



Opinion **Dynamics**



TECH CLEAN CALIFORNIA: KEY PERFORMANCE INDICATOR ASSESSMENT

PREPARED FOR THE CALIFORNIA PUBLIC
UTILITIES COMMISSION

JULY 18, 2024



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I. EXECUTIVE SUMMARY

The Technology and Equipment for Clean Heating (TECH) Clean California Initiative was developed in response to Senate Bill 1477, passed in 2018. TECH Clean California is designed to advance the state’s market for low-emission space and water-heating equipment for existing residential buildings. As stated in D. 20-03-027, the decision “Establishing Building Decarbonization Pilot Programs,” the initiative is a building decarbonization pilot program “intended to raise awareness of building decarbonization technologies and applications, test program and policy designs, and gain practical implementation experience and knowledge necessary to develop a larger scale approach in the future.”¹

Opinion Dynamics is the independent evaluator for TECH Clean California, researching program impacts, market effects, policy developments, and technology advances. We use our Whole Independent Systems Evaluation (WISE™) framework. The WISE approach allows us to maintain our third-party independent voice as we walk alongside Energy Solutions, the prime implementer for the Initiative, and its team of sub-contractors so that we can infuse real-time evaluation insights into every step of program design and implementation. This approach creates effective feedback loops to help all parties better understand complex market adoption patterns, program strategies' effectiveness, and course correction opportunities. At the outset of TECH Clean California, Opinion Dynamics created a Program Theory Logic Model (PTLM) that documents how the TECH Clean California activities lead to outputs and how those lead to short- and long-term outcomes. Opinion Dynamics also developed key performance indicators (KPIs) to measure the progress toward the outcomes.

This report presents KPIs from the first two years of TECH Clean California – 2022 and 2023. Some are reported quarterly and others annually. They touch on all of the initiative’s activities. Some data for the KPIs comes from Energy Solutions, the prime TECH Clean California implementer, and some of their subcontractors. Other data comes from the public data on TECH's public reporting website, and some KPIs come from Opinion Dynamics’ evaluation activities. As a result of our analysis, we offer the following conclusions and recommendations.

Overarching

Conclusion: The variable availability of TECH Clean California incentives strongly influenced many downstream KPIs, particularly customer activity on the Switch Is On website, and the number of installations. When incentives were available, we saw more program-driven marketplace activity by customers and contractors. Upstream KPIs were more stable and did not vary along with the availability of TECH Clean California incentives; these included manufacturer engagement and public reporting activities.

Recommendation: 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. Many of the emails TECH Clean California developed were about updates to incentives and the amount of incentives remaining. 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.

Marketing, Education, and Outreach

Conclusion: Activity on the Switch Is On website where customers can find electrification incentives, TECH-enrolled contractors, and request quotes aligns with availability of TECH Clean California incentives. In 2023 alone, the number of contractor quotes requested on the Switch Is On site grew from 1,116 in Q1 to 3,024 in Q4. We do not know,

¹ <https://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M331/K772/331772660.PDF>

however, how satisfied customers are with these quotes or to what extent contractors honor those quotes after visiting the home. A total of 14,338 quotes were requested through the site in two years.

Recommendation: We recommend future evaluation assessments with website users who requested a quote to understand their experience of how effectively this website feature allowed them to find a contractor for their project and satisfaction with the quotes. This future work should also estimate how many of these contractor quotes led to a TECH-incentive heat pump project. This investigation can also reveal the extent to which this site is encouraging heat pump installations through other programs. We plan to undertake this assessment as part of the 2024 TECH Process Evaluation.

Supply Chain Engagement

Conclusion: TECH Clean California has engaged more manufacturers and distributors than store retailers. The results of this engagement are unclear, and the TECH team has collected limited sales data from two distributors over two years. TECH has not achieved their goal of obtaining data that allows them to track the sales and stocks of heat pumps in the state due to distributor reluctance to share the necessary data. Moreover, with limited retailer engagement, there may be missed opportunities to influence equipment choices among customers who shop at retail stores.

Recommendation #1: Efforts must be made to track total heat pump distributions in the state to gauge the success of this market transformation program. Though Energy Solutions has not had much luck, other entities in the state may be able to fill in this crucial data gap. One group that may be able to collect and share heat pump sales data is the newly formed California Heat Pump Partnership. Opinion Dynamics will follow this group to see what data they may be able to provide.

Recommendation #2: The evaluation team should work with the implementation team to develop new metrics to measure the progress and accomplishments of CBOs assisting with Disadvantaged Worker (DAW) recruitment. At a minimum, we recommend tracking the number of TECH-enrolled contractors the CBOs recruited that meet the criteria for a DAW.

TECH Clean California Incentives and Projects

Conclusion: The heat pump market in California is still in a stage of development where installations are strongly influenced by the availability of incentives. The KPIs tracking installations show dips and spikes associated with stoppages and re-launches of TECH Clean California incentives. At the same time, project costs also seem to increase with TECH Clean California incentives' availability. It is unclear why the average project costs for both HVAC heat pumps and heat pump water heaters (HPWHs) substantially decreased when TECH Clean California incentives were available in fewer places. Project costs are influenced by a variety of factors including an area's cost of living, cost of labor, and level of competition; the cost of equipment; and the relative size and efficiency of the installed equipment. Our KPI data in this report are unable to disentangle what is driving the variability in costs, and therefore future research is recommended.

Recommendation: Opinion Dynamics' incremental cost study planned for 2024 will investigate the extent to which contractors' pricing practices are influenced by the availability of incentives compared to other factors driving project costs.

Conclusion: Single-family incentives largely went to projects outside of DACs, while multifamily incentives were more likely to go to projects in DACs. Yet, the percentage of multifamily incentives going to DACs was not consistent and largely declined between Q3 2022 and Q3 2023. This analysis does not include TECH funds allocated to DACs through the single-family low-income pilot which funded home remediation projects in support of heat pump installations.

Recommendation: The TECH Clean California team should explore ways to improve the amount of single-family incentives going to DACs.

Conclusion: The TECH Clean California team has increased the number of Program Administrators that participate in incentive layering with TECH Clean California incentives, but gaps remain that limit the true understanding of how heat pump incentives are affecting heat pump adoption in California. The seven Program Administrators TECH has a Memorandum of Understanding (MOU) with are all located in PG&E territory. Without visibility into how customers in Southern California have used other heat pump program incentives, such as those from the Los Angeles Department of Water and Power, we cannot know how incentive layering has influenced customer behavior and market performance.

Recommendation: The TECH Clean California team should make explicit efforts to pursue incentive layering with Program Administrators in SCG and SDG&E territory. If they have made efforts and have been unsuccessful, then they should produce a lessons learned report that describes their approach, the challenges, and what can be learned from their effort.

Customer Satisfaction

Conclusion: Customers' satisfaction with their TECH-enrolled contractors and their TECH-incented heat pump equipment was high. Customers' satisfaction with ductless heat pump equipment was a bit higher than with ducted heat pump equipment. As Opinion Dynamics has reported in our Insights into Customer Experience and Satisfaction Report, it will be important to set customer expectations about their heat pump equipment operation and performance to maintain high satisfaction.²

Financing

Conclusion: TECH Clean California's support of CAEATFA GGH loans to facilitate heat pump projects has been fruitful. TECH's backing of a Loan Loss Reserve fund allowed GGH loans to be offered in parts of the state it was not previously. The amount of loans to TECH Clean California customers increased from \$1.1M in 2022 to \$2.8M in 2023. The amount of GGH-funded projects that received TECH incentives (\$2.8M in 2023), however, is a small portion of total GGH loan volume (\$15.9M in 2023).

Recommendation: We recommend future research to assess how likely customers would have been to purchase the heat pump without the financing and their satisfaction with the loan process through CAEATFA. We plan to undertake this assessment as part of the 2024 TECH Clean California Process Evaluation.

Workforce Education and Training

Conclusion: The TECH Clean California team offered a range of trainings online and in-person. Some trainings were held in high unemployment zip codes, with some of the training attendees also living in those high-unemployment zip codes. Evaluation findings indicate contractors applied what they learned on the job frequently and planned to continue using what they learned in the training at work.

Pilots

Conclusion: The regional pilots encountered challenges leading to delays; some challenges were internal to the pilot teams, some stemmed from fluctuating TECH incentives, and others were from lengthy waits for external data. As such, they have not been able to supply scalable solutions to the TECH Clean California team in a timely manner. The pilots were originally expected to be finalized by June 2023, and none had been completed by the end of 2023. As of this report's publication in summer 2024, only one of the seven pilots has been completed. Some learnings have come out

² The Insights Into Customer Experience and Satisfaction Report can be access here:

https://techcleanca.com/documents/2377/TECH_Customer_Experience_and_Satisfaction_Final_Report_9.15.23.pdf

of the pilots, but the protracted execution of the pilots has led to delays in their assessment and scaling of effective pilot strategies.

Recommendation: Opinion Dynamics' assessment of the pilots as a strategy within TECH Clean California has been postponed due to the pilots not finishing yet. Opinion Dynamics should investigate the value of the pilots to TECH Clean California and make an assessment of whether the pilot activity should be expanded or contracted.

Public Reporting

Conclusion: TECH Clean California's quarterly stakeholder meetings have attracted the attention of hundreds of organizations. The public reporting website had fewer than 300 visitors in 2022, and this number grew to 1,416 unique visitors in 2023. The TECH Clean California team has continued to add customer datapoints and data products as more TECH-incubated projects happen. It is too early to tell whether the public has downloaded datasets and analyzed them to develop insights that can inform policy decisions.

Conclusion: TECH Clean California team members have spread awareness of the TECH Clean California program and its accomplishments at policy forums and conferences. They have also provided comments and created analyses informing policymakers.

2. INTRODUCTION

The Technology and Equipment for Clean Heating (TECH) Initiative was developed in response to Senate Bill 1477, passed in 2018. The TECH Initiative is designed to advance the state’s market for low-emission space and water-heating equipment for existing residential buildings. As stated in D. 20-03-027, the decision “Establishing Building Decarbonization Pilot Programs,” the TECH Initiative is a building decarbonization pilot program “intended to raise awareness of building decarbonization technologies and applications, test program and policy designs, and gain practical implementation experience and knowledge necessary to develop a larger scale approach in the future.”³

Opinion Dynamics is conducting Whole Independent Systems Evaluation (WISE), where we evaluate the initiative alongside, but independently, of the TECH Clean California implementer, Energy Solutions. This position allows us to deliver near real-time feedback to improve program operations. This approach creates effective feedback loops to help all parties better understand complex market adoption patterns, the effectiveness of program strategies, and opportunities for course correction.

At the outset of TECH Clean California, Opinion Dynamics created a Program Theory Logic Model (PTLM) that documents how the TECH activities lead to outputs, and how those lead to short- and long-term outcomes. Opinion Dynamics also developed key performance indicators (KPIs) to measure the progress toward the outcomes. The TECH Clean California Initiative conducts activities that touch on many aspects of the heat pump retrofit market and our KPIs relate to all of the activities. It is important to note that TECH Clean California is a midstream program, which means the incentives are available to TECH-enrolled contractors who offer the incentive to customers. This report is organized by TECH Clean California activity and presents the associated KPIs. The KPIs are intended to help measure progress in how the TECH Clean California activities are leading to the intended outcomes.

