Installation Costs for Zero-NOx Space and Water Heating Appliances

Version 2.0 - Rate Updates

Bay Area Air Quality Management District

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Executive Summary

In 2023, the Bay Area Air Quality Management District (BAAQMD) adopted amendments to Rule 9-4: Nitrogen Oxides from Fan Type Residential Central Furnaces and Rule 9-6: Nitrogen Oxides Emissions from Natural Gas-Fired Boilers and Water Heaters. These rules govern point of sale emission standards for water and space heating systems under stated thresholds. This analysis assesses the anticipated costs to install zero-NOx heat pump water heaters (HPWH) and heat pump heating ventilation and air conditioning (HP HVAC) equipment, the most efficient technologies available to replace existing NOx emitting appliances. Because Rules 9-6 and 9-4 are triggered at the point of sale, the most relevant way to evaluate costs is to understand the difference between a traditional NOx emitting appliance and the newly required zero-NOx appliance. Therefore, this analysis focuses on costs under two primary scenarios: upfront and incremental costs.

Because zero-NOx HP HVACs perform both heating and cooling functions, analysis of incremental costs associated with installing HP HVACs also includes the avoided costs of air conditioning. These costs represent the costs avoided from installing or upgrading air conditioning when installing a HP HVAC to replace a NOx emitting space heating appliance. As over 47% of the 1.7 million households in the San Francisco metropolitan area (including Oakland and Berkeley) have air conditioning, considering the cost of air conditioning replacement applies to many households in the Bay Area.

A summary table of the upfront and incremental costs associated with zero-NOx appliances are summarized in Table 1. These average values for cost were analyzed using the most recent data available for the nine Bay Area counties provided by incentive providers like CLEAResult, TECH Clean California, and community choice aggregators (CCAs). A detailed list of data sources is provided in Table 4.

Table 1 Upfront and Incremental Costs Summary

Appliance	Type	End Use	Average Upfront Cost: NOx Emitting Appliances	Average Upfront Cost: Zero-NOx Appliances	Incremental Cost	Avoided Air Conditioner Cost	Incremental Cost with Air Conditioning
Water heater	baseline Tanked + Tankless (N=450)[1]	Single-family	$5,231	$7,071	$1,840	N/A	N/A
Water heater	baseline Tanked (N=37)	Single-family	$3,575	$7,071	$3,496	N/A	N/A
Water heater	N/A	Multi-family	N/A	$8,939	N/A	N/A	N/A
Space Heating Appliance	Ductless	Single-family	$6,347*	$17,122	$10,775	$8,106	$2,669
Space Heating Appliance	Ducted	Single-family	$6,347*	$20,408	$14,061	$8,106	$5,955
Space Heating Appliance	Ductless	Multi-family	N/A	$11,816**	N/A	N/A	N/A
Space Heating Appliance	Ducted	Multi-family	N/A	$24,647**	N/A	N/A	N/A

Notes: N/A = Not applicable.

* The data for average NOx emitting upfront costs for space heating appliances in single-family homes did not identify whether the projects were ducted or ductless. Thus, only one cost aggregated across duct type is available. See Table 6 for details.

** Average zero-NOx upfront costs for multi-family homes represent the cost per HVAC unit.

See Table 5 to Table 17 for information on upfront costs. See Table 24 for information on air conditioner costs.

[1] Updated data from 2019-2024 of 37 tanked water heater installations provided by ClearResults in Q3 2024 showed the tanked only installation cost to be on average $3,575 dollars. While this average is lower than the reported $5,231 amount for all installations (tanked and tankless), it is based on a much smaller sample size. Both costs are shown in this report and more information can be found in Section 5.

Water Heating Cost Summary

Upfront costs to replace a NOx emitting gas water heater in the Bay Area is estimated based on the average cost data of 450 BayREN gas water heater installations in single-family homes (including both tanked and tankless). The more detailed dataset provided by BayREN's implementer CLEAResult in Q3 2024 showed that of the 450 projects with recorded costs, 37 were tanked water heaters with an average installation cost of $3,575. This report will summarize the incremental costs under both potential cost scenarios to provide a range of outcomes. Installation of a Zero-NOx HPWH is estimated to cost approximately $7,071 for upfront project costs in single-family homes, and $8,039 for multi-family buildings. Thus, the incremental cost to install a zero-NOx HPWH instead of a NOx emitting gas water heater is estimated to fall between $1,840, and $3,496 on average.[2] However, between $5,100 and $8,335 in incentives and tax credits are available for HPWH installations, depending on location and income bracket. Existing incentives not only close the incremental cost gap, but, for low- and moderate-income (LMI) households, provide cost savings to cover the upfront cost of a HPWH installation.

Space Heating Cost Summary

Average upfront costs for replacing a gas furnace are estimated to cost $6,347 in the Bay Area based on median cost data of 2,945 BayREN gas furnace installations in single-family homes. The cost and installment of a zero-NOx appliance was between $17,122 and $20,408 for ductless and ducted HP HVAC in single-family homes, respectively, and $11,816 and $24,647 for ductless and ducted HP HVAC in multi-family homes, respectively. This resulted in a $10,775 to $14,061 cost increase for ductless and ducted space heating, respectively, before rebates.[3] In addition, building owners who also need or desire an air conditioning upgrade would save an estimated additional $8,106. This reflects the cost of installing a new air conditioning unit, which would not be necessary if a HP HVAC was installed because an HP HVAC performs both heating and cooling functions. After considering the costs avoided from installing an air conditioning unit, the incremental costs for installing a zero-NOx HP HVAC are estimated to be $2,669 and $5,955 for ductless and ducted systems, respectively.

Rebates ranged across locations depending on access to federal, state, regional, community choice aggregator, and utility funding. Rebates were found to be in the range of $3,400-$13,900 to offset costs. With all incentives applied, LMI Bay Area households will experience no increase in incremental costs to install ductless HP HVACs, and may even experience cost savings ranging from $245-$3,145 depending on location/utility. Moderate- and high-income households may experience incremental costs ranging from $4,855-$7,755 after incentives. When installing ducted HP HVAC, LMI Bay Area households will experience a small incremental cost increase ranging from $161-$3,061 after incentives. For moderate- and high-income households, incremental costs could range between $8,161–$11,061. However, households who need or desire air conditioning experience lower incremental costs and even cost savings after incentives. When all incentives and avoided air conditioning costs are applied, LMI Bay Area households will experience cost savings ranging from $8,331-$11,231 for a ductless HP HVAC and $5,045-$7,945 for a ducted HP HVAC. Moderate- and high-income households will experience cost savings of $331-$3,231 for a ductless HP HVAC but incremental costs from $55-$2,955 for a ducted HP HVAC.

[2] Incremental costs for zero-NOx HPWH installations in multi-family homes could not be calculated because there was no data available for gas water heater installations in multi-family homes. Data was not available for commercial buildings.

[3] Incremental costs for zero-NOx HP HVAC installation in multi-family homes could not be calculated because there was no data available for gas furnace installations in multi-family homes. Data was not available for commercial buildings.

Electric Panel & Service Upgrades Cost Summary

Installation of electric zero-NOx appliances could necessitate electric panel upsizing and electric service upgrades. Panel upsizing is not usually needed above 100 amps and many projects were identified having been completed on 100 amps or less as shown in Table 19. However, if panel upsizing is needed, it could significantly increase cost burden for the building owner. Based on regional case studies and data analysis from Pacific Gas & Electric (PG&E), Palo Alto, San Mateo County, and East Bay, costs to upgrade electric panels generally fall within a range of $2,750-$4,250. According to PG&E's website electric service upgrades could range from $1,000-$60,000, or more depending on building location and if a service is above ground or underground. Of this service cost $3,225 is borne by the electric ratepayer as an electric service line allowance, reducing the total cost of the service upgrade borne by the individual customer. A panel or service line upgrade are key variables that could increase the cost for zero-NOx equipment.

Bill Impact Summary

Regional analyses from PG&E customers in East Bay showed utility bill cost savings for customers that switched to E-ELEC rates through PG&E, which can be accessed upon fuel switching from a NOx emitting water heater or HVAC to a zero-NOx appliance. This analysis focused on California Alternate Rates for Energy (CARE) customers who receive discounts based on income levels, or enrollment in public assistance programs. This analysis also evaluated the impacts of the recently approved Income Graduated Fixed Charge (IGFC). The data analysis found that 93% of CARE customers, and 95% of high-electric users analyzed in East Bay saw bill impact decreases after switching to E-ELEC when beneficial. A small subsection of customers in East Bay (53% of non-CARE low-usage multi-family customers, and 35% of non-CARE low-usage single-family customers) did see a small increase in average bills around $2 per month. Both studies found that moving to an electric specific rate was key to achieving cost savings after installation of zero-NOx appliances, but less significant once IGFC is implemented.

Key Takeaways

Once incentives are applied, homes that install tanked HPWHs will experience lower incremental costs, or cost savings, compared to installing a traditional gas water heater. Building owners with access to LMI incentives could see all upfront project costs covered for HPWH installations. HP HVAC units have a larger diversity of costs which depend on the type (ducted or ductless) of HP HVAC installed and the consideration of avoided air conditioning costs. However, current incentives help to narrow the incremental cost gap for ductless and ducted HP HVACs in all income brackets and provide cost savings for ductless HP HVACs in LMI households. Where applicable, avoided air conditioning costs further lower the incremental costs and provide cost savings in all scenarios except ducted HP HVACs in moderate- and high-income households. Furthermore, bill impacts are expected to decrease for most users after the switch to zero-NOx appliances (average of $23 per month) while a smaller percentage (27%) will see a small increase after electrification (average of $5 per month).

1 Introduction

The Bay Area Air Quality Management District (BAAQMD) regulates stationary sources of air pollution in the nine counties that surround San Francisco Bay. The Board oversees policies and adopts regulations for the control of air pollution, such as nitrogen oxides (NOx) within the district. On March 15, 2023 the BAAQMD Board adopted amendments to Rule 9-4: Nitrogen Oxides from Fan Type Residential Central Furnaces and Rule 9-6: Nitrogen Oxides Emissions from Natural Gas-Fired Boilers and Water Heaters. These rules govern point of sale emission standards for small, typically residential and commercial, water and space heating systems. Emissions of nitrogen oxides impact local and regional air quality and contribute to the formation of ozone and secondary particulate matter.

This whitepaper summarizes the costs for installation of zero- NOx equipment for space and water heating as required by (BAAQMD) Rules 9-4 and 9-6. The cost difference between installing zero-NOx equipment compared with traditional NOx emitting equipment is a key feasibility and equity concern associated with BAAQMD Rules 9-4 and 9-6. As the updated Rules take effect, NOx emitting water heaters under 75,000 British Thermal Units (BTU)/hour manufactured after January 1, 2027 will no longer be available for purchase or installation in the Bay Area.[4] NOx emitting furnaces under 175,000 BTU/hour, and combination heating/cooling units under 65,000 BTU/hour manufactured after January 1, 2029 will no longer be available for purchase or installation in the Bay Area.[5]

NOx emitting appliances currently include all propane or natural gas-fired water and space heating appliances, because fossil fuel-burning appliances without NOx emissions do not currently exist. The only technologies currently available that meet the requirements of the BAAQMD zero-NOx space and water heating rules are electric appliances. Although there are a range of electric alternatives (e.g. electric resistance space heating), heat pump heating ventilation and air conditioning (HP HVAC) and heat pump water heaters (HPWH) are the most cost-effective option on the market due to their significantly higher efficiency (300-400%) and resulting lower operating costs. Accordingly, this analysis focuses primarily on zero-NOx electric HPWH and HP HVAC technologies. This summary also covers costs for potential associated infrastructure upgrades for items such as wiring, panel upsizing, and service upgrades.

This analysis uses best available data for zero-NOx installation and infrastructure upgrade costs available in Fall/Winter of 2023 to guide the Implementation Working Group's (IWG) understanding of this issue.

[4] The Bay Area refers to all BAAQMD governed geographic regions across the Bay Area's nine counties: San Francisco, San Mateo, Santa Clara, Alameda, Contra Costa, Solano, Napa, Sonoma, and Marin County.

[5] Note that there will be an allowable "sell-through" period of these older units meeting the current requirements for 2024 ultra-low NOx requirements.

2 Regulation Overview

In March of 2023, BAAQMD adopted amendments to Regulation 9, Rules 4 and 6 to reduce emissions of nitrogen oxides (an air pollutant known to impact human health) from residential and commercial furnaces and water heaters in buildings in the Bay Area. Rule 9-6 amendments for zero-NOx water heaters will go into effect in 2027, while Rule 9-4 amendments for zero-NOx space heating will go into effect in 2029 and 2031.[6] These amendments to Rule 9-4 are in addition to "ultra-low NOx" requirements for fan-type central furnaces that go into effect in 2024.

2.1 Covered Appliances & Implementation Timelines

Rule 9-6 Water Heaters

Rule 9-6 will affect the future sale of NOx emitting water heaters and boilers with a rated heat capacity of 75,000 BTU/hour or less. NOx emitting water heaters manufactured after January 1, 2027 will not be able to be sold or installed in the Bay Area with the exception of an allowable "sell-through" period for older units meeting the current ultra-low NOx requirements.[7] The only zero-NOx appliance options currently available on market are electric (e.g., HPWHs, electric resistance storage water heaters, on-demand tankless water heater), or solar-thermal water heaters.[8] Cost analysis provided in the sections below will focus on HPWHs as they are the most cost-effective (i.e., available rebates, bill savings) and energy efficient option of the zero-NOx water heating appliances.[9]

Based on a review of BTU ratings on available water heaters, Rule 9-6 will apply to water heaters up to approximately 75 gallons installed in small to medium sized residential and commercial settings. Thresholds for regulated sizes of water heaters are expressed by Rule 9-6 in BTU/hour thresholds. The BAAQMD regulation threshold has been matched to common sizes of NOx emitting appliances, their corresponding building use (e.g., single-family home water heating), and potential zero-NOx emitting alternatives in Table 2. This table is intended to make the regulation translatable into regulated appliance options as they are understood by consumers and building owners. These sizes span several different appliance types that include tanked water heaters, tankless water heaters, which are used to heat water in homes with limited space, condensing water heaters, point of use water heaters, and HPWHs.

It should be noted that most water heater installers recommend upsizing the storage capacity of the water heating unit when switching from gas appliances to HPWHs since HPWHs are most efficient when heating more slowly in heat pump mode (as opposed to resistance heating mode). For example, a 55 gallon gas water heater would likely be upgraded to a 65 gallon storage tank HPWH.

[6] Rule 9-6 also regulates natural gas fired boilers and water heaters with a rated heat input capacity of 75,001- 2 million BTU per hour starting on January 1, 2031. These larger-sized appliances are not included in this memo at direction of BAAQMD due to the later start date of this regulation.

[7] Older NOx emitting units manufactured prior to the 2027 date will still be available for sale/install.

[10] Source(s) for appliance gallon size, household size, and BTU/hour range were pulled from manufacturer or retailer websites including Home Depot, Rheem, Ace Hardware:

[10] Source(s) for appliance gallon size, household size, and BTU/hour range were pulled from manufacturer or retailer websites including Home Depot, Rheem, Ace Hardware:

Table 2 Water Heating Common Appliance Sizes & Corresponding BAAQMD BTU/hour Threshold[10]

NOx Emitting Water Heater Tank Capacity (Gas)	Household Size Served	Building Application	BTU/hour Range	Zero-NOx Technologies Available for Replacement[2]
30 gallons or less	2 or less	Single-family home Multi-family (tankless) Small commercial (tankless)	33,000 BTU/hour	Tankless electric water heater (on-demand) Electric Resistance Water Heater (tanked)[3]
40 gallons	2-4	Single-family home	34,000 BTU/hour	HPWH Electric Resistance Water Heater (tanked)[3]
50 gallons	3-5	Single-family home - Duplex	40,000 BTU/hour	HPWH Electric Resistance Water Heater (tanked)[3]
55-74 gallons[1]	5 or more	Single-family home- Duplex Small commercial Low-rise multi-family	75,100- 76,000 BTU/hour	HPWH Electric Resistance Water Heater (tanked)[3]

[1] 75 gallon NOx emitting water heaters are the upper limit of the requirements effective in 2027. Water heaters sized larger than this BTU/hour threshold will be regulated starting in 2031 and are not included in the scope of this whitepaper.

[2] Available in analyzed datasets & literature that will be assessed in this whitepaper. Zero-NOx options not available in the provided cost datasets will not be a primary part of this analysis. Only HPWHs were available in assessed datasets. Tankless and tanked electric resistance water heaters will not be included in the cost analysis section of this paper. Note that tankless hot water heaters are not recommended for applications where there needs to be a large quantity of stored hot water, and are thus excluded from sizes 40-75 gallon size categories

[3] The cost discussion will have a short description of these options (on-demand, tanked electric resistance), but will ultimately be focused on heat pumps instead due to more favorable cost effectiveness data and more robust data availability. HPWH options are generally only available for sizes 40 gallons and above.

See retailer threshold (Home Depot; Menards) for sizing scan, as this was the smallest tank size: https://www.homedepot.com/p/Rheem-Performance-Platinum-50-Gal-10-Year-Hybrid-High-Efficiency-Tank-Electric-Heat-Pump-Water-Heater-XE50T10H45U0/312742081; https://www.menards.com/main/plumbing/water-heaters/heat-pump-water-heaters/richmond-reg-encore-reg-40-gallon-10-year-plug-in-heat-pump-water-heater/10e40-hp120/p-1642874302375512-c-8688.htm

[10] Source(s) for appliance gallon size, household size, and BTU/hour range were pulled from manufacturer or retailer websites including Home Depot, Rheem, Ace Hardware:

- Reliance 30 gal 33,000 BTU natural gas water heater; Ace Hardware; https://www.acehardware.com/departments/plumbing/water-heaters/gas-water-heaters/4587762?store=02651&gclid=Cj0KCQiAr8eqBhD3ARIsAIe-buO9VOucTfNm2eX4CHG6zNtfXq8mzYcLZk4p0djR8e7EozWtMvo1DtsaApXEEALw_wcB&gclsrc=aw.ds
- FVIR Eco-Defender Safety System 40 gal Tall 34 MBH Residential Natural Gas Water Heater; Ferguson; https://www.ferguson.com/product/bradford-white-fvir-eco-defender-safety-system-40-gal.-tall-34-mbh-residential-natural-gas-water-heater-burg140t6n394/7172791.html
- Performance Platinum 50 gal Tall 12 Year 40,000 BTU High Efficiency Natural Gas Tank Water Heater; Home Depot; https://www.homedepot.com/p/Rheem-Performance-Platinum-50-Gal-Tall-12-Year-40-000-BTU-High-Efficiency-Natural-Gas-Tank-Water-Heater-XG50T12HE40U0/204697785
- [Beyond 2027 requirement size]: Performance 75 Gallon Tall 6-year 75,100 BTU Natural Gas Water Heater; Home Depot; https://www.homedepot.com/p/Performance-75-Gal-Tall-6-Year-75-100-BTU-Ultra-Low-NOx-Natural-Gas-Water-Heater-XG75T06EN76U1/326431554.
- Performance platinum 55 gal. 12 year 50,000 BTU Natural Gas Tank Water Heater; Home Depot; https://www.homedepot.com/p/Rheem-Performance-Platinum-55-Gal-Tall-12-Year-50-000-BTU-Natural-Gas-Tank-Water-Heater-XG55T12EC50U0/205811176

Rule 9-4 Furnaces & Combination Heating Cooling

Rule 9-4 will affect the future sale of NOx emitting furnaces designed to be a source of interior space heating with a heat input rate of 175,000 BTU/hour or less, and combination heating/cooling units with an electric cooling rate less than 65,000 BTU/hour. NOx emitting furnaces and central furnaces manufactured after January 1, 2029 cannot be sold in the Bay Area. However, like water heaters under Rule 9-6, there will be an allowable "sell-through" period where older units meeting the current requirements can still be sold and installed.

The only zero-NOx appliance options currently available on the market are electric HP HVAC systems which function as both air conditioning and heating units, electric wall and baseboard heaters, electric furnaces, and on-demand electric resistance heating units. Electric resistance heating units are used primarily if there are space constraints to install a HP HVAC. Like water heating appliances described above, HP HVAC systems are currently the most cost-effective and will thus comprise the majority of the cost analysis in the sections below.[11]

Sizing for HVAC are described in Table 3 below. The Rule 9-4 BTU threshold for heat input rate and electric cooling rates span a wide range of commonly found NOx producing appliances including multi-speed single stage gas furnaces, light commercial rooftop package units, and commercial unit heaters. The threshold for a package unit aligns with light-unit sized package units below 8.5 tons, which provide both heating and cooling functions.[12]

A description of common market-available gas-powered furnaces and combination heating/cooling appliances that fall within this rated heat capacity is described below.

[11] The main types of heat pumps likely used for Bay Area residents are ducted air-source heat pumps, mini-split heat pumps for buildings without ducts. Geothermal heat pumps are also available but feature large variations in install cost and feasibility by location. In the case of ducted air-source heat pumps, heat pumps can reduce electricity use for heating by ~50% when compared to electric resistance heating like furnaces and baseboard heaters: https://www.energy.gov/energysaver/heat-pump-systems

[12] For threshold upper limit see: https://hvacdirect.com/airquest-8-5-ton-180-000-btu-commercial-gas-electric-packaged-unit-208-230v-3-phase.html?utm_source=%7Bgoogle%7D&utm_medium=%7Bcpc%7D&utm_campaign=20432895729&adgroupid=160731454011&utm_content=678666434101&utm_term=&cq_plac=&cq_ne

Table 3 Space Heating & Combination Heating/Cooling Common Appliance Sizes & Corresponding BAAQMD BTU/hour Threshold[13]

NOx Emitting HVAC Type (Gas Appliance)	Building Application	BTU/hour Range	Zero-NOx Technologies Available for Replacement
Wall-Furnace	Single-family home; Low-rise multi-family; Small-commercial	25,000 BTU/hour [no cooling function]	Ducted or ductless [mini split] HP HVAC
1.4 Ton Air Conditioner + Multi+ Multi Speed Furnace System [package unit]	Single-family home	Heating: 40,000 BTU/hour Cooling: 18,000 BTU/hour	Ducted or ductless [mini split] HP HVAC
4-ton package unit Gas/Electric package unit	Light commercial application (e.g., strip mall, retail)	Cooling BTU: 46,250 BTU/ hour. Heating: 80,000 BTU	Heat pump package unit [rooftop]
5-ton package unit	Light commercial	Cooling: 59,000 BTU/hour Heating: 140,000 BTU/hour	Heat pump package unit [rooftop]
80% AFUE multi-speed single stage gas furnace	Single-family house ('Smaller House')	88,000 BTU/hour [no cooling function]	Electric resistance heating [furnace, wall-heating] Ducted or ductless [mini split] HP HVAC
Commercial unit heater	Large commercial application	175,000 BTU/hour [no cooling function]	Heat pump package unit [rooftop]

[13] Source(s) for NOx emitting HVAC sizing; BTU/hour; Building Application:

- Wall-furnace, Home Depot: https://www.homedepot.com/p/Williams-25-000-BTU-hr-Monterey-Top-Vent-Wall-Furnace-Natural-Gas-Natural-Gas-2509622A/311800964
- 1.4 ton package unit, AC Wholesalers: https://www.acwholesalers.com/cooling/40000-btu-gas-electric-split-systems.html
- 4 ton unit; Alpine home air products: https://www.alpinehomeair.com/product/air-conditioning-cooling/self-contained-packaged-units/natural-gas-or-lp/14-16-seer/goodman/gpgm34808041?linkfrom=froogle&utm_source=google&utm_medium=cpc&utm_campaign=Goodman&utm_content=Goodman_Products&utm_term=453094755&gad_source=4&gclid=CjwKCAiAmZGrBhAnEiwAo9qHiXjIstlpFc5ipkrgS4VpC-OcjVewcaiy1IIRSaLL_Y-B6DInXU64KRoCDfYQAvD_BwE
- 5 ton unit, HVAC direct: https://hvacdirect.com/daikin-5-ton-140-000-btu-light-commercial-14-seer-gas-electric-packaged-unit-direct-driven-208-230v-dfg0603dh00001s1.html?utm_source=%7Bgoogle%7D&utm_medium=%7Bcpc%7D&utm_campaign=18012876183&adgroupid=&utm_content=&utm_term=&cq_plac=&cq_net=x&cq_pos=&cq_med=pla&cq_plt=gp&gad_source=1&gclid=CjwKCAiAmZGrBhAnEiwAo9qHieOd7pmGLilVNmCe-e_RcVCzI5cTvES84nAh93RUAbFM2x96x54OqxoCgjcQAvD_BwE
- 80% AFUE multi Speed Trane RunTru Gas Furnace, Ingram's Water & Air Equipment: https://iwae.com/shop/80k-btu-80-afue-multi-speed-trane-runtru-gas-furnace-multiposition-21-cabinet-ha21208.html?gad_source=1&gclid=CjwKCAiAmZGrBhAnEiwAo9qHiXig0EWc1AKi9tBGxnHaW_G8ke-wq53VUt4WZWBC56ztFuyzy77NFxoCSL4QAvD_BwE
- Commercial unit heater, THS: https://www.totalhomesupply.com/p/sterling-xf175a1ns111-175000-btu-gas-fired-tubular-unit-heater-convertible-standard-or-separated-combustion?gad_source=1&gclid=CjwKCAjwnOipBhBQEiwACyGLulddczb4enMVqbXUoqZla5oDQMc5pqMQl7GZ2UmpV8lDKiwIYhrpsxoC7gUQAvD_BwE

3 Methodology

This whitepaper analyzes the costs associated with zero-NOx appliances as per Rules 9-6 and 9-4. Specifically, this analysis incorporates **upfront, incremental, and operational costs** for zero-NOx appliances, as feasible given existing data availability.

3.1 Assumptions on Timing and Incremental Cost of Appliance Replacement

The majority of building owners would only replace their NOx emitting appliance with a zero-NOx alternative at the time of appliance failure ('burnout') after Rules 9-4 and 9-6 take effect.

As the building owner would have replaced the failed appliance for space or water heating regardless of energy-source, incremental costs, which compare the comparative cost of zero-NOx (electric) vs. NOx emitting (gas/propane-fueled appliances) are the focus of this analysis. Total upfront costs for zero-NOx appliance replacements are also provided for reference.

3.2 Cost Definitions

- **Upfront costs** include the costs to purchase, install (labor and contractor markup), and make the appliance operational borne by the customer. Costs to the utility and to ratepayers in general are not covered in this analysis.
  - **Behind the meter infrastructure costs** is a subsection of up-front costs, including updates to the main electrical panel and wiring that may be needed to accommodate zero-NOx appliances.
  - **Front-of-meter upgrades** are a subsection of upfront costs for zero-NOx appliance installation. This includes potential upgrades to service lines, transformers, and other distribution grid improvements that may be triggered by upgrading electrical panels to a higher amperage.
- Incremental cost describes the cost difference between the replacement of a NOx emitting gas appliance versus the installation of a zero-NOx appliance. Because this regulation is triggered at the time of sale, it is assumed that a new appliance would be purchased either way by the consumer/building owner. This means the incremental cost is the most relevant for gauging the cost impact of the regulation. Incremental costs describe how much more expensive it would be to install a zero-NOx appliance rather than replace it with an in-kind gas appliance.
  - If the incremental cost is zero, that means there is no cost difference between the installation of a NOx emitting appliance and a zero-NOx appliance.
  - If the incremental cost is *less than* zero, this indicates that installing a zero-NOx appliance is cheaper than installing a NOx emitting appliance.
- **Operational costs** describe the monthly or annual utility costs (e.g., electricity or natural gas usage) of operating the appliance. These costs can be described in terms of time period (e.g., annually) or over the course of the appliance's lifespan. Operational cost savings, if applicable, can be used to inform return on investment (ROI) of appliance upgrades. ROI describes how long it would take in operational cost savings to make up the incremental cost associated with installing a zero-NOx appliance.

