



Electrification Solutions Analysis

Challenging Water Heater Install Scenarios

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Background

Bar Area Air District Rule 9-6 Update - Zero NOx Water Heater Requirement

The Bay Area Air District plans to implement a Zero-NOx Water Heating policy. The policy would require that tank-type water heaters will be Zero-NOx starting with a manufacture date of 2027, resulting in electrification of this equipment upon replacement in most cases. The emissions reduction opportunity if this policy is successful is enormous. As the same time, the transition poses a variety of challenges as equipment is converted from gas to electric in existing homes and businesses.

Electrification Solutions Analysis

In 2024, SVCE led an RFP to hire a consultant to better understand the implications of the proposed Zero-NOx policy. Scope of work included identifying technical and economic barriers, surveying the technical solutions and Zero-NOx equipment offerings, and summarizing opportunities for program or policy adjustments that could ensure a smooth implementation of the policy. Arup and Redwood Energy were hired as technical consultants, with Silicon Valley Clean Energy, Peninsula Clean Energy, and CleanPowerSF acting as clients and funding the effort.

The following report sections include:

- Summary of Technical and Financial Challenges
- Water Heaters in Small Spaces Challenges
- Water Heaters Electrical Challenges
- Policy Considerations and Emerging Technologies



Summary of Technical and Financial Challenges

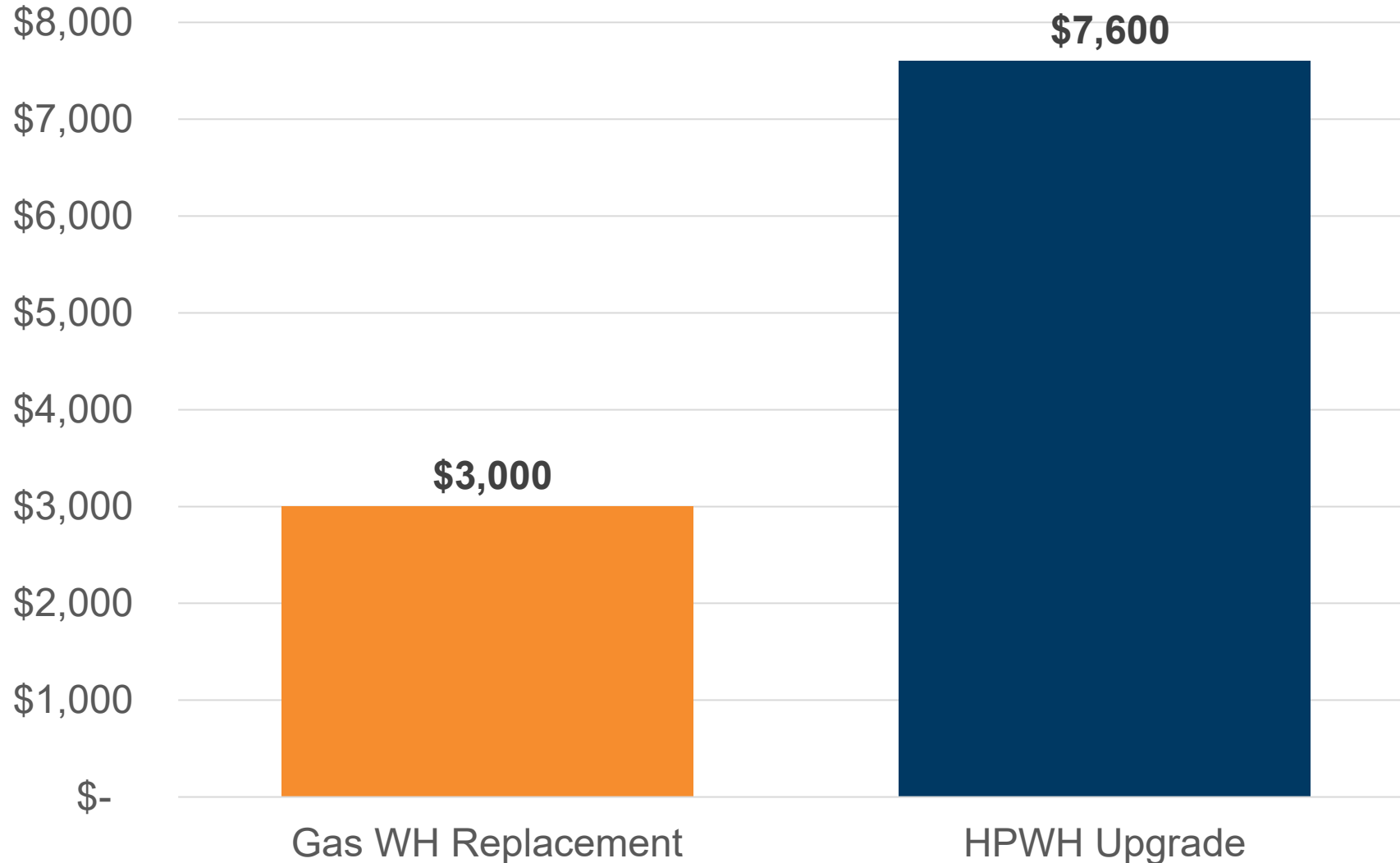


Summary of Challenges

	Challenge	Difficulty (1-10)	Mitigation Strategy	Hyperlink
Plumbing	Noise and Vibration of HPWH	1	Leverage sound isolation and vibration isolation strategies, new models with quieter operation (<45 dBA)	PCE HPWH guidelines for noise and vibration
	Condensate Drainage	2	Send to waste to drain or outdoors. Caveat – some installs require unique emergency drainage solutions.	PCE condensate drainage guidelines
	Emergency Replacements	6	Create an emergency replacement program, utilize plumbers that are competent in running electrical circuits, increase rate of proactive replacement.	SVCE emergency water heater replacement program
Electrical	100A Service per Dwelling Unit	2	Leverage National Electric Code (NEC) calculations or power efficient devices	PCE 100A guidelines