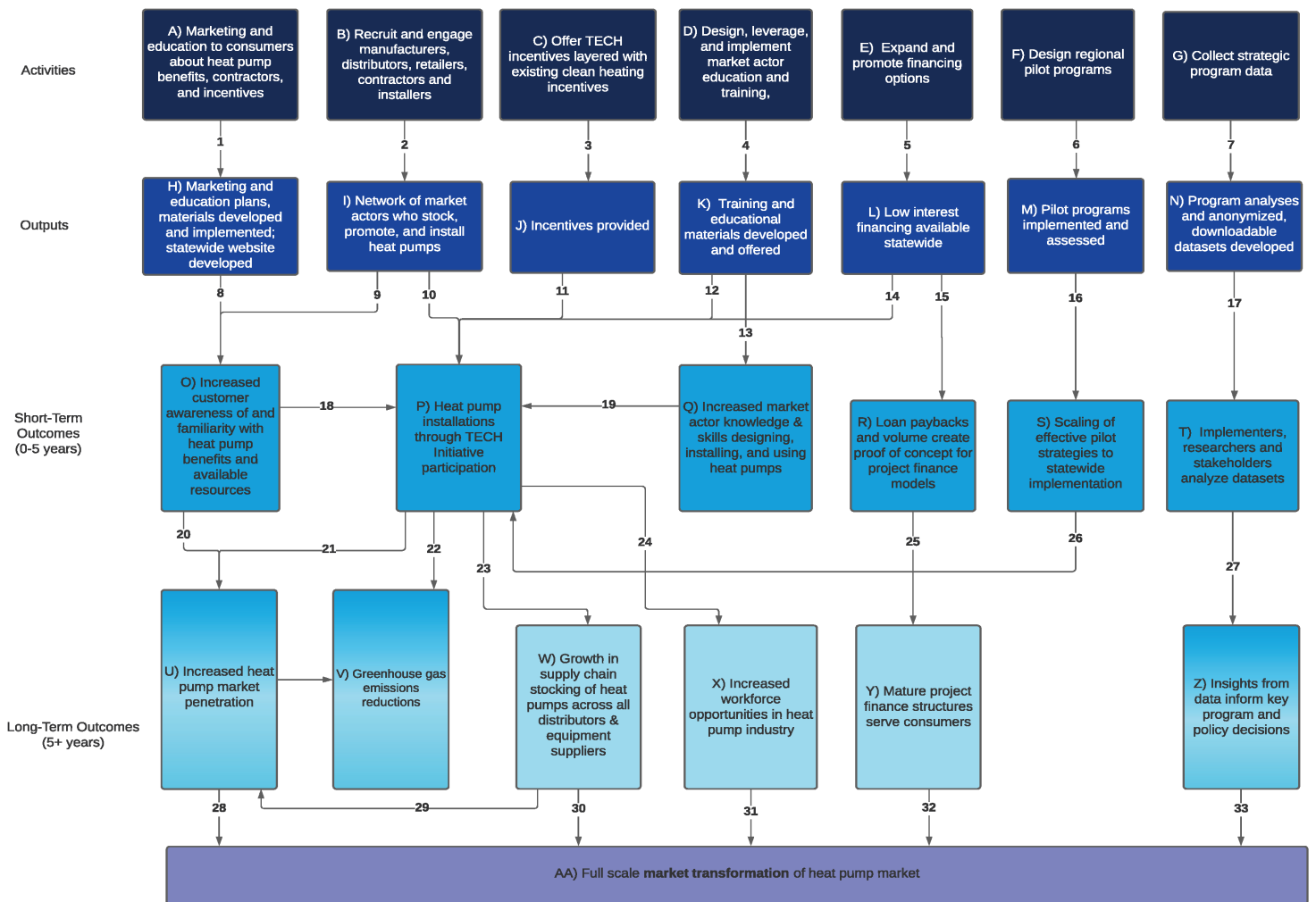
This report presents KPIs from the first two years of the TECH Clean California Initiative – 2022 and 2023. Some are reported quarterly and others annually. They touch on all of the Initiative’s activities. Some data for the KPIs comes from Energy Solutions, the prime TECH Clean California implementer as well as some of their subcontractors. Other data and KPIs come from Opinion Dynamics’ evaluation activities. See Appendix A for a list of topics and data sources. While the TECH Initiative does not have explicit spending goals for Disadvantaged Communities (DACs), they are required by Senate Bill 1477 to engage in activities that serve hard-to-reach customers and customers who reside in DACs.

2.1 PROGRAM THEORY AND LOGIC MODEL

The TECH Initiative was launched in December 2021. Around this time, Opinion Dynamics created a Program Theory Logic Model (PTLM) that documents how the TECH Clean California activities lead to outputs, and how those lead to short- and long-term outcomes (Figure 1). 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 also developed KPIs to measure the linkages.

³ <https://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M331/K772/331772660.PDF>

Figure 1. TECH Clean California Initiative Theory Logic Model



In the beginning of 2024, after two years of the TECH Initiative had elapsed, Opinion Dynamics had the opportunity to assess the KPIs represented in the logic model. This document presents our analysis of how TECH Clean California has impacted the California market for space- and water-heating heat pumps. The TECH Initiative is expected to continue its activities through 2026, and Opinion Dynamics plans to update the KPIs on an annual basis. Some KPIs are measured quarterly while others are measured annually.

2.2 DATA SOURCES

Through discussions with Energy Solutions, we decided the data sources for each KPI. Some of the KPIs are supported by data from the TECH Clean California team, including their subcontractors that manage various aspects of TECH Clean California, and others come from Opinion Dynamics' evaluation activities. Opinion Dynamics, with our subcontractor Jai J Mitchell Analytics analyzed TECH Clean California data to support some KPIs. A list of data sources can be found in Appendix A, and we identify the data source throughout this report.

2.3 TECH CLEAN CALIFORNIA TIMELINE

The TECH Initiative launched in December 2021 with \$120 million in funding from the California Air Resources Board’s Cap and Trade program for gas investor-owned utilities. At the end of March 2022, the TECH Clean California implementation team noticed rapid uptake of single-family incentives. As of April 5, 2022, contractors in SDG&E territory had claimed 67% of incentives available to them. Between the end of April and mid-May, the incentives claimed more than doubled in PG&E territory and nearly doubled in SoCalGas territory. The TECH Clean California team reportedly began checking the incentive budget twice daily to stay informed of how many funds remained. Incentive funds for SDG&E and PG&E territory were exhausted in May of 2022 as were HVAC heat pump funds in SCG territory. Only heat pump water heater (HPWH) incentives in SoCalGas territory remained, as shown in Figure 2. We refer to the initial funding and program structure as “TECH 1.0.”

The California Energy Trailer Bill, or Assembly Bill 179 (Ting, 2022), released on August 31, 2022, allocated an additional \$50 million in General Fund money for TECH Clean California to use beginning in 2023. With additional funding to extend program activities, the TECH Clean California team revised the incentive structure and created new Terms and Conditions for contractors to sign to offer the new incentives. The TECH Clean California incentives funded through this second round of statewide funding became available in April of 2023 and were focused on HVAC heat pumps. As Figure 2 shows, HPWH incentives were still available in SCG territory until July of 2023. We refer to the second funding period that began with HVAC incentives in April of 2023 as “TECH 2.0.” Later, Energy Solutions became the implementer for the Self Generation Incentive Program’s (SGIP) HPWH incentives, which were folded under TECH Clean California to avoid customer and contractor confusion. This newer TECH 3.0 stage includes single-family market-rate HPWH incentives, which became available on October 31, 2023. This ebb and flow of TECH Clean California incentive availability is helpful for interpreting how the KPIs fluctuate in this report.

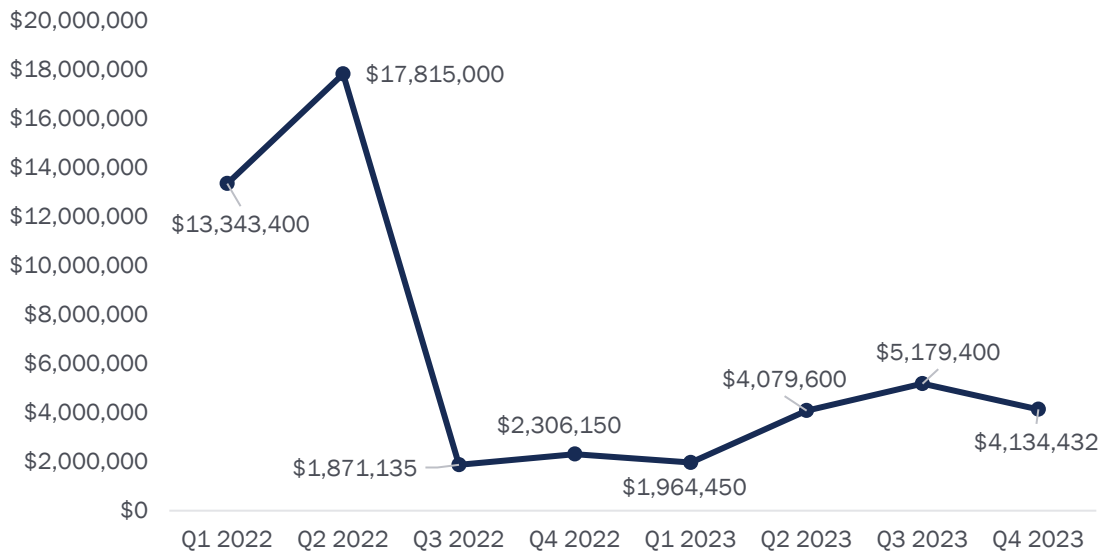
Figure 2. TECH Heat Pump Incentive Availability

IOU Territory	Equipment Type	TECH 1.0												TECH 2.0						TECH 3.0							
		2022												2023						2024							
		Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.
PG&E	HVAC	*															*										
	HPWH	*																					*				
SCG	HVAC	*															*										
	HPWH	*																					*				
SDG&E	HVAC	*															*										
	HPWH	*																					*				

★	Incentives launched
▨	Incentives ran out
□	No incentives available

Figure 3 shows the dollar amount of heat pump incentives issued by TECH each quarter between 2022 and 2023 for both single-family and multifamily projects. The spike in incentives in Q2 2022 mentioned above is apparent.

Figure 3. TECH Heat Pump Total Program Incentive Distributions by Quarter



3. MARKETING, EDUCATION, AND OUTREACH

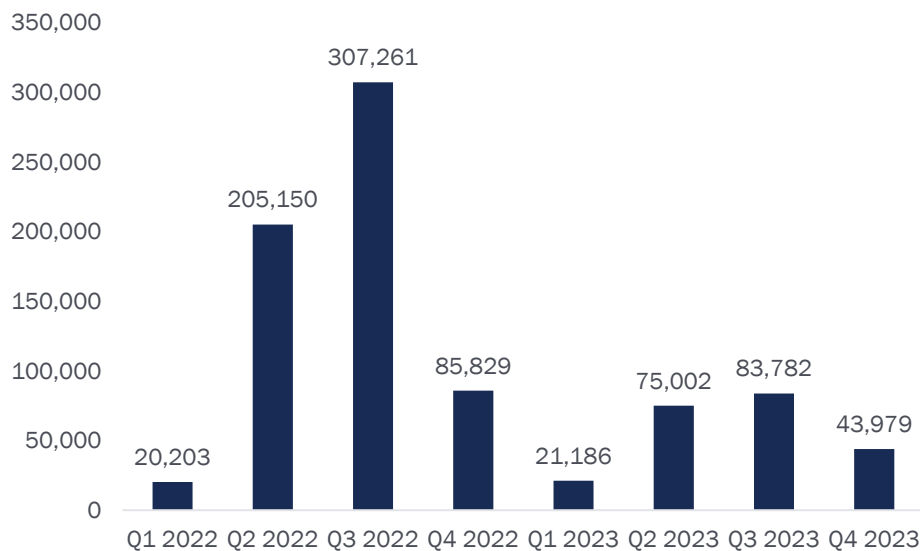
TECH Clean California uses the Building Decarbonization Coalition (BDC)'s Switch Is On website and consumer engagement campaign to conduct consumer-facing marketing. The website, switchison.org, serves as a statewide repository of electrification incentive information and resources. It also hosts a "Find a Contractor" tool that customers can use to connect with a contractor in their area who is qualified to offer the incentives. Contractors who have enrolled and taken the TECH Clean California training are specifically noted on the website so consumers can be sure to connect to the TECH Clean California incentives through TECH-enrolled contractors. The Switch Is On marketing and educational campaign is intended to increase customer awareness of and familiarity with heat pump benefits and available resources.