3.3 Data Sources

Upfront costs to install zero-NOx heat pump projects were analyzed using the most recent data available for the nine Bay Area counties provided by incentive providers including CLEAResult and TECH Clean California. Data was also provided by community choice aggregators (CCAs) in the Bay Area.

Data for bill impacts were analyzed using Silicon Valley Clean Energy (SVCE) and Peninsula Clean Energy datasets and case studies. Projects requiring electric panel upsizing were analyzed using TECH Clean California datasets. Costs to upgrade electric panels and service upgrades were analyzed using Pacific Gas & Electric (PG&E) data.

The data sources used for each analysis along with the included costs are summarized in Table 4 below.

Table 4 Data Summary

Appliance Type	Embedded Costs Included in Analysis	Data Source	Analysis Purpose
Gas Appliances for Water Heating	▪ Appliance Cost ▪ Labor (install) ▪ Contractor Markup	▪ CLEAResult[1]	Upfront, incremental costs
Electric Appliances for Water Heating	▪ Appliance Cost ▪ Labor (install) ▪ Contractor Markup ▪ Wiring	▪ CLEAResults[1] ▪ East Bay Community Energy (EBCE), Marin Clean Energy (MCE), and Clean Power San Francisco (CPSF)[2] ▪ Peninsula Clean Energy[3] ▪ SVCE[4] ▪ TECH Clean California (Single-family)[5] ▪ TECH Clean California (Multi-family)[6] ▪ Frontier Energy[7]	Upfront, incremental costs
Gas Appliances for Space Heating	▪ Appliance Cost ▪ Labor (install) ▪ Contractor Markup	▪ CLEAResult[1]	Upfront, incremental costs
Electric Appliances for Space Heating	▪ Appliance Cost ▪ Labor (install) ▪ Contractor Markup ▪ Wiring	▪ CLEAResults[1] ▪ EBCE, MCE, and CPSF[2] ▪ TECH Clean California (Single-family)[5] ▪ TECH Clean California (Multi-family)[6] ▪ Frontier Energy[7]	Upfront, incremental costs
Bill impacts	▪ N/A- no original data analysis conducted due to data analysis	▪ Peninsula Clean Energy ▪ SVCE ▪ E3	Lifecycle costs
Electric Panel Upsizing	▪ Infrastructure cost ▪ Install ▪ Permitting/ administration	▪ TECH Clean California (Single-family) [5] ▪ TECH Clean California (Multi-family) [6] ▪ Case Study: Palo Alto Electrification Final Report[8] ▪ Case Study: Peninsula Clean Energy Estimated Costs for Panel Upgrades[9]	Potential upfront costs

Appliance Type	Embedded Costs Included in Analysis	Data Source	Analysis Purpose
Service Upgrades	▪ Infrastructure cost ▪ Install ▪ Permitting/ admin	▪ PG&E ▪ California Energy Commission (CEC) [E3][10]	Potential upfront costs

[1] Data from BayREN's Single-family Program provided by CLEAResult.

[2] East Bay Community Energy (EBCE), Marin Clean Energy (MCE), Clean Power San Francsico (CPSF), and Peninsula Clean Energy. BAAQMD Heat Pump Installation Cost Data, compiled by the CCA's and provided by BAAQMD.

[3] Peninsula Clean Energy. Heat Pump Water Heater Projects (2021 and 2022). Accessed at https://www.peninsulacleanenergy.com/wp-content/uploads/2021/09/HPWH-Projects-with-costs-9-3-2021-v2.pdf and https://www.peninsulacleanenergy.com/wp-content/uploads/2022/07/HPWH-Projects-with-cost-data-2022-07-25.pdf.

[4] Silicon Valley Clean Energy (SVCE). Water Heater Plumbers & Electricians Excel. Accessed at https://svcleanenergy.org/find-contractor/.

[5] TECH Clean California. "TECH Working Data Set_Single-family". Accessed October 2023 at https://techcleanca.com/public-data/download-data/. Includes installations in single-family homes and small multi-family homes.

[6] TECH Clean California. "TECH Working Data Set_Multi-family". Accessed October 2023 at https://techcleanca.com/public-data/download-data/. Includes data on large-scale heat pump installations in multi-family residential buildings, typically involving large central systems that serve multiple apartments and/or many small unitary systems installed in adjacent apartments.

[7] Frontier Energy. Bay Area Multi-family Building Enhancements Program Heat Pump Data.

[8.] City of Palo Alto. TRC. Palo Alto Electrification Final Report.

[9.] Peninsula Clean Energy. 2035 Decarbonization Plan.

[10.] Benefit-Cost Analysis of Targeted Electrification and Gas Decommissioning in California, E3, https://www.ethree.com/wp-content/uploads/2023/12/E3_Benefit-Cost-Analysis-of-Targeted-Electrification-and-Gas-Decommissioning-in-California.pdf

3.4 Data Analysis and Aggregation Methodologies

Each data source is summarized for the average and, when available, the median costs. Using median costs helps remove outlier data points that may skew the average towards the minimum or maximum data points. Median costs were not available for several data sources. When summarized across groups within a data source or across data sources, cost data is summarized using a weighted average. Weighted averages allow more significance to be placed on data groups or data sources with a larger sample of data points.

Data sources and analyses are separated by single-family, multi-family, and commercial buildings. While Rule 9-4 and Rule 9-6 regulate by appliance capacity and not by appliance end-use, separating the data analyses by building sectors helps emphasize specific assumptions that were made to analyze the data (e.g., determining which appliances in the data may be covered and not covered by the regulation when tank size or heating/cooling capacity is not available). Because building owners may up-size their water heater or space cooling/heating appliance when switching to a heat pump, all single-family installations are assumed to be covered by Rule 9-4 and Rule 9-6.[14] Assumptions are detailed in each data table.

All data is filtered to only include data for installations located within the Bay Area, covered by Rule 9-6 and Rule 9-4, and relevant to each analysis (e.g., building type). Specifics on the filtering process for each data source, as well as any exceptions to the methodologies described within this subsection are summarized in each data table.

[14] Most installers of HPWHs recommend upsizing tanks to match the availability of hot water previously provided by zero-NOx appliances.

4 Cost Scenario Overview

Costs for appliance replacement for both space heating and water heating were analyzed in the following four ways:

Upfront Costs: NOx Emitting Appliances

This analysis demonstrates the amount of money that building owners would spend as a baseline if they planned on replacing their water heater and space heater with a NOx emitting gas-powered appliance, as they likely would have prior to the 2023 update of Rules 9-6 and 9-4. Establishing this base case is important as it allows for the measurement of cost increases and incremental costs above baseline.

Upfront Costs: Zero-NOx Appliances

This section analyzes the full upfront cost to install zero-NOx appliances for space and water heating of the sizes regulated by Rules 9-4 and 9-6. This scenario does not include bill impact savings, costs for panel upsizing or rebates/incentives.

Incremental Costs

This section subtracts the cost of the baseline gas appliances from the zero-NOx case to calculate incremental cost. This scenario highlights the incremental cost changes to install space and water heating appliances in the Bay Area without any incentives or rebates applied.

Currently Available Incentives and Rebates

This section lists the currently available rebates and incentives for each covered appliance. This section should be considered a snapshot in time as rebates and incentives change over time. Where applicable, the sunset date of each rebate and incentive has been listed.

Incremental Costs After Available Incentives

This section takes incremental costs outlined in scenario three and applies available federal, state, and local incentives for installation of HP HVACs and HPWHs. Incentives vary by geographic region, income bracket, and utility, and are subject to frequent changes at the local level.

Operational Costs of Zero-NOx HPWH and HP HVAC

This section summarizes two case studies, one from the East Bay and one from the Peninsula, focusing on the bill impact impacts of switching from gas fired water and space heating to zero-NOx HPWH and HP HVAC units.

5 Upfront Costs: NOx Emitting Appliances

5.1 NOx Emitting Water Heaters (Rule 9-6)

Single-Family Water Heating

This analysis demonstrates the amount of money that single-family homeowners would spend as a baseline if they planned to replace their water heater with a NOx emitting gas water heater. These costs describe all up-front costs for the installation, appliance, and labor for single-family homes by taking the average and median costs across one dataset of projects within Bay Area counties as detailed in Table 5.

The average costs to replace an existing NOx emitting water heater with a new NOx emitting water heater in the Bay Area is between **$5,231** and **$3,575** for a single-family home. The median costs when separating tankless and tanked are **$4,700** and **$2,200** for a single-family home. The BayREN data used for this analysis included 450 data points for natural gas water heater installation which includes a mix of tanked and tankless water heaters and another dataset of 37 tanked only water heaters. The lower value for tanked water heaters likely reflects the lower installation and equipment costs associated with tanked water heaters. This report will utilize both the higher value (and larger sample size) cost associated with both tanked and tankless water heaters as well as the lower cost (and sample size) tanked only value. The lower value presented here can be used to identify a more conservative estimate for incremental cost. The median cost was used for all incremental cost calculations due to several higher-than-expected installation costs found in the data. Through discussions with CLEAResult, the data provider, this was likely due to the inclusion of additional work completed along with water heater installation (e.g., safety tests, HVAC projects, insulation projects), but not accurately disaggregated. Using the median cost allows for a conservative estimate of incremental costs when upgrading to a zero-NOx appliance.

Table 5 Upfront Costs for NOx Emitting Water Heaters in Single-Family Homes

Project Type	Number of Projects	Average Upfront Cost	Median Upfront Cost
Tanked and Tankless Gas-fired water heaters	450	$5,231	$4,700
Tanked Gas-fired water heaters	37	$3,575	$2,200

Note: Because the data only includes water heaters installed in single-family buildings, it is assumed all included water heaters would be covered by BAAQMD Rule 9-6. Data is filtered for gas water heater installations within Bay Area counties (i.e., Alameda County, Contra Costa County, Marin County, Napa County, San Francisco County, San Mateo County, Santa Clara County, Solano County, and Sonoma County).

Source: CLEAResult

Multi-family/Commercial Water Heating

No data was available for multi-family or commercial NOx emitting appliance installation. However, since the initial 2027 deadline in Rule 9-6 only covers water heaters up to approximately 75 gallons, similar appliances are expected to be found in all building types. No large boilers or other more commercial systems would be expected to be covered by Rule 9-6. Therefore, it could be assumed that the NOx emitting installation costs would be similar across these building types.

5.2 NOx Emitting Space Heating (Rule 9-4)

This analysis demonstrates the amount of money that single-family homeowners would spend as a baseline if they planned on replacing their current space heating appliance with a new NOx emitting gas appliance. These costs describe all up-front costs for the installation, appliance, and labor for single-family homes by taking the average and median costs across one dataset of projects within Bay Area counties as detailed in Table 6.

The average cost to replace an existing NOx emitting space heating appliance with a new NOx emitting space heating appliance in the Bay Area is **$6,846** for a single-family home. The median cost is **$6,347** for a single-family home. Median installation costs for gas furnaces were used in the calculation of incremental costs for a conservative estimate when upgrading to a zero-NOx appliance. The average upfront cost to install air conditioning, although not regulated by Rule 9-4, is considered in the analysis of incremental costs and detailed in the Incremental Costs section. These costs do not include replacement of any associated air conditioning unit. The impacts of air conditioning (which is provided by a HP HVAC unit) are discussed further in the Incremental Cost section.

Table 6 Upfront Costs for NOx Emitting Gas Furnaces in Single-Family Homes

Project Type	Number of Projects	Average Upfront Cost	Median Upfront Cost
Gas-fired furnace	2,945	$6,846	$6,347

Note: Since the data only includes space heating appliances installed in single-family buildings, it is assumed all included installations would be covered by BAAQMD Rulings 9-6. Data is filtered for gas space heating installations within Bay Area counties.

Source: CLEAResult

Multi-family/Commercial Space Heating

No data was available for multi-family or commercial NOx emitting appliance installation. Rule 9-4 includes appliances from small 25,000 BTU wall furnaces up to commercial package units of five to six tons. This likely represents a large range of upfront costs for installation of NOx emitting space heating. Although large datasets for the whole Bay Area were not available, some local data has been provided by Peninsula Clean Energy in relation to the costs of rooftop package units which can be found in Figure 2 which is found in the commercial cost section. In general, these gas rooftop package units were found to have upfront costs between $22,750 and $37,250 depending on size.

6 Upfront Costs: Zero-NOx Appliances

6.1 Upfront Costs: Zero-NOx HPWH

Single-Family HPWH

These costs describe all up-front costs for the installation, appliance, and labor for zero-NOx electric HPWHs in single-family homes, including the cost of panel upsizing if required for appliance installation.[15]

The costs are calculated by taking the average of all collected costs weighted by the number of projects each cost summarizes. Collected costs included average and median costs from seven data sources. Three CCA's provided the average cost seen across the installation projects they supported. Four project datasets (i.e., Peninsula Clean Energy, SVCE, CLEAResult's, and TECH Clean California) were processed to calculate average and median costs by filtering installation projects for Bay Area counties, when available. Table 7 presents the average and, when available, median upfront costs collected from each data source. The last row in the table displays the weighted average of these collected costs.

Based on available data, the average cost to replace an existing NOx emitting gas water heater with a zero-NOx HPWH in the Bay Area is **$7,071** for a single-family home. The median cost is **$6,605** for a single-family home. Average installation costs for zero-NOx HPWHs in single-family homes were used in the calculation of incremental costs for a conservative estimate.

Table 7 Upfront Costs for Zero-NOx HPWH in Single-family Homes

Data Source	Number of Projects	Average Upfront Cost	Median Upfront Cost
EBCE	142	$7,266	N/A
MCE	108	$7,179	N/A
Peninsula Clean Energy	312	$6,888	$6,300
CPSF	61	$7,118	N/A
SVCE[1]	358	$5,653	$5,088
CLEAResult[2]	2,254	$6,848	$6,500
TECH Clean California (Single-family)[3]	1,127	$7,529	$6,900
Weighted Average		**$7,071**	**$6,605**

Notes: Since the data only includes water heaters installed in single-family buildings, it is assumed all included water heaters would be covered by BAAQMD Rulings 9-6.

[1] SVCE's cost data may include incentives and excludes the costs of panel upsizing. The average and median costs may therefore underestimate the total cost of installation. These costs were excluded from the weighted average calculations.

[2] CLEAResult cost data was filtered to only include projects in Bay Area counties and projects that involved a fuel switch.

[3] TECH Clean California (Single-family) cost data was filtered to only include projects in Bay Area counties, projects that involved a fuel switch (i.e., excluded projects that replaced an electric resistance water heater), and projects in single-family homes; and filtered to excluded HPWH installations of tank sizes greater than 110 gallons as these are assumed to exceed the size regulated by Rule 9-6 even with up-sizing. Projects that included costs for more than one appliance type, thereby inflating costs, were also excluded.

The weighted average represents the average of the collected average and median costs, weighted by the number of projects included in each. The weighted average excludes data from SVCE.

[15] Initially, the project team tried to determine embedded costs for panel upsizing and clean it from data sets, as it could be a major factor raising the estimate of total project cost. However, due to limitations and inconsistencies in analyzed data sets, costs for panel upsizing could not be 'backed out' of total upfront costs. The resulting data analysis thus includes the cost of electrical panel upsizing in 'average upfront cost' values.

For the datasets with detail available, upfront costs were broken down by tank size, as detailed in Table 8. The breakdown demonstrates that the majority of HPWH installations were of tank sizes between 41 to 50 gallons (i.e., 811 total projects) and 51 to 75 gallons (i.e., 838 total projects). This demonstrates that upfront costs remained relatively consistent across tank size with an increase in upfront costs for tanks sizes greater than 75 gallons.[16] Consistent with the datasets above, this tank-size analysis also includes all up-front costs for the installation, appliance, and labor for zero-NOx electric HPWHs in single-family homes, including the cost of panel upsizing if required.

Table 8 Upfront Costs for Zero-NOx HPWH in Single-family Homes by Tank Size

	SVCE[1]			Peninsula Clean Energy			TECH Clean California (Single-family)		
Tank Size	Number of Projects	Average Upfront Cost	Median Upfront Cost	Number of Projects	Average Upfront Cost	Median Upfront Cost	Number of Projects	Average Upfront Cost	Median Upfront Cost
<30 gallons*	26	$5,292	$4,322	0	N/A	N/A	0	N/A	N/A
31-40 gallons	16	$7,040	$7,211	6	$5,683	$6,425	14	$6,395	$5,786
41-50 gallons	187	$5,480	$4,913	161	$6,759	$6,322	392	$7,258	$7,994
51-75 gallons	77	$5,828	$5,158	97	$6,866	$6,564	627	$7,258	$6,813
75+ gallons	52	$5,770	$5,556	48	$7,515	$6,980	94	$10,634	$9,150

Notes: N/A = Not available.

[1] Costs provided by SVCE may include incentives and may therefore underestimate total costs.

Multi-family HPWH

HPWH projects in multi-family homes were also analyzed using available data. In multi-family buildings a single water heater can be installed in each housing unit, or a water heater can be installed centrally to serve multiple housing units. It is important to consider this distinction when analyzing cost data by normalizing upfront costs by the number of water heating units installed. The average upfront cost to replace an existing NOx emitting gas water heater with a zero-NOx HPWH is **$8,939** for a multi-family home. The median cost is **$9,130** for a multi-family home.

These costs describe all up-front costs for the installation, appliance, and labor for multi-family homes including the cost of panel upsizing if required for appliance installation. The costs are calculated by taking the average costs per water heating unit weighted by the number of projects across two datasets (i.e., TECH Clean California datasets) as detailed in Table 9. The table also includes the average costs per housing unit served from one dataset (i.e., Frontier Energy), for which the number of water heaters installed was unknown. Due to the small sample size of the available multi-family data, the results may not provide a complete representation of costs for multi-family projects in the Bay Area. Further data collection would be required to determine the accuracy of these cost results.

[16] Data from SVCE shows an increase in upfront costs for installations of HPWHs with tank sizes between 31 and 40 gallons; however, the data provided by SVCE has inconsistencies due to the inclusion and exclusion of rebates and can be considered an outlier in the analysis.

Table 9 Upfront Costs for Zero-NOx HPWH in Multi-family Homes

Data Source	Number of Projects	Average Upfront Cost per HPWH Unit	Median Upfront Cost per HPWH Unit	Average Upfront Cost per Housing Unit Served
Frontier Energy[1]	2	N/A	N/A	$9,578
TECH Clean California (Single-family)[2]	22	$8,104	$7,447	N/A
TECH Clean California (Multi-family)[3]	30	$9,552	$10,364	N/A
Weighted Average		**$8,939**	**$9,130**	**N/A**

[1] Frontier Energy cost data was filtered to exclude central HPWH projects. It is assumed these projects would exceed the tank size regulated by Rule 9-6.

[2] TECH Clean California (Single-family) cost data was filtered to only include projects in Bay Area counties, projects that involved a fuel switch (i.e., excluded projects that replaced an electric resistance water heater), and projects in multi-family homes; and filtered to excluded HPWH installations of tank sizes greater than 110 gallons as these are assumed to exceed the size regulated by Rule 9-6 even with up-sizing. Projects that included costs for more than one appliance type, thereby inflating costs, were also excluded.

[3] TECH Clean California (Multi-family) cost data was filtered to only include installations in Bay Area counties and installations that involved a fuel switch (i.e., excluded projects that replaced an electric resistance water heater). The dataset was also filtered to exclude HPWH installations of tank sizes greater than 110 gallons as these are assumed to exceed the size regulated by Rule 9-6 even with up-sizing. Projects that included costs for more than one appliance type, thereby inflating costs, were also excluded.

The weighted average represents the average of the collected average costs, weighted by the number of projects included in each.

For the datasets with detail available, upfront costs were broken down by tank size, as shown in Table 10. The breakdown shows upfront costs may increase with tank sizes when accounting for outliers (i.e., the two 31-40 gallon projects).

Table 10 Upfront Costs for Zero-NOx HPWH in Multi-family Homes by Tank Size

	TECH Clean California (Single-family)[1]			TECH Clean California (Multi-family)[2]		
Tank Size	Number of Projects	Average Upfront Cost per HPWH Unit	Median Upfront Cost per HPWH Unit	Number of Projects	Average Upfront Cost per HPWH Unit	Median Upfront Cost per HPWH Unit
<30 gallons*	0	N/A	N/A	0	N/A	N/A
31-40 gallons	1	$13,538	$13,538	0	N/A	N/A
41-50 gallons	11	$6,957	$8,840	6	$7,973	$7,495
51-75 gallons	7	$7,553	$9,379	5	$8,645	$8,932
75+ gallons	3	$11,783	$11,482	19	$10,289	$10,364

Notes: N/A = not applicable.

[1] The TECH Clean California (Single-family) database was filtered to only include projects in Bay Area counties, projects that involved a fuel switch (i.e., excluded projects that replaced an electric resistance water heater), and projects in multi-family homes; and filtered to excluded HPWH installations of tank sizes greater than 110 gallons as these are assumed to exceed the size regulated by Rule 9-6 even with up-sizing. Projects that included costs for more than one appliance type, thereby inflating costs, were also excluded.

[2] TECH Clean California (Multi-family) cost data was filtered to only include installations in Bay Area counties and installations that involved a fuel switch (i.e., excluded projects that replaced an electric resistance water heater). The dataset was also filtered to exclude HPWH installations of tank sizes greater than 110 gallons as these are assumed to exceed the size regulated by Rule 9-6 even with up-sizing. Projects that included costs for more than one appliance type, thereby inflating costs, were also excluded.

On-Demand (Tankless) Electric Hot Water Heater Upfront Costs

None of the incentive-provider datasets above detail costs for on-demand, or tankless hot water heaters. Incentive providers only incentivize high-efficiency HPHW. Furthermore, HPHWs significantly outperform tankless hot water heaters when considering lifecycle costs.[17] On-demand water heaters heat water instantaneously by heating flowing cold water through a heat exchanger in the unit. The delivery of hot water is instantaneous but has limited capacity for multiple simultaneous uses in large households. This is due to a limited flow rate for on-demand hot water heaters, which typically provide hot water at a rate of 2-5 gallons per minute. For example, in an instance where a household was using hot water for dishwashing and showers, this would stretch the flow rate of a typical on-demand heater to its maximum capacity. This can sometimes necessitate installation of multiple on demand hot water heaters in larger or more hot water intensive households. While heat pump hot water heaters are 300% to 400% more efficient than a gas water heater, an on-demand electric water heater is only marginally more efficient. This reduction in efficiency and the comparatively higher cost of gas means that HPWHs decrease bill impacts in most cases, but on demand electric water heaters will likely increase bill impacts.[18]

However, certain space-limited consumers may opt to install a tankless water heater due to space, noise, or other constraints. The installation of a tankless electric water heater will be similar to a HPWH in most cases, requiring a 240 volt electrical line and additional space on the electrical panel. Therefore, installation costs are expected to be similar to a tanked HPHW version and have the same panel and service line impacts.

Due to a lack of incentive data, the project team estimated average cost to install on-demand water heaters using available data from retailers. The average cost of an electric tankless water heater unit is approximately $647 compared to $2,500 for a 65 gallon hybrid heat pump. This means that on-demand electric water heaters would cost approximately $1,800 less than a HPWH for an average installation cost of $5,319.[19] Underlying cost estimates from retailers is described below in Table 11.

Table 11 Tankless Electric Water Heater Upfront Costs

Tankless Water Heater Specs	Cost	Notes
Rheem 18kW self-modulating 3.51 GPM Tankless Electric Water Heater	$459	Requires 2 x 40 amp double pole breakers
Steibel Eltron 24 kW 4.68GPM Residential Tankless Water Heater	$684	Requires minimum of 150 amp total service to residence
Steibel Eltron 28.8 kW 5.66 GPM Residential Tankless Hot Water Heater	$799	Requires 240 volt or 208 volt electric service
Average Cost	**$647**	

Notes: kW = kilowatt; amp = ampere.

[17] Consumer Reports. https://www.consumerreports.org/appliances/water-heaters/tankless-water-heaters-vs-storage-tank-water-heaters-a5291982593

[18] Department of Energy: https://www.energy.gov/energysaver/articles/new-infographic-and-projects-keep-your-energy-bills-out-hot-water; https://www.energy.gov/energysaver/tankless-or-demand-type-water-heaters

[19] Source(s):

- https://www.homedepot.com/p/Rheem-Performance-18-kW-Self-Modulating-3-51-GPM-Tankless-Electric-Water-Heater-RETEX-18/300800620;
- https://www.homedepot.com/p/Stiebel-Eltron-Tempra-24-Plus-Adv-Flow-Control-and-Self-Modulating-24-kW-4-68-GPM-Residential-Electric-Tankless-Water-Heater-Tempra-24-Plus/306745520;
- https://www.homedepot.com/p/Stiebel-Eltron-Tempra-29-Plus-Adv-Flow-Control-and-Self-Modulating-28-8-kW-5-66-GPM-Residential-Electric-Tankless-Water-Heater-Tempra-29-Plus/306745522

6.2 Upfront Costs: Zero-NOx HP HVAC

Total costs to replace an existing NOx emitting gas furnace with a zero-NOx space heating appliance can be analyzed across single-family and multi-family buildings. Data on commercial buildings was not available.

Single-Family HP HVAC

Based on available data, the average cost to replace an existing NOx emitting gas furnace with a zero-NOx HP HVAC in the Bay Area is **$19,640** for a single-family home as described in Table 12. The median cost is **$18,803** for a single-family home.

These costs describe all up-front costs for the installation, appliance, and labor for single-family homes including the cost of panel upsizing if required for appliance installation. The costs are calculated by taking the average of all collected costs weighted by the number of projects each cost summarizes. Collected costs included average and median costs from three data sources. Peninsula Clean Energy provided the average cost seen across the installation projects they supported. Two project datasets (i.e., BayREN provided by CLEAResults and TECH Clean California) were processed to calculate average and, where available, median costs by filtering installation projects for Bay Area counties.

Table 7 presents the average and, when available, median upfront costs collected from each data source. The last row in the table displays the weighted average of the average and median collected costs.

Table 12 Upfront Costs for Zero-NOx HP HVAC in Single-family Homes

Data Source	Number of Projects	Average Upfront Cost	Median Upfront Cost
Peninsula Clean Energy	817	$18,895	N/A
CLEAResults[1]	1,244	$12,958	$12,825
TECH Clean California (Single-family)[2]	2,834	$22,787	$21,427
Weighted Average		$19,640	$18,803

Notes: Since the data only includes space cooling/heating appliances installed in single-family buildings, it is assumed all included projects would be covered by BAAQMD Rulings 9-4.

[1] CLEAResult cost data was filtered to only include projects in Bay Area counties and projects that involved a fuel switch.

[2] TECH Clean California (Single-family) cost data was filtered to only include projects in Bay Area counties, projects that involved a fuel switch (i.e., excluded projects that replaced an electric resistance HVAC), and projects in single-family homes. Projects that included costs for more than one appliance type, thereby inflating costs, were also excluded.

The weighted average represents the average of the collected average costs, weighed by the number of projects. Because there was only one dataset with median collected costs, a weighted average of the median costs was not calculated.

