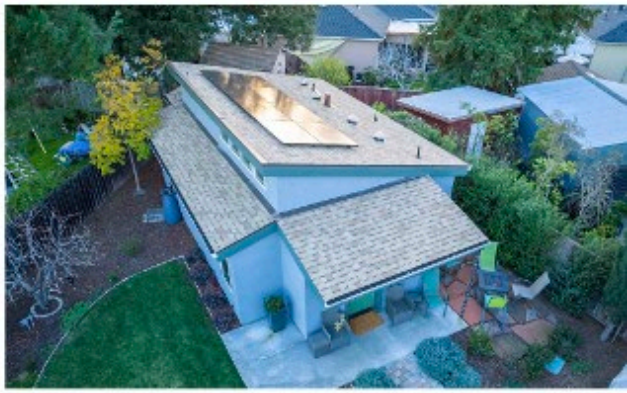
PENINSULA CLEAN ENERGY



Case Study of Whole-Home Electrification at Nine Low-Income Homes in San Mateo County

July 2025

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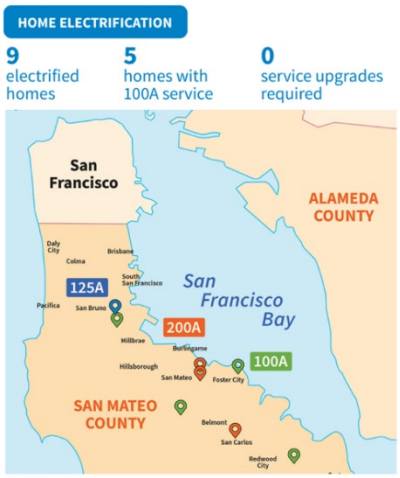
Executive summary

In 2024, Peninsula Clean Energy (PCE) fully electrified nine low-Income homes in San Mateo County through a pilot home electrification project. The primary objectives of the pilot were to: assess if whole home electrification can be achieved without upgrading electrical service, evaluate the performance and customers' experience of electric equipment and appliances in a typical home, and quantify both the capital and operational costs of electrification. The pilot's results will inform future PCE efforts it aims to help transform all of the homes its service area into carbon-free, all-electric buildings.



Peninsula Clean Energy is a not-for-profit public agency with a mission to provide affordable, clean electricity and support local solutions that lower costs, reduce pollution, and strengthen community resilience. PCE serves San Mateo County and Los Banos, providing clean electricity and other energy programs that support local objectives. As one of California's Community Choice Aggregation (CCA) organizations, PCE's cost savings are passed on directly to customers and reinvested in communities. Richard Heath & Associates, Inc. (RHA) implemented the Whole Home electrification pilot. Nine homes were selected, and all fossil fuel appliances were replaced with high-efficiency, electric equipment. The project was a resounding success.

Key findings:

- **All fully-electrified homes that were studied for bill impacts would see reduced monthly bills with the correct rate,** 5 of the 6 homes yielded customer savings post-electrification, and the 6th home would have saved money had the customer moved to an electrification rate.
- **On average, electrifying their homes saved customers about 20% on their energy bills.** Most customers can save an additional 8% by switching to an electrification rate, such as EV2-A.
- **No service upgrades required:** All homes were able to electrify without electrical service upgrades, and five of the homes had 100A service.
- **High customer satisfaction:** The average satisfaction score for a home's new electrical appliances was 4.6/5.0.

The table below summarizes the equipment installed at each home, as well as the costs and impact on each home's electrical system.

				Appliances Electrified - white indicates existing electric eqpt				
House	**Price**	**Panel Amps**	**Service Upgrade**	**# of Gas Appliances**	**Water Heating**	**Space Heating**	**Cooking**	**Clothes Drying**
San Mateo 1	$34,312	100A	No service upgrades required in pilot	4	120V	Ducted	Induction	Electric
Foster City	$36,179	100A		3	240V			
Millbrae	$33,556	100A		2				
Menlo Park	$45,187	100A		4		Ductless	Induction	Electric
Woodside	$48,595	100A		4		Ducted		
San Bruno	$36,788	125A		3				
San Carlos	$12,111	200A		2		Ductless		
San Mateo 2	$35,871	200A		3		Ductless	Induction	
San Mateo 3	$31,907	200A		2				
Average	**$34,945**			**3.0**				

Project background

Whole Home pilot and Home Upgrade Program summary

The goals of the Whole Home pilot were to determine the installation costs and on-bill impacts of whole home electrification in typical single-family homes. Additionally, the pilot aimed to determine if market barriers could be overcome—namely, electrifying without upgrading electrical service in a home. The pilot participants were selected from customers who expressed interest in the Home Upgrade program, met the minimum qualifying criteria, and were able to be served within the total budget and pilot timeline.