	Power Outages	2	Upsizing the tank, utilizing a mixing valve, & low-flow showerheads to enable 24 hours of hot water capacity.	
	Sub 100A Service per Dwelling Unit	8	Leverage power efficient devices, consider 120V HPWH	PCE 100A guidelines
	Knob & Tube Wiring	10	Requires remediation	
Tight Spaces	Small Space, on exterior wall of home	3	Duct to outdoors	PCE ducting guidelines
	Small Space, on interior of home	9	Relocation, louvered closet, or split system	See section 8



Incremental Cost for Simple Cases



Cost differential between gas WH replacement and a HPWH upgrade is approximately \$4,600

HPWH cost inclusive of:

- Permits
- Upsized tank
- Condensate management
- Added ventilation
- Minor electrical work
- + More

Source: Contractor interviews (gas WH cost), CCA rebate program data (HPWH cost)



Water Heaters in Small Spaces



HPWHs Can Increase Water Heater Size

A common HPWH install in the Bay Area will upsize the tank by over 40%, which allows for extra hot water but exacerbates space-constrained challenges. Below are Bay Area county-by-county statistics using [TECH Clean CA](#) data (assembled May 2025)

County	# of Installs	Previous Tank Size (Gallons)	HPWH Tank Size (Gallons)	Increase In Tank Size	% Tank Size Increase
Alameda	1,165	45.3	65.5	20.3	45%
Contra Costa	453	47.3	65.4	18.1	38%
Napa	16	45.5	54.5	9.0	20%
Sonoma	126	42.7	64.87	22.1	52%
Solano	249	44.5	59.4	14.9	34%
San Francisco	471	42.8	67.9	25.2	59%
San Mateo	442	45.8	64.4	18.6	41%
Santa Clara	770	47.8	64.2	16.4	34%
Marin	142	47.0	62.8	15.8	34%
Total (9-county)	3,834	45.7	64.9	19.1	42%



Small Spaces – Challenges & Solutions

Challenging Condition	Most Appropriate Solutions	
	Best solution	Backup Options
Shared washer-dryer closet	Move to stackable washer/dryer or All-in-one	Relocate Split System
Kitchen	Relocate	Split System
In a crawlspace	For crawlspaces less than 6 feet, specify 50 gallon unit	Relocate Split System
Low clearance garages	Use specific 240V, 50 gallon unit, stored at 140F or higher for larger homes	Relocate Split System
Small space, interior of home	Louvered door (potential noise concerns if near living area)	Relocate Split System

Not all small spaces are created equal. Different existing conditions have different preferred solutions. The table at right outlines the best solution, and viable alternatives, for a variety of small water heater locations encountered in the field.