Where available, upfront costs were broken down by equipment type and whether the system was ducted or ductless, as shown in Table 13. Each subtotal displays the average of each equipment type's costs weighted by the number of projects that were ducted and ductless. The table demonstrates that costs vary across equipment types with multi-split systems being the most expensive.

Table 13 Upfront Costs for Zero-NOx HP HVAC in Single-family Homes by Equipment Type

	Peninsula Clean Energy			CLEAResult[1]			TECH Clean California (Single-family)[2]		
Equipment Type	Number of Projects	Average Upfront Cost	Median Upfront Cost	Number of Projects	Average Upfront Cost	Median Upfront Cost	Number of Projects	Average Upfront Cost	Median Upfront Cost
Mini-Split	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**955**	**$21,317**	**$20,290**
Ductless	N/A	$16,395	N/A	N/A	N/A	N/A	168	$14,275	$12,220
Ducted	N/A	$20,424	N/A	N/A	N/A	N/A	787	$22,820	$21,311
Multi-Split	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**598**	**$24,778**	**$23,062**
Ductless	N/A	N/A	N/A	N/A	N/A	N/A	322	$22,850	$21,585
Ducted	N/A	N/A	N/A	N/A	N/A	N/A	276	$27,028	$24,960
Packaged Unitary Equipment	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**18**	**$15,645**	**$15,792**
Ducted	N/A	N/A	N/A	N/A	N/A	N/A	18	$15,645	$15,792
Small Duct High Velocity	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**8**	**$15,883**	**$15,370**
Ducted	N/A	N/A	N/A	N/A	N/A	N/A	8	$15,883	$15,370
Split Unitary Equipment	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**1,255**	**$23,104**	**$21,625**
Ductless	N/A	N/A	N/A	N/A	N/A	N/A	1	$16,999	$16,999
Ducted	N/A	N/A	N/A	N/A	N/A	N/A	1,254	$23,109	$21,629
Unspecified	**N/A**	**N/A**	**N/A**	**1,244**	**$12,958**	**$12,777**	**N/A**	**N/A**	**N/A**
Ductless	N/A	N/A	N/A	277	$12,191	$12,000	N/A	N/A	N/A
Ducted	N/A	$18,898*	N/A	967	$13,178	$13,000	N/A	N/A	N/A

Notes: N/A = Not available.

[1] CLEAResult cost data was filtered to only include projects in Bay Area counties and projects that involved a fuel switch.

[2] TECH Clean Energy (Single-family) cost data was filtered to only include projects in Bay Area counties, projects that involved a fuel switch (i.e., excluded projects that replaced an electric resistance HVAC), and projects in single-family homes. Projects that included costs for more than one appliance type, thereby inflating costs, were also excluded.

* Peninsula Clean Energy 's reported costs for an unspecified ducted system is a central space cooling/heating system (e.g., packaged unitary equipment or split unitary equipment).

Each subtotal row displays the weighted average costs for the equipment type.

The cost data can also be further analyzed by duct system type, as ducted vs. ducted. This characteristic was a major variable impacting total cost for space heating/cooling appliance installation. Table 14 summarizes the data across equipment types by ducted and ductless systems. Based on available data, the average cost to replace an existing NOx emitting space cooling/heating appliance with a zero-NOx space HP HVAC in the Bay Area is **$20,408** for a ducted system in a single-family home and **$17,122** for a ductless system in a single-family home. The median cost is **$19,263** for a ducted system in a single-family home and **$16,073** for a ductless system in a single-family home. Average installation costs for zero-NOx ducted and ductless space cooling/heating appliance in single-family homes were used in the calculation of incremental costs for a conservative estimate.

Table 14 Upfront Costs for Zero-NOx HP HVAC in Single-family Homes by System Duct Type

Duct System	Number of Projects	Weighted Average Upfront Cost	Weighted Median Upfront Cost
HP HVAC - Ductless	768	$17,122	$16,073
HP HVAC - Ducted	3,310	$20,408	$19,263

Notes: Average costs are calculated across equipment types in the CLEAResult and TECH Clean California (Single-family) datasets and weighted by the number of projects in each equipment type. Cost data from Peninsula Clean Energy was excluded from the weighted average because the number of projects was not available.

Multi-family HP HVAC

Space heating/cooling appliance projects in multi-family homes were also analyzed using available data. In multi-family buildings, a HVAC unit can be installed in each housing unit, or an HVAC unit can be installed centrally to serve multiple housing units. It is important to consider this distinction when analyzing cost data by normalizing upfront costs by the number of HVAC units installed. For the datasets with such information available, the average cost to replace an existing NOx emitting furnace with a zero-NOx appliance is **$20,676** for a multi-family home. The median cost is **$23,692** for a multi-family home.

These costs describe all up-front costs for the installation, appliance, and labor for multi-family homes including the cost of panel upsizing if required for appliance installation. The costs are calculated by taking the average and median costs per HVAC unit weighted by the number of projects across two datasets (i.e., TECH Clean California datasets) as detailed in Table 15. The table also includes the average costs per housing unit served from one dataset (i.e., Frontier Energy), for which the number of HVAC units installed was unknown.

Table 15 Upfront Costs for Zero-NOx Space HP HVAC in Multi-family Homes

Data Source	Number of Projects	Average Upfront Cost per HVAC Unit	Median Upfront Cost per HVAC Unit	Average Upfront Cost per Housing Unit Served	Median Upfront Cost per Housing Unit Served
Frontier Energy[1]	13	N/A	N/A	$5,216	4,443
TECH Clean California (Single-family)[2]	29	$17,214	$15,587	N/A	N/A
TECH Clean California (Multi-family)[3]	13	$28,398	$41,772	N/A	N/A
Weighted Average		**$20,676**	**$23,692**	**N/A**	**N/A**

[1] Frontier Energy cost data was filtered to exclude projects that do not involve a fuel switch and projects that served common area since size of the unit is unknown.

[2] TECH Clean California (Single-family) cost data was filtered to only include projects in Bay Area counties, projects that involved a fuel switch (i.e., excluded projects that replaced an electric resistance HVAC), associated with smaller multi-family homes (which are captured by this single-family dataset). Projects that included costs for more than one appliance type, thereby inflating costs, were also excluded.

[3] TECH Clean California (Multi-family) cost data was filtered to only include projects in Bay Area counties and projects that involved a fuel switch (i.e., excluded projects that replaced an electric resistance HVAC). All installations are within Rule 9-4's heating and cooling capacity thresholds listed in Table 3. Projects that included costs for more than one appliance type, thereby inflating costs, were also excluded.

The weighted average represents the average of the collected average costs, weighed by the number of projects. A weighted average of the collected median costs was not calculated because only one dataset had median costs available.

Where available, upfront costs were broken down by equipment type and whether the system was ducted or ductless, as shown in Table 16. Each subtotal displays the average of each equipment

type's costs weighted by the number of projects that were ducted and ductless. The table demonstrates costs vary across equipment types, with multi-split systems being the most expensive—similar to the trends for single-family homes. The cost data can also be further analyzed by duct system type. Table 16 and Table 17 summarize the data across equipment types by by ducted and ductless systems.

Based on available data, the average upfront cost to replace an existing NOx emitting gas furnace with a zero-NOx HP HVAC in the Bay Area is **$24,647** for a ducted system in a multi-family home and **$11,816** for a ductless system in a multi-family home. The median upfront cost is **$28,665** for a ducted system in a multi-family home and **$11,873** for a ductless system in a multi-family home. Due to the small sample size of the available multi-family data, the results may not provide a complete representation of costs for multi-family projects in the Bay Area. Further data collection would be required to determine the accuracy of these cost results.

Table 16 Upfront Costs for Zero-NOx HP HVAC in Multi-family Homes by Equipment Type

	TECH Clean California (Single-family)[1]			TECH Clean California (Multi-family)[2]		
Equipment Type	Number of Projects	Average Upfront Cost per HVAC Unit	Median Upfront Cost per HVAC Unit	Number of Projects	Average Upfront Cost per HVAC Unit	Median Upfront Cost per HVAC Unit
Mini-Split	**14**	**$16,359**	**$9,805**	**12**	**$30,348**	**$41,772**
Ductless	9	$8,941	$9,325	N/A	N/A	N/A
Ducted	5	$29,711	$25,839	12	$30,348	$41,772
Multi-Split	**9**	**$19,549**	**$17,995**	**N/A**	**N/A**	**N/A**
Ductless	4	$18,285	$17,606	N/A	N/A	N/A
Ducted	5	$20,560	$22,172	N/A	N/A	N/A
Split Unitary Equipment	**6**	**$15,707**	**$14,163**	**1**	**$5,000**	**$5,000**
Ducted	6	$15,707	$14,163	1	$5,000	$5,000

Notes:

[1] TECH Clean California (Single-family) cost data was filtered to only include projects in Bay Area counties, projects that involved a fuel switch (i.e., excluded projects that replaced an electric resistance HVAC), and projects in smaller multi-family homes (which are captured in this "single-family" database. Projects that included costs for more than one appliance type, thereby inflating costs, were also excluded.

[2] TECH Clean California (Multi-family) cost data was filtered to only include projects in Bay Area counties and projects that involved a fuel switch (i.e., excluded projects that replaced an electric resistance HVAC). All installations are within Rule 9-4's heating and cooling capacity thresholds listed in Table 3. Projects that included costs for more than one appliance type, thereby inflating costs, were also excluded.

Each subtotal row displays the weighted average costs for the equipment type.

Table 17 Upfront Costs for Zero-NOx HP HVAC in Multi-family Homes by System Duct Type

Duct System	Number of Projects	Weighted Average Upfront Cost	Weighted Median Upfront Cost
HP HVAC - Ductless	13	$11,816	$11,873
HP HVAC - Ducted	29	$24,647	$28,665

Notes: Average costs are calculated across equipment types in the TECH Clean California (Single-family) and TECH Clean California (Multi-family) datasets and weighted by the number of projects in each equipment type.

6.3 Commercial Costs for Zero-NOx HPWH, & HP HVAC Upgrades

The large datasets do not include data for commercial installations of covered BAAQMD zero-NOx appliances. While commercial buildings are generally more variable in their systems and operations than single-family and multi-family buildings, the zero-NOx standards only cover appliances up to a certain size or capacity.

Based on research conducted for this analysis, most central water heaters in multi-family homes are at the high end or over the range of thresholds covered by the BAAQMD zero-NOx standard for 2027 compliance. For example, the threshold for NOx emitting water heaters of up to 75,000 btu/hour regulated under Rule 9-6 zero-NOx standard starting in 2027 is roughly 74 gallons, which describes a water heater rated to serve approximately five people.[20] NOx emitting heating appliances regulated under Rule 9-4 are expected to affect a comparatively larger range of appliances, regulating hybrid gas/electric rooftop package units roughly corresponding to up to 5-tons, which are used in light-commercial applications.

This analysis will assume that the costs associated with multi-family installations would be similar to those for covered equipment in the small commercial setting. In addition, some small commercial projects would be small to medium sized water heaters similar to those found in the single-family residential setting. Replacing a 65-gallon water heater in a small office building requires the same steps to replacing a 65 gallon water heater in any building and the costs are likely to be comparable.

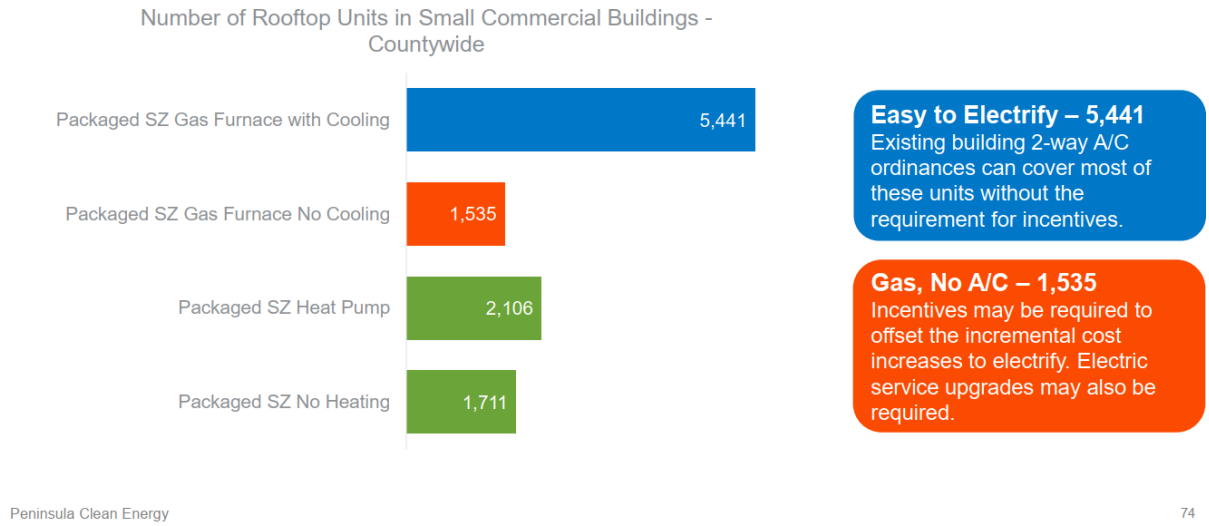
To help fill the data gap for commercial buildings, the project team reviewed the Peninsula Clean Energy 2035 Decarbonization Plan (2022) and The Rocky Mountain Institute The Economics of Electrifying Buildings: Medium Size Commercial Retrofits (2022), which include data on costs for zero-NOx appliance retrofits in commercial buildings.[21] Though these resources do not comprehensively analyze cost effectiveness for zero-NOx water and space heating in the commercial sector, they do illuminate cost effectiveness for certain commonly used appliance types including package units used for heating and cooling.

The Peninsula Clean Energy analysis notes that packaged Single Zone (SZ) Gas Furnaces with Cooling, are easy to upgrade to a zero-NOx appliance, since a 220 volt circuit and sufficient panel capacity is already available for the unit, which means that the installation of zero-NOx heat pump rooftop package units is logistically and cost feasible. The Peninsula Clean Energy analysis also notes that the Packaged SZ Gas Furnace with Cooling offers a sizable opportunity to upgrade to a zero-NOx appliance, with 5,441 Packaged SZ Gas Furnace with Cooling units across the County of San Mateo as shown below in Figure 1. These units would correlate with packaged, ducted, heat pump systems described in the multi-family analysis.

[20] Note that this analysis does not cover appliances sized to the 2 million BTU/hour threshold, where the compliance date starts in Jan 1, 2031.

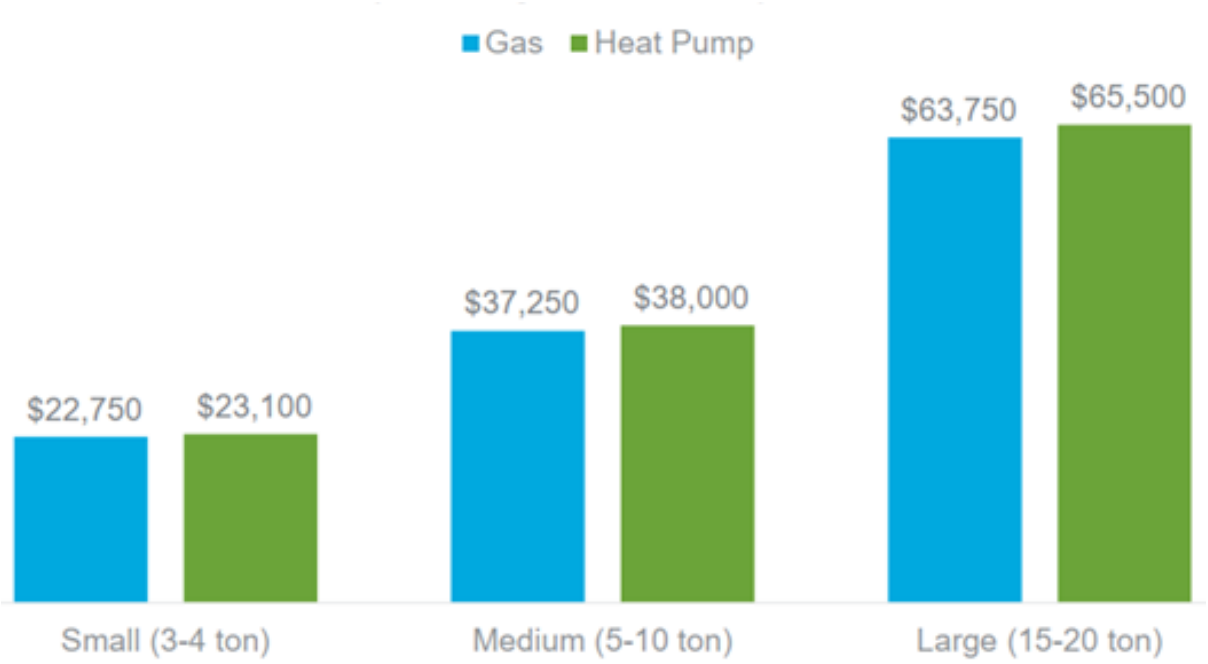
[21] The Rocky Mountain Institute report data specifies a 50,000 square feet. office space as a case study for mild climates relevant to the Bay Area. This was ultimately removed from the final analysis due to the unspecified size of the RTU that was analyzed as part of the report, as it likely goes beyond sizing rules under Rule 9-4 2029 thresholds. https://rmi.org/insight/economics-of-electrifying-buildings-medium-size-commercial-retrofits/

Figure 1 Peninsula Clean Energy 2035 Decarbonization Plan Commercial HVAC Equipment Analysis



Peninsula Clean Energy analyzed commercial rooftop packaged unit costs, finding that zero-NOx rooftop heat pumps are nearly identical to gas-fired rooftop packaged units, even without additional incentives, as shown below in Figure 2.

Figure 2 Peninsula Clean Energy 2035 Decarbonization Plan Commercial Rooftop Package Unit Cost Analysis



6.4 Electric Panel Upsizing Costs

The average upfront costs for HP HVAC and HPWH included costs for electric panel upsizing as they could not be separated from the overall datasets due to technical/data availability limitations. However, electric panel upsizing and its potential to necessitate a subsequent upgrade in electric service are a key cost variable for the installation of zero-NOx appliances. Due to their importance in overall costs to install zero-NOx appliances, estimated costs for panel upsizing and service upgrades have been analyzed individually here.

Electric Panel Cost Introduction

The electrical panel is also called the breaker box, load center, fuse box, distribution center, or distribution box. Buildings receive electrical service from the distribution grid, which is then distributed to individual circuits which begin and end at the panel. Panel size is measured in amperes (amps). Electric panel sizing is closely connected to building age ('vintage'). Generally, older homes have 60 to 100 amp panels, while newer homes have 200 amp panels. Homes built before the mid 1960's or early 1970's are likely to have main panels of 60 amps while buildings built before the 1980's are likely to have 100 amp panels.[22] Depending on the size of the home and the number of electric appliances installation of zero-NOx appliances could necessitate a larger panel.

Due to the variability of panel sizes across buildings, it is difficult to predict if panel upsizing will be needed for any individual building or project. Table 18 presents the number and percentage of projects completed without panel upsizing for the data sources with panel information available. The table demonstrates the majority of zero-NOx upgrade projects in single-family homes and all the projects in multi-family homes were completed without panel upsizing. When panel upsizing did occur, it is not clear if they were required for the project, or if they were completed preemptively to allow for future electrification projects or EV charging.

Additionally, as shown in Table 21 below, about 19-22% of all HPWH projects were successfully completed on a 100 amp or less electric panel across single-family/ multi-family projects respectively. About 24-29% of all HP HVAC projects were successfully completed on a 100 amp or smaller panel across single-family/multi-family projects respectively.

This analysis does not include zero-NOx upgrade projects that may have *not* been completed due to the potentially prohibitive costs of a panel upsizing, which is the subject of upcoming TECH Clean California surveys to be provided to BAAQMD.

[22] https://newbuildings.org/we-can-power-the-homes-of-the-future-with-electric-panels-of-the-past/#:~:text=Back%20in%201962%20the%20%E2%80%9CLive,and%20it's%20enough%20power%20now.

Table 18 Zero-NOx Upgrade Projects Completed Without Panel Upsizing

Data Source	Building Type	Number of Projects Completed without Panel Upsizing	Percent of Total Projects*
HPWH			
Peninsula Clean Energy	Single-family	267	86%
TECH Clean California (Single-family)[1]	Single-family	574	94%
TECH Clean California (Single-family)[2]	Multi-family	22	100%
TECH Clean California (Multi-family)[3]	Multi-family	41	100%
HP HVAC**			
TECH Clean California (Single-family)[4]	Single-family	1,999	96%
TECH Clean California (Single-family)[5]	Multi-family	25	100%
TECH Clean California (Multi-family)[6]	Multi-family	4	100%

[1] TECH Clean California (Single-family) cost data was filtered pursuant to the notes in Table 7 and to exclude projects with no information available on panels. For the purposes of this analysis, panel upsizing was defined as an increase in panel capacity of at least 50 amps.

[2] The TECH Clean California (Single-family) cost data was filtered pursuant to the notes in Table 9 and to exclude projects with no information available on panels. For the purposes of this analysis, panel upsizing was defined as an increase in panel capacity of at least 50 amps.

[3] TECH Clean California (Multi-family) cost data was filtered pursuant to the notes in Table 9 and to exclude projects with no information available on panels. For the purposes of this analysis, panel upsizing was defined as an increase in panel capacity of at least 50 amps.

[4] TECH Clean California (Single-family) cost data was filtered pursuant to the notes in Table 12and to exclude projects with no information available on panels. For the purposes of this analysis, panel upsizing was defined as an increase in panel capacity of at least 50 amps.

[5] TECH Clean California (Single-family) cost data was filtered pursuant to the notes in Table 15 and to exclude projects with no information available on panels. For the purposes of this analysis, panel upsizing was defined as an increase in panel capacity of at least 50 amps.

[6] TECH Clean California (Multi-family) cost data was filtered pursuant to the notes in Table 15 and to exclude projects with no information available on panels. For the purposes of this analysis, panel upsizing was defined as an increase in panel capacity of at least 50 amps.

* Total projects is filtered to only include projects with information available on panel amperes to remain conservative.

** Splitting HVAC out by ducted and ductless did not yield different results.

Electric Panel Size Modeling

Additionally, an analysis was conducted to evaluate the number of households across the Bay Area that likely have a 200 amp panel. This analysis was completed using publicly available data from the National Renewable Energy Laboratory's (NREL) ResStock, a national dataset representing the United States residential building stock, with geospatial granularity at the county-level, including key building stock characteristics such as vintage, building system, and energy consumption.

Households that currently have a 200 amp panel will not require any panel upsizing. To determine the number of households that likely already have a 200 amp panel, the following criteria were used:

- Currently has electric heating system OR
- Currently has air conditioning OR
- Building vintage later than 1980

Table 19 presents the number and percentage of gas households in the Bay Area that likely have a 200 amp panel. It should be noted that this analysis may not perfectly reflect building counts, as they are based on NREL's model instead of US census data. Following the criteria listed above, approximately 44% of all living units and homes in the Bay Area have a 200 amp panel. About 46-47% of single-family housing, 29% of low-rise multi-family housing, and 39% of high-rise multi-family units have a 200 amp panel. This analysis is conservative, as it does not account for customers who have already undergone electric panel upsizing for electric vehicle charging, PV solar installation, building expansion or accessory dwelling unit (ADU) addition, or earlier panel safety failures.

A recent study conducted by UCLA found that only 3% of single family residential and 10% of multi-family properties will need panel upgrades in order to fully electrify, while an additional 32% (single-family) and 59% (multi-family) will require further load management or watt diet approaches to electrify on their current panel.[23]

[23] https://www.sciencedirect.com/science/article/pii/S0301421524002581

Table 19 Estimated Number of Households That Have a 200 amp Panel

		Alameda	Contra Costa	Marin	Napa	San Francisco	San Mateo	Santa Clara	Solano	Sonoma	Total
SF Detached	Has 200 amp Panel	95,200	163,700	15,000	12,600	15,700	42,600	105,100	66,100	42,300	558,300
	Total	259,600	212,600	55,200	27,400	67,800	126,600	283,800	80,600	92,700	1,206,300
	% with 200 amp Panel	37%	77%	27%	46%	23%	34%	37%	82%	46%	46%
SF Attached	Has 200 amp Panel	19,800	17,000	2,400	500	9,400	7,500	24,700	3,600	5,100	90,000
	Total	39,700	22,800	6,500	2,200	37,500	18,600	48,400	5,100	10,200	191,000
	% with 200 amp Panel	50%	75%	37%	23%	25%	40%	51%	71%	50%	47%
MF 2-4 Units	Has 200 amp Panel	10,900	12,100	1,900	700	9,000	3,400	8,000	4,100	3,200	53,300
	Total	42,100	17,700	5,800	1,900	59,100	13,100	27,600	5,800	8,500	181,600
	% with 200 amp Panel	26%	68%	33%	37%	15%	26%	29%	71%	38%	29%
MF 5+ Units	Has 200 amp Panel	28,600	23,700	3,900	1,500	16,200	8,500	27,800	8,900	6,100	125,200
	Total	79,400	31,000	10,900	2,700	79,400	30,300	59,800	11,600	12,600	317,700
	% with 200 amp Panel	36%	76%	36%	56%	20%	28%	46%	77%	48%	39%
Mobile Home	Has 200 amp Panel	2,200	3,900	500	1,500	500	1,400	8,000	3,200	2,900	24,100
	Total	6,800	5,800	1,700	2,700	700	2,900	16,000	3,400	7,700	47,700
	% with 200 amp Panel	32%	67%	29%	56%	71%	48%	50%	94%	38%	51%
Total	Has 200 amp Panel	156,700	220,400	23,700	16,800	50,800	63,400	173,600	85,900	59,600	850,900
	Total	427,600	289,900	80,100	36,900	244,500	191,500	435,600	106,500	131,700	1,944,300
	% with 200 amp Panel	37%	76%	30%	46%	21%	33%	40%	81%	45%	44%

Notes: amp = ampere.

While demonstrated to be infrequent, if upsizing an electrical panel is deemed necessary to install a zero-NOx appliance, the building owner will incur additional costs to enlarge the electrical panel. The total upfront costs provided above include the cost to upsize panels if it was necessary for the zero-NOx project.

While the Peninsula Clean Energy and TECH Clean California databases include information on panel upsizing, the data is not used to estimate costs for this analysis. The TECH Clean California databases likely underestimate panel upsize costs due to inconsistencies within the data. Many projects within the databases are labeled as including a "panel upgrade" but show no difference in the before and after panel capacity (amps). This may be due to other "upgrades" such as adding a sub-panel or additional breakers to existing panels.

To fill this gap, two geographically relevant case studies from the City of Palo Alto and Peninsula Clean Energy are referenced below.

Estimated Costs for Electric Panel Upsizing- Palo Alto Case Study

Panel upsizing costs were derived from TRC's 2016 report Palo Alto Electrification Final Report.[24] The modeling uses a panel upsize cost of $4,250 per customer for single-family homes and $2,750 per customer for multi-family homes. PG&E has estimated that electric panel upsizing costs would range from $5,000 to $14,000 per panel. The lower-end estimate reflects a panel attached to an exterior wall with exterior conduit conductors. The higher-end estimate reflects when the panel is inserted into a wall with conductors placed inside the wall cavity, and thus would require demolition and repairs to the wall.[25]$3

Estimated Costs for Electric Panel Upsizing- Peninsula Clean Energy

Peninsula Clean Energy's 2035 Decarbonization Plan estimates that the average cost for panel upsizing in San Mateo County is $3,700. Two thirds of 25 total projects were between $1,500 and $5,000.[26] This indicates a somewhat consistent range for two geographic data points in the Bay Area (City of Palo Alto, County of San Mateo) using available data.