This pilot was run under PCE's Home Upgrade program. The original Home Upgrade Program provided income-qualified, single-family residences with no-cost home repairs and upgrades, energy efficiency measures, and at least one electrification measure. Homes were evaluated to determine and prioritize all feasible measures that could be installed through the Home Upgrade and other leveraged programs. Peninsula Clean Energy and Silicon Valley Clean Energy launched a new version of the Home Upgrade Program in 2024, targeting **hundreds of homes per year and installing full electrification at each home**. Costs for low-income homes will be entirely covered by the CCAs.

Home Upgrade Program eligibility criteria

To be eligible for the program, participants must:

1. Live in San Mateo County or the City of Los Banos
2. Own and live in a single-family home, duplex, triplex, or fourplex
3. Currently use gas or propane appliances
4. Have a household income at or below 80% of the area median income

Whole Home Electrification pilot eligibility criteria

The additional Home Upgrade Whole Home pilot criteria were:

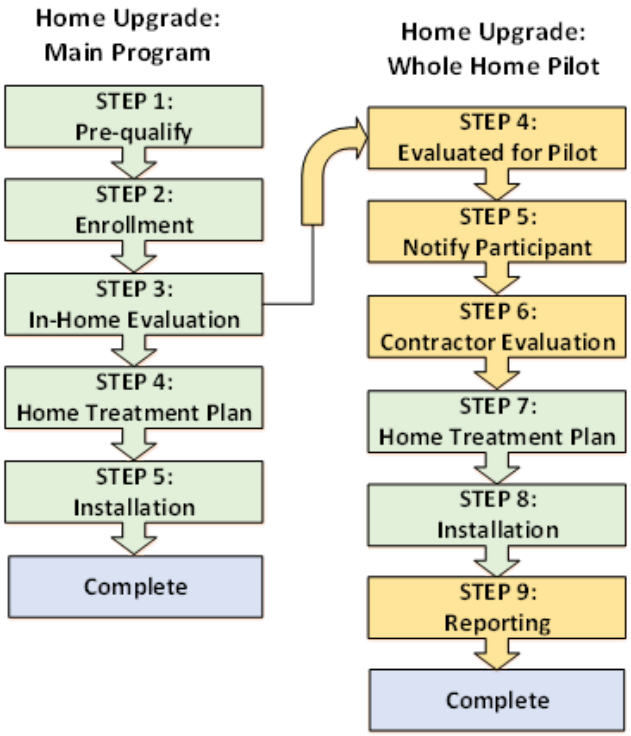
1. Participants must use gas or propane for at least two appliances:
   1.1. Existing qualifying 100-, 125-, 150-, or 200-amp electrical service and a distribution panel
   1.2. Existing electrical panels have adequate service capacity for full electrification
2. At least 50% of the homes served in the pilot must have 100-amp appliances
3. The home must have capacity for electrification, including a minimum 120V 20-amp circuit for a level 1 electric vehicle (EV) charger in the garage or near vehicle parking
4. The home must have minimal deferred maintenance, a good building envelope, and inefficient older equipment to ensure bill savings and the need for an upgrade

Pilot project team

For the Whole Home pilot, Peninsula Clean Energy collaborated with Richard Heath and Associates, Inc. (RHA), a program implementer. PCE customers were very satisfied with the performance of the RHA team, as indicated by one- and six-month surveys.

Pilot participant journey

All participants and their homes went through an evaluation for the pilot program. After confirming a pilot participant's enrollment, a custom Home Treatment Plan was created for the customers, listing feasible electrification and minor home repair measures.



The installation process included the replacement of all gas or propane appliances, along with other home improvement work. The timeline for the homes varied between one to two months, with the first home completed in February 2024 and the last home completed in April 2024.

After installation, Peninsula Clean Energy tracked customers' experiences through customer satisfaction surveys, in-person inspections, and equipment monitoring. Customer satisfaction surveys were sent at the one-month and six-month marks. In-person inspections were conducted by RHA to ensure high quality work and verify the customer was having a positive experience. Lastly, all customers had an Emporia VUE WiFi connected device installed to monitor electric consumption at a circuit level for all newly installed appliances.

All installations were permitted at appropriate local jurisdiction.

Avoiding service upgrades

The major focus of the pilot was to test Peninsula Clean Energy's hypothesis that whole home electrification can be performed without the added cost and time of service upgrades.

