. Low market demand affected the distributors' motivation to keep HPWHs in stock and market demand was even lower in regions without a utility HPWH incentive program to drive sales. Supply shortages from the manufacturer were a result of the impact of the COVID-19 pandemic causing shipping and manufacturing delays. One distributor mentioned that planned replacements are being affected by supply shortages. They are seeing that customers want to upgrade to a HPWH, but the multiple month-long wait time deters customers, and the customers end up choosing a like-for-like replacement. All interviewees had positive reactions to TECH Clean California's contractor incentive program because they agreed that incentives drive interest in contractors and customers, which in turn drives demand.

Another barrier that was identified is that staff in distribution centers need more training to increase their knowledge on HPWHs. Staff may currently have some general knowledge, but not be at the level where they are comfortable enough to drive those sales. The sales process for residential projects tends to be a quick sales cycle where a contractor comes in already knowing what unit they need to purchase and there is little room for discussion on other viable options. Staff who are not comfortable with HPWH knowledge may not utilize these opportunities to educate contractors on HPWH benefits.

Documentation of existing processes for replacement of gas water heaters

In the case of planned gas water heater replacements, some but not many distribution center staff are trained to upsell HPWHs. However, one distributor expressed that often offering a HPWH did not make sense for the homeowner as they think HPWHs have lower performance and higher operating costs when compared to a gas water heater. Emergency replacements, when a customer is out of hot water, accounts for 80-90% of sales of residential water heaters. Often these sales are for non-HPWHs as distribution center staff prioritize selling the unit that is quickest to install at the lowest cost to complete the emergency replacement quickly so that the customer is not out of hot water for a long time.

Retailers

The interview questions developed for retailers explored existing gaps in the retailer sales process, purchase considerations from a user perspective, experience with grid connected HPWHs, and stocking impacts. There were four retailer interviews across Lowe's and Home Depot and two manufacturer interviews.

Summary of interview results and key insights gathered

We interviewed retailers and manufacturers to document the existing gas water heater replacement process, to understand installation barriers, and to compare this information to today's market stated barriers. A common concern was around the 2015 NAECA 3 (National Appliance Energy Conservation Act) efficiency standard which requires all residential storage electric water heaters that are larger than 55-gallons to be HPWHs. It is costly to stock HPWHs larger than 55 gallons which take up valuable storage space without the corresponding need and sales demand to justify it. Therefore, larger HPWHs are less available than 50-gallon HPWHs or smaller, which presents a barrier to HPWH market adoption. Distributors have also commented on keeping stocking space for higher selling units and noted the low demand for HPWHs. Retailers expressed concerns about the lack of customer interest and lack of incentives to drive demand which makes HPWHs, especially the larger ones, a lower priority to keep stocked. Retailers need proof that the higher gallon, larger in physical size HPWHs will sell on a regular basis to justify holding stock. A suggestion from manufacturers was having higher incentives for higher gallon HPWH and proper sizing information training. They shared that the stocking cost would be justifiable with a higher rate of sales.

The HPWH Project team also conducted direct phone calls to Lowe's locations to gain insights on current employees' suggestions for HPWHs. Staff recommended a 50-gallon HPWHs for a family of four to six with 6–12-year warranty options, though the retailer's website suggests a 56+ gallon water heater or larger for homes with more than five people. This could be because the 50-gallon is more readily in stock or because the employee is not familiar with how to properly size the equipment. The staff interviewed did not state whether or not appliance-specific training was available from their store. The employees pointed to a rebate reference on the website to see what incentives applied to a specific HPWH. They also commented that Lowe's could install a natural gas water heater for customers but not a HPWH. The installation would be done by a professional independent installer that has partnered with Lowe's.

Additionally, some auxiliary components of HPWHs, such as additional condensate pumps or venting kits, are available at certain locations but not every retailer has them or sees them as necessary. The interviews with retailers gave little insight into auxiliary equipment, such as a thermostatic mixing valve, that would be needed and instead suggested to work with partnered installers. This may be an issue that deters customers over time if parts are not also incentivized or easily available. Retailers would benefit from increased training in auxiliary equipment as well as HPWH specific training. Currently Lowe's does not have CTA-2045 modules or WIFI modules available and only sell unitary, not split, HPWHs.

A high percentage of water heaters sold at Home Depot are installed by contractors. While it varies by region, independent contractors or smaller companies with one-three installers take more advantage of volume discounts, financing, and the proximity of retailer stores with stock in HPWHs, when compared with larger companies with many installers. All the Home Depot models are CTA-2045 capable, although not all Lowe's models are so this presents a divided retailer environment. Furthermore, Home Depot lists the smart monitoring features and benefits of the Rheem EcoNet on the product and online, which also pushes sales. Upon speaking with Home Depot's employees within the plumbing section, we again found that staff were recommending a 50-gallon HPWH because those were the only units in stock. Alternatively, the customers could order online and pick up instore, or at another store location, and in some cases have a delivery to their home

Key insights from interviews with manufacturers included that HPWHs have a lower fail rate than the average residential water heater. Fuel conversion was noted as a major barrier experienced in California due to the high cost associated with electrical panel upgrades when switching from gas to electric water heaters. Some lower voltage HPWHs at 120v, compared to the current 240v models, may soon be released, and would reduce the need for costly panel upgrades. Manufacturers also mentioned higher stock of HPWHs in areas that have a significant HPWH rebates available. Manufacturers mentioned the ease of retailer websites to display HPWH rebates available based on customer zip code. Currently, HPWH sales are greatest in Florida due to lack of gas lines in swamp areas but they shared there is still a need for incentives for further market penetration. The recommendation to increase sales in California is to offer higher incentives, quicker upfront rebates, and proactive conversations with customers. They have seen the greatest sales increase in areas where there is an investment in driving consumer demand and not just contract training as retailers respond to consumer demand.

Documentation of existing processes for replacement of gas water heaters

At Lowe's, when a customer is deciding what size HPWH to get, there are poster signs with instructions and a representative to ask general questions such as, what size water heater the customer previously had and if they were satisfied with the amount of hot water it provided. These resources are also available online where the customer can walk through the questions themselves. There is also a rebate finder on Lowe's website that is powered by Eco Rebates and is searchable by zip code. There are two common use cases for a customer purchasing the unit: installing the unit themselves, known as do-it-yourself (DIY); and having a contractor install the unit. A representative shared that there may be DIY kits with most of the general equipment needed, except venting kits, which were located near the aisle of water heater sales. The advice for DIY installers and website instructions on Lowe's website urge installers to understand local building codes for compliance instructions or to call a professional if a self-installer is not comfortable or knowledgeable about regulations.

For Home Depot, the website provides a water heater sizing rule of thumb based on the number of occupants in the home. Rebates can be found on the Home Depot website under the rebate center. A customer or employee can search for HPWHs by zip code to find what rebates are available. Some rebate programs provide a direct link to the rebate application, and some provide a link to general rebate program information. Standard printed guides for DIY installers including a spec sheet and use and care manual are included by the manufacturer when the HPWH is purchased, and online resources that outline ducting requirements The retailer representative we talked with provided locations of online HPWH specification sheets, assured a use and care manual would be included with the unit, and recommended online instructions for general duct and vent sizes. The retailer website had a *DIY Projects and Ideas* section that included instructions for self-installing certain equipment, like mini split installations, but there were no instructions for HPWHs. The online webpage on Home Depot for HPWH information has a number to find partnered contractors through Home Depot and a message to DIY installers that is recommended to have a professional installation due to permitting, codes and installation intricacies.

Community Choice Aggregation (CCA) /Community Choice Energy (CCE) Staff

The HPWH Project team identified Community Choice Aggregators (CCAs) within the four geographic regions for the Project. Interview questions were developed to understand the CCAs existing outreach, education, and incentive programs on HPWHs within their respective service areas. Four interviews were conducted with at least one CCA in each region except for Region 2 (Central Valley) since there are not any existing CCAs.

Summary of interview results and key insights gathered

Interviews were conducted with six representatives from four CCAs spread across all the regions of the HPWH Project excluding Region 2. The participating CCAs varied in experience with HPWH rebate or incentive program ranging from none or minimal experience to well established and continuing incentive programs. Despite this variation, interviews yielded common barriers across the regions: lack of stock of HPWHs; lack of rate-based incentives for HPWHs; and lack of skilled workforce to install HPWHs. Barriers emphasized in the interviews were low customer awareness of the benefits of HPWHs and customer concern over potential installation and/or electricity bill cost increases for installing a HPWH. CCA representatives in Region 3 also expressed that the lack of targeted marketing to Multifamily building owners posed a barrier to market penetration of HPWHs in their territories.

CCAs in Regions 1 and 3 with established HPWH programs for both customers and contractors mentioned that a slow ramp-up to incentive programs are typical due to the necessary upfront outreach work by the CCAs to educate and inform customers on benefits of HPWHs. An important insight from more established CCA incentive programs is that regardless of which group (customer or contractors) that is targeted through marketing or outreach, success is dependent on the relationship between the customers and contractors. Hence, without demand from the customers, contractors are less likely to highlight HPWHs to customers looking to replace their water heaters.