Approaches to Reduce Panel Upsizing

There are well-established strategies to avoid panel upsizing, and their associated costs. These strategies include the 'watt diet' approach, and 120-volt equipment, both of which are elaborated upon below.

Watt Diet Approach

Recent studies from Rewiring America, Redwood Energy, and the San Mateo Office of Sustainability have found that whole-home electrification, including electric vehicle charging, induction burners, and electric dryers can be accommodated on a 100 amp panel. Most buildings do not use the whole capacity of their electric panel at any one time. However, accommodating new electric loads on an existing panel sized 100-150 amps is understood to take additional planning, selection of high-efficiency electric appliances, additional efficiency retrofits, and potentially purchase of power

[24] Palo Alto Electrification Final Report (cityofpaloalto.org)

[25] https://www.ethree.com/wp-content/uploads/2023/12/E3_Benefit-Cost-Analysis-of-Targeted-Electrification-and-Gas-Decommissioning-in-California.pdf

[26] https://www.peninsulacleanenergy.com/wp-content/uploads/2022/01/2022.09-BOD-2035-Decarb-Plan-Complete-Analysis-Draft-Plan-1.pdf ; slide deck page 83

sharing devices and load shifting technologies.[27] Examples from the TECH datasets used throughout this analysis of projects completed on 100 amp or less panels are described above in Table 18.

The 'watt diet' approach describes avoided electrical panel upsizing due to the selection of energy-efficient electric appliances (e.g., variable speed HP HVAC), and the use of load sharing devices if needed. Electric vehicle charging is often considered one of the key reasons for upgrading panel sizes but is not covered under Rules 9-6 or 9-4. However, building owners may want to consider panel upsizing as a future investment in charging capacity for electric vehicles. The watt diet approach may also necessitate the use of prioritized circuit sharing devices that can automatically pause car charging while other appliances finish their use, in the case of a building with electric vehicle charging. Cost savings from the watt diet can include both costs to increase electrical panel capacity size, as well as subsequent service upgrades that may be triggered post panel-upgrade.[28]

Table 20 shows current retailer costs for circuit splitters, prioritized circuit sharing devices, and smart panels. Installation costs for these devices were not available and therefore, not included. Although the purchase of these devices does require additional upfront costs, they still could be significantly cheaper than panel upsizing and an accompanying service upgrade.

Table 20 Watt Diet Appliance Costs

Watt Diet Appliance Type	Appliance Description	Total Cost
SPAN Smart Panel	Smart panel allowing for control of circuits based on appliance energy need	$3,500[1]
Leviton Smart Circuit Breaker Box + Whole Home Energy Monitor	Smart panel allowing for turning on and off breakers based on appliance energy need paired with data monitoring app	$358 (whole home energy monitor) $244 (Smart Circuit Breaker)[2]
Eaton Smart Circuit Breaker	Smart energy monitoring & load control	$236[3]
NeoCharge 240 volt Smart Splitter	Smart load shifting tailored to EV charging uses	$399-476[4]

[1] https://www.span.io/panel Available for additional IRA rebates, bringing cost to $2,900

[2] https://store.leviton.com/search?type=product&q=whole+energy+monitor

[3] https://www.homedepot.com/p/Eaton-Smart-Circuit-Breaker-2-Pole-20-Amp-120-Volt-240-Volt-10-kA-Interrupt-Rating-BREM2020/322052158

[4] https://electrek.co/2020/09/04/neocharge-240v-smart-splitter/

Total zero-NOx upgrade projects completed on a 100 amp or lower project without panel upsizing are described below in Table 21. These projects indicate zero-NOx upgrades completed without additional needs for watt diet technologies or panel upsizing.

[27] Source(s): *https://www.smcsustainability.org/energy/decarbonizing-homes/;* https://assets-global.website-files.com/62b110a14473cb7777a50d28/639a356754b8a56402cc37be_SF-Retrofit-Guide-One-Pager-21-08-02.pdf

[28] https://www.redwoodenergy.net/watt-diet-calculator

Table 21 Number of Zero-NOx Upgrade Projects Completed on a 100 amp (or Lower) Panel

Appliance/Building Type	Number of Projects Completed on a 100 amp Panel or Lower	Percent of Total Projects*
HPWH		
Single-family[1]	134	22%
Multi-family[2]	10	19%
HP HVAC**		
Single-family[1]	499	24%
Multi-family[2]	11	29%

Notes: amp = ampere.

[1] Single-family data calculated from TECH Clean California (Single-family) dataset. Data was filtered to only include projects in Bay Area counties, projects that involved a fuel switch (i.e., excluded projects that replaced an electric resistance HVAC), and projects in single-family homes; and filtered to excluded HPWH installations of tank sizes greater than 110 gallons as these are assumed to exceed the size regulated by Rule 9-6 even with up-sizing. Projects that included costs for more than one appliance type, thereby inflating costs, were also excluded.

[2] Multi-family data is calculated from TECH Clean California (Single-family) dataset and TECH Clean California (Multi-family) dataset. TECH Clean California (Single-family) cost data was filtered to only include projects in Bay Area counties, projects that involved a fuel switch (i.e., excluded projects that replaced an electric resistance HVAC), and projects in multi-family homes. Projects that included costs for more than one appliance type, thereby inflating costs, were also excluded. TECH Clean California (Multi-family) cost data was filtered to only include projects in Bay Area counties and projects that involved a fuel switch (i.e., excluded projects that replaced an electric resistance HVAC). All installations are within Rule 9-4's heating and cooling capacity thresholds listed in Table 3. Projects that included costs for more than one appliance type, thereby inflating costs, were also excluded.

* Total projects is filtered to only include projects with information available on panel amperage to remain conservative.

** Splitting HVAC out by ducted and ductless did not yield different results.

120 Volt Equipment

A standard HPWH uses 240 volts, and 30 amps of electrical power. This potential increase in voltage and amperage may necessitate electric wiring and panel upsizing when installing a zero-NOx HPHW. This standard appliance-sizing may require additional electrical work, and potentially, panel upsizing.

120-volt HPWH appliances like Rheem's ProTerra 50-gallon HPWH could be a solution to avoid the costs associated with panel upsizing. This technology development is recent, with Rheem releasing the ProTerra in September of 2022. 120-volt HPWH's do not require new circuits or subsequent electrical panel upsizing as they can be plugged into a standard wall socket. This appliance available from Rheem is expected to be followed by similar models from manufacturers A.O. Smith, General Electric, and Nyle.[29] 120-volt HPWH could also be a promising solution if there are technical or cost barriers to a panel upsizing (e.g. costly electrical service upgrades requiring retrenching).

Incentives for Electric Panel Upsizing

In the instance that an electric panel upsize is unavoidable as the result of zero-NOx appliance installation, there are incentives and rebates available to reduce the cost burden on building owners. These incentives are described for single-family, multi-family, and commercial building stock types in the sections below.

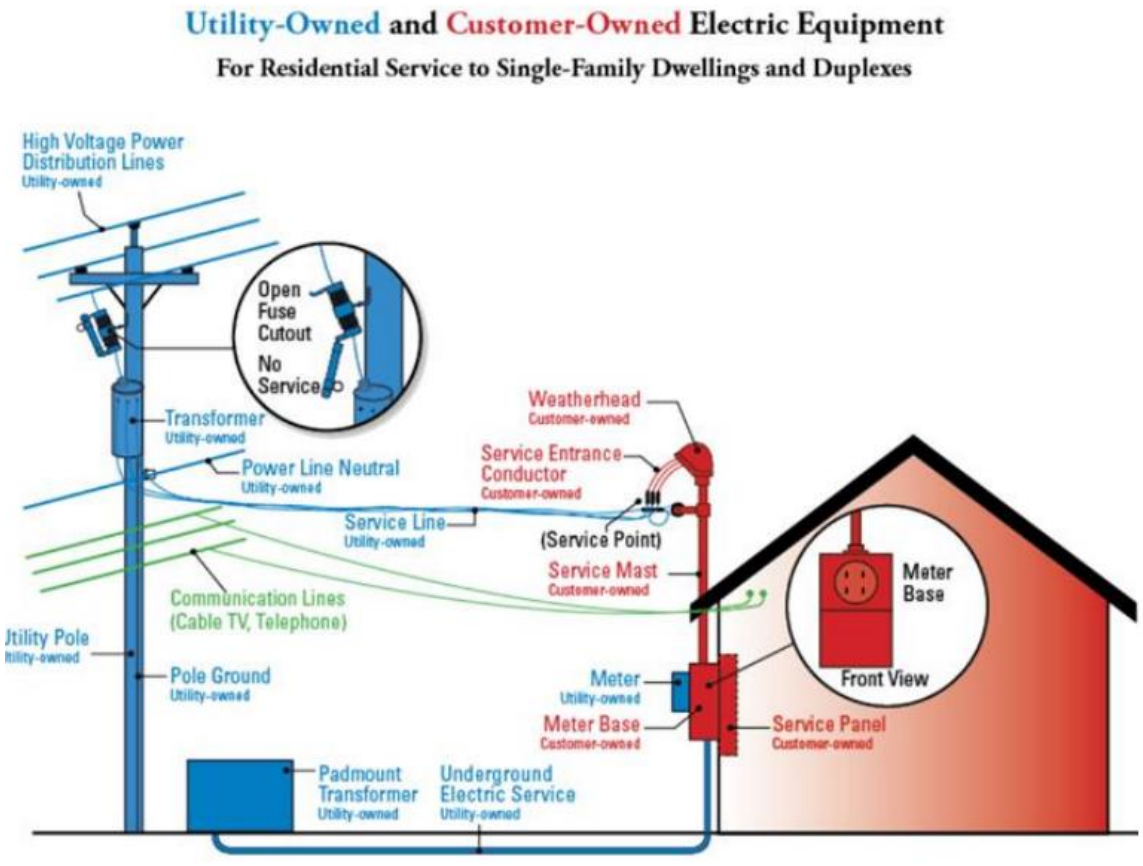
[29] https://www.canarymedia.com/articles/heat-pumps/finally-a-heat-pump-water-heater-that-plugs-into-a-standard-outlet; https://newbuildings.org/new-study-explores-potential-of-120-volt-heat-pump-water-heaters/; https://hotwatersolutionsnw.org/partners/news/120-volt-heat-pump-water-heater-product-overview

6.5 Electrical Service Upgrade Costs

Panel upsizing may also necessitate electrical service upgrades, which require coordination with utilities. PG&E owns and is responsible for constructing, maintaining, and upgrading electrical infrastructure up to the meter panel, while the customer is responsible for everything behind the meter. A diagram of customer vs. utility owned electrical equipment for single-family homes and duplexes is shown below in Figure 3 to visualize which costs will be borne by the customer. In PG&E service areas that characterize much of the Bay Area (with the exception of Publicly Owned Utilities [POU]), this will require going through PG&E's stages of Added Load Process.

According to PG&E, key variables that impact the cost taken on by an individual customer include panel location and its distance from the nearest distribution point, if a single customer is on a transformer (thus taking on the cost of upgrade), as well as the location of the service (above ground or underground). Types of customer costs that could be taken on include necessary trenching, substructure/conduit installation of a new service conductor, and a new protective structure.[30]

Figure 3 Electrical Equipment (Utility vs. Customer Owned)[31]



[30] https://pda.energydataweb.com/api/view/2635/Service%20Upgrades%20for%20Electrification%20Retrofits%20Study%20FINAL.pdf; - https://www.oaklandca.gov/topics/service-upgrades-for-electrification-retrofits

[31] PG&E presentation to City of Oakland https://cao-94612.s3.us-west-2.amazonaws.com/documents/Workshop-Slides-09.28.22-Final.pdf

Electric Service Upgrade Costs

Distribution service upgrade costs were derived using PG&E estimated costs based on three candidate sites in the East Bay for targeted electrification. As part of a California Energy Commission (CEC) research project, PG&E provided estimates that electric service upgrade costs would range from $10,000 to $60,000 per customer based on their evaluation of three communities in the East Bay. The low end of this range would apply when overhead electric services are short in distance with minimal connections, and the high end would describe circumstances where significant underground trenching is required. Residential customers receive a ratepayer-funded allowance of $3,255 borne by electric ratepayers, with the customer responsible for paying the remainder.[32] More generally, PG&E reports a range of between $1,000 and greater than $8,000 for overhead service upgrades and between $1,000 and over $20,000 for underground service upgrades as shown in Figure 4.

Primary Electric Distribution Costs

Primary electric distribution costs reflect upstream distribution costs at the level of the distribution substation or feeder have considered the impact of building electrification on electric distribution system costs.

Two recent studies have considered the impact of widespread electrification on electric distribution system costs. The first study is by researchers from UC Berkeley and is published in the peer-reviewed journal *Environmental Research: Infrastructure and Sustainability*.[33] The second study is by the firm Kevala and was prepared for the California Public Utilities Commission.[34] Both studies found that building electrification is likely to drive relatively small costs on the electric distribution system, while vehicle electrification will be responsible for much more significant distribution-system cost impacts.

PG&E's Distribution Deferral Opportunity Report provides an indication of the cost of [34] Individual distribution-system investments and the number of customers served by each investment.[35] While this report does not reflect a high electrification scenario per se, it provides a useful indication of the cost of primary distribution investments where they are needed. PG&E's 2021 Distribution Deferral Opportunity Report provides details on 70 planned distribution investments across the Bay Area. The costs of these investments vary widely but have a mean of $2,200 per customer and median of $1,000 per customer served by these projects.

Final Line Transformer Costs

Final line transformer (either pad mounted or pole mounted) costs include costs of final line transformer upgrades triggered by electrification. In the CEC research described above, PG&E distribution engineers provided cost estimates for the three neighborhood-scale electrification projects in the East Bay. The average costs for these three sites was $1,033/customer.

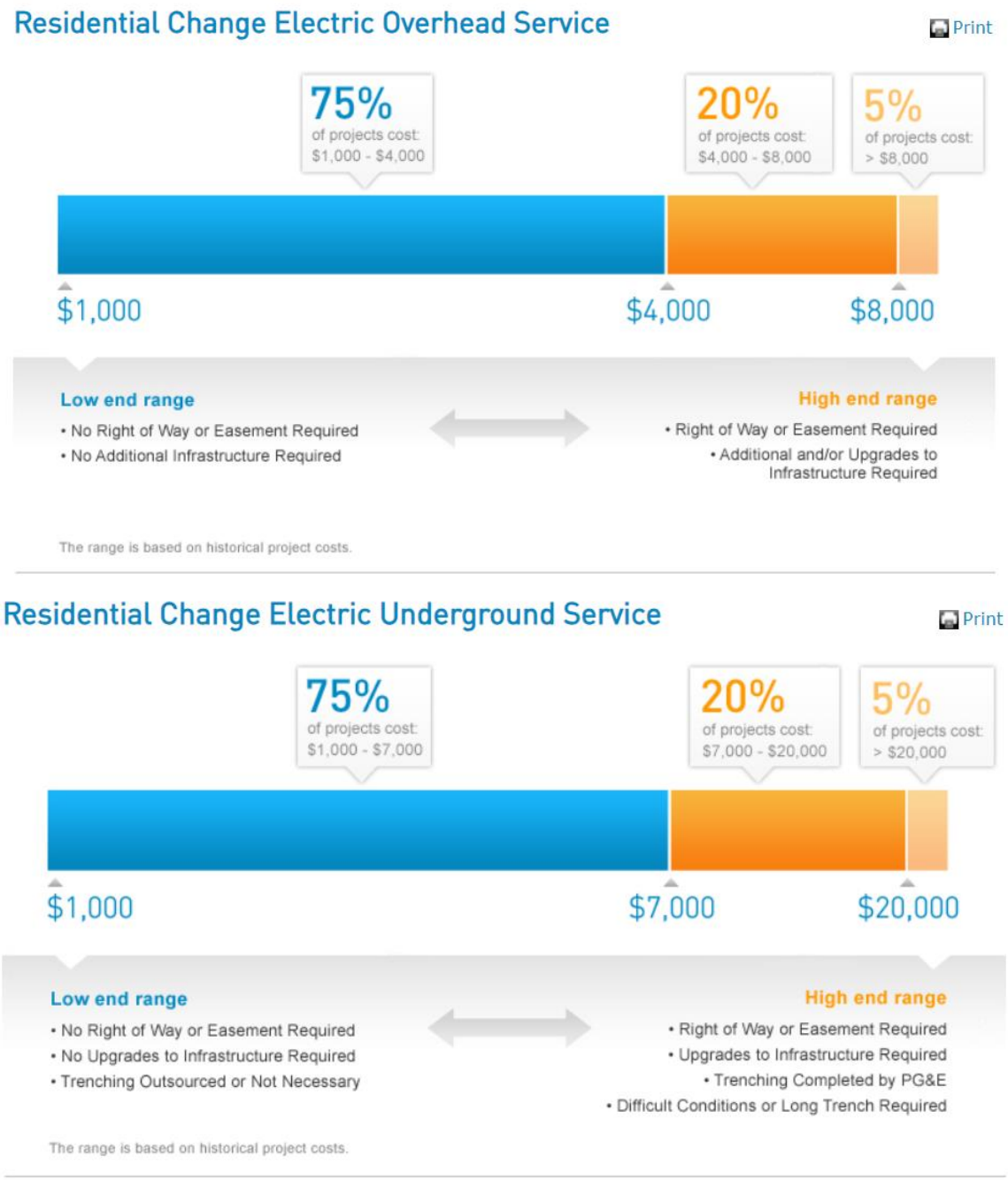
[32] https://www.ethree.com/wp-content/uploads/2023/12/E3_Benefit-Cost-Analysis-of-Targeted-Electrification-and-Gas-Decommissioning-in-California.pdf

[33] https://iopscience.iop.org/article/10.1088/2634-4505/ac949c/meta

[34] https://docs.cpuc.ca.gov/PublishedDocs/Efile/G000/M508/K423/508423247.PDF

[35] PG&E 2021 DDOR

Figure 4 PG&E Historic Service Upgrade Costs[36]



[36] https://www.pge.com/en/myhome/customerservice/other/newconstruction/projectcosts/results.page?serviceType=electric_over&gasType=&electricOverType=elec_over_change&electricUnderType=elec_under_change&pevType=&proj=elec_over_change

7 Incremental Costs

7.1 Single-Family Homes

Due to data limitations, incremental costs are calculated only for zero-NOx appliances in single-family homes. Single-family homes are generally classified as under five units. There are no incremental costs calculated for the commercial sector, or for multi-family buildings (five units or more) due to data limitations. There was also no cost data available to assess upfront costs for zero-NOx appliances in commercial buildings.

Average upfront costs for appliance replacement were used to calculate incremental costs for zero-NOx appliance replacements without additional application of incentives or rebates.[37] Sections below will detail federal, state, regional, and local incentives for the electrification of space and water heating.

Incremental Upfront Costs for Zero-NOx Appliances

Table 22 describes the incremental costs to install zero-NOx electric HPWHs in the Bay Area to replace an existing NOx emitting gas water heater. Using average costs from across the Bay Area, zero-NOx appliance installation for electric HPWH in single-family homes costs between **$1,840 and $3,496** more than a 'like-for' like gas appliance replacement.

Table 22 Incremental Upfront Costs for Zero-NOx HPWH

Average Upfront Cost: NOx Emitting Appliances	Average Upfront Cost: Zero-NOx Appliances	Incremental Cost
Tankless and Tanked Water Heater Data		
$5,231	$7,071	$1,840
Tanked Only Water Heater Data		
$3,575	$7,071	$3,496

Table 23 describes the incremental costs to install a zero-NOx electric HP HVAC in the Bay Area to replace a NOx emitting gas furnace. This cost analysis applies to building owners who did not want to install air conditioning and had to install an HP HVAC with both heating and cooling functions to replace a NOx emitting space heating appliance. Incremental costs are shown for both ducted and ductless HP HVACs, as duct system type is a major upfront cost variable. Using average costs from across the Bay Area, zero-NOx appliance installation for electric HP HVACs in single-family homes costs **$14,061** more than a 'like-for' like gas appliance for ducted HP HVAC, and **$10,755** for ductless HP HVAC.

[37] Incremental costs = Zero-NOx Costs – NOx Emitting Costs

Table 23 Incremental Upfront Costs for Zero-NOx HP HVAC

Baseline Upfront Cost (NOx Emitting Appliance) – Gas Furnace	Replacement Upfront Cost (Zero-NOx Appliance)– Electric HP HVAC	Incremental Cost
Ducted HP HVAC		
$6,347*	$20,408	$14,061
Ductless HP HVAC		
$6,347*	$17,122	$10,755

Notes:

* Gas furnaces could not be disaggregated for duct/ductless base cases, so one base case value is used across both scenarios.

Incremental costs equal zero-NOx upfront costs minus NOx emitting upfront costs.

Role of Air Conditioning in Reducing Incremental Costs for Zero-NOx HP HVAC

Zero-NOx HP HVACs perform both heating and cooling functions, displacing the need to have both a furnace and air conditioner. This means that if the building owner wanted to install air conditioning, installing a single HP HVAC would displace the costs of both a NOx emitting gas furnace and an air conditioning, producing cost savings (or avoided costs) equal to the entire cost of a new air conditioning unit. As over 47% of the 1.7 million households in the San Francisco metropolitan area (including Oakland and Berkeley) have air conditioning, the role of air conditioning is a relevant factor for this analysis.[38]

According to an Angi's list estimate based on project costs for the Bay Area, the normal range for San Francisco building owners to install a ducted air conditioning unit with air distribution via fans or ductwork ranges from $5,035-$11,211. Angi's list estimates that a portable air conditioning unit would cost $100-$500, a window air conditioning unit would cost $150-$800, and a top-of-the-line ductless split system could cost $600-$20,000. The average cost to install a central air conditioning unit referenced throughout this report is $8,106.[39] As with all costs for appliance installation analyzed in this whitepaper, cost ranges and averages will likely vary by incentive provider.

When factored into this analysis, average avoided air conditioning costs of $8,106 lower the incremental costs of replacing a NOx emitting gas furnace with a zero-NOx HP HVAC to $2,669 and $5,955 for ductless and ducted systems, respectively, in single-family homes in the Bay Area. Table 24 details the results of incorporating avoided air conditioner costs in the incremental cost analysis.

[38] https://www.census.gov/programs-surveys/ahs/data/interactive/ahstablecreator.html?s_areas=41860&s_year=2021&s_tablename=TABLE3&s_bygroup1=1&s_bygroup2=1&s_filtergroup1=1&s_filtergroup2=1

[39] https://www.angi.com/articles/how-much-does-installing-new-ac-cost.htm

Table 24 Incremental Upfront Costs for Zero-NOx HP HVAC with Air Conditioning

Baseline Upfront Cost (NOx Emitting Appliance) – Gas Furnace	Replacement Upfront Cost (Zero-NOx Appliance)– Electric HP HVAC	Incremental Cost	Avoided Air Conditioning Cost	Incremental Cost with Avoided Air Conditioning Costs
Ductless HP HVAC				
$6,347*	$17,122	$10,755	$8,106	$2,669
Ducted HP HVAC				
$6,347*	$20,408	$14,061	$8,106	$5,955

Notes:

* Gas furnaces could not be disaggregated for duct/ductless base cases, so one base case value is used across both scenarios.

Incremental costs equal zero-NOx upfront costs minus NOx emitting upfront costs. Incremental costs with avoided air conditioning costs equal zero-NOx upfront costs minus NOx emitting upfront costs minus avoided air conditioning costs.

8 Currently Available Incentives & Rebates[40]

8.1 Overview of Incentives & Rebates for Zero-NOx Appliances

There are significant incentives for the installation of HPWH and HP HVAC available at the federal level (Inflation Reduction Act [IRA]), State level (TECH Clean California) regional level (BayREN), and community choice aggregator (CCA) and POU level throughout the Bay Area.

The total funding amount by program, and sunset date/funding refresh update cycle will impact the amount of funds available to subsidize zero-NOx appliance upgrades. It should be assumed that all CCA/POU funds can change, potentially multiple times per year, and so are not further described in Table 25. This total amount of funding is consequential as it can only cover the incremental cost of a limited number of heat pump installations throughout the State. For example, all available federal funding from High Efficiency Electric Home Rebate (HEEHRA) and Homeowner Managing Energy Savings (HOMES) through 2032 could only cover the incremental cost of about 41,200 ducted HP HVAC upgrades throughout California.[41]

To give a sense of the funding amounts, and longevity of each fund, the larger federal, state, and regional funds, sunset dates, and availability windows as of January 2024 are summarized in Table 25 below.

Table 25 Total Funds & Funding Update Schedules (IRA; TECH; BayREN)

Program Name	$ Available	Funding Update Schedule/Sunset Date
Federal		
HEEHRA and HOMES Rebate Program	$528 million available to the State of California for both funds[1]	Available 2024, already allocated to State to be distributed by state energy offices 10-year rebate program or until funds run out [Sunset date: 2032][2]
State		
TECH Clean California	Single-family residential HP HVAC - $22 million incentive budget statewide Multi-family residential: $7 million statewide Commercial: $4.23 million statewide[3]	Funding availability has varied since program authorization by SB 1477 in 2018. Suspended multiple times due to budget exhaustion. Requires annual budget approval allocated through CPUC[4]
Regional		
BayREN Home + (single-family rebates) & BAMBE (multi-family rebates)	2022 reported HOME+ operating budget: $11 million 2022 reported BAMBE budget: $ 5 million	Funds allocated through CPUC, funding availability updated not infrequently at discretion of BayREN in connection to funding availability through programs like TECH Clean California[5]

[40] Incentives reflect available incentives as of November/December of 2023.

[41] Referencing an incremental cost of $14,101 for ducted HP HVAC

Program Name	$ Available	Funding Update Schedule/Sunset Date

1. https://www.energy.ca.gov/programs-and-topics/programs/inflation-reduction-act-residential-energy-rebate-programs-california#:~:text=More%20than%20%24582%20million%20is,program%20development%20in%20late%202023
2. https://www.rewiringamerica.org/policy/high-efficiency-electric-home-rebate-act
3. https://techcleanca.com/incentives/
4. https://techcleanca.com/about/#:~:text=and%20disadvantaged%20communities.-,Funding,%2472%20million%20reserved%20for%20incentives.; https://buildingdecarb.org/tech-clean-california-incentives-relaunch-to-help-california-homeowners-electrify
5. https://www.bayren.org/about/how-we-work; https://www.bayren.org/news/bay-area-regional-energy-network-announces-rebate-adjustments; https://www.bayren.org/sites/default/files/2023-05/BayREN%20AR%2011x17.pdf

Excluded Rebates & Incentives

This analysis does not include rebates for whole-home electrification, or rebates that could not be combined with state or federal incentives. Excluded incentives include Golden State Rebates,[42] which cannot be combined with other third-party incentive/rebate programs funded by CPUC Public Goods Charge funds (BayREN). However, Golden State Rebates can be stacked with funding sources including IRA and HEEHRA. Golden State Rebates were ultimately excluded from the final list of rebates to establish a conservative scenario for available incentives.

Several programs including TECH Clean California Multi-family Incentives were in the process of updating their funding portfolio during the writing of this memo and did not have available incentive information, so are also excluded. It should be noted that State (TECH Clean California), Regional (BayREN), and local (CCA) incentives change frequently at the discretion of the funder.

