TECH CLEAN CALIFORNIA

TECH Clean California Best Practices Report

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Disclaimer

This report reflects the analysis and findings of Energy Solutions and Opinion Dynamics. It does not necessarily reflect the opinions or views of the California Public Utilities Commission (CPUC) and has not been reviewed or approved by the CPUC or its employees. This report has been updated for clarity and conciseness based on input from parties to the Building Decarbonization proceeding R.19-01-011.

Report Structure

The purpose of this report is to provide a high-level summary of program lessons learned through four years of implementation and evaluation. This report seeks to:

1. Assemble evidence supporting or refuting the underlying theory of change.
2. Provide insights for future implementers regarding best practices that should be integrated into decarbonization programs.
3. Offer guidance to policy makers for policy approaches to pursue and avoid when considering how to advance the state's building decarbonization goals.

Following **Section 1. Executive Summary** and **Section 2. Introduction**, the substance of this report is organized into three sections:

- **Section 3. Program Design Best Practices** addresses portfolio design for optimizing across multiple policy objectives; the importance of simplicity in program design and implementation; cost-containment strategies around electric service rightsizing; approaches for addressing remediation needs for low-income customers; lessons learned around customer engagement; and the role of data and analytics.[1]
- **Section 4. Supporting Sectors and Strategies** dives into complementary capacity-building strategies, with a focus on supply chain engagement; contractor engagement; workforce education and training; opportunities to align with customer needs via solar partnerships; and electrification readiness support.
- While Sections 3 and 4 are retrospective, **Section 5. Achieving Scale: Long-Term Vision** looks forward to how the lessons learned so far can inform continued efforts to scale building decarbonization. It views this topic through the lens of the aligning implementation with the California Heat Pump Partnership Blueprint, which distills the consensus recommendations from California state agencies and the private sector into 11 strategies for scaling California's heat pump market to six million installed units by 2030.[2]

[1] An additional best-practices section, *Measure-Specific Best Practices*, can be found in Appendix A.
[2] California Heat Pump Partnership (CAHPP). *California Heat Pump Partnership Blueprint: Scaling California's Heat Pump Market: The Path to Six Million.* March 2025. https://heatpumppartnership.org/wp-content/uploads/2025/03/CAHPP_Blueprint_2025.pdf

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Contents

1.Executive Summary 1
Initiative Outcomes and Lessons Learned 1
Conclusions and Recommendations 6
2. Introduction 9
3. Program Design Best Practices 11
3.1 Integrated Program Offerings 11
3.2 Simplifying Program Design to Reduce Costs and Burdens 35
3.3 Right-Sizing Electric Service 42
3.4 Recognizing Remediation Needs 43
3.5 Excelling in Customer Buy-In 45
3.6 Role of Data and Analytics in Informing Policy and Programs 52
4. Supporting Sectors and Strategies 54
4.1 Upstream Market Development Efforts 54
4.2 Contractor Engagement 55
4.3 Workforce Education and Training (WE&T) 57
4.4 Solar + Electrification Opportunities 59
5. Achieving Scale: Long-Term Vision 61
5.1 Improve Customer Economics 61
5.2 Streamline Sales and Installation Processes 63
5.3 Accelerate Market Adoption 64
5.4 Proposed Long Term Approach 64
Appendix A: Measure-Specific Best Practices 69
Appendix B: Low-Income Leveraging Pilot Findings and Recommendations 74
Appendix C: Residential Decarbonization Measure List 81
Appendix D: Program Theory Logic Model 84
Appendix E: Frameworks for Optimizing Policy Objectives 88
Appendix F: Driver Analysis and the Importance of Site-Level Granularity 91
Appendix G. Initiative Design, Evaluation, and Data Considerations 94
G1. Approach to Initiative Design 94

G2. Independent Embedded Evaluation Approach 96
G3. Notes on Data Sources 96
Appendix H. Program Simplicity Case Studies 100
H1. Case Study: Demand Flexibility Requirements for SGIP HPWH Program 100
H2. Case Study: Preapproval and Incentive Reservation 101
H3. Case Study: Workforce Education and Training 103
Appendix I. Opportunities and Challenges of Serving Rental Housing 106
Appendix J. Best Practices from Pilots and Quick Start Grants 108
J1. Program Design and Administration 108
J2. Implementation and Grant Management 109
J3. Scaling and Strategic Value 110

Tables

Table 1. Evaluator estimates of customer bill impacts by season, all customer and project types 15
Table 2. Evaluator estimates of customer bill impacts from heat pump water heaters. 17
Table 3. Evaluator analysis of CARE or FERA and Non-CARE or FERA annual bill impacts 18
Table 4. Implementer estimates of average lifecycle GHG emissions impacts by project type 21
Table 5: TECH Clean California goal correlation matrix for single-family customers 28
Table 6: Savings for Retroactively Targeted Versus Non-targeted Heat Pump HVAC Retrofits 29
Table 7. Non-exhaustive List of Modifications to TECH Clean California's Incentive Design 31

Abbreviations and Acronyms

Abbreviation/Acronym	Definition
AC	Air conditioning
CCA	Community Choice Aggregators
CPUC	California Public Utilities Commission
GHG	Greenhouse gas
HVAC	Heating, ventilation, and air conditioning
SGIP	Self-Generation Incentive Program
TECH	Technology and Equipment for Clean Heating
TSB	Total System Benefit

1. Executive Summary

Space and water heating account for 91 percent of residential gas usage and 43 percent of residential greenhouse gas (GHG) emissions.[3] Launched in December 2021 with $120 million from California Air Resources Board Cap and Invest funds, the Technology and Equipment for Clean Heating initiative (TECH) supports adoption of low-emissions space- and water-heating technologies with the guiding principles of "equity, cost-effectiveness, regulatory simplicity, and market transformation."[4] Publicly known as TECH Clean California, the initiative advances California's carbon-neutrality goal for 2045 through contractor incentives, supply chain engagement, workforce development, consumer education, regional pilots, Quick Start Grants, and public data reporting.

TECH Clean California has achieved significant participation, with more than 75,000 heat pumps installed and 1,600 contractors participating across 54 of the state's 58 counties. The initiative has also received national recognition, winning three national awards since 2021.[5] Energy Solutions serves as the program implementer, and Opinion Dynamics serves as the independent evaluator. This report summarizes best practices identified through more than four years of implementation and evaluation.

Initiative Outcomes and Lessons Learned

TECH Clean California's investments in heat pump market development are making an impact. TECH Clean California has invested heavily in capacity building by working closely with manufacturers and distributors, leveraging their roles as "trusted messengers" to support contractor recruitment and more broadly align the initiative with supply chain needs (see Sections 4.1 and 4.3). Heat pump market transformation is occurring: Contractors are investing in their businesses to expand heat pump offerings, and heat pump heating, ventilation, and air conditioning (HVAC) and

> *"The TECH Clean California initiative is a significant driver supporting the adoption of heat pump water heaters from a national point of view. While many US states have very low adoption rates for heat pump water heaters, California and its TECH Clean California initiative have progressively made in-roads in year-over-year increases driving the adoption of the technology."* ***Participating Manufacturer***

[3] DNV GL Energy Insights USA, Inc. *2019 California Residential Appliance Saturation Survey (RASS)*. July 2021. https://www.energy.ca.gov/sites/default/files/2021-08/CEC-200-2021-005-ES.pdf

[4] California Public Utilities Commission. *Decision Establishing Building Decarbonization Pilot Programs*. R.19-01-011, Decision 20-03-027. March 26, 2020. https://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M331/K772/331772660.PDF

[5] The three national awards TECH has won are the Groundbreaking Program Design and Implementation Award from the Association of Energy Services Professionals (2023), the Residential Heat Pump Market Transformer Award by the Advanced Water Heating Initiative (2024), and an Excellence in Load Management award by the Peak Load Management Alliance (2025).

heat pump water heaters make up a growing share of their installations.[6] Over 80% of surveyed contractors stated that heat pump experience was "very" or "moderately" attractive when making hiring decisions, and a growing share of their staff now works on heat pump projects. The proportion of contractor firm staff attending HVAC heat pump trainings has substantially increased over the past few years, and contractors' self-reported confidence working with HVAC heat pumps has likewise increased.[6] TECH Clean California workforce training investments have been effective in supporting foundational market education, awareness-building, and participant engagement across a broad set of market actors. Employers generally valued the skills and knowledge gained through these trainings, and nearly half (43 percent) of attendees received a promotion within six months.[7] At the same time, evaluation findings suggest that different training pathways serve different workforce development functions, with introductory webinar-based trainings supporting scalable awareness-building and market orientation, while installation-focused manufacturer and apprenticeship pathways remain important for development of installer-level technical competencies.

Overall, TECH Clean California participants have been very satisfied with their heat pumps. Ninety percent of heat pump water heater participants reported being "very" or "somewhat" satisfied with their equipment, reflecting positive customer experiences. Satisfaction with heat pump HVAC systems was similarly high: 91 percent satisfaction for ducted systems and 97 percent for ductless systems.[8] These satisfaction levels suggest heat pumps are meeting customer expectations for comfort and performance, helping build confidence in broader market adoption.[9]

Customers value heat pumps' comfort and cost savings benefits, while customers with environmental motivations or existing solar make up important early-adopter segments. The vast majority of both heat pump HVAC (93 percent) and heat pump water heater (89 percent) customers rated their purchase as a "good" or "great" value. The top reasons were financial (long-term cost savings, rebates, equipment efficiency, existing solar), comfort (HVAC only), and environmental impact.

> *"With the rebates, [the heat pump water heater] was an excellent deal! Without rebates, it would have been very expensive, and I probably would have gotten a different type of water heater."* ***TECH Clean California Customer***

[6] Opinion Dynamics. *TECH Clean California: Time 2 Market Assessment Final Report*. May 14, 2025. https://opiniondynamics.com/wp-content/uploads/2026/03/TECH-Time-2-Market-Assessment_Final.pdf
[7] Opinion Dynamics. TECH Post-Training Level 3 Behavior Survey Findings Memorandum. February 28, 2023. https://opiniondynamics.com/wp-content/uploads/2024/12/TECH_Contractor_Six-Month_Post-Training_Findings_Memo.pdf
[8] Opinion Dynamics. *TECH Clean California: Insights into Customer Experience and Satisfaction Wave 2*. March 27, 2025. https://opiniondynamics.com/wp-content/uploads/2025/09/TECH_Updated-Customer-Experience-and-Satisfaction-Report_3.31.2025_Clean_UPDATED.pdf
[9] Opinion Dynamics. *TECH Clean California: Insights into Customer Experience and Satisfaction Wave 2*. March 27, 2025. https://opiniondynamics.com/wp-content/uploads/2025/09/TECH_Updated-Customer-Experience-and-Satisfaction-Report_3.31.2025_Clean_UPDATED.pdf

Among the minority of customers who did not view their heat pump as a "good" or "great" value, high upfront cost and high utility bills were the top two reasons.[10]

TECH Clean California's single-family participants have disproportionately been early adopters, as evidenced by the high penetration of rooftop solar (27 percent) compared to the general population (10 percent).[11] The pattern is especially pronounced among heat pump water heater adopters, 45 percent of whom have existing solar. As heat pumps scale, their value proposition will increasingly need to center on low upfront costs, bill savings, and comfort, underscoring the need to narrow upfront cost gaps with gas appliances and advance rate reforms that strengthen customer bill savings.

Across the entire TECH project portfolio, average customer annual bill impacts were close to break-even; however, there is substantial variation in bill impacts depending on climate zones, select home attributes (especially prior presence of air conditioning or rooftop solar), installed measures, and customer rate classes.[12] Non-solar customers with existing air conditioning achieved average bill savings of $304 per year and average savings increased to $423 per year for customers with on-peak electricity consumption exceeding one MWh. Those customers without existing cooling saw an average bill increase of $69 per year but gained the ability to cool their homes. Non-solar heat pump water heater customers had an average bill reduction of $97 per year.[13]

It is possible to predict with some confidence whether a customer's investment in an HVAC upgrade is likely to save on future bills, based on the customer's baseline energy consumption patterns, climate, and heat pump technology choices.

Strategic electrification, such as replacing inefficient air conditioning with heat pump HVAC is an especially effective approach to simultaneously achieve customer bill savings, ratepayer savings, and GHG reductions. While building decarbonization and heat pump adoption can benefit from lower electricity rates, there are significant opportunities now under existing rates. Electrification of space and water heating has potential to improve energy affordability to all ratepayers, by adding peak load to the grid largely during off-peak and partial-peak hours.[14] This enables fixed costs, which represent most of the customer electric bill, to be spread across more

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[10] Opinion Dynamics. *TECH Clean California: Insights into Customer Experience and Satisfaction Wave 2*. March 27, 2025. https://opiniondynamics.com/wp-content/uploads/2025/09/TECH_Updated-Customer-Experience-and-Satisfaction-Report_3.31.2025_Clean_UPDATED.pdf

[11] Opinion Dynamics. *TECH Population-based Pathway Impact Report.* November 27, 2024. https://opiniondynamics.com/wp-content/uploads/2025/12/TECH-Population-Pathway-Impact-Analysis-Report-FINAL.pdf

[12] Opinion Dynamics. *TECH Population-based Pathway Impact Report.* November 27, 2024. https://opiniondynamics.com/wp-content/uploads/2025/12/TECH-Population-Pathway-Impact-Analysis-Report-FINAL.pdf

[13] Implementer's internal analysis of bill impacts for non-solar customers with and without pre-existing air conditioning.

[14] Scheer, Adam. Recurve. 2025 ACEEE Hot Water & Air Forum Presentation "Measured Impacts of TECH Heat Pump Installations". March 6, 2025. https://drive.google.com/file/d/1oju5s-S4zltvkv5rzDFuDu6k3ftKujPT/view

electricity sales, thereby putting downward pressure on electric rates.[15] In particular, focusing on customers with both existing air conditioning and above median existing energy consumption, such as those with homes in hot, inland parts of the state, could achieve 10 times the peak demand savings, 2.7 times utility bill savings, and 40 percent higher GHG savings, while serving more customers in disadvantaged communities than an untargeted approach. Optimizing future programs around replacing existing air conditioning in hotter parts of the state could deliver substantially greater customer and ratepayer benefits, all for the same amount of funding invested, and under current utility rates.

Customers on income-qualified rates, such as CARE/FERA, typically experience more bill savings from fuel substitution than market rate customers. This trend is primarily driven by the higher discount on electric rates (30 percent to 35 percent) relative to the gas rate discount (20 percent). The TECH Clean California evaluator results for a combined heat pump HVAC and heat pump water heater portfolio found an average $75 improvement in bill impacts for CARE versus non-CARE customers.[16]

Increased incentives for customers based on income qualification are an important way to serve customers equitably.[17] Since the July 2025 launch of TECH Clean California's dedicated equity kicker incentives, equity customers have received 54 percent of incentives, exceeding TECH Clean California's current goal of 50 percent. The rapid uptake of TECH Clean California's higher incentives for income-qualified single-family customers underscores a substantial need and demonstrates that appropriately sized equity incentives can help low-income households adopt heat pumps. Moreover, numerous contractors are creating dedicated business models to serve this specific demographic. TECH Clean California's Low Income Leveraging Pilot results point to a pathway for expanding home electrification services for income-qualified households via existing weatherization programs, particularly for those households in need of remediation and minor home repairs prior to home electrification.

Changes in electricity and natural gas tariffs will affect utility bill outcomes of installing building electrification measures. For example, the addition of the Base Services Charge is expected to improve bill outcomes for all customers installing a heat pump. Based on utility rates in effect in 2022 and 2023, the implementer forecasts that median bill savings could improve by an estimated $91 to $104 per year for non-solar customers installing a heat pump HVAC project

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[15] This is consistent with PG&E's 2026 analysis that suggests electrification could reduce distribution rates by 25% by 2040. Pacific Gas & Electric. January 30, 2026. "New PG&E Study Shows Electrification Will Lower Electricity Rates Over Time." https://www.pge.com/en/newsroom/currents/future-of-energy/new-pg-e-study-shows-electrification-will-lower-electricity-rate.html

[16] Opinion Dynamics. *TECH Population-based Pathway Impact Report*, Figure 3. November 27, 2024. https://opiniondynamics.com/wp-content/uploads/2025/12/TECH-Population-Pathway-Impact-Analysis-Report-FINAL.pdf

[17] Opinion Dynamics. *TECH Clean California: Insights into Customer Experience and Satisfaction Wave 2*. March 27, 2025. https://opiniondynamics.com/wp-content/uploads/2025/09/TECH_Updated-Customer-Experience-and-Satisfaction-Report_3.31.2025_Clean_UPDATED.pdf

without prior air conditioning (AC), enough to shift median impacts from a slight bill increase to bill savings.[18] Median bill impacts for heat pump water heaters, and for heat pump HVAC customers with prior AC, were estimated to decrease bills by approximately $42 to $54. Future analyses could refresh these results with more recent rates and a larger project portfolio to yield results by utility.

Multifamily building electrification requires a distinct approach tailored to its needs, including dedicated funding and technical assistance, electrification readiness, and infrastructure support. Multifamily buildings house roughly half of low-income households, making them critical for large-scale, equitable decarbonization. To date, TECH Clean California has served over 15,000 multifamily units, with 71 percent of funding serving low-income households and 77 percent of projects focused on water heating, reflecting the sector's unique load profile. These projects range from single-unit upgrades to replacement of large central systems and often require technical assistance to navigate electrification upgrades. Incentive layering—combining TECH Clean California incentives with weatherization assistance, tax credits, and owner capital—has been crucial for lowering out-of-pocket costs to less than 10 percent, and in most cases to $0, enabling projects to move forward.

The single most consistent feedback the TECH Clean California team has received from market actors is the need for program consistency and predictability, which enables the supply chain to shift their business models toward heat pumps. The elimination of incentive starts-and-stops would have a cascading effect to encourage broader participation by reducing the administrative costs and contractor business risk of short program funding windows. The California Heat Pump Partnership Blueprint and the California Energy Commission's Draft Building Energy Action Plan have similarly highlighted the need for longer-term stability.[19,20] Additionally, in support of its air quality regulation of natural gas-fired water heaters, the Bay Area Air Quality Management District's 2024 Implementation Report has called for continuation and expansion of initiatives like TECH Clean California that reduce costs for heat pump water heater installation.[21]

> *"Simplicity and stability, even if that means lower rebate amounts…that's always been what we've wanted."*
> ***Participating Contractor***

Program simplicity is key to success. In 2020, California Public Utility Commission (CPUC) Decision D.20-03-027 identified "regulatory simplicity" as one of the core guiding principles for

[18] At the time of analysis, there were insufficient heat pump water heater projects to effectively model BSC impacts for customers, although future efforts may include them.

[19] California Heat Pump Partnership (CAHPP). *California Heat Pump Partnership Blueprint.* March 2025. https://heatpumppartnership.org/blueprint

[19] California Energy Commission. *California Building Energy Action Plan (Draft).* December 19, 2025. https://www.energy.ca.gov/sites/default/files/2025-12/CEC-400-2025-001-CMD.pdf

[21] Bay Area Air Quality Management District. *Staff Report Informational Update Regarding Regulation 8, Rule 6: Nitrogen Oxides Emissions from Natural Gas-Fired Water Heaters less than 75,000 BTU/hr.* December 2024. https://www.baaqmd.gov/~/media/dotgov/files/rules/reg-9-rule-4-nitrogen-oxides-from-fan-type-residential-central-furnaces/2021-amendments/documents/20241127_board-report-dec-2024-pdf.pdf?rev=f9b89cc7ceb54588b5c505d6f20635e3&sc_lang=en

TECH Clean California. While the program has achieved significant participation and uptake, there is further opportunity to simplify TECH Clean California and future programs. In both formal and informal feedback, contractors most often recommend making TECH Clean California easier to navigate, particularly for smaller businesses with limited time and capacity.[20],[21] Although many requirements are understandable individually, their cumulative effect can create friction that deters participation and increases administration costs. This complexity shows up in longer approval timelines, higher rejection rates for minor errors, and elevated contractor soft costs, particularly for small businesses. Contractor satisfaction with TECH Clean California grew 29 points from June 2022 to June 2024, in large part due to simplified rules and an 18-month period in which heat pump HVAC incentives were continuously available. While evaluating the cost-benefit trade-off of potential program requirements can be challenging, program administrators should fully consider the implications that they may have on participation and stakeholders more broadly.

Publicly accessible data accelerates market transformation. A cornerstone of the TECH Clean California strategy is the secure, public sharing of anonymized project and contractor data via the public reporting website techcleanca.com, along with progress reports and research results. The value of TECH Clean California's data is best evidenced by its broad utilization by governmental agencies and stakeholders across the state who have cited TECH Clean California results in key reports and have conducted independent analyses of the public data to drive their own policy decisions.

> *"TECH Clean California's data platform has been indispensable to SPUR's research on equitable electrification. Granular, publicly accessible data on program costs, geographic reach, and consumer uptake is genuinely rare in this space. We've been able to ask and answer questions that simply weren't possible with other programs' data. This has in turn supported real policy decisions and program designs that have enhanced the cost-effectiveness of public expenditures. TECH Clean California has set a gold standard for what data transparency looks like in practice, and we regularly point to it as the model for others to follow."* ***Sam Fishman, San Francisco Bay Area Planning and Urban Research Association (SPUR)***

Conclusions and Recommendations

A substantial multiyear funding commitment is critical to delivering the program consistency and predictability that the market needs to advance heat pump adoption. Program incentive funding is still critical for advancing the heat pump market to meet California's goals. Over time, as the heat pump installation market matures, market gains can be locked in via codes and standards, and program resources can shift to focus more narrowly on high impact opportunities such as full phaseouts of air conditioners in favor of heat pumps, targeted zonal electrification, and serving those customers at risk of being left behind in the clean energy transition.

Focus market-rate program investments on high-value opportunities that improve energy affordability by delivering a triple bottom line of customer bill savings, ratepayer savings, and

GHG reductions. Such targeted investments can offset ratepayer impacts from investments made for other policy purposes, such as equity, heat pump market acceleration, and grid modernization.

Programs should offer income-qualified kicker incentives to encourage heat pump retrofits in low-income households and ensure equitable electrification.

Continue investment in workforce education and training to support heat pump market development and long-term workforce capacity while improving alignment across training, credentialing, and program participation pathways. More consistent competency standards, individual-level credentialing approaches, and clearer differentiation between introductory orientation training and installer-level technical training could help strengthen installation quality, workforce mobility, and customer confidence as California scales building electrification.

Offer multifamily properties dedicated funding and technical assistance, electrification readiness, and infrastructure support to meet the sector's broad needs to adopt heat pumps.

Continue analysis to better understand how energy, greenhouse gas, and bill impacts of residential space and water heating electrification vary across different subpopulations, and how ongoing changes in utility rates and other factors may shift project economics over time. Project outcomes vary significantly across customer segments, and subpopulations defined by climate zone or other attributes (e.g., CARE/FERA status) may experience outcomes that differ substantially from population-wide averages.[22] In addition, both natural gas and electric utility tariffs continue to evolve, which may further influence project economics across these groups. Ongoing analysis and public reporting of program data is essential to ensure policy and program decisions are informed by these shifting market dynamics.

Consistent with CPUC guidance, future programs and policy direction should explicitly incorporate regulatory simplicity as a core guiding principle to ensure it is considered.[23] Because simplicity is one of the most important aspects in achieving strong participant satisfaction, it should be given dedicated consideration during policy, program design, and implementation phases.

Adopt an integrated portfolio approach that balances scale, simplicity, equity, and market development needs. TECH Clean California intentionally focused its initial program design at the contractor level to influence contractor decision making and collect program data that would help inform California's long-term building decarbonization strategy. Looking forward to how a future building decarbonization program might be designed to reflect the lessons learned thus far, the TECH Clean California implementation team believes there would be value in eventually shifting market rate incentives to distributors or retailers to more effectively scale. A certain level of market maturity would facilitate this approach. Low-income customers and multifamily buildings need

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[22] Opinion Dynamics. *TECH Population-based Pathway Impact Report.* November 27, 2024. https://opiniondynamics.com/wp-content/uploads/2025/12/TECH-Population-Pathway-Impact-Analysis-Report-FINAL.pdf

[23] California Public Utilities Commission. *Decision Establishing Building Decarbonization Pilot Programs*. R.19-01-011, Decision 20-03-027. March 26, 2020. https://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M331/K772/331772660.PDF

more funding and support to overcome additional barriers that are not solved through distributor and retailer programs alone. These barriers include overcoming language barriers, navigating program requirements, remediation, and electrification planning. Without individualized project support from contractors and programs to address these issues, these customers are unable to access these incentives.

In a broad view, this creates a three-pronged building decarbonization approach to incentive design and market development, since these needs do not always perfectly align within a single program:

1. **Statewide distributor and retail point-of-sale incentives,** focused narrowly on cost-effective achievement of the state's climate and grid resiliency goals, with attention to customer economics, simplicity, and expanding participation and heat pump adoption.
2. **Statewide or regional contractor-based program, comprised of:**
    - Single-family income-qualified incentives to deliver program benefits broadly to equity households,[24] and;
    - Multifamily incentives and market support to deliver benefits to equity households and renters.
3. **Statewide or regional direct install programs,** such as the Equitable Building Decarbonization and Energy Savings Assistance programs, serving the most financially distressed households that need full subsidies and concierge program services to move forward.
    - Transition the Repair and Replacement program under Energy Savings Assistance to deliver electrification services as standard practice for replacing gas appliances.
    - Offer whole-house or partial electrification upgrades to the most financially distressed households, particularly those that require some form of remediation assistance as a precondition for electrification.

These core electrification programs can be complemented as needed with supplemental market development support, as well as local or regional programs to capture locally concentrated opportunities (e.g., zonal electrification) or stack additional grid benefits that are not fully realized within the core portfolio. The TECH Clean California team believes this three-pronged approach, designed and implemented together in an integrated fashion, can enable California to advance its environmental and equity goals while improving energy affordability for all ratepayers.

[24] An "equity" customer or household includes disadvantaged communities as defined by CalEnviroScreen 4.0, hard-to-reach customers, and those that qualify based on income.

2. Introduction

Electrifying buildings is one of the least-cost pathways to achieving California's climate goals.[25] The Technology and Equipment for Clean Heating (TECH Clean California) initiative was established by the California Public Utilities Commission (CPUC) Decision 20-03-027, in keeping with legislative direction from California Senate Bill 1477 (Stern, 2018). The initiative was designed to help advance the state's goal to achieve carbon neutrality by accelerating the market of low-emissions space and water-heating technologies for existing single-family and multifamily residential homes, with the guiding principles of equity, cost-effectiveness, regulatory simplicity, and market transformation.[26]

TECH Clean California's Primary Goal: Market Acceleration

TECH Clean California's primary goal is to accelerate the market for low-emissions space and water heating equipment to support California's GHG emissions reduction goals. As such, the initiative was designed to pilot approaches and leverage program data that would address key barriers to enable broad, long-term heat pump adoption.

TECH Clean California launched in December 2021, with $120 million in funding from the gas allowances of the California Air Resources Board's Cap and Invest program. In the intervening four years, the initiative has received four additional funding allocations totaling $265 million for a combined investment of $385 million. TECH Clean California has had significant contractor and customer participation, with more than 75,000 heat pumps installed and 1,600 contractors participating across 54 of the state's 58 counties.[27] The need for four additional funding allocations is a testament to the popularity of the program, as funding has been quickly exhausted when it was made available.

TECH Clean California's theory of change is that targeted program interventions can catalyze market transformation through three strategic pillars:

Pillar One: Spur the Clean Heating Market for Electrification through Statewide Strategies

- **Focus on contractors to prime the market.** Recognizing the direct influence contractors exert on customers' heating, ventilation, and air conditioning (HVAC) and water heater purchase decisions, the program emphasizes contractor and installer training on the technology, value proposition, and business model aspects of electrification and motivates contractors to sell heat pump technologies via contractor incentives. See Section 4. Supporting Sectors and Strategies for details.

[25] California Energy Commission Energy Research and Development Division. *Deep Decarbonization in a High Renewables Future: Updated Results from the California PATHWAYS Model*. CEC-500-2018-012. June 2018.
[26] California Public Utilities Commission. *Decision Establishing Building Decarbonization Pilot Programs*. R.19-01-011, Decision 20-03-027. March 26, 2020. https://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M331/K772/331772660.PDF
[27] TECH Clean California has also received national recognition, winning three national awards since 2021.

- **Provide heat pump water heater and heat pump HVAC incentives for both single-family and multifamily residences**. See Section 3.1 D. Program and Portfolio Design Optimization and Strategies for details.
- **Leverage existing marketing infrastructure to inform consumer decision making.** To inform customer decisions and drive demand, TECH Clean California integrates with and enhances the Building Decarbonization Coalition's (BDC) electrification website, The Switch Is On, as well as their broader consumer inspiration campaign. See Section 3.5 Excelling in Customer Buy-In for details.

Pillar Two: Create Scalable Models for Market Transformation through Regional Pilots and Focused Outreach

- **Test solutions through regional pilots and Quick Start Grants (QSGs).** Regional Pilots and QSGs were utilized to test scalable solutions addressing specific barriers to electrification. See Section 3.4 Recognizing Remediation Needs, Section B. Multifamily Engagement and Buy-in, Appendix B: Low-Income Leveraging Pilot Findings and Recommendations, and Appendix J. Best Practices from Pilots and Quick Start Grants.
- **Target low-income, hard-to-reach, and disadvantaged communities (DACs)**. TECH Clean California has a goal to invest 50 percent of program incentives in low-income households and DACs. See "Scalable Solutions to Serving Equity Customers" in Section 3.1. D. Program and Portfolio Design Optimization and Strategies.

Pillar Three: Inform Long-Term Building Decarbonization Framework

- **Public reporting informs policy:** TECH Clean California supports regional and statewide agencies pursuing building electrification policies by providing real market data to inform these policy decisions. See 3.6 Role of Data and Analytics in Informing Policy and Programs for details.
- **Quantify the value of decarbonization:** Through rigorous interval meter data analysis to quantify gas and electric load impacts, GHG savings, customer bill savings and other decarbonization benefits, TECH Clean California derives results that can optimize public and private investments and support large-scale project finance and deployment, similar to the supply side energy resources such as wind and solar. See 3.1 Integrated Program Offerings for details.

3. Program Design Best Practices

3.1 Integrated Program Offerings

A. Designing a Portfolio Strategy that Maximizes Synergies among Customer Savings, GHG Emissions Reductions, and Grid Benefits to Utilities

Accelerating the market for low emissions space and water heating equipment requires a compelling value proposition for participating customers, in addition to recognizing the full environmental, economic, and social value of heat pumps to society. From a customer perspective, heat pump technologies must offer one or more advantages relative to "baseline" gas appliances. To this end, TECH Clean California has sought to advance four customer-facing value propositions:

1. Little or no incremental cost of installation
2. Favorable operating costs (i.e., positive bill savings relative to what one would have spent to operate the gas alternative)
3. Non-energy services (e.g., health, comfort, safety, reliability) equal to or better than gas alternatives
4. Minimal hassle factor relative to gas alternatives during equipment installation

TECH Clean California has also sought to advance the following societal benefits of heat pumps:

1. Maximize GHG reductions overall, while achieving those reductions at minimal cost.
2. Support energy affordability by reducing peak electric loads, improving demand flexibility, and avoiding new grid infrastructure costs.
3. Distribute decarbonization benefits equitably across California households.

The section reviews program impacts across multiple objectives and discusses how these sometimes-conflicting priorities can be integrated into a cohesive program design. **The TECH Clean California implementation team's internal analysis has shown that the outcomes tied to different policy objectives are not always correlated; that is, designing to maximize outcomes for one objective may not always align (or in some cases even undermine) efforts to accomplish other objectives.** Nevertheless, an intentional program design approach can identify these relationships and reconcile them to simultaneously address an integrated set of program goals.

B. Valuing the Customer Benefits of Heat Pumps

UPFRONT INSTALLATION COSTS

The incremental cost of heat pump equipment is a substantial barrier to heat pump adoption. A series of market studies by the evaluator show that upfront cost is the primary barrier preventing

homeowners from adopting heat pump HVAC and heat pump water heaters.[28] The evaluator's studies found that **heat pump HVAC** systems have a total project cost $10,800 greater, on average, than a gas furnace replacement, though incremental cost drops to $2,400 when replacing a gas furnace and central air conditioner. Meanwhile, **heat pump water heaters** were found to have an incremental cost of approximately $4,000 over a gas storage water heater.[29] Achieving cost parity or better with baseline equipment would address this important first-cost barrier.

TECH Clean California project data enables in-depth analysis of project cost drivers. Project costs vary widely due to a range of factors including existing home infrastructure, equipment installed, and location. Understanding the top drivers of heat pump HVAC and heat pump water heater retrofit project costs is the first step to reducing the first-cost barrier. However, it is infeasible to require participating contractors to estimate the cost of each retrofit project component, and these estimates would vary widely among contractors. Instead, the TECH Clean California implementer collects detailed data describing each project and the total project cost. Using machine learning, project and cost data can be analyzed, top drivers of project costs can be identified, and the cost impact of each driver can be measured. The TECH Clean California implementer demonstrated this approach in a 2023 report on heat pump HVAC cost drivers, identifying 11 project features with a statistically significant impact on total project cost.[30] In 2026, TECH Clean California is completing a cost drivers analysis covering both heat pump water heater and heat pump HVAC retrofits in single-family and multifamily homes. Full results will be published in an updated Cost Drivers report, but key findings are also included herein as well as in Appendix A: Measure-Specific Best Practices.