The CCAs in Regions 1 and 3 are interested in grid interactive water heaters for load shifting and diversifying load management, in general. A Region 3 CCA emphasized that they want to avoid the

over-reliance of load shifting or management on grid interactive HPWHs alone. This Region 3 CCA is also exploring backup battery storage through a solar and backup storage program. They also expressed that they are encouraged by the potential impact of grid-capable HPWHs but are unconvinced that they will have great effect and are diversifying their load management technologies. Another CCA in Region 3 wanted to see the effects and impact of WatterSaver before discussing potential HPWH programs within their area.

The CCAs in Regions 3 and 4, with different territory characteristics but both without a HPWH incentive program, are in a wait-and-see position, but the CCA in Region 3 is hoping to launch a program within the next year. They expressed concern about better understanding the bill impacts on customers and getting buy-in from industry trade unions and workforce who will be strong players in the HPWH market. CCAs in Region 1 and 3 also expressed concerns on potential electricity cost increase with HPWH adoption and the need for rate structures that can incentivize customers to install HPWHs. A CCA in Region 3 suggested that future HPWH programs should focus on upsizing to allow superheating, installation of TMVs, and better technical training for installers or technicians on the back-up electric resistance mode of HPWHs. This Region 3 CCA described a scenario in which HPWHs were improperly installed to run solely on the back-up electric resistance mode, which can consume more electricity than needed. They would like to ensure that proper training is available to the technicians to ensure that HPWH units are properly installed.

Documentation of existing processes for replacement of gas water heaters

The CCA HPWH programs have similar but slightly different program designs. To outline the existing water heater installation process, this section focuses on the BayREN Midstream Contractor Program. The process for replacement usually begins with the customer recognizing the need for a water heater. For eligible customers aware of a CCA HPWH program, they can contact program representatives directly who provide a list of eligible HPWH equipment for rebates and connect them to a list of contractors. Customers can also contact a contractor directly. The contractor then recommends installing a HPWH over a like-for-like replacement based on their awareness of contractor incentives available. After the contractor sale and installation of an eligible HPWH unit, the contractor applies for the rebate or incentive. After verification of successful installation, the HPWH program sends the contractor a rebate check.

Consensus among the CCAs is that water heaters are equipment that consumers do not plan to replace until there are signs of deterioration or failure. The ability to influence and educate consumers and contractors on planning for the switch to HPWHs will be instrumental in getting more grid-capable HPWH units in homes. CCAs interviewed in Regions 1 and 3 offer incentive programs with electrification readiness efforts for residential customers which include a free comprehensive energy consultation and assessment to prepare customers for making the switch to electric energy saving equipment, including HPWHs.

Multifamily Owners and Property Managers

Interviews were conducted with six people from five multifamily property owners across four regions to understand the unique concerns and structures that impact water heater planning such as timing and funding for capital improvements. All but one owner developed new properties in addition to managing

and/or acquiring existing properties. There was a range of portfolio sizes: one owner with less than twenty-five properties; one owner with fifty-five properties and three owners with greater than 100 properties. The total units in portfolios range from 99 at low end, around 2,600 midrange and approximately between 6,700-9,500 total units for larger portfolios. The portfolios served primarily low-income populations and within each owner served different segments including family, seniors, farmworker and veteran housing. The building configurations within portfolios also varied to align with local community and population served ranging from duplex/ townhomes, garden style walk up, and low rise and midrise apartment buildings. All owners had familiarity with electrification, ranging from starting to plan a retrofit to having completed a partial retrofit or new construction project. Multifamily property owners were asked a series of questions about their experience, decision-making process, financial evaluation, and approach for water heater replacement.

Summary of interview results and key insights gathered

There are several key areas of insight gathered from the interviews: funding availability to help cover upfront costs, organizational structure and goals, upfront cost and feasibility, and the need for technical support. Lastly, owners were asked about time-of-use rates and demand response programs.

Overall, availability of funding drives decision for upgrades regardless of technology, thereby requiring that HPWH replacement costs must be close in parity to gas replacements. Many property owners expressed interest to move to a more proactive planned replacement of appliances across their portfolio and avoid emergency repair. Property owners indicated the challenge in navigating different building typologies and property types in their portfolio as listed above. In addition, water heating systems included both central domestic hot water and individual for all but one owner whose portfolio only included individual water heaters. In addition, some systems were combined water heating and spaced heating systems (in-unit gas water heaters also serving an in-unit hydronic fan coil). The owners interviewed had limited direct experience with HPWH installations and noted that overall, there are different funding barriers for different properties in their portfolio based on such factors as building configuration or size of capital budget to cover upgrades.

In addition, owners shared an interest in layering funding that has similar requirements and goals to simplify the project. Funding can come from a variety of sources including refinancing, acquisition/ rehabilitation[3], private financing, property financial reserves and/or incentives. Another factor impacting funding is if the owner or tenant are paying the utility bill. If the owner is paying the utility bill, the investment in equipment to reduce operational costs directly offset owner investment. If tenants are paying the utility bills, there is less direct economic benefit to the owner. As a result, for projects where tenants pay utility bills, often it is the combination of significant incentives to eliminate upfront costs,

[3] The federal government's low-income housing tax credit (LIHTC) program facilitate providing financial incentives for the investment of private equity capital in the development and rehabilitation of regulated affordable rental housing. For existing buildings, these typically takes one of two forms – a major LIHTC funded rehabilitation of an existing property already owned by an affordable housing developer, or the acquisition of a currently unregulated property, that then undergoes a comprehensive rehabilitation using LIHTC funding and becomes a regulated affordable property. Typically, once a LIHTC property completes its 15-year compliance period, the ownership reserves the option to see another round of low-income housing tax credit as part of a new comprehensive rehabilitation. This process of undergoing major rehabilitation using LIHTC on 15-year cycles, thereby preserving an existing LIHTC property, is called "re-syndication".

combined with the ownership's mission to ensure that housing and associated utility costs are affordable for the low-income occupants, which drive investments in energy upgrade retrofits.

While financial feasibility remains a critical factor, adopted organizational goals for electrification and/or clean energy can provide flexibility in decision-making. For many owners, sustainability goals and affordable housing missions also drive decision-making. Therefore, costs do not have to be exactly on par with, but relatively close to, natural gas water heater retrofits to enable owners to choose to invest in housing improvements for residents.

Capital costs for improvement are often limited and result in prioritization of fixing maintenance issues over energy efficiency and electrification upgrades. The increased upfront costs of HPWH retrofits driven by building configuration and electrical infrastructure upgrades exacerbate this prioritization challenge, this can apply to both central and individual units. Central heat pump hot water systems require more storage than gas boilers and therefore more space in addition to requiring increased electrical capacity over gas boilers. For central systems, these two conditions result in higher upfront capital costs and retrofit complexities compared to a like-for-like retrofit. For individual HPWHs which are larger than conventional gas water heaters for apartments, small closets, common in apartments to accommodate individual systems, may require space modifications and/or ducting to accommodate replacement HPWH or identification of a new location for the HPWH. Both conditions result in increased costs over a like-for-like upgrade. In addition, many multifamily apartments have limited electrical panel capacity which cannot accommodate additional electrical load from new HPWHs; a similar situation applies to common area panels serving central HPWH systems, albeit slightly less recurrent of a barrier as compared to apartment panels. These undersized panels frequently serving central systems or apartments may need to undergo costly upgrades to increase the electrical capacity, and those upgrades may not qualify for incentives. Technical assistance to identify HPWH products, support water heater system selection and sizing, and support coordination with contractors are key to reducing owner time burden. This technical assistance results in greater capacity for the owner to facilitate HPWH installation and increases the owner's knowledge making them more comfortable with HPWH installations in the future.

This technical assistance is critical when working with a contractor and/or architect who is not familiar with the benefits of HPWHs to educate that design team on HPWHs and assist the owner in water heater selection strategy. Without this assistance, the burden is on the owner to educate the design team and they may not have time nor bandwidth to undertake this additional responsibility. Ideally, there would be a larger pool of knowledgeable contractors that can work with a property owner. While not the norm, one of the contractors interviewed drives the decision-making for their clients guiding them to HPWH. They have taken on that role to educate property owners to undertake the perceived newer strategy of installing HPWHs.

Owners were interested in DR programs if it benefitted their tenants but there were several considerations:

1) Owners were not clear on the ability to reduce load during a DR event as many properties were occupied at all hours of the day.
2) Concern that a high level of effort from property management was needed for DR enrollment. Based on limited understanding of programs, the concern is the added time and resources necessary to enroll tenants in DR programs may conflict and compete with already busy

schedules and staff responsibilities, such as managing the rental and turnover of units, annual utility analysis activities, or other regulatory reporting responsibilities.

Both concerns indicate an opportunity to engage with property owner and managers on the benefits of these programs for tenants and the enrollment process to understand how they may support enrollment and timing of enrollment while minimizing burden on property management staff. This is a new concept and owners do not understand the level of effort to support enrollment in a program which could range from providing information to repeated follow-up to ensure enrollment. After a property is fully occupied, there may be an opportunity to engage with tenants through community meetings or regular posting of notifications, taking advantage of existing processes.

Documentation of existing processes for replacement of gas water heaters

Replacement of water heaters commonly occur under the following scenarios: resyndication, refinance, acquisition/rehabilitation, capital needs projects[4], and emergency replacement. Key takeaways from the process of water heater replacements are described below.