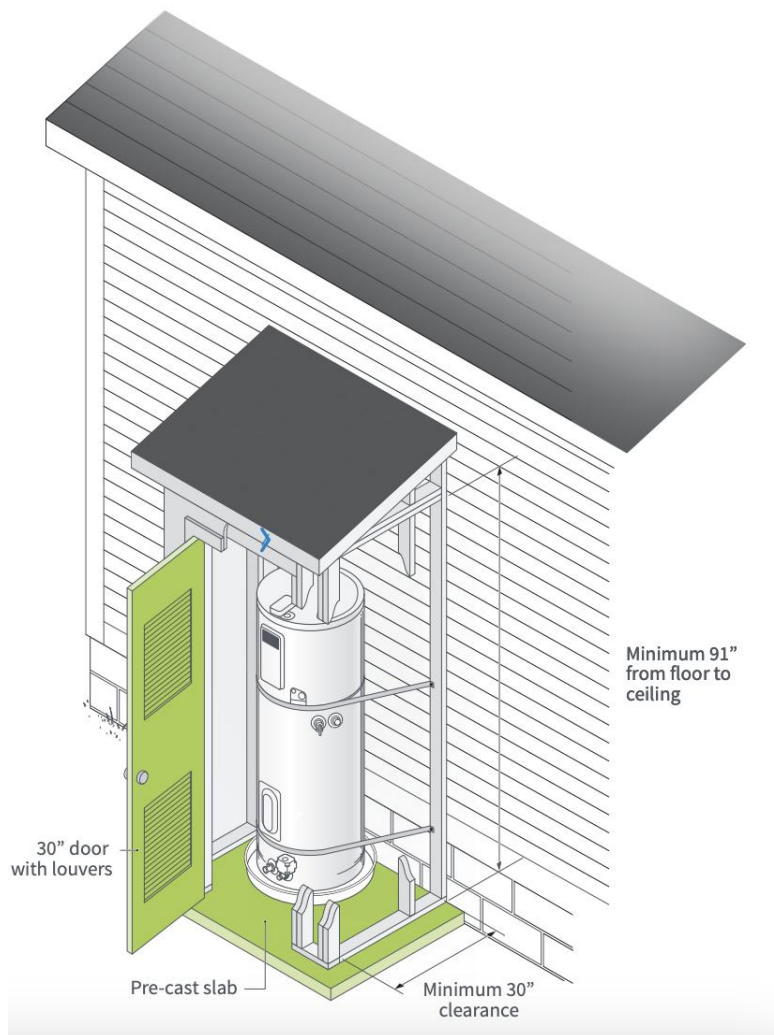
Relocation

If it doesn't fit, move it out.

Relocating water heating systems to a new location can free up space. The most typical approach is to move the unit outdoors and build an exterior closet.

When to use:

- Tiny interior closet
- Under a stairway
- Kitchen or other living area
- When a water heater is near a bedroom
- Noise-sensitive occupants



Costs

Relocation Cost = \$1,500
HPWH Installation Cost = \$7,600
Total Cost = \$9,100

Labor Hours

2 - 4 hours (*factored into relocation cost*)

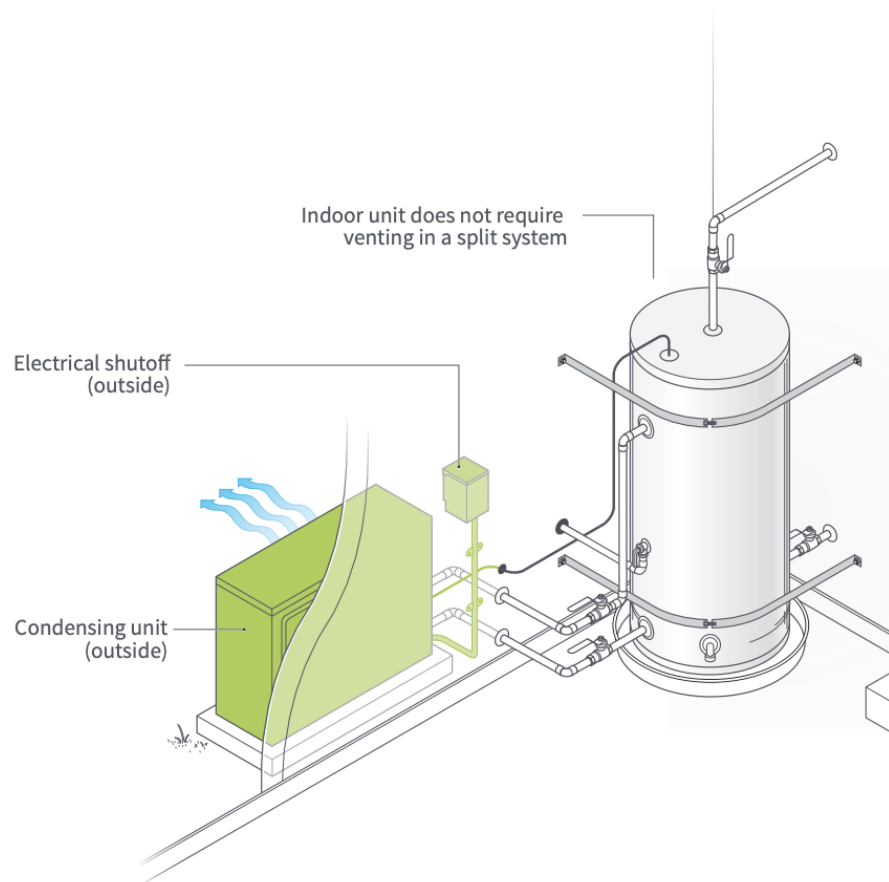
Split Systems

Split the System

Split system water heaters decouple the heat pump from the tank, like most household air conditioners. This mitigates the need for ventilation to the tank.

When to use:

- Tiny interior closet
- Under a stairway
- Kitchen or other living area
- When a water heater is near a bedroom
- Noise-sensitive occupants



Costs

Split System Total Cost
(Equipment & Installation) =
\$12,000 – 25,000

Note: CCA programs have seen Sanden SanCO2 split system total costs of \$12,300. There may be less expensive, newer split options now available.