Project costs and benefits are interdependent. Many drivers of heat pump retrofit costs also improve long-term benefits of electrification. Indeed, the implementer's analysis of costs and benefits has found that certain project features contribute to higher upfront costs while also improving customer value propositions, including bill savings and quality of energy services. For example, rated storage volume is one of the top three drivers of heat pump water heater retrofit costs in single-family homes. However, under-sizing a heat pump water heater in order to reduce project cost would lead to unhappy customers with insufficient hot water service. The program design team has thus had to weigh trade-offs between increased installation costs versus value propositions such as GHG reductions, customer bill savings, customer satisfaction, and peak demand reduction. These are described further in Section

[28] Opinion Dynamics. *TECH Clean California: Time 2 Market Assessment Final Report*. May 14, 2025. https://opiniondynamics.com/wp-content/uploads/2026/03/TECH-Time-2-Market-Assessment_Final.pdf
[29] Opinion Dynamics. *TECH Clean California: Gas Baseline Incremental Cost Study*. September 25, 2025. https://opiniondynamics.com/wp-content/uploads/2026/01/TECH-Incremental-Cost-Study-Final-Report.pdf
[30] Sarkisian, Dylan, Energy Solutions. Kirwan, Desmond; Sean Parker; Abigail, Hotaling; and Michael Fink, VEIC. *TECH Clean California: Heat Pump HVAC Cost Drivers*. October 3, 2023. https://techcleanca.com/documents/2641/Heat_Pump_HVAC_Retrofit_Cost_Drivers_v4W3bW0_kiFU8k4.pdf

3.2 Simplifying Program Design to Reduce Costs and Burdens and in Appendix A: Measure-Specific Best Practices.

To better understand the tradeoff between upfront costs and customer benefits, the TECH Clean California implementer has begun an analysis of customer return on investment (ROI) – which integrates both lifetime bill savings and incremental upfront cost. Key findings from this analysis are discussed herein, and the full analysis results will be published in 2026.

Expanding TECH Clean California contractor enrollment has created downward pressure on overall project cost. The implementer found that, with all else held equal, heat pump HVAC projects in counties served by 100 or more enrolled contractors cost $1,031 less on average than projects in counties served by just 10 contractors.[31] Furthermore, the implementer's preliminary analysis of customer ROI indicates that the number of contractors serving a county is one of the top drivers of improving ROI for both heat pump water heater and heat pump HVAC customers. This finding implies that simplifying program processes and creating stable incentives, which increase the *rate* and *diversity* of contractor participation, can result in improved affordability and lower project cost. It also points to the need for proactive contractor outreach in underserved areas that otherwise would not benefit from price competition.

Incentives that cover incremental cost are highly effective at increasing heat pump adoption, but program administrators need flexibility to adjust incentive levels as markets mature. To maximize the impact of the TECH Clean California incentive budget, the initiative has reduced heat pump HVAC incentives over time to align more closely to the incremental cost of an air conditioner to heat pump replacement (AC-to-heat-pump), while maintaining high participation levels. This approach encourages AC-to-heat-pump projects and still facilitates furnace-only replacements, while declining to offer the high incentives that would be required to achieve cost parity with a furnace-only replacement. For heat pump water heaters, the TECH Clean California implementer has reduced incentives over time to levels below the incremental cost as markets mature. For example, the initiative reduced incentives in Southern California from an initial high of $3,100 to $2,100 while maintaining consistent volume. For more discussion on incentive design, reference Section 3.1 D. Program and Portfolio Design Optimization and Strategies.

High incentives can contribute to price inflation when set above median installation cost. This pattern was most evident for Self-Generation Incentive Program (SGIP) heat pump water heater equity incentives, which had a maximum of $8,885—far above the median TECH heat pump water heater project cost. When incentives are set lower than median cost, inflation is less apparent. Three factors in combating price inflation are 1) contractor competition, as discussed above; 2) program simplicity, which reduces contractor soft costs of program participation; and 3) customer willingness and ability to pay. For market-rate customers, willingness to pay is typically based on upfront cost compared to a new air conditioning unit for heat pump HVAC, compared to a gas tank water heater

[31] Sarkisian, Dylan, Energy Solutions. Kirwan, Desmond; Parker, Sean; Abigail, Hotaling; and Fink, Michael. VEIC. *TECH Clean California: Heat Pump HVAC Cost Drivers*. October 3, 2023. https://techcleanca.com/documents/2641/Heat_Pump_HVAC_Retrofit_Cost_Drivers_v4W3bW0_kiFU8k4.pdf

for heat pump water heater. For lower-income customers, willingness to pay is more strongly constrained by *ability* to pay. When project costs exceed a customer's ability to pay (even if they would otherwise be willing), then lower income customers must choose whether to defer project upgrades, forego needed energy services, or make other financial compromises. Low-income customers' more constrained ability to pay puts downward pressure on project costs. Aside from SGIP heat pump water heater project costs, we did not observe price inflation for equity projects.

Right-sizing heat pump HVAC heating capacity is a major cost savings opportunity. The implementer's analysis has found that heating capacity is consistently one of the top cost drivers for heat pump HVAC installations in both single-family and multifamily homes. While heating capacity and cooling capacity are both strongly correlated with cost, machine learning analysis consistently finds that heating capacity is a more important cost driver than cooling capacity. Furthermore, as shown by Figure 8 in Appendix A: Measure-Specific Best Practices, the relationship between total project cost and heating capacity is not linear. Right-sizing the heating capacity of heat pump HVAC equipment during the installation process is therefore especially effective if a customer can avoid passing the cost thresholds at ~2.4 and ~3.4 tons of heating capacity, as these correspond with rapid cost increases. Simply replacing a customer's furnace with a heat pump HVAC of equivalent heating capacity creates a risk of oversizing if the original furnace was itself oversized. While quality installation measures like performing Manual J calculations do typically add labor costs, these can also save costs to the extent that they help installers unnecessarily avoid oversizing equipment.

Heat pump HVAC upfront costs have a complex relationship with home age. Costs tend to be lowest in homes built in or after 1985, and costs tend to increase as home age increases beyond this. The implementer obtained property assessor-based data comprising the year in which each participant's home was built. This enables analysis of the relationship between total project cost and home age. Preliminary results indicate that project cost has a complex, non-linear relationship with home age. As shown by Figure 9 in Appendix A: Measure-Specific Best Practices, heat pump HVAC project costs tend to slightly decrease with age for homes built more recently than 1985, but costs tend to increase as home age increases for homes built before 1985. This is despite the fact that upfront costs tend to increase with home size, and home size tends to *decrease* with home age. This suggests that heat pump retrofits in homes built prior to 1985 tend to require either more labor or more expensive equipment than those in newer homes. This is supported by the TECH team's understanding of the building stock: homes built after 1985 tend to have modern breakers and allow for higher electrical panel capacity, which makes equipment replacement and electrification projects much easier to manage and complete, compared to homes built before 1985. Additionally, homes built after 1985 tend to have larger mechanical spaces that allow for easier heat pump installation, and their homeowners tend to be more proactive in addressing necessary repairs and preventive care measures. Conversely, the data does not support a clear trend between the upfront costs of heat pump water heater retrofits and home age. The implementer plans to continue investigating the relationship between home age and total project cost and will publish results in the updated project cost drivers report.

Several other cost drivers bear further analysis. The implementer has identified other significant contributors to total project cost needing further investigation, including installation duration, previous space heating equipment type (especially for multifamily homes), and equipment efficiency. These will be discussed further in the updated project cost drivers report.

CUSTOMER BILL SAVINGS AND AFFORDABILITY OF ENERGY SERVICES

Both the evaluator and implementer analyses observed a wide distribution of bill savings outcomes for TECH Clean California incentive recipients. The two sets of analysis results are broadly consistent, varying primarily in the different approaches analysts took to disaggregating results. Evaluator results are shown in Table 1.[32] The analysis included over 10,000 TECH Clean California projects completed between July 2021 and July 2023, including all incentivized technologies across both HVAC and water heating end uses and including all customers with and without pre-existing solar, as evidenced by their NEM tariff. The analysis included both single-family customers and individually metered multifamily customers.

Table 1: Evaluator estimates of customer bill impacts by season, all customer and project types.

Measure	Electric Estimate	Gas Estimate	Annual Net Change
Annual Average Impact	+$333	-$344	-$11
Winter	+$316	-$222	+$94
Summer	-$33	-$24	-$56
Shoulder	+$50	-$99	-$49

The evaluation yielded an average annual impact that was close to break even. In general, customers were estimated to save on their bills during summer and shoulder seasons, with winter bill increases due to new electric heating loads.

The implementation team found that the greatest bill savings opportunities were concentrated among those customers with high summer cooling bills. While the evaluator focused primarily on program-level impacts, the implementation team focused more attention on factors that drove variations in savings. The implementer analyzed 1,515 projects for customers with no pre-existing solar, completed between July 2021 and January 2023. The analysis focused on three technology portfolios: "HVAC, AC Detected;" "HVAC, No AC Detected;" and "Heat pump water heater" (see Figure 1). [33]

[32] Opinion Dynamics. *TECH Population-Based Pathway Impact Report*. November. 27, 2024. https://opiniondynamics.com/wp-content/uploads/2025/12/TECH-Population-Pathway-Impact-Analysis-Report-FINAL.pdf

[33] The implementer's ability to analyze differential impacts across technologies, project attributes, and customer demographics was constrained at this stage by the small population of projects with sufficient post-retrofit energy consumption data. Future iterations of this analysis will have access to a much larger project population, supporting more granular analysis.

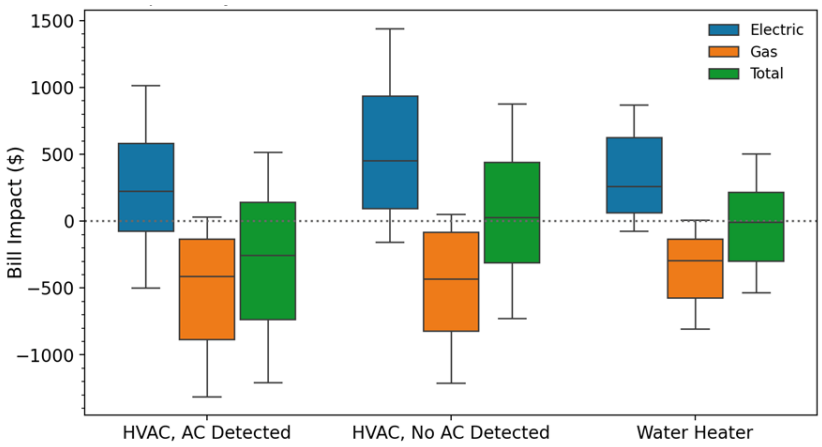


Figure 1: Median annual bill impacts by project type. [34, 35]

Customers with existing AC typically experienced modest or negative savings on winter bills but accrued additional savings during summer months. Heating bill impacts depend on the magnitude of gas heating bill savings, compared to heating electric bill increases. Summer electricity savings come from the increased cooling efficiency of the new heat pump relative to their previous equipment. Overall, the implementation team's analysis of non-solar customers with existing AC indicated average bill savings were $304 per year (median savings were $260 per year) based on 2022-2023 rates, and 67 percent of adopters experienced positive bill savings.[36]

The energy bill savings from furnace-only replacements are derived exclusively from winter gas bill savings relative to electric bill increases. Those savings are generally modest or in some cases negative due to the high electricity-to-gas price ratio in some service territories and the addition of new cooling loads. Heat pump HVAC retrofits replacing a gas furnace in homes without existing cooling loads show a small average annual bill increase of $69 per year and a median increase of $35 per year, counterbalanced by a gain in cooling functionality and extreme heat protection.[37]

Heat pump water heater bill impacts: The evaluator's analysis of heat pump water heater impacts is shown in Table 2.[37]

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[34] Scheer, Adam. Recurve. 2025 ACEEE Hot Water & Air Forum Presentation "Measured Impacts of TECH Heat Pump Installations". March 6, 2025. https://drive.google.com/file/d/1oju5s-S4zltvkv5rzDFuDu6k3ftKujPT/view

[35] Analysis based on a sample size of 1,515 non-solar projects. The implementation team's ability to segment by technology, project attributes, customer demographics, and utility was constrained by the sample size.

[36] The impact of AC on customer bills was also corroborated in customer self-report responses to the TECH Clean California evaluator's customer satisfaction survey. More than half of those with air conditioning before reported a decrease in their bills (236 of 445; 53 percent), while two-fifths of customers without air conditioning prior experienced a decrease (76 of 189). Heat pump water heater adopters perceived that their bills declined or stayed the same 71 percent of the time. Opinion Dynamics. *TECH Clean California: Insights into Customer Experience and Satisfaction Wave 2*. March 27, 2025. https://opiniondynamics.com/wp-content/uploads/2025/09/TECH_Updated-Customer-Experience-and-Satisfaction-Report_3.31.2025_Clean_UPDATED.pdf

[37] Opinion Dynamics. TECH Population-Based Pathway Impact Report. November. 27, 2024. https://opiniondynamics.com/wp-content/uploads/2025/12/TECH-Population-Pathway-Impact-Analysis-Report-FINAL.pdf

Table 2: Evaluator estimates of customer bill impacts from heat pump water heaters.

Measure	Electric Estimate	Gas Estimate	Annual Net Change
Heat pump water heater	+$177	-$362	-$184

As expected, the results show substantial gas savings, offset by an increase in electric water heating costs.

The TECH Clean California implementation team's analysis found broadly consistent results: heat pump water heater retrofits replacing gas water heaters achieve an average saving of $97 dollars per year and median savings of $6 per year. Again, results vary significantly by utility rate, income status, geography, and household energy consumption, among other factors.

Customer perceptions of bill impacts. Perhaps as important as bill impacts themselves are customer perceptions of those impacts. In response to the evaluator's satisfaction survey, more than 93 percent of heat pump HVAC adopters rated their purchase as a "good" or "great" value. Cost savings were the most frequently cited reason for customers who viewed their heat pump as a valuable investment. Likewise, 90 percent of heat pump water heater adopters rated their purchase as good or great value. Over one-fourth of those customers said they valued the monthly and long-term reduction in their energy bills.[38]

Bill savings are highly variable. As Figure 1 illustrates, almost 50 percent of heat pump HVAC projects with no prior AC produced positive bill savings. Nearly 50 percent of heat pump water heater projects produced positive bill savings. Finally, two-thirds of heat pump HVAC with preexisting AC produced bill savings. Results vary widely by climate, utility rate, income status, and household energy consumption patterns, among other factors.[39] Climate exerts a smaller influence on heat pump water heater bill savings compared to heat pump HVAC.

Customer utility electricity and gas rates are a major driver of bill impacts. The role of utility rates was most evident in the comparison of bill impacts observed between Sacramento Municipal Utility District (SMUD) and Pacific Gas and Electric (PG&E) customers. The implementer analysis estimated that the median SMUD customer saved $516 per year for heat pump HVAC replacements with preexisting AC and $102 per year for heat pump water heater replacements. By comparison, the median PG&E customer saved $276 per year for heat pump HVAC replacements with preexisting AC, while the median heat pump water heater replacement increased bills by $57.[40] The differences were attributable both to lower electric bill increases for SMUD customers, tied to lower rates, and higher gas bill savings for SMUD customers, possibly driven by higher heating needs and

[38] Opinion Dynamics. *TECH Clean California: Insights into Customer Experience and Satisfaction Wave 2*. March 27, 2025. https://opiniondynamics.com/wp-content/uploads/2025/09/TECH_Updated-Customer-Experience-and-Satisfaction-Report_3.31.2025_Clean_UPDATED.pdf

[39] Opinion Dynamics. *TECH Population-based Pathway Impact Report.* November 27, 2024. https://opiniondynamics.com/wp-content/uploads/2025/12/TECH-Population-Pathway-Impact-Analysis-Report-FINAL.pdf

[40] Electricity and gas rates have changed significantly since this analysis was completed, and thus these values should be interpreted as directional outcomes that will shift based on changes to fluctuations in electricity and gas rates.

larger homes around the Sacramento area. The evaluator did not report customer bill savings by utility.

Heat pumps likely provide some protection against future rate increase and price volatility; however, that value proposition is difficult to quantify. The value proposition of heat pumps acting as a "hedge" against volatile prices is clear-cut when considering future gas rate increases, which building electrification mitigates. Customers can extend the hedge to future electric rates by combining building electrification with rooftop solar and battery storage. This combination allows the customer to produce and self-consume at a known and fixed electricity cost for the life of the solar and storage system, while minimizing gas charges or avoiding them entirely. This value proposition may help explain the popularity of heat pumps and heat pump water heaters among customers with preexisting solar arrays. In future analyses of customer bill savings and ROI, it would be important to further segment solar and non-solar customers to better understand this difference.

Customers on income qualified rates, such as CARE/FERA, experience more bill savings from fuel substitution than market rate customers. Analyses by both the evaluator and the implementer indicate that heat pump HVAC customers on a CARE/FERA rate experience more bill savings from fuel substitution than non-CARE/FERA customers. This increase is primarily driven by the higher discount on electric rates (30-35 percent) relative to the gas rate discount (20 percent). Evaluator results for a combined heat pump HVAC and heat pump water heater portfolio found an average $75 improvement in bill impacts for CARE versus non-CARE customers (annual savings of $109 versus $34).[41]

Table 3: Evaluator analysis of CARE or FERA and Non-CARE or FERA annual bill impacts.

Low-Income Status	Electric Estimate	Natural Gas Estimate	Annual Net Change
CARE or FERA	+$95	-$205	**-$109**
Non-CARE or FERA	+$327	-361	**-$34**

The addition of the Base Services Charge is expected to improve bill outcomes for all customers. Based on utility rates in effect in 2022 and 2023, the implementer forecast that median bill savings could improve by an estimated $91–104 per year for non-solar customers installing a heat pump HVAC project without prior AC, enough to shift median impacts from a bill increase to bill savings.[42] Median bill impacts for heat pump water heaters and HVAC with prior AC were estimated to decrease bills by $42–54 per year. Future analyses could refresh these results with more recent rates and a larger project portfolio that can yield utility-specific results.

[41] Opinion Dynamics. *TECH Population-based Pathway Impact Report*; Figure 3. November 27, 2024. https://opiniondynamics.com/wp-content/uploads/2025/12/TECH-Population-Pathway-Impact-Analysis-Report-FINAL.pdf

[42] At the time of analysis, there were insufficient HPWH projects to effectively model BSC impacts for customers, although future efforts may include them.

Bill savings for heat pump water heaters could be further improved through the adoption of baseline consumption allowances. To explore this possibility, the implementer modeled a hypothetical baseline allowance for PG&E customers, set at the average measured increase in electricity consumption for heat pump water heaters, which was 2.4 kWh per day in the summer and 4.0 kWh per day in the winter. The change was sufficient to improve median bill savings by $96 per year and transition from negative to positive savings.

Subsequent analysis can support more granular results to improve California's building decarbonization strategy. Going forward, the continued growth of completed projects with more than one year of post-install data offers an opportunity to address gaps in the above analysis and improve rigor across the board, by utility, climate zone, and technology, and isolate specific drivers to understand how they individually contribute to outcomes. For example, considering the large observed energy impact differences for CARE and non-CARE customers, it will be necessary to further investigate the differences between these groups to better isolate the effect of the CARE program on electrification bill impacts. Among other enhancements, increased data availability could shed light on utility variation. Likewise, the implementer did not estimate heat pump water heater bill impacts in some instances due to small sample size. With continued growth in the TECH Clean California's project portfolio, these gaps may be addressed in a subsequent analysis.

NON-ENERGY SERVICES: CUSTOMER COMFORT, HEALTH, AND RESILIENCE

Comfort is the key benefit customers derive from their heating-cooling systems. Comfort and reliability are critical customer considerations. Customers identify reliability, performance, and cost as the most important factors when replacing their HVAC equipment, and over 80 percent rated heat pumps as very effective at both heating and cooling their homes (8 out of 10 or higher). [43] Heat pump water heaters are effective at meeting customer demand, with 71 percent of customers always having sufficient hot water to meet their needs, and 23 percent had sufficient hot water "most of the time."[44] Customers also cited perceived health and safety benefits of heat pumps, as well as supplemental benefits of heat pump water heaters such as cooling of unconditioned spaces.[45]

Heat pumps strengthen climate resilience. Installing heat pump HVAC for customers who previously lacked air conditioning significantly improves resilience in hot climate zones by enabling households to better withstand extreme heat events. When paired with solar and battery storage,

[43] Opinion Dynamics. *Technology and Equipment for Clean Heating (TECH) Initiative Baseline Market Assessment*. July 15, 2022. https://opiniondynamics.com/wp-content/uploads/2024/12/TECH_Baseline_Market_Assessment_Final_Report_8AHwAxk.pdf

[44] Opinion Dynamics. *TECH Clean California: Insights into Customer Experience and Satisfaction Wave 2*. March 27, 2025. https://opiniondynamics.com/wp-content/uploads/2025/09/TECH_Updated-Customer-Experience-and-Satisfaction-Report_3.31.2025_Clean_UPDATED.pdf

[45] Opinion Dynamics. *TECH Clean California Heat Pump Equipment: Insights into Customer Experience and Satisfaction*. September 15, 2023. https://opiniondynamics.com/wp-content/uploads/2024/12/TECH_Customer_Experience_and_Satisfaction_Final_Report_9.15.23.pdf

heat pumps further enhance preparedness during extended power outages, particularly when considering that modern gas appliances rely on electricity to operate.

HASSLE FACTOR, TRANSACTION FRICTION

While heat pumps offer significant value to individual customers, the hassle factor of installing a heat pump as compared to a replacement gas appliance can be a significant deterrent to customer adoption. Transaction friction can impact customers directly, (e.g., delays in getting installations completed, complex documentation requirements for incentive applications; repeated site visits from installers and inspectors) which may interfere with work or other duties. It can also impact customers indirectly when contractor-level friction translates into higher installation prices. Transaction friction for heat pump installations comes from three primary sources:

1. Program requirements associated with incentive applications
2. Differential application of state laws and policies such as building permit requirements, customer protections, workforce training, and labor standards that ideally should apply to all appliance installations, but are consistently enforced only on program participants
3. Inherent work scope complexity compared to gas alternatives (e.g. wiring, relocation).

For opportunities to address the first source of friction, see 3.2 Simplifying Program Design to Reduce Costs and Burdens for a discussion of lessons learned and best practices. The second source of friction, differential application of state laws and policies, will remain an issue until regulators and policy makers resolve the issue more broadly.

There are emerging opportunities to mitigate project complexity. As for the third source of friction, there has been some progress in reducing the inherent complexity of heat pump installations. In some cases, technology innovations have succeeded in simplifying project work scopes, particularly related to duct design and wiring upgrade requirements. Mini splits, for example, have greatly simplified the task of retrofitting HVAC in a home that lacks preexisting air ducts. TECH Clean California has seen positive market response to the introduction of 120V heat pump water heaters, which mitigates the need for expensive wiring upgrades and reduces overall project cost (see Appendix A: Measure-Specific Best Practices). Since TECH Clean California was launched, developments in power-efficient design have reduced the need for service panel upsizing.

While new technologies have succeeded in resolving some points of work scope friction, other sticking points remain, particularly when an appliance needs to be relocated or when a service panel upgrade cannot be avoided. The points of friction can increase when the extra work scope complexity triggers additional permit requirements.

CONSIDERATION OF OTHER CUSTOMER PREFERENCES

While this section focuses on the economic value and customer cost of heat pump retrofits, people rarely make decisions in perfect accordance with economic theory. Meeting a customer's financial thresholds may be a necessary precondition to heat pump adoption, but other value propositions also come into play, including access to reliable energy services, home health and comfort, and even impacts on social status and alignment with personal values and beliefs. Moreover, the way those

value propositions affect program uptake can be expected to change as participation moves beyond "early adopters" to include "early majority" customers.

For example, heat pump water heaters are clearly in an "early adopter" stage, and heat pump water heater customers were much more likely than heat pump HVAC customers to list "solar/electrification" or "environmental" reasons for moving forward with a heat pump or have functioning equipment but searching for an alternative as opposed to emergency replacement. In contrast, heat pump HVAC is in the "early majority" stage of market adoption, and thus retrofit drivers are more consistent with standard business practices. Sixty-four percent of heat pump HVAC customers reached out to a contractor because their equipment was old, malfunctioning, or broken, whereas only 42 percent of heat pump water heater customers had those reasons.[46]

C. Valuing the Societal Benefits of Heat Pumps

GREENHOUSE GAS EMISSIONS (GHG) IMPACTS

Building electrification can deliver cost-effective GHG reductions. The primary source of GHG emission reductions comes from decommissioning gas appliances. While the new electric heating load from heat pumps contributes GHG emissions, those emissions are substantially lower (74 percent) than the gas heating emissions they replace.[47] These heating-related electricity emissions are expected to decline as electricity generation continues to decarbonize to meet California's commitment to a fully decarbonized grid by 2045 (Senate Bill 100, 2018). The TECH Clean California implementer analyzed GHG savings at a measure level (Table 4). The implementer found that GHG emissions reductions from heat pump HVAC retrofits are even lower when replacing a furnace-AC combination because the heat pump reduces summer cooling loads and associated emissions.

Table 4. Implementer estimates of average lifecycle GHG emissions impacts by project type[48,49]

	Average Lifecycle GHG Impacts per Participant (Tons CO2e)		
Portfolio	**Electric**	**Gas**	**Total**
HVAC, AC	+7.8	-27.0	-19.2
HVAC, No AC	+13.0	-25.8	-12.8
Water Heater	+7.6	-21.4	-13.8

[46] Opinion Dynamics. TECH Customer Post-Install Survey Topline Findings. September 2023. https://opiniondynamics.com/wp-content/uploads/2024/12/TECH_Single-Family_Customer_Post-Install_Survey_Topline_Findings_Q4_2022.pdf

[47] Sarkisian, Dylan. Energy Solutions. 2024 ACEEE Hot Water & Hot Air Forum Presentation "The Roadmap to Scale: Using Analysis of Heat Pump Installations to Inform the Next 20 Million Projects". March 13, 2024. https://drive.google.com/file/d/1YrcUEcHaTh3Cw3dTrMpa5WuqttSSK967/view

[48] Scheer, Adam. Recurve. 2025 ACEEE Hot Water & Air Forum Presentation "Measured Impacts of TECH Heat Pump Installations". March 6, 2025. https://drive.google.com/file/d/1oju5s-S4zltvkv5rzDFuDu6k3ftKujPT/view

[49] For TECH Clean California electrification projects installed in 2021 and 2022. Negative values denote GHG emissions reductions, based on 2022 Avoided Cost Calculator emissions factors.

Across the portfolio, the evaluator calculated GHG emissions reductions to be 16.42 tons of CO2e across the measure lifetime. In addition to estimating the overall emissions impacts, the evaluator also estimated the program cost per avoided metric ton of CO_2-e,[50] finding that streamlined program implementation would deliver CO_2-e reductions at an average cost of $240 per ton.[51] This value is close to the California Air Resources Board's 2035 estimated cost for reducing a metric ton of CO_2-e via building decarbonization ($235).[52] It should be noted that the evaluator results were derived from the cohort of projects completed between July 2021 and July 2023. During that timeframe, the HVAC heat pump incentive decreased from $3,000 to $1,000 per unit in May 2022, so an updated analysis should show lower incentives per installed unit and thus a lower cost per ton of GHG reductions. Likewise, the implementer's internal analysis has identified opportunities to maximize GHG reductions along with other policy priorities (See Section 3.1D. Program and Portfolio Design Optimization and Strategies for more information). These opportunities are currently being operationalized. In short, there is ample reason to believe that a well designed and implemented program in a maturing market could achieve reductions at a cost well below $235 per metric ton.

Furnace decommissioning for heat pump HVAC projects generates substantially higher GHG savings than projects that do not. Internal analysis by the TECH Clean California implementation team found that median GHG savings for heat pump HVAC electrification projects where the furnace was fully decommissioned are 63 [53]

Heat pump deployment has implications for refrigerant-related GHG emissions and voluntary initiatives can continue to provide a pathway for data gathering. Air conditioners and heat pumps use refrigerants, with technology and policy advancing to lower their global warming potential (GWP). Variables that can determine the amount of refrigerant-related emissions from an air conditioning or heat pump unit are the GWP of the refrigerant used, and the amount of leakage during the life of the equipment, including the end-of-life management and disposal processes. When an air-conditioner is replaced with a newer heat pump, there is an opportunity to lower refrigerant-related emissions, depending on these variables. When a heat pump is added to a building without air conditioning or a heat pump water heater replaces a non-refrigerant water heater, there is potential for increasing refrigerant-related emissions, dependent on the variables mentioned above. However, overall there are significant net emission reductions from replacing a gas water heater and furnace, even assuming 100 percent refrigerant leakage, based on ex ante

[50] Opinion Dynamics. *TECH Population-based Pathway Impact Report*. November 27, 2024. https://opiniondynamics.com/wp-content/uploads/2025/12/TECH-Population-Pathway-Impact-Analysis-Report-FINAL.pdf

[51] "Streamlined implementation" excludes administrative and incentive costs related to both pilots and Quick Start Grants and workforce training and development activities. The intent is to show potential impacts for a full-scale program in a more mature market.

[52] California Air Resources Board. *2022 Scoping Plan for Achieving Carbon Neutrality*. December 2022. https://ww2.arb.ca.gov/sites/default/files/2023-04/2022-sp.pdf

[53] Sarkisian, Dylan. Energy Solutions. 2024 ACEEE Hot Water & Hot Air Forums Presentation "The Roadmap to Scale: Using Analysis of Heat Pump Installations to Inform the Next 20 Million Projects" Slide 11. March 13, 2024. https://drive.google.com/file/d/1YrcUEcHaTh3Cw3dTrMpa5WuqttSSK967/view.

savings from the California Electronic Technical Reference Manual and California Air Resources Board GHG emissions saving factors.[54,55] TECH Clean California has offered an incentive kicker for heat pump water heaters with low-GWP refrigerants, but the GHG impact of reducing refrigerant emissions is not included in the evaluation. The TECH Clean California implementation team recommends continued support for voluntary programs that lower GWP refrigerant deployment and end-of-life management to collect data and inform future program and policy designs.

PEAK LOAD REDUCTIONS, AVOIDED COSTS OF GRID INFRASTRUCTURE

AC to heat pump replacements generally reduce peak demand. Heat pumps that replace inefficient ACs with high summer cooling loads substantially reduce summer peak—no load shifting required—whereas heat pumps for furnace-only replacements add summer peak loads (Figure 2).

Water heating electrification does not meaningfully increase household peak demand. The TECH Clean California evaluator found that the peak impact during the Resource Adequacy window from 4:00 p.m. to 9:00 p.m. on summer weekdays from heat pump water heaters was less than 0.01 kW.[50]

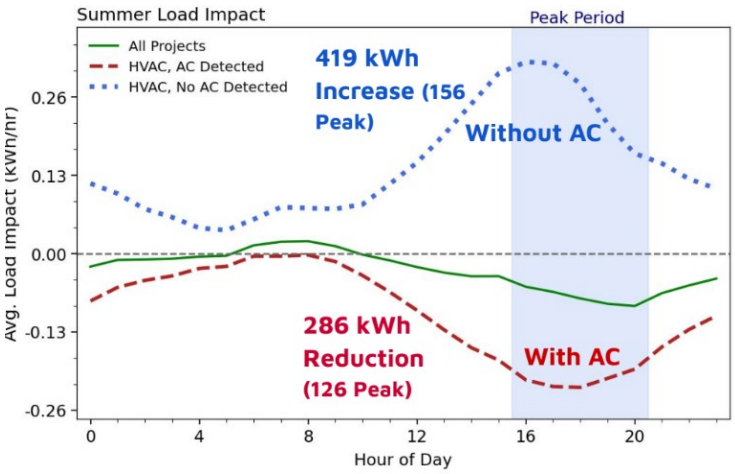


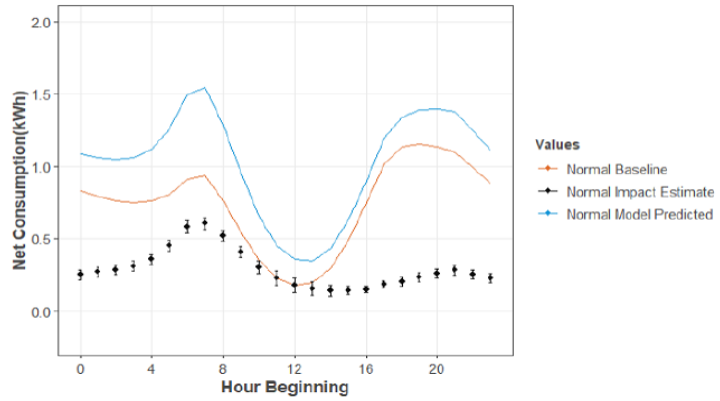
Figure 2: Average summer load impact from heat pump HVAC retrofits.[56]

Even though building electrification measures add electric load to the grid, they can achieve significant peak demand reductions and support demand flexibility. Electrification of space and water heating has potential to improve energy affordability to all ratepayers, by adding load to the grid, largely during off-peak and partial-peak hours.[56] This enables fixed costs, which represent most of the customer electric bill, to be spread across more kWh, thereby putting downward pressure on electric rates. This is consistent with PG&E's 2026 analysis that suggests electrification could reduce

[54] California Electronic Technical Reference Manual. California Technical Forum. 2026. https://www.caetrm.com/
[55] "Quantification Methodologies and Calculator Tools", California Climate Investments. https://www.caclimateinvestments.ca.gov/tools#calculator

[56] Scheer, Adam. Recurve. 2025 ACEEE Hot Water & Air Forum Presentation "Measured Impacts of TECH Heat Pump Installations". March 6, 2025. https://drive.google.com/file/d/1oju5s-S4zltvkv5rzDFuDu6k3ftKujPT/view

distribution rates by 25 percent by 2040.[57] Both evaluator and implementer analysis identified that adding heat pumps for either space conditioning or water heating produces a morning winter peak, which is still small compared to the summer peak and existing grid capacity (see Figure 3).