Approach to improvements: General improvement projects are regularly identified through capital improvement planning that commonly occurs annually, but this process may not always occur. Typical Physical Needs Assessments (PNA) and Capital Needs Assessments (CNA) utilize an Energy Use Index (EUI) for when to schedule water heater replacements which does not enable accounting for electrification, but rather like-for-like replacement. Maintenance issues will be prioritized for cash-tight properties and improvements are commonly only considered for cash-adequate properties. It is common for improvements based on energy efficiency to be value-engineered out of the capital improvement plan.

Replacements are driven by availability of funding. Funding availability drives replacements regardless of scenario. Requirements for receiving funding such as needing to create higher performing buildings or select electrification measures typically drive equipment selection. Where possible, owners prioritize grant funding over loans as there are limits to debt that can be incurred. Jurisdictions such as local cities, counties, or municipal utilities with available funding directed for electrification investments can spur replacement through the availability of a Notice of Funding Availability (NOFA) which are typically in the form of grants, and do not need to be repaid. Ideally, owners would understand available funding and then identify properties that are ready for replacements. Identifying funding opportunities allows owners to plan for the upcoming 1-5 years. This is an ideal situation that often only occurs with gut rehabilitation[5], re-syndication or refinancing.

Information for decision-making. Decisions for a specific scope of work are based on financial economics that include funding availability, initial capital costs, operational costs, future replacement costs, maintenance costs and tenant benefits. Compiling these data requires technical knowledge and time to evaluate replacement technologies, costs, and incentives that owners often do not have. Project

[4] Capital needs projects are driven by capital needs assessments (CNA) or property needs assessments (PNA) which are property inspection reports that estimate future costs of property maintenance, determining cost of repairs and appliance replacement based on end of useful life.

[5] A gut rehab is defined as stripping a building down to the framing and replacing all systems.

level technical assistance available through incentive programs provides owners with this necessary information. This information can then be incorporated in the owner's internal decision-making process to approve a retrofit scope of work.

Multifamily Maintenance Staff

Multifamily maintenance staff were asked to respond to questions about their experience with HPWHs, their approach for replacing water heaters during various scenarios, what would need to change to adjust the current approaches, and their experience maintaining existing water heaters. This section summarizes the interview results and delivers insights about the installation processes.

Summary of interview results and key insights gathered

Multifamily maintenance staff from four different organizations were interviewed, three of which had broad geographic representation and one that was focused on Region 3. For each of the four organizations interviewed, the overall priority for multifamily maintenance staff is getting hot water to the building and its occupants. During emergency replacement scenarios the maintenance staff have significant autonomy to do whatever is necessary to complete the replacement in the quickest and most cost reasonable way, which is commonly a like-for-like replacement. Maintenance staff were less involved in planned replacement scenarios, with the exception that they may play a role in alerting decision makers of an upcoming replacement need based on the declining, but not yet emergency, condition of existing equipment.

Most maintenance staff are wary of new technologies that will complicate their job. For example, common aspects of new technologies are additional maintenance, questions from tenants and staff, and additional repair troubleshooting which add job complexities that they are either unable or unwilling to undertake. Additionally, there is often little guidance from larger asset managers (mid-level manager overseeing operation of multiple properties) or property owners on when and if to pursue alternative technologies. Maintenance staff are not rewarded or encouraged to spend time researching alternatives. and even if they were, some maintenance staff are resistant to complicated work scopes or new responsibilities. They are the front line when things go wrong or when occupants complain and avoiding that is more important than environmental or utility bill impacts. For organizations that have properties with recently installed HPWH, they identified the need to have reliable and quick warranty and maintenance support from manufacturers to address any performance issues causing issues with satisfactory hot water delivery. They also identified the lack of trained service technicians, although compared to 2-3 years ago, they've already seen improvement in this area. Interviewed organizations did not indicate whether they had an appreciable number of existing electric resistance water heaters, and the vast majority were understood to be existing gas water heaters.

Documentation of existing processes for replacement of gas water heaters

Maintenance staff shared they were rarely involved in planned replacement scenarios, and if they were, the role was often limited to providing information to decision makers on the declining condition of the existing water heaters. However, maintenance staff play a key role in emergency replacement scenarios. In general, either in-house maintenance staff or their preferred list of on-call contractors, will replace the failed existing water heater on a like-for-like basis, and in these situations, they usually do not need to

run approvals by upper management. The primary focus is to return hot water service to tenants as fast as possible and in a cost reasonable manner. In some cases, upper management is not even aware of the replacement happening until reviewing annual reports or budgets. It did not appear that emergency replacements went through standard permitting channels, which may create an added logistical barrier when considering HPWH emergency replacements, especially those triggering electrical upgrades which require a permit.

List of installation barriers

Interviews with market actors highlighted a variety of barriers to installation for HPWHs. Included below is a summary of the most impactful barriers to increasing the adoption of HPWHs. The barriers were organized by region to determine if barriers varied based on region or similar barriers were distributed across regions. Therefore, each row is a common barrier and if there is a blank box in specific column of that row it means the barrier was not brought up in that region.

Table of barriers across stakeholders and regions

Table 7: Barriers identified by local government building department staff

	Region 1	Region 2	Region 3	Region 4
Local Gov't Building Dept Staff	Lack of contractor familiarity with HPWH technologies		Lack of contractor familiarity with HPWH technologies	Lack of contractor familiarity with HPWH technologies
	Lack of building department staff familiarity with HPWH technologies and requirements		Lack of building department staff familiarity with HPWH technologies and requirements	Lack of building department staff familiarity with HPWH technologies and requirements
	Inconsistent and/or complex permitting practice		Inconsistent and/or complex permitting practice	Inconsistent and/or complex permitting practice
				Lack of coordination between in-field and building department staff

Table 8: Barriers identified by Single family contractors

	Region 1	Region 2	Region 3	Region 4
Single family contractors	High cost of unit and for installation (especially compared to like-for-like replacement)			
	Difficult to convince the customer to purchase a HPWH.			

	Region 1	Region 2	Region 3	Region 4
	This barrier includes the high cost of fuel switching, comfort concerns and needing to install a larger HPWH because a lack of on-demand hot water compared to a smaller gas unit, and then just the cost of natural gas compared to electric. Customers are not aware of HPWH technology and the benefits of switching fuels.			
	Lack of skilled workforce to install HPWHs driven by lack of workers and unique skills to install a new, complex technology requiring venting, condensation, etc.			
	Not enough space in the home to install the HPWH			
	Long delays in receiving new equipment or supplies due to supply chain constraints from the pandemic			
	Permitting and inspection is complex and not consistent across permitting jurisdictions.			
	Lack of awareness of what the product is, reliability, and energy saving potential			
	High cost of electrical panel upgrades		Rebate programs that require bringing the whole building up to code	No rebate program in the area
	Nosier than gas tank counterparts	Hard to convince customer to get rid of gas appliances	Customer information and education on HPWH	

Table 9: Barriers identified by Multifamily contractors

	Region 1	Region 2	Region 3	Region 4
Multifamily contractors	Lack of experience to sell, size, engineer and install HPWHs			
	Higher first cost of HPWH installation compared to like-for-like water heater replacement. Especially important in multifamily situations that commonly go out to bid for water heater installation with the lowest cost bid winning			
	Increased complexity of HPWH installations due to needing electrical infrastructure upgrades and building modifications such external ducting and/or installing the ability for condensate discharge			

Table 10: Barriers identified by Distributors

	Region 1	Region 2	Region 3	Region 4
Distributors	Lack of motivation to stock HPWH due to low customer demand.			
	Distributor residential sales staff need more training on HPWHs.			
	Residential HPWH sales are focused on first cost, instead of lifecycle cost, and has a quick sales cycle.			
	Lack of stock of HPWHs and grid-connected HPWHs.			

Table 11: Barriers identified by Retailers

	Region 1	Region 2	Region 3	Region 4
Retailers	Lack of reasons to use store space to stock HPWHs (especially larger capacity HPWHs)			
				Low incentives, no motivator to stock HPWHs
	High first cost of HPWH units result in low consumer demand			
	Lack of contractor's knowledge and comfort to sell HPWH			

Table 12: Barriers identified by CCAs/CCE

	Region 1	Region 2	Region 3	Region 4
CCA/CCE	Lack of stock of HPWHs		Lack of stock of HPWHs	Lack of stock of HPWHs
	Increased electricity bill after installing HPWH installations due to lack of rate-based incentives for HPWHs		Increased electricity bill after installing HPWH installations due to lack of rate-based incentives for HPWHs	Increased electricity bill after installing HPWH installations due to lack of rate-based incentives for HPWHs
	Customers and contractors not aware of benefits of grid-capable HPWHs as marketing focuses on the health and safety benefits		Customers not aware of benefits of HPWHs and concerned with potential cost increase	
			Lack of skilled workforce and training	Lack of skilled workforce and training
			Lack of targeted marketing to MF owners	

Table 13: Barriers identified by multifamily owners and property managers

	Region 1	Region 2	Region 3	Region 4
Multifamily owners and property managers	Lack of adequate capital to cover higher costs of HPWH replacements			
	Funding opportunities and HPWH incentive models do not align with the processes for the different types of upgrades: acquisition rehabilitation, 15 yr syndication, capital improvements, refinancing, emergency replacements.			
	Typical lending options do not assume reduced operational costs for energy efficiency and do not reward electrification in lending determinations.			
	Standard property needs assessments and capital needs assessments which guide upgrade investments are based on efficiency rather than values of electrification of end uses for cleaner and more efficient appliances.			
	Lack of adopted organizational prioritization for electrification including HPWHs			
	If tenants are paying the utility costs, owners investment is more of a challenge because there is not direct payback for investment.			
	Unknown operational costs due to variations in predicting current future rate structures.			
	Higher first cost of HPWH equipment and installation compared to like-for-like water heater replacement.			
	High soft costs due to lack of HPWH knowledge creating a higher time commitment from the project owner to gain the needed knowledge and/or share the HPWH knowledge to complete the water heater project.			