Service upgrades can cost anywhere from $3,500 to $30,000+, and they often result in significant delays due to the slow PG&E service upgrade and interconnection process.[1]

No service upgrades required in the pilot

Of the nine pilot homes:

- Zero needed service upgrades due to electrification requirements
- Five homes were 100A and did not require upgrades

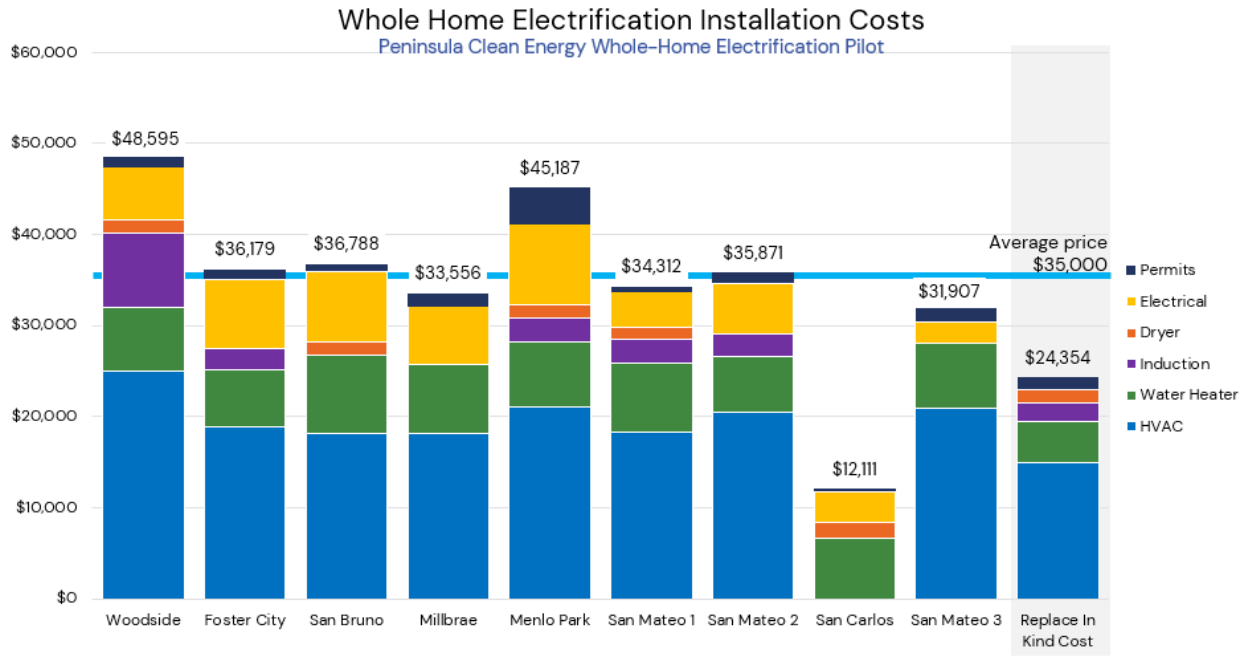
[1] Service Upgrades for Electrification Retrofits Study – Redwood Energy/NV5, 2022

Costs of electrification

Appliance installation costs

In this section, the pilot project's costs are examined to gain insight into the typical cost of whole-home electrification.

The chart below outlines the costs associated with appliances for each home. It demonstrates the individual appliance's cost, the average installation cost across the nine homes, and compares this cost to what a replacement in-kind cost would be.



Key installation cost findings:

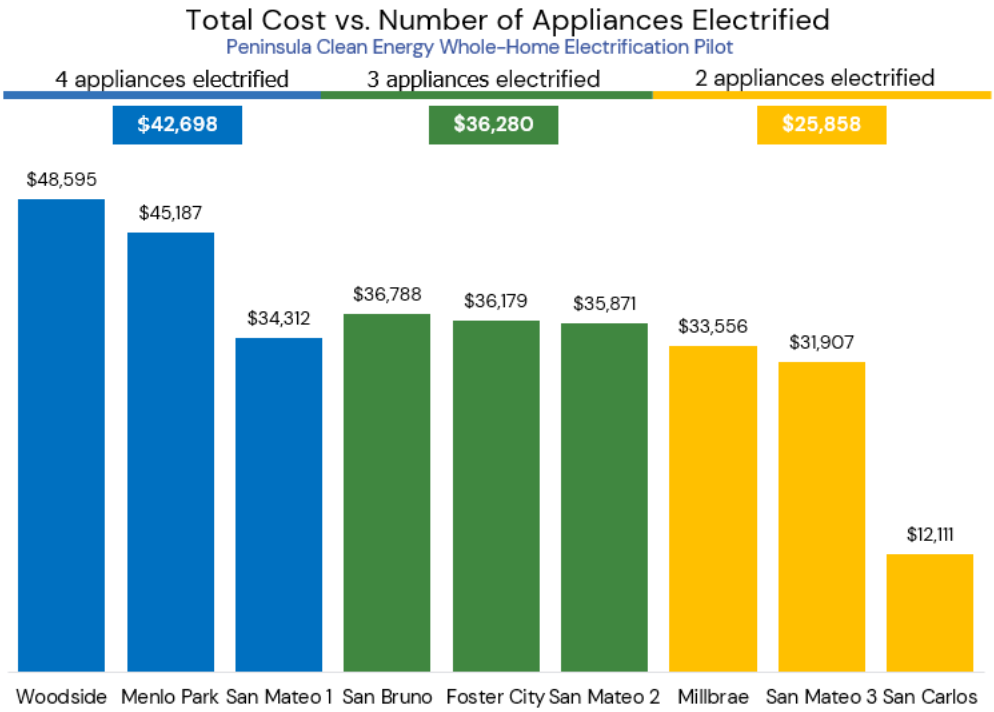
- The average installation cost per home was $35,000, with roughly **$10,000 in incremental costs**.
- **No service upgrades required**: All homes were able to electrify without electrical service upgrades, and five of the homes already had 100A service.
- **HVAC represented the highest cost**, ranging from $18,000-$21,000.
- **There was high variation in electrical costs.**
- There was a direct relationship between the number of appliances electrified and the cost of the whole-home electrification.