The KPIs we measured for this activity area include:

- # of unique users of Switch Is On; Views of Incentive Resources Page, and contractor quotes requested
- # of TECH-enrolled contractors available for referral on the Switch Is On
- # of marketing materials developed
- # of marketing channels employed

The BDC utilizes the Switch Is On website to promote multiple electrification activities throughout the state, not only the space-conditioning and water-heating heat pumps incentivized by TECH Clean California. Therefore, counts of total users and page views provided by the BDC give a sense of statewide interest in electrification and are not limited to interest in TECH Clean California. The total unique users showed a rapid ramp-up into the third quarter of 2022 and a steep decline in website activity levels in the fourth quarter of 2022 (Figure 4). This activity level corresponds with TECH Clean California installation activities and shows how the gap between TECH 1.0 and TECH 2.0 incentives and promotional activities drives website usage.

Figure 4. SwitchIsOn.Org - Total Unique Users



The total number of views on the incentive resources page follows a similar pattern, reflecting TECH Clean California program activity levels (Figure 5). There were no page views in Q1 2022 because the site was not yet active, and views reached a high point in Q2 of 2022 at 18,644 views. These are total page views, which means that one person could have visited the page multiple times.

Figure 5. SwitchIsOn.Org – Views of Incentive Resources Page

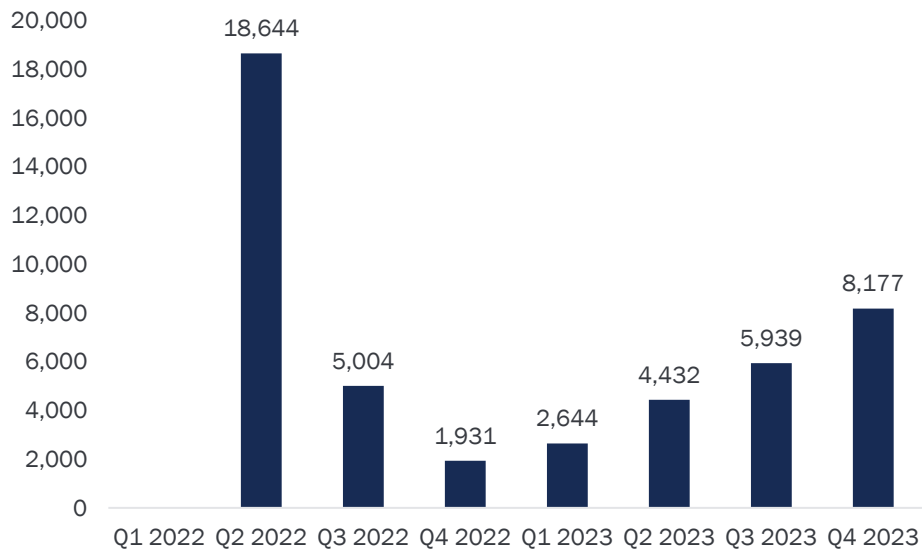
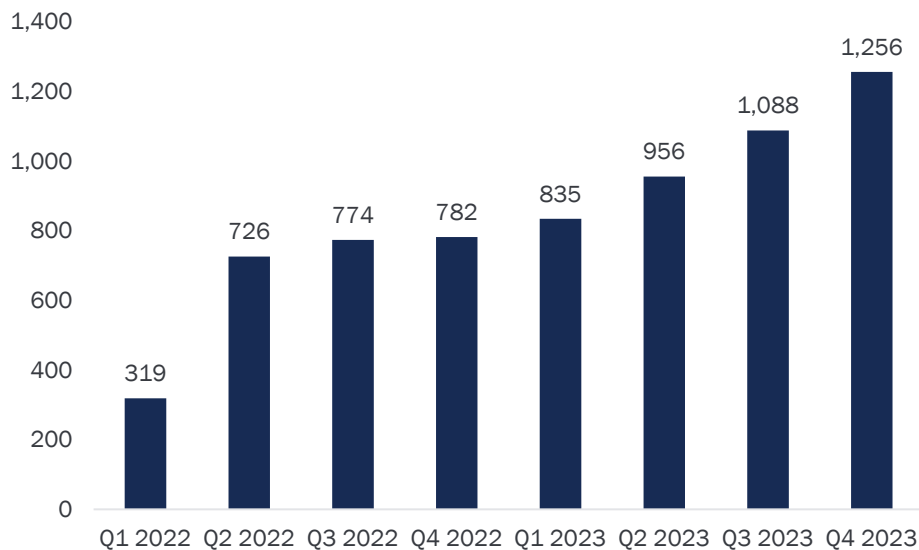


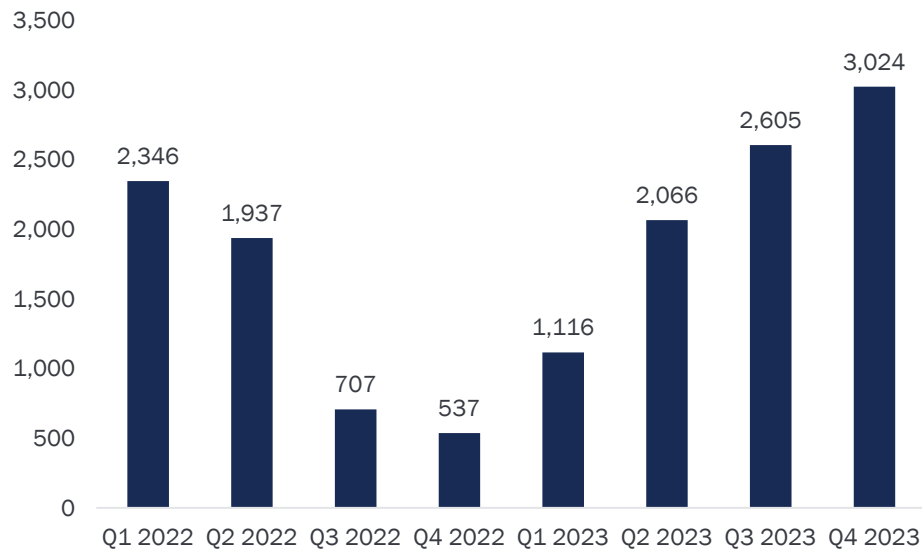
Figure 6 shows the gradual accumulation of approved contractors included in the Find a Contractor tool. California customers can use the tool to find contractors qualified to offer TECH Clean California incentives. Customers can search for contractors by the services they offer, by their location, and by other categories, such as language. According to Energy Solutions, Frontier Energy updates the contractor list on the website every week to remove any contractors that choose to no longer offer TECH Clean California incentives and/or do not re-enroll in TECH.

Figure 6. SwitchIsOn.Org – TECH-Enrolled Contractors Available for Referral



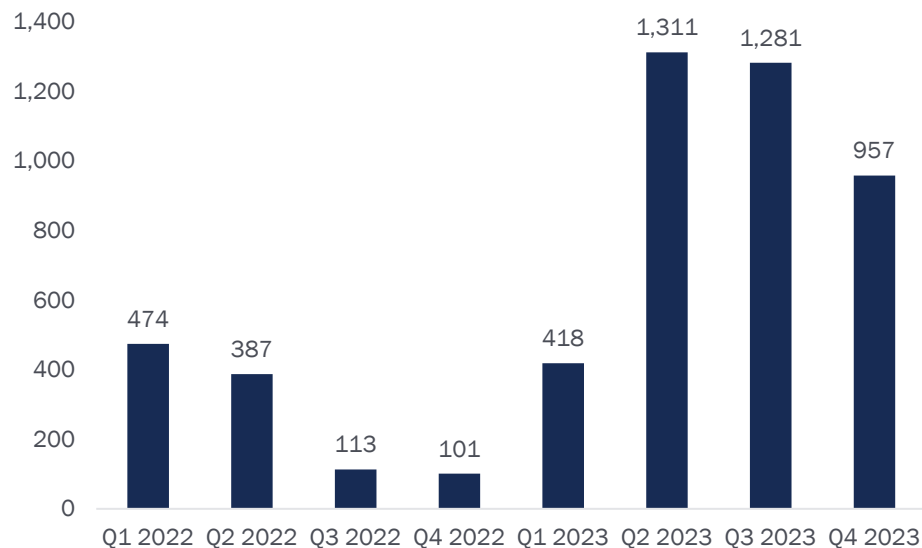
After customers have found contractors on the Switch Is On website, they can request a quote from them by filling out a form. The form asks for contact information, whether the customer is looking for one of four services (Energy Audits, Fresh Air Ventilation Systems, Heat Pump Clothes Dryer, or Heat Pump Water Heaters), and offers a box for optional notes. After filling out the form, the contractor will follow up with the customer to provide a quote. Request a quote activity slowed during the latter half of 2022 when fewer TECH Clean California incentives were available and rebounded after TECH 2.0 began in spring of 2023 (Figure 7). A total of 14,338 quotes were requested across 2022 and 2023.

Figure 7. SwitchIsOn.Org – Contractor Quotes Requested



The Switch Is On website also provides a contractor-facing page called the Training Hub. This page hosts the short training video required for TECH Clean California enrollment and lists free training sessions available to TECH-enrolled contractors through organizations partnered with TECH Clean California. Training Hub page views showed minimal activity during the TECH 1.0 period compared with a large increase during TECH 2.0 (Figure 8). The increase in views in Q2 2023 likely relates to the requirement to enroll in TECH 2.0 when the single-family HVAC incentives were re-launched in April. The high volume of page views in Q2, Q3, and Q4 2023 likely relates to the launch of TECH 2.0 SGIP HPWH incentives.

Figure 8. SwitchIsOn.Org - Training Hub Page Views



In addition to the Switch Is On website, the TECH Initiative developed education and outreach materials for multiple audiences. Energy Solutions provided these data to support the KPI analysis. For TECH contractors, TECH developed training presentations, FAQs, and flyers covering topics such as the Qualified Products List, technical trainings available, program changes, program rules, and incentive suspensions. Materials for the multifamily sector included a training

calendar, emails announcing electrification trainings, a multifamily incentive rules webinar, and FAQs. The TECH Clean California team created webpage content, a flyer, and social media posts about the Quick Start Grants. Manufacturers received quarterly market reports in Q3 and Q4 of 2022. For stakeholders, emails announced webinars for quarterly TECH Clean California stakeholder meetings, the Energy Trailer Bill funding from Assembly Bill 179, workshops, and annual reports. TECH Clean California also staffed a booth at the California State Fair and Orange County Fair in 2023.

The TECH Clean California program used six marketing channels for outreach and education activities. They were the same for both 2022 and 2023. They were:

1. Websites (switchison.org, techcleanca.com)
2. Emails
3. Social Media (LinkedIn, Facebook)
4. Paid Advertising
5. Earned Media (newspaper and media coverage)
6. Community Events (tabling, speaking engagements)

4. SUPPLY CHAIN ENGAGEMENT

As a market transformation program, TECH Clean California’s overarching goal is to increase the volume of heat pumps offered in the state. The implementers planned to recruit and engage manufacturers, distributors, retailers, contractors, and installers to create a network of market actors who stock, promote, and install heat pumps. The role of the upstream market actors is to offer and sell heat pumps qualified for TECH Clean California incentives, while downstream market actors are responsible for the installation of clean space and water heating technologies. The implementer also planned to collect sales data from the manufacturers and distributors.

The KPIs we measured for this TECH Clean California activity area included:

- # of enrolled contractors
- # of high-volume contractors
- # of CBOs assisting with disadvantaged worker recruitment
- # and % of participating contractors who reside in DAC areas
- # and % of participating contractors who service DAC area
- # of disadvantaged worker attendees of a TECH-sponsored training

4.1 CONTRACTOR ENROLLMENT & PROJECT VOLUME

California contractors have to meet license and insurance requirements and sign a participation agreement to enroll in TECH Clean California. Contractors also completed a short training session to learn about customer eligibility and how to complete incentive applications. According to data provided by Frontier Energy, the subcontractor that manages TECH Clean California contractor enrollment, just over 1,000 licensed contractors were enrolled in TECH 1.0 (Table 1). As of February 2024, fewer contractors have enrolled in TECH 2.0. In the TECH 2.0 time period, 349 contractors enrolled to offer the HPWH incentives that became available in October 2023.