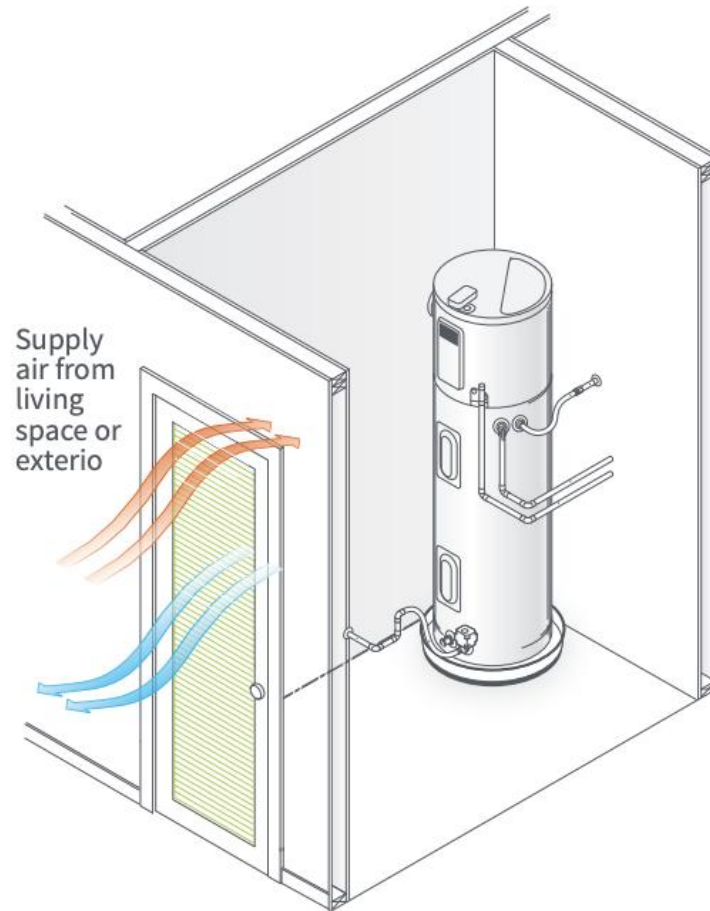
Louvered Doors

Ventilate with Louvered Doors

Louvered doors are aesthetically pleasing without blocking air flow. Some water heaters have special requirements, but in small spaces you can generally use louvered doors for ventilation. Consider potential noise impacts to adjacent living spaces before using this approach.

When to use:

- Tiny interior closet
- Shared washer-dryer closets, where stackable washer-dryer is not an acceptable solution



Costs

Door and Install Cost = \$750
HPWH Installation cost = \$7,600
Total Cost = \$8,350

Labor Hours

~1 hour (factored into door + install costs)

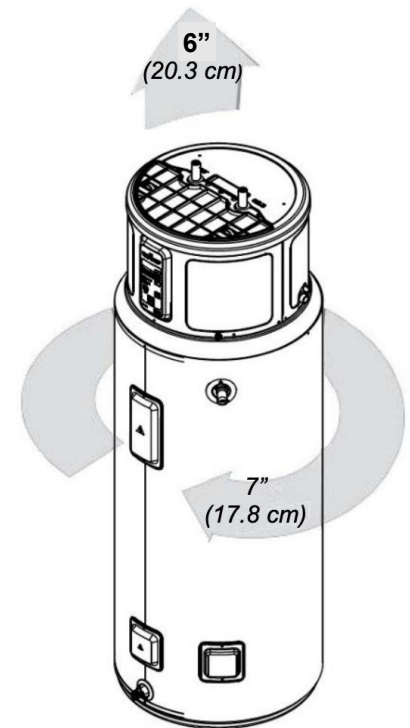


Low Clearance Garages

The California Building Code requires protection of water heating equipment from vehicles when located in garages. While this requirement is likely meant for gas-fired water heaters due to flammable gases and hazardous exhaust fumes, the requirement applies to both gas and electric water heaters. The 18" pedestal required in garages results in a minimum total garage height of 7.2 feet for the smallest heat pump water heater currently available on the market. If the garage ceiling is less than 7.2 feet, consider relocating the water heater or installing bollards to avoid relocation.

Note: If the local Authority Having Jurisdiction rules that a pedestal is only allowed for gas water heaters, the ceiling can be as low as 6 feet.

Component	Height
Pedestal	18"
Rubber mat	0.5"
Rheem 50G HPWH	61.75"
Airflow requirement above unit	6"
Total height required	86.25" (7.2')

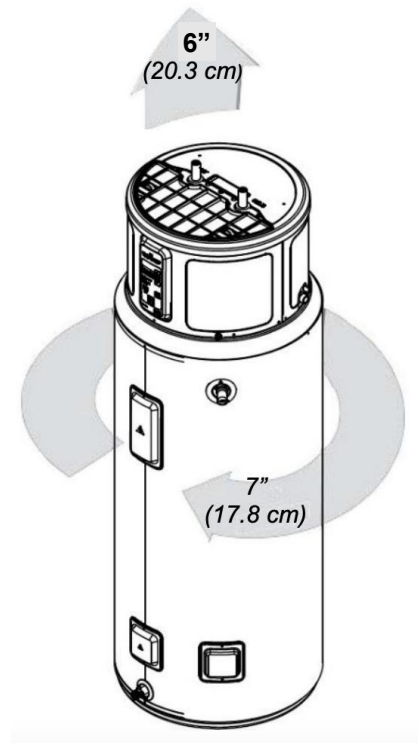




Low Clearance Spaces (non-Garage)

If a water heater is located in an area with a ceiling that is less than 6 feet, pay careful attention to water heater specifications before purchase. Only some heat pump water heaters are short enough to be installed in 6 foot spaces.