Whole-Home Electrification - Installation Cost Breakdown at Nine Pilot Homes							
	Water Heater	HVAC	Induction	Dryer	Electrical	Permits	Total
Woodside	$7,031	$24,937	$8,209	$1,500	$5,722	$1,196	$48,595
Foster City	$6,239	$18,850	$2,450	$0	$7,585	$1,055	$36,179
San Bruno	$8,527	$18,155	$0	$1,500	$7,760	$846	$36,788
Millbrae	$7,556	$18,201	$0	$0	$6,380	$1,419	$33,556
Menlo Park	$7,150	$21,121	$2,500	$1,500	$8,845	$4,071	$45,187
San Mateo 1	$7,525	$18,291	$2,640	$1,393	$3,865	$598	$34,312
San Mateo 2	$6,100	$20,476	$2,500	$0	$5,595	$1,200	$35,871
San Carlos	$6,650	$0	$0	$1,811	$3,300	$350	$12,111
San Mateo 3	$7,022	$20,976	$0	$0	$2,459	$1,450	$31,907
Average	**$7,089**	**$20,126**	**$3,660**	**$1,541**	**$5,723**	**$1,354**	**$35,000**

There are typically three gas appliances, not four

Although four different appliances are commonly considered when discussing electrification—water heaters, space heaters, dryers, and cooktops—there are not four gas appliances in every home. Fewer appliances to electrify per home means lower costs for whole-home electrification. As such, it is important to understand the typical number of electric appliances in a home for long-term decarbonization planning and programmatic budgeting.

The homes in PCE's pilot averaged three appliances per home. The chart below outlines the direct correlation between the number of appliances in the home and the electrification costs.



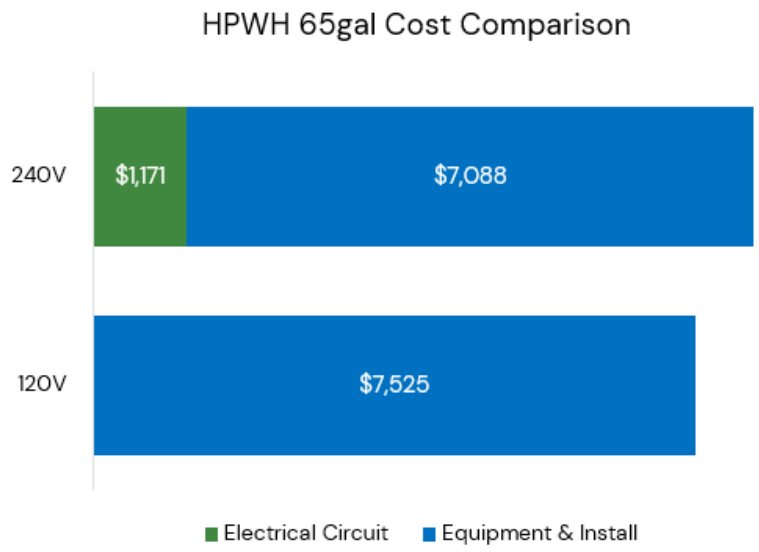
120V versus 240 HPWH installation costs

One pilot home was equipped with a 120V 65-gallon heat pump water heater, while seven of the homes had a 240V 65-gallon heat pump water heater installed.