Table 1. Contractors Enrolled in TECH Clean California

	TECH 1.0 Dec 2021 – March 2023	TECH 2.0 April 2023 – February 2024
Total Contractors Enrolled	1,105	798
Active Contractors (submitted at least one project)	591	409
Percent Participating of those Enrolled	53%	51%

Table 2 shows the licenses held by the TECH-enrolled contractors as indicated in the Enrollment Report provided by Frontier Energy. There are more licenses listed than contractors enrolled because many contractors hold multiple licenses. For example, a general contractor may also hold a plumbing or electrical contracting license. C-20 HVAC contractors were the most common license held by TECH-enrolled contractors in both TECH 1.0 and 2.0. The number of C-10 electrical contractors with a C-10 electrical license decreased by almost 50% during the transition from TECH 1.0 to TECH 2. It should be noted that TECH cannot enroll a contractor who holds only a C-10 license, so the numbers related to the C-10 license reflect contractors who hold more than one license.

Table 2. Licenses Held by TECH-Enrolled Contractors

License Type	TECH 1.0 Dec 2021 – March 2023	TECH 2.0 April 2023 – February 2024
B-General Contractor	243	204
C-10 Electrical	235	134
C-20 HVAC	986	671
C-36 Plumbing	272	250

The TECH Initiative sought to develop high-volume contractors who have converted their business practice to focus on electrification and heat pumps who could serve as a model to other contractors. To identify high-volume contractors, Energy Solutions used the Pareto principle that assumes 80% of installations are done by 20% of contractors. Using that as a guide, they identified the cutoffs as more than 13 HPWHs or greater than 30 HVAC heat pump installations in 2022 and more than 19 HPWH installations and 53 HVAC heat pump installations in 2023 (Table 3). This analysis, however, obscures how concentrated projects are with some contractors. For example, there are six contractors with more than 300 HVAC heat pump installations and six contractors with more than 100 HPWH installations.

Table 3. Contractors with High-Volume of Installations by Product Type

Criteria for high-volume	2022	2023
>13 HPWH Installations	10	--
>30 HVAC Installations	59	--
>19 HPWH Installations	--	12
>53 HVAC Installations	--	41

When we look at the volume of HVAC heat pump and HPWH projects by contractors in each gas IOU territory, we see a fairly even spread among the top 20 contractors selling HVAC equipment, but a different story appears among contractors selling HPWHs (Table 4). Since TECH began, only 15 firms have sold HPWHs in SDG&E territory, accomplishing 60 installations by March 26, 2024. Contractors in SCG territory have sold one-third the amount of HPWHs as contractors in PG&E territory. There have been some highly active HPWH contractors in PG&E territory: The top three HPWH contractors there sold more than 1,000 HPWH while the top three SCG HPWH contractors sold 355 in the same period. We calculated the project counts using TECH Application data from March 26, 2024, that Energy Solutions provided to us.

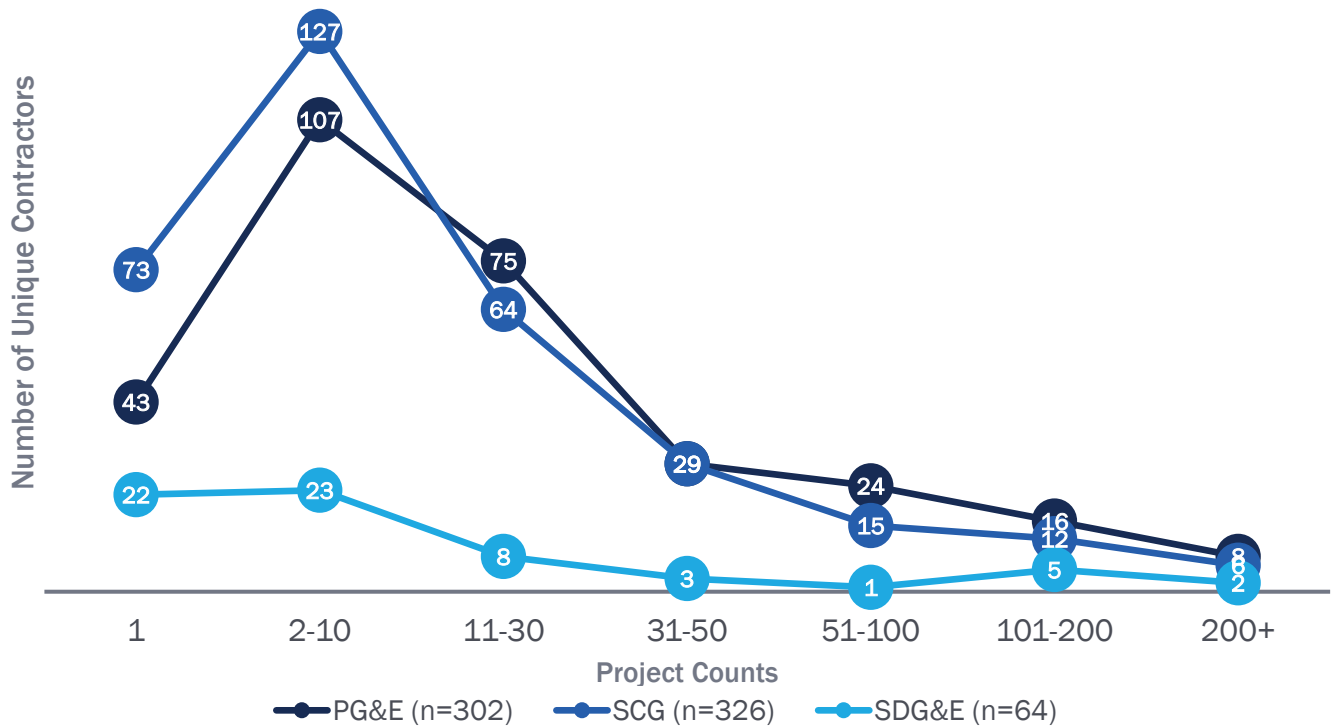
Table 4. Contractor Install Counts by Heat Pump Type and Gas IOU

Top 20 contractors	PG&E	SCG	SDG&E	PG&E	SCG	SDG&E
	HVAC Heat Pump Installs			HPWH Installs		
Contractor # 1	557	720	695	448	161	18
Contractor # 2	465	372	247	339	134	11
Contractor # 3	291	301	186	222	60	5
Contractor # 4	244	291	183	126	36	5
Contractor # 5	240	241	158	76	31	4
Contractor # 6	232	207	157	59	27	4
Contractor # 7	231	199	130	56	19	3
Contractor # 8	201	192	59	54	18	2

Top 20 contractors	PG&E	SCG	SDG&E	PG&E	SCG	SDG&E
Contractor # 9	198	190	47	44	9	2
Contractor # 10	193	165	37	43	9	1
Contractor # 11	192	154	32	42	9	1
Contractor # 12	158	125	29	37	8	1
Contractor # 13	152	124	22	35	8	1
Contractor # 14	152	112	21	33	7	1
Contractor # 15	148	111	17	31	7	1
Contractor # 16	138	111	15	31	7	--
Contractor # 17	136	110	14	30	7	--
Contractor # 18	129	102	14	30	6	--
Contractor # 19	126	98	11	29	6	--
Contractor # 20	126	97	10	27	5	--
Total	4,309	4,022	2,084	1,792	574	60

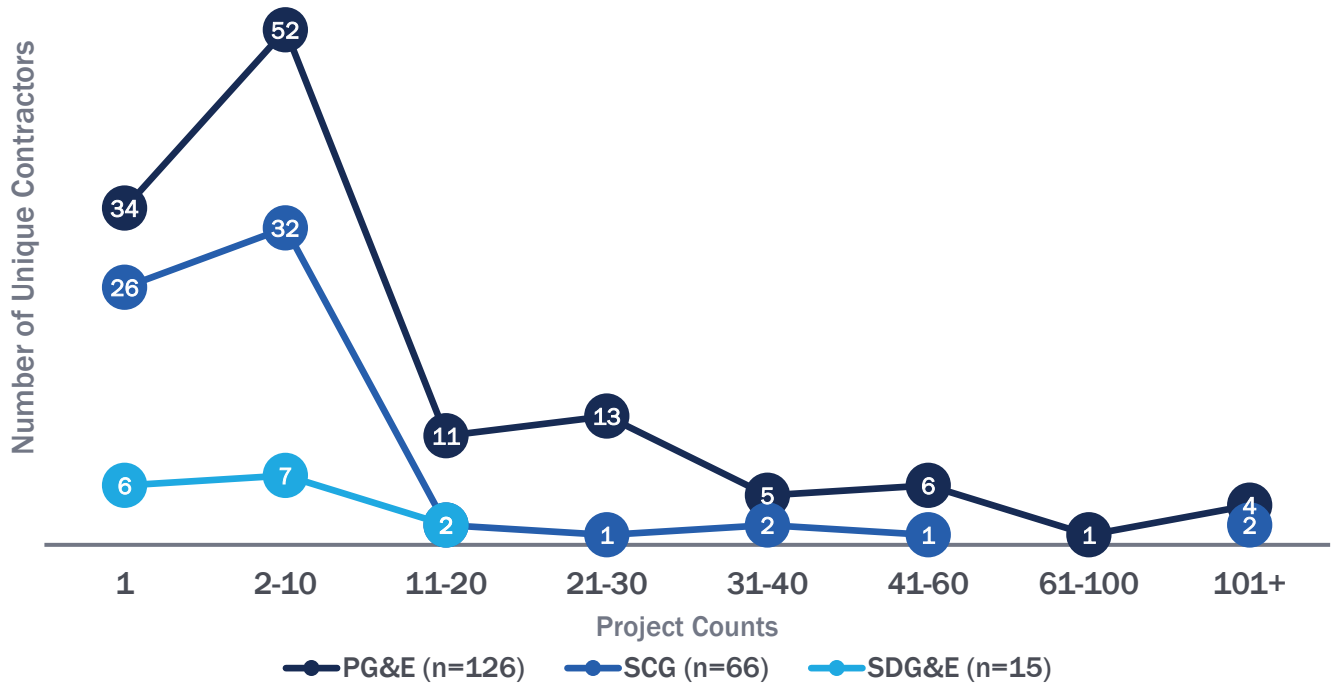
Figure 9 shows that SCG territory had more contractors than PG&E territory with smaller project counts while PG&E had more contractors with higher project counts. While difficult to see in the figure, PG&E had eight contractors with more than 200 HVAC projects and SCG had six contractors with 200+ HVAC projects.

Figure 9. Number of Contractors by HVAC Project Counts by Gas IOU



In Figure 10, we can see that PG&E has about double the number of HPWH contractors as SCG territory. PG&E territory also has many more contractors with 11+ HPWH installs than SCG territory.

Figure 10. Number of Contractors by HPWH Project Counts by Gas IOU



TECH Clean California engages with Community Based Organizations (CBOs) to recruit disadvantaged workers (DAW) and help them enroll in TECH.⁴ Table 5 shows that the number of CBOs that TECH Clean California engaged for this activity increased significantly from 2022 to 2023. The data provided by Energy Solutions showed that the two CBOs in 2022 trained 28 DAC/Hard-to-Reach Energy Savings Assistance (ESA) contractors. In 2023, the Ortiz Group trained 61 CBOs that recruit and hire within the DAC community. Please note that TECH 1.0 did not have an explicit goal for reaching customers in DACs.