Table 14:15 Barriers identified by multifamily maintenance staff

	Region 1	Region 2	Region 3	Region 4
Multifamily maintenance staff	HPWH retrofits for emergency replacement take too long due to installation complexities and permitting. A permit is not usually pulled in a like-for-like replacement.			
	HPWH retrofits adds complexity (during installation and future maintenance), which adds to staff workload, is outside of job scope, and is perceived to lack intrinsic motivation			
	Maintenance staff are not receiving upper management directive to prioritize HPWH installations			

Implementation strategies for barriers

The barriers identified from the interviews were narrowed down to the top three most impactful barriers per stakeholder group. Then a strategy was developed to best overcome each barrier. The strategy ranged from education, training, process improvement and financial inducements. The list of implementation strategies can be found in the attached Excel file: HPWH Supply Chain Market Study Implementation Strategies.xlsx

Design financial inducement structure

This section identifies the largest barrier per stakeholder group and then designs a financial inducement structure to overcome that barrier. This is different from the implementation strategies section that could use education or training as a solution for overcoming barriers. Instead, here the Project Team focuses on an inducement designed to make the biggest impact to increase HPWH adoption for a specific stakeholder in the HPWH supply chain. While the Project Team recognizes that there are many aspects to a successful program including education and awareness, this section only focuses on inducements. The HPWH Project had resources to move forward with one inducement structure and in collaboration with PG&E it was decided to test the Distributor inducement as it had the greatest opportunity to drive large scale change.

Local Government

Inducement structure

Through Frontier Energy's engagement with local building department staff in Regions 1, 3, and 4, staff found the largest area of need for local building departments was education and training. To help incentivize this learning, continuing education units (CEUs) for trainings can help induce participation in these activities.

Value proposition

From the building department perspective, inducement strategies need to align with local government best practices and/or requirements that prohibit local government staff from receiving financial payments from third parties outside of their existing agency compensation. Given most building department professionals need to earn continuing education units (CEUs) as part of their employment and/or professional credentials, the best inducement strategy would be to provide additional no-cost HPWH installation requirement and best practices trainings that are eligible for CEUs.

Inducement layering

There is not a need to layer additional HPWH trainings on top of existing HPWH trainings on the same topic. Existing training providers already engaged with building departments, including but not limited to the Statewide Codes & Standards Energy Code Ace program, the Bay Area Regional Energy Network (BayREN) Codes and Standards program, and the Tri-County Regional Energy Network's Code and Standards Program, offer a channel to coordinate trainings. Most Energy Code Ace and BayREN trainings are already approved for CEUs through the ICC. New HPWH training content eligible to provide CEUs developed in concert with existing training providers would offer more options and value to building department staff.

Single Family Contractor

Inducement structure

1. To address the high cost of installation barrier: provide an electrical panel upgrade inducement to lower the overall cost of installations. This can be layered with a HPWH unit inducement available via the TECH Clean California statewide incentives.
2. To address the barrier regarding customer reluctance to purchase a HPWH: provide free or reduced cost sales training aimed at assisting contractors in presenting the benefits of HPWHs to homeowners and encouraging them to make the upgrade. This would include marketing materials such as video content about the benefits of HPWHs and a free tablet for enrolled contractors to share the video content with customers about the benefits of a HPWH. The tablet would also provide contractors with a tool to easily access information regarding eligible incentives for a potential project while on-site.
3. To address the barrier of lack of available contractors to install HPWHs: provide direct-to-worker inducements in the form of an immediate bonus for a sale for completed installations and a reimbursement for training and certification related to HPWH installation. This will encourage a more robust and skilled workforce to support the ever-increasing need for skilled workers.

Value Proposition

1. Electrical panel upgrade inducement
    a. Currently there is a TECH Clean California regional pilot offering incentives for electrical panel upgrades in the Bay Area. This electrical panel upgrade inducement would be available to all PG&E contractors who qualify.
    b. Contractor firms – this will lower the overall cost of installs, making it easier for contractors to sell more equipment.
    c. Homeowners – this will lower the overall cost of installs, making it easier to select a HPWH instead of like-for-like replacement that is traditionally cheaper.
2. Sales training and tablet
    a. Contractor firms – sales training and the free tablet will give contractor firms and their technicians tools to help them address sales barriers and convince customers of the benefits of HPWH resulting in greater revenue for the contractor, as HPWHs have a high profit margin.
    b. Homeowners – the HPWH sales information provided by contractors will educate a homeowner on a new technology allowing the customer to select a HPWH for installation that provides air quality, environmental and financial benefits. The contractor can also utilize the tablet to begin the inducement application process while still in the home. This will save time for both the contractor and the customer as it will eliminate the back and forth to gather all the key data points for the inducement.
3. Direct-to-worker inducements
    a. Contractor firms (business owners and managers) – this inducement would increase the overall number of workers in the marketplace with HPWH training without placing the training burden on the contractor and allow contractor firms to book more HPWH installation projects.

b. Technicians (building professionals working in the HPWH industry as employees of contractor firms, or entry level workers) — this inducement will assist the workforce in pursuing continued education and reward workers for completed HPWH installations. Outreach about these inducements could be focused on small/diverse businesses and communities, in support of quality and access goals for workforce and the "high road principles" regarding equity, sustainability, and job quality for disadvantaged workers as referenced in the Environmental and Social Justice Action Plan Draft Version 2.0.[6]

Inducement layering

The three suggested inducement structures can be layered with a variety of existing efforts to promote electrification and maximize program benefits and offerings to contactors.

1. Electrical panel inducement –California's regulatory market has mandated programs to coordinate with each other to identify opportunities to layer other incentives and funding sources to support electrification. Relevant programs to layer electrification and energy-efficiency financial programs include:
    - CAEATFA's GoGreen Home Financing
    - TECH Clean California
    - BayREN HPWH Midstream Program
    - BayREN Home +
    - MCE's Contractor Rebate Program

1. Sales training and tablet – current programs in the market offer a sales training as described in the layering for the direct-to-work inducement. The inducement of offering a free tablet is unique and therefore would not be limited for fear of overlap.

3. Direct-to-worker inducement – relevant programs that could be harnessed to provide an inducement for completing the trainings for inducement structures 2 and 3 include:

    - Silicon Valley Clean Energy FutureFit Program
    - 3C-REN's Building Performance Training Program
    - MCE's Workforce Education and Training Program
    - Sonoma Clean Energy Advanced Energy Center Program

All three of these inducement strategies could be layered with outreach and incentives from other programs and can help lower the cost of installs, raise awareness with contractors and homeowners, and develop the workforce to ramp up electrification in California.

[6] Environmental & Social Justice Action Plan Version 2.0 – Draft version for public comment. California Public Utilities Commission, October 26, 2021. Available online.

Distributor

Inducement structure

Currently TECH Clean California is offering a HPWH incentive directly to contractors to help reduce the overall high cost of HPWH replacement installations and therefore drive greater demand. Given that all stakeholders interviewed in the HPWH Project mentioned the barrier of high HPWH costs in limiting demand, it is not evident that only a contractor incentive is enough to overcome that barrier. Each time a piece of equipment moves down the supply chain from manufacturer to distributor, to contractor, to customer, a small price mark-up takes place to cover the cost of business for that supply chain market actor. Therefore, the HPWH Project Field Test will offer a $1000 inducement to distributors per grid-capable HPWH sold and installed in retrofit[7] projects and a $200 inducement per TMV. The $1000 inducement is set to cover the average incremental measure cost between a natural gas water heater and a HPWH of comparable sizes. The $200 TMV inducement covers the full average TMV cost. These two inducement levels help decrease any concerns customers have about purchasing a higher cost product along with a TMV, which isn't always required.

Value Proposition

Distributors are less likely to stock equipment if they do not have confidence that the equipment will sell. Holding stock of equipment takes up valuable warehouse space, the cost of which comes at a premium in many parts of California. Therefore, to reduce their financial burden, distributors will focus their buying practices based on what they think will sell, and right now HPWHs are not selling because of their high cost. In discussions with HPWH manufacturers, they shared that the strong SMUD HPWH incentives were a major driver in deciding to move most of their stock shipped into California into warehouses in the Sacramento area. This practice started to change as more rebate programs emerged in the Bay Area, showing that incentives are a driver in manufacturer stocking decisions. Also, many distributors will focus what they stock and sell based on what they are most comfortable with. HPWHs are still new in California, meaning many distributors may not have confidence to push the product to their customers (contractors).