The 120V HPWH has a higher upfront equipment cost due to the product being equipped with a thermostatic mixing valve. However, the total cost of installation for the 120V HPWH was lower than the cost of 240V HPWH due to the reduced cost of running a new electrical circuit. The chart below shows the cost difference of about $700.

Of note, the costs of HPWH installation in the pilot program were higher than industry average costs. For example, the average cost of HPWH installation in Peninsula Clean Energy's rebate program is about $7,000 across approximately 1,700 HPWHs installed as of July 2025.

For more information on 120V HPWHs, including design considerations, please review Peninsula Clean Energy's "120 Volt Heat Pump Water Heater Pilot."



Energy bill impacts

Year-over-year energy bill comparison

All homes for which complete historical data was available and when the customer was on the best rate showed post-electrification savings. Even for homes not on the best rate, 5 of the 6 delivered savings, and the 6th would have provided customer savings had a beneficial rate been selected.

To understand the impact of electrification on the home's energy bills, the home's monthly energy cost before and after installation was analyzed. The three major data components undergoing analysis are Pre-Installation, Post-Installation, and a Business-As-Usual scenario.

Three homes out of the nine pilot homes were excluded from the analysis. Two of those homes were missing pre-electrification energy usage and cost data, including one home that utilized propane-based heating[2]. The third home was a solar net energy metering (NEM) customer, which provided data challenges in performing a complete comparison of pre- versus post-electrification.

Pre-installation and post-installation data components are comprised of the customer's historical energy usage and rates. The Business-As-Usual (BAU) scenarios are estimates of what each home bill would have been if they have not electrified, but have been updated with 2024-2025 rate prices. To estimate BAU, it was assumed that the customer kept similar usage behavior and used the pre-installation energy usage (gas + electricity). Then, the updated 2024 and 2025 rates applied to reflect the most current rates. As most of the homes are enrolled in CARE, the discount was reflected in the analysis when enrolled. This estimate gave a better understanding of what the home's energy bills might have looked like today without electrification and therefore was used to calculate monthly energy cost savings.

Five out of six homes studied saved on their total energy bills compared to what they would have paid in 2024-2025, with an average 20% savings of the customer's energy bill.[3] Please see the graph and table on the next page for details on each home.

This pilot with real-world customer's consumption and cost data confirms previous modeled results. The pilot findings align with the previous modeled Bill Impact analysis conducted by SVCE and PCE, which estimated $20-$30 per month in savings from installing a heat pump and switching to an electrification-friendly rate (such as EV2-A).

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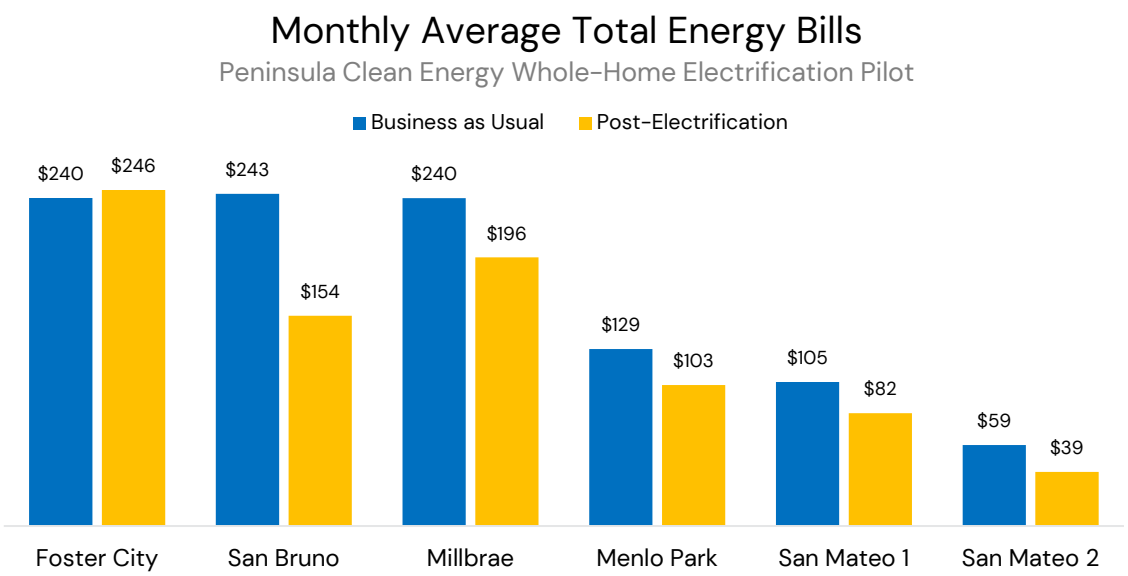
2 PCE did not study the cost comparison of fuel switching from propane to electrical appliances. However, customers were likely to save given the typical propane residential energy price in CA is $31.53/mmbtu, according to *EIA, Table E3. Residential sector energy price estimates, 2023.*

3 This analysis did not include weather normalization. The variation in heating degree days across the analysis (2022-2025) was less than 10%, which falls within the margin of error. Heating degree days (HDD) measures the demand of heating by subtracting the hourly outdoor temperature from a base temperature of 65°F.