BayREN funding for fuel switching from gas to electric appliances is only available for PG&E customers that pay into electric rates and gas rates. Accordingly, BayREN incentives for zero-NOx appliances are not available for customers of POUs that have their own electric service including Alameda Municipal Power, SVCE, City of Palo Alto Utilities, CPSF, and the City of Healdsburg (Healdsburg Electric).[43]

Income-Qualified Rebates for Zero-NOx Space and Water Heating

Funding is organized according to three different Area Median Income (AMI) tiers that will impact future availability of federal point-of-sale rebates through the High-Efficiency Electric Homes and Rebates Act (HEEHRA), which is a program passed under IRA. As IRA and HEEHRA funding is expected to be one of the most long-term, stable sources of funding for electrification, it is used as the primary organizing factor for rebates for electrification.[44] AMI tiers are described below.

- Low-income: <80% AMI
- Moderate-income: 80-150% AMI
  - Low- and moderate-income (LMI) spans both categories and is used to refer to both low-income and moderate-income categories
- Moderate- and high-income: >150% AMI

[42] PG&E funded program for retailer (e.g., Lowes, Home Depot) coupons could not be combined with other incentives. See No. 16 of terms and conditions: https://goldenstaterebates.com/goldenstaterebates/rebates/terms-conditions/

[43] BayREN correspondence, 12/2023. https://www.BAYREN.org/multi-family-property-owners/building-improvements. Electric only POUs include: Alameda Municipal Power, Silicon Valley Power, and Healdsburg Electric. Palo Alto Utilities includes gas and electric services.

[44] The Home Owner Managing Energy Savings (HOMES) program under IRA allocates funding for whole-home retrofit packages, and goes beyond BAAQMD regulated end-uses, so is not included here.

Single-Family vs. Multi-family Classification

Incentives are also categorized by the type of building that is served. Many CCA funders like Peninsula Clean Energy have funding available for those on residential electric rates across building types. Rebates can span both single and multi-family buildings, provided the ratepayer is on a residential rate. Other funders, like Electrify Marin specific building type for eligibility of rebates for electrification. Generally, incentives that specify building-specific electrification classify single and multi-family buildings as follows:

- Single-Family: less than 5 units
- Multi-family: 5 units or more

Incentives Without Income Requirements [Sunset Date: 2032]

IRA Tax Credit

Tax credits under the energy efficient home improvement credit are set to be in effect from 2022 to 2032, and cover the following zero-NOx appliance installation categories.[45] The tax credit is capped at $2,000 for both appliances per year. To take advantage of the full tax credit for both years, HPWH and HP HVAC replacements would have to happen on separate years. This is a likely scenario given that most building owners will replace appliances one-by-one as they fail.

- 30% of Costs for HPHW, up to $2,000 (Tax Credit)
- 30% of Costs for HP HVAC, up to $2,000 (Tax Credit)

These rebates are available for all income brackets, including LMI income brackets that have additional upfront rebates through HEEHRA. For LMI income brackets, these tax credits will stack with HEEHRA rebates.[46] It should be noted that only individuals/households with a tax burden will be able to access tax rebates. Furthermore, the tax rebates are capped at $2,000 total per year. So a homeowner could not apply it to a HPWH and HP HVAC in the same year. For this analysis, it is assumed that each appliance would be replaced in different years to capitailze on the full IRA incentives.

State, Federal, and Local Incentives with Income Requirements

Most rebates are available without specific income requirements unless otherwise specified (e.g. California Alternate Rates for Energy [CARE] and Family Electric Rate Assistance [FERA] rate customers) by the incentive provider. Income requirements under HEEHRA are an important exception, as described below.

The Home Owner Managing Energy Savings (HOMES) rebate program is another Federal program awarded from the Department of Energy to state energy offices to provide rebates to homeowners and aggregators for whole-house energy savings retrofits. HOMES' implementation window begins on the date of enactment of the IRA and must be completed by September 30, 2031. HOMES allocates rebates based on modeled energy savings (%) resulting from retrofits, covering up to 80%

[45] IRS Fact Sheet: Frequently asked questions about energy efficient home improvements and residential clean energy property credits (2022): https://www.irs.gov/pub/taxpros/fs-2022-40.pdf

[46] The 25C federal tax credit can be combined with HEEHRA rebates, though it is still unclear if it can be combined with the HOMES rebate program
https://building-performance.org/bpa-journal/10-key-contractor-takeaways-from-does-new-ira-rebate-guidelines/#:~:text=Modeled%20HOMES%20rebates%20can%20be,with%20the%20HOMES%20rebate%20program

of the project cost based on project cap thresholds for projects ranging from $2,000-$8,000. HOMES rebates cannot be combined with IRA and HEEHRA electrification upgrades for the same project, though two programs could be stacked for different upgrades within the same project (e.g. new weatherization + heat pump installation). Information available about the HOMES program is currently limited. Although certain heat pump retrofit projects could potentially meet the energy savings threshold of 15-35% of total modeled energy system savings, details of financing available for heat pump installation would vary from building to building, and still have uncertain guidelines around 'stacking' with other incentives sources. For this reason, HOMES is not included as an additional source of incentives in this analysis.[47]

Income-Requirement Incentives under HEEHRA [Sunset Date: 2032]

The High-Efficiency Electric Homes and Rebates Act (HEEHRA) (Section. 50122, page 583), passed as part of the 2022 IRA appropriates billions of dollars through FY2031 aimed at serving LMI households with rebates for zero-NOx HPWHs and HP HVACs.[48] HEEHRA rebates take the form of point-of-sale rebates for the purchase and installation of qualified Energy Star appliances.

Funds for consumers under HEEHRA are capped at $14,000 per consumer, and $500 for each contractor. This overall incentive cap includes zero-NOx appliances for space and water heating regulated by BAAQMD rules, but also includes clothes dryers, and electric wiring. HEEHRA rebates have been allocated to California, with rebates expected to become available in 2024. Exact details of funding availability via HEEHRA may need to be revisited upon release of final details by the CEC/U.S. Department of Energy.[49]

- Low-income: <80% AMI
  - 100% costs covered including installation
    - $8,000 HP HVAC (maximum)
    - $1,750 for HPWH (maximum)
- Moderate-income: 80-150% AMI
  - 50% of costs covered including installation
    - $8,000 HP HVAC (maximum)
    - $1,7500 for HPWH (maximum)

This analysis also includes rebates for electric panel upsizing, as it is considered as a potential cost associated with zero- NOx appliance installation.

Due to relatively higher installation costs in the Bay Area documented in this analysis, HEEHRA incentives are expected to be maxed out to the appliance cap-level for zero-NOx space and water heating regardless of LMI category. Costs to upgrade electric panels are the only document exception where the incentive maximum will not cover the entirety of 50% of the project costs available to moderate-income households as shown below in Table 26. This also indicates that

[47] https://www.rewiringamerica.org/app/ira-calculator/information/whole-home-energy-reduction-rebates; https://www.energy.gov/sites/default/files/2023-07/Home_Energy_Rebates_Program_Requirements_and_Application_Instructions.pdf; https://iratracker.org/programs/ira-section-50121-home-energy-efficiency-rebate-program/; https://iratracker.org/actions/doe-announces-allocations-for-home-energy-rebate-program/

[48] https://www.rewiringamerica.org/policy/high-efficiency-electric-home-rebate-act

[49] https://www.energy.ca.gov/programs-and-topics/programs/inflation-reduction-act-residential-energy-rebate-programs-california

HEEHRA rebates designed to cover 100% of project costs for low-income households will not cover all project costs due to high costs for appliance installation found across the Bay Area.

Table 26 HEEHRA Income Limits vs. Projected Project Cost in the Bay Area

Zero-NOx Appliance	100% of Average Upfront Cost – Low-income Household	50% of Average Upfront Cost – Moderate-income Households	HEEHRA Incentive Maximum – LMI Households
HPWH – Single-family	$7,071	$3,536	$1,750
HPWH – Multi-family	$8,939	$4,470	$1,750
Ductless HP HVAC	$17,122	$8,561	$8,000
Ducted HP HVAC	$20,408	$10,204	$8,000
Electric Panel Upsize[1]	$3,700	$1,850	$4,000

Notes: LMI = Low- and moderate-income households.

1. Peninsula Clean Energy estimate from 2035 Decarbonization Plan

When incentives are included in the incremental costs below, it is assumed that for all cases except for electric panel upsizing, both low and medium income brackets will be able to claim 100% of the maximum HEEHRA rebates.

Data for existing rebates and incentives were collected from most recent online sources as made available by funder at the time of writing this whitepaper. The only appliance type subsidized for space and water heating are heat pumps, as they significantly outperform their electric resistance counterparts on energy efficiency and therefore, bill impacts. Though some incentives are available to switch from electric resistance to heat pump appliances, the only incentives referenced here reflect incentives available for fuel switching from gas appliances to zero-NOx HPWH and HP HVAC.

The total amount of HEEHRA funding available to California is limited to about $290 million through 2031, though it is not yet clear how long these rebates will be available before they are exhausted.

Gaps in Incentive Landscape

Gaps in existing incentives include financing for any space or water heating appliances that are not a HP HVAC or HPWH, such as space and water heaters that may be needed for very small spaces (e.g., on-demand electric water heaters, portable air conditioners + heat pumps).

Definitions of electric panel upsizing vary between funders. While IRA programs also can cover wiring improvements associated with panel upsizing, most incentive programs appear to only cover panel and subpanel upsizing with requirements for amperage, but not new circuitry or wiring (e.g. Peninsula Clean Energy). IRA programs, and a handful of POU/CCAs also incentivize smart panels (e.g. SPAN smart panels) and load sharing devices to avoid panel upsizing. However, it appears that incentives for load shifting and smart panels are not included as an incentive by most funders. These funder-specific definitions for panel upsizing and electrical work require a location-by-location understanding of available incentives.[50]

[50] https://guidehouseinsights.com/news-and-views/the-ira-a-boost-for-smart-homes; https://www.peninsulacleanenergy.com/wp-content/uploads/2022/09/Peninsula-Clean-Energy-Appliance-Rebates-Terms-Conditions_10.01.22.pdf; https://www.rewiringamerica.org/app/ira-calculator/information/electrical-panel; https://www.siliconvalleypower.com/residents/rebates-6214

Incentive gaps also are described by geography- not every CCA or POU offers additional rebates for electrification. Building owners who are customers of CCAS or POUs that do not offer additional rebates will thus experience fewer cost savings to install zero-NOx appliances.

On a geographic/CCA level, some of the Bay Area's most populous regions do not have access to single-family incentives for water heating electrification. Both the parts of the City and County of San Francisco served by CPSF, and Alameda County via AVA, which encompasses the City of Oakland, do not currently have access to additional local/utility provider resources to install zero-NOx HPWH and HP HVAC.

The following section summarizes single-family home incentives for all zero-NOx appliances for space and water heating.

8.2 Single-Family Incentives for Zero-NOx Appliances and Associated Infrastructure

Table 27 describes rebates and incentives available for zero-NOx electric HPWHs, HP HVAC, and panel/wiring upgrades across the Bay Area from Federal (IRA, HEEHRA), State (TECH Clean California), and regional (BayREN) sources.

Many incentive structures also have adders for whole-home electrification and CARE, which is a program for low-income customers that receive a 30-35 percent discount on their electric bill and 20 percent on the natural gas bill. CARE is income qualified or qualified via enrollment in a public assistance program (e.g., CalFresh/SNAP). The FERA program also discounts electricity rates for low-income customers.

However, as these programs' income requirements and eligibility differ from the HEEHRA AMI requirements, they are not included in this final incremental cost minus incentives analysis.

Table 27 Bay Area Single-family Incentives for Zero-NOx HPWH; HP HVAC; Panel Upsizing

Funder + Rebate	$ Amount	Technology Incentivized	Accessibility for LMI Households	Notes on Availability
Incentives for Zero-NOx HPWH				
Stackable Incentives – Bay Area Wide				
HEEHRA- Rebate	$1,750	HPWH	IRA – Moderate-income (80-150% AMI) 50% of costs covered up to given amount. Low-income (<80% AMI) covers 100% of costs up to same cap.	$ amount reflects maximum cap: $1,750
IRA – Tax Credit	$2,000	HPWH	Not income qualified	Tax Credit (25C): 30% tax credit for heat pumps and water heaters, capped at $2,000/year for both appliances
TECH Clean California – General Market	$3,100	HPWH	Additional equity incentives available if: live in single-family low-income residences; have household income which is 80% of the	First come first serve.

Funder + Rebate	$ Amount	Technology Incentivized	Accessibility for LMI Households	Notes on Availability
			AMI; and have participated in programs which verify income at ≤80% AMI or ≤250% of federal poverty level (FPL). Note additional $700 available for >= Gallon Capacity Initiative	
TECH Clean California- Equity Incentives	$4,185	HPWH	Single-family homes <80% AMI At or below 250% of Federal Poverty Level Note additional $700 available for >= Gallon Capacity Initiative	N/A
BayREN	$400	HPWH	Unified energy factor (UEF) ≥ 3.30 (All tank sizes).	Stackable only for PG&E customers. POU customers excluded
Local Incentives: CCAs and POUs				**Incentives subject to change**
MCE	$1,000	HPWH	N/A	Contra Costa, Marin, Napa, Solano [counties]. Must be MCE Customer
Electrify Marin	$500	HPWH	$2,000 rebate for income qualified rebate – very low-income AMI threshold.	County of Marin Collaborator of MCE, Run by County of Marin Community Development Agency
Peninsula Clean Energy	$2,000	HPWH	Additional rebate available for CARE/FERA customers $1,000/ heat pump appliance.	San Mateo County resident, Peninsula Clean Energy customer.
SVCE	$2,000	HPWH	Additional rebate available for CARE/FERA customers $1,000/ heat pump appliance.	Campbell, Cupertino, Gilroy, Los Altos, Los Altos Hills, Los Gatos, Milpitas, Monte Sereno, Morgan Hill, Mountain View, Saratoga, Sunnyvale, Unincorporated Santa Clara County. SVCE Account in good standing.
AVA	$0	N/A	No additional rebates for HPHW available	N/A
Sonoma Clean Power	$700	HPWH	$5,000 additional rebate for CARE/FERA customers	County of Sonoma SCP Residential Account
Alameda Municipal Power	$1,500	HPWH	N/A	City of Alameda Alameda Municipal Power account holder
Silicon Valley Power	$0	HPWH	N/A	City of Santa Clara Only available for electric resistance heater
City of Palo Alto Utilities	$1,500	HPWH	N/A	$1,500 cap- real incentive may be lower. City of Palo Alto

Funder + Rebate	$ Amount	Technology Incentivized	Accessibility for LMI Households	Notes on Availability
				City of Palo Alto Utility Account Holder
CPSF	$0	N/A	No additional rebates for HPHW available	N/A
City of Healdsburg	$1,500	HPWH	N/A	City of Healdsburg; Healdsburg Electric Account Holders
Incentives for Zero-NOx HP HVACs				
Stackable Incentives – Bay Area Wide				
HEEHRA- Rebate	$8,000	HP HVAC	IRA – Moderate-income (80-150% AMI) have 50% of costs covered up to given amount. Low-income (<80% AMI) covers 100% of costs up to same amount	$ amount reflects maximum Cap: $8,000
IRA – Tax Credit	$2,000	HP HVAC	Not income qualified	Tax Credit (25C): 30% tax credit for heat pumps and water heaters, capped at $2,000/year for both appliances
TECH Clean California – General Market	$1,000	HP HVAC	Note no TECH equity rate for HP HVAC	First come first serve.
BayREN	$400	HP HVAC	Unified energy factor (UEF) ≥ 3.30 (All tank sizes).	N/A
Local Incentives: CCAs and POUs				**Incentives subject to change**
MCE	$0	HP HVAC	N/A	Contra Costa, Marin, Napa, Solano [Counties]. Must be MCE Customer. Incentives provided through Electrify Marin instead.
Electrify Marin	$500	HP HVAC	$2,000 rebate for income qualified rebate – very low income AMI threshold.	County of Marin Collaborator of MCE, Run by County of Marin Community Development Agency
Peninsula Clean Energy	$2,500	HP HVAC	Additional rebate available for CARE/FERA customers $1,000/ heat pump appliance.	San Mateo County resident, Peninsula Clean Energy customer.
SVCE	$2,500	HP HVAC	Additional rebate available for CARE/FERA customers $1,000/ heat pump appliance.	Campbell, Cupertino, Gilroy, Los Altos, Los Altos Hills, Los Gatos, Milpitas, Monte Sereno, Morgan Hill, Mountain View, Saratoga, Sunnyvale, Unincorporated Santa Clara County. SVCE Account in good standing.
AVA	$0	HP HVAC	No additional rebates for HPHW available	N/A

Funder + Rebate	$ Amount	Technology Incentivized	Accessibility for LMI Households	Notes on Availability
Sonoma Clean Power	$1,000	HP HVAC	$5,000 additional rebate for CARE/FERA customers	County of Sonoma SCP Residential Account
Alameda Municipal Power	$1,500	HP HVAC	No additional rebates for HP HVAC Available	City of Alameda Alameda Municipal Power account holder
Silicon Valley Power	$0	HP HVAC	No additional rebates for HP HVAC Available	City of Santa Clara
City of Palo Alto Utilities	$0	HP HVAC	No additional rebates for HP HVAC Available	City of Palo Alto City of Palo Alto Utility Account Holder
CPSF	$0	HP HVAC	No additional rebates for HP HVAC Available	N/A
City of Healdsburg	$2,000	HP HVAC	N/A	City of Healdsburg; Healdsburg Electric Account Holders
Incentives for Electric Panel Upsizing & Wiring				**Note no BayREN or Tech incentives for panel or wiring**
Stackable Incentives – Bay Area Wide				
HEEHRA- Rebate	$4,000	Electric Panel Upsizing	IRA – Moderate-income (80-150% AMI) 50% of costs covered up to given cap Low-income (<80% AMI) covers 100% of costs up to same cap	$ amount reflects maximum Cap: $8,000 Total cap of $14,000
HEEHRA- Rebate	$2,500	Wiring and Circuits	IRA – Moderate-income (80-150% AMI) 50% of costs covered up to given amount. Low-income (< 80% AMI) covers 100% of costs up to same cap	$ amount reflects maximum Cap: $8,000 Total cap of $2,500
IRA – Tax Credit	$600	Electric Panel Upsizing	Not income qualified	Tax Credit (25C): 30% tax credit for heat pumps and water heaters, capped at $2,000/year for both appliances
Local Incentives: CCAs and POUs				**Incentives subject to change-only incentive providers with rebates for panels and wiring included.**
Electrify Marin	$250	Electric Panel Upsizing	$1,000 rebate for income qualified rebate – very low income AMI threshold.	County of Marin Collaborator of MCE, Run by County of Marin Community Development Agency
Peninsula Clean Energy	$1,000	Electric Panel Upsizing	N/A	San Mateo County resident, Peninsula Clean Energy customer.
SVCE	$1,000	Electric Panel Upsizing	N/A	Campbell, Cupertino, Gilroy, Los Altos, Los Altos Hills, Los Gatos, Milpitas, Monte

Funder + Rebate	$ Amount	Technology Incentivized	Accessibility for LMI Households	Notes on Availability
				Sereno, Morgan Hill, Mountain View, Saratoga, Sunnyvale, Unincorporated Santa Clara County. SVCE Account in good standing.
Alameda Municipal Power	$2,500	Electric Panel Upsizing	N/A	City of Alameda Panel upsizing to 200 amps or greater
Silicon Valley Power	$2,000	Smart Panel Upsizing	Bonus rebate of $1,000 for LIHEAP customers	City of Santa Clara Panel upsizing of 100 amps or greater

Notes: N/A = not available.

* Total whole-home electrification cap for HEEHRA: $14,000. There are a number of 'full home electrification rebates' (e.g., California Energy Smart Homes) that are excluded from this analysis. Golden State Rebates also include instant rebate coupons $500-900 for fuel switching to HPWHs but is not considered 'stackable' with other third-party rebates so not included here

8.3 Multi-family Incentives & Rebates [5+ Units]

Multi-family incentives generally mirror the incentives available for single-family home electrification. A handful of incentives (e.g. BayREN's BAMBE Program; TECH Clean California) target space heating/cooling and water heating for multi-family buildings specifically, but most multi-family incentives offered by CCAS apply the same incentives for single-family homes and multi-family, assuming the account holder is listed as a residential rate. Multi-family home electrification could happen at the unit level, or whole-building (central) level depending on system. In certain cases (e.g. BayREN), if appliance replacement is happening in a 2–4 unit low-rise multi-family level the building owner can apply to the single-family rebate. BayREN rebates are not available to POU customers.

Potentially because of the large variability and process loads of multi-family homes, many existing incentive structures for multi-family buildings target overall energy efficiency, not appliance replacement (e.g. MCE, IRA Home Efficiency Project). These incentives are not included in this analysis as they are not specifically targeted to the appliances regulated by BAAQMD.

These energy efficiency incentives nonetheless warrant a brief description as degraded LMI housing stock is a significant equity issue. Buildings that require basic maintenance work would also require weatherization and energy efficiency measures in order to cost effectively retrofit NOx emitting appliances with zero-NOx appliances.[51] A brief description of these programs and overall program budget is included in the table below.

At the time of writing this whitepaper, multi-family incentives for unitary and central HPWH through TECH Clean California were unavailable and being updated by the funder.[52] IRA and HEEHRA funding

[51] Poor building envelope insulation, leaky HVAC ducts, and presence of asbestos in older/ degraded housing stock have been named as a challenge in zero-NOx retrofits by the Berkeley Existing Buildings Electrification Strategy, City of Sacramento Existing Buildings Electrification Strategy [Draft]. https://www.cityofsacramento.org/-/media/Corporate/Files/CDD/Planning/General-Plan/2040-General-Plan/Draft-Existing-Building-Electrification-Strategy.pdf?la=en; https://berkeleyca.gov/sites/default/files/2022-01/Berkeley-Existing-Buildings-Electrification-Strategy.pdf

[52] https://techcleanca.com/incentives/multi-family-information/

for single-family homes also extends to multi-family buildings, if 50% of the multi-family is classified as LMI. The IRA Home Efficiency Project also provides incentives of up to 80% of project costs of up to $400k for a multi-family building for a multi-family building provided that the project has 35% predicted energy savings. However, as this incentive funding does not specific appliance type, it is not included here for reference only.[53]

Table 28 Describes funding available at the federal and local (BayREN) region for electrification of water heating across the entirety of the Bay Area's 9 counties. It also includes CCA and POU funding available at the local level, as available. Unless the funder allows for any residential customer to access funding, or explicitly named a multi-family program, it was assumed that local funder incentives at the appliance level only applied to single-family homes and was thus excluded from the table.

Table 28 Multi-family Zero-NOx HPWH; HP HVAC; Panel Upsizing Incentives

Funder + Rebate	$ Amount	Technology Incentivized	Accessibility for LMI Households	Notes on Availability
Incentives for Zero-NOx HPWH				
Stackable Incentives – Bay Area Wide				
HEEHRA- Rebate	$1,750	HPWH	IRA – Moderate-income (80-150% AMI) 50% of costs covered up to given amount. Low-income (< 80% AMI) covers 100% of costs up to same cap	$ amount reflects maximum Cap: $1,750 HEEHRA rebates only extended to multi-family buildings in which 50% of residents are LMI. Some sources indicate that HEEHRA 50% and 100% of project costs will also cover whole project costs for multi-family buildings, though details are still being determined at the state level.
IRA – Tax Credit	$2,000	HPWH	Not income qualified	Tax Credit (25C): 30% tax credit for heat pumps and water heaters, capped at $2,000/year for both appliances. Available for multi-family residents as tax credit functions at the appliance level. Applicable for multi-family residents who own their apartment
TECH Clean California – Multi-family Incentives	$900/kWh	HPWH	Higher rate for equity incentives-max of $300,000 per project	Multi-family Central HPWH and Multi-family HVAC incentives will reopen at a future undetermined date- future rates TBD

[53] https://www.energy.gov/node/4834051

Funder + Rebate	$ Amount	Technology Incentivized	Accessibility for LMI Households	Notes on Availability
BayREN- BAMBE Program[54]	$1,500	HPWH	N/A	Per apartment. Not Available for POU customers
	$1,000	Central HPWH	N/A	Per apartment served – property cap of $100,000
	$1,000	Laundry/ Common Area HPWH	N/A	Per equipment
Local Incentives: CCAs and POUs				**Incentives subject to change**
Peninsula Clean Energy	$2,000	HPWH	Additional rebate available for CARE/FERA customers $1,000/ heat pump appliance.	San Mateo County resident, Peninsula Clean Energy customer. Included as rebate still applies if building owner is listed as a residential account holder
SVCE	TBD	N/A	Program set to launch in Spring of 2024	Campbell, Cupertino, Gilroy, Los Altos, Los Altos Hills, Los Gatos, Milpitas, Monte Sereno, Morgan Hill, Mountain View, Saratoga, Sunnyvale, Unincorporated Santa Clara County. SVCE Account in good standing.
Sonoma Clean Power	$400	HPWH	$5,000 additional rebate for CARE/FERA customers	County of Sonoma SCP Residential Account – included as multi-family residential account holders could still access
Alameda Municipal Power	$1,500	HPWH	N/A	City of Alameda Alameda Municipal Power account holder – assumed also okay if multi-family (no building type specified)
City of Palo Alto Utilities	$1,500	HPWH	N/A	$1,500 cap- real incentive may be lower. City of Palo Alto City of Palo Alto Utility Account Holder – assumed also okay if multi-family (no building type specified_
City of Healdsburg	$1,500	HPWH	N/A	City of Healdsburg; Healdsburg Electric Account Holders – assumed also okay if multi-family

[54] Multi-family properties can check for eligibility through BAMBE at the map explorer tool provided by BayREN: https://slipstreaminc.maps.arcgis.com/apps/instant/lookup/index.html?appid=95f9ade124d745f5add7323e93cbfb9c

Funder + Rebate	$ Amount	Technology Incentivized	Accessibility for LMI Households	Notes on Availability
Incentives for Zero-NOx HP HVAC				
Stackable Incentives – Bay Area Wide				
HEEHRA- Rebate	$8,000	HP HVAC	IRA – Moderate-income (80-150% AMI) 50% of costs covered up to given amount. Low-income (< 80% AMI) covers 100% of costs up to same cap	$ amount reflects maximum Cap: $8,000 HEEHRA rebates only extended to multi-family buildings in which 50% of residents are LMI. Some sources indicate that HEEHRA 50% and 100% of project costs will also cover whole project costs for multi-family buildings, though details are still being determined at the state level.
IRA – Tax Credit	$2,000	HP HVAC	Not income qualified	Tax Credit (25C): 30% tax credit for heat pumps and water heaters, capped at $2,000/year for both appliances Appliance level, so still applies to multi-family
TECH Clean California – Multi-family Incentives	TBD	HPWH	TBD	Multi-family HVAC incentives will reopen at a future undetermined date.
BayREN- BAMBE	$1,500	HP HVAC	N/A	In-unit HP HVAC
	$1,000	HP HVAC [Central]	N/A	Central system- $1,000 rebate/ apartment served
	$1,000	HP HVAC [Common Area]	N/A	Common areas
Local Incentives: CCAs and POUs				Incentives subject to change
Peninsula Clean Energy	$2,500	HP HVAC	Additional rebate available for CARE/FERA customers $1,000/ heat pump appliance.	San Mateo County resident, Peninsula Clean Energy customer. Included as residential account could also be multi-family
SVCE	TBD	N/A	Program set to launch in Spring of 2024	Campbell, Cupertino, Gilroy, Los Altos, Los Altos Hills, Los Gatos, Milpitas, Monte Sereno, Morgan Hill, Mountain View, Saratoga, Sunnyvale, Unincorporated Santa Clara County. SVCE Account in good standing.
Sonoma Clean Power	$1,000	HP HVAC	$5,000 additional rebate for CARE/FERA customers	County of Sonoma SCP Residential Account – included if residential account holder also multi-family building resident

Funder + Rebate	$ Amount	Technology Incentivized	Accessibility for LMI Households	Notes on Availability
Alameda Municipal Power	$1,500	HP HVAC	No additional rebates for HP HVAC Available based on income	City of Alameda Alameda Municipal Power account holder – included if residential account holder also multi-family building
City of Healdsburg	$2,000	HP HVAC	N/A	City of Healdsburg; Healdsburg Electric Account Holders
Incentives for Electric Panel Upsizing & Wiring				
Stackable Incentives – Bay Area Wide				
HEEHRA- Rebate	$4,000	Electric Panel Upsizing	IRA – Moderate-income (80-150% AMI) 50% of costs covered up to given amount. Low-income (< 80% AMI) covers 100% of costs up to same cap	$ amount reflects maximum Cap: $8,000 Total cap of $14,000
HEEHRA- Rebate	$2,500	Wiring and Circuits	IRA – Moderate-income (80-150% AMI) 50% of costs covered up to given amount. Low-income (< 80% AMI) covers 100% of costs up to same cap	$ amount reflects maximum Cap: $8,000 Total cap of $2,500
IRA – Tax Credit	$600	Electric Panel Upsizing	Not income qualified	Tax Credit (25C): 30% tax credit for heat pumps and water heaters, capped at $2,000/year for both appliances
BayREN- BAMBE	$1,000	Electric Panel Upsizing	N/A	Apartment Served
	$5,000	Electric Panel Upsizing	N/A	Central/common area
Local Incentives: CCAs and POUs				**Incentives subject to change- only incentive providers with rebates for panels and wiring included.**
Peninsula Clean Energy	$1,000	Electric Panel Upsizing	N/A	San Mateo County resident, Peninsula Clean Energy customer. Assumed okay for multi-family so long as residential account holder
Alameda Municipal Power	$2,500	Electric Panel Upsizing	N/A	City of Alameda Panel upsizing to 200 amps or greater Assumed okay for multi-family so long as residential account holder
Silicon Valley Power	$2,000	Smart Panel Upsizing	Bonus rebate of $1,000 for LIHEAP customers	City of Santa Clara Panel upsizing of 100 amps or greater

Funder + Rebate	$ Amount	Technology Incentivized	Accessibility for LMI Households	Notes on Availability
Incentives based on Energy Efficiency				
Federal Programs				
Home Energy Rebates Programs [IRA Section 50121]	Total program budget: $4.3 billion	Efficiency upgrades	Prioritizes LMI and multi-family housing. Specific allocation not yet available at the state level. Discounts for energy efficiency upgrades predicted to save at least 20% of home energy use.	Available through 9/30/2021
Regional Programs				
BayREN multi-family Base Rebate	$500/unit	2+ energy efficiency upgrades saving more than 10% of building energy	Base rebate available after clearing threshold for energy efficiency upgrade %	Updated at BayREN's discretion

Notes: TBD = to be determined; N/A = not available.