Table 5. CBOs Assisting with Disadvantaged Worker Recruitment

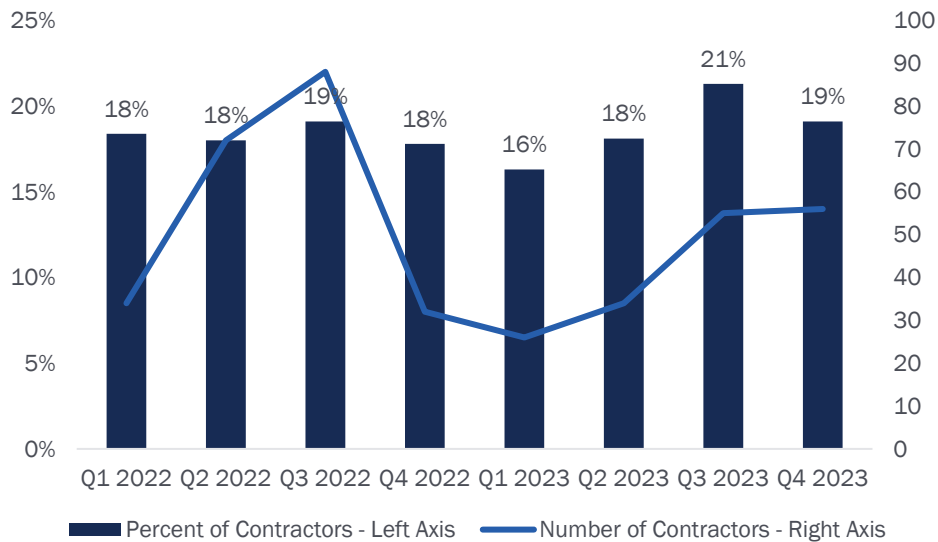
	2022	2023
CBOs Assisting with Disadvantaged Worker Recruitment	2	61

⁴ D.18-10-008 (October 11, 2018), "Decision Addressing Workforce Requirements and Third Party Contract Terms & Conditions", defines a disadvantaged worker as "an individual that meets at least one of the following criteria: lives in a household where total income is below 50 percent of Area Median Income; is a recipient of public assistance; lacks a high school diploma or GED; has previous history of incarceration lasting one year or more following a conviction under the criminal justice system; is a custodial single parent; is chronically unemployed; has been aged out or emancipated from the foster care system; has limited English proficiency; or lives in a high unemployment ZIP code that is in the top 25 percent of only the unemployment indicator of the CalEnviroScreen Tool."

4.2 CONTRACTOR CHARACTERIZATIONS

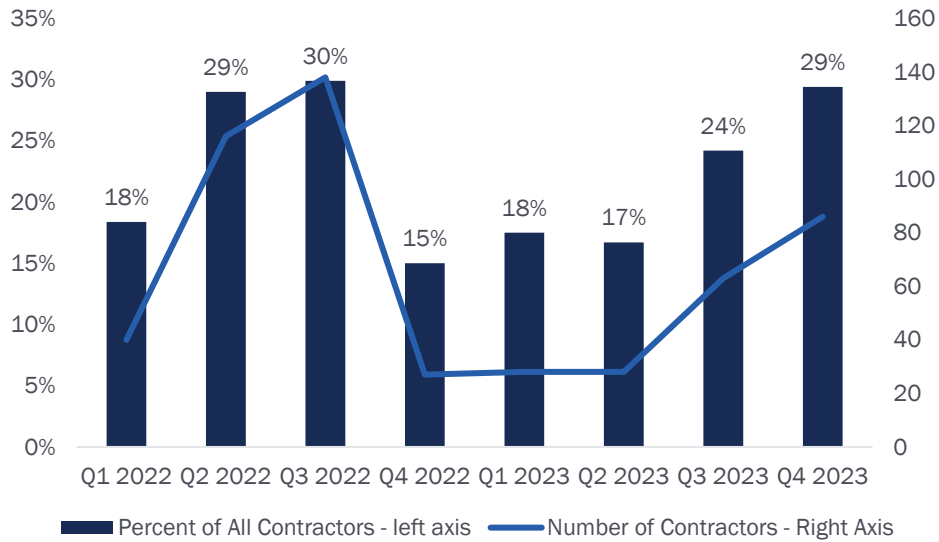
One of the metrics we sought to track was the number and percent of the TECH Clean California participating contractors who reside in DACs. The TECH Clean California team did not have contractors' home addresses and instead used their business shipping address to calculate this KPI. The shipping address is associated with the contractors' business location and is a proxy for where they reside. TECH Clean California also collects the contractors' business mailing addresses. However, mailing address was not used to calculate this KPI because larger companies will have one mailing address for several locations. Hence, the shipping address was the best option to use to determine if the contractors reside in a DAC. About one-fifth of TECH-enrolled contractors had company shipping addresses located in DACs, which held fairly steady over TECH's first two years (Figure 11).

Figure 11. TECH-Enrolled Contractors Whose Shipping Address is Located Within a DAC



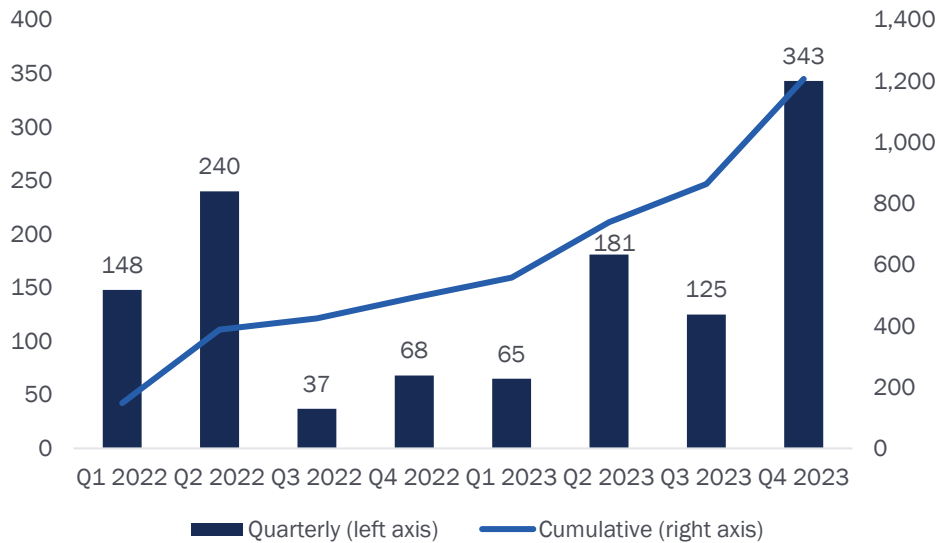
The percent of all TECH-enrolled contractors who completed a TECH Clean California project in a DAC ranged from 15% to 30% (Figure 12). The number of contractors working in DACs increased in the first half of 2022 when TECH Clean California incentives were available in all gas IOU territories. These counts fall after the TECH Clean California single-family incentives became exhausted in most territories. After re-engagement during TECH 2.0 the ratio of contractors serving DACs, as a percentage of all participating contractors, returned to TECH 1.0 levels.

Figure 12. Participating Contractors Who Completed a TECH Project Within DACs



A TECH Clean California goal is to assist disadvantaged workers to achieve increased upward mobility through employment and education. A KPI was established to track the number of training attendees who reside in ZIP Codes identified as high unemployment areas. Figure 13 below shows that the number of trainees residing in high unemployment areas increased significantly in the fourth quarter of 2023. This may be the result of increased CBO engagement for the assistance of disadvantaged worker recruitment that was reported for this year.

Figure 13. Number of Training Attendees who Reside in High Unemployment ZIP Codes



4.3 DISTRIBUTOR ENGAGEMENTS

Distributors are responsible for maintaining inventory and distributing supply from manufacturers to their contractors. Often these contractors operate under exclusivity licenses, receiving training and benefits to install a specific brand of heat pump. At the outset of TECH Clean California, the implementation team intended to collect sales data from distributors to establish a baseline. Per the TECH Clean California implementation plan, their team will “set a sales target for each distributor and provide additional incentives for achieving and exceeding their target. [Distributor]

Participants will be provided with market share reports to drive competition and raise awareness of product uptake among those who are not yet selling many heat pumps.”

The KPIs we measured for this TECH California activity area included:

- # of distributors engaged
- # of distributors providing sales data

Energy Solutions’ Trade Ally Management team established relationships with distributors and held recurring meetings with them. However, most distributors were unwilling to share sales data, despite Energy Solutions’ best efforts and reassurances of data aggregation. As Table 6 shows, the team engaged distributors but did not succeed in collecting sales data. As such, the distributor market share reports have not been produced. In mid-2024, Energy Solutions reported that they plan to request sales data, but with fewer datapoints. The Trade Ally Management team hypothesizes that the longer-standing relationships they have made with distributors combined with a pared-down data request will result in more success in late 2024 and early 2025.

Table 6. Distributor Engagements per Year

	2022	2023
Number of Distributors Engaged	36	45
Number of Distributors Providing Sales Data	0	2

4.4 MANUFACTURER ENGAGEMENT

Manufacturers engagement is a necessary activity for effective market transformation programs. Manufacturers can increase distributor engagements and increase downstream workforce program awareness and program participation. The KPIs we measured for this TECH Clean California activity area included:

- # of manufacturers engaged

An engagement is an interaction on behalf of TECH Clean California to disseminate program information and sometimes interact with the manufacturer for program design feedback. These engagements include in-person meetings, Zoom calls, phone calls, events, and email campaigns. TECH Clean California engaged a similar number of manufacturers in both 2022 and 2023 (Table 7).

Table 7. Manufacturers Engaged per Year

	2022	2023
Number of HVAC Manufacturers Engaged	13	15
Number of HPWH Manufacturers Engaged	5	5

4.5 RETAILER ENGAGEMENT

Retailers are typically the most difficult-to-reach component of the upstream supply chain. Market transformation activities can often miss retailers. At smaller one-off stores, the owners can be reluctant to change their practices and prefer to maintain inventories of what has already been selling in their experience. They are also often quite busy,

engaged with direct customer sales and education and may not be aware of rebates unless they are provided as point-of-sale purchase incentives. At larger chain stores, the decisionmaker may be in a corporate office and difficult to reach.

The KPI we measured for this TECH Clean California activity area was:

- # of retailers engaged

In the face of these barriers, TECH Clean California staff engaged two retailers in 2023 and zero in 2022 (Table 8). Energy Solutions reports that Lowes and The Home Depot were included in email campaigns that provided program updates throughout 2023. Specifically, 156 contacts were made with Home Depot stores located across 29 California counties and 95 contacts were made with Lowe’s stores located across 28 California counties. All of these contacts were at the corporate level.

Table 8. Retailers Engaged per Year

	2022	2023
Number of Retailers Engaged	0	2

TECH Clean California confronts other challenges that make it unrealistic to provide heat pump incentives via retailers. These challenges include:

- The fact that California’s Statewide Plug Load and Appliance Program already provides incentives through retailers for heat pumps, which would be redundant and overlap with the TECH offerings.
- TECH Clean California largely performs verification of heat pump installations through closed permits, and thus needs to engage with the contractor to verify the permit was closed. Offering a customer an incentive via a retailer with their own contractor network prevents TECH staff from being able to see the permits and verify the installations.
- Given that most TECH Clean California customers are replacing natural gas-powered equipment, there are safety issues related to capping the gas lines, and thus it is not safe for customers to install a heat pump in a do-it-yourself manner. Therefore, it is not prudent for TECH to encourage do-it-yourself installations via incentives at retailers.

In light of these challenges, the role that TECH could play in the retailer space is to provide consumer educational materials for display in the store as long as the Plug Load and Appliance program is not already doing so.

5. TECH CLEAN CALIFORNIA INCENTIVES AND PROJECTS

TECH Clean California offered residential incentives for existing single-family properties (1–4 units) for the installation of different styles of HVAC heat pumps:

- Unitary systems are ducted HVAC systems that come in two primary configurations:
 - Packaged Unitary: In this configuration, the compressor/condenser unit and the forced-air unit are combined into a single enclosure. Typically, this package is installed on rooftops.
 - Split Unitary: This configuration separates the compressor/condenser unit from the forced-air unit and is located outside. The separate forced-air unit is located indoors or in a closet and delivers the conditioned air via the duct system to the occupied spaces.
- Mini/Multi-Splits: These are ductless systems and consist of a single outdoor compressor/condenser unit paired with single or multiple indoor fan units or “heads.”
 - Mini-Splits: These systems are designed to serve a single room and a single indoor fan unit.
 - Multi-Splits: In contrast, multi-split systems use a single outdoor compressor/condenser unit but serve multiple rooms using a separate indoor fan unit and temperature control for each room.