Note: Normal weather estimates based on fixed-effects D-in-D panel regression analysis of TECH participant and matched nonparticipant interval electricity consumption data. Error bars show 95% confidence intervals.

Figure 3: Average winter weekday electric load shape and impacts.

Beyond peak load reductions, building electrification contributes a suite of total system benefits like reducing natural gas usage.[58] The implementer's internal analysis has quantified a suite of public benefits from heat pump technologies, as shown in Figure 4. Of note, the most substantial public benefits are a result of reducing gas consumption, and include reduced environmental impacts, avoided fuel costs, and avoided distribution infrastructure costs. The benefits of reducing gas are offset to a small degree by some incremental electric costs, although AC to heat pump replacements ("HVAC, AC Detected") result in increased grid capacity.

[57] Pacific Gas & Electric. January 30, 2026. "New PG&E Study Shows Electrification Will Lower Electricity Rates Over Time." https://www.pge.com/en/newsroom/currents/future-of-energy/new-pg-e-study-shows-electrification-will-lower-electricity-rate.html

[58] The system benefits and avoided cost value in this report are based on the 2022 CPUC approved ACC which was the most current at the time of the analysis. Future analyses will use the 2024 ACC.

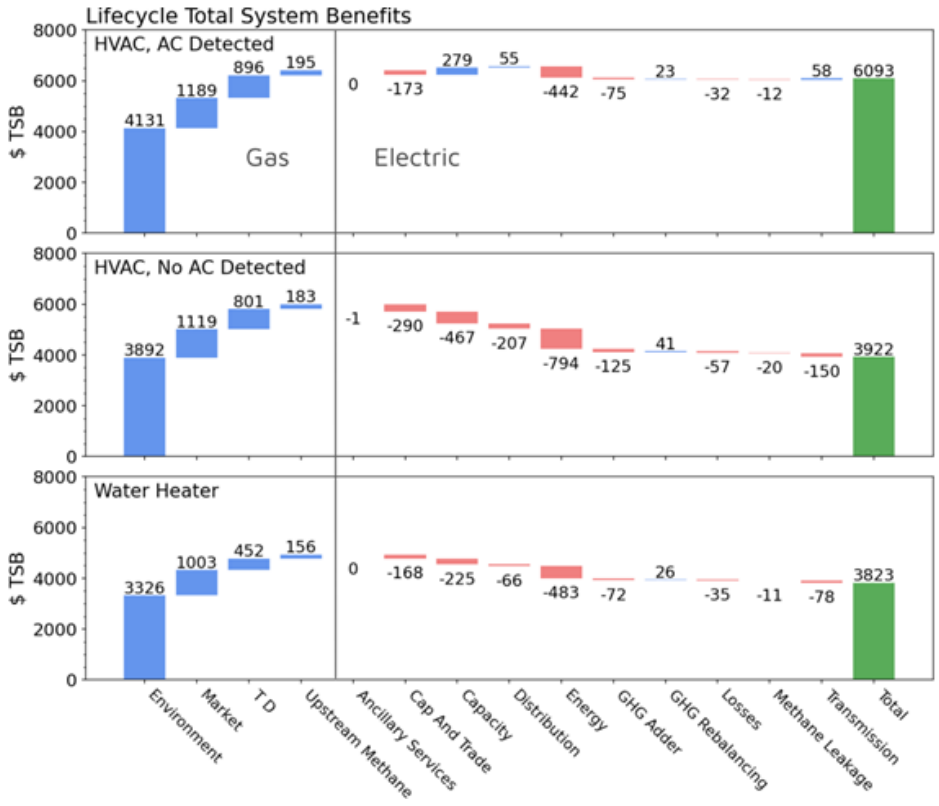


Figure 4: Lifecycle total system benefits for three technology portfolios.[59]

AC to heat pump replacements generally reduce peak demand. Heat pumps that replace inefficient ACs with high summer cooling loads substantially reduce summer peak—no load shifting required—whereas heat pumps for furnace-only replacements add summer peak loads (Figure 2).

[59] Scheer, Adam. Recurve. 2025 ACEEE Hot Water & Air Forum Presentation "Measured Impacts of TECH Heat Pump Installations". March 6, 2025. https://drive.google.com/file/d/1oju5s-S4zltvkv5rzDFuDu6k3ftKujPT/view

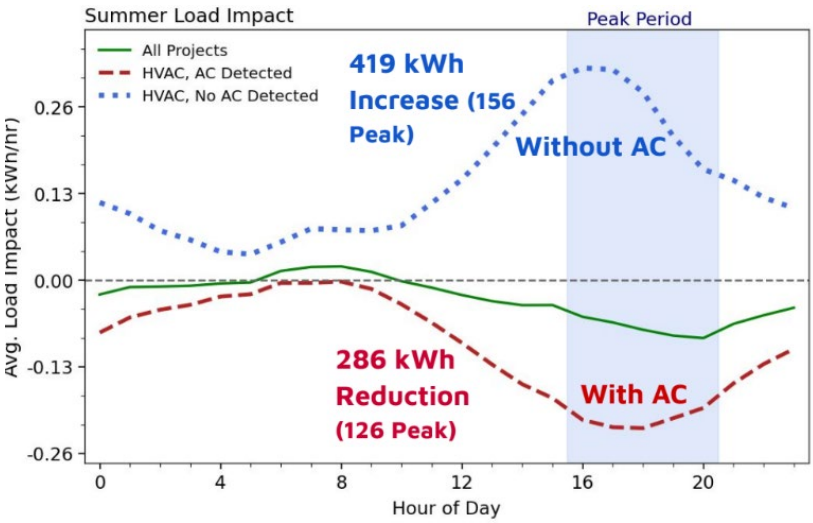


Figure 5: Average summer load impact from heat pump HVAC retrofits.[60]

Integrated Demand Side Management (IDSM) program design can provide significant value to the grid and to customers by shifting load to off-peak hours. The SGIP Heat Pump Water Heater program launched incentives for heat pump water heaters (with demand flexibility requirements) under the TECH Clean California brand in October 2023. Figure 6 demonstrates the substantial amount of load shed during peak periods from JA13-enabled sites (those that participated in the SGIP heat pump water heater program).

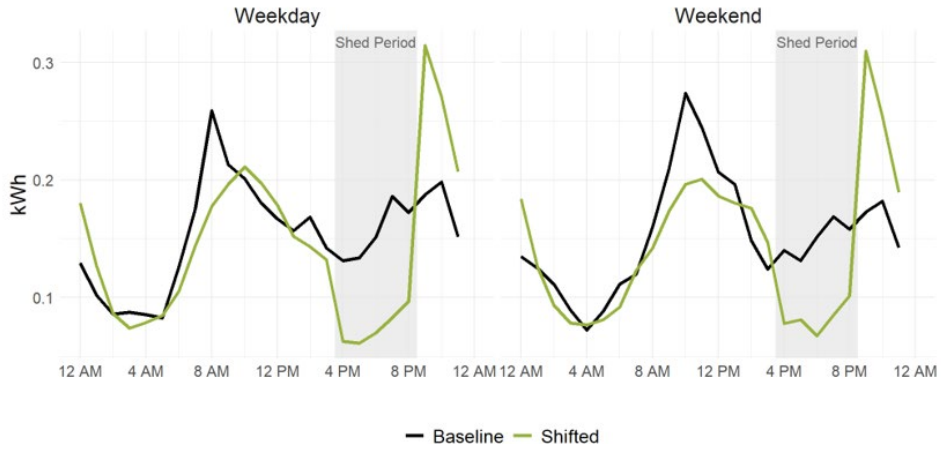


Figure 6: Average hourly load profile, JA13-enabled sites.[61]

Water heating electrification does not meaningfully increase household peak demand. The TECH Clean California evaluator found that the peak impact during the Resource Adequacy window from 4:00 p.m. to 9:00 p.m. on summer weekdays from heat pump water heaters was less than 0.01 kW.

[60] Scheer, Adam. Recurve. 2025 ACEEE Hot Water & Air Forum Presentation "Measured Impacts of TECH Heat Pump Installations". March 6, 2025. https://drive.google.com/file/d/1oju5s-S4zltvkv5rzDFuDu6k3ftKujPT/view

[61] Upcoming Interim Evaluation Report for SGIP HPWH [not yet published] by program evaluator Verdant.

ADVANCING ENERGY EQUITY

Advancing energy equity via building decarbonization programs is best achieved by serving the customer segments that benefit most from building decarbonization measures. Low-income customers in hot climate zones stand to benefit the most from building decarbonization.

CARE customers are more likely to realize bill savings from heat pump installations than market rate customers. CARE customers are more likely to achieve utility bill savings following heat pump retrofits than market-rate customers (reference Section 3.1 C. Customer Bill Savings and Affordability of Energy Services).

Hot climate zones are an opportunity to serve California's equity communities, while also prioritizing bill savings opportunities. A disproportionate number of DACs and income-qualified customers are concentrated in hot interior climate zones. Customers in those areas stand to benefit the most financially from heat pump adoption. To ensure equitable distribution of benefits, a program design with a focus on AC replacement (to drive bill savings and grid benefits) should be balanced with programming enabling access to cooling for added customer health, comfort, and safety benefits. This customer segment includes customers who have existing window units or cooling systems that are underused due to cost impacts and therefore may not show up as having cooling loads.[62,63]

D. Program and Portfolio Design Optimization and Strategies

Building decarbonization programs can deliver significant benefits to utilities, the grid, customers, and society at large. In many cases, these benefits are interrelated—but they do not automatically align without intentional program design. TECH Clean California energy impacts, GHG emissions, and bill impacts vary between climate zones, measures, and customer segments such as customers on CARE and FERA.[64] The variations in these program metrics show varying degrees of correlation, which opens an opportunity to optimize across multiple metrics.

This section summarizes how the TECH Clean California implementation team investigated how different objectives relate to one another and the relative tradeoffs in prioritizing different metrics. The implementation team found that it is possible to improve program performance around its core mission of reducing greenhouse gas emissions without compromising ratepayer affordability or ignoring equity considerations—in fact, all three policy priorities can be enhanced in tandem.

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[62] Etherington, Rachel; Krishpinovich, Irina; and Ortiz, David. The Ortiz Group LLC. Harwood, Meghan; Schaff, Becky; Staub, Ben; and Parker, Asa. VEIC. *Pilot Project Final Report: Low-Income Leveraging Pilot*. December 15, 2025. https://techcleanca.com/documents/5705/8.2_Low_Income_Leveraging_Pilot_v260105.pdf

[63] Dryden, Amy; Stratton, Chris; and Chen, Yushi. Association for Energy Affordability. Schaff, Becky and Chase, Tom. VEIC. *TECH Clean California Multifamily Pilot Final Report.* March 3, 2026. https://techcleanca.com/documents/5729/8.3_MF_Final_Report_v260316.pdf

[64] Opinion Dynamics. *TECH Population-based Pathway Impact Report*. November 27, 2024. https://opiniondynamics.com/wp-content/uploads/2025/12/TECH-Population-Pathway-Impact-Analysis-Report-FINAL.pdf

EMBRACING A MULTIVARIATE APPROACH TO BUILDING DECARBONIZATION

As part of its program optimization strategy, the implementation team analyzed relationships among six key program metrics.

Table 5 illustrates the varying levels of synergies between TECH Clean California's goals.[65] For customers in single-family homes, Total System Benefit (TSB) shows strong alignment with GHG emissions reductions and some alignment with customer bill savings and peak period load reductions. However, equity-related metrics (low-income, hard-to-reach county, and disadvantage community) have a slight negative correlation with TSB and GHG savings and inconsistent relationships with bill savings and peak load reductions. That does not mean that equity metrics are mutually exclusive with the other metrics, but it also means that they would not be achieved on their own without specific, intentional program support. This analysis informed the TECH Clean California decision to offer dedicated equity incentive kickers to advance energy equity. For full methodology, reference Appendix E: Frameworks for Optimizing Policy Objectives.

This strategy for program optimization has also been used by the Equitable Building Decarbonization team to support outreach to candidates most likely to benefit and with high alignment with the program's GHG objectives.[66]

Table 5: TECH Clean California goal correlation matrix for single-family customers.[67]

Correlation Matrix	Low Income	HTR County	Disadvant. Comm.	GHG Savings	TSB	Annual Bill Savings
Peak MWh Savings	-0.02	0.16	0.02	0.10	0.51	0.54
Annual Bill Savings	-0.02	0.14	0.06	0.39	0.68	
TSB	-0.09	0.11	-0.06	0.88		
GHG Savings	-0.12	0.04	-0.11			
Disadvant. Comm.	0.24	0.28				
HTR County	0.13					

OPTIMIZING SINGLE-FAMILY PROGRAM DESIGN

As TECH Clean California has collected program data, a clear program design strategy has emerged to maximize both the customer and societal benefits of building decarbonization in single-family homes. A primary focus on **air conditioner replacements in hot climates** is compelling to the customer because they have (1) a relatively low incremental cost of installation, which requires lower incentive amounts per project; and (2) strong customer bill savings; and they have substantial

[65] Scheer, Adam. Recurve. 2025 ACEEE Hot Water & Air Forum Presentation "Measured Impacts of TECH Heat Pump Installations". https://drive.google.com/file/d/1oju5s-S4zltvkv5rzDFuDu6k3ftKujPT/view.
[66] Maneta, Daniela. California Energy Commission. CPUC Building Decarbonization Best Practices and Future Pathways Workshop; "Equitable Building Decarbonization Direct Install Program". January 22, 2026. https://www.cpuc.ca.gov/-/media/cpuc-website/divisions/energy-division/documents/building-decarb/bdworkshop20260122updatev2-pdf.pdf
[67] Note that a comparable correlation analysis for multifamily customers might show different relationships between program goals, pointing to different targeting solutions.

societal benefits from (3) peak load reductions and avoided costs of grid infrastructure, (4) improved GHG reductions, (5) TSB, and (6) improved equity outcomes, more often located in equity communities.

Customer segmentation and targeting can drastically improve critical impact metrics. Table 6 shows a segmentation analysis of heat pump HVAC projects. Compared to "all heat pump retrofits," homes with pre-existing A/C and on-peak electricity use above the median (which is primarily composed of projects in the Central Valley and Southern California) had:

- Much higher bill savings ($423/year);
- Greater societal benefits (over $2,000 in additional lifecycle total system benefit, nearly 30 percent more GHG savings, and nearly 10 times the on-peak electricity savings; and
- Were more often located in disadvantaged communities.

Table 6: Savings for retroactively targeted versus non-targeted heat pump HVAC retrofits.

Customer Cohort	Number of projects	On-Peak Electricity Savings (kWh)	Annual Utility Bill Savings ($)	Lifecycle GHG Savings (MT CO2e)	Lifecycle Total System Benefit ($)	Total Project Cost ($)
All heat pump **HVAC retrofits**	1,918	32	155	15	5,219	18.0k
Homes with AC and on-peak electric use > 1 MWh	789	311	423	21	7,582	17.7k

Table 6 illustrates the value of steering heat pump HVAC incentives to projects in homes with existing air conditioning and high on-peak electricity consumption.[68] As a first step, TECH Clean California **increased the incentive for customers with preexisting air conditioning** by $500 (a fraction of the additional TSB these projects achieve). The intent is to not exclude other projects, but signal to contractors the value of focusing on these opportunities.

Looking forward, the implementation team will conduct a similar optimization analysis for heat pump water heating, which makes up 23 percent of single-family projects and 64 percent of multifamily projects. One can expect that climate variation will be less important as a savings driver, whereas factors such as tank upsizing, utility rates, and the presence of solar may prove more important in project outcomes.

[68] Sarkisian, Dylan. Energy Solutions. 2025 ACEEE Hot Water & Air Forum Presentation: "Threading the Electrification Needle: Finding Peak Demand Savings Drivers for Heat Pump HVAC Retrofits with Machine Learning". March 6, 2025. https://drive.google.com/file/d/1T8jK6xCAMFWOwSpWdcHvmaUio69YDiep/view

APPLYING TARGETING APPROACHES IN THE FIELD

Targeting via geographic propensity is more scalable than targeting individual households.

TECH Clean California has tested deploying targeted marketing campaigns to customer segments with high savings opportunities. Both the Innovative Customer Targeting Pilot, in partnership with Southern California Edison (SCE), and the Inclusive Utility Investment Pilot, in partnership with Silicon Valley Clean Energy (SVCE), leveraged historical energy consumption data and advanced analytics to identify specific households most likely to benefit from heat pump retrofits. Both efforts showed success in identifying households likely to achieve better than average heat pump retrofit project outcomes, but they encountered challenges in targeting customers who are both: 1) good candidates and 2) in the market for new equipment. The need to *avoid* marketing to the majority of customers placed a substantial constraint on the market channels and methods that could be employed, resulting in low overall customer participation. In short, these targeted marketing efforts have not produced program designs that can be scaled statewide. Instead, the TECH Clean California implementation team recommends targeting areas in which there is a higher-than-average concentration of homes with attributes that correlate with higher savings opportunities. For example, a marketing effort that increased the percentage of AC to heat pump conversions amongst all participants without constraining eligibility would substantially increase the benefits of installed projects while still enabling furnace-only heat pump HVAC replacements.

Recommendations for future applications

- For program administrators going forward, performance-based targeting may be most applicable to **identify geographies where customers with promising bill savings opportunities are concentrated** to support sustained, multi-channel communication.
- A **"Customer Lookup Tool"** could empower contractors to identify candidates with high savings potential and communicate potential benefits to customers, thereby amplifying the impact of the targeting approach.

LEVERAGING PROGRAM DATA TO INFORM INCENTIVE DESIGN

TECH Clean California has evolved and refined its incentive design over time, to incorporate new insights driven by program data. Table 7 lists select changes to TECH Clean California incentives, and the rationale. These changes were made to incentivize installations with the greatest value to both customers and the public (reference Section 3.1 Integrated Program Offerings).

Table 7. Non-exhaustive List of Modifications to TECH Clean California's Incentive Design[69]

Category	Change	Reason
HP HVAC	Increase incentive for projects that **fully replace furnace and air conditioner** (as of Nov. 2024)	• 3x greater utility bill savings • 25 percent greater GHG emissions savings • Peak demand **reduction** of 20 percent
HP HVAC	Require **multi-** or **variable-speed compressors** (as of Nov. 2024)	• 9x greater utility bill savings when replacing air conditioner • 2x greater peak demand reduction when replacing air conditioner
Heat Pump Water Heater	Increase incentive for heat pump water heaters with **≥55-gallon tank** (as of Oct. 2023)	Projects that up-sized the water heater tank by at least 20 percent had 20 percent greater GHG savings

The changes to incentive structure had a significant effect on the types of installations incentivized by TECH Clean California, demonstrating the influence that incentives can have in driving market change. Figure 7 illustrates the change in percentage of installations aligned with the increased incentives or requirements for each of the three changes described in Table 7. Higher incentives for >55-gallon heat pump water heaters went into effect in October 2023; the higher incentive for fully decommissioned furnace and previous AC went into effect in November 2024, and the requirement for variable or multi-speed compressors occurred in November 2024.

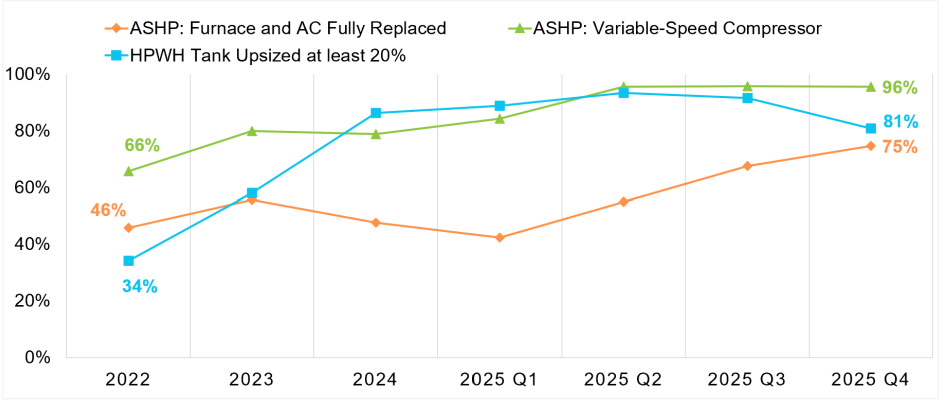


Figure 7: Effects of Incentive Redesign on TECH Clean California Initiative Participation (Single-family Heat Pump Water Heating).[69]

[69] TECH Clean California. 15th Quarterly Stakeholder Meeting. October 31, 2025. https://techcleanca.com/documents/5673/TECH_15th_Quarterly_Stakeholder_Meeting_IPTFwGx.pdf

MULTIFAMILY HOME PROGRAM DESIGN OPTIMIZATION

While some program lessons learned may apply to both single-family and multifamily, there are important differences between the two customer segments that necessitate a different optimization solution.

Multifamily housing in California by the numbers

- Multifamily housing represents 28 percent of California's housing stock
- 91 percent of multifamily units are rentals.
- Approximately half of low-income households in California live in multifamily properties.

While the implementer has not yet conducted the multivariate optimization analysis for multifamily that was described for single-family, it is reasonable to expect that such analysis would produce substantially different results. For one thing, given the demographics of multifamily residents, multifamily initiatives disproportionately benefit low-income households and renters even in the absence of income eligibility requirements. Thus, there may not be the same tension between equity and environmental outcomes that the implementer observed in the single-family sector (See Table 1).

Another salient difference is that water heating is the dominant multifamily electrification opportunity: of the 16,000+ multifamily apartment units served by TECH Clean California, 77 percent of them were for heat pump water heater installations.[70] Water heating represents the biggest opportunity for GHG reductions, bill savings, and grid benefits in the multifamily sector. Water heating loads are less seasonal than space conditioning, so there is not the same additional value from targeting hot climates that one sees for single-family customers. In fact, multifamily housing tends to be concentrated coastally in large urban areas.

The complexity of the multifamily sector necessitates consideration of additional design elements to maximize adoption and impact. TECH Clean California's lessons learned for this segment are discussed throughout the report and inform our recommendations for achieving scale. See the following sections: Section 3.2 C. Program Complexity Has Practical Implications for Incentive Layering, Section 3.3 B. Right Sizing in the Multifamily Sector, and Section 3.5 B. Multifamily Engagement and Buy-in.

SCALABLE SOLUTIONS TO SERVING EQUITY CUSTOMERS

Existing Weatherization Programs Offer an Opportunity to Support Decarbonization for Income-Qualified Customers. TECH Clean California has pursued equity investments for the dual purpose of serving equity populations and demonstrating the value of reorienting the larger energy efficiency and weatherization programs around decarbonization goals. California's primary direct install programs, Energy Savings Assistance (ESA) and the Low-Income Home Energy Assistance

[70] TECH Clean California. 16th Quarterly Stakeholder Meeting. February 12, 2026. https://techcleanca.com/documents/5720/TECH_16th_Quarterly_Stakeholder_Meeting.pdf

Program (LIHEAP), account for a combined annual $40 million of gas appliance installations for low-income customers.[71]

Multiple factors in ESA program design have intentionally or unintentionally led to missed opportunities for heat pump adoption in favor of like-for-like gas appliance replacement, thus leaving this vulnerable group of residents behind in the transition to clean energy. For example, during the implementation of its Low-Income Pilot Program, TECH Clean California partnered with the ESA program to fund remediation work for projects that exceeded the ESA program's funding cap of $3,000 per home and was able to fund additional electrification-related measures, including minor home repairs associated with heat pump installation, and other associated costs outside of ESA's program scope.[72]

As enumerated in the Statewide ESA Program Manual, appliances are not routinely electrified as part of ESA work scopes. Furnace and water heaters are eligible for replacement only when they require repair or replacement. Under those conditions, fuel substitution is allowed but not required and frequently discarded as an option due to cost effectiveness and bill impact constraints. As a matter of practice, like-for-like replacement remains the norm in LIHEAP. While central air conditioners and central heat pumps replacements are both listed as eligible measures in the Statewide ESA Program Manual for fuel substitutions, ESA does not often replace air conditioning units with heat pumps unless those replacements are part of the overall program design, such as in building electrification pilots.

Offering electrification as a routine part of an ESA work scope would take ESA's prior investment to gain customer participation and, in the case of failed gas equipment, could be achieved for the incremental cost of the electric alternative. In contrast, replacing old gas appliances with new gas appliances means that any subsequent public investments to help these customers decarbonize would have to address the full equipment replacement costs.

Weatherization partnerships through both ESA and LIHEAP are instrumental in addressing potential bill increases resulting from electrification measures being installed. Properly installed shell measures help create thermal mass and improve the building envelope, allowing electrified homes to use energy more efficiently while reducing peak demand and protecting low-income customers from higher utility costs.

TECH Clean California's collaboration with the ESA programs of two investor-owned utilities points to opportunities to refine the ESA program in ways that better integrate California's equity and climate policy priorities. For more information, see Appendix B: Low-Income Leveraging Pilot Findings and Recommendations.

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[71] TECH Clean California. *TECH Clean California Annual Report 2022-2023. Year Two: September 2022-August 2023.* March 14, 2024. https://techcleanca.com/documents/4324/TECH_Annual_Report_2022-2023_v230212.pdf

[72] Etherington, Rachel; Krishpinovich, Irina; and Ortiz, David. The Ortiz Group, LLC. Harwood, Meghan; Schaaf, Becky; and Parker, Asa. VEIC. *Low-Income Leveraging Pilot Final Report*. December 15, 2025. https://techcleanca.com/documents/5705/8.2_Low_Income_Leveraging_Pilot_v260105.pdf. Quick Start Grant Final Reports are available at https://techcleanca.com/quick-start-grants/

Higher incentives for income-qualified customers have been an important factor in TECH Clean California's ability to allocate 46 percent of its incentive spending to equity households to date.[73] TECH Clean California introduced higher incentives for income-qualified customers and households, which boosted the heat pump HVAC incentive for qualified households from $1,000 to $3,500. TECH Clean California now forecasts 54 percent of incentives will go toward equity households across funding sources through the life of the program. The inclusion of income-qualified incentives has been instrumental in putting TECH Clean California on track to achieve Governor Newsom's goal of directing at least 50 percent of incentives to disadvantaged communities.[74] The market response to the bonus has illuminated several important lessons:

- **A number of contractors have turned their attention to serving equity households and have been successful in bringing equity customers into the program**. Of particular note, some contractors have even found solutions for serving residents of mobilehome parks.
- **Simplifying the income verification process remains an important program design challenge.** Income verification has also resulted in multiple points of customer frustration. Firstly, a recurring misconception among both contractors and customers is that completing income verification automatically reserves funding, which it does not. Furthermore, income verification adds another element in which errors can be introduced into processing applications, thereby increasing the chance a claim is rejected. Yet another challenge is that contractors who engage with low-income customers may encounter barriers such as limited English proficiency and limited internet or email access.
- **A dedicated multifamily initiative is critical for comprehensively serving low-income customers.** Specific best practices are discussed under Appendix A: Measure-Specific Best Practices and in Section 3.5 B. Multifamily Engagement and Buy-in.

[73] TECH Clean California. 16th Quarterly Stakeholder Workshop. February 12, 2026. https://techcleanca.com/documents/5720/TECH_16th_Quarterly_Stakeholder_Meeting.pdf
[74] Office of the Governor. Letter to Liane Randolph, Chair of the California Air Resources Board. July 22, 2022. https://www.gov.ca.gov/wp-content/uploads/2022/07/07.22.2022-Governors-Letter-to-CARB.pdf

3.2 Simplifying Program Design to Reduce Costs and Burdens

This chapter examines the opportunities, challenges, and lessons learned while weighing cost/benefit trade-offs of different design choices in the context of sometimes competing policy priorities.

A. Simplify Program Requirements Where Feasible

As a market transformation program created by legislation, TECH Clean California has had a significant degree of flexibility in designing its approach and implementing the solutions that have enabled its success. While program results are reported, the program is not subject to strict cost-effective requirements. This flexibility in program design has, in large part, allowed the program to adapt to a changing market and has enabled many of the successes of the program.

While TECH has more latitude in program design than other programs, there are lessons learned from the TECH implementation that have elucidated opportunities for program design best practices that enhance the participant experience and increase participation.

The Increasing Complexity of TECH Clean California Over Time

TECH Clean California launched in December 2021, with $120 million in funding from the gas allowances of the California Air Resources Board's Cap and Invest program. Assembly Bill 179 (Ting, 2022) allocated an additional $50 million in General Fund money for TECH Clean California to use across all of California beginning in 2023. TECH Clean California also received an additional $95 million from the Greenhouse Gas Revenue Fund in 2023 through Senate Bill 101 (Skinner, 2023) and $40 million in targeted funding from the Aliso Canyon Settlement Fund (Assembly Bill 157, Gabriel, 2024). In addition to these legislative allocations, the program also received a one-time allocation of $80 million in the Self-Generation Incentive Program (SGIP heat pump water heater) to support demand-flexible heat pump water heaters. While these funds have enabled TECH Clean California's success and scale, each comes with distinct requirements that layer onto the base program design, increasing complexity over time and affecting participation.

Changes in funding sources have brought an evolving range of requirements that fall into three primary categories: **funding source requirements**, which come from the funding source or legislation itself, and limit how specific funds can be leveraged;[75] **state requirements**, which come from existing statewide law, such as construction permit requirements, and govern how projects must be implemented; and **programmatic requirements**, which often come from the Regulatory Decisions or the program team itself, and define eligibility and participation requirements.

While the intent behind these requirements is understandable, an accumulation of constraints can create friction and implementation challenges that deter participation. Each requirement has operational implications, often adding processing time, adding complexity to the participation

[75] For example, TECH Clean California's original funding was from gas IOU cap and invest funding, which required incentive funding to be allocated exactly along gas IOU proportions (PG&E: 42.34 percent, SoCal Gas 49.26 percent, SDG&E 6.77 percent, Southwest Gas 1.63 percent), effectively creating four different program budgets to manage.

process, or segmenting program funding. These combined impacts strain participating contractors' staffing resources and information systems; add to their soft costs that either reduce profitability or get passed through to customers; and erode both contractor and customer participation.

Evaluating the cost-benefit trade-off of program requirements can be challenging. The benefits of a requirement may be relatively easier to quantify during the regulatory or initial scoping process, while the operational and participation costs of additional requirements may not become fully apparent until the program is implemented. As electrification programs are asked to meet multiple objectives simultaneously, excessive layering of requirements can ultimately undermine participation and dilute program impact.

Case Studies for Simplification of Program Requirements

Three examples illustrate the opportunities and challenges of simplifying program requirements. These examples are discussed in more detail in Appendix H. Program Simplicity Case Studies.

Demand Flexibility Requirements for SGIP Heat Pump Water Heater Program. The SGIP Heat Pump Water Heater program required incentivized water heaters to function as grid resources by shifting load from peak to off-peak periods. In addition to requiring set up of JA13 time-of-use (TOU) controls for load shifting, customers were also required to enroll in demand response programs and TOU rates. The latter two requirements added significant complexity to the participation process that may outweigh the potential incremental grid value. On the administrative side, a provision in the CPUC decision required the implementer to confirm TOU enrollment prior to approving applications. This involved back and forth data sharing with the utilities, and this seemingly minor requirement created weeks of payment delays and frustrated contractors.

Preapproval and Incentive Reservation. TECH Clean California initially launched incentives on a "first-come, first-served" basis with no reservation system. Significantly higher demand than expected led to abrupt funding exhaustion. In order to better manage participant experience with "start and stop" funding and multiple funding "buckets," the program developed a system to allow contractors to submit "draft claims" to reserve funds and provide more assurance to contractors that claims would be paid out. However, this system enabled some contractors to submit low-quality or speculative claims to secure a "slice of the pie," leading to an inaccurate pipeline and continued over-subscription in specific funding buckets. In response, TECH Clean California introduced the preapproval system. This system allowed the team to manage a waitlist and communicate "soft landings" before funding was fully exhausted. However, minor clerical errors in which preapproval does not match a claim can now create issues and necessitate additional administrative procedures. The increased administrative complexity has also had a negative impact on incentive disbursal timelines and contractor cash flows. Floating funds to customers while waiting for payment from TECH Clean California can create cash flow issues, particularly for smaller contracting firms. Consistent funding would reduce the need for incentive reservations, potentially simplifying participation.