*Total whole-home electrification cap for HEEHRA: $14,000. There are a number of 'full home electrification rebates' (e.g., California Energy Smart Homes) that are excluded from this analysis. Golden State Rebates also include instant rebate coupons $500-900 for fuel switching to HPWHs but is not considered 'stackable' with other third-party rebates so not included here

8.4 Commercial Incentives for Zero-NOx Appliance Upgrades

Compared to the residential sector there are fewer incentives for zero-NOx appliances for commercial building owners. This is likely due to the wide variability of systems and sizes in commercial buildings. Unlike the appliance types that are available at the low-rise multi-family and single-family level, the type of appliance that would need to be electrified is comparatively less predictable, and potentially more expensive due to larger process loads and comparatively more complex engineering systems.

Incentives available for commercial electrification of space and water heating are more limited than for buildings in the residential sector, as shown in Table 29. Though there are a number of programs like AllElectricDesign.org offered through CCAs to assist larger commercial buildings in designing in all-electric zero-NOx functions, these programs are not specific to space and water heating end uses regulated by Rules 9-4 and 9-6. Additionally, these buildings may feature systems with large sizes not yet governed under the Rules (e.g., large boilers). Accordingly, these programs are excluded from the total list of incentives listed below. It should be noted that SVCE has a small and medium business electrification support program and is the only CCA currently offering incentives tailored for small and medium businesses whose appliances will likely be regulated under the Rules.

Table 29 Incentives for Commercial Zero-NOx HPWH, HP HVAC, Panel Upsizing[1]

Funder + Rebate	$Amount	Technology Incentivized	Accessibility for LMI Households	Notes on Availability
PG&E: Government and K12 Program[2]	TBD	HPWH; HP HVAC Package Units	N/A	Custom projects are known to take longer, but HPWH are known to be an easy path forward. Only applies to schools and government buildings
IRA - Tax Credit	TBD	Energy Efficiency	May contribute to bill savings	Tax credit for energy efficiency based on square footage (Tax Credit 179D) – not specific to electrification of space and water heating
TECH Clean California – Small Business HPWH Incentive	$3,100-$3,800	HPWH	Small businesses- HPWH serving a single business can only qualify	Dependent on water heater size. Not available to POUs
Local Incentives: CCAs and POUs				
SVCE	$600/ ton of cooling	Packaged and split system HP HVAC (3-20 tons)	Small and medium businesses; nonprofit adders available	Campbell, Cupertino, Gilroy, Los Altos, Los Altos Hills, Los Gatos, Milpitas, Monte Sereno, Morgan Hill, Mountain View, Saratoga, Sunnyvale, Unincorporated Santa Clara County. Current SVCE Account
	$2,500/unit	Electrical Infrastructure for spit system/ package HP HVAC	N/A	Cannot exceed project costs
	$2,000/unit	40-80 gal HPWH	N/A	Cannot exceed project costs
	$4,000/unit	Commercial grade HPWH (80-120 gal)	N/A	Cannot exceed project costs

Notes: TBD = to be determined; N/A = not available.

[1] Incentives subject to change – cannot exceed project costs.

[2] Only applies to K-12 Schools and Government Buildings: https://www.willdan.com/programs/PGE-GK12-School_Flyer.pdf

9 Incremental Upfront Costs with Incentives

9.1 Single-family Homes

Incremental Costs for Zero-NOx HPWHs with Incentives

This sections and table series below describe incremental costs for single-family water heating installations after available incentives at the CCA/POU level. The CCA/POU level was used to organize these rebates since each CCA/POU has different incentives available. Each region is also broken out by AMI tier to apply the HEEHRA upfront rebates that will be available through the early 2030's. LMI HEEHRA rebates are combined into one table for each appliance because the high costs of zero-NOx appliance installation in the Bay Area are expected to max-out the HEEHRA cap for each appliance regardless of AMI tier.[55] A negative number in the final column indicates cost savings beyond incremental costs.

The analysis shows when installing zero-NOx HPWHs compared to NOx emitting gas water heaters, no Bay Area building owners will experience increased incremental costs once incentives are applied and will even experience cost savings. For LMI households, cost savings range from $4,439-$8,495 as shown in Table 30.[56] These cost savings could cover the full upfront costs for installing a HPWH. For moderate- and high-income households, cost savings range from $1,604-$5,660, as shown in Table 31. In summary, across the Bay Area, installation of zero-NOx HPWHs is the most cost-effective option for water heating currently available.

[55] HEEHRA incentives allow for 100% of project cost coverage for low-income households and 50% of project cost coverage for moderate-income households.

[56] Any final incremental cost exceeding $7,119 more than covers the full cost of the HPWH. Note that all incentive providers cap incentives at 100% of project cost/

Table 30 LMI (<80% AMI and 80-150% AMI) Single-family Water Heating Incremental Costs with Incentives (Tanked and Tankless)

		Federal		State		Regional	Local	
CCA/POU Incentive Provider	Incremental Cost	IRA Tax Credit	HEEHRA Discount (Max) – Up to 100% of Project Cost	TECH Clean California (Equity)	TECH Clean California (General) – Not Applied in Low-Income Scenario	BayREN*	CCA/Local Provider Incentive	Final Incremental Cost – All Incentives + Tax Credit
CCAs								
MCE	$1,840	$2,000	$1,750	$4,185	$0	$400	$1,000	($7,495)
Electrify Marin*	$1,840	$2,000	$1,750	$4,185	$0	$400	$500	($6,995)
Peninsula Clean Energy	$1,840	$2,000	$1,750	$4,185	$0	$400	$2,000	($8,495)
SVCE**	$1,840	$2,000	$1,750	$4,185	$0	$400	$2,000	($8,495)
AVA	$1,840	$2,000	$1,750	$4,185	$0	$400	$0	($6,495)
Sonoma Clean Power***	$1,840	$2,000	$1,750	$4,185	$0	$400	$700	($7,195)
POUs								
Alameda Municipal Power	$1,840	$2,000	$1,750	$4,185	$0	$0	$1,500	($7,595)
Silicon Valley Power****	$1,840	$2,000	$1,750	$4,185	$0	$0	$0	($6,095)
City of Palo Alto Utilities	$1,840	$2,000	$1,750	$4,185	$0	$0	$1,500	($7,595)
CPSF	$1,840	$2,000	$1,750	$4,185	$0	$0	$0	($6,095)
City of Healdsburg	$1,840	$2,000	$1,750	$4,185	$0	$0	$1,500	($7,595)

Notes:

* Has a HUD requirement for very low income – potentially not applicable to HEEHRA threshold. Excluded from total table. POUS not available for BayREN

** Enrollees in CARE and FERA can receive an additional $1,000 rebate. Excluded from table for consistency.

*** Enrollees in CARE and FERA can receive an additional $5,000 waiver. Excluded from table for consistency.

**** Rebate only available for Electric Resistance Heater.

Final incremental costs equal incremental costs minus the sum of all incentives and tax credits for customers in each CCA/POU.

Table 31 Moderate- and High-income (> 150% AMI) Single-family Water Heating Incremental Costs with Incentives (Tanked and Tankless)

		Federal		State		Regional	Local	
Zero- NOx Appliance	Incremental Cost	IRA Tax Credit	HEEHRA Discount – Not Available	TECH Clean California (Equity) – Not Eligible above 90% AMI	TECH Clean California (General) – Not Applied in Low-Income Scenario	BayREN*	CCA/Local Provider Incentive	Final Incremental Cost – All Incentives + Tax Credit
CCAs								
MCE	$1,840	$2,000	$0	$0	$3,100	$400	$1,000	($4,660)
Electrify Marin*	$1,840	$2,000	$0	$0	$3,100	$400	$500	($4,160)
Peninsula Clean Energy	$1,840	$2,000	$0	$0	$3,100	$400	$2,000	($5,660)
SVCE**	$1,840	$2,000	$0	$0	$3,100	$400	$2,000	($5,660)
AVA	$1,840	$2,000	$0	$0	$3,100	$400	$0	($3,660)
Sonoma Clean Power***	$1,840	$2,000	$0	$0	$3,100	$400	$700	($4,360)
POUs								
Alameda Municipal Power	$1,840	$2,000	$0	$0	$3,100	$0	$1,500	($4,760)
Silicon Valley Power****	$1,840	$2,000	$0	$0	$3,100	$0	$0	($3,260)
City of Palo Alto Utilities	$1,840	$2,000	$0	$0	$3,100	$0	$1,500	($4,760)
CPSF	$1,840	$2,000	$0	$0	$3,100	$0	$0	($3,260)
City of Healdsburg	$1,840	$2,000	$0	$0	$3,100	$0	$1,500	($4,760)

Notes:

* Has a HUD requirement for very low income – potentially not applicable to HEEHRA threshold. Excluded from total table.

** Enrollees in CARE and FERA can receive an additional $1,000 rebate. Excluded from table for consistency.

*** Enrollees in CARE and FERA can receive an additional $5,000 waiver. Excluded from table for consistency.

**** Rebate only available for Electric Resistance Heater.

Final incremental costs equal incremental costs minus the sum of all incentives and tax credits for customers in each CCA/POU.

Table 32 LMI (<80% AMI and 80-150% AMI) Single-family Water Heating Incremental Costs with Incentives (Tanked Only)

		Federal		State		Regional	Local	
CCA/POU Incentive Provider	Incremental Cost	IRA Tax Credit	HEEHRA Discount (Max) – Up to 100% of Project Cost	TECH Clean California (Equity)	TECH Clean California (General) – Not Applied in Low-Income Scenario	BayREN*	CCA/Local Provider Incentive	Final Incremental Cost – All Incentives + Tax Credit
CCAs								
MCE	$3,496	$2,000	$1,750	$4,185	$0	$400	$1,000	($5,839)
Electrify Marin*	$3,496	$2,000	$1,750	$4,185	$0	$400	$500	($5,339)
Peninsula Clean Energy	$3,496	$2,000	$1,750	$4,185	$0	$400	$2,000	($6,839)
SVCE**	$3,496	$2,000	$1,750	$4,185	$0	$400	$2,000	($6,839)
AVA	$3,496	$2,000	$1,750	$4,185	$0	$400	$0	($4,839)
Sonoma Clean Power***	$3,496	$2,000	$1,750	$4,185	$0	$400	$700	($5,539)
POUs								
Alameda Municipal Power	$3,496	$2,000	$1,750	$4,185	$0	$0	$1,500	($5,939)
Silicon Valley Power****	$3,496	$2,000	$1,750	$4,185	$0	$0	$0	($4,439)
City of Palo Alto Utilities	$3,496	$2,000	$1,750	$4,185	$0	$0	$1,500	($5,939)
CPSF	$3,496	$2,000	$1,750	$4,185	$0	$0	$0	($4,439)
City of Healdsburg	$3,496	$2,000	$1,750	$4,185	$0	$0	$1,500	($5,939)

Notes:

* Has a HUD requirement for very low income – potentially not applicable to HEEHRA threshold. Excluded from total table. POUS not available for BayREN

** Enrollees in CARE and FERA can receive an additional $1,000 rebate. Excluded from table for consistency.

*** Enrollees in CARE and FERA can receive an additional $5,000 waiver. Excluded from table for consistency.

**** Rebate only available for Electric Resistance Heater.

Final incremental costs equal incremental costs minus the sum of all incentives and tax credits for customers in each CCA/POU.

Table 33 Moderate- and High-income (>150% AMI) Single-family Water Heating Incremental Costs with Incentives (Tanked Only)

		Federal		State		Regional	Local	
Zero- NOx Appliance	Incremental Cost	IRA Tax Credit	HEEHRA Discount – Not Available	TECH Clean California (Equity) – Not Eligible above 90% AMI	TECH Clean California (General) – Not Applied in Low-Income Scenario	BayREN*	CCA/Local Provider Incentive	Final Incremental Cost – All Incentives + Tax Credit
CCAs								
MCE	$3,496	$2,000	$0	$0	$3,100	$400	$1,000	($3,004)
Electrify Marin*	$3,496	$2,000	$0	$0	$3,100	$400	$500	($2,504)
Peninsula Clean Energy	$3,496	$2,000	$0	$0	$3,100	$400	$2,000	($4,004)
SVCE**	$3,496	$2,000	$0	$0	$3,100	$400	$2,000	($4,004)
AVA	$3,496	$2,000	$0	$0	$3,100	$400	$0	($2,004)
Sonoma Clean Power***	$3,496	$2,000	$0	$0	$3,100	$400	$700	($2,704)
POUs								
Alameda Municipal Power	$3,496	$2,000	$0	$0	$3,100	$0	$1,500	($3,104)
Silicon Valley Power****	$3,496	$2,000	$0	$0	$3,100	$0	$0	($1,604)
City of Palo Alto Utilities	$3,496	$2,000	$0	$0	$3,100	$0	$1,500	($3,104)
CPSF	$3,496	$2,000	$0	$0	$3,100	$0	$0	($1,604)
City of Healdsburg	$3,496	$2,000	$0	$0	$3,100	$0	$1,500	($3,104)

Notes:

* Has a HUD requirement for very low income – potentially not applicable to HEEHRA threshold. Excluded from total table.

** Enrollees in CARE and FERA can receive an additional $1,000 rebate. Excluded from table for consistency.

*** Enrollees in CARE and FERA can receive an additional $5,000 waiver. Excluded from table for consistency.

**** Rebate only available for Electric Resistance Heater.

Final incremental costs equal incremental costs minus the sum of all incentives and tax credits for customers in each CCA/POU.

Incremental Costs with Incentives for Zero-NOx Space Heating

This section describes incremental costs minus incentives for ducted and ductless zero-NOx HP HVACs for building owners who did not want to install air conditioning. It should be noted that potential additional savings for CARE/FERA customers have not been incorporated and could further lower costs by up to $5,000 for Bay Area residents who qualify for CARE/FERA electric rates.

The table series below describes incremental costs for single-family space heating with incentives applied at the CCA/ POU level. This analysis is broken out by AMI tier to apply the HEEHRA rebates that will be available through the early 2030's. Similar to HEEHRA HPWH incentives, regardless of low- or moderate-income bracket, the high upfront installation costs are expected to max-out the total HEEHRA appliance cap by incentive type. A value of zero in any column indicates that there were no additional local or state/regional rebates available in that locality. A negative number in the final column indicates cost savings beyond incremental costs.[57]

Due to more complicated requirements for installation, ducted HP HVACs are $3,286 more expensive than ducted HP HVACs. Accordingly, this cost analysis divides final cost after incentives into ducted and ductless HP HVAC categories.

Incremental Upfront Costs with Incentives: Ductless HP HVAC

When installing zero-NOx ductless HP HVACs compared to NOx emitting gas furnaces, LMI Bay Area building owners will experience cost savings ranging from $245-$3,145 after incentives as shown in Table 34. Moderate– and high-income households may experience incremental costs ranging from $4,855-$7,755 after incentives, however, as shown in Table 35.

[57] Note that there is no separate equity and general rate for HP HVAC for TECH Clean California, so TECH incentives are consistent across all tables.

Table 34 LMI (<80% AMI and 80-150% AMI) Single-family Ductless HP HVAC Incremental Costs with Incentives

Zero- NOx Appliance	Incremental Cost	Federal		State	Regional	Local	Final Incremental Cost – All Incentives + Tax Credit
		IRA Tax Credit	HEEHRA Discount (Max) – up to 100% of Project Cost	TECH Clean California	BayREN*	CCA/Local Provider Incentive	
CCAs							
MCE	$10,755	$2,000	$8,000	$1,000	$400	$0	-$645
Electrify Marin	$10,755	$2,000	$8,000	$1,000	$400	$500	-$1,145
Peninsula Clean Energy	$10,755	$2,000	$8,000	$1,000	$400	$2,500	-$3,145
SVCE	$10,755	$2,000	$8,000	$1,000	$400	$2,000	-$2,645
AVA	$10,755	$2,000	$8,000	$1,000	$400	$0	-$645
Sonoma Clean Power	$10,755	$2,000	$8,000	$1,000	$400	$1,000	-$1,645
POUs							
Alameda Municipal Power	$10,755	$2,000	$8,000	$1,000	$0	$1,500	-$1,745
Silicon Valley Power	$10,755	$2,000	$8,000	$1,000	$0	$0	-$245
City of Palo Alto Utilities	$10,755	$2,000	$8,000	$1,000	$0	$0	-$245
CPSF	$10,755	$2,000	$8,000	$1,000	$0	$0	-$245
City of Healdsburg	$10,755	$2,000	$8,000	$1,000	$0	$2,000	-$2,245

Notes: Final incremental costs equal incremental costs minus the sum of all incentives and tax credits for customers in each CCA/POU.

Table 35 Moderate- and High-income (>150% AMI) Single-family Ductless HP HVAC Incremental Costs with Incentives

		Federal		State	Regional	Local	
Zero- NOx Appliance	Incremental Cost	IRA Tax Credit	HEEHRA Discount (Max) – up to 100% of Project Cost	TECH Clean California	BayREN*	CCA/Local Provider Incentive	Final Incremental Cost – All Incentives + Tax Credit
CCAs							
MCE	$10,755	$2,000	$0	$1,000	$400	$0	$7,355
Electrify Marin*	$10,755	$2,000	$0	$1,000	$400	$500	$6,855
Peninsula Clean Energy	$10,755	$2,000	$0	$1,000	$400	$2,500	$4,855
SVCE**	$10,755	$2,000	$0	$1,000	$400	$2,000	$5,355
AVA	$10,755	$2,000	$0	$1,000	$400	$0	$7,355
Sonoma Clean Power***	$10,755	$2,000	$0	$1,000	$400	$1,000	$6,355
POUs							
Alameda Municipal Power	$10,755	$2,000	$0	$1,000	$0	$1,500	$6,255
Silicon Valley Power****	$10,755	$2,000	$0	$1,000	$0	$0	$7,755
City of Palo Alto Utilities	$10,755	$2,000	$0	$1,000	$0	$0	$7,755
CPSF	$10,755	$2,000	$0	$1,000	$0	$0	$7,755
City of Healdsburg	$10,755	$2,000	$0	$1,000	$0	$2,000	$5,755

Notes: Final incremental costs equal incremental costs minus the sum of all incentives and tax credits for customers in each CCA/POU.

Ducted HP HVAC Incremental Costs with Incentives

When installing zero-NOx ducted HP HVACs compared to NOx emitting gas furnaces, LMI Bay Area households will experience incremental costs ranging from $161-$3,061 as shown in Table 36. For moderate- and high-income households, incremental costs could increase from between $8,161–$11,061 as shown in Table 37.

Table 36 LMI (<80% AMI and 80-150% AMI) Single-family Ducted HP HVAC Incremental Costs with Incentives

		Federal		State	Regional	Local	
Zero- NOx Appliance	Incremental Cost	IRA Tax Credit	HEEHRA Discount (Max) – up to 100% of Project Cost	TECH Clean California	BayREN*	CCA/Local Provider Incentive	Final Incremental Cost – All Incentives + Tax Credit
CCAs							
MCE	$14,061	$2,000	$8,000	$1,000	$400	$0	$2,661
Electrify Marin	$14,061	$2,000	$8,000	$1,000	$400	$500	$2,161
Peninsula Clean Energy	$14,061	$2,000	$8,000	$1,000	$400	$2,500	$161
SVCE	$14,061	$2,000	$8,000	$1,000	$400	$2,000	$661
AVA	$14,061	$2,000	$8,000	$1,000	$400	$0	$2,661
Sonoma Clean Power	$14,061	$2,000	$8,000	$1,000	$400	$1,000	$1,661
POUs							
Alameda Municipal Power	$14,061	$2,000	$8,000	$1,000	$0	$1,500	$1,561
Silicon Valley Power	$14,061	$2,000	$8,000	$1,000	$0	$0	$3,061
City of Palo Alto Utilities	$14,061	$2,000	$8,000	$1,000	$0	$0	$3,061
CPSF	$14,061	$2,000	$8,000	$1,000	$0	$0	$3,061
City of Healdsburg	$14,061	$2,000	$8,000	$1,000	$0	$2,000	$1,061

Notes: Final incremental costs equal incremental costs minus the sum of all incentives and tax credits for customers in each CCA/POU.

Table 37 Moderate- and High-income (>150% AMI) Single-family Ducted HP HVAC Incremental Costs with Incentives

Zero- NOx Appliance	Incremental Cost	Federal		State	Regional	Local	Final Incremental Cost – All Incentives + Tax Credit
		IRA Tax Credit	HEEHRA Discount (Max) – up to 100% of Project Cost	TECH Clean California	BayREN*	CCA/Local Provider Incentive	
CCAs							
MCE	$14,061	$2,000	$0	$1,000	$400	$0	$10,661
Electrify Marin	$14,061	$2,000	$0	$1,000	$400	$500	$10,161
Peninsula Clean Energy	$14,061	$2,000	$0	$1,000	$400	$2,500	$8,161
SVCE	$14,061	$2,000	$0	$1,000	$400	$2,000	$8,661
AVA	$14,061	$2,000	$0	$1,000	$400	$0	$10,661
Sonoma Clean Power	$14,061	$2,000	$0	$1,000	$400	$1,000	$9,661
POUs							
Alameda Municipal Power	$14,061	$2,000	$0	$1,000	$0	$1,500	$9,561
Silicon Valley Power	$14,061	$2,000	$0	$1,000	$0	$0	$11,061
City of Palo Alto Utilities	$14,061	$2,000	$0	$1,000	$0	$0	$11,061
CPSF	$14,061	$2,000	$0	$1,000	$0	$0	$11,061
City of Healdsburg	$14,061	$2,000	$0	$1,000	$0	$2,000	$9,061

Notes: Final incremental costs equal incremental costs minus the sum of all incentives and tax credits for customers in each CCA/POU.

Role of Air Conditioning in Reducing Incremental Costs with Incentives

This subsection describes incremental costs minus incentives for ducted and ductless zero-NOx HP HVACs for building owners who want to install air conditioning. As noted under the Incremental Costs section, if the installation of a HP HVAC effectively displaces both a gas furnace and an air conditioner, building owners would save an additional $8,106 in installation costs.[58]

The table series below summarizes incremental costs for single-family space heating with incentives and avoided air conditioning costs. The incentives presented represent the minimum and maximum total incentives (the aggregate of the federal, state, regional, local incentives at each CCA/POU level presented in Table 34 to Table 37) that a Bay Area homeowner could receive in each AMI tier. The analysis is also separated by ducted and ductless HP HVACs.

This analysis shows when installing zero-NOx ducted HP HVAC compared to a NOx emitting gas furnace and air conditioning, LMI Bay Area households will experience cost savings ranging from $8,331-$11,231 for a ductless HP HVAC and $5,045-$7,945 for a ducted HP HVAC, as shown in Table 38. Moderate- and high-income households will experience a cost savings of $331-$3,231 for a ductless HP HVAC. However, for a ducted HP HVAC, moderate- and high-income households will experience an incremental cost after incentives and avoided air conditioning costs ranging from $55-$2,955, as shown in Table 26. In summary, when applicable, avoided air conditioning costs make zero-NOx ductless HP HVACs a cost-effective option in all scenarios, and zero-NOx ducted HP HVACs a cost-effective option in most scenarios.

Table 38 Single-family Ductless and Ducted HP HVAC Incremental Costs with Incentives and Air Conditioning by AMI Tier

AMI Tier	Incremental Cost with Avoided Air Conditioning Cost	Incentives - Low Range*	Incentives - High Range**	Final Incremental Cost After Low Incentives	Incremental Cost After High Incentives
Ductless HP HVAC					
LMI (> 80% AMI and 80-150% AMI)	$2,669	$11,000	$13,900	-$8,331	-$11,231
Moderate- and High-income (>150% AMI)	$2,669	$3,000	$5,900	-$331	-$3,231
Ducted HP HVAC					
LMI (> 80% AMI and 80-150% AMI)	$5,955	$11,000	$13,900	-$5,045	-$7,945
Moderate- and High-income (>150% AMI)	$5,955	$3,000	$5,900	$2,955	$55

Notes:

*Low range incentives represent the minimum amount of incentives and tax credits (summed across state, federal, regional, and local incentives and tax credits) a customer in the AMI scenario would receive based on their CCA/POU.

**High range incentives represent the maximum amount of incentives (summed across state, federal, regional, and local incentives) a customer in the AMI scenario would receive based on their CCA/POU.

Final incremental costs after incentives equal incremental costs minus the low or high range incentives for customers in each AMI tier.

[58] This is the average cost of an air conditioner in the Bay Area. This cost is considered displaced because of the displaced need to install an additional appliance (air conditioner).