Component	Height
Pedestal	4"
Rheem 50G HPWH	61.75"
Airflow requirement above unit	6"
Total height required	71.75" (5.97')





Small Space Cost Summary

Costs associated with solutions to electrifying water heaters in small spaces have been compiled from a variety of sources, including:

- Existing fixed-pricing for turnkey programs operated by Bay Area CCAs and utilities
- Rebate program data
- Manufacturer websites
- New Buildings Institute 120V pilot report

Some of these costs may already factored into the \$7,600 average cost for a HPWH upgrade reported by CCA rebate programs.

Solution	Cost	Source
Relocation	\$1,500	CCA turnkey pricing CPAU WH program costs
Split Systems	\$12,000 – 25,000	SFPUC & PCE WH rebate program project costs
New Split Systems	New split systems are coming on the market in 2025 and may be less expensive (~\$3,500).	Eco-logical.com
Louvered Door	\$750	Home Depot equipment cost + estimated labor cost
Added Ventilation	\$600 – 900 (ducting) \$210 (basic vents)	CCA turnkey pricing CPAU WH program costs
Thermostatic Mixing Valve	\$250	NBI 120V HPWH pilot TMV cost



Air District Research on Space Constraints

Split systems & on-demand electric equipment options

Appliance	Space Requirement	Building Application	Pros/Cons
SANCO2: Central mini-split HPWH ¹	43-83 Gallon	Multi-family	Currently in-use for multi-family central HPWH retrofits
Steibel Eltron 24 kW 4.68 GPM Residential Tankless Water Heater ²	1-2 showers; 16.5" by 4.5"	Small spaces/ apartment buildings	Requires minimum of 150 amp total service to residence; considered to be less energy efficient than HPWH
120 volt 41 Gallon HPWH Split System (EmberH2O) ³	41-Gallon	Manufactured Homes/ Utility Closets	Emergent technology still in pilot phase in California; market available in Australia.



Air District Research on Space Constraints

Electric resistance has limited T24 code compliance

- H. **Water-heating system.** Altered or replacement service water-heating systems or components shall meet the applicable requirements below:
- i. **Pipe insulation.** For newly installed and existing accessible piping, the insulation requirements of Section 150.0(j)1 shall be met.
 - ii. **Distribution system.** For recirculation distribution systems: serving individual dwelling units, only demand recirculation systems with manual on/off control as specified in the Reference Appendix RA4.4.9 shall be installed.
 - iii. **Water heating system.** The water heating system shall meet one of the following:
 - a. A natural gas or propane water-heating system; or
 - b. A single heat pump water heater. The storage tank shall not be located outdoors and be placed on an incompressible, rigid insulated surface with a minimum thermal resistance of R-10. The water heater shall be installed with a communication interface that either meets the requirements of Section 110.12(a) or has an ANSI/CTA-2045-B communication port; or
 - c. A single heat pump water heater that meets the requirements of NEEA Advanced Water Heater Specification Tier 3 or higher; or
 - d. If the existing water heater is an electric resistance water heater, a consumer electric water heater; or
 - e. A water-heating system determined by the Executive Director to use no more energy than the one specified in Item a above; or if no natural gas is connected to the existing water heater location, a water-heating system determined by the executive director to use no more energy than the one specified in Item d above.

ER replacing gas may only be approved on case-by-case basis



BAAQMD Solutions for Space Constraints

Electric resistance (tanked/tankless) is not a viable option

1. Very limited T24 compliance	Must seek approval for exception
2. Electric service requirements & grid impacts	<ul style="list-style-type: none">• Tankless ER - not an option for <150A service (often have 50+ Amp ratings) & makes electrification of other end uses on existing service impossible• Tanked ER - lower ratings (~30A) but still challenging to accommodate with existing service
3. Bill impacts	Lower install costs (cheaper equipment) but ER bill impacts quickly outpace the upfront savings. While ER can be paired with solar (fixed rooftop, plug-in portable systems) to reduce bill impacts, the system costs are high (fixed rooftop) or have compliance challenges (plug-in portable systems lack NEC compliance and UL certification, Source: Canary Media Balcony Solar Challenges)
4. Minimum flow-rate requirements	Tankless ER may be incompatible with low flow showerheads since flow rate does not trigger WH to turn on



Small Spaces Prevalence by County

Santa Clara County BayREN Home Energy Score Data

BayREN Home Energy Score Audits performed between 2020 and 2025 included water heater location information. These tables outline the water heater location prevalence of the 1,921 homes in Santa Clara County that include water heater location data (which corresponds to 70% of the HES dataset). The vast majority of water heaters are in garages, with 4% located in interior spaces.

Water Heater Location	% of Santa Clara County Sample
Garage	68%
Basement	20%
Outdoors	6%
Interior Closet	4%
Living space	< 1%
Attic	< 1%
Other	< 1 %



Small Spaces Prevalence by County

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* Monte Sereno, & Los Altos Hills are among the smallest jurisdictions in Santa Clara County and may not have statistically significant samples in the BayREN dataset with only 10 houses total.