"Don't expect contractors to act as bankers until you folks get around to cutting checks. People calling us [asking], "Where is their rebate?" drove us nuts. It ruins the satisfaction of getting a rebate if clients (or contractors) have to wait more than 2 or 3 weeks for their payment." ***Participating Contractor***

Competency Verification, Installer Quality, and Training. Heat pumps are a more technically complex installation than a gas equipment replacement. On the positive side, a large and increasing share of contractors and their individual installers have undergone training. The evaluator found that 78 percent of surveyed HVAC contractors (75 of 91) and 79 percent of surveyed water-heating contractors (69 of 87) had received heat pump equipment training.[76] Nevertheless, there is a continuing need to improve training quality, expand training opportunities, particularly for entry-level workers, and give consumers greater visibility into contractors' heat pump installation credentials. At present, there is no federal or state-level mechanism for consumers to verify if a contractor or their installer possesses specialized training in heat pump technology. While Investor-Owned Utilities (IOUs) and various partnerships offer 62 distinct on-demand heat pump courses, these programs lack a common underlying curriculum or instructor credential requirements. In addition, apprenticeship programs are a proven pathway for training new workers, yet there are no apprenticeship programs accepting new applicants that focus on residential installations. This fragmentation creates several market barriers:

- **Information Asymmetry:** Consumers cannot easily distinguish "trusted" contractors from those without specialized training.
- **Administrative Friction:** Because utility program credentials are held at the company level rather than the individual installer level, even working with a credentialled contractor is not a guarantee that an individual installer is proficient with heat pumps.
- **Contractor Fatigue:** Contractors and their installers are often forced to navigate a patchwork of training requirements to remain eligible for various regional or utility-led programs.

Going forward, TECH Clean California recommends that policy makers and program administrators move towards workforce alignment via (1) curriculum standardization, (2) cross-program credential reciprocity, and (3) individual-level credentialing. Toward that end, there are existing frameworks that California can leverage as a baseline for statewide building electrification competency verification and installer trainings. The Department of Energy Skilled program already provides a framework for recognizing training programs and certifications (for example, the HVAC Excellence Heat Pump Installer Credential) that meet modern building

[76] Opinion Dynamics. *TECH Clean California: Time 2 Market Assessment Final Report*. May 14, 2025. https://opiniondynamics.com/wp-content/uploads/2026/03/TECH-Time-2-Market-Assessment_Final.pdf

science and heat pump installation standards. Another option is the NATE Specialty Heat Pump certification program.

B. Avoid Incentive Funding "Starts and Stops," Which is Critical to Market Actor Engagement

TECH Clean California comprises three core segments, each with their own funding allocation and budget: single-family heat pump HVAC, single-family heat pump water heater, and multifamily. However, within each funding tranche, there may be specific geographic or equity requirements that further split the funding into smaller subprograms. When considering all the individual subprograms, TECH Clean California incentive funding has been depleted 27 times over the past four years of implementation.

Incentives have been effective at driving heat pump sales. TECH Clean California incentives have clearly a significant impact on heat pump adoptions both for space conditioning and for water heating. Many surveyed contractors (88 percent) observed an increase in their heat pump sales since they began participating in TECH Clean California and cited the initiative's incentive in driving this increase.[77] Likewise, many contractors reported a negative impact on their heat pump sales during periods when TECH Clean California funding was paused.[77] Periodic disruptions to incentive availability have been cited repeatedly as sources of transaction friction, confusion, increased cost and complexity, and contractor reluctance to engage with the program.

> *"TECH Clean California HVAC initially started giving $3,000 per outdoor unit, HVAC outdoor unit. Cool. That was a little too good to be true, and it turns out it was, so [the TECH Clean California initiative] ran out of money pretty fast. Then they slimmed it down to $1,000, and that, we've seen more longer-term benefits from the $1,000 than the $3,000. So, less money that, to encourage stability, seems to be better, leads to long-term, much better results. So, simplicity and stability, even if that means lower rebate amounts, that's always been what we've wanted."* ***TECH Clean California Contractor***

[77] Opinion Dynamics. *Process Evaluation of the TECH Clean California Initiative*. May 2, 2025. https://www.calmac.org/publications/TECH_Process_Evaluation_Final_Report.pdf

Program funding interruptions have negative effects for a spectrum of key market actors.

Interruptions in program funding negatively affect market actors in various ways:

> *"This uncertainty doesn't just affect us; it affects every single contractor and customer involved in this process. It is creating a black eye on programs that should be celebrated, making it harder to get buy-in from contractors who would otherwise be eager to participate."* ***TECH Clean California Contractor, describing the effects of funding pauses***

- **Distributors and retailers**. Upstream market actors make stocking decisions on two- to three-month cycles. Volatile program conditions such as abrupt funding "stops and starts reduce distributors and retailers' willingness to stock heat pump HVAC and heat pump water heater equipment. These interruptions also create hesitation around staff training and marketing investments. Downstream, suppliers' ability to keep these technologies in stock is critical for contractors to plan their business operations.
- **Contractors**. Participation in incentive programs also requires an investment from contractors to provide their installers and sales staff with training, understand and keep up to date with incentive requirements, purchase qualifying equipment, and adjust marketing strategies. To justify these business costs, contractors also rely on program consistency and stability over longer timeframes. While contractor participation in TECH Clean California has grown over time, participation program data reveals a level of churn in contractor participation that is attributable to disruptions in incentive availability.[78] Both the TECH Clean California implementer and evaluator have received reports of contractors who invested significantly in marketing for heat pumps only for incentives to run out weeks afterwards.

> *"I don't know what zip codes or what jurisdictions the rebate is still available for, so that's the biggest problem. [We] don't know where money is available for customers so we don't want to sell a customer on [the incentive] and then them not get it."* ***Statewide contractor***

- **Local organizations supporting electrification, such as utilities, community choice aggregators (CCAs), and regional energy networks**. Local organizations provide critical on-the-ground support tailored to the needs of their local community. A multi-year statewide program would provide these organizations with the planning certainty they need to develop complementary services.
- **TECH Clean California implementation team**. Inconsistent funding creates a dilemma for TECH Clean California program planning itself, particularly regarding market development activities. Consumer education campaigns, workforce initiatives, pilots, and marketing efforts all

[78] TECH Clean California. *TECH Clean California Annual Report Year 3. July 2023-June 2024*. November 21, 2025. https://techcleanca.com/documents/5689/TECH_Annual_Report_2023-2024_v251114.pdf

lose effectiveness when incentive availability fluctuates. The periodic interruption in incentive availability triggered the need for extra incentive administration processes during each start/stop, including:

- Project preapplications and preapprovals to reserve incentives in advance
- Public-facing incentive dashboard to show incentive availability in real time
- High-frequency cadence of contractor communications regarding incentive availability

As the TECH Clean California evaluator has observed, "TECH Clean California's supply of incentives that make their way to end-use customers should be more stable to ensure continued heat pump installations… the fluctuating availability of incentives introduces uncertainty into contractor business practices and undermines their confidence that incentives will be available at a given time. If we want to keep installations at a steady or growing pace, incentives must continually be available."[79]

C. Program Complexity Has Practical Implications for Incentive Layering

Over the course of its implementation, TECH Clean California has served as a platform for several additional programs with their own funding streams and program administrators by virtue of the program's unique role as a state-wide initiative:

- SGIP Heat Pump Water Heater was administered through TECH Clean California with a primary goal of positive grid impacts and GHG reductions through the market acceleration of equipment that reduces peak load.
- California's Home Electrification and Appliance Rebates (HEEHRA) Program was administered by the CEC through TECH Clean California.
- Funding from the Aliso Canyon Recovery Account was allocated to TECH Clean California via AB 157 (2024) with a priority of reducing winter natural gas demand from the Aliso Canyon natural gas storage facility.
- Incentives from regional programs such as the BayREN Heat Pump Water Heater Incentive Program and 3CE Electrify Your Home were also administered via the TECH Clean California platform.

Leveraging the mature TECH Clean California infrastructure promised much quicker deployment of these additional funds and streamlined the experience for customers. However, each funding stream carried distinct programmatic and contractual requirements, along with differing priorities and expected outcomes. These differences created several "programs" all under TECH Clean California umbrella, and because these programs each have different, typically inflexible requirements, it limited the extent to which alignment and administrative efficiencies could truly be realized.

Incentive layering is most effective when aligning requirements across programs. TECH Clean California's initial single-family offering was designed to encourage incentive layering directly, with

[79] Opinion Dynamics. *TECH Clean California: Key Performance Indicator Assessment.* July 18, 2024. https://www.calmac.org/publications/TECH_Clean_California_Key_Performance_Indicator_Assessment.pdf

an enhanced measure structure in regions where a partner program existed. The initial intent was to leverage the scale and statewide nature of the TECH incentives to influence smaller, more regional programs to create consistency across various programs and create a single submission approach. The incentive structure sets up three distinct methods of layering with another incentive on a single claim submission. These included:

- Stacking both incentives on a single claim form, with a single check paid to participants.
- Stacking both incentives on a single claim form, while incentives were paid out separately by each program.
- Operating both programs separately, but data was shared on the backend between program implementers to reduce participant burden.

TECH Clean California discontinued the third option of integration as it proved to be an administrative burden that did not significantly reduce participant burden.[80] In many cases regional programs had limited interest and/or ability to modify their program rules to perfectly align with TECH. In practice, the feasibility of layering incentives from two different programs has hinged on the degree of alignment around program requirements pertaining to (1) technologies, (2) customers, (3) projects, and (4) installers. Layering opportunities can be characterized as follows:

- **Best:** Program requirements are completely aligned across all four sets of requirements, facilitating unified workflows, information systems, etc.
- **Good:** For a requirement category with less than complete alignment, the requirements for one program are a subset of the other program requirements, such that the program with fewer requirements can function as a base offering, with the stricter requirements acting as an optional higher threshold. For example, program A might offer an incentive for a code-compliant heat pump, whereas program B might contribute a kicker incentive for variable speed models.
- **Also good:** Program requirements are non-overlapping; for example, program A might incentivize heat pump HVAC while program B incentivizes heat pump water heaters.
- **Poor:** Incompletely overlapping and conflicting requirements. In this case, the resulting offer with layered incentives becomes more complex than either program individually. The compounded complexity adds administrative burden and project costs while thwarting customer participation.

Simplifying requirements across programs remains an important streamlining opportunity, however long-term, stable funding would likely be required for local programs to invest time and effort into the streamlining process.

The need for incentive layering is particularly acute in the multifamily sector. Multifamily heat pump water heater projects were often funded through a variety of incentive sources, in addition to TECH Clean California incentives. These additional funding sources included BayREN incentives,

[80] TECH Clean California. *TECH Clean California Annual Report 2022-2023. Year Two: September 2022-August 2023*. March 14, 2024. https://techcleanca.com/documents/4324/TECH_Annual_Report_2022-2023_v230212.pdf

federal tax credits, and California's Low-Income Weatherization Program (LIWP), as well as other means such as HOA fees or rental income. In contrast, multifamily HVAC heat pump projects were generally funded using the property owner's own funds, such as financial reserves, capital expenditure budgets, or rental income.[81] In both cases, TECH Clean California incentives played a significant role, with some property owners indicating they would have been unlikely to purchase the equipment without these incentives.[82]

After layering eligible incentives from other programs, the multifamily pilot provided an average of $6,600 per unit to cover the funding gap for participating properties to fully electrify. With limited reserves in most low-income properties, property owners rely on outside funding to bring out-of-pocket costs down to less than 10 percent—or in most cases, $0—for projects to move forward.

CONCLUSION: AN OUTCOME-ORIENTED REGULATORY APPROACH WOULD BE MOST EFFECTIVE IN ACHIEVING PROGRAM GOALS.

For the reasons stated above, the TECH Clean California team recommends an outcome-oriented regulatory approach that provides clear policy direction around the intended outcomes while limiting prescriptive implementation requirements. This framework allows program implementers to adapt strategies, refine program design, and respond to market feedback while still meeting policy objectives.

3.3 Right-Sizing Electric Service

Recent innovations in power-efficient design have demonstrated that **service panel upsizing can be avoided for the vast majority of single-family upgrade projects**. The emerging consensus among practitioners is that 100 amps is generally sufficient to fully electrify a single-family home, and 60 amps is sufficient for a multifamily unit.[83] Fournier, et al., (2024), in an analysis of publicly available TECH Clean California data plus other sources, found that less than two percent of TECH Clean California participants had service panels below these thresholds.[84]

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[81] Opinion Dynamics. *Process Evaluation of the TECH Clean California Initiative*. May 2, 2025. https://www.calmac.org/publications/TECH_Process_Evaluation_Final_Report.pdf

[82] Opinion Dynamics. *Interim Process Evaluation: Technology and Equipment for Clean Heating (TECH)*. November 7, 2022. https://opiniondynamics.com/wp-content/uploads/2024/12/TECH_Interim_Process_Evaluation_Final_Report.pdf

[83] While there may be some bias in TECH data since they only reflect completed TECH projects, the fact that upsizing rates were low even when there was an incentive early on in the program suggests that upsizing rates are not particularly high. See for example: https://powerefficiency.ca/wp-content/uploads/2025/03/electrification-guide-for-retrofits.pdf and https://www.redwoodenergy.net/watt-diet-calculator.

[84] Fournier, E. D., Cudd, R., Smithies, S., & Pincetl, S. Quantifying the electric service panel capacities of California's residential buildings. Energy Policy, Volume 192. June 27, 2024. https://doi.org/10.1016/j.enpol.2024.114238

A. Right Sizing in the Single-Family Sector

Incentives for service panel upgrades should be narrowly targeted to avoid incentivizing unnecessary upgrades. At launch, TECH Clean California offered kicker incentives for electrical panel upgrades required to accommodate heat pump water heaters, covering up to 50 percent of electrical costs up to $2,000 for projects in select areas. The launch of SGIP Heat Pump Water Heater incentives also came with kicker incentives for service panel upgrades. The kicker incentives were discontinued in 2025. A 2024 evaluator analysis identified that only 3 percent (1,004 of 30,630) of households who purchased TECH Clean California incented heat pump equipment required an electrical panel upgrade, consistent with the expectation that upsizing is generally unnecessary.[85]

Going forward, it may be prudent to offer a kicker incentive for service panel upsizing in single-family homes, narrowly targeted to income qualified households with panels less than 100 amps. Complementary incentives could be offered for power-efficient design solutions for homes with less than 150 amps of service panel capacity.

Continued focus on contractor and building department education is critical to avoiding unnecessary service panel upsizing. Installer training on system sizing and electric load planning can help installers learn to specify power-efficient design solutions that reduce project costs, timelines, and other friction points that may jeopardize a project. Likewise, providing education to building departments on right sizing best practices is important for avoiding potential conflicts between contractors' project scope recommendations and building department requirements.

Utility coordination and partnership will be crucial. Training should be supported by utilities providing usable information about household demand, as well as existing electrical distribution system capacity and service connections.

B. Right Sizing in the Multifamily Sector

In contrast to the single-family sector, electrical infrastructure upgrades or the studies required to avoid upsizing were the *main expense* during the multifamily pilot.[86] Eleven out of 13 properties needed upgraded infrastructure to support electrification, and seven projects avoided electrical upsizing due to investment in monitoring and/or engineering and analysis. **Right-sized electrical service in advance of full electrification can lower retrofit costs over time, but electrification readiness must be followed with engagement through to full electrification.**[87]

3.4 Recognizing Remediation Needs

[85] Opinion Dynamics. *Process Evaluation of the TECH Clean California Initiative*. May 2, 2025. https://www.calmac.org/publications/TECH_Process_Evaluation_Final_Report.pdf

[86] Defined here as upsizing or upgrades to electrical infrastructure downstream of the meter, including apartment sub-feeders, main breakers, and main and subpanels.

[87] Dryden, Amy; Stratton, Chris; and Chen, Yushi. Association for Energy Affordability. Schaff, Becky; and Tom Chase. VEIC. *TECH Clean California Multifamily Pilot Final Report.* March 3, 2026. https://techcleanca.com/documents/5729/8.3_MF_Final_Report_v260316.pdf

A major challenge for existing decarbonization programs in serving low-income households in an inclusive manner is the prevalence of remediation needs in this segment; that is, work that must be completed before electrification can proceed safely. Many existing weatherization programs include limited funding for remediation, so households with higher repair needs are often excluded when project costs exceed program caps. TECH Clean California has implemented several initiatives designed to pilot approaches that effectively address remediation needs. These pilots and Quick Start Grants have resulted in lessons learned that can help inform future efforts to more inclusively decarbonize low-income and equity communities by effectively and strategically investing in home remediation and repair.

Supplementing existing programs with targeted funding to cover costs above these caps is an effective strategy for enabling participation and building decarbonization of income-qualified households. TECH Clean California's Low-Income Leveraging Pilot partnered with the San Joaquin Valley Disadvantaged Community Pilot and the Energy Savings Assistance (ESA) Program to sponsor excess remediation and home repair costs for 520 households that would have otherwise been excluded from those programs. Likewise, Quick Start Grantee Revalue.io collaborated with home rehabilitation programs to identify properties, perform repairs and remediation, and electrify water heating, HVAC, and cooking appliances for an additional 70 homes. Collaboration enabled TECH Clean California to contribute funding through existing program infrastructure to qualify these homes for electrification upgrades.

A portfolio-level budgeting approach enables programs to address the wide diversity of remediation needs at a reasonable average cost without sacrificing efficiency. The ESA program currently caps remediation work at $3,000 per home. By monitoring portfolio-wide spending rather than imposing rigid per-home limits, TECH Clean California accommodated high-cost remediation projects while still maintaining an average project cost of $5,197 for single-family homes and $11,203 for mobilehomes/manufactured homes. Eighty-seven percent of all Low-Income Leveraging Pilot projects required less than or equal to $10,000 in supplemental remediation work. Non-energy remediation costs are summarized in the Low-Income Leveraging Pilot Final Report and in the Quick Start Grant Final Reports from Revalue.io and Franklin Energy, The Energy Coalition, and the City of Sacramento.[88]

Minimizing administrative burdens for participating contractors is critical to the viability of this approach. Contractors face significant administrative challenges when serving higher-need households and layering multiple funding sources. TECH Clean California offered a modest $225 incentive and technical support to ESA contractors to participate in and layer with the Low-Income Leveraging Pilot, which proved effective at addressing this barrier. Quick Start Grantee The Energy Coalition found that "[l]ow-income decarbonization programs should plan to provide contractors with customer and program management support. The time required to coordinate installations for

[88] Etherington, Rachel; Krishpinovich, Irina; and Ortiz, David. The Ortiz Group, LLC. Harwood, Meghan; Schaaf, Becky; and Parker, Asa. VEIC. *Low-Income Leveraging Pilot Final Report*. December 15, 2025. https://techcleanca.com/documents/5705/8.2_Low_Income_Leveraging_Pilot_v260105.pdf. Quick Start Grant Final Reports are available at https://techcleanca.com/quick-start-grants/.

customers that face more barriers takes away from contractors' bottom line. Contractors need assistance to maintain communication with customers, access funding from multiple programs, and address unexpected issues as they arise. Without this support, contractors will prioritize less complicated projects to sustain their business operations, perpetuating underservice to these communities." [89]

Non-energy benefits to the participating households were substantial, and driven by providing or restoring access to reliable heating and cooling systems that deliver health, comfort, and safety in the face of extreme heat and weather events. These benefits were typically delivered via the following types of remediation work:

- **Electrical Panel Upsizing:** 315 projects (60 percent) added circuits to an existing panel to increase capacity or upgrading <100- amp panels to 200 amps to enable heat pump installations. In some cases, panel upsizing could have been avoided by applying panel optimization techniques that have been more recently developed.
- **Heat Pump Water Heater Relocations:** 232 projects (43 percent) moved water heaters from non-compliant locations to suitable outdoor or garage installations.
- **Structural Remediation:** 251 projects (47 percent) had minor wall, roof, or enclosure repairs to allow safe electrification.
- **HVAC System Upgrades:** 236 projects (44 percent) removed gas furnaces, installation of electric heat pump HVAC systems.

Some remediation issues, particularly asbestos, have limited or no funding sources available to fund repairs. In some cases, the presence of existing unpermitted work posed an additional legal and financial obstacle to project completion and limited customer participation.

Overall, pilot results reinforce the need for complementary program pathways. While supplemental funding to existing programs can expand access to building decarbonization for low-income and equity communities, a subset of households will require direct install models with full or near-full subsidies and concierge services. However, integrating remediation and electrification more directly into core weatherization programs will be critical to achieving equitable scale.

3.5 Excelling in Customer Buy-In

While contractors and their installers play an influential role in the property owner's consideration of a new space conditioning or water heating system, the willingness of contractors to prioritize heat pumps increases when their customers are aware of heat pumps and asking for them ("market pull"). TECH Clean California has thus taken a combined "push-pull" approach, promoting both contractor supply and customer demand.

[89] Bugarin, Genaro; Choy, Jalen; and Rodriguez, Nenetzin. The Energy Coalition. *Basset Avocado Heights Advanced Energy Community Heat Pump Water Heater Initiative Quick Start Grant Report*. August 21, 2024. https://techcleanca.com/documents/5416/The_Energy_Coalition-_Final_Report_v240821.pdf

A. Progress Towards Building Customer Awareness and Positive Perceptions of Heat Pump Technologies.

EVALUATION RESULTS

Customer experience plays an important role in shaping perceptions of heat pump technologies and influencing broader market adoption through word-of-mouth. The TECH Clean California evaluator conducted multiple market assessments and customer experience surveys to track changes in awareness and perceptions of heat pump equipment in California and inform program optimization.

California homeowners' awareness of heat pumps has been improving since the baseline assessment in 2022, reaching 60 percent for HVAC heat pumps in 2024 (an 11 percent increase over baseline) and 37 percent for heat pump water heaters (a 5 percent increase over baseline).[90] The evaluator also observed that homeowners' perspectives on heat pumps are changing. Homeowners increasingly view heat pumps as reliable and efficient heating and cooling technologies. However, homeowner familiarity with heat pump technologies is still lacking; about half of homeowners still did not know the benefits and drawbacks of HVAC heat pump systems, despite being generally aware of them.

"Early adopters" are the main customer profile among TECH Clean California's single-family participants. Early adopters of technology, particularly those who are looking to maximize self-generation, are disproportionally more likely to be adopting heat pumps. A disproportionately high percentage of TECH participants also have rooftop solar on their homes (27 percent) compared to the general population (10 percent).[91] The discrepancy is particularly evident among heat pump water heater adopters, where TECH Clean California internal program data shows that 45 percent of heat pump water heater participants have existing solar.

The evaluator found that solar PV is a key driver of the choice to install a heat pump, satisfaction with it, and the perceived value of the investment.[92] Being able to take advantage of solar power contributed to customers rating their purchase as a good or great value and the majority of customers who were extremely likely to recommend their heat pump had solar. As discussed elsewhere in this report, when programs can capitalize on the complementary relationship between solar and heat pumps, it enhances customer satisfaction with the technology.

Satisfaction rates exceed 90 percent for heat pump technologies, which is a necessary precondition for positive word-of-mouth. The vast majority of customers surveyed by the

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[90] Opinion Dynamics. *TECH Clean California: Time 2 Market Assessment Final Report*. May 14, 2025. https://opiniondynamics.com/wp-content/uploads/2026/03/TECH-Time-2-Market-Assessment_Final.pdf

[91] Opinion Dynamics. *TECH Population-based Pathway Impact Report.* November 27, 2024. https://opiniondynamics.com/wp-content/uploads/2025/12/TECH-Population-Pathway-Impact-Analysis-Report-FINAL.pdf

[92] Opinion Dynamics. *TECH Clean California: Insights into Customer Experience and Satisfaction Wave 2*. March 27, 2025. https://opiniondynamics.com/wp-content/uploads/2025/09/TECH_Updated-Customer-Experience-and-Satisfaction-Report_3.31.2025_Clean_UPDATED.pdf

evaluator perceive heat pump HVAC and heat pump water heaters as a "good" or "great" value, with existing solar being a major positive driver. Heat pump HVAC had particularly strong perceived value, with 96 percent of ductless HVAC and 92 percent of ducted HVAC systems rating it a "good" or "great" value. This figure was 89 percent for heat pump water heaters.[92] To illustrate the importance of word-of-mouth, almost half of surveyed customers who installed an HVAC heat pump found their TECH contractor through existing personal relationships, from either a previous experience with the contractor or recommendations from a friend or family member.[93] Furthermore, a recommendation from a professional contractor and other customers' reviews were rated as the most influential sources to surveyed homeowners when considering purchasing a new heating system.[94]

LESSONS FROM THE FIELD

TECH Clean California partnered with Switch Is On to build customer awareness, cultivate positive perceptions, and connect customers with both incentives and trained contractors. Through multiple iterations of testing, deploying, and refining, the following lessons have emerged:

- **Use real stories to build trust.** Poll after poll indicates that the strongest messengers are neighbors, family, and friends. Programs should use testimonials from customers and contractors to increase credibility, reduce perceived risk, and help normalize heat pump adoption in local communities.
- **Invest in upstream education across multiple channels:** Programs should use layered, consistent messaging across paid, owned, earned, and in-person channels to normalize heat pump technologies and prime customers *before* equipment replacement becomes their near-term priority.
    - Paid ads are essential for driving general awareness, but they are not good for conversions.
    - Paid search is great for people who are looking for things, so they have good conversions but do less to reach new audiences.
    - Earned media is effective at achieving both, but very hard to quantify because the web traffic is not trackable.
- **Optimize the digital experience for conversions:** A predictable customer journey has emerged: Awareness → Incentive Search → Contractor Search → Consultation → Installation. The Incentive Finder page is one of the most popular pages on the Switch is On website. Thus, programs should make incentive discovery simple and prominent, seamlessly connect incentive tools to a high-quality contractor directory, and make it easy to request consultations and obtain

[93] Opinion Dynamics. *Interim Process Evaluation Technology and Equipment for Clean Heating (TECH) Initiative.* November 7, 2022. https://opiniondynamics.com/wp-content/uploads/2024/12/TECH_Interim_Process_Evaluation_Final_Report.pdf

[94] Opinion Dynamics. *TECH Clean California: Time 2 Market Assessment Final Report.* May 14, 2025. https://opiniondynamics.com/wp-content/uploads/2026/03/TECH-Time-2-Market-Assessment_Final.pdf

three bids. Similarly, contractors should be encouraged to respond quickly to new leads and invest in a strong web presence.

- **Support customers through the contractor selection experience:** The variability within bids can be paralyzing for people who do not have a sense of urgency to replace a broken piece of equipment. Addressing this barrier can help increase the rate of planned replacements. Programs should help customers understand the differences between bids so that they can make informed, confident decisions.
- **Fully fund incentive programs:** Incentives are the primary behavioral nudge that moves customers from seeking information to acting. However, the constant starts and stops have fueled confusion and frustration for both customers and contractors. Policy makers should prioritize regulatory certainty and sustained funding.

TECH Clean California's pilots and QSGs have shed additional light on best practices for engaging income-qualified customers and disadvantaged communities.

- **Focus on both cost savings and increased comfort and health.** Communications with prospective participants should include clear and factual expectations around potential bill impacts, while also highlighting other benefits to participants, such as adding cooling or increased comfort.
- **Community-based organizations (CBOs) are effective outreach partners for building momentum in historically underserved communities**. As one example, The Energy Coalition QSG enlisted a local CBO to lead outreach and enroll homeowners for a free water heater "tune up" service and assessment. These early interactions built trust and credibility with residents that opened up opportunities to offer more comprehensive retrofits. The Sacramento QSG showed how neighborhood-specific outreach at existing meetings and events can be an efficient way to scale recruitment beyond broad-based marketing campaigns.

B. Multifamily Engagement and Buy-in

Multifamily engagement initiatives should be treated as fundamentally distinct from single-family, since multifamily properties have distinct customer journeys, decision-making structures, technologies, timelines, and workforce needs. Multifamily properties have an entirely different customer journey than single-family – different contractors, technologies, and timelines. Similar to TECH, future programs should focus on multifamily through a separate and dedicated initiative.

Multifamily engagement is a long-term process and requires deliberate trust-building. Advancing multifamily heat pump projects requires ongoing coordination with property decisionmakers and technical stakeholders (operators, engineers, contractors, and maintenance staff) over extended planning horizons. Currently, there are few technical or workforce resources to support this trust-building over time. Programs should invest in sustained engagement models rather than relying solely on incentives to drive near-term participation.

Highly variable project scope, financing constraints, and minimizing tenant disruption create structural barriers to multifamily electrification. Multifamily pilot projects showed considerable

variation in project scope. Projects ranged from single unit upgrades for individual apartment units to the replacement of large central systems that served multiple units at once; and most required electrical infrastructure upgrades (such as upgrades to the building's electrical panel, electrical service, or transformer, or upgrades to panels in individual units).

One of the major barriers for multifamily electrification is the challenge of replacing equipment at unit turnover or burnout on a property that is not undergoing a large capital improvement scope of work. Phasing an electrification scope has the benefits of reducing the capital burden on the property owner by spreading project-related expenses across longer timelines and reducing the likelihood of needing to temporarily relocate residents if major upgrades occur in the dwelling units all at once.

A dedicated multifamily engagement strategy should include stable and flexible incentives over a longer timeframe that accommodates extended planning horizons and diverse upgrade strategies. Multifamily retrofit decisions are shaped by financing constraints, engineering requirements, and long-term asset management strategies. Simplicity and flexibility are essential ingredients to multifamily incentive program success, where incentives must align with long-term planning horizons driven by complex financing structures, engineering challenges, and business decisions.

The multifamily pilots demonstrated that financing also varied by measure. Multifamily heat pump water heater projects were often funded through a variety of incentive sources, in addition to TECH Clean California incentives. These additional funding sources included BayREN incentives, federal tax credits, and California's Low-Income Weatherization Program (LIWP), as well as other means such as HOA fees or rental income. In contrast, multifamily HVAC heat pump projects were generally funded using the property owner's own funds, such as financial reserves, capital expenditure budgets, or rental income.[95] In both cases, TECH Clean California incentives played a significant role, with some property owners indicating they would have been unlikely to purchase the equipment without these incentives.[96]

Electrification readiness and phased approaches are critical to enabling multifamily electrification. One of TECH Clean California's Multifamily Pilot Activities tested the impact of providing building owners with electrification readiness support, including technical assistance, site assessments, and electrical analysis to develop a detailed plan for how to electrify all appliances and equipment in a property over time. Plans included scopes of work for electrical upgrades for full electrification, appliances to be installed today, and readiness measures for future appliances. In addition, the pilot team collaborated with affordable housing portfolio owners to create roadmaps that guide electrification across their portfolios, including prioritizing properties. Taken together,

[95] Opinion Dynamics. *Process Evaluation of the TECH Clean California Initiative*. May 2, 2025. https://www.calmac.org/publications/TECH_Process_Evaluation_Final_Report.pdf

[96] Opinion Dynamics. *Interim Process Evaluation: Technology and Equipment for Clean Heating (TECH)*. November 7, 2022. https://opiniondynamics.com/wp-content/uploads/2024/12/TECH_Interim_Process_Evaluation_Final_Report.pdf

these initiatives produced important insights for accelerating electrification in the multifamily sector:

- **The pilot activity demonstrated that electrification does not have to be taken on all at once**, offering both affordable and market-rate building owner's different ways to phase electrification in this resource-constrained sector.
- **Funding sources must be widely available to pay for electrical infrastructure**, other electrification readiness measures, and the engineering analysis to either implement or avoid electrical infrastructure upgrades. Eligible measures should be defined broadly to include measures such as ventilation and space modifications needed to fully enable future installation of electric appliances.
- **Easier access to demand data and/or monitoring data, coupled with proper professional training**, is necessary to undertake electrification readiness and achieve the benefits. Analysis efforts were hindered by ineffective utility request processes, lack of options from municipal utilities, and/or time-consuming efforts that exceeded staff capacity. This analysis approach for full electrification, utilizing demand data and/or appropriate NEC calculations, should be used to enable full electrification all at once when possible.
- **Approaching these projects in a phased approach requires extensive and ongoing engagement with property owners, engineers, and contractors**. Electrification readiness can reduce or avoid retrofit costs over time, but since this brings no immediate energy savings value, there needs to be continued engagement with project decision makers to move forward when funding becomes available.