9.2 Upfront Costs for Multi-Family Zero-NOx Appliance Installation with Incentives

There was no data available to establish a gas NOx emitting base case for multi-family water and space heating replacement scenarios. As a result, there are estimated costs for upfront zero-NOx appliance replacement for space and water heating functions, but no available data to calculate an incremental cost to install zero-NOx compliant heat pumps.

In addition, funding was highly variable based on type of heating/cooling system, building type, and appliance for multi-family buildings. Due to these data limitations, this analysis does not assess incremental costs to fully implement heat pump projects for multi-family buildings but does provide upfront costs with available incentives applied in a high-low cost reduction range.

Upfront costs to install zero-NOx appliances for multi-family buildings were as follows:

- $9,024 for zero-NOx HPWHs
- $24,511 for zero-NOx ducted HP HVAC systems
- $10,499 for zero-NOx ductless HP HVAC systems

The high-low end ranges for incentives described show that multi-family building owners could see an up to 75% reduction in overall costs for once stacked incentives are applied to HPWHs. For Ductless HP HVAC projects, building owners could see a 100% of upfront costs covered, to a reduction of $6,499 per project (36% of total project cost). Ducted HP HVACs, which were significantly more costly than their ductless counterparts, could see total project cost reductions of between 16-55% once all incentives were applied.

Zero-NOx HPWH Upfront Costs with Incentives

As eligibility for multi-family housing rebates and incentives varied so widely by definition of multi-family, ratepayer type, and requirements for systems served (e.g., in-unit or central), incentives were not combined to model multi-family upfront costs with incentives. However, the project team did model a high-low incentive range based on the incentives that were stackable in to approximate potential appliance-level cost reductions for the installation of multi-family HPWHs and HP HVACs.

Incentive Ranges & Reduced Upfront Cost for HPWH

This analysis shows that even with variable incentives for zero-NOx HPWH, multi-family residents/building owners could still see 75-38% reductions in overall cost, not factoring in TECH rebates which are based on kilowatt-hour savings or additional energy efficiency rebates under IRA that could be applied. Cost reductions are based on projected overall upfront project costs of $9,024 for multi-family HPWHs.

- Low range: $3,400 in total incentives[59]
  - Total upfront costs after low-range incentives: $5,624
- High range: $6,750 in total incentives[60]
  - Total upfront costs after high range incentives: $2,274

[59] Excluded: HEEHRA; Included: Tax Incentive; BayREN; SCP (low-end local rebate)

[60] Excluded: SCP; Included: Tax Incentive; HEEHRA; BayREN; Peninsula Clean Energy (high-end local rebate)

Incentive Ranges & Reduced Upfront Cost for Ductless HP HVAC

This analysis shows that even with variable incentives for zero-NOx HPWH, multi-family residents/building owners could still see full coverage of upfront cost-36% cost reductions, not factoring in energy efficiency rebates under IRA that could be applied. Cost reductions are based on projected overall upfront project costs of $10,499 for multi-family ductless HP HVAC.

- Low range: $4,000 in total incentives[61]
  - Total upfront costs after low range incentives: $6,499
- High range: $13,500 in total incentives[62]
  - Total upfront costs after high range incentives: $0- full cost coverage of project

Incentive Ranges & Reduced Upfront Cost for Ducted HP HVAC

Zero-NOx ducted HP HVAC for multi-family homes are expected to be significantly more expensive than ductless HP HVAC (which likely are being replaced at the unit-level), with a total upfront install cost of $24,511. This cost likely reflects the more complex installation cost of large central ducted systems in larger multi-family buildings. This analysis shows that even with variable incentives for zero-NOx HPWH, multi-family residents/building owners could still see 55-16% reductions in overall cost, not factoring in additional energy efficiency rebates under IRA that could be applied. Note that the incentive range for all HP HVAC is the same, regardless of the type of HP HVAC subsidized.

- Low range: $4,000 in total incentives[63]
  - Total upfront cost – low range incentives: $20,511
- High range: $13,500 in total incentives[64]
  - Total upfront cost – high range incentives: $11,011

9.3 Upfront Costs for Commercial Zero-NOx Appliance Installation with Incentives

Due to the general lack of incentives available for commercial buildings, a dedicated analysis of commercial costs after incentives was not conducted. See the commercial building cost analysis for a description of upfront costs associated with commercial building electrification.

[61] Excluded: HEEHRA; Included: Tax Incentive; BayREN; SCP (low-end local rebate)

[62] Excluded: SCP; Included: Tax Incentive; BayREN; Peninsula Clean Energy (high-end local rebate)

[63] Excluded: HEEHRA; Included: Tax Incentive; BayREN; SCP (low-end local rebate)

[64] Excluded: SCP; Included: Tax Incentive; BayREN; Peninsula Clean Energy (high-end local rebate)

10 Operational Costs of Zero-NOx HPWH & HP HVAC

Operational or bill impacts are another important piece of the overall economics of upgrading to electric appliances. Bill impacts describe how much the building owner will pay to operate appliances on gas, or on electricity. Bill impacts will vary depending on building size, heating and cooling behaviors, and most significantly, electricity and gas rates.

This analysis references two geographically relevant case studies. The first study was conducted by E3 on about 1,500 PG&E customers in East Bay. The second analysis was conducted by Peninsula Clean Energy and SVCE using customer data along with modeled assumptions. Both analyses use current rates for both gas and electricity specific to each area of study. However, the analysis is sensitive to changes in rates which occur regularly.

The E3 analysis concluded that most space and water heating heat pump projects will lead to either no change in energy bills or a slight decrease. About one quarter of projects would result in a small (about $5) a month bill increase. The Peninsula Clean Energy and SVCE study showed that the average customer would save $30-$40 a month after switching all appliances (including stove and dryer) to electric when using the E-ELEC rate structure. Both analyses note that using an electrification specific rate (such as E-ELEC) is key to seeing bill savings. Residents who stayed on standard Time of Use rates did not see cost savings in most cases.

10.1 Case Study: Bill Impact of Switching to Space and Water Heating Heat Pumps [East Bay]

The project team (E3) analyzed the bill impact of HVAC and WH heat pumps on about 1,500 customers in the East Bay using monthly customer data provided by Ava Community Energy. This modeling is based on work done in a CEC-funded research project investigating targeted electrification and gas decommissioning.[65]

A number of important factors will affect bill savings for individual customers. First, for customers enrolled in the CARE bill discount program, CARE provides a larger percentage discount on electric bills than on gas bills, which supports greater bill savings for CARE customers who switch to electric appliances.[66] Another important factor is that the E-ELEC rate, designed to support electrification, will structurally benefit larger electricity users. Based on these factors, almost 100% of high electricity users and about 60% of low electricity users would benefit from switching to the E-ELEC tariff, as the rates exist today. If these customers remained on their existing tariffs post-electrification, they would experience either bill increases or less significant bill decreases.

In January 2024, PG&E implemented significant hikes to both gas & electric rates. The results shown below in Table 39, Figure 5 and Figure 6 are reflective of rates as of January 2024. These results indicate bill decreases for 65% of CARE customers after switching to space and water heating heat

[65] https://www.ethree.com/wp-content/uploads/2023/12/E3_Benefit-Cost-Analysis-of-Targeted-Electrification-and-Gas-Decommissioning-in-California.pdf

[66] CARE is a monthly discount of 20% or more on gas and electricity, which participants can qualify for by meeting income guidelines or enrolling in public assistance programs (e.g. SNAP, CalFresh). https://www.pge.com/en/account/rate-plans/find-your-best-rate-plan/electric-home.html

pumps. It also indicates bill decreases for 95% of electric users who used more than 5,000 kilowatt-hours prior to switching to electric appliances. The most concerning group post- water and space heating heat pump installation is low-usage, non-CARE customers in multi-family properties. Single-family low-usage non-CARE customers may also experience small bill increases.[67]

This analysis categorizes customers by key factors for bill impact including low-high pre-electrification electricity usage, building type (single-family vs. multi-family) and bill discount program enrollment (CARE vs. non-CARE).

Table 39 Zero-NOx Water Heating + Space Heating Bill Impact

Usage	Sector	Customer	% Customers who Switch to E-ELEC	Bill Impact	% Customers	Avg $/Month
Low	SF Res	CARE	55%	Increase	49%	$2.36
				Decrease	51%	-$10.25
		Non-CARE	67%	Increase	89%	$9.62
				Decrease	11%	-$3.75
	MF Res	CARE	65%	Increase	44%	$2.46
				Decrease	56%	-$8.19
		Non-CARE	50%	Increase	95%	$11.64
				Decrease	5%	-$22.84
High	SF Res	CARE	99%	Increase	3%	$1.31
				Decrease	97%	-$21.23
		Non-CARE	98%	Increase	8%	$4.44
				Decrease	92%	-$51.35
	MF Res	CARE	89%	Increase	6%	$1.60
				Decrease	94%	-$21.06
		Non-CARE	94%	Increase	3%	$5.48
				Decrease	97%	-$38.32

[67] https://www.pge.com/en/account/rate-plans/find-your-best-rate-plan/electric-home.html

Figure 5 Zero-NOx Space and Water Heating CARE and Non-CARE Bill Impacts [Single-family]

Figure 6 Zero-NOx Space and Water heating CARE and Non-CARE Bill Impacts [Multi-family]

Future change: Income Graduated Fixed Charge

Starting in 2025, electric rates in California will be subject to an Income Graduated Fixed Charge (IGFC), as approved by the California Public Utility Commission (CPUC). The IGFC will require all rates to include a fixed monthly charge of $24.15 for Non-CARE customers and $6.00 for CARE customers. When the IGFC is introduced, volumetric rates will also be adjusted to account for the new fixed charge. Current rates that do NOT have a fixed charge, like E-TOU-C, will see volumetric rate reductions ranging from 9-13%, depending on the TOU period, while current rates that DO have a fixed charge, like E-ELEC, will see volumetric rate reductions ranging from 2-5%, depending on TOU period.

It is important to keep in mind that impacts of IGFC on electrification cost-effectiveness will be convoluted with two structural changes from IGFC:

1) Income notwithstanding, a larger fixed charge will structurally benefit larger electricity users while leading to small bill increases for smaller electricity users.
2) IGFC reforms will introduce uniform fixed charges for all rates. Thus, high-usage customers will no longer see the same benefits from switching to E-ELEC that they might have seen in the past.

These two structural changes yield the following outcomes:

1) For low-usage customers, IGFC enables the greatest bill savings from electrification, but not necessarily the lowest overall bills, compared to electrification on pre-IGFC rates.
2) For high-usage customers, IGFC enables electrifying customers to see the lowest overall bills, but not necessarily the same level of bill savings they could have seen pre-IGFC (due to E-ELEC benefits).

The results shown below in Table 40 are reflective of July 2024 rates, adjusted to account for the IGFC. Compared to results with January 2024 rates, electrifying both space heating and water heating yields similar results for high usage customers, 95% of whom see bill savings or no change in bills. However, far more low-usage customers see bill decreases from electrification with the presence of the IGFC, with approximately 91% of single-family CARE, 65% of single-family non-CARE, 94% of multi-family CARE, and 47% of multi-family non-CARE low-usage customers experiencing a bill decrease.

Table 40 Zero-NOx Water Heating + Space Heating Bill Impact with IGFC

Usage	Sector	Customer	% Customers who Switch to E-ELEC	Bill Impact	% Customers	Avg $/Month
Low	SF Res	CARE	49%	Increase	9%	$1.41
				Decrease	91%	-$13.60
		Non-CARE	58%	Increase	35%	$1.96
				Decrease	65%	-$9.10
	MF Res	CARE	59%	Increase	6%	$1.45
				Decrease	94%	-$13.64
		Non-CARE	53%	Increase	53%	$2.29
				Decrease	47%	-$10.12
High	SF Res	CARE	88%	Increase	4%	$1.50
				Decrease	96%	-$22.88
		Non-CARE	89%	Increase	5%	$1.71
				Decrease	95%	-$37.77
	MF Res	CARE	79%	Increase	7%	$1.42
				Decrease	93%	-$25.11
		Non-CARE	88%	Increase	3%	$1.24
				Decrease	97%	-$32.80

In addition to the HPWH and HP HVAC scenario, E3 also ran an analysis on just switching to an HPWH since Rule 9-6 will be implemented first (2027). Under this scenario, similar results were seen to the previous scenario with 95% of high usage customers seeing bill savings or no change in bills after switching to a HPWH and approximately 35% of single-family and 60% of multi-family non-CARE, low-use customers seeing a bill increase of around $2 on average per month. With only water heating electrification, even fewer customers switch E-ELEC. These details are shown in Table 41. A more detailed breakdown of bill impacts by customer type and building type (single-family/multi-family) is provided in Figure 7 and Figure 8.

Table 41 Zero-NOx Water Heating Bill Impacts with IGFC

Usage	Sector	Customer	% Customers who Switch to E-ELEC	Bill Impact	% Customers	Avg $/Month
Low	SF Res	CARE	8%	Increase	12%	$1.33
				Decrease	88%	-$8.28
		Non-CARE	10%	Increase	34%	$1.73
				Decrease	66%	-$7.51
	MF Res	CARE	13%	Increase	10%	$1.33
				Decrease	90%	-$7.89
		Non-CARE	18%	Increase	59%	$2.09
				Decrease	41%	-$7.65
High	SF Res	CARE	62%	Increase	4%	$1.50
				Decrease	96%	-$15.38
		Non-CARE	64%	Increase	5%	$1.71
				Decrease	95%	-$32.97
	MF Res	CARE	48%	Increase	7%	$1.42
				Decrease	93%	-$16.58
		Non-CARE	76%	Increase	3%	$1.24
				Decrease	97%	-$27.59

Figure 7 Zero-NOx Water Heating CARE and Non-CARE Bill Impacts with IGFC [Single-family]

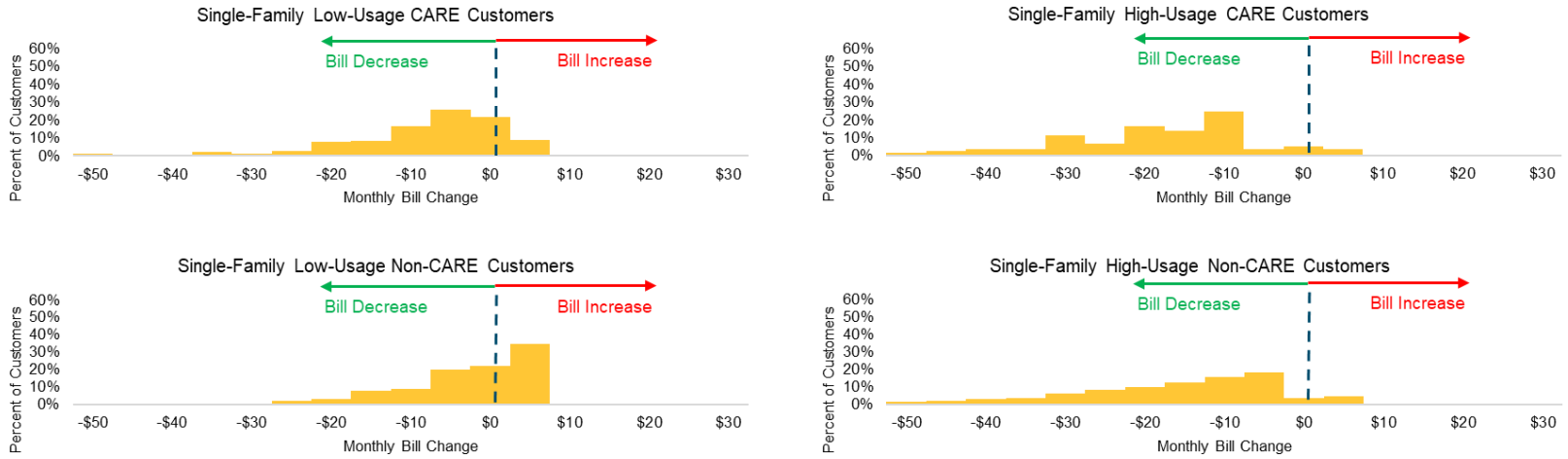


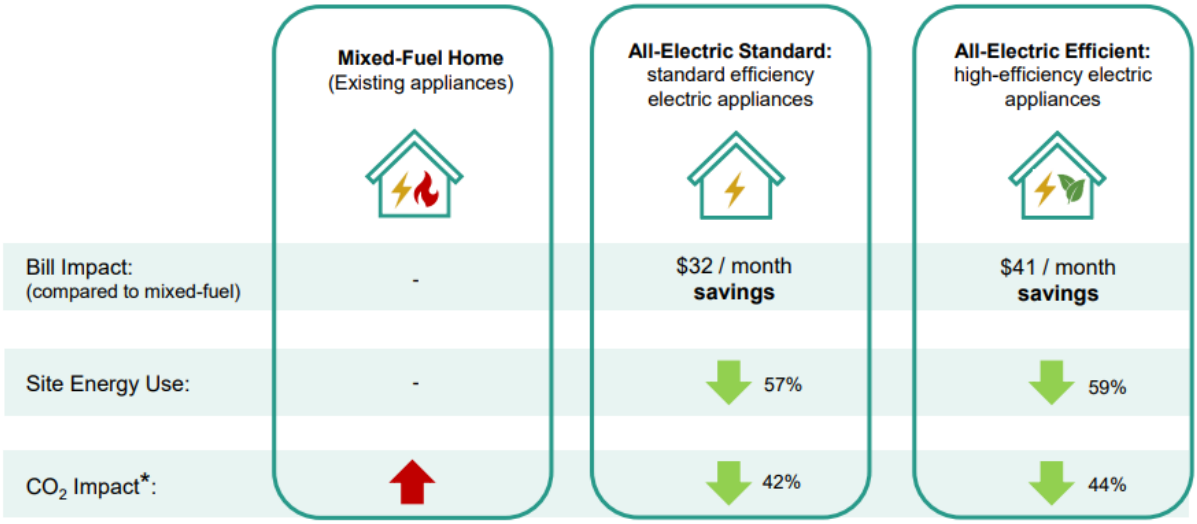
Figure 8 Zero-NOx Water Heating CARE and Non-CARE Bill Impacts with IGFC [Multi-family]

Case Study: Bill Impacts for Existing Single-family Homes [SVCE & Peninsula Clean Energy 2023 Analysis][68]

This analysis evaluates the bill impact impacts of switching from existing gas appliances to electric appliances in single-family homes based on median household customer data in Climate Zone 4, representing energy usage for a single-family home of approximately 1,830 square feet.

The analysis found that single-family homes could lead to savings of about $380 per year when switching from gas to standard-efficiency electric appliances. If high-efficiency electric appliances are used, savings could increase to $495 annually as shown below (depicted monthly savings) in Figure 9.

Figure 9 Bill Impacts of Mixed Fuel vs. All-Electric Homes



*Based on 0.720 lbs CO2e/kWh per SVCE 2022 GreenStart Power Content Label and 13.446 lbs CO2e/therm per PG&E.

The study also notes that switching to the electric residential rates (E-ELEC or EV-2A) were critical in achieving bill savings, as shown below in Table 42.

[68] https://svcleanenergy.org/wp-content/uploads/SVCE-PCE-Single-Family-On-Bill-Impacts-Results-2023.pdf

Table 42 Total Annual Gas & Electric Costs

Residential Rate	Mixed-Fuel *New Equipment*	Mixed-Fuel *Existing Equipment*	All-Electric *Minimum Efficiency*	All-Electric *Standard Efficiency*	All-Electric *High Efficiency*
E1 (B)	$3,410	$3,655	$3,810	$3,705	$3,540
E1 (H) (Electric Heating)	-	-	$3,720	$3,615	$3,450
TOU-C (B)	**$3,360**	**$3,605**	$3,690	$3,585	$3,430
TOU-C (H) (Electric Heating)	-	-	$3,600	$3,495	$3,345
EV-2A	-	-	$3,325	$3,245	$3,125
E-ELEC	-	-	**$3,300**	**$3,225**	**$3,110**

Bill savings were seen, even when electrifying with minimum efficiency equipment, as long as the right rate is used. We recommend switching to E-ELEC or EV-2A.

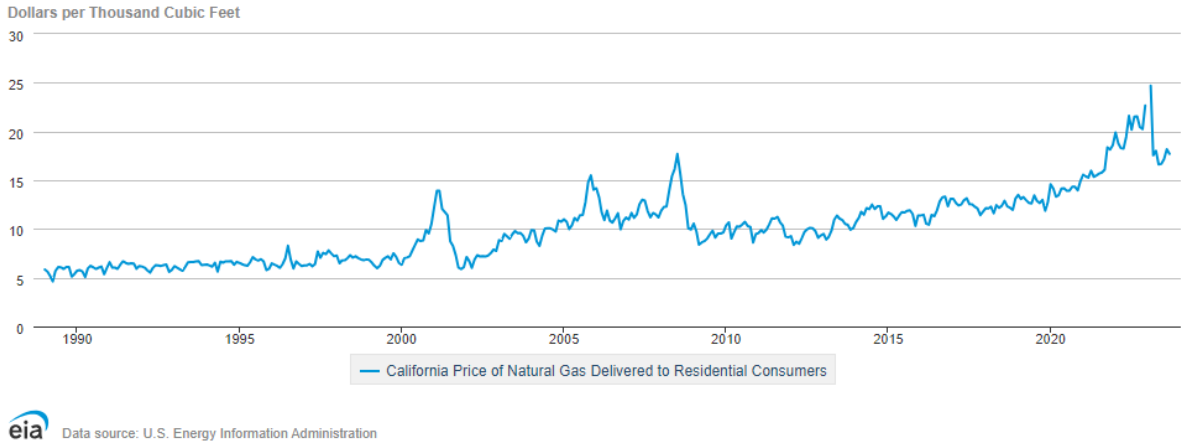
These bill rate savings only apply to single-family buildings and potentially to low-rise multi-family buildings with similar electricity loads. The loads and bill impacts for commercial buildings, whose systems are frequently oversized, will likely vary widely from building to building.

Gas Rates

The comparison between current gas rates and electricity rates is critical to the accuracy of the bill impact analysis. Both gas and electricity rates fluctuate over time. Electricity rates commonly have a time of use rate structure where each hour of the day has a different cost. Gas rates fluctuate over the course of the year as supply and demand impacts costs.

In general, winter rates are higher when heating demand is highest. Figure 10 from the U.S. Energy Administration shows historical natural gas prices since 1990 depicting an overall increase in cost as well as annual fluctuations, some of them significant. The increased cost of gas in winter increases the cost effectiveness of electrification, especially for HVACs, since a majority of heating loads would come during the winter when gas rates are generally at their peak.

Figure 10 California Price of Natural Gas Delivered to Residential Customers in California



In addition to this variability, future gas prices are expected to increase at a growing rate. Due to electrification and general energy efficiency a smaller volume of natural gas is expected to be consumed. However, this gas will likely be distributed through a similar sized system of pipes and other infrastructure. The lower volume of gas sales would need to pay for the same amount of infrastructure (a large portion of the cost of each therm of gas supports infrastructure construction and maintenance). This is expected to increase gas rates by as much as $19 by 2050 without a managed transition away from gas. [69]

[69] https://gridworks.org/wp-content/uploads/2019/09/CA_Gas_System_in_Transition.pdf

11 Conclusion

- **HPWH installation is the least expensive option for water heating once incentives are applied.**[70] The total upfront cost of installation could be covered by available incentives available to LMI households. Moderate- and high-income houses would still experience cost savings in comparison to installation of a NOx emitting gas water heater, with no additional incremental costs to install HPWHs once incentives are applied.
- **Incentives for heat pump installation and electric panel upsizing (when necessary) are critical in closing the incremental cost gap for zero-NOx appliance installation.** However, local incentives available via BayREN, CCAS, and POUs change frequently and should continue to be monitored. Federal level incentives through IRA are comparatively more stable and are expected to be available through the next decade.
- **HP HVAC installation is generally more costly to the building owner even after incentives have been applied.** Due to relatively higher incremental costs ranging from $10,775 [ductless] to $14,601 [ducted], incentives can cover the incremental costs of zero-NOx appliance installation for ductless HP HVAC installation for LMI households but cannot completely close the incremental cost gap for all other income and HP HVAC types. This means in most cases, building owners will experience a range of cost increases from $161 [ducted HP HVAC; LMI]-$11,061 [ducted HP HVAC; high-income] to install HP HVAC after incentives have been applied. Factoring in the avoided cost of air conditioning, however, lowers the incremental costs for all incomes and HP HVAC types and completely covers the incremental costs after incentives for ductless HP HVACs in LMI and moderate- and high-income households, and ducted HP HVACs in LMI households.
- **Factoring in the value of air conditioning closes the incremental cost gap.** While not all buildings currently have AC, those that do or that wish to upgrade see much lower incremental costs. When factored into this analysis, average avoided air conditioning costs of $8,106 lower the incremental costs of replacing a NOx emitting gas furnace with a zero-NOx HP HVAC to $2,669 and $5,955 for ductless and ducted systems, respectively, in single-family homes in the Bay Area before any rebates are applied.
- **Electric panel upsizing and subsequent electric service upgrades could significantly increase costs to the building owner.** These potentially costly upgrades could be avoided through 'watt diet' techniques like smart panels and circuit splitters, which would likely be enough to cover new zero-NOx appliance installation electrical loads on a 100 amp panel. However, building owners may want to prepare for future electrical loads like electric vehicle charging through panel upsizing now. Panel upsizing and service upgrades are more likely to affect older building stock built before 1975, which feature panel sizes of 150 amp or smaller.
- **Most PG&E customers are expected to see reductions in electric bills after switching to E-ELEC rates when it is beneficial**. Once IGFC is implemented, approximately 95% and 92% of high-use CARE customers and low-use CARE customers, respectively, are expected to see reductions in electric bills. 95% or more of high-use, non-CARE customers will see significant cost savings of$37 per month, on average. Alternatively, 40% of low-usage non-CARE customers are expected to see a bill increase of $2 on average monthly bills.

[70] Interpretation for HPWH and HP HVAC in the conclusion applies to single-family buildings. Incremental costs were not analyzed for high-rise multi-family and commercial buildings due to data limitations.

Appendix A – Cost Distribution

This appendix analyzes the distribution of the cost data used to analyze gas water heater, gas furnace, heat pump water heater (HPWH), and heat pump heating, ventilation, and air conditioning (HP HVAC) installations in the Installation Costs for Zero-NOx Space and Water Heating Appliances report for the Bay Area Air Quality Management District (BAAQMD). The following sections present the cost distribution analysis for single-family and multi-family data by data source and appliance type.

This appendix visualizes the data through a series of box and whisker graphs. The box and whisker graphs can be read as follows:

- The box shows where 50% of the data is found (aka. shows the range of the interquartile interval)
- The whiskers (i.e., the lower and upper lines) show where the bottom and top 25% of data occur (aka., lower and upper quartile)
- The "X" represents the average of the data. The line within the box represents the median of the data
- The dots show outliers.

Single-family Cost Distribution

The following figure series displays the cost distribution for gas water heaters, gas furnaces, HPWH, and HP HVAC—separated by ducted and ductless system types— installations in single-family homes. The graphs show HPWH installations generally have a narrower cost distribution than HP HVAC installations as 50% of the data occurs within a $2,000 range. Likewise, gas water heater and gas furnace installations have a relatively narrow cost range of about $2,000 to $3,000, respectively. Each appliance type in the datasets has outliers. These outliers are likely due to data entry errors in the datasets (e.g., including full project costs which may include more than the targeted appliance installation). However, using the average and median helps account for this variability since the datasets are large.