The TECH-incented HVAC heat pump is required to replace a pre-existing non-heat pump heating source. The non-heat pump heating sources that are eligible for replacement are propane, natural gas, wood burning, electric resistance, and solar-heated appliances. Furnaces eligible for replacement included but were not limited to, central furnaces, wall furnaces, forced-air furnaces, electric baseboard furnaces, and wood-burning stoves.

HPWHs for single-family homes are similar to typical residential storage water heaters but incorporate a heat pump compressor/condenser typically located on top of the unit and often have slightly larger storage capacity than the typical gas unit to compensate for the relatively lower on-demand heating capacity of the heat pump.

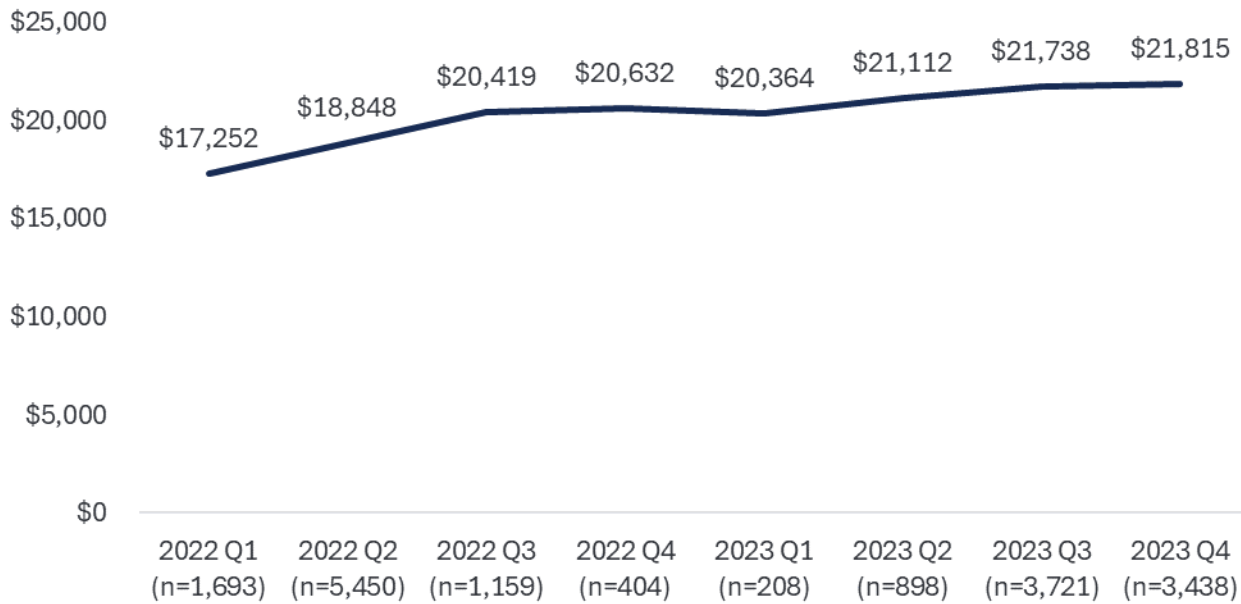
5.1 AVERAGE PROJECT COST

The KPIs we measured for this TECH Clean California area included:

- Average project costs for single-family HPWH installations in and out of DACs
- Average project costs for single-family HVAC heat pump installations in and out of DACs

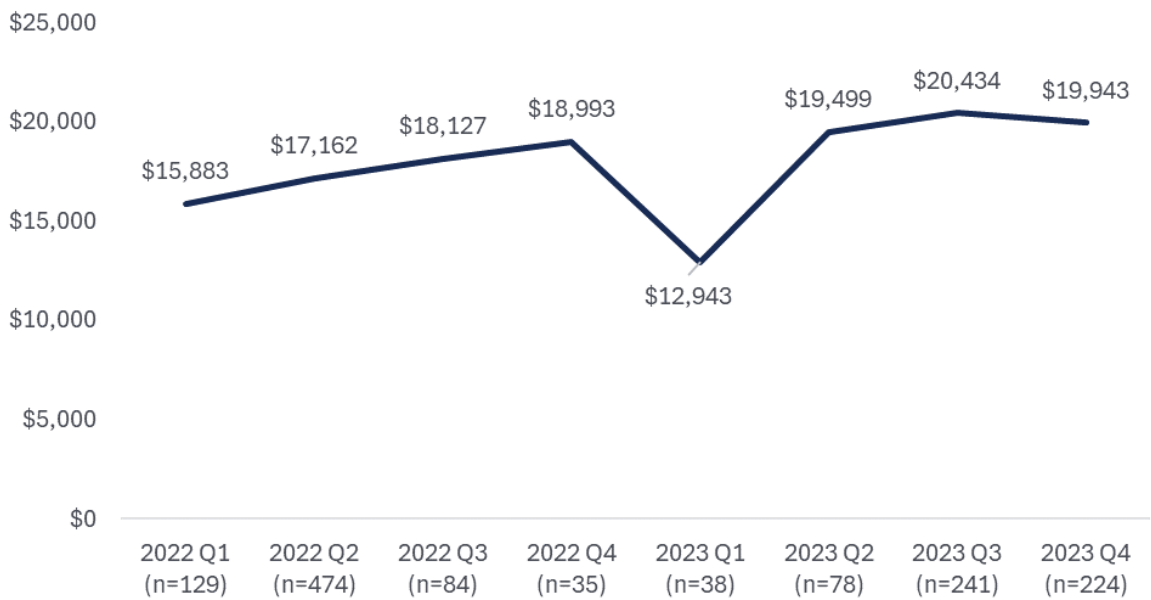
Average single-family HVAC project costs outside of DACs gradually increased over TECH Clean California’s first two years (Figure 14). This analysis takes into account packaged heat pump systems and split systems. Opinion Dynamics calculated these averages from TECH application data provided by Energy Solutions. We summed the total project costs for each quarter and divided that total by the number of projects to calculate the average project cost.

Figure 14. Single-Family Average HVAC Project Cost: Non-DAC



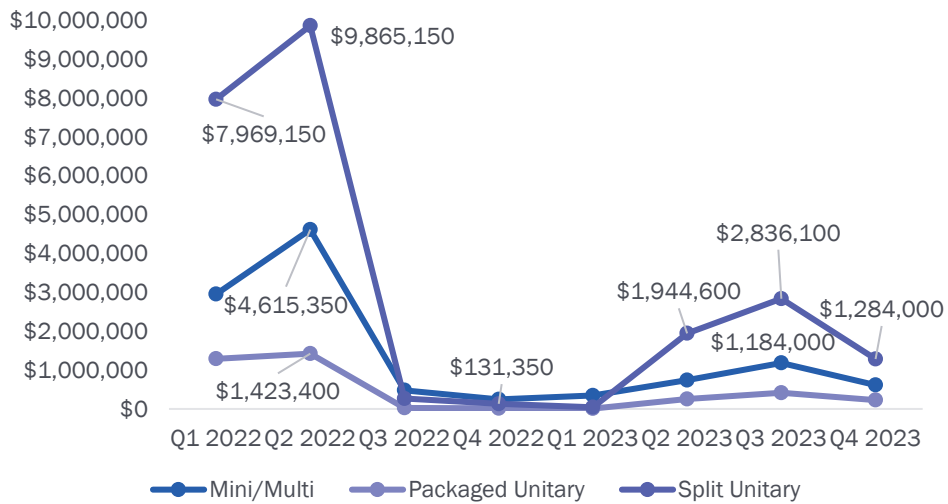
Average project costs of HVAC projects in DACs were slightly lower than those seen outside of DACs (Figure 15).

Figure 15. Single-Family Average HVAC Project Cost: DACs



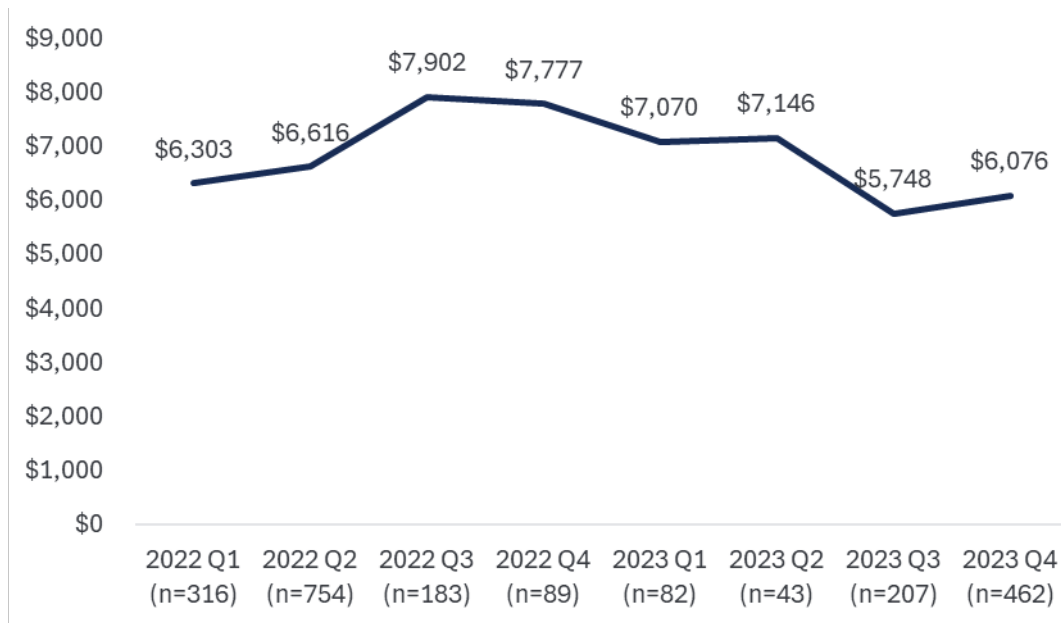
In Figure 16 below, the total amount of single-family HVAC incentives issued by quarter closely aligns with the HVAC incentive availability between TECH 1.0 vs. TECH 2.0.

Figure 16. Total-Single-Family TECH Clean California incentives by Quarter – HVAC



Average single-family project costs for HPWHs outside of DACs ranged between \$5,748 and \$7,902 in TECH Clean California’s first two years (Figure 17). HPWH project costs peaked in Q3 2022 and were lowest at the re-launch of HPWH incentives. Please note that some quarters had relatively few projects compared to others, such as Q2 2023 with only 43 single-family HPWH projects.

Figure 17. Single-Family Average HPWH Project Cost: Non-DAC



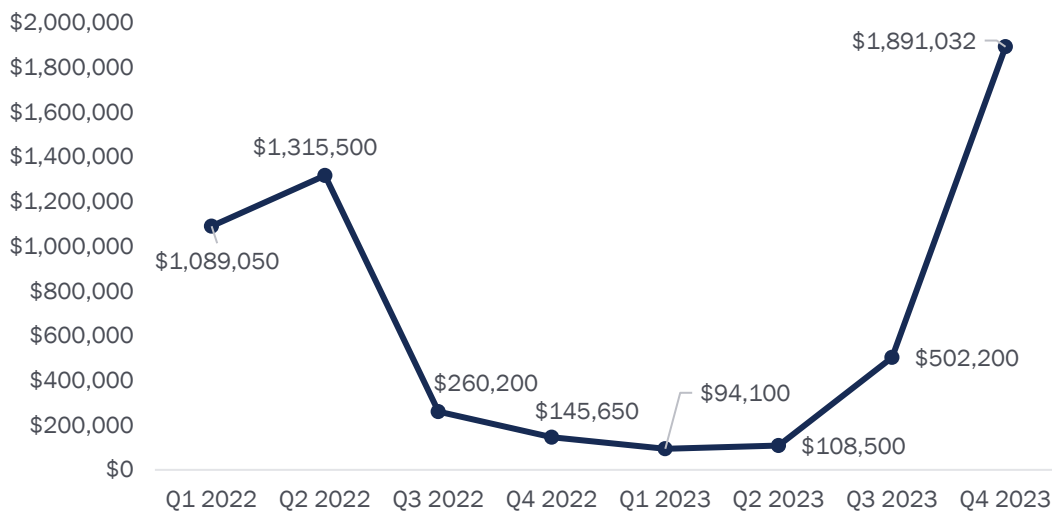
The average project costs of HPWH projects in DACs varied more than they did outside of DACs (Figure 18). This variability is likely due to the small number of projects completed each quarter in DACs.