Jurisdiction	% of Water Heaters Located in Interior Closet
Campbell	1%
Gilroy	2%
Los Gatos	3%
Milpitas	3%
San Jose	3%
Mountain View	3%
Cupertino	4%
Los Altos	5%
Sunnyvale	5%
Santa Clara	6%
Saratoga	14%
Monte Sereno*	17%
Los Altos Hills*	25%
Morgan Hill	N/A



Water Heaters Electrical Challenges



Electrical Cost Summary

Incremental costs vary significantly

Solution	Cost	Source	Additional Considerations
220.83 NEC calculation	\$0		
Tandem breakers	\$15 - 100	Equipment-only ('Simply Breakers')	
120V HPWH	\$7,500	CCA turnkey pricing (equipment+ install cost)	
Power efficient strategies	\$250 – 1,000s	Assumes circuit splitters > smart panels	
Subpanel	\$1,600	CCA turnkey pricing	
Panel Replacement	\$3,700	PCE rebate project data	Increased project timeline (weeks - months)
Service Upgrade	\$5,000 – 11,000	Assumes \$1-7k additional costs above panel replacement (BAAQMD report PG&E costs)	Increased project timeline (12-18 months)
Mitigate knob & tube wiring	\$24,000	CCA turnkey pricing	Increased project timeline (weeks)



Electrical Cost Summary

Incremental costs vary significantly

Not every electrical barrier is created equal. Different barriers call for different solutions, which have different prices. The table below outlines the preferred solution based on each existing issue, the backup options, and the associated price for each approach.

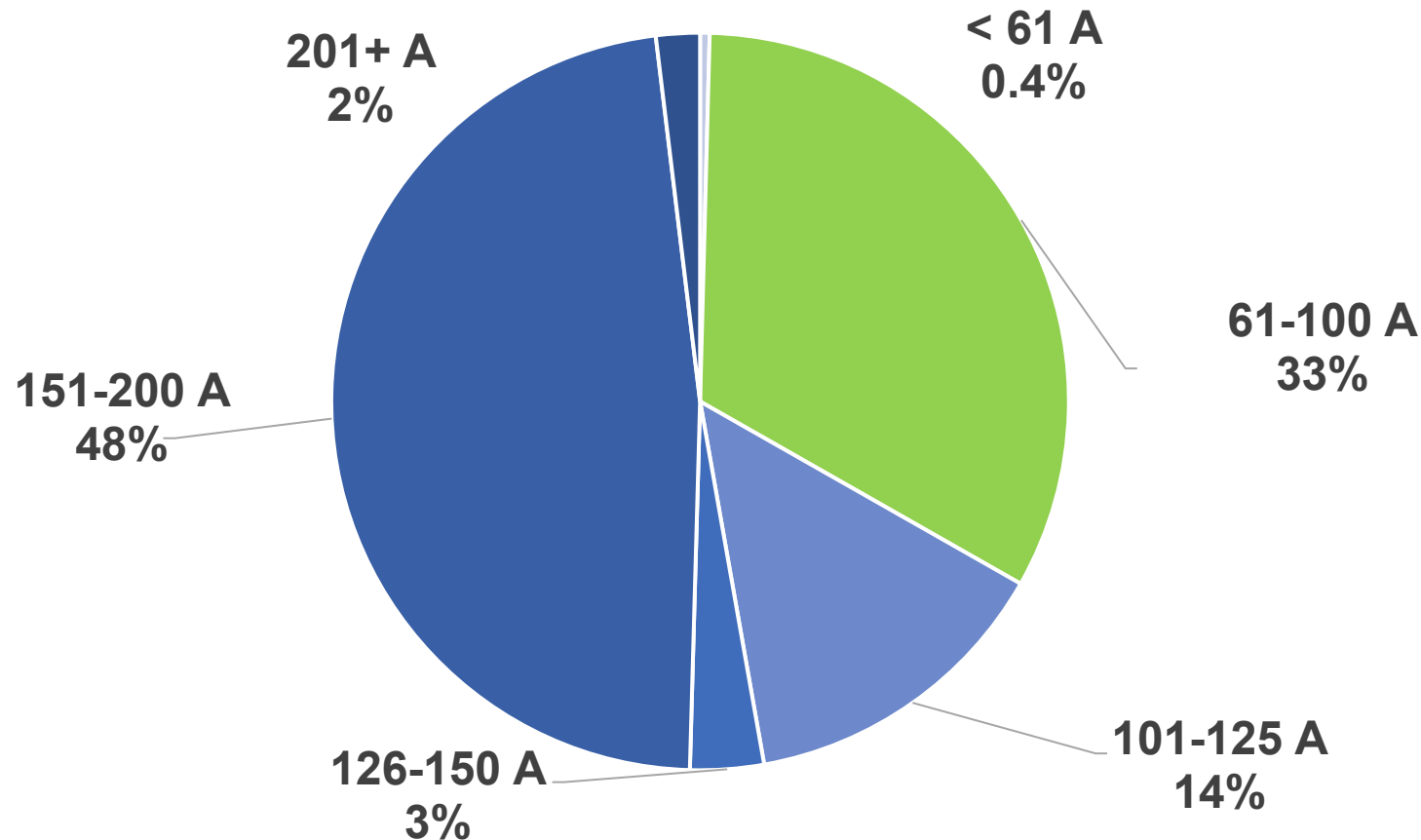
Barrier	Best solution	1st Backup	2nd Backup
Limited Breaker Slots	Tandem breakers (\$15-100)	Subpanel (\$1,600)	Panel replacement (\$3,700)
Knob & Tube Wiring	Mitigate knob and tube (\$24,000)		
Limited Electrical Service (80A per dwelling unit or less)	Service upgrade (\$5,000-\$11,000)	Power efficient strategies (\$250-\$1,000s)	120V HPWH (\$7,600)
Limited Electric Service (100A per dwelling unit or less)	220.83 calculation (\$0)	Power efficient strategies (\$250-\$1,000s)	
Unsafe Panels (e.g. Federal Pacific)	Panel replacement (\$3,700)	Subpanel (\$1,600)	120V HPWH (\$7,600)