Average total energy bills before and after electrification among pilot homes

	Foster City	San Bruno	Millbrae	Menlo Park	San Mateo 1	San Mateo 2	San Carlos*
Pre-Install Gas Use (therms/mo)	52	43	63	24	23	5	9
Pre-Install Electricity Use (kWh/mo)	288	588	249	228	225	190	181
Post-Install Electricity Use (kWh/mo)	572	640	693	348	344	165	348
Pre-Install Actual Monthly Energy Cost (2022/2023 Rates)	$223	$217	$236	$92	$91	$49	$103
Business as Usual Monthly Energy Cost (2024/2025 Rates)	$240	$243	$240	$129	$105	$59	-
Post-Install Monthly Energy Costs (2024/2025 Rates)	$246	$154	$196	$103	$82	$39	$101
Monthly Energy Cost Savings	-$6	$89	$43	$26	$23	$20	$2

* San Carlos home is on NEM (solar) and was not included in the BAU analysis

Air conditioning energy use & costs

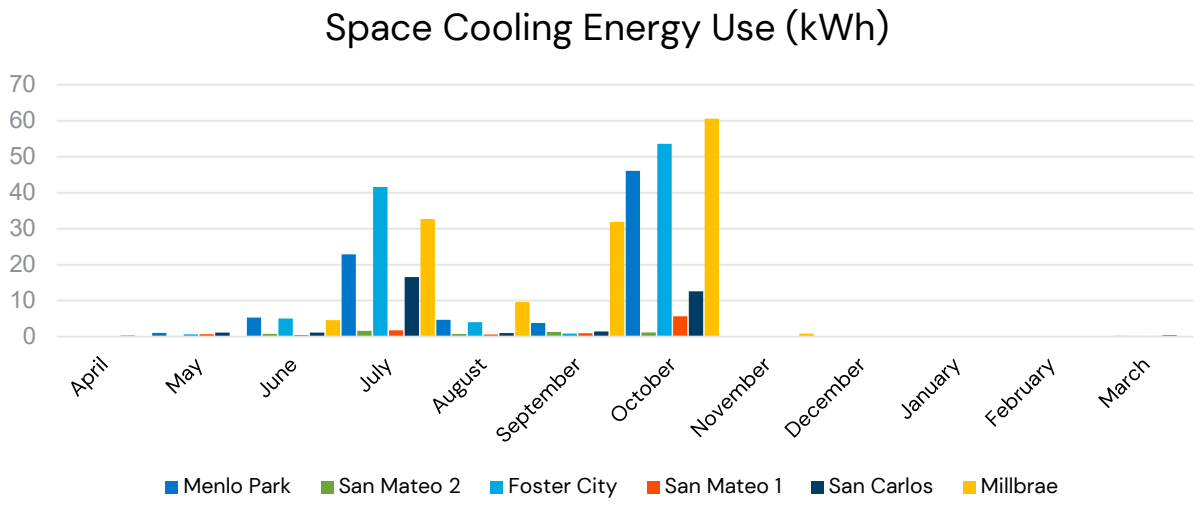
Prior to the pilot, none of the pilot homes had air conditioning. With the addition of heat pumps, each home now has air conditioning—a significant comfort benefit. PCE was concerned that the addition of air conditioning might have a detrimental energy cost impact. However, there were still significant on-bill cost savings, even in light of the addition of A/C. This is largely because San Mateo County has a mild coastal climate, and all nine homes are located within California climate zone 3.[4]

Submetering was installed for each electrified circuit in each home, allowing the team to estimate the energy use and cost impact of air conditioning.

The chart and table below show estimated cooling energy use and associated costs at each home. **Of the nine homes, only six of the homes appeared to use cooling** at all, with only three homes regularly using cooling.