Figure 18. Single-Family Average HPWH Project Cost: DACs



HPWH incentives going to single-family customers surpassed \$1.3 million in Q2 of 2022, then experienced a decline in the latter half of 2022 and early half of 2023 (Figure 19). They rebounded significantly in Q3 2023 when the SGIP HPWH incentives became available.

Figure 19. Total Single-Family TECH Clean California Incentives by Quarter - HPWH



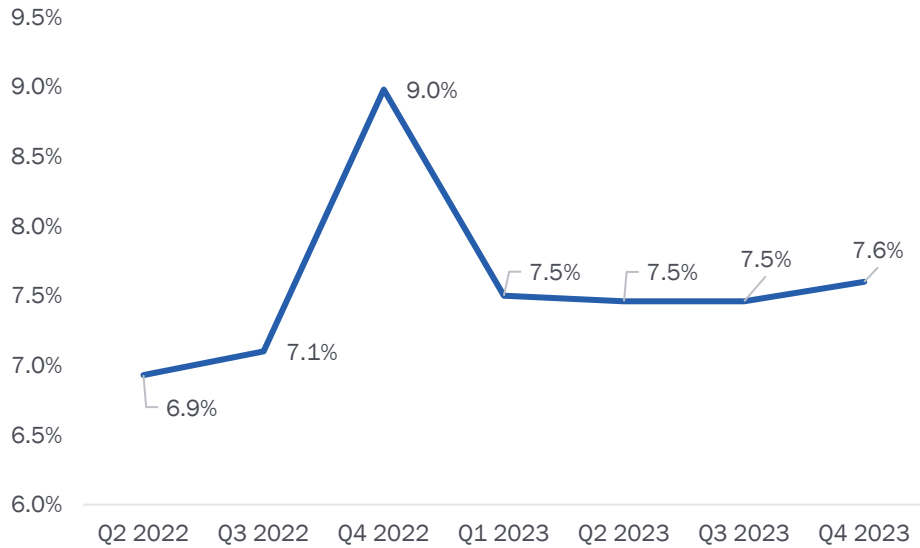
5.2 PERCENT OF INCENTIVES GOING TO DACS

The KPIs we measured in this TECH Clean California area included:

- % of single-family incentives going to DACs in California
- % of single-family incentives going to DACs by HVAC heat pump and HPWH installations
- % of multifamily incentives go to DACs in California

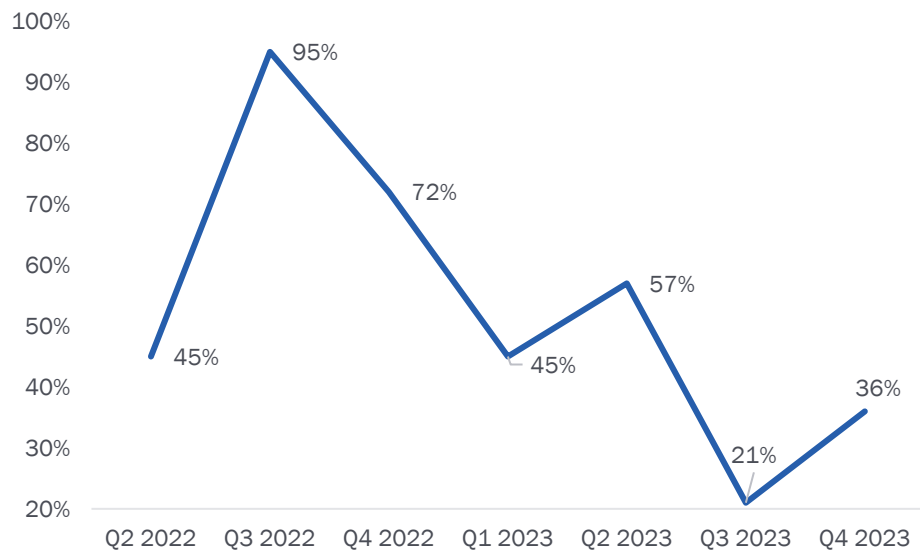
A small percentage of total quarterly single-family incentives went to DACs, never exceeding 9% of all single-family incentives distributed in one quarter. This calculation groups incentives offered to single-family homes regardless of equipment type (Figure 20) and excludes low-income pilot activity.

Figure 20. Percent of All Single-Family Incentives Going to DACs



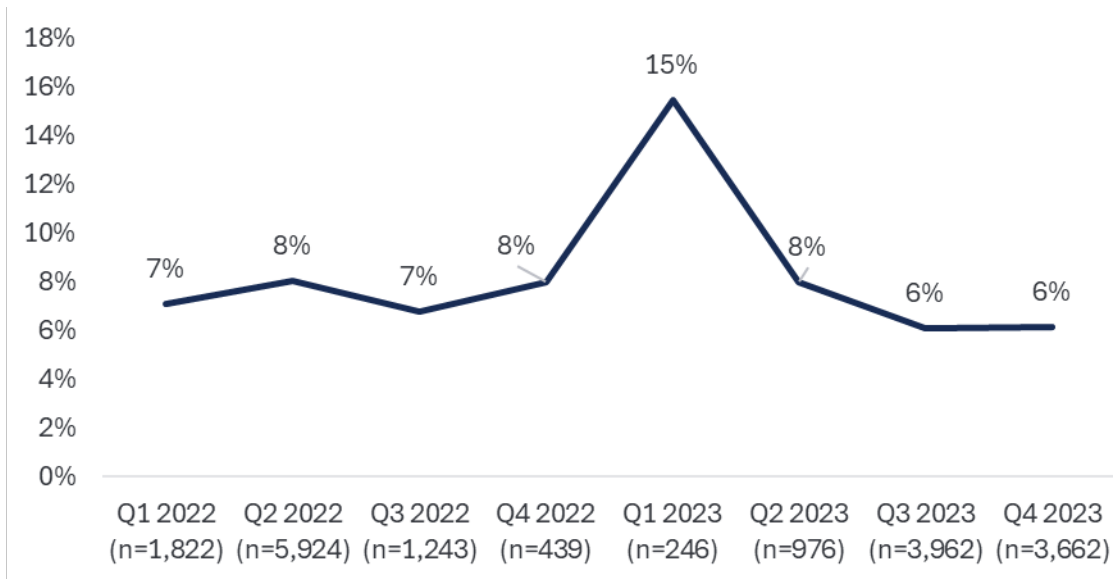
Compared to single-family projects, many TECH Clean California incentives that went to DACs were for multifamily projects. During Q3 2022, 95% of all multifamily incentives were distributed within DACs. This value dropped to 21% in Q3 2023, with a slight recovery in the fourth quarter of 2023 (Figure 21).

Figure 21. Percent of Multifamily Incentives Going to DACs



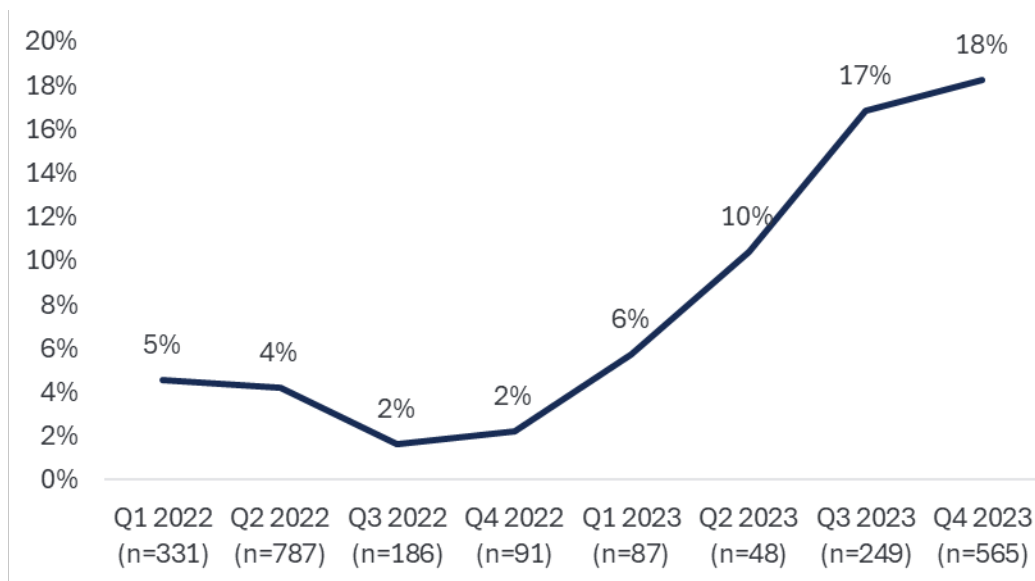
A minority of TECH's single-family HVAC incentives went to DACs, as shown in Figure 22. The peak of 15% reached in Q1 2023 is just 38 HVAC heat pump projects in DACs out of a total of 246 completed that quarter.

Figure 22. Percent of Single-Family TECH Clean California Incentives Going to DACs - HVAC



In 2022, 5% or less of TECH’s single-family HPWH incentives went to customers in DACs (Figure 23). The proportion rose in 2023 to a high of 18% after HPWH incentives became available in Q3 2023.⁵

Figure 23. Percent of Single-Family TECH Clean California Incentives Going to DACs - HPWH

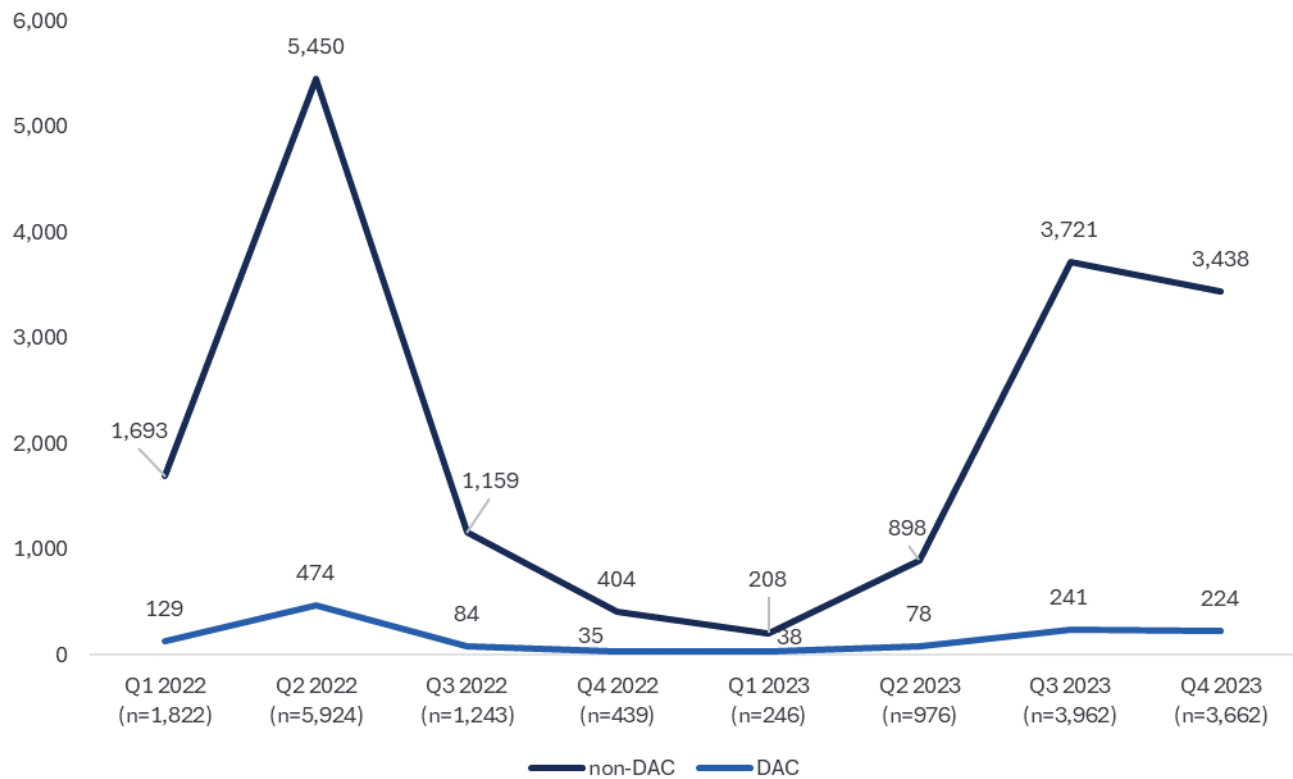


⁵ The SGIP HPWH incentive allocates 50% for “equity customers” but the definition of an equity customer is based on individual household characteristics and not residency in a DAC.