Based on pilot results, key attributes of multifamily engagement strategy should include:

- **Contractor open-market delivery model** that enables property owners to choose their own contractors and leverage their in-house property maintenance teams
- **Long and flexible incentive timelines** that allow for extended planning horizons and diverse upgrade strategies, ranging from gut rehabilitation to incremental upgrades of housing units upon tenant turnover.
- **Simple incentive requirements** that enable funds to be combined from multiple sources.
- **Planning assistance, resources, and decision tools** to help project sponsors map out an electrification readiness strategy that accommodates upgrades over time and across large project portfolios.
- **Strong technical assistance**, including training, case studies, and designing best practices to address technical challenges with multifamily central heat pump water heater retrofits and electrical infrastructure evaluation. Programs may need to provide project-specific design consulting in some instances.

- **Capacity building across stakeholders**, including contractors, engineers, maintenance personnel, and other decision-makers.[97]

[97] Dryden, Amy; Stratton, Chris; and Chen, Yushi. Association for Energy Affordability. Schaff, Becky; and Chase, Tom. VEIC. *TECH Clean California Multifamily Pilot Final Report.* March 3, 2026. https://techcleanca.com/documents/5729/8.3_MF_Final_Report_v260316.pdf

3.6 Role of Data and Analytics in Informing Policy and Programs

TECH Clean California team's robust public program reporting infrastructure, including program implementation experience and understanding of likely outcomes for customers, driven by customer-level analysis and complemented with evaluation reports, have contributed to building decarbonization programs and policies across the state, and beyond (see sidebar for highlights). Internal data analysis and program insights have supported TECH Clean California's comments informing regulatory proceedings focused on building decarbonization, the future of gas, the Energy Savings Assistance program, and the energy efficiency portfolio.[98]

Publicly accessible data accelerates market transformation. A cornerstone of the TECH Clean California strategy is the secure, public sharing of anonymized project and contractor data via the public reporting website techcleanca.com, along with progress reports and research results. The value of TECH Clean California's data is best evidenced by its broad utilization by governmental agencies across the state. The California Public Utilities Commission, California Air Resources Board, California Energy Commission, Bay Area Air District, and South Coast Air Quality Management District have not only

TECH Clean California Informing Policy

TECH Clean California brings program insights and data to inform the California's building decarbonization policy and program design. Highlights include:

1. Generated written or verbal comments in six proceedings and presented as panelists at multiple agency workshops or conferences
2. Participated as a Technical Expert for CARB's zero-emission appliance standards rule development
3. Participated in the Implementation Working Group for Bay Area Air District standards for zero-emission space and water heating appliances, as well as South Coast Air Quality Management District Working Group for their proposed rules.
4. Participated and provided data analysis to CPUC Working Groups working on technical analysis of viable electric alternatives to gas appliances

"The TECH program is doing foundational, nation-leading work – transforming the HVAC and water heating market and blowing past its 50% equity program goals. But on top of that, TECH is a paragon of program analysis and adaptive management, distilling insights from its large project base and integrating them into future implementation. The program's data set is unparalleled, enabling policymakers and market actors to update legacy assumptions based on new facts, and implementers' insights are much appreciated by the clean buildings community." ***- Clean Energy Advocacy Nonprofit Organization***

[98] TECH Clean California. *TECH Clean California Annual Report 2022-2023: Year Two: September 2022-August 2023*. March 14, 2024. https://techcleanca.com/documents/4324/TECH_Annual_Report_2022-2023_v230212.pdf

cited TECH Clean California results in key reports but have also conducted independent analyses of the public data to drive their own policy decisions. In addition, many stakeholders and organizations have cited TECH data and or used it for their own decision making.

TECH Clean California also illustrates the power of shared data infrastructure to accelerate decarbonization through inter-agency collaboration. Primary research funded by the California Energy Commission (CEC) on end-use detection of air conditioning was used by the TECH Clean California team to conduct granular segmentation analysis of heat pump installations in homes with and without air conditioning (for more information, see Appendix F: Driver Analysis and the Importance of Site-Level Granularity**).** In short, the multivariate optimization framework has turned the TECH Clean California meter data into an operational tool for designing and targeting electrification portfolios that simultaneously support decarbonization, affordability, system value, and equity. This granular analysis has in turn been used by the CEC's Equitable Building Decarbonization team to screen for customers that will benefit most and drive program goals.

Data anonymization strategies and standardized data requests can enable coordination across programs while protecting privacy. Combined gas and electricity consumption data with single-fuel utilities has been limited due to privacy and liability concerns. TECH Clean California has identified strategies to share valuable dual-fuel consumption insights with a single-fuel utility *without* disclosing private information across utilities. One strategy has been to aggregate consumption data into quartiles. Alternatively, in shared savings or carbon credit scenarios, it would make sense to establish agreements between parties to allow utilities to see the combined impacts at the customer level. The implementer and evaluator also created a standardized data request delivered to the IOUs and other Program Administrators in the state to facilitate sharing of personally identifiable information. This standardized form allows us to identify when one customer layers incentives across programs, understand what fields each program collects, and inform data policy updates.

CASE STUDY: IMPROVING PERMITTING IN MOBILEHOME AND SPECIAL OCCUPANCY PARKS

As an example of TECH Clean California's data and program insights informing policy, TECH Clean California provided comments into the Department of Housing and Community Development (HCD)'s rulemaking related to regulations for mobilehome parks (Title 25, Chapters 2 and 2.2) as it related to heat pump water heater installations in September 2025. The TECH Clean California team submitted comments derived from field experience via the Low-Income Leveraging Pilot and AESC Quick Start Grant that elevated permitting inconsistencies and challenges for heat pump water heater installations. HCD's updated language, published in October 2025, directly reflected the TECH Clean California team's comments. It now specifically accepts split systems for both heat pump water heaters and heat pump HVAC, while allowing unitary heat pump water heaters in an outdoor enclosure if installations follow manufacturer guidelines. Critically, this outcome allows installers to select heat pump equipment that offers the best fit for an individual mobilehome project, considering both internal and external space constraints.

4. Supporting Sectors and Strategies

This section describes TECH Clean California's various approaches to engaging the market actors to realize "win-win" scenarios and create a cohesive and effective strategy for building decarbonization in concert with market actors.

Key takeaways:

- **Engage Market Players:** Actively involve manufacturers and distributors in the development and implementation of building decarbonization programs to ensure programs aligned with market needs and processes.
- **Support Contractor and Installer Participation:** Contractors and their installers are the most critical influence in a customer's heating and cooling equipment replacement journey. Prioritize sales and installation training to expand heat pump sales.
- **Invest in Workforce Education**: Continuously invest in workforce education and training for both contractors and their technicians to maintain installation quality and expand career opportunities for contractors and installers.
- **Adopt Inclusive Approaches**: Implement inclusive strategies, such as supporting DIY installations and focusing on high-unemployment areas, to ensure broader participation and equity in the program.
- **Implement Phased Electrification**: Promote the benefits of a phased approach to electrification. Allow property owners to spread project-related expenses over time and reduce the need for immediate, large-scale upgrades.

4.1 Upstream Market Development Efforts

Engagement with equipment manufacturers accelerates market transformation. TECH Clean California has been implemented as a mid-stream program focused primarily on contractors. Nevertheless, the program's engagement with equipment manufacturers and distributors has contributed welcome momentum to market transformation efforts. Manufacturers engaged heavily in the development of the California Heat Pump Blueprint,[99] so manufacturers and the program have aligned interests around Blueprint implementation. Manufacturers already invest heavily in training contractors and their technicians on proper installation and maintenance procedures for their products. More than 68 percent of HVAC and heat pump water heater contractors surveyed reported receiving heat pump equipment training most commonly from distributors or through a

[99] The **California Heat Pump Partnership (CAHPP)** is a private-public partnership to rapidly scale heat pump adoption in California. The "Blueprint" outlines near-term strategies to address technical, market, and policy barriers to heat pump adoption in service to reaching the California's goal of six million heat pumps installed by 2030. March 2025. https://heatpumppartnership.org/blueprint/.

manufacturer; the latter being a contractor's preferred training source.[100] TECH Clean California's engagement with manufacturers on Workforce Education and Training has built on those prior investments with good results.

Manufacturers are looking at nationwide markets. Heat Pump market acceleration efforts should take a broader lens and coordinate with interstate and regional programs. TECH Clean California's ability to influence future equipment technical specifications and form factors is limited unless the program can articulate a market need that extends beyond the program and beyond California. California's influence on technical specifications (like the 120V heat pump water heater) succeeded because advocates successfully signaled a market need that resonated beyond state lines. Without this broader "market case," manufacturers are hesitant to retool production. Coordination of programs to aggregate demand across state borders via multi-state coalitions can lead to faster commercialization of heat pumps that meet the needs of the broader market.

> *"California overall and its TECH Clean California initiative is one of the largest markets for heat pump water heaters. Our distributors are well stocked with heat pump water heaters, and all pure-bred plumbing distributors are supporting heat pump water heaters in California today."* ***Heat Pump Water Heater Manufacturer***

4.2 Contractor Engagement

Contractors play an influential role in the heat pump adoption process. As the TECH Clean California evaluator found in a survey of 500 customers, a recommendation from a professional contractor was one of the three most influential sources when homeowners considered purchasing a new space heating system. More than half of respondents rated it extremely or very important in influencing their decision.[101]

While contractors and their installers wield considerable influence in the adoption decision, they are reluctant to exercise that influence in favor of heat pumps if they believe that doing so would risk leaving the customer unsatisfied. Moreover, building electrification can represent a substantial shift to contractor business models, which contractors may perceive as risky. To reverse this dynamic, TECH Clean California has adopted a **suite of tactics to support contractors** in transitioning their business to focus on HVAC and hot water electrification.

- **Technical training**. TECH Clean California has offered a full array of technical training opportunities and resources and has collaborated with training partners to integrate electrification content into existing training programs for contractors and installers.

[100] Opinion Dynamics. TECH Clean California: Time 2 Market Assessment Final Report. May 14, 2025. https://opiniondynamics.com/wp-content/uploads/2026/03/TECH-Time-2-Market-Assessment_Final.pdf
[101] Opinion Dynamics. *TECH Clean California: Time 2 Market Assessment Final Report*. May 14, 2025. https://opiniondynamics.com/wp-content/uploads/2026/03/TECH-Time-2-Market-Assessment_Final.pdf

- **Business skill training**, including quality management, effective marketing and sales tactics for heat pump HVAC and heat pump water heaters, and related business skills.
- **Demand generation** through active outreach and education to consumers. The Switch is On website has attracted 400,000 to 1 million visitors per year, supported 300,000 to 500,000 searches per year for available incentives.
- **Amplifying contractor visibility** via the Switch is On Contractor Directory, which features over 2,500 Contractors and generated more than 12,000 leads to contractors in 2025.
- **Incentives** to help contractors compete on an installed cost basis with gas appliance offers.

TECH Clean California's internal research has identified effective ways to recruit contractors to participate in the initiative. For example, contractor enrollment increases when TECH Clean California implementers partner with trusted and well-known industry organizations to drive interest through their channels. By contrast, the least effective contractor recruitment strategies include cold calls and paid or print advertisements. Contractor recruitment has higher prospects for success when program participation is simple, the program trajectory is predictable, and the value of participation is clear.[102]

While incentives are well-established tools for getting customer attention, spurring a sense of urgency to act, and giving contractors a price advantage over their competitors, **the incentive application process brings its own participation challenges, which has necessitated proactive contractor engagement.** Through experience, the TECH Clean California team has distilled the following lessons learned for effective contractor engagement:

- **Offer a variety of resource formats to meet the needs of a diverse contractor base,** including contractor support articles, direct-to-customer resources, office hours, and one-on-one support.
- **Contractors have consistently ranked dedicated, one-on-one contractor support as the most helpful resource.**[103]
- **Proactively reaching out to contractors directly over email, phone, and text messages** can be highly effective in maintaining contractor participation and satisfaction.
- **A phased approach to deploying and enforcing new program requirements, with simpler provisions required at the outset and more complex provisions phased in later**, allows contractors to evolve their business practices over time. New requirements invariably require a learning curve, and any difficulties in complying with those requirements directly impact the contractor's bottom line.

These interventions appear to be building contractor confidence to shift their business practices and recommend heat pumps to their customers, at least in some regions. More than half of surveyed contractors experienced an increase in their confidence when working with heat pump

[102] TECH Clean California. *TECH Clean California Annual Report Year 3. July 2023-June 2024*. November 21, 2025. https://techcleanca.com/documents/5689/TECH_Annual_Report_2023-2024_v251114.pdf
[103] SGIP HPWH Contractor Surveys. Summer 2024, 59 responses; Winter 2025/26, 29 responses

equipment or presenting heat pump options to customers, according to evaluator findings.[104] To illustrate the potential for market transformation when contractors shift their business practices, a handful of pump water heater contractors in Kern County have been the primary drivers of 1,539 heat pump water heater installations in the county, equivalent to the deployment per capita in Sacramento County and eight times more than Los Angeles County on a per capita basis. Building on their prior experience serving income-qualified customers through weatherization programs, these contractors saw a business opportunity through TECH Clean California and adapted their practices to maximize it.

Evaluator-conducted interviews captured the following outcomes from TECH Clean California enrolled contractors:

> *"I have definitely started to push and offer heat pump conversions on a regular basis now, whereas before it was very rarely."* ***Attendee of EMH's Residential Space Conditioning and Water Heating Electrification Course***

> *"Due to the training, I have a much better knowledge base than I did previously. I am better prepared to explain the benefits of transitioning [to a heat pump] from what a customer currently has, even if it may be at a higher cost initially. I now have more tools and resources to expand my standing in the industry, while at the same time increasing my company's ability to conduct meaningful and profitable work."* ***Attendee of EMH's Residential Space Conditioning and Water Heating Electrification Course***[105]

4.3 Workforce Education and Training (WE&T)

Continued investments in workforce education and training are needed for heat pump market development. Younger workers are needed to replace an ageing workforce that approaches retirement. Improving installation quality remains an additional training priority for delivering promised heat pump benefits to customers. While roughly 90 percent of TECH Clean California customers were "very satisfied" or "somewhat satisfied" with their heat pump project, the TECH

[104] Opinion Dynamics. TECH Contractor Six-Month Post-Training Finds Memorandum. February 28, 2023. https://opiniondynamics.com/tech-contractor-6-month-post-training-findings/
[105] Opinion Dynamics. TECH Contractor Six-Month Post-Training Finds Memorandum. February 28, 2023. https://opiniondynamics.com/tech-contractor-6-month-post-training-findings/

Clean California evaluator found that more than 20 percent of projects exhibited at least one issue, with many of the identified problems related to installation quality or configuration.[106,107]

Proficiency with heat pumps is linked to career advancement. Of the hundreds of contractors and installers that TECH Clean California has trained, 43 percent of those surveyed reported earned a promotion since completing the training (18 of 42).[108] Moreover, schools and other training centers offering heat pump trainings supported by TECH Clean California report that available training slots fill quickly, and that almost all students trained are finding employment immediately.[109] Reassuringly, HVAC contractors surveyed in 2024 noted that at least half of their staff had worked on HVAC heat pumps in the past year – a 14 percent increase over 2023. Only 16 percent of contractors surveyed in 2024 reported no heat pump water heater experience – a significant decrease since the 2022, when 28 percent of surveyed contractors had no heat pump water heater experience.[110]

Eliminating training enrollment friction maximizes participation. Initially, TECH Clean California training was only open to contractors participating in the program. Beginning in 2024, TECH Clean California has opened training events to all contractors and installers, not just TECH Clean California enrolled contractors. Enrollment now simply requires one's name and email address.

Targeted training in "electrification deserts" is essential for program equity. Installation data from TECH Clean California has revealed regions with disproportionally low project installs ("electrification deserts"), including portions of the Central Valley and Inland Empire. These "electrification deserts" overlap significantly with hard-to-reach communities and/or disadvantaged communities, as designated by CalEnviroScreen 4.0. To address this issue, TECH Clean California has focused its training efforts on high-unemployment zones. As a result, nearly 55 percent of participants in TECH Clean California's trainings in the 2023-2024 program year represented high-unemployment areas.[111]

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[106] The most common HPWH issues respondents described related to their equipment needing a part repaired or replaced or issues with their Wi-Fi or the online app for controlling their appliance. The most common HVAC issues respondents described related to their thermostat, general performance of the system, or equipment needing a part repaired or replaced. Only a handful of issues (3 of 301 HPWH and 5 of 634 HP HVAC) required full unit replacement.

[107] Opinion Dynamics. *TECH Clean California: Insights into Customer Experience and Satisfaction Wave 2*. March 31, 2025. https://opiniondynamics.com/wp-content/uploads/2025/09/TECH_Updated-Customer-Experience-and-Satisfaction-Report_3.31.2025_Clean_UPDATED.pdf

[108] Opinion Dynamics. TECH Post-Training Level 3 Behavior Survey Findings Memorandum. February 28, 2023. https://opiniondynamics.com/wp-content/uploads/2024/12/TECH_Contractor_Six-Month_Post-Training_Findings_Memo.pdf

[109] TECH Clean California. *TECH Clean California Annual Report Year 3. July 2023-June 2024.* November 21, 2025. https://techcleanca.com/documents/5689/TECH_Annual_Report_2023-2024_v251114.pdf

[110] Opinion Dynamics. *TECH Clean California: Time 2 Market Assessment Final Report*. May 14, 2025. https://opiniondynamics.com/wp-content/uploads/2026/03/TECH-Time-2-Market-Assessment_Final.pdf

[111] TECH Clean California. *TECH Clean California Annual Report Year 3. July 2023-June 2024.* November 21, 2025. https://techcleanca.com/documents/5689/TECH_Annual_Report_2023-2024_v251114.pdf

Leveraging existing training infrastructure is more effective than standing up specific training. Manufacturers are "trusted messengers" in workforce development efforts. Contractors cite manufacturers and distributors as their preferred training sources, particularly via in-person training.[112] Manufacturers have already invested heavily in training contractors on proper installation and maintenance procedures for their products. TECH Clean California's "Heat Pump Ready" initiative has coordinated closely with manufacturers and distributors to get working heat pump units into training programs to give trainees hands-on experience with the equipment before they go into the field. TECH Clean California has provided heat pump equipment to 56 trade schools, colleges, and union training centers across the state with 23 new schools joining the Heat Pump Ready program in Q3 of 2026, which will bring the total to 79 educational facilities. These schools have not only received equipment, but instructors have also been trained on the equipment, and TECH Clean California has facilitated the updating of curriculum and instructor credentialing.

A fragmented training and credentialing ecosystem creates inconsistency in quality of installs. Despite progress in workforce development, California's training and credentialing ecosystem remains fragmented across utilities, CCAs, unions, manufacturers, and other training providers. Curriculum developers and training organizations often have varying levels of alignment with rapidly evolving industry needs, emerging technologies, and field installation realities.

In addition, there is limited credentialing at the individual installer level. In California, the California Contractors State License Board licenses contractors and requires individuals performing installation work to operate under the supervision of a licensed contractor. However, contractor licenses and many workforce credentials are often held at the company level rather than by individual technicians. As a result, licensing structures do not necessarily ensure that every installer has specialized training or demonstrated competency in technologies such as heat pumps, low-GWP refrigerants, controls integration, commissioning, or load management technologies.

As California accelerates building electrification, rapid workforce expansion may increase reliance on newer or less experienced installers, raising concerns regarding installation quality, system commissioning, customer satisfaction, and long-term system performance. For more information, please reference Appendix H3. Case Study: Workforce Education and Training .

4.4 Solar + Electrification Opportunities

Solar is a key driver influencing customer decisions to install HVAC heat pumps and heat pump water heaters. As previously noted, solar owners make up 27 percent of TECH Clean California participants overall and 45 percent of heat pump water heater adopters, compared to 10 percent of the general population.[113] Customers with solar are overwhelmingly likely to report that their

[112] Opinion Dynamics. *TECH Clean California: Time 2 Market Assessment Final Report*. May 14, 2025. https://opiniondynamics.com/wp-content/uploads/2026/03/TECH-Time-2-Market-Assessment_Final.pdf
[113] Opinion Dynamics. *TECH Population-based Pathway Impact Report*. November 27, 2024. https://opiniondynamics.com/wp-content/uploads/2025/12/TECH-Population-Pathway-Impact-Analysis-Report-FINAL.pdf

monthly utility bills went down when they installed a heat pump water heater. The combination of solar and heat pumps also appears to improve customer satisfaction with their heat pump decision.[114]

The TECH Clean California evaluator's impact analysis of more than 10,000 TECH Clean California projects installed between July 2021 and July 2023 found that NEM 1.0 and 2.0 participants experienced a 14 percent decrease in average hourly demand during the resource adequacy (RA) window from 4:00 p.m. to 9:00 p.m. on summer weekdays, compared to a one percent decrease for non-NEM participants.[115] Further analysis may provide additional insights, particularly as the program dataset begins to include customers on the Net Benefit Tariff and more customers combine solar with battery energy storage.

[114] Opinion Dynamics. *TECH Clean California Heat Pump Equipment: Insights into Customer Experience and Satisfaction*. September 15, 2023. https://opiniondynamics.com/wp-content/uploads/2024/12/TECH_Customer_Experience_and_Satisfaction_Final_Report_9.15.23.pdf

[115] Opinion Dynamics. *TECH Population-based Pathway Impact Report*. November 27, 2024. https://opiniondynamics.com/wp-content/uploads/2025/12/TECH-Population-Pathway-Impact-Analysis-Report-FINAL.pdf

5. Achieving Scale: Long-Term Vision

In 2025, the California Heat Pump Partnership published a Blueprint proposing 11 strategies for scaling California's heat pump market to six million installed units by 2030.[116] To align with this established public-private consensus, the TECH Clean California team has utilized the Blueprint as a framework for applying our "lessons learned" to future decarbonization policy. A few Blueprint strategies are outside of TECH Clean California's purview, but the following relate directly to our work:

Improve Customer Economics

- *Support long-term, stable incentives to provide market certainty.*
- *Direct 50 percent of program funds to low-income and disadvantaged communities, ensuring all Californians are included in the heat pump transition.*
- *Target near-term, high value opportunities for appliance retrofits, especially AC replacements in warm climates and water heater retrofits in regions with forthcoming appliance standards.*

Streamline Sales and Installation Processes

- *Simplify incentive program design to ease customer accessibility.*

Accelerate Market Adoption

- *Supercharge heat pump marketing efforts, with a two-pronged focus on consumers and contractors.*
- *Develop a comprehensive workforce engagement campaign to address gaps, provide essential training and sales tools, and position contractors as key advocates for heat pump adoption.*

With these strategies in mind, the implementation team offers the following suggestions for scaling building decarbonization, based on our accrued experience.

5.1 Improve Customer Economics

The customer economics of heat pump installation comprises two major factors: upfront and ongoing costs. Strategies for improving customer economics include 1) reducing upfront costs using incentive programs, so that heat pumps are competitive with baseline equipment on a first cost basis, and 2) improving operating cost economics (rates), so that customer bill savings make heat pumps a compelling investment case.

[116] **The California Heat Pump Partnership (CAHPP)** is a public-private partnership that brings together state policy leaders, heat pump manufacturers, retailers, distributors, utilities, and other key market stakeholders to rapidly scale California's heat pump market and achieve Governor Newsom's goal of installing six million heat pumps in California's buildings by 2030. California Heat Pump Partnership (CAHPP). *California Heat Pump Partnership Blueprint.* March 2025. https://heatpumppartnership.org/blueprint.

A. Reducing Upfront Costs through Stable, Predictable Incentives:

The single most consistent feedback the TECH Clean California team has received from market actors is the need for program consistency and predictability, which enables the supply chain to shift their business models towards heat pumps (see Section 3.2 B. Avoid Incentive Funding "Starts and Stops," which is Critical to Market Actor Engagement). The CEC's first recommendation in the Draft 2025 California's Building Energy Action Plan is to "continue to prioritize funding for incentives to achieve GHG targets." The California Heat Pump Partnership recommended the establishment of a long-term, stable incentive program to meet the state's goals. An investment of this magnitude would support the predictability and stability of incentives that market actors have repeatedly signaled they need.

When establishing a long-term program, consider the following best practices:

- Enable the program administrators to set predictable incentive phases, with any changes to availability or amounts communicated to the market well in advance.
- Offer point-of-sale rebates through retailers and distributors to simplify the process, with contractor-level efforts reserved for specific hard-to-reach customer types.
- Aim for upfront cost parity with gas appliances and air conditioner replacements.
- Support low-income households and the contractors that serve them through dedicated kicker incentives, additional wrap-around services, funding to cover electrification capital and retrofit planning, and repair and remediation needs.
- Continue incentives even after appliance standards are in place; at least for income-qualified customers.
- Narrowly target panel upgrade incentives to encourage panel optimization best practices.

B. Improve Customer Operating Cost Economics

Over the long term, customer economics of building electrification can improve in response to other policy and regulatory levers, in particular, electrification-friendly rates.[117, 118] While rate design falls outside TECH Clean California's scope, aligning rates (heat pump specific or otherwise) closer to the actual marginal cost of delivering energy is one of the potential solutions for improving the customer economic value proposition of electrification (see Section 3.1 B. Valuing the Customer Benefits of Heat Pumps).

In the near-term, there is a large fraction of California households where the project operating cost economics are already compelling: 1) customers with existing cooling loads where AC-to-heat pump HVAC conversion provides significant bill savings, particularly in the hotter, inland areas of the state; 2) customers in publicly owned utilities with relatively low electricity rates; 3) customers with

[117] Malinowski, Matt; Sussman, Reuven; Moony, Paul; and Lewallen, Grace. ACEEE. *Electricity Rates that Keep Bills Down after Electrification of Home Heating.* April 2025. https://www.aceee.org/sites/default/files/pdfs/b2502.pdf

[118] Chhabra, Mohit. Natural Resource Defense Council. *Powering Change: Understanding California's Electric Rate Challenge and Affordability Solutions*. March 2025. https://www.nrdc.org/sites/default/files/2025-03/PGE_Rates_Report_R_25-03-A_03.pdf

existing solar; 4) customers with comparatively high gas rates; and 5) customers with electric or propane heating.

5.2 Streamline Sales and Installation Processes

A. Eliminating Starts and Stops can Simplify Program Participation

Eliminating fluctuations in program funding and funding consistent incentives for the long term would have a cascading simplification effect and encourage broader participation by reducing the administrative costs and participant business risk inherent with short program funding windows. For example, TECH Clean California significantly increased heat pump HVAC program participation during the 18-month period from 2023-2025 when there no start/stops, despite incentives being lower than previous offerings, and received consistent feedback that this stability was a top priority for contractors.

> *"Since its inception in the year 2021, the program has supported the increased sales of heat pump water heaters by an estimated 500 percent between 2021 and 2025. Given the stops and starts of the program, significant dips occur when the program is running out of funds requiring a lot of additional work to re-start the work for contractors and distributors."* ***Heat Pump Water Heater Manufacturer***

For more information, please reference Section 3.2 B. Avoid Incentive Funding "Starts and Stops," which is Critical to Market Actor Engagement.

B. Simplify the Application Process Where Possible

A complex or administratively burdensome incentive application process can significantly depress program participation and/or participant satisfaction, negatively impacting the ability of programs to achieve their goals. Implementers should critically review application processes to streamline requirements where feasible, retaining only those requirements with a clear and compelling justification for inclusion. Where possible, regulators and policymakers should provide sufficient flexibility to implementers to modify programs to adapt to changing conditions and market feedback.

Beyond the program itself, policymakers could encourage or require Authorities Having Jurisdiction to standardize building permits requirements across the state, which would relieve an important pain point for contractors and may facilitate more uniform code enforcement.

Finally, policymakers should consider the pros and cons of requiring the program to enforce requirements that are either not applicable to the broader marketplace, not uniformly enforced, or may be better suited to be handled at a statewide level. Such requirements penalize program participants who must compete against nonparticipants who are not subject to the same requirements; where these requirements are necessary, they should be offset by enhanced incentives to maintain market interest.

For more discussion on this topic, please reference Section 3.2 C. Program Complexity Has Practical Implications for Incentive Layering.

5.3 Accelerate Market Adoption

The implementation team recommends continuing to prioritize capacity-building investments. As discussed in Section 4. Supporting Sectors and Strategies, TECH Clean California has invested heavily in contractor engagement, workforce education and training, and consumer engagement. The implementation team has continued to hone and refine its tactics over time, and those efforts appear to be having a positive effect. Customer awareness and satisfaction with heat pumps is rising, contractors are gaining proficiency and comfort with selling and installing heat pumps, and the changes are translating into both improved career opportunities for training participants and increased market share for both heat pump HVAC and heat pump water heaters.

5.4 Proposed Long Term Approach

A. The Role of Building Decarbonization in Advancing Energy Affordability

The focus of the Heat Pump Partnership's Blueprint on customer economics aligns well with the broader policy focus on improving energy affordability across the board, which considers both participant and non-participant bill impacts.

- **Focus market-rate program investments on high-value opportunities that improve energy affordability by delivering a triple bottom line of customer bill savings, ratepayer savings, and GHG reductions.** Building decarbonization efforts can act as an investment engine to accelerate affordability gains by achieving disproportionate customer, ratepayer and societal benefits in relation to program costs. The TECH Clean California team has found that grid benefits tend to co-occur with customer bill savings (reference Section 3.1 D. Program and Portfolio Design Optimization and Strategies); focusing on high value opportunities could deliver results at a modest cost per capita. Key preconditions are continued program funding and program simplicity, stability, and scale.
- **Emphasize scale.** Achieving the state's heat pump and building decarbonization goals require approaches that align with the scale of that ambition, focusing on opportunities that are widespread and program designs that can serve high volumes of contractors and customers throughout the state. An explicit emphasis on scale drives market maturation. As decarbonization practices become "business as usual," public resources can increasingly focus on harder-to-reach segments.

B. A Three-Pronged Approach to Building Decarbonization

In keeping with Commission guidance from Decision 20-03-027, TECH Clean California has been delivered via a "contractor open market" structure. Several factors informed this choice:

- Statutory requirements and regulatory guidance that necessitated project-specific eligibility criteria.

- The ability to focus on the contractor and their installers as the key source of influence in customer decision-making.
- The ability to collect project characteristics and track meter-based outcomes to fill an information void about building decarbonization best practices.

As the market matures, the last two factors become less critical for market acceleration. Contractors are becoming more familiar with heat pumps, and, as customer awareness and adoption rates ratchet up, peer-to-peer word of mouth is expected to gain importance as a source of influence. Conversely, once we have gathered enough project data and conducted enough analysis to address information gaps, the marginal value of additional project-specific data should decline. In short, a simpler point-of-sale delivery model should become increasingly viable.

Looking forward to how a future building decarbonization program might be designed to reflect the four years of lessons learned thus far, the TECH Clean California implementation team believes there would be value in a building decarbonization program portfolio with three major program "prongs," since approaches to incentive design and market capacity building may not always perfectly align within a single program (reference Section 3.1 D. Program and Portfolio Design Optimization and Strategies):

1. **Statewide or regional distributor and retail point-of-sale incentives**, complemented by market development and consumer outreach and focused narrowly on cost-effective achievement of the state's climate and grid resiliency goals, with attention to customer economics and expanding participation.
2. **Statewide or regional contractor-based program, comprised of**
    - **Single-family income-qualified incentives** to deliver program benefits broadly to equity households.
    - **Multifamily incentives and market support** to deliver benefits to equity households and renters.
3. **Statewide or regional direct install program**, serving the most financially distressed households that need full subsidies and concierge program services to move forward.

These three core building electrification programs can be complemented as needed with market development programs, as well as local or regional programs to capture locally concentrated opportunities or stack additional grid benefits that are not fully realized within the core portfolio. A few possible examples include:

4. **Targeted zonal electrification initiatives**, focused on local opportunities to reduce or avoid gas infrastructure investments via whole-building electrification.
5. **Dedicated demand flexibility program** to maximize demand flexibility beyond the permanent load shifting and peak reduction benefits that would accrue from building electrification and time-of-use rates. This approach could stack on the core decarbonization

portfolio via “bring your own thermostat” or “bring your own heat pump water heater" program models.

STATEWIDE DISTRIBUTOR AND RETAIL INCENTIVES

As the heat pump markets mature, the implementation team believes there will be efficiencies to be gained by eventually shifting the incentive focus from contractors to distributors and retailers. For example, the Northeast Heat Pump Accelerator (NEHPA) program[119] in New England is currently delivering a modified version of the TECH program structure with distributor level incentives. The advantages of a distributor approach include:

- The program could reach virtually the entire market simply by enlisting the participation of a relatively small number of distributors and retailers.
- Engagement at the distributor and retailer level would facilitate collection of heat pump sales data, which enables regional/state level market tracking and is a significant existing gap.
- By including both retailers and distributors, the program could serve both contractor installations and DIY projects (which are currently excluded as a viable program use case).
- The delivery of point-of-sale rebates reduces program barriers to serving emergency replacements.
- The incentive model could readily be extended to cover the full range of climate-friendly appliances, not just space conditioning and water heating.
- By targeting incentives at the wholesale level, the point-of-sale price discount would be multiplied by the retail markup rate.
- Administrative burdens to contractors would be dramatically reduced, along with other participation barriers. Based on experience to date, expanded contractor participation and decreased administrative burden should exert downward pressure on installation prices.
- Limited project-specific requirements translate to low transaction friction and low administrative cost.
- As previously noted, targeting air conditioner replacements in hot climates offers the biggest opportunity to maximize impacts per program dollar invested and optimize outcomes across multiple policy objectives. This design criterion could be met by benchmarking incentives to incremental costs relative to like-for-like air conditioner replacement and geographically targeting them to hot interior climate zones.