Estimated Total Annual Cooling Energy			
Home	**Energy Use (kWh)**	**Cost**	**Cooling Run Hours**
Menlo Park	84	$42	67
San Mateo 2	6	$3	3
Foster City	106	$53	84
San Mateo 1	10	$5	5
San Carlos	35	$17	27
Millbrae	140	$70	101
San Bruno	0	$0	0

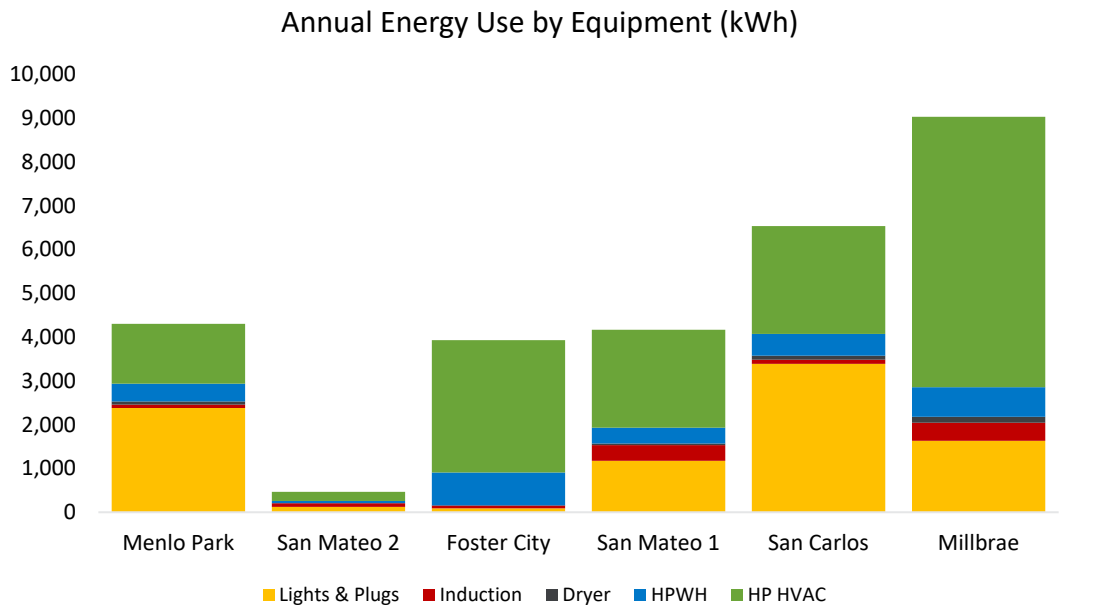
Average cooling cost was $55 per year ($13 per summer month) for the three homes which regularly used air conditioning. The chart below outlines monthly cooling electricity use at each home.

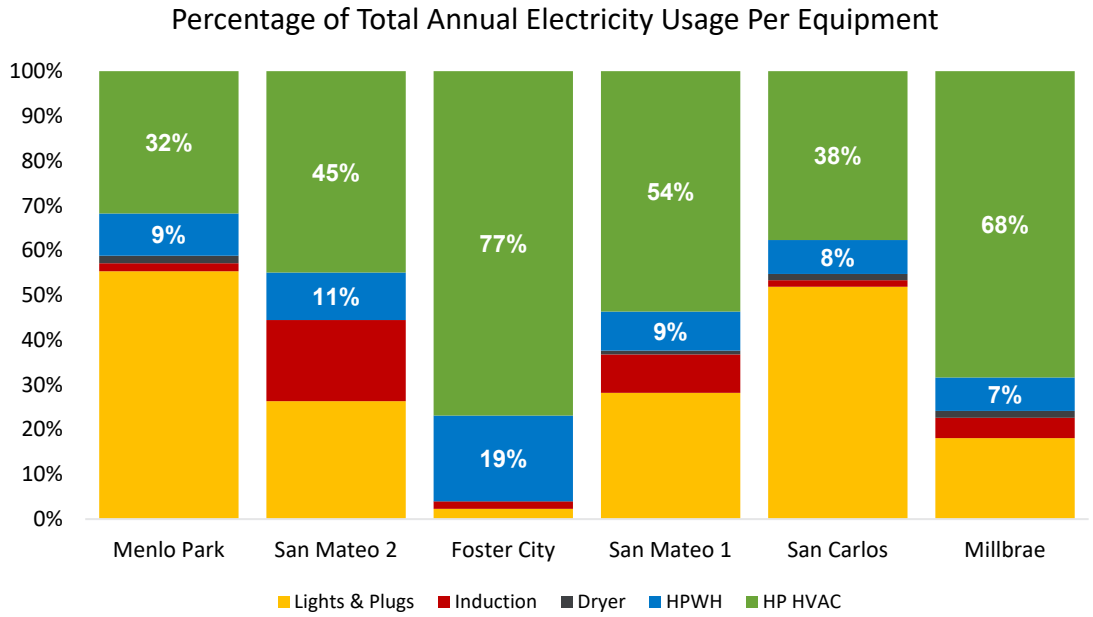


[4] *The team reviewed National Oceanographic and Atmospheric Administration (NOAA) weather files for years 2022-2024. While cooling season included in the analysis was somewhat milder than usual the average total cost of cooling in the warmer years would increase by roughly $25 per year, a negligible cost difference.*