Figure 11 CLEAResult Gas Water Heater (Tanked Only) Cost Distribution

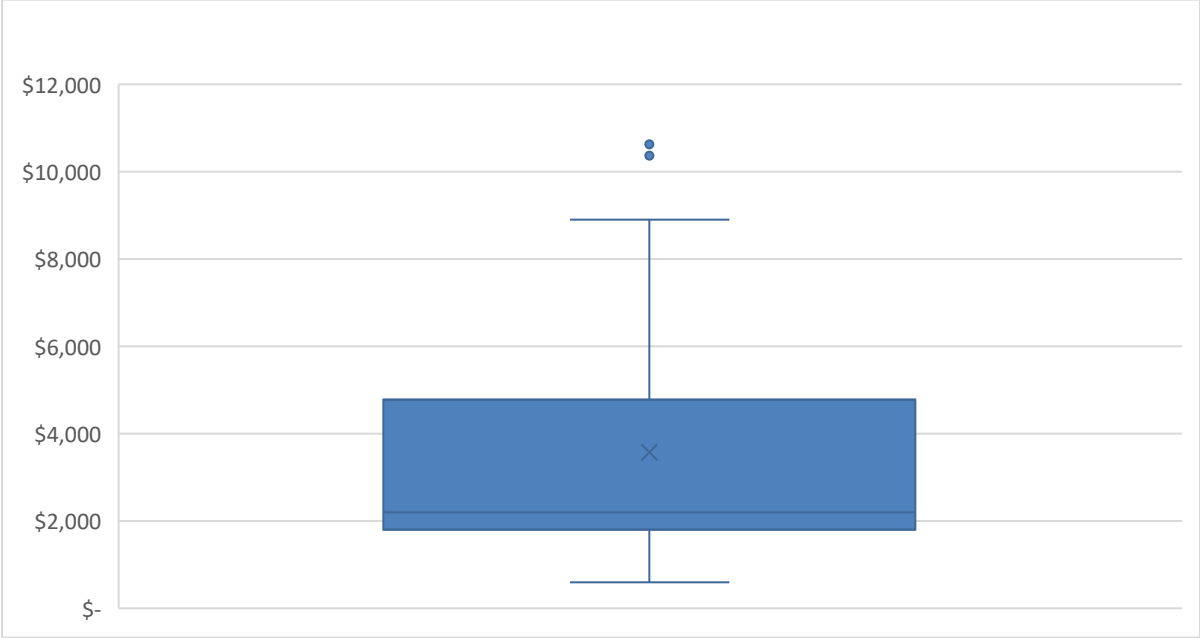


Figure 12 CLEAResult Gas Water Heater (Tanked and Tankless) Cost Distribution

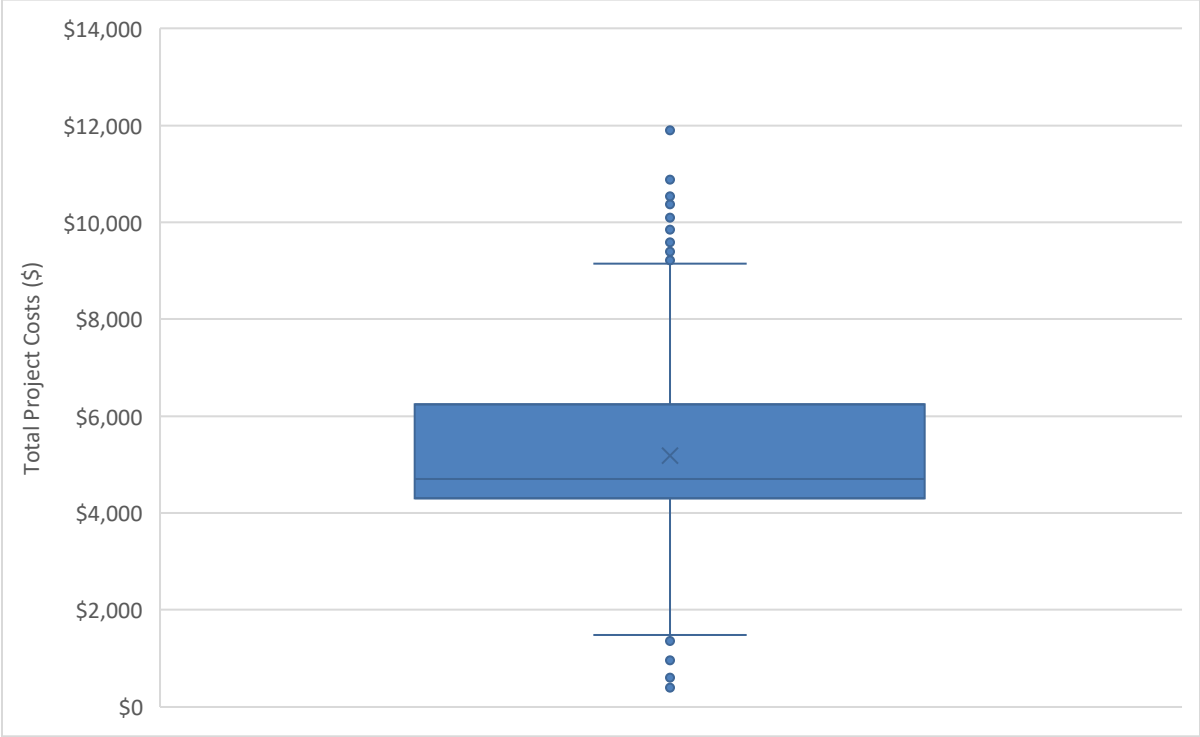


Figure 13 CLEAResult Gas Furnace Cost Distribution

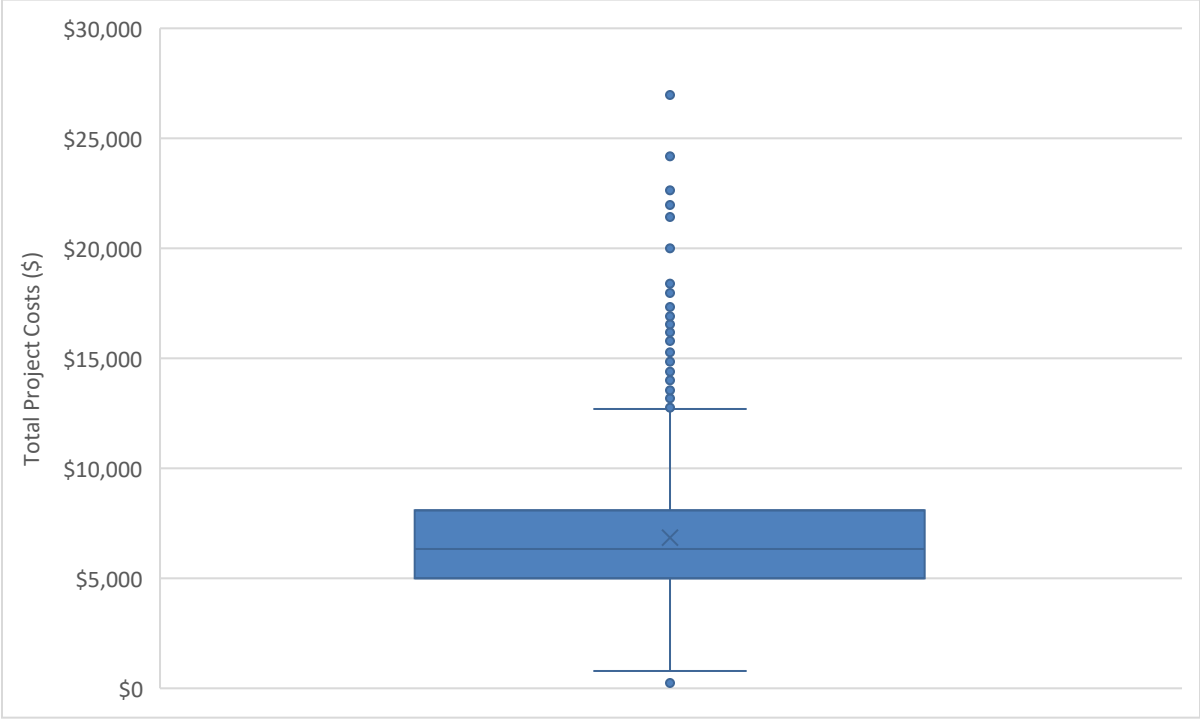


Figure 14 TECH Clean California (Single-family) HPWH Cost Distribution

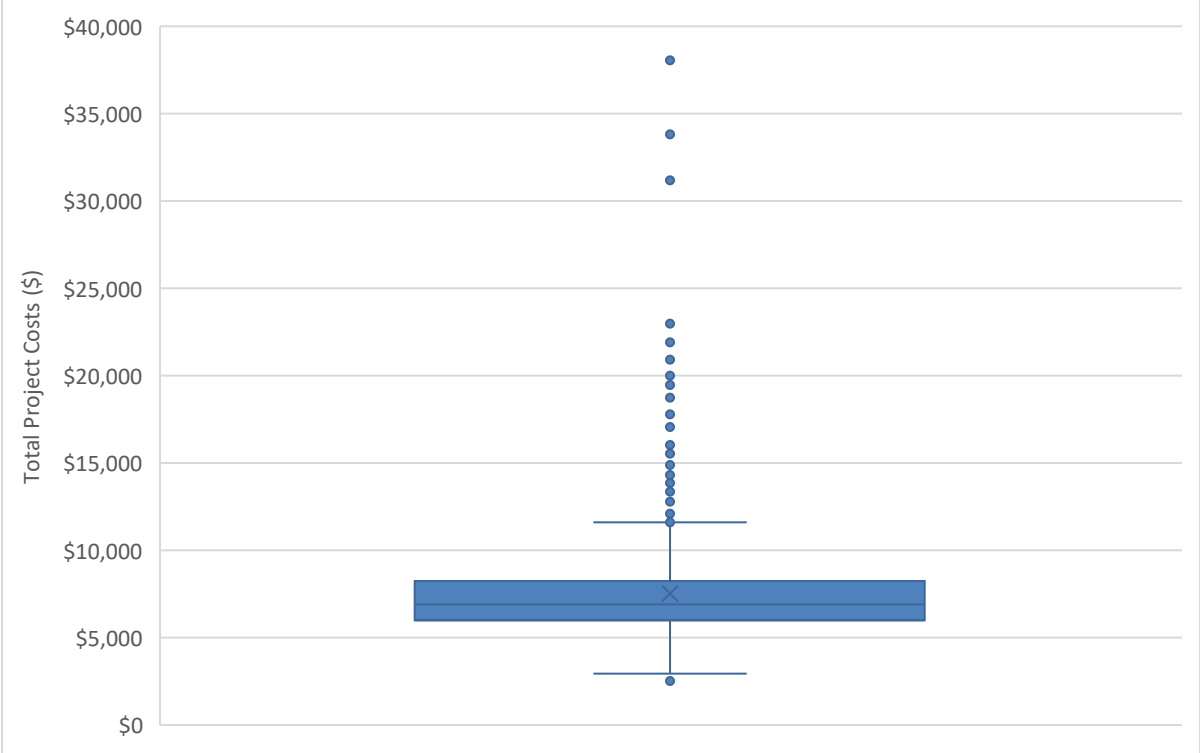


Figure 15 CLEAResult HPWH Cost Distribution

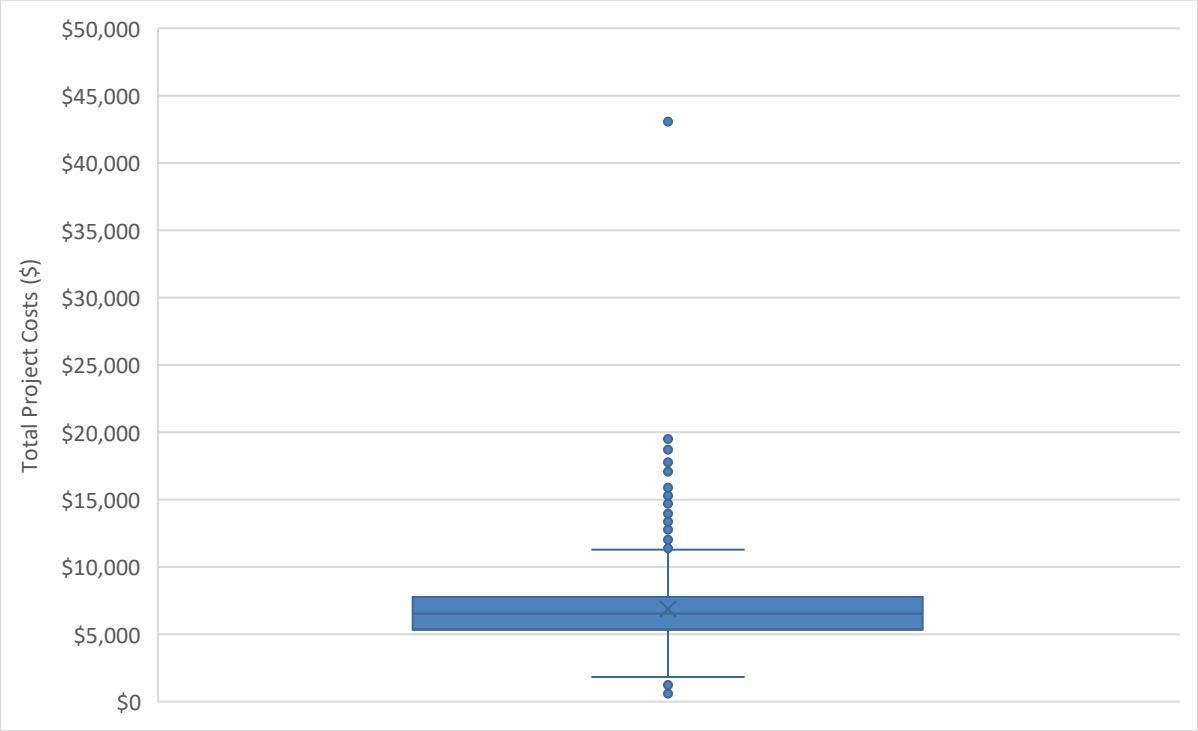


Figure 16 TECH Clean California (Single-family) HP HVAC Cost Distribution

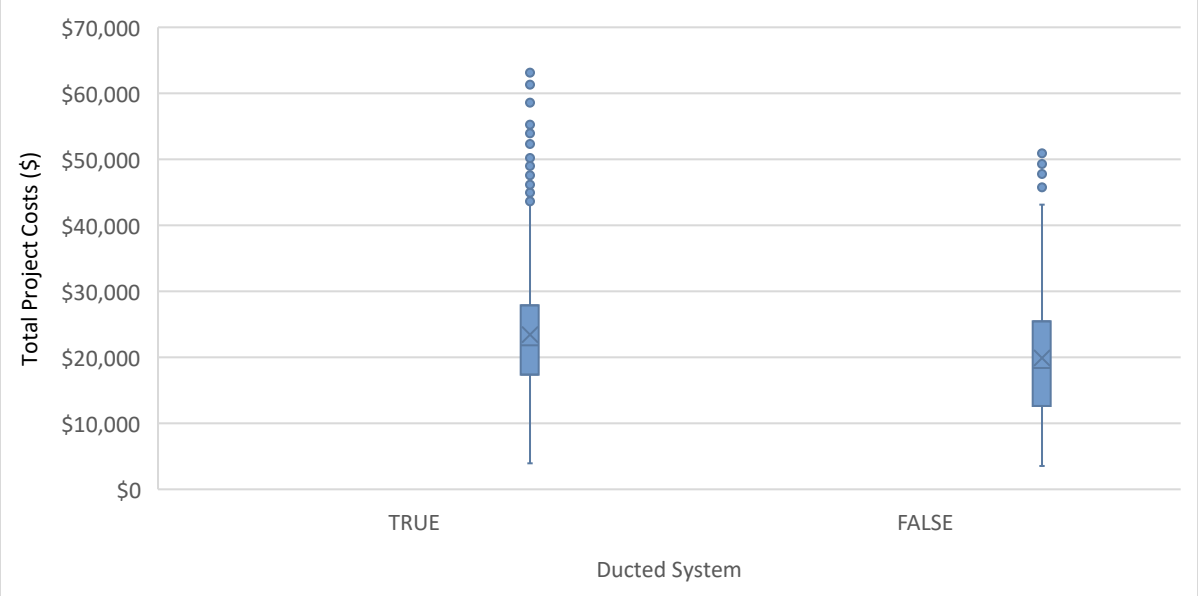
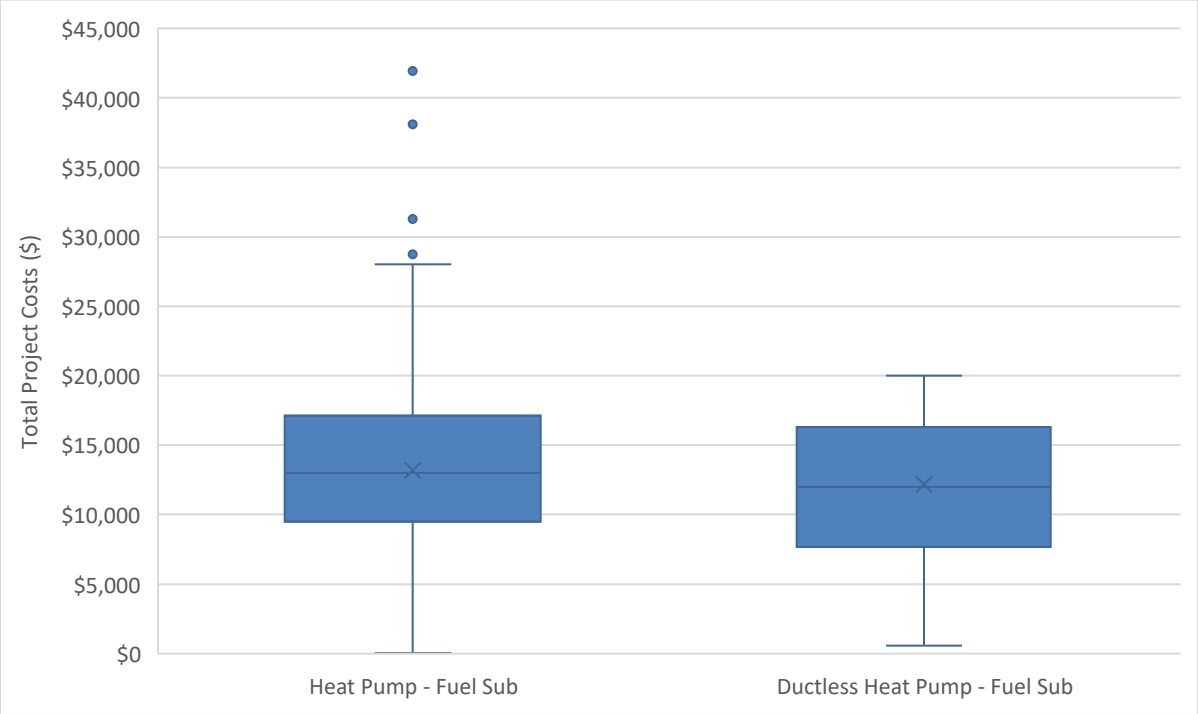


Figure 17 CLEAResult HP HVAC Cost Distribution



Multi-family Cost Distribution

The following figure series displays the cost distribution for HPWH and HP HVAC—separated by ducted and ductless system types— installations in single-family homes. The appliances in each dataset generally have larger cost ranges than those in the single-family installations. Because the datasets are smaller in size, outliers cannot be identified, and the average and median may be less representative of actual costs.

Figure 18 TECH Clean California (Single-family) HPWH Cost Distribution

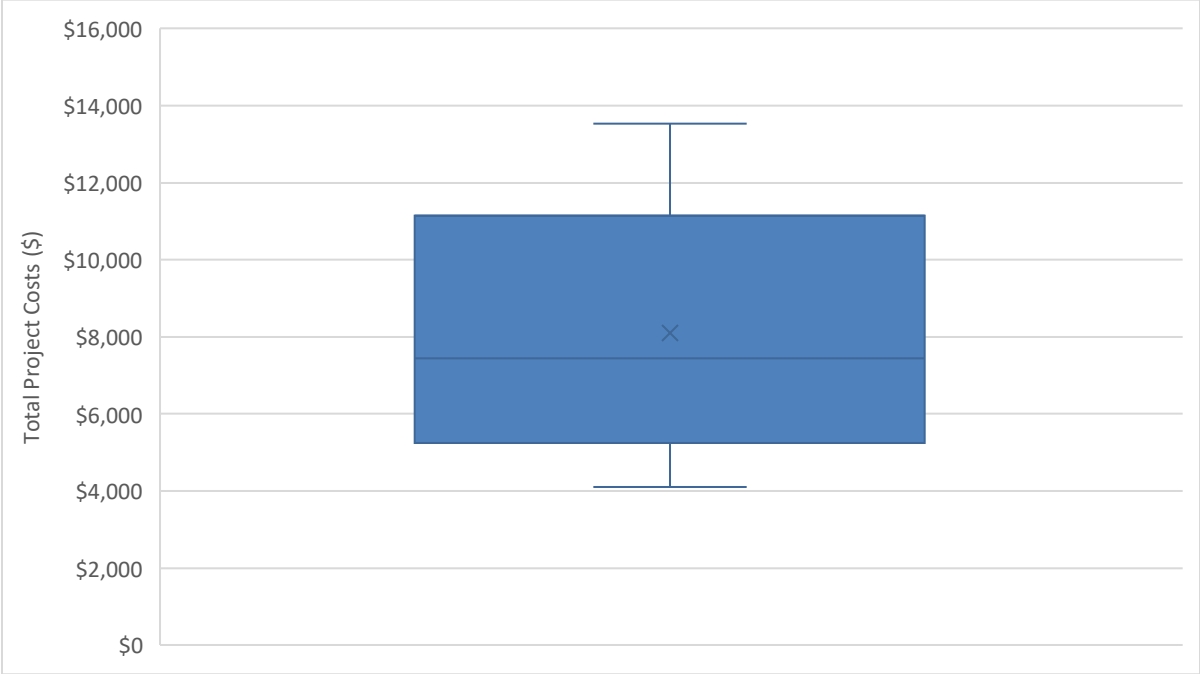


Figure 19 TECH Clean California (Multi-family) HPWH Cost Distribution

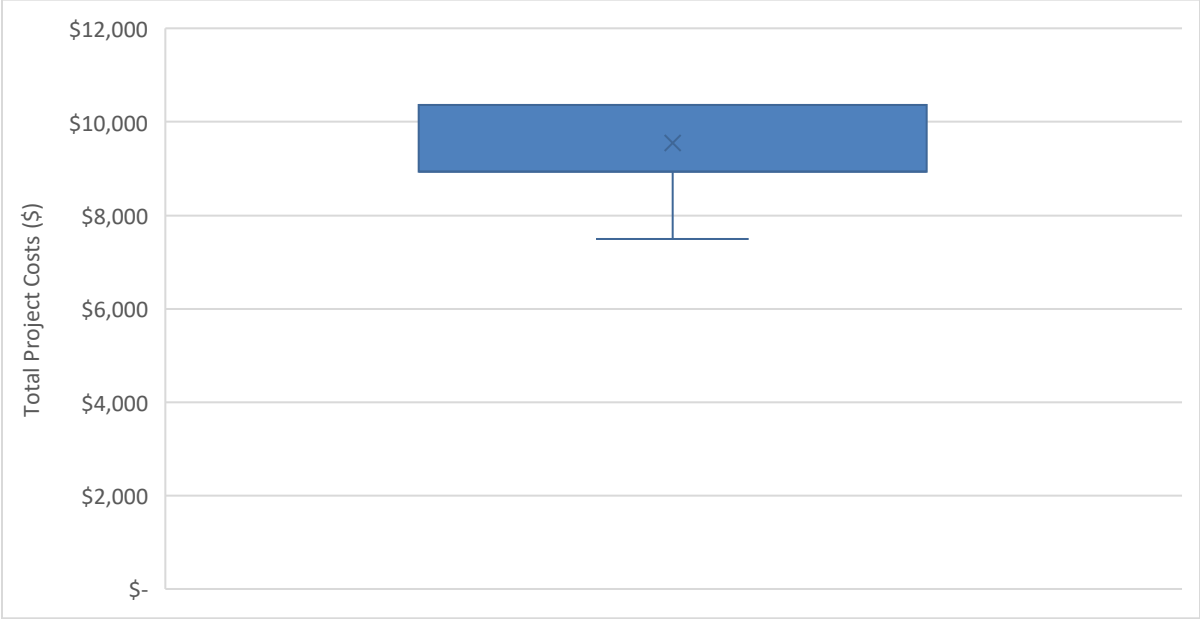


Figure 20 TECH Clean California (Single-family) HP HVAC Cost Distribution

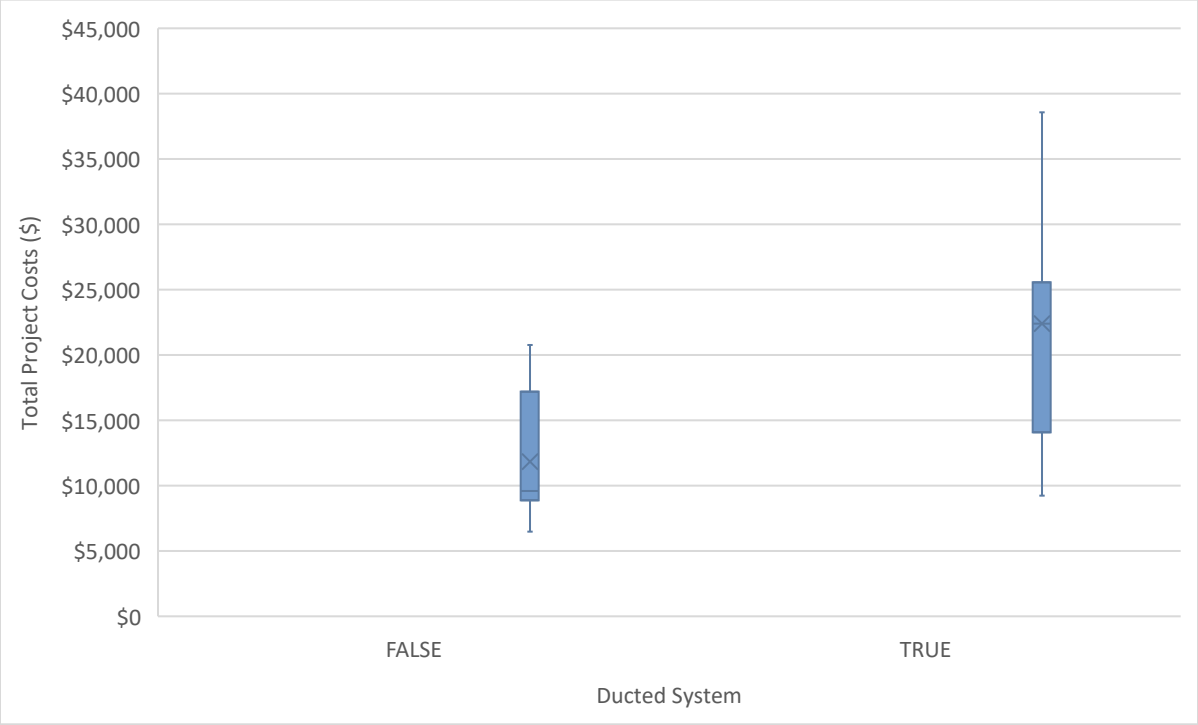


Figure 21 TECH Clean California (Multi-family) HP HVAC Cost Distribution