A distributor-based incentive helps overcome these barriers in the following ways:

- The incentives at the distribution level can help lower the cost difference between HPWH and natural gas water heaters, giving distributors more confidence that they can sell the units
- The distributor-based inducements can also give manufacturers confidence that units will sell, causing them to push more stock to the regions that offer the inducement
- Keeping the inducement at the distribution level also gives the distributors flexibility to use some of the funds to educate their sales staff and/or conduct marketing focused on the equipment, increasing the confidence level in their staff to sell the units

[7] Initial distributor HPWH inducement applications received were for New Construction projects. These new construction applications remained eligible though the Distributor Participation Agreement was updated to clarify that only retrofit HPWH projects would be eligible moving forward. This HPWH Project decided to pivot and focus on the retrofit use case as that contains the largest barriers to increasing HPWH adoption.

Inducement Layering

As we've learned, distributors will stock what will sell and for residential equipment, that is commonly driven by what customers are asking for. Therefore, the HPWH distributor inducement is being layered with the TECH Clean California contractor incentive to drive that customer demand. The TECH Clean California contractor incentive is also able to be layered with incentives from CCA programs that do not claim Energy Efficiency (EE) savings, like the BayREN Home+ Program, which offers a customer incentive.

By reducing HPWH unit costs at the distributor level, savings will trickle down to contractors. Contractors will then receive an incentive through TECH Clean California and additional cost savings will further trickle down to the customer level. By layering incentives at different market actor levels, we expect to see overall project costs decreasing over time.

Retailer

Inducement structure

After interviewing retailers and the manufacturers that supply them, it was found that the best way to increase HPWH adoption is to increase demand. An inducement structure to increase HPWH sales is to give customers instant rebate options at the retail point-of-sale (POS). This can be done with an online app or Quick Response (QR) code scanning service that allows customers to see valid rebates for the product they are looking at while in retailers' stores.

There are three key aspects to support the success of the retailer point-of-sale inducement structure.

1. Simple customer validation – name, account address, zip code
2. Effective delivery method for the rebate coupon – phone, email, or text
3. Instant rebate delivery – rebate coupon can be scanned in store for an immediate discount

This inducement structure is customer-focused with an easy-to-use model that will lead to HPWH purchases. The online application would be simple, allow limited time offers to be displayed as funding changes in different areas, and would work for different customer segments.

Value proposition

Throughout the interviews with retailers and manufacturers the biggest barriers were the lack of storage space to hold HPWHs and the need for customer demand to justify keeping more in stock. The lack of customer demand is due to the high prices for customers to buy HPWHs which further contributes to the high cost for retailers to keep them stocked, especially if units are not sold fast enough. These issues can be addressed with a point-of-sale inducement that allows customers to lower the cost of a HPWH and generate interest in various sizes and models of HPWHs which can then make keeping them in stock less costly.

Inducement layering

A POS rebate offered by PG&E may be layered with some existing rebates to maximize customer impacts as outlined below.

Table 16: Inducement Layering Scenarios

Other Program Rebates to Layer with PG&E Retailer POS Rebate	Layering Status
TECH Clean California	Allowed
CCA Rebates	Case by Case
PG&E Downstream	Not Allowed

Layering a PG&E retailer POS rebate with TECH Clean California would be approved because PG&E can claim and fund the incentive via energy efficiency savings and TECH Clean California is not claiming energy efficiency savings. The second scenario would be layering with an existing CCA operated incentive program. In most cases this would be denied, with the assumption that the CCA program will be claiming energy savings. Both PG&E and the CCA program cannot claim the same energy efficiency savings. This would only work if that CCA program is not also trying to account for energy savings as PG&E does. The last case would be layering the PG&E POS with a PG&E downstream program. This would be an overlapping issue with two programs in PG&E trying to claim the same energy efficiency savings and would not be allowed. The successful layered inducements would help drive the demand for HPWHs and justify the need for more stocking space and higher units of sales.

Conclusion

The HPWH Project conducted a supply chain market study and will use a field test to test strategies to engage midstream market actors to accelerate the adoption of grid-capable HPWHs for load shifting. Both activities are focused on four specific geographic regions to allow for gathering insights across three use cases. These regions are BayREN North Bay, BayREN South Bay, Central Valley and Central Coast. During the implementation of the HPHW Project, TECH Clean California expanded incentive strategies from local to statewide contractor incentives which eliminated one of the original use cases which had intended to test impacts of distributor inducements in an area without contractor incentives.

The supply chain market study included interviews conducted across the HPWH supply chain, including local government building department staff, single-family contractors, multifamily contractors, distributors, retailers, CCAs, and multifamily owners, property managers and maintenance staff. From these interviews, the Project Team documented the main barriers to increasing HPWH adoption for each stakeholder group. The most common barriers across regions and stakeholders were the high cost of HPWH installations, the lack of contractor familiarity with HPWH technology, long delays in equipment due to supply chain issues, cost of electrical panel upgrades, and permit issues. Then the Project Team designed implementation strategies to overcome the three most impactful barriers per stakeholder group. Finally, a specific inducement structure to overcome the largest barrier was created for the four major stakeholders. For local government building departments, the inducement would be free training classes that are eligible for CEUs. The contractor inducement was a direct-to-worker payment. The Project Team decided to use the Project Field Test to evaluate the suggested financial inducement offered to distributors to stock and upsell grid-capable HPWHs as it had the greatest impact to scale. The inducement to retailers was a point-of-sale instant rebate solution that customers could access while at the store. There are many ways to increase the adoption of grid-capable HPWHs and this supply chain market study outlined clear barriers, solutions and inducements that can be implemented to drive the greatest change.

APPENDIX B: HPWH SUPPLY CHAIN MARKET STUDY IMPLEMENTATION STRATEGIES

Task 3:Implementation Strategies to Overcome Barriers

Local Government Building Department Staff

	Barrier 1	Barrier 2	Barrier 3
Barrier description	Lack of contractor familiarity with HPWH code requirements affects the permit application process.	Lack of building department staff knowledge of code requirements related to HPWH's.	Building department business practices and workflows lead to slow and inconsistent permitting practices for HPWHs.
Implementation strategy description	Increase training courses and educational materials on HPWH technologies for contractors.	Increase trainings and educational materials on HPWH technologies for local building department staff.	Consulting jurisdictions on HPWH permitting best practices. For instance, jurisdictions should be consulted to integrate electrical and plumbing work into a single streamlined HPWH permit. Additionally, jurisdictions should be supported to update digital permitting practices for HPWHs, such as utilizing an online portal for permit submission.
Rationale	In interviews with building department staff throughout Regions 1, 3, and 4, staff members consistently referenced the lack of contractor familiarity with HPWH's as a barrier to adoption. There are some existing training offerings, notably the BayREN HPWH course, but additional trainings are needed. These existing resources should be leveraged to conduct more trainings.	Jurisdictions remarked there were complications understanding the energy code when analyzing permits for installing HPWHs. There are existing training offerings, notably through BayREN, which seek to educate building department staff on HPWH technologies and energy code requirements for installation. Existing resources should be leveraged in developing curriculums geared to the local building department audience. Additionally, HPWH training courses should be expanded the regions outside the Bay Area through Energy Code Ace.	Jurisdictions have different systems and practices for managing HPWH permitting and review. Jurisdictions interviewed had a variety of web-based solutions for permit submittal, but the more limited online processes such as a monitored email address were acknowledged to be slow, inconsistent, and unreliable. Additionally, some jurisdictions require separate electrical and plumbing permits be submitted to obtain a HPWH permit. Navigating this process is cumbersome, adds complexity, cost, and time.
Resources and education required	Training materials geared towards contractor audience covering the following topic areas: 1) HPWH technology 2) When HPWHs are allowed under 2019 Energy Code 3) Energy code requirements for HPWH installation 4) How to complete compliance forms Target Audience: Contractors, building professionals	Training materials geared towards building dept staff covering the following topic areas: 1) HPWH technology 2) When HPWHs are allowed under 2019 Energy Code 3) Energy code requirements for HPWH installation 4) How to complete compliance forms Target Audience: Permit technicians, plan checkers, and field inspectors.	Create materials related to best practices for HPWH permitting processes and standardized permitting software. Leverage work underway with the TECH Permitting Pilot team to circulate resources and learn best practices.
How and why strategies vary by region	Existing training programs are offered through BayREN, a regional energy network limited to the 9 counties of the Bay Area. Strategy would involve expanding BayREN scope within Region 1 and Region 3. Expanded outreach to Region 2 and Region 4 through Energy Code Ace could be successful to increase the number of trainings in these regions.	Existing training programs are offered through BayREN, a regional energy network limited to the 9 counties of the Bay Area. Strategy would involve expanding BayREN scope within Region 1 and Region 3. Expanded outreach to Region 2 and Region 4 through Energy Code Ace could be successful to increase the number of trainings in these regions.	Strategy does not vary by region. Different building departments are constrained by budgets and other factors unique to their jurisdictions.
Metrics	Number of contractors attending HPWH courses.	Number of building department staff attending HPWH courses.	Duration between HPWH application and rewarding of permit.
Key indicators of success	Increased number of successful HPWH permits approved within a given jurisdiction.	Increased number of successful HPWH permits approved by jurisdiction staff.	Faster times to achieve a HPWH permit.