This approach does not lend itself to high-touch, project-specific oversight such as permit verification, tenant protections, etc. The approach would limit (but not eliminate) the ability to track meter-based project outcomes, and it would have limited ability to prioritize equity and target

[119] New England Heat Pump Accelerator. 2026. https://www.nehpa.org/

individual customers. For these reasons, the team believes that a certain level of market maturity is necessary to enable this approach. There needs to be a robust base of experienced contractors and installers who can perform quality installations with little oversight beyond the standard building permit process. Meter-based project impacts need to be well understood to the point that additional data delivers diminishing returns. Most importantly, this approach should make up just one prong of a three-pronged strategy, with the remaining two prongs addressing equity gaps.

STATEWIDE OR REGIONAL CONTRACTOR-BASED PROGRAM

The success of the TECH Clean California's equity-based kicker incentives for single-family customers highlights the existence of a substantial customer segment that needs more financial assistance than the standard market-rate incentive yet could be well served by the same "contractor open market" structure that underpins the current program. This approach offers multiple benefits:

- Compared to distributor and retailer incentives, contractors could more narrowly deliver program resources to specific households based on equity criteria
- Enables the program to require best practices for workforce quality and training that exceed standard practices in the marketplace. The extra administrative burden to contractors would need to be addressed as part of incentive design.
- Allows a path for these best practices to cross-pollinate the broader market. In doing so, the program avoids imposing a monopoly on publicly supported building decarbonization.

On the multifamily front, a contractor-based delivery model would disproportionately benefit low-income households and renters even in the absence of income eligibility requirements. The multifamily subprogram should be tailored to this segment rather than grafting a single-family program design onto the multifamily market. Key attributes of the multifamily engagement strategy should include:

- Program delivery through a "contractor open market" model that enables property owners to choose their own contractors and work with their in-house property maintenance teams.
- Long and flexible incentive timelines that allow for extended planning horizons and diverse upgrade strategies, ranging from gut rehabilitation to incremental upgrades of housing units over time (i.e. unit turnover, maintenance schedules, funding opportunities).
- Simple incentive requirements that enable funds to be combined from multiple sources.
- Planning and technical assistance, resources, and decision tools to help project sponsors map out an electrification readiness strategy that accommodates upgrades over time and across large project portfolios.
- Strong technical assistance, including training, case studies, and design best practices to address technical challenges with multifamily central heat pump water heater retrofits and electrical infrastructure evaluation. Programs may need to provide project-specific design consulting in some instances.

- Emphasis on capacity building, including knowledge transfer to contractors, engineers, maintenance personnel, property managers and owners and other decision-makers.

STATEWIDE OR REGIONAL DIRECT INSTALL PROGRAM

The implementation team recognizes the continuing need for direct install programs, such as the Energy Savings Assistance and Equitable Building Decarbonization programs, to offer full or nearly full subsidies and concierge services to the most financially distressed households. Within this segment, TECH Clean California has found a still narrower subset with costly remediation and minor home repair needs that must be addressed before decarbonization upgrades can even be considered. Going forward, the implementation team recommends:

- Transition the Repair and Replacement program under Energy Savings Assistance to deliver electrification services as standard practice for replacing gas appliances.
- Offer whole-house electrification upgrades to the most financially distressed households, particularly those that require some form of remediation assistance as a precondition for electrification and weatherization to enhance utility bill savings potential.

D. Closing Remarks

Looking back over TECH Clean California's accomplishments to date, the team is proud of its successes, grateful for lessons learned, and confident that future heat pump efforts build on the TECH Clean California experience and support the California legislature's original intent in Senate Bill 1477 to "make low-emission heating equipment readily available and affordable in California."

Appendix A: Measure-Specific Best Practices

This section covers select technical best practices associated with each technology type (heat pump HVAC and heat pump water heater). Customer and contractor engagement best practices associated with each technology are described in Section 3. Program Design Best Practices and Section 4. Supporting Sectors and Strategies, respectively.

A.1 Air-Source Heat Pump HVAC

Encourage (or require) dual-speed and/or variable speed compressors. TECH Clean California found that replacing an air conditioner with a heat pump with multi- or variable-speed compressor delivers nine times greater utility bill savings and twice the peak demand reduction, compared to a heat pump with a single speed compressor. In response, TECH Clean California eliminated incentives for single speed compressors in favor of multi- or variable-speed compressors.

There are limited incremental benefits beyond HSPF2 of 10 for heat pump HVAC bill savings. SEER and HSPF are important metrics describing the cooling and heating efficiency, respectively, of heat pump HVAC equipment. Analysis of utility bill impacts indicates that HVAC equipment with HSPF lower than 8.5 tended to have reduced utility bill savings compared to the average project, while those with HSPF of at least 11.7 tended to have greater utility bill savings. However, increasing HSPF beyond 11.7 (equivalent to an HSPF2 of 9.5-10.5, depending on the product type) did not yield significant further increases in utility bills.

Contractors (and their technicians) should advise customers with ducted heat pumps about what to expect with the air temperature coming out of their vents. In evaluator surveys, TECH Clean California customers noticed that the air coming out of the vents was not as hot as it had been with a furnace and that their heat pumps ran longer to heat up the home. About two-thirds of customers who noticed the change in air temperature from the vents were bothered by it. Contractors and their technicians should educate their customers about these differences in what customers should expect during the sales process. Setting the customers' expectations in advance should reduce the number of callbacks and hopefully lead to a more satisfied customer.[120]

Provide support to help ductless heat pump customers with their new thermostat. The TECH Clean California evaluator found that ductless heat pump users, in particular, were troubled by their thermostats, with about one-third of customers finding their ductless thermostat harder to use than their prior thermostat. A minority (39 percent) felt comfortable using their thermostat right away. It

[120] Opinion Dynamics. *TECH Clean California Heat Pump Equipment: Insights into Customer Experience and Satisfaction*. September 15, 2023. https://opiniondynamics.com/wp-content/uploads/2024/12/TECH_Customer_Experience_and_Satisfaction_Final_Report_9.15.23.pdf

is important to enhance end-user guides and manuals to empower customers to troubleshoot issues as effectively as possible.[121]

Furnace decommissioning achieves larger GHG reductions than leaving a backup in place. Internal analysis by the implementer showed that projects in which the furnace was fully decommissioned had 63 percent greater median annual GHG reductions than projects where the furnace was left in as backup/auxiliary heat.[122]

Right-sizing. Average heat pump HVAC total project cost increases significantly as heating capacity increases. Meanwhile, there is no evidence that utility bill savings increase as heating capacity increases. Preliminary analysis of customer return on investment (ROI), which incorporates both incremental upfront cost and lifecycle utility bill savings, suggests that heating and cooling capacity are two highly influential factors that tend to *decrease* customer ROI. Based on these findings, it is evident that right-sizing heat pump HVAC equipment is an effective way to decrease costs and improve customer ROI. It is especially effective if a customer can avoid passing the cost thresholds at ~2.4 and ~3.4 tons of heating capacity, as these correspond with massive cost increases (Figure 8).

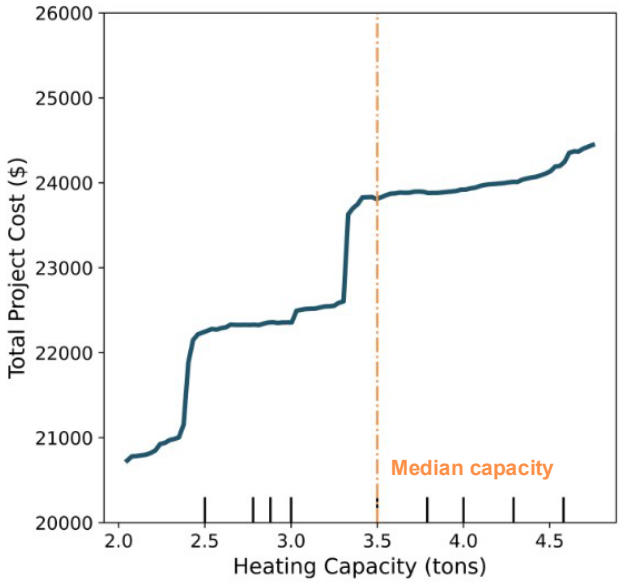


Figure 8: Average Heat Pump HVAC Total Project Cost versus Heating Capacity.[123] Median capacity is marked by a dotted orange line, and declines are marked by black lines on x-axis.

[121] Opinion Dynamics. *TECH Clean California: Insights into Customer Experience and Satisfaction Wave 2*. March 27, 2025. https://opiniondynamics.com/wp-content/uploads/2025/09/TECH_Updated-Customer-Experience-and-Satisfaction-Report_3.31.2025_Clean_UPDATED.pdf

[122] Sarkisian, Dylan. Energy Solutions. "The Roadmap to Scale: Using Analysis of Heat Pump Installations to Inform the Next 20 Million Projects" Slide 11. 2024 ACEEE Hot Water & Hot Air Forums. March 13, 2024. https://drive.google.com/file/d/1YrcUEcHaTh3Cw3dTrMpa5WuqttSSK967/view.

[123] Bay Area Air District (BAAD) Building Appliances Rule 9-4 Implementation Working Group (IWG) Phase 2 General Meeting #2. December 3, 2025. https://www.baaqmd.gov/en/community-health/building-appliances-rule-implement

Anticipating complications based on home age. The implementer obtains property assessor-based data on the year in which each participant's home was built. This enables analysis of the relationship between total project cost and home age. Preliminary results indicate that project cost has a complex, non-linear relationship with home age, as shown by Figure 8. Project costs tend to slightly decrease with age for homes built more recently than 1985, but cost increases with age for homes built before 1985. This is despite the fact that upfront costs tend to increase with home size, and home size tends to *decrease* with home age. This suggests that heat pump retrofits in homes built prior to 1985 tend to require either more labor or more expensive equipment than those in newer homes.

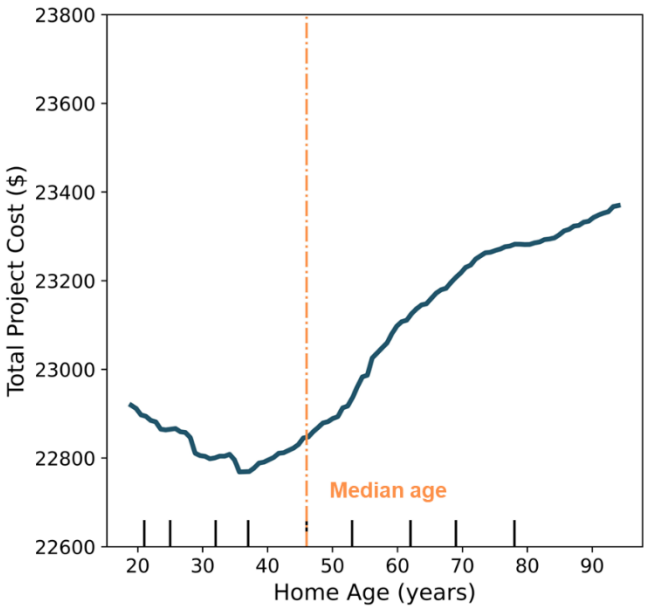


Figure 9: Average Heat Pump HVAC Total Project Cost versus Home Age.[124] Median age is marked by a dotted orange line, and declines are marked by black lines on x-axis.

A.2 Unitary Heat Pump Water Heaters

Tank upsizing reduces electricity consumption and GHGs, while improving hot water availability. Through a combination of contractor education and kicker incentives, TECH Clean California has encouraged contractors to upsize heat pump water heaters and include thermostatic mixing valves (TMV), both to improve GHG savings and help customers avoid running out of hot water. Since 2022, the fraction of TECH Clean California heat pump water heater installations with upsized tanks by 20 percent compared to the prior gas water heater increased by 58 percentage points, from 34 to 92 percent. Internal analysis has shown that projects that these projects produced 20 percent greater GHG savings, with minimal impact on peak demand.[125] The evaluator's 2024

[124] Bay Area Air District Building Appliances Rule 9-4 Implementation Working Group (IWG) Phase 2 General Meeting #2. December 3, 2025. https://www.baaqmd.gov/en/community-health/building-appliances-rule-implement

[125] TECH Clean California. 15th Quarterly Stakeholder Presentation. October 30, 2025. https://techcleanca.com/documents/5673/TECH_15th_Quarterly_Stakeholder_Meeting_IPTFwGx.pdf

customer satisfaction survey showed that 94 percent of TECH Clean California participants with a heat pump water heater had enough hot water to meet their needs "always" or "most of the time".[126]

Panel upsizing is more common for heat pump water heaters than for heat pump HVAC. One hypothesis for this finding is that air conditioner replacement projects can typically reuse an existing circuit, whereas gas water heater replacement projects are more likely to need a new dedicated circuit.[127]

120V heat pump water heaters play a meaningful role in the market. Partially attributed to a Quick Start Grant funded by TECH Clean California, New Buildings Institute (NBI) demonstrated that 120V heat pump water heaters can mitigate costly electrical infrastructure upgrades often required with traditional 240V heat pump model, at a lower installed cost. From 2023-25, 120V units accounted for 21 percent of TECH Clean California unitary heat pump water heater projects, and they have dramatically reduced the need for electrical work for these projects. Since TECH Clean California launched water heating incentives, 25 percent of 240V heat pump water heater installations involved electrical upgrades of some kind, such as new circuits or panel upsizing, while only 4 percent of 120V systems did – even though the average pre-installation panel capacity for 120V projects was 28 amps less than for 240V projects. On average, total project costs for 120V unit installations were 22 percent less than 240V projects.[128] This reflects a slightly higher equipment price for 120V units but a far lower installation cost, leading to an overall reduction in project cost.

Ensure contractors properly set the appropriate heat pump water heater mode at the time of installation: The TECH Clean California evaluator's analysis found that TECH Clean California contractors reported setting 4 percent of heat pump water heaters on electric resistance operating mode. [129] This setting sacrifices the benefits of the heat pump, resulting in fewer GHG savings and customer energy savings.

A.3 Central Heat Pump Water Heaters

Roughly half of TECH Clean California' s multi-family heat pump water heater projects have been served by central heat pump water heaters. Central heat pump water heaters are still in the early stages of market development, and thus require supplemental support, but significant potential to serve a broad segment of the state's multifamily households.

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[126] Opinion Dynamics. *TECH Clean California: Insights into Customer Experience and Satisfaction, Wave 2*. March 27, 2025. https://opiniondynamics.com/wp-content/uploads/2025/09/TECH_Updated-Customer-Experience-and-Satisfaction-Report_3.31.2025_Clean_UPDATED.pdf

[127] TECH Clean California. *TECH Clean California Annual Report 2022-2023. Year Two: September 2022-August 2023*. March 14, 2024. https://techcleanca.com/documents/4324/TECH_Annual_Report_2022-2023_v230212.pdf

[128] TECH Clean California. 14th Quarterly Stakeholder Meeting. July 23, 2025. https://techcleanca.com/documents/5623/TECH_14th_Quarterly_Stakeholder_Meeting_Xt3e3vj.pdf

[129] Opinion Dynamics. *Interim Process Evaluation: Technology and Equipment for Clean Heating (TECH)*. November 7, 2022. https://opiniondynamics.com/wp-content/uploads/2024/12/TECH_Interim_Process_Evaluation_Final_Report.pdf

The complexity of central heat pump water heater projects requires heightened attention to technical assistance and market capacity building. Technical assistance should include:

- Pre-installation support such as system design and pre-retrofit monitoring, analysis, and fixes for issues such as distribution system imbalance—both to ensure sufficient upfront investment in proper sizing and to address distribution issues that would negatively impact the performance of a newly installed central heat pump water heater plant.
- Post-retrofit commissioning and monitoring is necessary to ensure systems are operating as intended, identify issues that arise over time, and support troubleshooting.
- Expanded training and technical support to build contractor knowledge and capacity to implement central heat pump water heater projects.

Based on these key learnings, the next set of multifamily offerings through TECH Clean California will include expanded and required training for contractors, training on industry best practices, standards for evaluation of existing systems, and system sizing incorporated into enhanced support pathway incentives. The offers will also include incentives for pre-retrofit monitoring to identify distribution issues and post-retrofit monitoring for performance verification.

Appendix B: Low-Income Leveraging Pilot Findings and Recommendations

See Low-income Leveraging Pilot Final Report, pages 5–11, for a list of recommendations pertaining to low-income programs and strategies to address remediation needs.[130]

Summary of Findings

Table 1: Qualitative Findings

Findings	Summary
The additional remediation needs of the households treated through this pilot range include a large range, with an average of $5,893 per project. Funding to support remediation work, whether challenged through low-income energy efficiency programs such as Energy Savings Assistance or otherwise, will need to increase dramatically to serve the households treated through this pilot — particularly to support households in disadvantaged communities and mobile and manufactured homes.	With a range of between $225 up to over $30,000 per project, 87 percent of all projects required less than or equal to $10,000 in supplemental remediation needs. While the average remediation contribution was $5,983, that average decreased to $4,989 when the highest 5th percentile was removed—indicative of the opportunity to serve the majority of participants at a lower overall average, when removing the highest-cost outliers. For single-family homes, 91 percent of projects fell at or below $10,000, while for mobilehomes/manufactured homes, only 58 percent fell below the threshold**. The average supplemental remediation contribution for single-family homes was $5,197 (median of $4,071), compared with the average for mobilehomes/manufactured homes at $11,203 (median of $9,074).** Increasing program remediation caps to allow up to $10,000 in total remediation and minor home repair work within the Energy Savings Assistance (ESA) Program would have enabled the participation of 468 additional homes across the three leveraged and partner programs. This could have been managed against a lower average across the portfolio.

[130] Etherington, Rachel; Krishpinovich, Irina; and Ortiz, David. The Ortiz Group LLC. Harwood, Meghan; Schaaf, Becky; Staub, Ben; and Asa Parker. VEIC. *Pilot Project Final Report: Low-Income Leveraging Pilot*. December 15, 2025. https://techcleanca.com/documents/5705/8.2_Low_Income_Leveraging_Pilot_v260105.pdf

Findings	Summary
Leveraging existing low-income programs is a meaningful way to deliver benefits to disadvantaged communities.	While TECH Clean California's dedicated equity funds deliver benefits and incentives to a broad range of equity communities inclusive of disadvantaged communities, only 14 percent of TECH Clean California incentive projects occur in disadvantaged communities. Within the Low-Income Leveraging Pilot scope of income-qualified customers, **47 percent of pilot projects occurred in disadvantaged communities.**
Main panel upgrades and panel upsizing were expensive line items that impacted total remediation costs, though not as dramatically as expected.	**The average supplemental remediation contribution for households that involved a panel upgrade or upsizing was $6,387 (median of $5,760), compared with the average for households without an electrical upgrade at $5,150 (median of $3,529).** Additional pilot data discusses the portion of projects that fall within remediation cost categories, between projects that did include a panel upgrade or upsizing relative to those that did not (see: Figure 4).
Disadvantaged community status had a strong relationship with remediation costs and needs.	A larger portion of projects within the Low-Income Leveraging Pilot served households in disadvantaged communities, compared with the TECH Clean California program as a whole (see: Figure 3). **The average supplemental remediation contribution for households in a disadvantaged community was $7,505 (median of $6,509), compared with the average for households not in a disadvantaged community at $4,483 (median of $3,362).**
Unsurprisingly, projects that involved both heat pump heating, ventilation, and air conditioning and heat pump water heater installation—versus just a heat pump water heater—were more expensive and required more remediation needs.	The pilot gathered data on remediation costs for projects that involved only a heat pump water heater installation, relative to projects that involved both a heat pump water heater and heat pump heating, ventilation, and air conditioning retrofit (see: Figure 6).
Mobilehomes/manufactured homes have much costlier remediation and minor home repair needs than single-family homes.	The pilot reports on the average remediation contribution for mobilehome/manufactured homes projects relative to single-family households and

Findings	Summary
	projects, inclusive of both heat pump water heater and heat pump HVAC projects (see: Table 4). Additionally, the pilot demonstrates the remediation cost range for mobilehome/manufactured home projects relative to single-family households (see: Figure 7). **The average supplemental remediation contribution for single-family homes was $5,197 (median of $4,071), compared with the average for mobilehomes/manufactured homes at $11,203 (median of $9,074).**
Home vintage was an indicator of remediation and minor home repair costs and needs, but not as strong as we would have guessed.	**The average supplemental remediation contribution for homes built before 1978 was $7,808 (median of $7,331), compared with the average for homes built after 1978 of $4,604 (median of $3,362).** This report compares the remediation cost range for projects pre-1978 vintage relative to post-1978 vintage (see: Figure 8).
While older homes almost always required a main panel upgrade or sub-panel upgrade or upsize—i.e., panel upsizing—about half of newer post-1978 construction homes required an upgrade as well.	The report demonstrates remediation cost ranges for project participants, by home type, home vintage, and panel upsizing requirement (see: Figure 2).
Cost drivers and factors influencing remediation and minor home repair needs are site-specific, though commonalities indicate opportunities for targeted training and home assessment strategies.	Challenges varied from heat pump water heater relocation, sealing and ducting for heating, ventilation, and air conditioning retrofits, to electric panel upgrades or upsizing and access challenges. However, there are common challenges and solutions that could inform future training or home assessment and prioritization work. Those include things such as: 1) water heater relocations, prompted by space constraints (previous unit in a small interior closet), ventilation and air flow requirements, noise and vibration considerations, and more; 2) heating, ventilation, and air conditioning retrofit needs, such as new and extensive duct sealing or replacement, structural modifications, roof or wall repair work, and more; or 3) electric panel upsizing or main panel replacement,

Findings	Summary
	whether simply adding circuits to an existing panel or requiring an entire main panel upgrade.

Table 2: Qualitative Findings

Finding	Summary
Non-energy benefits are substantial to the participating households—low-income households and households in disadvantaged communities.	Non-energy benefits can include restoring basic access and functionality of air conditioning or water heater systems that deliver health, comfort, and safety in the face of extreme heat and weather events.
Program leveraging and incentive stacking are complex, and minimizing administrative burdens for participating contractors or homeowners is crucial. Providing robust technical assistance to minimize additional administrative or cost burden on participating contractors, alongside proactive incentives to layer on new scope and funding, served as an effective model.	As contractors are often disincentivized from maximizing layered funding on behalf of customers because of administrative burden, TECH Clean California offered a $225 incentive to ESA contractors to participate in and layer with TECH Clean California. That contractor incentive was intended to cover the labor cost of additional administrative work. In addition, Ortiz Group contributed in-kind technical assistance to simplify the process. The Ortiz Group supported contractors by writing a set of Standard Operating Procedure (SOP) documents and checklists for contractors (e.g., step by step how to enroll as a TECH Clean California contractor, submitting incentive applications, and field checklists to ensure contractors capture all photos and project documentation required to report on the incentive application). Stacking incentives with different rules and administrative requirements is extremely difficult for both contractors and homeowners. Simplifying program rules is the lowest-cost pathway to supporting funding stacking and avoids having to pay out more substantial incentives to contractors to encourage participation in multiple programs.
Identifying complementary scope of works between programs maximizes funding and retrofit potential.	This can include aligning programs based on their individual funding metrics, such as complementing programs tied to cost-effectiveness with more flexible funding.

Finding	Summary
Managing low-income programs using a portfolio-wide average instead of a per-household cap enables a program to serve more households at the same average cost.	Programs typically include a maximum allowable cost associated with the funds spent toward remediation. A portfolio-wide average provides flexibility to programs because they can accommodate higher costs while remaining within budget. This strategy enables higher cost outliers to participate when balanced with lower-cost projects, allowing a program administrator to manage an expected average portfolio cost. Programs typically include a maximum allowable cost associated with the funds spent toward remediation. A portfolio-wide average provides flexibility to programs because they can accommodate higher costs while remaining within budget.
Ensure strong coordination and alignment between various program administrators and implementers.	This includes creating opportunities for a project manager to review project needs on a flexible basis, with an eye toward avoiding duplicative efforts, streamlining processes, as well as seeking project cost-reduction measures.
Contractors and their technicians remain unfamiliar with heat pumps, both as a new technology and the varied installation challenges in the field. Training should include heat pump-specific education and field training.	This should include hands-on troubleshooting and a focus on real-world challenges, such as electrical upgrades, panel sizing and airflow, and common remediation scopes across different building typologies. Program administrators might also consider on-going technical support for contractors and their technicians, such as electrification specific on-site advisors, or the creation of peer learning and mentorship networks.

Summary of Recommendations and Future Areas for Research

FOR POLICYMAKERS AND PROGRAM DESIGN

Prioritize flexibility over funding caps and enable portfolio-level goal setting. This enables programs to serve higher-cost outliers and acknowledge regional differences in housing conditions within a program's service territory, for example, while planning toward a portfolio-wide average.

Align program rules and regulations to minimize administrative burden to support flexibility, funding streamlining, and layering. Where possible, enable funding stacking and project intake through existing programs—including ones with existing income qualification and customer outreach processes. Policymakers and regulators should coordinate funding initiatives by pairing

more flexible sources with more stringent ones to maximize impact, whether enabling deeper retrofits per house, furthering reach in higher-need low-income households, or otherwise.

Focus on electrification-ready measures, including weatherization, efficiency, and optimized electrical upsizing or upgrades. Though expensive upfront, measures such as attic insulation and air sealing can be crucial for long-term affordability. Similarly, efficient and optimized electrical upsizing or upgrades can set up a household for longer-term decarbonization while saving costs upfront.

Value non-energy household benefits and climate benefits of electrification. Whenever possible, particularly for more flexible funding sources, programs should account for the individual household financial, health, comfort, and other benefits, as well as societal benefits.

Programs should manage toward and optimize for high-impact outcomes—whether cost-effectiveness, energy savings, greenhouse gas impact, or customer benefits—on a portfolio basis. At the same time, programs and policymakers must plan for long-term equity and market transformation by investing in technological, financial, and delivery solutions tailored to serve high-need, high-cost homes over time. This includes building separate, sustained funding pathways or specialized interventions for homes with extensive remediation needs, rather than expecting every core program to absorb all outlier costs. A cost-effective portfolio should be designed to enable some higher-cost projects, while optimizing for specific metrics and outcomes—whether maximizing energy savings, cost-effectiveness or Total System Benefit, minimizing bill impacts, or otherwise. Programs and policymakers need to simultaneously focus on transforming the market for low-income households, investing in solutions to common challenges such as heat pump technologies for households that are space constrained or have minimal electrical capacity, such as 120V solutions; installation solutions that minimize cost and complexity, such as power-efficient approaches and panel optimization; program solutions that enable scale, such as accessible financing; and other policy solutions to enhance affordability, such as equitable rate design. This is particularly important as the state advances appliance standards policies, when low-income households with high remediation needs will need the most support in electrifying.

Consider mechanisms for supporting low-income electrification as a long-term affordability strategy. Ensuring low-income households are not left with future stranded gas assets, volatile fuel prices, and the negative health benefits of gas appliances is crucial for long-term affordability. Existing data can be used to target and support households expected to have immediate bill savings from electrification with retrofit and program support before appliances fail. When managing emergency replacements, minimizing or neutralizing negative bill impacts will remain crucial—whether through specific rates, pairing a retrofit with robust efficiency and weatherization or solar measures, or otherwise. It will also be critical to avoid funding new gas appliances, which will become stranded assets over time.

FOR PROGRAM ADMINISTRATORS AND IMPLEMENTERS

Invest in installer training for both electrification and electrification-ready measures. This should include proactive and hands-on training for contractors who traditionally support low-income

direct-install programs and energy efficiency and weatherization — such as Energy Savings Assistance program contractors — related to heat pumps, on-site remediation trends and needs, bill impact assessment tools, and panel optimization opportunities.

Fund detailed site assessments and building stock characterization work to account for and understand the variation among properties. Detailed site and market assessments can source main drivers of variation across geographies, for example. Programs should create processes for protocol and best practice sharing among contractors and program administrators to avoid unexpected or unnecessary costs.

Develop culturally and locally relevant electrification educational materials, both for homeowners and contractors. Highlight the non-energy benefits of electrification, and develop materials in multiple formats and languages, which enables households to make decisions based on their own priorities.

FOR FUTURE RESEARCH

Invest in market characterization and transformation for low-income households specifically, as well as the higher-cost outliers that are continuously left behind. This can include developing better standards, best practices, and protocols for managing high-cost remediation needs that are commonplace in specific building stock or geographies. It should also include researching and investing in new technological or market solutions — such as 120V technologies, inclusive and accessible financing, panel upgrade alternatives, and more.

Create a value proposition for contractors that enables funding stacking/leveraging without driving up project costs. This includes further understanding the adequate incentives — whether financial or otherwise — to encourage contractors to participate and layer funding.

Develop new resources for contractors for low-income electrification, focused on remediation and minor home repair challenges, as well as cost-savings strategies like panel optimization and panel upgrade alternatives. This could also include materials on best practices or existing tools for bill impact assessments.

Appendix C: Residential Decarbonization Measure List

Below is a table listing the eligible residential decarbonization measures applicable for participants of the Equitable Building Decarbonization Program (EBD).[131]

Category	Measure	Details
Heating and Cooling	Heat pump for space heating and cooling	Eligible as a replacement for gas-fired or electric resistance heating equipment. Must meet the highest efficiency tier (not including any advanced tier) established by the Consortium for Energy Efficiency (CEE). Equipment installed on or after 7/1/24 must use refrigerant with global warming potential (GWP) less than 750.21 Installer must possess U.S. Environmental Protection Agency Section 608 Technician Certification. Home Energy Rating System (HERS) field verification and diagnostic testing is required consistent with the California Energy Code.
Heating and Cooling	Duct testing/sealing, and/or new ducts, returns, and registers	Duct testing/sealing is required in conjunction with installation of a ducted heat pump for space heating and cooling consistent with the California Energy Code.
Heating and Cooling	Occupant controlled smart thermostat	Required in buildings with central heating/cooling system, if not already present. Must be certified compliant with Joint Appendix 5 (JA5) of the California Energy Code
Heating and Cooling	Ceiling fan or whole-house fan	Ceiling fans must be ENERGY STAR®-certified
Building Envelope	Air sealing	

[131] California Energy Commission. *Equitable Building Decarbonization Direct Install Program Guidelines (Adopted)*. CEC-400-2023-003-CMF. October 23, 2023. https://efiling.energy.ca.gov/GetDocument.aspx?tn=252682&DocumentContentId=87762

Category	Measure	Details
Building Envelope	Insulation	
Building Envelope	Solar window film	Must be certified by the National Fenestration Rating Council
Water Heating	Heat pump water heater (unitary)	Eligible as a replacement for a gas-fired or electric resistance water heater. 240V heat pump water heaters must meet Northwest Energy Efficiency Alliance (NEEA) Advanced Water Heater Specification for Integrated or Split-System Heat Pump Water Heaters at Tier 3 or higher; 120V heat pump water heaters must meet NEEA Advanced Water Heater Specification for Plug-In Heat Pump Water Heaters at Tier 2 or higher. Must be certified compliant with Joint Appendix 13 (JA13) of the California Energy Code and installed in accordance with JA13 specifications. Must meet the highest efficiency tier (not including any advanced tier) established CEE.
Water Heating	Heat pump water heater (central)	Eligible as a replacement for a gas-fired or electric resistance water heating system. Must appear on CEC's Central Heat Pump Water Heater Performance Map Certification List.
Water Heating	Low-flow showerheads and faucets	Low-flow showerheads are required in conjunction with heat pump water heater installation, if not already present. Must be WaterSense certified and comply with California Tile 20 standard for water efficiency.
Cooking	Induction range or cooktop	Only eligible as a replacement for a gas range or cooktop. Provide gift card for purchase of compatible cookware.
Laundry	Electric clothes dryer (heat pump or electric resistance)	Only eligible as a replacement for a gas clothes dryer. Must be ENERGY STAR-certified.

Category	Measure	Details
Lighting	Light-emitting diode (LED) bulbs and fixtures	Replace interior and exterior incandescent, compact fluorescent, halogen, and T12 linear fluorescent bulbs with LED. New fixtures may be installed where existing bulbs cannot be upgraded. Must be certified compliant with Joint Appendix 8 (JA8) of the California Energy Code.
Indoor air quality	Air filtration	Replace existing air filter with a Minimum Efficiency Reporting Value (MERV) 13-rated filter, and associated modifications needed to comply with pressure drop requirements in the California Energy Code.
Electrical	Electrical wiring and panel upsizing	Upgrades and new wiring needed to enable full electrification of the building. Excludes upgrades on the utility side of the meter and distribution system upgrades, which are ineligible for program funding. Subject to cost caps (see Table 5). See Section 5, Electrical Upgrades.
Electrical	Automatic circuit sharing	See Section 5, Electrical Upgrades
Remediation and safety	May include construction needed to create physical space for decarbonization measures, repair of roof or envelope leaks/damage, remediation of galvanized pipe, lead paint, asbestos, and/or mold, installation of smoke and carbon monoxide alarms, ventilation, and other work needed to bring property up to code.	Subject to cost caps (see Table 5)

Appendix D: Program Theory Logic Model

TECH Clean California's theory of change is that program interventions can catalyze market transformation through a three-phase evolution. We assess that heat pump market transformation efforts are currently in Phase 2.