Sub-metered electricity usage

As part of the pilot, PCE sub-metered the homes to obtain a detailed breakdown of the electricity consumption for each individual piece of equipment installed, as well as the whole-home electricity consumption. On average, installing a **HP HVAC added 2,578 kWh annually** to the home's electrical load, accounting for an average of 52% of total electricity consumption. **HPWH added on average 452 kWh annually**, accounting for 10% of the total electrical load of the home. The two graphs below illustrate a detailed breakdown of the annual electricity consumption for all 3-4 electrical equipment pieces installed.





Switching to an electrification-friendly rate: EV2-A

In addition to actual savings seen by the customer, PCE aimed to understand the potential cost savings if the homes switched to an "electrification friendly" rate, such as EV2-A. EV2-A is a time-of-use rate available to PG&E customers if they have an EV, heat pump HVAC, heat pump water heater, or a battery system. The rate has off-peak, partial-peak, and peak periods. PCE also analyzed E-ELEC when determining which rate provided the greatest savings for post-electrification households. It was determined that EV2-A resulted in greater savings; therefore, PCE used EV2-A for this study. Each home's hourly internal system was run through a rate calculator to estimate what their electricity costs would have been under EV2-A during 2024-2025.

The table below provides a breakdown of the projected monthly average bill charge for each home on their existing rate, on EV2-A, and the monthly cost difference. **Most homes showed an average of 8% savings per month by switching to EV2-A**, those savings ranging from $5/month to $25/month. Two of the homes showed an increase of $1/month in savings by switching from E-TOU C to EV2-A, which is within the margin of error of the rate calculator.

Home	Current Rate	Existing Monthly Avg	EV2-A Monthly Avg	Cost Savings by Switching Rates	Cumulative Savings by Electrification + Switching Rates
Foster City	E-1	$246	$222	$24	$18
San Bruno	E-TOU C, CARE	$154	$155	($1)	$88
Millbrae	E-TOU C, CARE	$196	$157	$25	$68
Menlo Park	E-TOU C, CARE	$103	$97	$6	$32
San Mateo 1	E-TOU C, CARE	$82	$77	$5	$28
San Mateo 2	E-TOU C, CARE	$39	$41	($1)	$18

Note: The California Alternate Rates for Energy (CARE) is an available bill discount for lower income customers. CARE customers receive a 30% discount on their electricity rates. These discounts were applied to both their current rate and the EV2-A rate. Because the CARE discount is applied as a percentage to their overall bill, regardless of rate, it does not impact the proportional savings potential of electrification. Therefore, non-CARE customers should expect similar percentage cost savings.

Policy implications

Ending fossil fuel use in buildings is critical to meeting state climate goals. While Peninsula Clean Energy performed the whole-home electrification pilot to inform future direct-install and appliance rebate programs, some takeaways may also be useful for broader policymaking.

Policies that encourage electrification are likely to generate customer bill savings, not increased costs

Pilot homes saw an average of 20% savings on their energy bill. Policies that encourage or require electrification will support customers by resulting in monthly energy savings, in addition to climate and health benefits. The pilot strongly indicates that, in at least a moderate climate zone, electrification results in clear bill savings.

Electrification installation costs are higher than traditional replacement costs, so rebates are needed

The cost of running new wiring can be high. While this is a one-time cost, electric wiring costs have seen significant inflation, and many Americans are facing an affordability crisis. In addition, some high-efficiency electric appliances are more expensive than their in-kind gas replacements. As such, *durable* rebates may be required to ensure our most vulnerable populations can afford to participate in the energy transition. In addition, once electrified, customers are expected to see savings on their monthly energy bill.

Concerns about expensive service line and panel upgrades are unfounded

Concerns about the cost of electrical panel and service line upgrades, especially for underground lines, have been a consistent focus of discussion regarding existing building electrification. In recent years, research has shown that electrification on 100A service panels is possible in almost all cases. While replacement of panels is sometimes necessary, the pilot demonstrated that it is possible to electrify within 100A, avoiding the more costly and time-consuming service upgrades.

Conclusion

This pilot study provides insights into whole home electrification, highlighting key findings in installation cost, limiting electrical service upgrades, and energy bill impacts that can help inform for policymaking. The average whole home electrification cost was $35,000, zero of the nine homes needed an electrical service upgrade, and six out of the seven homes saw energy bill savings after one year of installation. In the new version of the Home Upgrade program, we will continue to provide insights on cost, limitations, and bill impacts of home electrification.