Task 3:Implementation Strategies to Overcome Barriers

Single Family Contractors

	Barrier 1	Barrier 2	Barrier 3
Barrier Description	High cost of installation - Out of the 10 interviews, this barrier was mentioned by 9 contractors.	Difficult to convince the customer to purchase a HPWH. This was mentioned 7 times out of 10 in the interviews.	Lack of available technicians who have training to install HPWH - only 2 out of 10 surveyed contractors said that it would be easy to hire new staff who have expertise in installing HPWH.
Implementation strategy description	Provide direct-to-contractor incentives to lower the cost of installation, currently offered by TECH Clean California.	For contractors: Provide increased sales training and an incentive for a free tablet for in-home presentations. Provide an educational video on heat pump technology that could be presented to customers using the tablet.	Provide two incentives layered with the current TECH Clean California contractor incentive, designed to go to the workers and not the general contractor. The incentives would include a spiff for completed installations and a reimbursement for training and certification related to HPWH installation to attract workers to the HPWH industry.
Rationale	Most of the contractors who were interviewed listed multiple issues that could require bringing in a subcontractor. Whether it's an installation that requires an electric panel upgrade, or sizing issues, or adding pipe, this incentive would be designed to help lower the overall cost of the installation and make HPWHs more competitive in the market. While similar incentives are availbalbe through TECH, they are only being offered in the Bay Area and are not available to most PG&E customers. This incentive would change that.	We need to give contractors more tools to help them sell the customer when they're presenting options at the dinner table. #1: We can provide items such as incentive sheets, information about heat pumps and electrification, and a free tablet with a video that goes into the advantages of HPWH and the current incentives that are available. The tablet offers a unique opportunity to provide tailored information to the customer about potential energy savings and how a HPWH could lower their monthly bill. This collateral could be left with a customer to review while they're assessing the equipment needs and the costs of the install. This gives the customer an opportunity to absorb that information at their own pace and then ask questions once the contractor is able to give them an estimate. If customers are more aware of what electrification is, and why these incentives might not always be there, it could greatly help contractors to sell more HPWH. #2: The tablet also presents an	There is a shortage of experienced staff across the trades, so not having staff available to install the equipment is a common barrier for contractors. #1: Providing a spiff to current workers for finished projects will help draw new staff to the HPWH industry by making the industry more lucrative and attractive to people who are looking to go into the trades. Enrolled contractors can use this spiff as a tool to recruit potential workers to their industry. #2: Provide reimbursement to contractors for training and certification to lower the cost of entering the HPWH industry and attract new people to the market.
Resources and education required	Funding for contractor incentives; training and engagement with contractors regarding the incentive.	Funding in the form of an incentive for enrolled contractors for a single tablet to be used for in-home education of customers; training and engagement with the contractors on HPWH technology and sales strategies; educational video and flyers that can be shared with customers.	Funding for worker incentives; training and engagement with workers and contractors regarding the incentive.
How and why strategies vary by region	This strategy should not vary by region though installation costs will vary by region. 1) The cost of necessary upgrades vary by region, depending on availability of sub contractors and the complexity of the work. 2)The number of older homes could vary by city or by county. Areas with a higher concentration of older homes that would require additional upgrades as part of the installation process. 3) This would also provide an opportunity to do targeted outreach towards disadvantaged communities such as low income, minority, and women owned businesses.	Region 2 may require more marketing collateral to support a contractor explaining and selling HPWHs as rural areas are less exposed to HPWHs. 1) Customer knowledge about HPWH can vary by city or county. Metro and suburban areas could be more familiar with heat pump technology and electrification, whereas rural areas could be less knowledgeable and more resistant. 2) Convincing a customer to make the fuel switch could be largely impacted by economics of a community, city, or county. Lower income families could face a larger barrier when comparing the cost of gas to electricity. 3) Lack of existing advertising and awareness in minority and non-English speaking communities.	This strategy may vary by region and need should be assessed on the city or county level. 1) The number of potential workers could vary by city or county based on denser population or rural areas. 2) Opportunities for continued education could be harder to find in the rural areas. 3) This could also be a great opportunity to focus outreach and engagement towards small/diverse businesses and communities, in support of quality and access goals for workforce and the "high road principles" regarding equity, sustainability, and job quality for disadvantaged workers as referenced in the Environmental and Social Justice Action Plan Draft Version 2.0 (CPUC, October 2021).
Metrics	Dollar value of incentives by region; volume of incentive claims filed.	Number of contractor staff trained; number of tablets disbursed to contractors; views on awareness video provided to contractors.	Number of contractor staff trained; dollar value of incentives by region; volume of incentive claims filed.
Key indicators of success	Increased numbers of incentive claims paid and higher dollar value of incentive claims by region.	More HPWH sold and installed, especially in rural areas.	Increased number of trained professionals entering the workforce; increase in overall projects statewide .

Task 3: Implementation Strategies to Overcome Barriers

Multi-family contractors

	Barrier 1	Barrier 2	Barrier 3
Barrier Description	Lack of experience to sell, size, engineer, and install HPWH's.	Higher first cost of HPWH installation compared to like-for-like water heater replacement. Especially important in multifamily situations that commonly go out to bid for water heater installation with the lowest cost bid winning	Increased complexity of HPWH installations due to needing electrical infrastructure upgrades and building modifications such as external ducting and/or installing the ability for condensate discharge
Implementation strategy description	Develop education and training to MF contractors to describe the benefits of HPWH (to support sales), as well as technical information on sizing, engineering and installing. Create generous inducement strategies on a limited basis, so that contractors have an opportunity to install at least one MF HPWH project, thereby increasing first-hand experience.	Provide distributor incentives so that bids that include HPWH can have incentives baked into them. Incentives need to be attractive enough to be at parity, or cheaper, than like-for-like installations, inclusive of the added installation costs that HPWH bids would entail, including building and electrical modifications.	Develop technology solutions and building retrofit-ready incentive initiatives to prepare for HPWH installations, such that the incremental costs for building modifications and electrical infrastructure upgrades have already been addressed
Rationale	Education and training offerings, as well as actual project experience, enables the contractors to improve experience, knowledge and comfort with selling, sizing, designing, and installing HPWH systems in MF buildings	Unless HPWH net costs are on parity with like-for-like installations, some property owners will select the lowest cost bids	Reduces the time, cost, and complexity of trying to address building modifications and electrical infrastructure upgrades at the same time of HPWH installations
Resources and education required	Online and in-person trainings providing educational information to contractors. Funding for inducement	Incentive funds and engagement with distributors	Incentive funds and engagement with properties to prepare the property to be HPWH retrofit ready
How and why strategies vary by region	Strategy would not vary by region	Strategy would not vary by region	Strategy would not vary by region
Metrics	# of contractors staff trained, # of contractors completing at least 1 HPWH installation	# of units incentivized and total incentives distributed	Incentives amount per MF project to prepare the property to be HPWH retrofit ready
Key indicators of success	Increased number of central and in-unit HPWH installed via contractors in MF buildings	Retrofit HPWH equipment pricing is comparable to equipment pricing for like-for-like replacements	Increased number of central and in-unit HPWH installed via contractors in MF buildings

Task 3: Implementation Strategies to Overcome Barriers

Distributors

	Barrier 1	Barrier 2	Barrier 3
Barrier Description	Lack of motivation to stock HPWH's due to low customer demand.	Distributor residential sales staff need more training on HPWH's.	Residential HPWH sales are focused on first cost, instead of lifecycle cost, and has a quick sales cycle.
Implementation strategy description	Offer a per unit HPWH incentive to distributors for each unit sold.	Distributor level HPWH unit incentive to motivate distributors to educate sales staff. Program/manufacturer led co-sponsored training for desk staff to increase knowledge and comfortability to drive HPWH sales.	Allow distributors to use the HPWH incentive to motivate sales staff to sell HPWHS. Have quick reference educational collateral on HPWH at counter.
Rationale	If there are more incentives available for HPWH's then that will drive interest and increase customer demand. This will allow for distributors to ask manufacturers to push more products into their regions.	If there is an incentive to financially reward distributors for selling HPWHs they will be motivated to teach staff about HPWHs. If staff are not comfortable in their knowledge of HPWH, they may not be motivated to push those sales. Increasing knowledge will then increase comfort level in staff to talk about the new technology.	Counter staff will have financial motivation to break the quick sale cycle to push HPWH sales. Quick reference material can help educate contractors on benefits of HPWHs and get the conversation started.
Resources and education required	Distributor incentives.	Distributor incentives. Program/manufacturer led co-sponsored training for desk staff	Distributor incentives. Quick Reference collateral to leave at counters.
How and why strategies vary by region	Regions that are more saturated with HPWH incentives may not need as big of a push as regions without incentive programs.	Staff in regions with more saturation in HPWH incentives may generally have a higher level of understanding than other regions.	Knowledge of HPWH varies person-to-person and regions with HPWH incentive programs will generally have more HPWH knowledgeable staff.
Metrics	Number of units incentivized, monthly stock of HPWHs.	Number of units incentivized, attendance of desk staff at training events.	Number of units incentivized
Key indicators of success	Distribution centers have HPWH stock readily available.	Increased HPWH sales.	Increased HPWH sales.