Phase 1 Initial Deployment: At the outset of market transformation activities, program incentives drove contractor and consumer demand and catalyzed tens of thousands of project installations. These early projects generated empirical evidence needed to document market responses to program interventions and quantify costs, outcomes, and meter impacts that inform program refinement.

Phase 2: Lessons learned from Phase 1 are informing the development of a long-term decarbonization framework, including rigorous performance measurement to quantify the impact and value of the clean energy resources that heat pumps provide (e.g., GHG reductions, peak load impacts, participating customer bill savings, additional non-peak electric load, etc.). In Phase 2, we expect to start seeing incremental cost reductions due to product and installation efficiencies as the market gains more experience and competition increases.[132]

Phase 3: A maturing market will enable the establishment of clear policy direction and a long-term heat pump investment structure, which drives economies of scale. Performance measurement will transition heat pumps and electrification into an investable clean energy resource, where continued public investments can be tied to the underlying value of the resource, and where a functional market develops—one that values heat pumps' societal and customer benefits.

To drive market transformation through these three phases, TECH Clean California has organized its interventions around three pillars.

Pillar One: Spur the Clean Heating Market for Electrification through Statewide Strategies

Focus on contractors to prime the market: TECH Clean California concluded that a focus on contractors would have the greatest impact since they most directly influence customers' heating, ventilation, and air conditioning (HVAC) and water heater purchase decisions. However, contractors are often hesitant to break away from their existing profitable sales model and invest time and effort to sell and install nascent technologies with yet-to-be proven demand. To address these concerns, the program emphasizes contractor training on the technology, value proposition, and business model aspects of electrification and motivates contractors to sell heat pump technologies via contractor incentives.

Provide heat pump water heater and heat pump HVAC incentives for both single-family and multifamily residences: Incentives attract consumer and contractor attention, address upfront cost

[132] Assessing changes in incremental cost has been challenging due to higher-than-expected volatility, inflation and supply chain shocks since TECH was designed in 2020.

barriers and impart a sense of urgency to act. Incentives for multifamily properties help the initiative reach renters who typically lack control of infrastructure upgrade decisions.

Leverage existing marketing infrastructure to inform consumer decision making: To inform customer decisions and drive demand, TECH Clean California integrates with and enhances the Building Decarbonization Coalition's (BDC) electrification website, The Switch Is On, as well as their broader consumer inspiration campaign. This resource provides information for every step of the customer journey, including electrification guides and resources to find qualified contractors and available incentives.

Pillar Two: Create Scalable Models for Market Transformation through Regional Pilots and Focused Outreach

Test solutions through regional pilots and Quick Start Grants (QSGs): Six regional pilots and 26 QSGs have been designed to test innovative solutions to heat pump adoption barriers in a small-scale, targeted fashion. Successful pilot approaches can then demonstrate an approach that can be scaled.

Target low-income, hard-to-reach, disadvantaged communities (DACs): Investments in impacted communities help fuel economic recovery and respond to the needs of those hit hardest by historical environmental and social inequities. TECH Clean California has a goal to invest 40 percent of program incentives in low-income households and DACs.

Pillar Three: Inform Long-Term Building Decarbonization Framework

Public reporting informs policy: TECH Clean California provides program data for California through its public reporting website, www.techcleanca.com, offering market transparency with program information on installation details, project prices, deployment progress, and meter impacts. TECH Clean California also presents relevant program insights and data at its quarterly stakeholder meetings and other webinars. TECH Clean California data supports regional and statewide agencies pursuing building electrification policies by providing real market data to inform these policy decisions.

Quantify the value of decarbonization: Through rigorous interval meter data analysis to quantify gas and electric load impacts, GHG savings, customer bill savings and other decarbonization benefits, TECH Clean California intends to create an actuarial level of understanding of how specific drivers influence outcomes. This ability to forecast outcomes and investment strategies can then be used to optimize public and private investments and support large-scale project finance and deployment, similar to the wind and solar industry.

The evaluator created a Program Theory Logic Model (PTLM) for the TECH Clean California program. The PTLM documents how the activities, outputs, and short- and long-term outcomes are interconnected. The PTLM activities are listed from left to right, and the outcome categories are listed in chronological order from top to bottom. The PTLM features arrows labelled with numbers, and these arrows represent linkages.

Opinion Dynamics started the PTLM development process by creating an initial PTLM that captured the core theory behind TECH Clean California including its key activities, outputs of activities, and intended outcomes. This initial PTLM was informed by review of TECH Clean California implementation plans. The evaluation team presented this initial PTLM to key staff from the Energy Solutions implementation team and solicited feedback about the accuracy of each element. We used feedback to refine the PTLM, which is presented below.

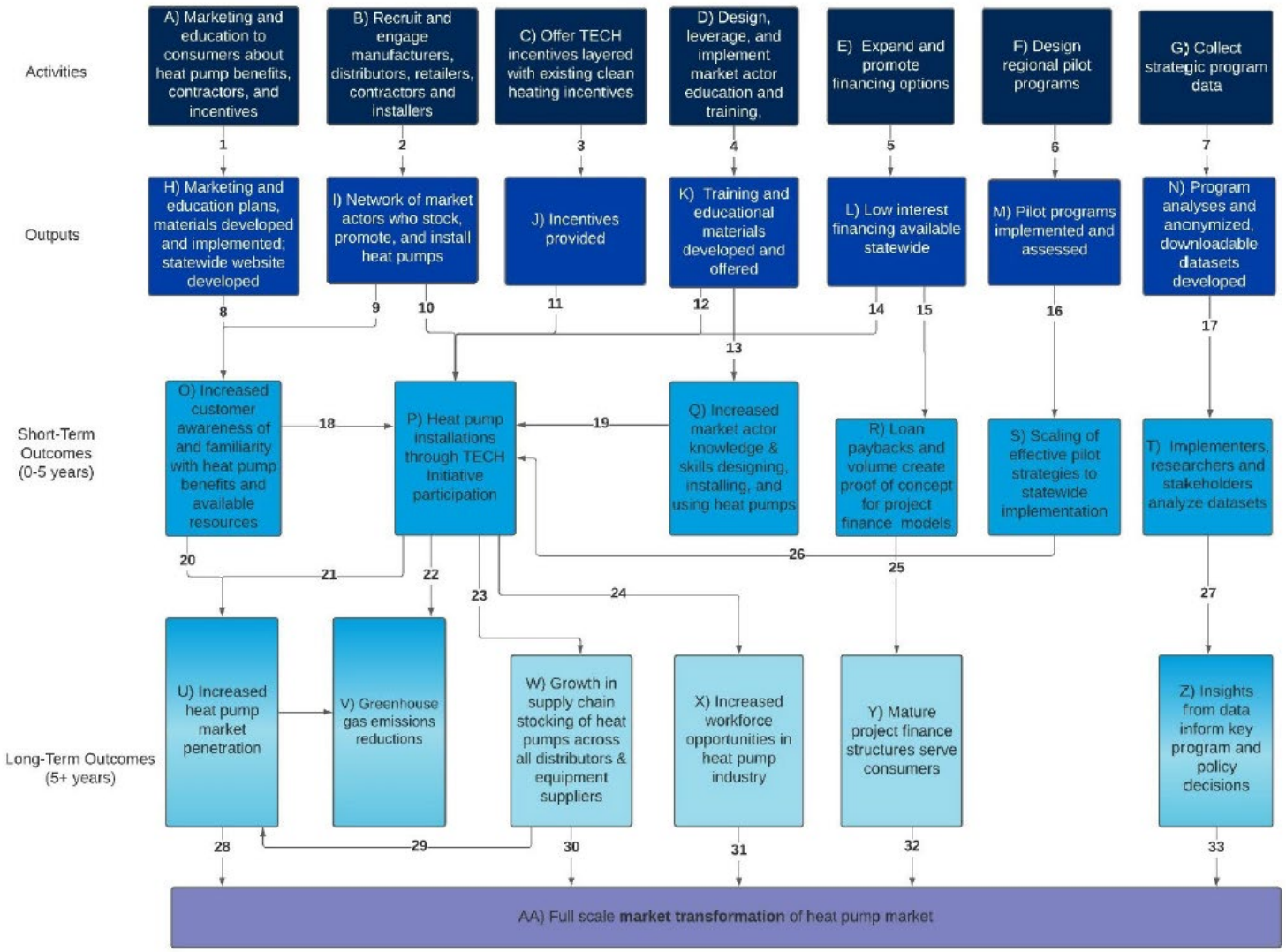


Figure 10. TECH Clean California Program Theory Logic Model

Appendix E: Frameworks for Optimizing Policy Objectives

E.1 Optimizing Across Competing Program Objectives via Electrification Potential Score

The electrification initiatives are frequently asked to advance multiple policy objectives simultaneously: reducing GHG emissions, improving customer affordability, delivering system benefits, and prioritizing low-income, hard-to-reach (HTR), and disadvantaged communities (DACs). These goals are not always aligned. For example, projects with the highest system value may not always be located in priority equity communities, and projects that maximize GHG reductions may not always yield the largest bill savings.

To manage these trade-offs in a transparent and repeatable way, analysis of key drivers of outcomes can be used to create a multivariate optimization framework and produce a single Electrification Potential Score for prospective projects. This score reflects how well that project may advance a weighted combination of program objectives and can be forecasted in advance for all prospective participants.

E.2 Objectives and Scoring Framework

The framework incorporates multiple objectives for an HVAC electrification portfolio:

Maximize GHG emissions reductions	Maximize system benefits	Maximize customer bill savings
Maximize peak period savings	Serve low-income customers	Serve HTR customers and DACs

Program administrators assign weights to each objective based on its relative importance, with the weights summing to 100 percent. Equity metrics (low-income, HTR, DAC) can be scored so that each flag provides a meaningful advantage in the final score, relative to other core program objectives, such as peak savings, bill savings, and the combination of system benefits and GHG savings.

To put all objectives on a common footing once they have been weighted by importance, each objective is normalized to a 0-1 range. Continuous metrics (system benefits, GHG savings, bill savings, peak MWh savings) are normalized using a Min-Max-style transformation that preserves their relative distribution, and equity indicators are represented as binary values (1 for True, 0 for False).

Each project's Electrification Potential Score is then computed as the weighted sum of its scaled objective values. If a component is missing (for example, a bill impact where rate data are

unavailable), that component is set to zero, and the score is re-scaled based on the sum of the weights of the available components, preserving comparability across projects.

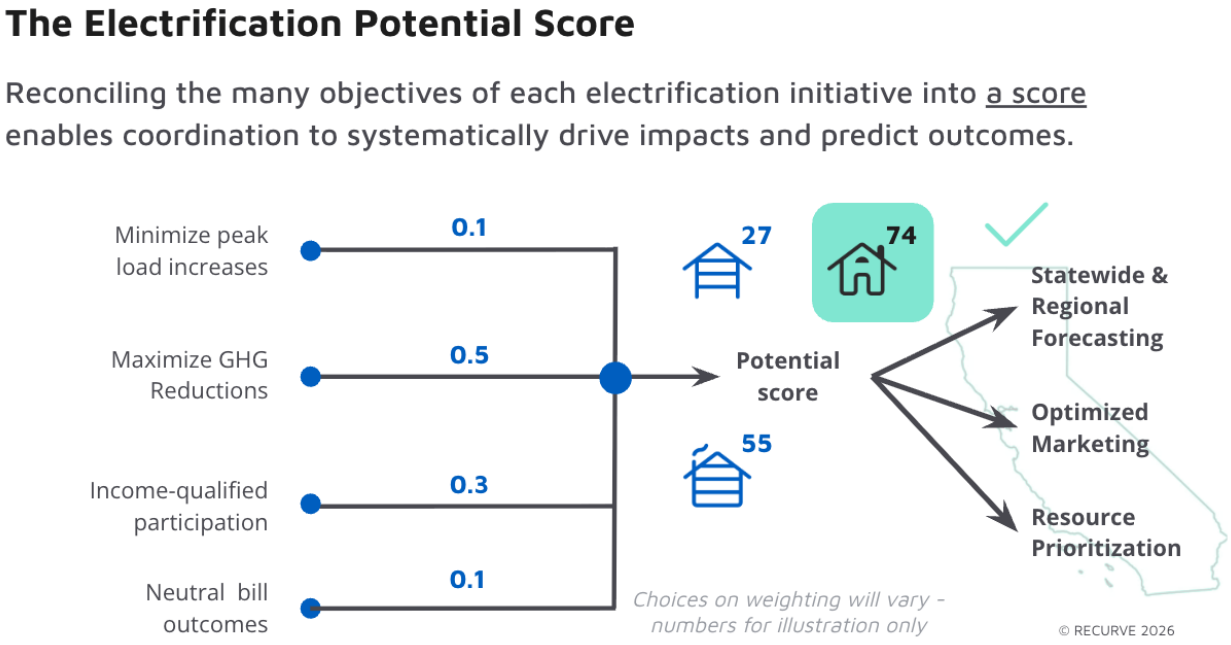


Figure 11: Steps for scoring an electrification initiative.

E.3 Forecasting Scores for Prospective Participants

Once measured in Recurve's FLEX platform, Electrification Potential Scores are established for existing projects. The machine-learning forecasting engine is calibrated to predict scores based on drivers using available data for all prospective TECH Clean California participants (e.g., pre-program load shapes, climate zone, equity flags, utility, and rate category).

The model can reliably separate projects into score quartiles, with predicted and measured scores closely aligned on average. This validates the framework as a practical targeting tool: scores can be assigned to all eligible customers in the population dataset prior to enrollment, and implementation teams can prioritize marketing messaging and geographic outreach to groups with the highest Electrification Potential Scores.

E.4 Optimization as an Electrification Best Practice

By intentionally considering the role of multiple, sometimes competing, program objectives within a standardized framework, program administrators, regulators, and stakeholders can gain a clearer understanding of the trade-offs and ensure that resources are focused where they have the potential to deliver the biggest impact.

Projects in the top-scoring quartile have the potential to deliver substantially greater impacts than those in the bottom quartile. By intentionally weighting equity factors, they will be represented in the top-quartile focus groups alongside other drivers that affect their outcomes.

This best practice makes policy trade-offs explicit and actionable through objective weighting. The drivers identified in TECH Clean California provide a foundation for forecasting outcomes and optimizing future initiatives. It provides a transparent, quantitative basis for prioritizing outreach and incentives and can be updated over time as more meter data becomes available or as policy priorities evolve.

In short, the multivariate optimization framework has turned the TECH Clean California meter data into an operational tool for designing and targeting electrification portfolios that simultaneously support decarbonization, affordability, system value, and equity.

Appendix F: Driver Analysis and the Importance of Site-Level Granularity

F.1 Identifying Baseline AC use is Essential to Electrification Program Optimization.

A central finding of the implementation team's analysis is that site-level drivers–in particular, whether a home had preexisting air conditioning (AC)–strongly influence both grid and customer outcomes from heat pump electrification. This appendix summarizes AC's role as a key driver and explains why site-level granularity is essential for optimizing the design of electrification programs.

F.2 Presence of AC as a Primary Outcome Driver

Recurve's FLEX Platform was used to identify the presence of AC in homes participating in the TECH Clean California.[133] This visibility into baseline technology identified that the preexistence of AC as one of the key drivers of customer and grid impacts in a detailed value stream analysis. In the analysis, heat pump HVAC projects were divided into two canonical portfolios based on pre-program AC status:

- HVAC, AC Detected – homes where a heat pump replaces both a gas furnace and an existing AC system.
- HVAC, No AC Detected – homes where a heat pump replaces a gas furnace in homes without detectable prior AC, effectively adding cooling service.

HVAC electrification operates differently in these two cases:

In homes with AC, the heat pump serves as both a fuel switch (gas-to-electric for heating) and an efficiency upgrade for cooling. Analysis found that these projects reduce summer peak electric load because the new heat pump is more efficient than the existing AC, resulting in significant GHG savings from reduced electricity use during California's summer peak hours of 4 pm to 9 pm.

In homes without AC, the heat pump is displacing gas heating, but it also introduces new cooling load where little or none existed before. Under hot conditions, these projects increase summer peak demand, and customers may experience higher electric bills if rate design and building shell conditions are not supportive.

At the same time, both portfolios deliver substantial gas savings—on the order of 200+ therms per year on average—which drive large GHG reductions.

The impact of just this one driver is important to consider in policy decisions and program design and tactics. The same electrification technology can either reduce or increase summer peak load and bills, depending largely on whether AC was present beforehand.

[133] See FLEX Platform capabilities. https://recurve.com/platform/how-it-works/

F.3 Regional and System Planning Implications

The distribution of AC status across regions further amplifies its importance as a driver. In the Inland/Desert region, most customers already have AC, so heat pump HVAC largely acts as an AC efficiency upgrade. Installing one million such projects with a 90/10 split between customers with and without preexisting AC would reduce summer evening peak demand by more than 300 MW.

In contrast, in cooler Coastal/Northern regions, a higher share of projects is in homes without prior AC, so electrification tends to add summer peak load, even as it reduces gas use and improves comfort.

These differences cannot be managed by limiting certain technology types; they emerge only when site characteristics like existing AC status are measured and analyzed.

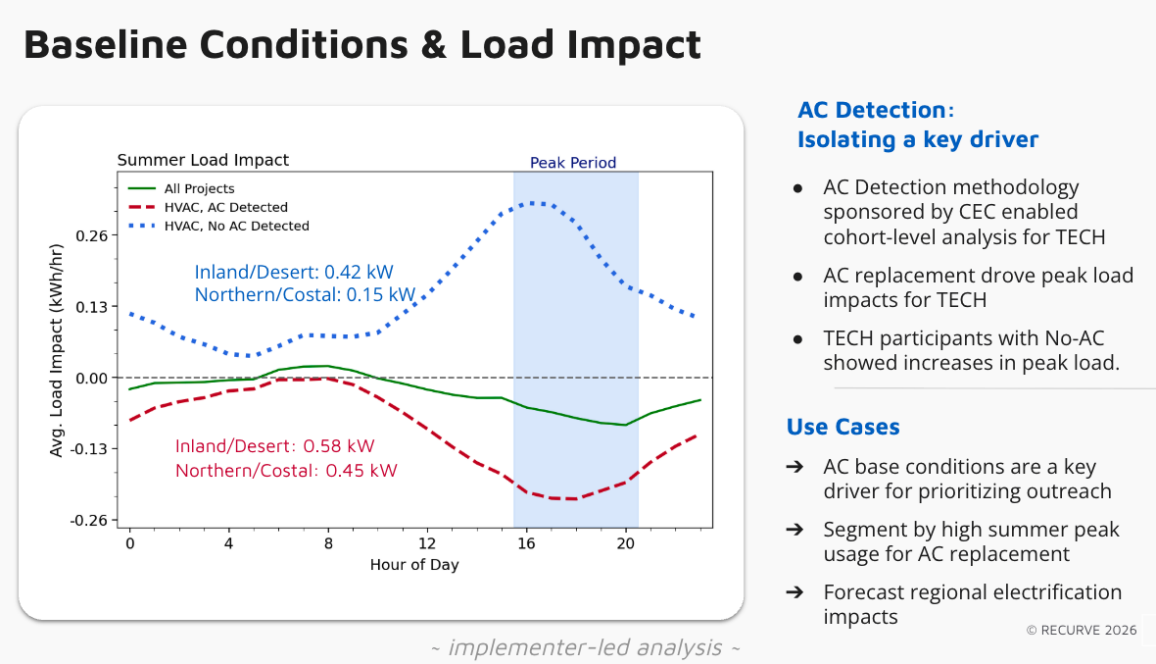


Figure 12: Baseline Conditions and Load Impact.[134]

F.4 Why Site Granularity Is Essential for Program Optimization

As illustrated in this one example, the presence or absence of AC so strongly shapes outcomes that site granularity is not a "nice to have"; it is a prerequisite for designing responsible, scalable electrification portfolios.

Specifically, site data enables programs to:

Differentiate core use cases. The same "heat pump HVAC" measure represents either a fuel switch plus efficiency upgrade (AC Detected) or a fuel switch plus comfort and service expansion (No AC

[134] Scheer, Adam. Recurve. 2025 ACEEE Hot Water & Air Forum Presentation "Measured Impacts of TECH Heat Pump Installations". March 6, 2025. https://drive.google.com/file/d/1oju5s-S4zltvkv5rzDFuDu6k3ftKujPT/view

Detected). Treating them as a single category obscures critical differences in peak impacts and bill risk.

Target high-value, low-risk segments. With meter-based driver analysis, programs can prioritize replacement projects in regions where summer peak relief is most valuable and identify homes where added cooling can be delivered with manageable bill and capacity impacts.

Feed multivariate optimization and scoring by understanding the underlying drivers and the relationships between drivers of program outcomes.

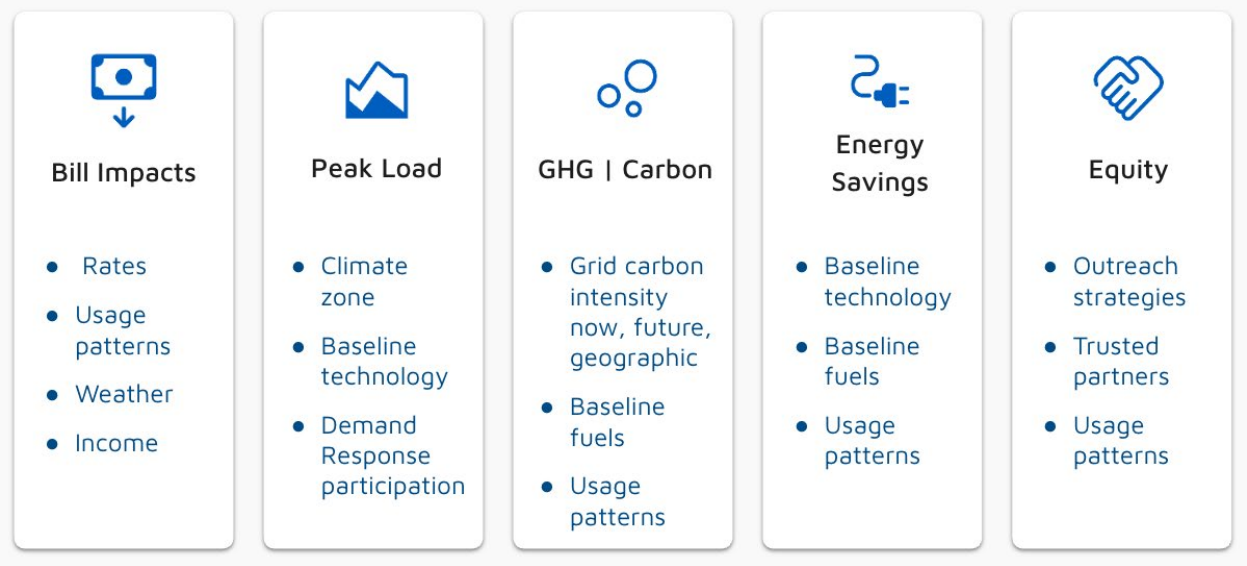


Figure 13: Factors to include in site descriptions.

Driver analysis provides critical insights into how to achieve program goals for grid support, GHG, and bill outcomes. Site-level granularity is indispensable for managing affordable electrification to maximize value and advance affordability and equity.

Appendix G. Initiative Design, Evaluation, and Data Considerations

G1. Approach to Initiative Design

Senate Bill 1477 (Stern, 2018) established that TECH Clean California shall advance the market for low-emission space and water heating equipment through "upstream market development" as well the "the provision of upstream and midstream incentives." The Commission defined upstream and midstream market development in Decision 20-03-027:

- Upstream market development: Program elements aimed at encouraging manufacturers to make the most GHG-reducing equipment available at competitive prices.
- Midstream market development: Program elements that provide incentives to wholesale distributors, retailers, e-commerce companies and/or contractors to stock and/or sell more efficient products.

In practice, TECH Clean California has been delivered via a "contractor open market" structure, taking the following considerations into account.

Point of Sale (Distributor and Retail)

- **Pros:** Point-of-sale incentives enable all contractors to benefit from the program and gives them maximum flexibility for how they integrate the incentives into their service offerings. The speed and simplicity support emergency equipment replacements, and the lack of installer requirements, accommodate "do-it-yourself" installations, which make up over 50 percent of water heater replacements in California.[1] Wholesale-level incentives generate a multiplier effect by reducing retail markups. It enables administrators to collect sales data for market tracking.
- **Cons:** In a point-of-sale delivery model, it is difficult to enforce permit verification, tenant protections, professional training and credential requirements, and other downstream program requirements. The model offers limited ability to track project characteristics or prioritize individual equity customers. Finally, to drive true market adoption, an upstream delivery model needs sufficient incentive availability to serve a broad market over an extended period.

Contractor Open Market (e.g., the current TECH Clean California model)

- **Pros:** Incentives are targeted at contractors, with any contractor meeting minimum eligibility able to participate. The program can offer higher, more narrowly targeted incentives based on customer-specific data (income, energy usage, etc.). The approach can accommodate more complex requirements such as professional training, credential requirements, and project eligibility requirements.

- **Cons:** Compared to distributor/retailer incentives, this channel involves higher "transaction friction" and administrative costs, which can limit participation from small businesses. It is less suited for emergency replacements, and "do-it-yourself" (DIY) projects are excluded entirely.

Contractor Closed Market

- **Pros:** In this variation on the contractor model, a limited set of contractors is selected through a competitive process based on pricing and qualifications. These contractors provide a "concierge" experience, managing the project from scope to installation. This approach is well suited for a deep equity focus with high-touch support and 100 percent program subsidies (i.e., Direct Install). It resolves multiple barriers (upfront cost, language, community distrust, and landlord-tenant split incentives) and enables a whole-home approach, delivering health, safety, and bill savings to those who otherwise could not afford any retrofit. Installation costs can be negotiated at the portfolio level rather than project by project.
- **Cons:** High per-project costs associated with full subsidies can limit total volume and reach/market acceleration impacts of the program. The "program monopoly" approach does little to transform the broader, non-subsidized home improvement market and requires longer timelines for enrollment as well as project evaluation and scoping.

Direct to Consumer (excluded from consideration by SB 1477).

- **Pros:** Incentives targeted directly to consumers enable downstream project eligibility requirements and the collection of site-specific data.
- **Cons:** Rebate applications need to be done by each individual customer. Few households actually utilize downstream rebates due to the amount of paperwork. High friction application processes do not help customers with emergency replacements. Downstream programs also require relatively high administration costs versus more upstream models where participants number in the tens or hundreds. Finally, downstream rebates have lower incentive leverage due to markups throughout the supply chain.

As noted above, TECH Clean California opted to institute a "contractor open market" structure. Several factors informed this choice:

- Statutory requirements and regulatory guidance that necessitated project-specific eligibility criteria.
- The ability to focus on the contractor as the key source of influence in customer decision making.
- The ability to collect project characteristics and track meter-based outcomes to fill an information void about building decarbonization best practices.

As the market matures, the last two factors become less critical for market acceleration. Contractors are becoming more familiar with heat pumps, and, as customer awareness and adoption rates ratchet up, peer-to-peer word of mouth is expected to gain importance as a source of influence.

Conversely, once we have gathered enough project data and conducted enough analysis to address information gaps, the marginal value of additional project-specific data should decline. In short, a simpler point-of-sale delivery model should become increasingly viable.

As the heat pump installation market continues to mature, market gains can be locked in via codes and standards, and program resources can shift to focus more narrowly on opportunities such as full phase outs of air conditioners in favor of heat pumps, zonal electrification, and support for those customers in danger of being left behind in the clean energy transition.

G2. Independent Embedded Evaluation Approach

In 2021, Opinion Dynamics was selected as the embedded evaluator for both Building Initiative for Low-Emissions Development Program (BUILD) and TECH Clean California Initiative. Embedded Evaluation is based on the principles of Developmental Evaluation as defined by Dr. Michael Quinn. It is an approach to insert evaluation within the program design, implementation, and reporting processes to support evidence-based decision-making as well as informed ongoing decision-making.

Opinion Dynamics uses its Whole Independent Systems Evaluation (WISE™) framework in its TECH Clean California evaluation, which applies a combination of traditional process, impact, and market transformation evaluation methods, starting at the very beginning of the initiative instead of waiting until the end. This approach allows for more timely insights to stakeholders and immediate feedback that the program implementer can leverage to refine the initiative and optimize its outcomes.

Embedded evaluation has provided valuable suggestions for modifications that the implementation team can act upon quickly. For example, rapid feedback enabled the implementation team to troubleshoot application data quality issues with participating contractors. Similarly, timely data collection around baseline costs for gas appliances proved useful for informing both incentive design and policymaking.

Embedded evaluation also enabled real-time participant research that resulted in above-average response rates and more representative samples. Collecting insights from larger sample sizes closer to the time of the intervention provided greater confidence in the validity of the findings and a stronger ability to uncover variations among participants. The evaluator also followed up with customers at multiple points in time, yielding longitudinal data on how customers' perspectives of heat pump equipment change as they gain experience with it. Having robust data is particularly important for pilot programs to inform the most effective strategies for scaling, which aligns with the vision of Senate Bill 1477.

The full array of third-party evaluation results can be accessed via the Opinion Dynamics TECH Clean California Initiative Research Index.

G3. Notes on Data Sources

The data in this report comes from a wide range of TECH Clean California activities and reports completed by the TECH Clean California implementation team and TECH Clean California evaluator, including:

TECH Clean California evaluator reports. The studies included process evaluations conducted with enrolled contractors and property owners who received incented equipment; impact evaluations measuring portfolio-wide energy impacts, peak demand reductions, GHG reductions, and bill impacts; market assessments with general population homeowners and contractors; and evaluations of TECH Clean California's workforce development efforts. These studies and others, including Key Performance Indicator Assessments, and an evaluation of the initiative's pilot and QSG strategy, can be found at https://opiniondynamics.com/tech-clean-california-research-index/.[135]

TECH Clean California implementation team findings derive from an array of published reports covering pilots and QSGs, 16 quarterly stakeholder meetings, three annual reports, and a number of webinars, conference presentations, published program resources, and internal analyses to inform future program design—all of which can be found at: https://techcleanca.com/ . Findings also reflect formal and informal feedback provided by participating customers, contractors, distributors, and manufacturers. In addition, based on the evaluator findings of widespread variability across customers and need to better understand specific project types such as customers with and without existing air conditioning,[136] the Implementation Team developed an internal analysis of project meter-based impacts to inform refinements to program design. The implementation team's internal analyses cited in this report were not independently verified by the TECH Clean California evaluator.

It is important to note that bill impacts were calculated using the rate schedules and magnitudes in place during the first reporting year for each customer, largely during 2022–2023. Utility tariffs continually evolve, and electric and gas rates have experienced significant volatility in the past four years. Thus, these numbers should be used to understand general directionality of outcomes and not a static value proposition. Future analyses will incorporate updated meter and rates data and will more accurately reflect the present moment.

In some cases, there may be some differences in analysis outcomes between the implementation and evaluation teams; because each team had different research purposes, they used different methods and sampling. For example, when conducting energy impacts analyses, the evaluator took a comprehensive program perspective, including all customers and both end uses to assess program portfolio impacts. The implementers analyzed drivers of outcomes to provide granular insights and enable forecasting and thus focused more on customer segmentation. While these findings are

[135] Opinion Dynamics evaluated the TECH Initiative with the exception of the program activities funded by the Self Generation Incentive Program (SGIP), which was conducted by Verdant.
[136] Opinion Dynamics. *TECH Population-based Pathway Impact Report.* November 27, 2024. https://opiniondynamics.com/wp-content/uploads/2025/12/TECH-Population-Pathway-Impact-Analysis-Report-FINAL.pdf

directionally similar, when multiple sources are cited, we attempt to describe the fundamental purpose and differences influencing the various outcomes.

Overview of Initiative Data Streams

Data and analytics have played a foundational role in planning, assessing progress, and driving market transformation. TECH Clean California has produced the nation's first large-scale dataset on the real impacts of heat pump installations. The combination of data on the installed equipment, project, home, and energy consumption has yielded a robust and comprehensive dataset that enables analysis of energy savings, contractor performance, project costs, and demographic and geographic trends. Having objective data and analytics embedded in TECH Clean California operational infrastructure has allowed for responsive adaptation to drive success. Embedded data analytics has helped the implementer identify cost drivers and market responses in weeks and months rather than years. TECH Clean California prioritized assembly of three data sets: **Project Data**, **Meter-Based Consumption Data**, and **Evaluation Data**. These data can be combined and utilized to inform program strategy as well as state goals (see Section 3.1 D. Program and Portfolio Design Optimization and Strategies). Insights from TECH Clean California's data analysis have been incorporated throughout this report.