Electrical Prevalence by County

Santa Clara County BayREN Home Energy Score Data

Main Panel Capacity



Solutions must be found for full-electrification of 60-100A homes

66% of homes should be easy to fully electrify (with 100A +)



Policy Considerations and Emerging Technologies



Air District Policy Considerations

Two major challenges are electrical infrastructure and space-constrained installations

- Space Constrained Installations, two options, need more:
 - Split Systems (increase expense)
 - Relocation (increase expense)
 - **Need More Form Factors** (unlikely before 2027)
- Electrical Infrastructure – **NO fast fixes:**
 - Knob & Tube
 - Out of Compliance Panels (Federal Pacific)
 - Sub 100-Amp Panels (common in older multifamily)



Promising Emerging Technologies



Next Gen Water Heaters

New features such as higher 160F storage temperature and dual (120v/240v) voltage help with small footprints or emergency replacements.



New split systems

New split systems have arrived which are providing a lower price point for a split-system approach.



Multifunction Heat Pumps

These Air-to-water heat pumps are common overseas and have been slowly growing in the U.S. They offer flexible designs to electrify, similar to a split system but also provide heating.



Technologies In Development

Solar water heaters with integrated tanks and backup electric heat

Solar hot water systems are over two times as efficient at collecting the sun's energy as solar photovoltaic panels. Common in parts of Europe, integrated tank systems are an especially reliable option and are available with backup electric heating elements.



Wall-mounted heat pump water heaters

Wall-mounted heat pump water heaters are widely available in Europe and Asia, including from American manufacturer AO Smith. These units may be useful in tackling the small spaces problem.



Extra Slides

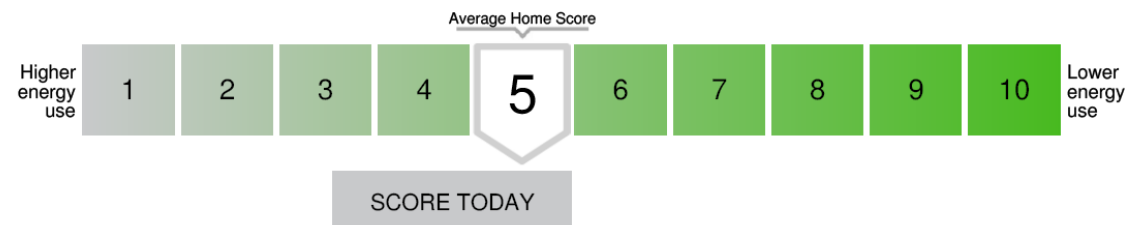


BayREN Home Energy Score Data



What is Home Energy Score?

- Developed by U.S. Department of Energy and its national laboratories
- Enables comparison: similar to a miles-per-gallon rating for a car or nutrition facts– but for your home
- Provides homeowners, buyers, and renters comparable and credible information about a home's energy use



Nutrition Facts	
Serving Size 172 g	
Amount Per Serving	
Calories 200	Calories from Fat 8
% Daily Value*	
Total Fat 1g	1%
Saturated Fat 0g	1%
Trans Fat	
Cholesterol 0mg	0%
Sodium 7mg	0%
Total Carbohydrate 35g	12%
Dietary Fiber 11g	45%
Sugars 6g	
Protein 13g	
Vitamin A 1%	Vitamin C 1%
Calcium 4%	Iron 24%

*Percent Daily Values are based on a 2,000 calorie diet. Your daily values may be higher or lower depending on your calorie needs.