Task 3: Implementation Strategies to Overcome Barriers

Retailers

	Barrier 1	Barrier 2	Barrier 3
Barrier Description	Lack of reasons to use store space to stock HPWH's (especially larger capacity HPWHs)	Lack of demand from contractors to buy HPWHs from retail locatrions due to limited knowledge and comfort in selling HPWHs	High first cost of HPWH units result in low consumer demand
Implementation strategy description	Drive more HPWH sales to ensure storage space to stock more HPWHs	Training for plumbers and other storyteller practices for wider outreach and connections to customers	Ensure easy to access rebates with point of sale application system at all locations
Rationale	More consumer demand drives more equipment to be available	Customers will understand the importance of HPWH's if plumbers and contractors do and can explain it to them well thus higher HPWH sales	Having rebates readily available drives customer demand
Resources and education required	View the changing market trends for HPWH's, increases over time display the demand is rising	Trainings for plumbers and contractors so they fully understand why HPWH's are necessary	EcoRebates tool on the Lowe's website can be widely implemented better
How and why strategies vary by region	Overall similar apporach to push for increased sales	Connections within each region may vary but overall the approach should be the same	Region 4 lacks certain incentives, other regions have more layered incentives
Metrics	Number of sales over time, customer requests, and contractor requests for HPWH's	Trainings and feedback	Use of app on phone with customer based view and simple login to get incentives
Key indicators of success	Increased stock of HPWH's of all sizes	Trends in HPWH sales increasing by each plumbing/contracting company	Use of all rebates; ease of access finding other rebates

Task 3: Implementation Strategies to Overcome Barriers

CCA/CCE

	Barrier 1	Barrier 2	Barrier 3
Barrier Description	Lack of stock of HPWH	Increased electricity bill after installing HPWH installations due to lack of rate based incentives for HPWHs	Lack of skilled workforce
Implementation strategy description:	Rebates that cover incremental costs of HPWH installation such as permitting costs, panel upgrades, etc.	Provide a rate based incentive for customers that switch to a HPWH	Targeted outreach and training programs for contractors
Rationale:	Consumer demand likely to increase if the costs of installing a HPWH are reduced and made cost competitive to other water heaters. This would lead to more HPWH's being stocked with Retailers and Distributors as demand is expressed by end users, contractors and installers	Customers that switch from a gas water heater to a HPWH will see an increase in their electricity bill for the new electrical appliance; providing a rate based incentive will reduce the increase in electricity bill and prevent the barrier of a higher cost electricity bill after installing a HPWH	The HPWH market will greatly benefit from a properly trained and knowledgeable workforce who can communicate effectively to consumers and guide them towards HPWH's that can meet their specific needs while providing grid and environmental benefits. A skilled workforce can also reduce the customer decision and installation period for HPWH's and drive down labor costs
Resources and education required:	Funding for midstream incentives; Increased incentive layering opportunities for HPWH installation	Engaging with load serving entities to develop rate based incentives;	Manufacturer based or led training programs; Partnerships or engagement with workforce unions and industry; Permitting compliance resources/training; Standardized training for SF and MF settings
How and why strategies vary by region:	Strategies may vary as Region 1 has had downstream success with incentive program so midstream incentives may be a useful addition. Region 3 CCA identified that customers have high heating load as well as a prevalence of solar electric customers (existing electric customers are the top 50% of summer natural gas users) who could be targeted participants for incentives.	No variation in strategy between territories.	Modes of outreach may vary based on relationships between workforce, customers, and HPWH industry. Regions interviewed are focused on developing relationships with contractors and installers. Local installers in region 4 prefer to hear directly from manufacturers when it comes to training resources while region 3 would use resources to better serve MF areas.
Metrics:	Number of available HPWH units with retailers and distributors after incentive program created; Dollar incentive values by region, and number of HPWH installations	Measuring the cost increase of an electricity bill before and after HPWH installation when a customer moves to the new incentive-based rate; Cost decrease or avoided cost of gas bill	Number of trainings available; Number of workforce attending trainings
Key indicators of success:	Increased HPWH availability; Increased demand for HPWH from end-users, contractors, and installers	Number of customers with HPWH units enrolled in new rate	Increased number of contractors and installers that can install grid capable HPWHs; Increased contractor and installer knowledge of HPWHs

Task 3: Implementation Strategies to Overcome Barriers

Multi-family owners and property managers

	Barrier 1	Barrier 2	Barrier 3
Barriers Description	Higher first cost of HPWH equipment and installation compared to like-for-like water heater replacement.	High soft costs due to lack of HPWH knowledge creating a higher time commitment from the project owner to gain the needed knowledge and/or share the HPWH knowledge to complete the water heater project.	Funding opportunities and HPWH incentive models do not align with the processes for the different types of upgrades: acquisition rehabilitation, 15 yr syndication, capital improvements, refinancing, emergency replacements.
Implementation strategy description	Provide increased incentives and incentives that can be layered to create closer parity between like-for-like retrofits. Create alignment with program requirements for electrification to enable layering.	Provide technical assistance to defray upfront soft costs. Provide financial incentives to defray costs of design team in upfront retrofit design and specification.	Provide flexible downstream incentive program to account for different considerations and financial models for retrofits (i.e acquistion rehab vs capital improvement project). Upstream may be able to overcome come the specific situation but this system lacks ability of funding for commitment.
Rationale	Owners and Managers are allocating budgets for maintenance as well as energy efficiency. HPWH retrofits have higher costs when accounting for the full extent of the scope of work. Creating funding that will bring costs in closer parity to like-for-like changeouts will enable owners to make the investment in HPWHs.	Increasing knowledge and capacity within an organization is needed to support decision-making in favor of electrification. Providing incentives to expand existing planning processes to account for electrification can start to move the market within existing framework. That said, traditional planning processes need to change and define a new standard that accounts for health, clean energy and electrification.	Multi-family water heater retrofits require planning time and need to reserve funds to support planned efforts that would occur under refinancing, notice of funding, re-syndication, rehabilitation, and capital improvements. In addition, cash tight properties must prioritize maintenance issues over efficiency (i.e bill reduction) strategies.
Resources and education required	Alignment of funding criteria to support electrification; Reference of available funding sources that can be layered; Engagement with owners on how incentives can be layered.	Technical assistance to select, specify and define scope of work for HPWH retrofit; Training to owners, development staff, asset managers, facility managers.	Definition of scenarios; Description of application of incentives for each scenario
How and why strategies vary by region	The extent of the funding to create parity may vary by region based on existing incentives.	Strategies will not vary by region but will vary with an owners experience with electrification and organizational missions.	Strategies will not vary by region.
Metrics	# of properties that undergo electrification retrofits; Dollar value of incentives by region; ease of layering incentives	# of properties that install HPWHs; # of champions within an organization	# of different retrofit types
Key indicators of success	Increased number of HPWH retrofits	Increased number of HPWH retrofits	Increased number of HPWH retrofits

Task 3: Implementation Strategies to Overcome Barriers

Multi-family maintenance staff

	Barrier 1	Barrier 2	Barrier 3
Barrier Description	HPWH retrofits for emergency replacement take too long due to installation complexities and permitting. A permit is not usually pulled in a like-for-like replacement.	HPWH retrofits adds complexity (during installation and future maintenance), which adds to staff workload, is outside of job scope, and is perceived to lack intrinsic motivation	Maintenance staff are not receiving upper management directive to prioritize HPWH installations
Implementation strategy description	Provide loaner water heaters or create "a buy-back program" for interim water heaters, during emergency replacements in order to provide time for a HPWH installations. Where possible, prepare the property to be HPWH ready by phasing in electrical upgrades and building modifications, such as added louvers and preparing for HPWH ductwork.	Increase maintenance comfort by funding demonstration projects at multifamily properties. Considering financial incentives direct to property staff to address the lack of intrinsic motivation from maintenance staff.	Establish crosscutting organization policies to move towards electrification. Make it decision makers financial interest to move this direction (more incentives, can be at distributor level, so that HPWH is cheaper than BAU). Empower maintenance staff to prepare for HPWH conversions on incremental timelines
Rationale	A loaner water heater or a buy back program for a interim water heater allows the property to provide hot water to occupants while HPWH installation work takes place during emergency situations, which can be a longer process. Preparing the property to be HPWH retrofit ready ahead of time will also reduce the time and costs for HPHW installation, especially in emergency situations.	By funding demonstration projects, maintenance staff can learn and increase comfort with the fact that there should not be a dramatic increase in their work load burden. Providing financial incentives to maintenance staff addresses the lack of intrinsic motivation from maintenance staff.	Standardize communication and unified approach throughout organization, so that all parties agree that HPWH installations are the priority for all water heater retrofit applications. Providing incentives such that HPWH retrofits are cheaper than like-for-like retrofits will help management establish organizational policies.
Resources and education required	Create standard operating procedure, funding, and resource guides for HPWH readiness and for loaner/buy-back water heaters that can be used until HPWH can be installed.	Provide funding to increase the number of demonstration projects, provide education resources to MF maintenance staff to address concerns about significant increases in staff maintenance effort, and provide funding to incentives maintenance staff to install HPWH	Provide incentives for HPWH installations to be the same cost or cheaper than like-for-like replacements. Provide education and resources for organizations to develop HPWH-first procurement plans.
How and why strategies vary by region	No major change between regions	No major change between regions	No major change between regions
Metrics	Quantity of loaner/buy-back WH used during emergency applications and Quantity of HPWH installed	Quantity of maintenance staff benefitting from demonstration projects. Quantity of maintenance staff incentivized for HPWH installations	Quantity of properties developing an organization wide HPWH-first procurement plan and policy
Key indicators of success	Increased number of central and in-unit HPWH installed via maintenance scenarios in MF buildings for emergency replacement scenarios	Increased number of central and in-unit HPWH installed via maintenance scenarios in MF buildings	Increased number of central and in-unit HPWH installed via maintenance scenarios in MF buildings

APPENDIX C: HPWH MIDSTREAM FIELD TEST PARTICIPATION OVERVIEW MARKETING COLLATERAL

Midstream Residential
Heat Pump Water Heating Program

Energy Solutions

Heat Pump Water Heater Sales. Reimagined.