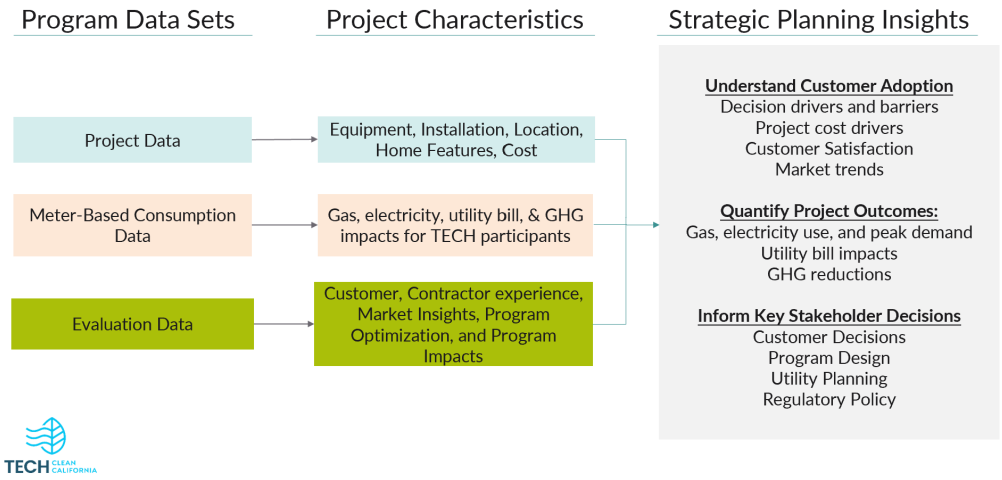


Figure 14. TECH Clean California Data Stream Overview[137]

- **Project Data enables detailed documentation of heat pump retrofit project components and costs.** Energy Solutions' Iris database tracks project data from incentive applications. Capturing detailed project-specific information about costs, baseline equipment and technology specifications for more than 75,000 project installations, the database has

[137] Kisch, Teddy. Energy Solutions; Best, Carmen. Recurve. CPUC Building Decarbonization Workshop Best Practices and Future Pathways Workshop. "Leveraging Data to Inform Building Decarbonization Strategy". January 21, 2026. https://www.cpuc.ca.gov/-/media/cpuc-website/divisions/energy-division/documents/building-decarb/bdworkshop20260121updatev2-pdf.

afforded visibility into project costs, cost drivers, benefits, and market responses to program design changes.

- **Weather-normalized energy consumption data supports advanced targeting and screening strategies to maximize both customer and societal benefits.** CPUC D.21-11-002 established data sharing requirements for TECH Clean California and set clear expectations on data accessibility for program optimization, not just evaluation. Crucially, the guidance supported combining both gas and electric utility metered consumption data to track the fuel switching impacts on both energy sources.

  The TECH Clean California team member Recurve leads meter-data-based targeting and analytics. Recurve's FLEX platform provides weather-normalized calculations of changes in customer energy consumption resulting from heat pump adoption. It has been used for end-use detection (AC and PV presence) and for a granular assessment of baseline usage to inform targeted customer outreach and resource deployment (see Section 3.1 B. Valuing the Customer Benefits of Heat Pumps). Additionally, the platform integrates the aforementioned project data, enabling the implementation team to identify key drivers of outcomes and inform incentive design for TECH Clean California and other decarbonization initiatives, as described in Appendix F: Driver Analysis and the Importance of Site-Level Granularity.

- **Evaluation Data generates a wealth of information, from how TECH Clean California has impacted market assessments to customer and contractor experienced actors across the supply chain.** Repeated surveys with end-users revealed the customer experience with their TECH Clean California contractor and heat pump equipment, identifying opportunities for improvement. Opinion Dynamics' impact evaluation demonstrated GHG reductions, peak demand reductions, as well as energy and customer bill impacts. Surveys and interviews with contractors provided feedback on trainings promoted by TECH Clean California, what contractors learned, and how they applied those learnings on the job. The market assessments measured changes in customer awareness and familiarity with heat pump equipment, and contractor confidence with selling, sizing, and installing heat pumps including differences between the single-family homes and multifamily buildings. Interviews with manufacturers and distributors assessed how TECH Clean California incentives influenced their stocking and production processes. Finally, the Technology and Policy Briefs showcased trends in technology advancements and summarized relevant policies affecting manufacturers and equipment performance.

Appendix H. Program Simplicity Case Studies

H1. Case Study: Demand Flexibility Requirements for SGIP Heat Pump Water Heater Program

Align program requirements with the capabilities of the installed technology, while maintaining program simplicity. The SGIP Heat Pump Water Heater program required incentivized water heaters to function as grid resources by shifting load from peak to off-peak periods. In addition to requiring set up of JA13 TOU controls for load shifting, projects were also required to have customers enroll in demand response programs and verify participation in TOU rates.

Self-Generation Incentive Program Heat Pump Water Heater Program (SGIP HPWH Program)

Key Outcome: ***Load Shifting***

HPWHs are an eligible measure for California's SGIP Program due to their ability to shift load from peak to off-peak time periods. D.20-01-021 established a budget allocation for HPWHs specifically. The SGIP HPWH Program has been implemented under the umbrella of TECH Clean California, enabling the program to utilize the TECH Clean California initiative infrastructure, though the goals and outcomes of SGIP HPWH funding were more narrow and the SGIP HWPH program is evaluated on the reduction in customer peak demand, and direct GHG emissions reductions, among other metrics (California Public Utilities Code section 379.6)

Contractors' ability to describe demand flexibility requirements to the customer requires subject matter expertise and administrative effort.[138] Contractors experienced confusion around requirements to participate in distinct "demand response" *and* "load shifting" programs.[139] When the requirement for participants to enroll in a water heater load shifting program (in addition to an event-based demand response program) was added after launch, a separate "water heater rewards program" category was created for program communications to distinguish these programs from event-based demand response. Since load shifting programs are commonly considered demand response programs by the industry, the new load shifting requirement led to confusion and miscommunication. While SGIP Heat Pump Water Heater provided a wealth of information on its numerous requirements via online program resources and webinars, the volume and intricacies of the requirements

"Demand Response" programs call for adjustments in energy use in response to prices or to support grid reliability.

"Load Shifting" programs shift energy use on a recurring basis, for example, from peak to off-peak times

[138] Upcoming Interim Evaluation Report for SGIP HPWH [not yet published] by program evaluator Verdant

[139] D.23-12-004 requires SGIP HPWH customers enroll in both a CAISO market-integrated *demand response* program and a *water heater load shifting* program. All stakeholders expressed confusion regarding the demand response program being unrelated to the water heater, and some customers attempted to connect their HPWH to OhmConnect instead of the water heater load shifting program.

necessitated one-on-one email and phone support for participating contractors to identify and resolve points of confusion.[140] Both the TECH Clean California implementer and evaluator have received contractor feedback asking to simplify the application process and program complexity has negatively impacted contractor satisfaction.[141,142] Additionally, participating contractors ranked "getting the customer to agree to enroll [in a demand response program]" as part of TECH Clean California's requirements (49 percent) and "distinguishing the demand response requirement from the required TOU rate plan enrollment and heat pump water heater TOU scheduling requirements" (47 percent) as the most challenging aspects of demand response enrollment requirement.[143]

On the administrative side, a provision in the CPUC decision required the implementer to confirm TOU enrollment prior to approving applications. This involved back and forth data sharing with the utilities, and this seemingly minor requirement created weeks of payment delays and frustrated contractors. After SGIP Heat Pump Water Heater funds were exhausted, TECH Clean California was able to cease active enforcement of the TOU verification requirement and instead communicate the expectation through program terms and conditions, dramatically reducing implementer and contractor administrative burden, decreasing payment timelines and reducing contractor risk while maintaining the program's demand flexibility objectives.

Focus on the "highest value" requirements to balance program impacts complexity. For heat pump water heaters, the primary mechanisms to support load shifting are JA13 TOU rate-based scheduling functionality and participation in connected water heater load shifting programs, where available. Additional demand flexibility requirements, such as separate "qualified" demand response program enrollment and TOU verification, added significant complexity to the participation process. Future regulation informing program design should emphasize flexibility and alignment with technology capabilities, rather than prescribing detailed requirements in advance.

H2. Case Study: Preapproval and Incentive Reservation

Incentive programs benefit from consistent and stable funding. In the absence of stable funding, transparency of funding status and a reservation system alleviates at least some market concerns. The initiative moved through three distinct phases as we refined our strategy to offer more transparency to market actors and mitigate the effect of funding starts-and-stops on the market.

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[140] This one-on-one support was ranked as the most helpful support resource over two contractor surveys (Summer 2024, 59 responses; Winter 2025/26, 29 responses). More in-depth Summer 2024 survey results are covered in the TECH Load Shifting Pilot Final Report and the Opinion Dynamics *Process Evaluation of the TECH Clean California Initiative* https://www.calmac.org/publications/TECH_Process_Evaluation_Final_Report.pdf. Winter 2025/26 survey results will be discussed in the upcoming Final Evaluation Report for SGIP HPWH [not yet published] by program evaluator Verdant.

[141] Opinion Dynamics. *Interim Process Evaluation: Technology and Equipment for Clean Heating (TECH) Initiative.* November 7, 2022. https://opiniondynamics.com/wp-content/uploads/2024/12/TECH_Interim_Process_Evaluation_Final_Report.pdf

[142] Upcoming Interim Evaluation Report for SGIP HPWH [not yet published] by program evaluator Verdant.

[143] Opinion Dynamics. *Process Evaluation of the TECH Clean California Initiative*. May 2, 2025. https://www.calmac.org/publications/TECH_Process_Evaluation_Final_Report.pdf

- **Phase 1: "First-Come, First-Serve" *(December 2021–May 2023)*:** TECH Clean California initially launched incentives on a "first-come, first-served" basis with no reservation system. Significantly higher demand than expected led to abrupt funding exhaustion. Contractors often made sales assuming incentives were available, only to be left "holding the bag" when the funding was depleted before their claim was processed and paid out.
- **Phase 2: Claim-Based Reservations *(5/2023–11/2024 HVAC; 05/2023–07/2025 Heat Pump Water Heater):*** To provide more assurance to contractors that claims would be paid out, the program allowed "draft claims" to reserve funds. However, since the only required field was an address, and all fields - including the address - could be modified while still reserving the incentive, the system enabled some contractors to submit low-quality or "speculative" claims to secure a "slice of the pie." This system created an inaccurate pipeline and failed to prevent over-subscription in specific funding buckets.
- **Phase 3: Preapproval Reservation System *(11/2024-Present HVAC; 07/2025-Present Heat Pump Water Heater):*** TECH Clean California introduced the preapproval system. By requiring project characteristics upfront, which could not be subsequently modified, the program gained a reliable view of the pipeline across diverse funding buckets (e.g., Equity vs. Market Rate for differing utility territories). This system allowed the team to manage a waitlist and communicate "soft landings" before funding was fully exhausted.

Trade-offs for the Preapproval System: The preapproval system has helped to mitigate contractor frustration at funding starts-and-stops, since TECH Clean California only preapproves claims that we have funding for. However, there are some trade-offs. Because preapproval data fields are "locked" upon submission to ensure more accurate budgets, minor clerical errors (in which a preapproval does not match a claim) can create issues and necessitate manual staff intervention. While the preapproval process is not mandatory to begin an installation, the perceived financial risk of proceeding without a reservation creates a logistical hurdle that disproportionately impacts smaller contractors. The administrative complexity favors larger, resource-heavy firms. The evaluator's contractor survey showed that most contractors found it easy to address needed updates to incentive applications, although 40 percent found it difficult for heat pump water heater applications and 19 percent had trouble for HVAC.[144]

One of the consequences of increased administrative complexity has been the negative impact on incentive disbursal timelines and contractor cash flows. TECH Clean California recommends that contractors pass through the incentive to customers as an instant discount at the time of sale. However, floating funds to customers while waiting for payment from the initiative can create cash flow issues for smaller contracting firms. The approval process and incentive payment timeline can be further delayed if contractors are not aware that their application has been flagged for corrections. The evaluator reported that many contractors expressed dissatisfaction with the long wait times for receiving incentive payments, attributable to payout timelines from three weeks to

[144] Opinion Dynamics. *Process Evaluation of the TECH Clean California Initiative*. May 2, 2025. https://www.calmac.org/publications/TECH_Process_Evaluation_Final_Report.pdf

three months. The evaluator recommended that the implementation team consider ways to expedite the contractor reimbursement process, such as a mobile payment service.[145]

> *"Don't expect contractors to act as bankers until you folks get around to cutting checks. People calling us "where is their rebate?" drove us nuts. It ruins the satisfaction of getting a rebate if clients (or contractors) have to wait more than 2 or 3 weeks for their payment."* ***Participating Contractor***[146]

Program administrators and implementers must consider the impacts that every incremental increase in application complexity has on program participants and balance the potential participation impacts with benefits.

H3. Case Study: Workforce Education and Training

Contractors and their installers are crucial participants in midstream program delivery and central to achieving California's building decarbonization goals. The success of building decarbonization programs ultimately depends on individual installers that are technically proficient in installing heat pumps to avoid quality issues. However, California lacks a consistent statewide framework for verifying installer competency and ensuring installation quality at scale.

A FRAGMENTED LANDSCAPE OF HEAT PUMP INSTALLER TRAINING AND CREDENTIALING

Heat pump installations frequently involve more integrated system considerations than conventional gas equipment replacements, particularly with respect to electrical infrastructure, controls integration, commissioning, airflow optimization, and broader building-system interactions. While California licenses HVAC contractors through the California Contractors State License Board, there is currently no consistent statewide mechanism for verifying individual installer competency in heat pump technologies. Existing certifications and training programs vary considerably across utilities, manufacturers, labor organizations, and other market actors, and often serve different purposes ranging from introductory market awareness to installer-focused technical instruction.

For example, the TECH & ESMAC heat pump water heater training was approved as one of several qualifying training pathways associated with participation in the heat pump water heater contractor pathway. The course functions primarily as a scalable introductory orientation designed to familiarize participants with heat pump water heater technologies, market concepts, installation

[145] Opinion Dynamics. *Process Evaluation of the TECH Clean California Initiative*. May 2, 2025. https://www.calmac.org/publications/TECH_Process_Evaluation_Final_Report.pdf

[146] Opinion Dynamics. *Interim Process Evaluation Technology and Equipment for Clean Heating (TECH) Initiative*. November 7, 2022. https://opiniondynamics.com/wp-content/uploads/2024/12/TECH_Interim_Process_Evaluation_Final_Report.pdf

considerations, customer education topics, manufacturer resources, and program-related information within a standardized virtual webinar format. The training appears well-suited to support broad market awareness and foundational knowledge transfer across a diverse set of market actors, including contractors, distributors, sales staff, and program personnel.

However, some challenges emerge when introductory webinar-based trainings are treated as equivalent to installation-focused training pathways for purposes of contractor qualification or program participation. Apprenticeship programs and manufacturer-led installation training typically incorporate hands-on instruction, applied practice, troubleshooting exercises, equipment setup, commissioning procedures, code application, and competency verification processes intended to support installer-level technical proficiency and field readiness. As a result, different training pathways may serve fundamentally different workforce development functions, despite sometimes being treated similarly within program participation structures.

Although IOUs and various workforce partnerships collectively offer numerous heat pump training courses, these programs frequently differ in curriculum depth, instructional rigor, competency verification approaches, and intended learning outcomes. Many programs effectively support foundational awareness, market education, and participant orientation, but may provide limited opportunities for applied learning, hands-on instruction, or technical competency assessment associated with installer readiness. In addition, training pathways are not always clearly differentiated by participant role, technical background, or desired competency outcomes.

This fragmentation creates several market failures:

- **Information Asymmetry:** Consumers cannot easily distinguish contractors with demonstrated heat pump expertise from those without specialized training or experience.
- **Administrative Friction:** Because licenses and many workforce credentials are held at the company level rather than the individual installer level, working with a credentialled contractor does not guarantee that the individual installer is proficient with heat pumps.
- **Contractor Fatigue:** Contractors and their installers must often navigate a patchwork of training requirements to maintain eligibility across multiple programs and jurisdictions.

LEVERAGING EXISTING CREDENTIALING PROGRAMS

There are several existing credentialing programs that California could leverage to create greater consistency in heat pump installer training and competency verification. Existing credentials such as the HVAC Excellence Heat Pump Installer Credential and the North American Technician Excellence (NATE) Specialty Heat Pump Certification could serve as starting points for broader statewide coordination and recognition.

In addition, portions of the California Contractors State License Board C-20 Warm-Air Heating, Ventilating and Air-Conditioning Contractor and C-36 Plumbing Contractor trade examinations could potentially serve as a foundation for developing an installer-level heat pump credential focused on technical competency, installation quality, commissioning, and code compliance.

RECOMMENDATIONS FOR WORKFORCE ALIGNMENT

Individual-Level Credentialing: Work with the California Contractors State License Board (CSLB) to establish or formally recognize a specialized credential for heat pump installers that is tied to the individual technician rather than the contracting company. This would help ensure that individuals performing installations possess verified competencies in heat pump technologies, commissioning, and related installation practices. Existing components of the CSLB C-20 trade examination could potentially inform development of such a credential.

Curriculum Alignment and Competency Standards: Develop greater consistency across state-recognized heat pump and weatherization training programs through establishment of common curriculum elements, competency benchmarks, and instructor qualification expectations. Standardized competencies could include areas such as electrical panel optimization, controls integration, commissioning, airflow verification, and low-GWP refrigerants.

Tiered Training Pathways and Role Clarity: Establish clearer distinctions among introductory market-awareness training, contractor orientation training, and installer-level technical training pathways. Training programs should clearly communicate intended learning outcomes, target audiences, and whether the course is designed to support general awareness, program participation, or demonstration of field-level installation competency. Introductory webinar-based trainings may serve important market development and awareness-building functions but should not necessarily be treated as equivalent to installation-focused pathways that include hands-on instruction and competency verification.

Cross-Program Recognition and Reciprocity: Explore opportunities to establish reciprocal recognition across state, utility, regional, and manufacturer-supported programs so that installers holding recognized credentials or verified competencies can more easily participate across multiple program pathways. Greater reciprocity could reduce administrative burden for contractors, training providers, and program administrators while improving workforce mobility and consistency.

Appendix I. Opportunities and Challenges of Serving Rental Housing

Supporting rental housing remains an important segment, particularly supporting the emerging portable heat pump market to address. TECH Clean California's Quick Start Grant with 350 Bay Area piloted an approach to give renters control over their energy usage, health, and comfort, while bypassing the need to engage landlords around expensive building upgrades.[147] The pilot deployed window heat pumps and air purifiers as a solution for renters who lack air conditioning to address both extreme heat days and particulate matter (PM) pollution from transportation, industrial activities, and wildfires. The Energy Coalition is also testing a similar approach in Pomona, California, with a full suite of portable heat pumps, electric cooking appliances, air purifiers, portable batteries, fans, and energy management plugs and apps.[148]

- **Current designs of portable heat pumps require professional skill to install. Manufacturers should simplify and improve the window interface to facilitate customer installation.**
- **Programs should plan to provide initial installation assistance and remain available for repairs throughout the project.** Education and ongoing support, from installation through maintenance and operation, are critical to ensuring effective use of these technologies. Programs should plan to provide language-appropriate, one-on-one assistance.
- **Ongoing support from trusted, well-established community groups is essential for low-income communities to ensure the long-term success of clean energy initiatives.**

An ongoing issue when designing future building decarbonization programs is contractor education on panel streamlining and panel organization. Experienced contractors can effectively determine the right size and methods to manage increased load from electrification on an existing panel. TECH Clean California's Quick Start Grant with Franklin Energy and Marin Clean Energy (MCE) found that while participating in the program, "contractor[s] encountered panels with many issues, such as unbalanced loads, different styles of breakers, panel updates for half a panel, or a new subpanel and old main panel. These issues do not necessitate a full panel replacement…[and] can be addressed by rebalancing the load or installing new breakers."[149] Installing new panels or new breakers for participating homes on an individual basis would require significant contractor resources. When

[147] Neish, Laura. 350 Bay Area. Higbee, Emily. Redwood Energy. *Quick Start Grant Final Report: Fast Path to Clean Indoor Air*. September 25, 2024. https://techcleanca.com/documents/5555/TECH_Quick_Start_Grant_350_Bay_Final_Report_v250204_R50VvSK.pdf

[148] The Energy Coalition. "Direct-to-Renter™: An Energy Program for Public Health Equity". BayREN Q2 Forum. June 10, 2025. https://www.bayren.org/sites/default/files/documents/2025/04_Direct-to-Renter%20-%20BayREN%20Q2%20Forum%20-%20June%2010%202025%20%28final%29.pdf

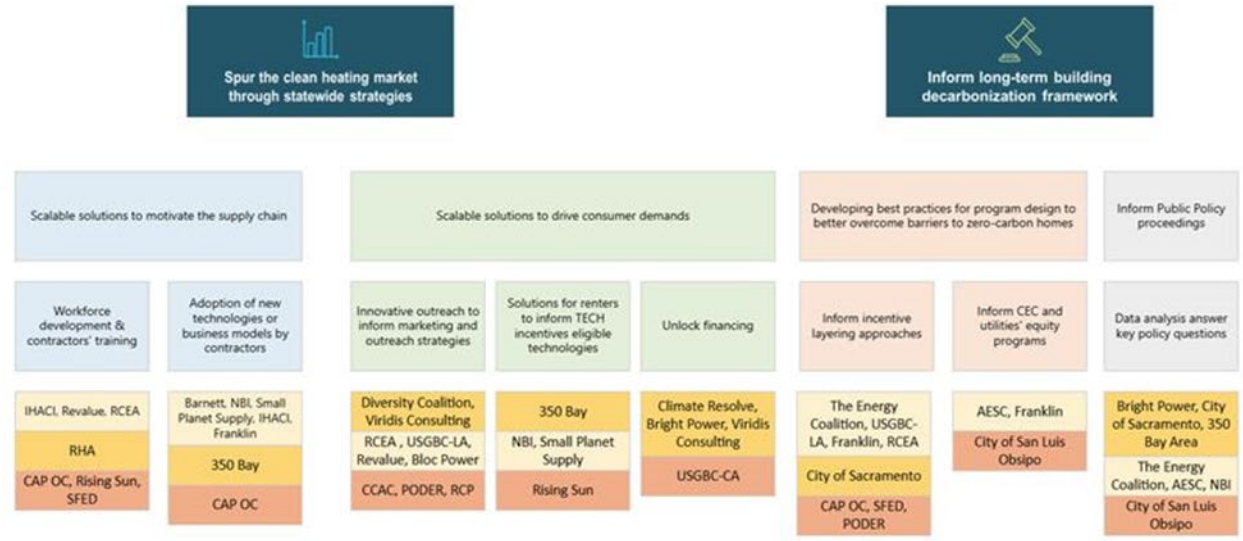
[149] Reyes, Isai A.; Bishop, Brett; and Perez, Eric. Franklin Energy. *Addressing Home Repair Barriers in Marin Clean Energy's Home Energy Savings Program*. August 14, 2024. https://techcleanca.com/documents/5348/Franklin_Energy_-_Final_Report_v240813.pdf

considering the design for future programs targeting rental housing, a more prudent incentive to incorporate would be for participating contractors to supporting work that could best be defined as "circuit work/repair". This "circuit work/repair" would allow contractors to address issues related to optimizing a home's existing panel without the need to increase project costs by defaulting to installing a new and larger panel.

Appendix J. Best Practices from Pilots and Quick Start Grants

The TECH Pilots and Quick Start Grants (QSGs) were designed not only to test discrete solutions, but to reveal what it takes to run an innovation-focused grant strategy within a statewide market transformation program. Over six years, the challenges and successes of the pilots and QSGs generated lessons about how to structure flexible pilots and grant programs, support project teams, collect actionable data, and design projects with a realistic path to scale. The insights below summarize what worked, what limited impact, and what future innovation efforts should consider building into their design from the start.

Figure 14. Mapping Quick Start Grants to TECH Pillars



J1. Program Design and Administration

Build flexibility into pilot and grant management practices from the start.

- Nearly all pilot and QSG projects needed to adjust their initial scope or direction in response to real-world challenges, including regulatory barriers or delays, shifts in incentives, difficulties with participant recruitment, and other unforeseen obstacles or opportunities.[150,151]

[150] Opinion Dynamics, TECH Clean California Pilots and Quick Start Grant Evaluation. June 4, 2025. https://opiniondynamics.com/wp-content/uploads/2025/07/TECH-Pilot-Evaluation-Report-2025-06-04.pdf.
[151] Kirwan, Desmond, and Seel, Alison. VEIC, *Quick Start, Lasting Impact: Lessons from the TECH Clean California Quick Start Grant Program*. https://techcleanca.com/documents/5640/Quick_Start_Grant_Final_Pilot_Report_v250626.pdf. June 11, 2025., 20.

- Program administrators should expect implementation challenges and establish clear processes for pilot or grant teams to adjust scope, timeline, or strategies, including:
    - Clear reporting obligations
    - Processes to document and track changes
    - Flexible contract terms to avoid time-consuming approvals

Build a working relationship with project teams that supports transparency.[152]

- Flexible administration only works when project teams – especially external grantees – feel comfortable sharing challenges early.
- Investing in relationships empowers grantees to be ambitious and candid about progress while administrators retain enough visibility to protect program integrity.
- The program administrator should act as an active partner, not a distant reviewer, to ensure visibility and keep projects aligned with market transformation goals.

Require reporting that produces actionable insights.

- The TECH program evaluation found that inconsistent documentation limited the usefulness of some pilots and QSG for program improvement or scaling. The report notes "missed opportunities to provide insights for course corrections, program improvements, and scaling plans."[153]
- Reporting should require clear hypotheses, matched research questions, and evidence-backed analysis. "Reports should be specific enough that TECH Initiative and other program staff can take concrete actions for both new and existing programs."[153]
- Reporting should distinguish between pre-existing knowledge and insights gained through the project. [153]

Fund the full ecosystem required for electrification.

- Many QSG projects used TECH funding to fill budget gaps—especially electrical repairs and remediation—that other programs did not cover. [154]
- Project funding must extend beyond the electrification measure itself, because without infrastructure support, many households cannot participate.

J2. Implementation and Grant Management

Keep pilots testable and data-driven.

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[152] Kirwan, Desmond and Seel, Alison. VEIC, *Quick Start, Lasting Impact: Lessons from the TECH Clean California Quick Start Grant Program*. June 11, 2025. https://techcleanca.com/documents/5640/Quick_Start_Grant_Final_Pilot_Report_v250626.pdf. 20.
[153] Opinion Dynamics, TECH Clean California Pilots and Quick Start Grant Evaluation. June 4, 2025. https://opiniondynamics.com/wp-content/uploads/2025/07/TECH-Pilot-Evaluation-Report-2025-06-04.pdf. 48.
[154] Kirwan, Desmond and Seel, Alison. VEIC, *Quick Start, Lasting Impact: Lessons from the TECH Clean California Quick Start Grant Program*. June 11, 2025. https://techcleanca.com/documents/5640/Quick_Start_Grant_Final_Pilot_Report_v250626.pdf. 21-22.

- Some TECH pilots and grant projects drifted when scopes changed but the implementing team did not revisit their initial research hypothesis or data-gathering plans. Without a clear hypothesis, teams lost the ability to produce meaningful insights.
- Program administrators should take care that a clear research question and data plan exists after scopes shift.

Look for opportunities to share results and engage stakeholders during implementation, not just at the end.

- The independent evaluator noted that waiting until the end of the TECH pilots to share projects' results and lessons learned created missed opportunities for mid-stream learning: "[p]eriodic dissemination … may accelerate market transformation by making vital information accessible to more people and organizations who support decarbonization. Mechanisms for dissemination to the broader public could include webinars, videos, articles, or other media that make clear what pilots are accomplishing and learning as they go." [155]
- The pilots that had early stakeholder engagement, clear pathways to influence programs, and identified "scaling partners," such as a government agency, ongoing partner program, or utility/CCA, were more likely to expand their impact.
- Especially for multi-year projects like pilots, project teams should engage stakeholders throughout the process, for example with a Technical Advisory Committee or regular communication with identified interested stakeholder groups.
- Both pilot and QSG project teams should consider the audience for the lessons learned through their project from the outset, and design reporting that effectively reaches that audience.

Improve market access with community-based partners.

- Many QSGs were implemented by community-based or local organizations with long-term, trust-based relationships in the communities where projects took place, and deep understanding of the history, interests, and needs of these communities.[156]
- Valuing these relationships expands the reachable population of market transformation programs by identifying barriers, expanding participation pathways, and increasing program legitimacy among households that have been historically excluded by clean energy programs.

J3. Scaling and Strategic Value

Design for scale from day one.

[155] Opinion Dynamics, TECH Clean California Pilots and Quick Start Grant Evaluation. June 4, 2025. https://opiniondynamics.com/wp-content/uploads/2025/07/TECH-Pilot-Evaluation-Report-2025-06-04.pdf. 48.
[156] Kirwan, Desmond and Seel, Alison. VEIC, *Quick Start, Lasting Impact: Lessons from the TECH Clean California Quick Start Grant Program*. June 11, 2025. https://techcleanca.com/documents/5640/Quick_Start_Grant_Final_Pilot_Report_v250626.pdf. 22.

- Pilots should define their scaling pathway up front (i.e. replication, integration into existing programs, or expansion into adjacent barriers).
- This plan shapes data collection, partner selection, and reporting.
- When designing a scaling strategy, pilots can consider multiple approaches to scaling:
- Horizontal scaling (replication in new places or populations, generally to build robustness of evidence for the approach)
- Vertical scaling (changing the practices of existing programs, policies, or institutions)
- Functional scaling (expanding what the intervention does to address adjacent barriers, such as for similar technologies)
- The program administrator has a responsibility to facilitate scaling of promising ideas.[157] This includes:
- Helping grantees develop scaling strategies and identify opportunities for the market transformation program to integrate pilot findings.[158,159,160,161]
- Recognizing that some grantee organizations do not have the resources or capabilities to support a project's scaling pathway and need the program administrator to step in and carry the idea further.

When building a portfolio of pilots or grants, value both targeted and systems-oriented projects.

[157] Opinion Dynamics, TECH Clean California Pilots and Quick Start Grant Evaluation. June 4, 2025. https://opiniondynamics.com/wp-content/uploads/2025/07/TECH-Pilot-Evaluation-Report-2025-06-04.pdf. (Recommending the TECH pilot and QSG program "create a framework or plan for scaling promising approaches uncovered by the pilots.")
[158] Khanolkar, Amruta; Egolf, Mischa; and Gabriel, Noah. New Buildings Institute. *Statewide 120-Volt Heat Pump Water Heater Field Study*. July 27, 2023. https://techcleanca.com/documents/2114/NBI_-_Final_Report_230810.pdf (TECH incorporates incentives for a technology tested through a QSG)
[159] Hatherly, Amanda. Richard Health & Associates. *Creating the Standard: Heat Pump Water Heater Retrofit Best Practices*. September 23, 2024. https://techcleanca.com/documents/5553/RHA_QSG_Final_Public_Report_Review_v250204_w4vCVLU.pdf (TECH staff able to facilitate conversations and connections to increase use of resource developed through a QSG)
[160] Valmiki, MM. ASK Energy. Valenzuela, Keith, and Baroi, Derek. AESC. *Testing Heat Pump Water Heaters in Manufactured Housing*. https://techcleanca.com/documents/5570/AESC_QSG_Final_Report_v250312.pdf (report on manufactured housing barriers referenced to encourage regulatory changes).
[161] Kirwan, Desmond and Seel, Alison. VEIC, *Quick Start, Lasting Impact: Lessons from the TECH Clean California Quick Start Grant Program*. June 11, 2025. https://techcleanca.com/documents/5640/Quick_Start_Grant_Final_Pilot_Report_v250626.pdf, Appendix D (summaries of grant project activities after the grant period).

- Some QSGs delivered quick, low-cost wins (i.e., a field test of a new technology, or a visual field guide to heat pump water heater installation). Others tackled deeper, interconnected barriers like housing quality, program layering, or socioeconomic constraints.[162,163]
- Projects centered on a single product or intervention tended to be lower cost and had a clearer path to scale; projects that sought to create comprehensive electrification strategies were inherently more complex and resulted in fewer installations per dollar invested.[164]
- A comprehensive program strategy values both projects that deliver immediate, measurable outcomes as well as those that foster more gradual, foundational changes.[165]
- Market transformation programs should strive for a balanced portfolio of pilots.[166]
- Quick wins accelerate adoption (i.e., Does this intervention work?).[167]
- Systems-oriented projects reveal why certain customers remain difficult to serve and what must change for durable and equitable market transformation (i.e., What market conditions must change for this intervention to work at scale?).[168]

[162] Rooks, Albert. Small Planet Supply. *Packaged Central Heat Pump Boiler Project*. August 3, 2023. https://techcleanca.com/documents/2116/Small_Planet_Supply_-_Final_Report_230810.pdf (project focused on discrete product)

[163] Kolarick, Sarah; Harohalli, Saurabh; Lasher, Gillian, and Magallanes, Alex. City of Sacramento. Patel, Ravi and Villalpando, Heather. Sacramento Municipal Utility District. *Sacramento Home Energy Equity Pilot*. November 2024. https://techcleanca.com/documents/5459/City_of_Sacramento_-_Final_Report_v241114.pdf (project focused on interconnected barriers).

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