What to Expect During an HES

- HES is an in-person simplified, primarily visual energy assessment
- A certified Assessor will come to the home and collect over 50 data points on the home's construction, appliances, the size of home, and more
 - Will need access to any attics, basements, crawlspaces and outside of the home
- It does not include diagnostic testing like a blower door test or duct blasting, but often these can be added on for an additional fee
- The HES takes about 1 hour depending on the size of the home (more if testing is added)



Home Energy Score Energy Savings Pathway Report

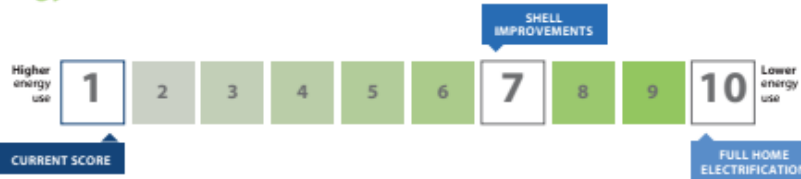


U.S. DEPARTMENT OF ENERGY
Home Energy Score™

LOCATION: YEAR BUILT: 1908
BEDROOMS: 3 HEATED FLOOR AREA: 1,932 sq.ft. ASSESSMENT DATE: 04/15/2024
COMPANY: ASSESSOR:
EMAIL: PHONE:

Current Score	Recommended Shell Improvements ¹	Full Home Electrification ²
1 OUT OF 10 Estimate of Current Yearly Energy Costs ³ \$3,823	7 OUT OF 10 Estimate of Energy Costs with Shell Improvements \$2,808	10 OUT OF 10 Estimate of Energy Costs with Electrification \$2,833

Home Energy Score Details



Official Assessment: ID# 513669

Average U.S. Home's Score = 5

The U.S. Department of Energy's Home Energy Score assesses the energy efficiency of a home based on its structure and heating, cooling and hot water systems. Learn more at HomeEnergyScore.gov.

Current Estimated Energy Use By Fuel Type³

Fuel Type	Estimated Current Use	After Shell Improvements	After Full Electrification
Electric: 7,070 kWh/yr (\$0.31/kWh)	\$2,190	\$2,102	\$2,833
Natural Gas: 689 therms/yr (\$2.37/therm)	\$1,633	\$706	\$0
Other:	\$0	\$0	\$0
Renewable Generation: (\$0.31/kWh)	N/A	N/A	N/A
TOTAL ESTIMATED YEARLY ENERGY COSTS	\$3,823	\$2,808	\$2,833

This Home's Carbon Footprint⁴

Carbon footprint by fuel type (measured in Metric tons of CO₂): Electric: 0.3 Natural Gas: 3.6



Learn how to improve this score and electrify your home to use less energy on the next page.



Basic home information



Current score and score if different improvement pathways are taken



Estimated energy costs, energy consumption for current home and improvement pathways



Estimated carbon emissions

Tackle energy waste today!

- Get your home energy assessment. Done!
- Choose energy improvements from the list of recommendations below.
- Select a contractor (or two, for comparison) and obtain bids.
- Perform upgrades and enjoy a more comfortable and energy efficient home.

Current Score
1
OUT OF 10

For More Information Visit the Websites Below

BayREN Homeowner Info



SCAN ME

bayren.org/homeowners

State Information



SCAN ME

energy.ca.gov

US Rebates & Tax Credits



SCAN ME

energy.gov/save

Incentive Information



SCAN ME

incentives.switchchison.org

Energy Improvements Customized for Your Home

SHELL IMPROVEMENTS ¹		
FEATURE	TODAY'S CONDITION	RECOMMENDED IMPROVEMENTS
Envelope/Air sealing	Not professionally air sealed	Professionally air seal
Attic insulation	Ceiling insulated to R-3	Insulate to R-44 or higher
Duct insulation	Insulated	No recommendation
Duct sealing	Sealed	No recommendation
Wall insulation	Insulated to R-0	Insulate to R-13 or higher
Floor insulation	Insulated to R-0	Insulate to R-30 or fill floor cavity
Knee Wall insulation	Knee wall insulated to R-0	Insulate to R-15 or higher
Cathedral Ceiling/Roof	Roof insulated to R-0	Insulate R-30 or maximum possible
Windows	Single-pane	Upgrade to double-pane or other high-efficiency windows

FULL HOME ELECTRIFICATION IMPROVEMENTS ²		
FEATURE	TODAY'S CONDITION	RECOMMENDED IMPROVEMENTS
Appliances: Heat Pump Dryer	No Dryer	Replace with electric or heat pump dryer
Appliances: Induction Cooking	Gas Range/Cooktop	Replace with induction range
Air Conditioner	None installed	Upgrade to Electric Heat Pump, minimum 15 SEER
Heating equipment	Natural gas furnace 80% AFUE	Upgrade to Electric Heat Pump, minimum 8.6 HSPF
Solar PV	None installed	Consider solar PV
Water Heater	Natural gas UEF 0.63	Replace with heat pump hot water heater

Next page provides additional notes from your Home Energy Score Assessor

← Next steps to take action

← Rebate and tax credit information

← Current conditions and recommendations about building shell improvements

← Current conditions and recommendations about electrification improvements

How it Works

- Program is run through [HES Partners](#)
 - Partner (StopWaste for BayREN) performs mentoring for new Assessors
- Assessors must hold a credential from [DOE list](#)
 - Pass DOE Simulation training
 - Enroll with a partner
- Partner performs DOE-required QA check of 5% of all scores
 - Ensures the results for a home are unbiased and do not differ between assessors
- BayREN program includes additional checklist of electrification-specific items not in DOE HES
- Detailed scoring methodology:
<https://betterbuildingsolutioncenter.energy.gov/home-energy-score/home-energy-score-methodology>