Incentives for Residential Equipment

Pacific Gas and Electric Company (PG&E) is offering valuable incentives on the sales of Heat Pump Water Heater equipment available to residential customers. As a Participating Distributor you'll earn an incentive for every eligible heat pump water heater you sell for installation at a qualifying address.

Why Should I Become a Participating Distributor?

Participating Distributors can offer customers discounted pricing on eligible equipment sales. You'll increase your sales of high-efficiency, high-margin equipment and earn incentives while helping your customers save.

Only Participating Distributors can offer these incentives — it's easy to enroll and gives you a competitive advantage over non-participating distributors.

The Benefits of Participating

- Lower pricing can increase your sales of high-margin, energy-efficient equipment.
- Fast payment. Incentives paid within an average of two weeks from application approval.
- No paperwork required. Your customers get lower prices at the point of sale, increasing customer satisfaction and retention.
- You'll receive an incentive payment for each eligible high-efficiency unit that is sold for installation by a PG&E customer.
- The streamlined online tool makes it easy to submit reimbursement applications individually or in a batch format and to track payments.

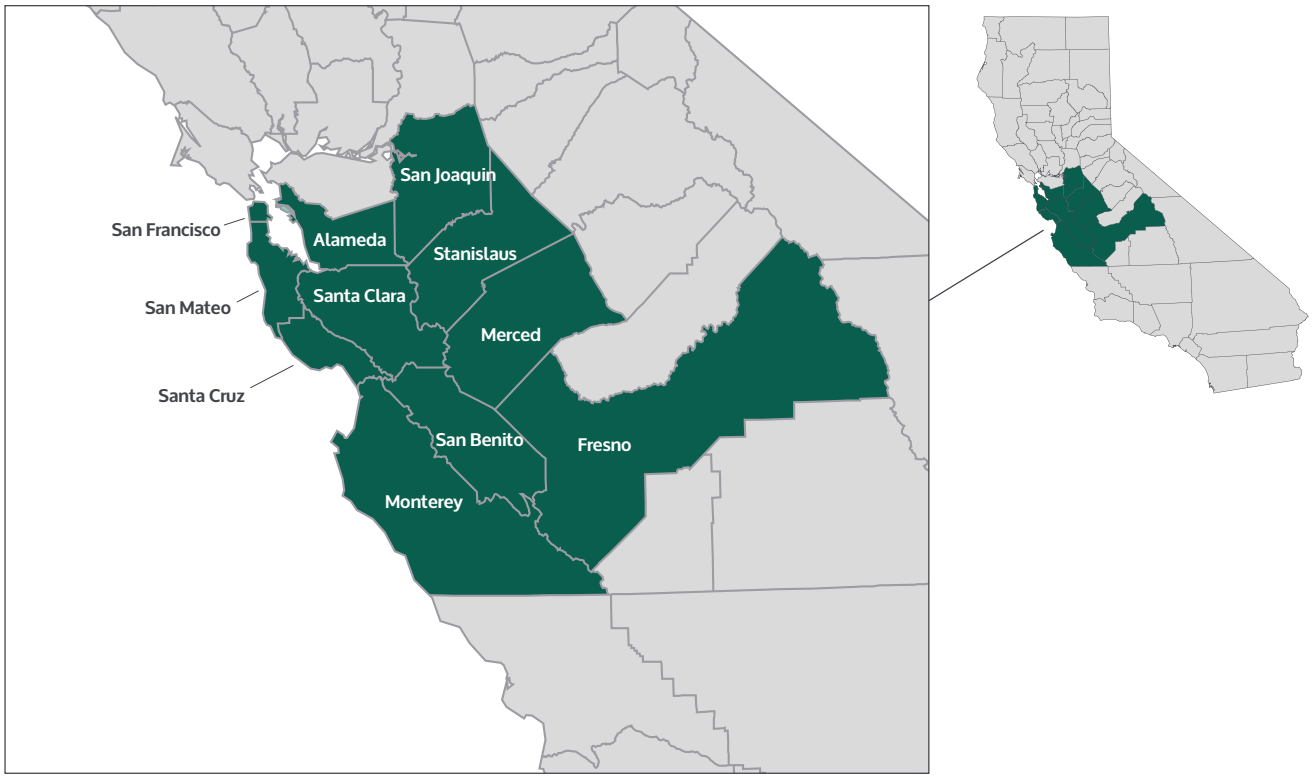
The Energy Solutions Advantage:

For more than 25 years Energy Solutions has designed and implemented successful upstream and midstream programs in the lighting, HVAC, refrigeration, foodservice, and water heating, for residential, commercial, and industrial sectors in more than 20 states throughout the country.

Our program experiences, depth of technical expertise, and decades-long track record of implementation and innovation have honed our systems and processes. We have developed deep and essential relationships with major manufacturers and market actors, that have resulted in eleven national program awards.

For more information contact us at:
510.428.4420 x227
pflorin@energy-solution.com
www.PGEHPWHIncentives.com

The program offers incentives for the following heat pump water heating equipment in the counties highlighted.



Measure Category	Incentive
Per HPWH	$1,000
Per Thermostatic mixing valve*+	$200

*Thermostatic mixing valves must be sold in conjunction with a qualifying HPWH to qualify
+ HPWHs with embedded thermostatic mixing valves are eligible for the additional $200 incentive

About Energy Solutions

At Energy Solutions, we focus on big impacts. And we believe that creating solutions that align with the needs of the market is the most powerful way to deliver large-scale energy, carbon and water-use savings. For 25 years our cost-effective solutions in energy efficiency, demand management, distributed energy resources, and codes and standards have delivered significant and reliable results for our utility, government, and institutional customers.

For more information contact us at:
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www.PGEHPWHIncentives.com

Material code: C29472

APPENDIX D: HPWH MIDSTREAM FIELD TEST SALES FLYER

Midstream Residential
Heat Pump Water Heating Program

Energy Solutions

Build Your Business with Heat Pump Water Heaters

A better choice for you and your customers

Understand benefits of heat pump water heaters and receive discounts on your purchase

Heat Pump Water Heaters (HPWH) are the technology of the future for California homes. You can help your customers get ahead of this trend and increase your sales of high-margin equipment by helping them understand the benefits of a heat pump. **Look for available incentives using the Switch is On at switchison.org/contractors/incentive-resources.**

Better technology

HPWHs primarily transfer heat from the surrounding air to heat the water (even in colder climates) so they are much more efficient than standard water heaters — up to 3 times more efficient!

When connected to a load shifting program like Pacific Gas and Electric Company (PG&E) WatterSaver, the HPWH can heat water at times of day when electricity prices are lower and keep it hot all day. Your customers have hot water when they need it, without paying the highest electricity price.

Customer benefits of HPWHs

- Increased efficiency — up to 3 times more efficient
- Safer for your home — no harmful emissions
- Can help you avoid paying the highest electricity costs without sacrificing your comfort
- Can help you save even more on water heating by enrolling in a load shifting program
- ENERGY STAR® certified with a standard 10-year warranty offering high performance that you can count on

For more information contact us at:
510.428.4420 x227
pflorin@energy-solution.com
PGEHPWHIncentives.com

Customers can earn money while they save

Utilities may also offer a load shifting program, like PG&E's WatterSaver (**watter-saver.com**), which pays customers to heat their water at off-peak times of day. With a HPWH, not only do customers avoid the highest electricity prices, they get paid to do it!

How can I find contractor discounts for my purchase of a HPWH and Thermostatic Mixing Valve (TMV)?

1. Ask the distributor about available HPWH and TMV equipment
2. Visit the Switch Is On contractor incentive resources page: **switchison.org/contractors/incentive-resources**

About Energy Solutions

At Energy Solutions, we focus on big impacts. And we believe that creating solutions that align with the needs of the market is the most powerful way to deliver large-scale energy, carbon and water-use savings. For 25 years our cost-effective solutions in energy efficiency, demand management, distributed energy resources, and codes and standards have delivered significant and reliable results for our utility, government, and institutional customers.

For more information contact us at: 510.428.4420 x227 | pflorin@energy-solution.com | PGEHPWHIncentives.com

Pacific Gas and Electric Company

The Midstream Heat Pump Water Heater (HPWH) Study and Field Test is funded by California utility customers and administered by PG&E under the auspices of the California Public Utilities Commission, through a contract awarded to Energy Solutions. Study and Field Test funds, including any funds utilized for rebates or incentives, will be allocated on a first-come, first-served basis until such funds are no longer available. This Study and Field Test may be modified or terminated without prior notice. Customers who choose to participate in this Study and Field Test are not obligated to purchase any additional goods or services offered by Energy Solutions or any third party.

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