5.3 SINGLE-FAMILY INSTALLATIONS

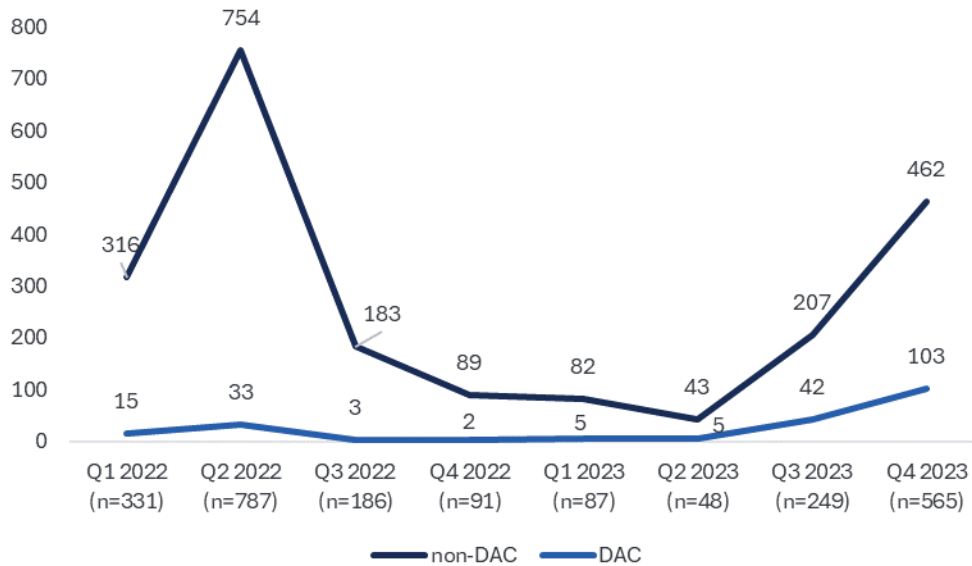
Opinion Dynamics calculated the number of heat pumps installed using application data provided by Energy Solutions. Single-family HVAC heat pump installations tracked closely with the availability of incentives (Figure 24). TECH 2.0 Heat pump HVAC installations in 2023 were at a somewhat reduced level compared to the prior program cycle.

Figure 24. Single-Family HVAC Installation Counts by Quarter and Type



HWPB incentives for single-family homes showed a similar dip in late 2022 and early 2023, aligning with incentive availability (Figure 25). HWPB installs reached a peak in Q2 of 2022 at 787 and reached a low in Q2 of 2023 at 48.

Figure 25. Single-Family HPWH Installations by Quarter



5.4 INCENTIVE LAYERING AND DATA SHARING

TECH Clean California’s incentive structure was designed to encourage layering with other programs incentivizing heat pumps. Layering allows the customer to apply more than one program’s incentive to their heat pump project, increasing the total discount on the heat pump equipment. The KPI we measured related to this TECH Clean California activity was:

- # of separate incentive program administrators with whom the TECH Clean California implementer signs a Memorandum of Understanding (MOU) enabling data sharing and incentive layering

Table 9 shows that the TECH Clean California team increased the number of Program Administrators that share data and layer their incentive with TECH Clean California between 2022 and 2023. Energy Solutions provided these counts.

Table 9. Number of Separate Incentive Program Administrators that have Signed MOUs for Data Sharing and Incentive Layering

	2022	2023
Administrators who participate in data sharing	0	6
Administrators who participate in incentive layering	3	7

The seven Program Administrators that allow incentive layering with TECH Clean California are listed in Table 10. They are all in the PG&E service territory. It is unclear whether TECH Clean California staff have made efforts to engage Program Administrators in SCE and SDG&E territory and/or have been unsuccessful, or whether they have not made efforts.

Table 10. 2023 Partner Program Administrators

Program Administrator	Gas IOU Territory
BayREN	PG&E
City of Alameda	PG&E
Central Coast Community Energy	PG&E
PG&E	PG&E
Silicon Valley Clean Energy	PG&E
Sacramento Municipal Utility District (SMUD)	PG&E
Sonoma Clean Power	PG&E

6. CONSUMER SATISFACTION

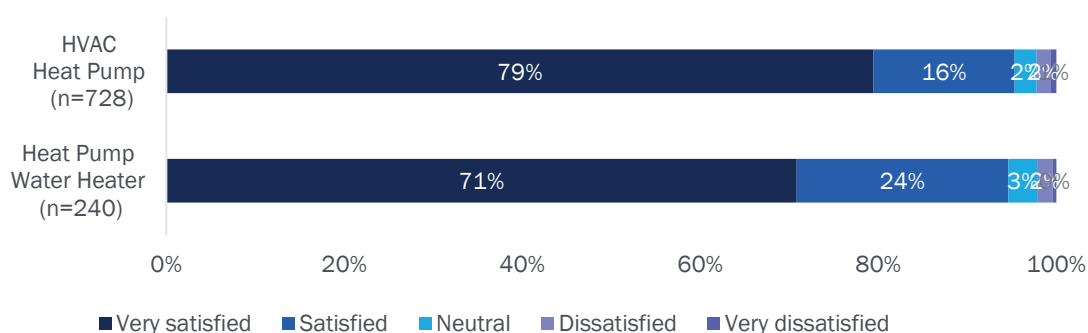
Satisfied customers are likely to share positive testimonials about their experience with heat pump equipment or their contractor. Therefore, maximizing consumer satisfaction is important to accelerating heat pump sales. The KPIs we measured related to consumer satisfaction included:

- Satisfaction with TECH Clean California contractor
- Satisfaction with heat pump equipment performance

Customer satisfaction data comes from the “TECH Clean California Heat Pump Equipment: Insights into Customer Experience and Satisfaction Report” published by Opinion Dynamics on September 15, 2023. The findings in this report come from a survey conducted with TECH Clean California customers who had their heat pump installed and operating for at least six months.

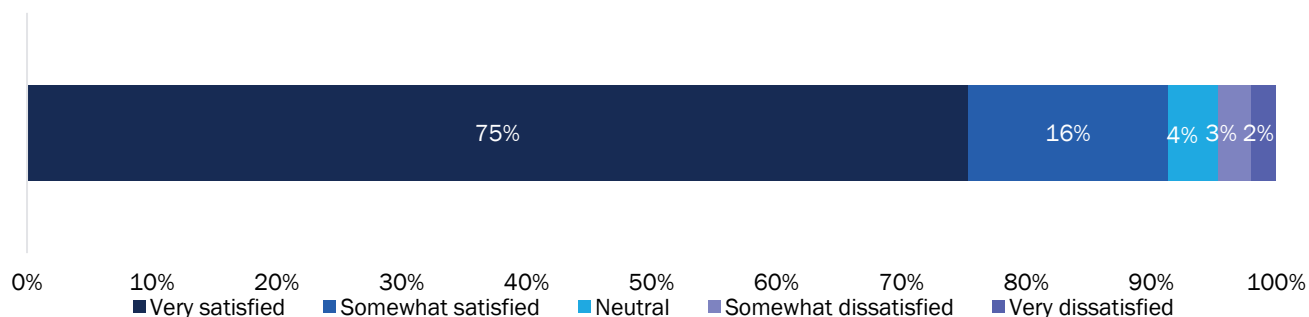
Overall customer satisfaction with their TECH Clean California installation contractors was highly favorable with over 95% of customers surveyed rating their experience as “satisfied” or “very satisfied” (Figure 26).

Figure 26. Overall Customer Satisfaction with TECH-Enrolled Contractor



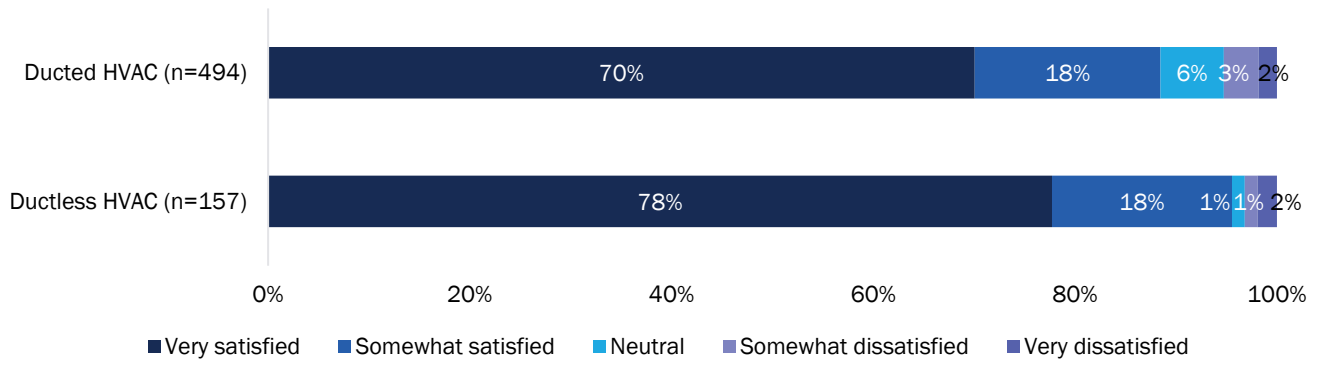
Opinion Dynamics’ survey of TECH Clean California customers indicated very high levels of satisfaction with over 91% of HPWH customers reporting they were “very satisfied” or “somewhat satisfied” with their equipment (Figure 27).

Figure 27. Customer Satisfaction with HPWH (n=300)



HVAC heat pump customer satisfaction differed somewhat between ducted and non-ducted systems with ducted system satisfaction returning a slightly lower proportion of “very satisfied” customers than ductless systems (Figure 28). Overall customer satisfaction with HVAC heat pump units was high.

Figure 28. Customer Satisfaction with HVAC Heat Pump



7. FINANCING

Opinion Dynamics' research with California consumers shows the upfront cost of HVAC heat pumps and HPWHs remains one of the biggest consumer barriers to purchasing a heat pump. Access to financing allows a customer to reduce or eliminate the upfront cost of their heat pump installation. The California Alternative Energy and Advanced Transportation Financing Authority (CAEATFA) GoGreen Home (GGH) Financing program provides low-interest loans to residential customers for energy efficiency and electrification home improvement projects. Prior to 2022, only customers receiving electric service from an IOU could leverage GGH loans. In order to expand the program statewide, CAEATFA partnered with TECH Clean California to fund a loan loss reserve (LLR) for non-IOU home energy projects. This LLR reduces financier risk and allows non-IOU customers to access the same low-interest capital as electric IOU customers.

We measured the following set of KPIs for this TECH Clean California activity area:

- Annual GGH HVAC heat pump and HPWH loan volume
- Annual TECH-funded GGH HVAC heat pump and HPWH loan volume
- Number of TECH-funded GGH HVAC heat pump loans, by quarter
- Average value of TECH-funded GGH HVAC heat pump loans, by quarter

GGH's expansion simplified program eligibility requirements for contractors, helping, in part, to increase participation statewide. Figure 29 demonstrates the substantial increase in total GGH funding between 2022 and 2023 for heat pump projects. Energy Solutions provided the annual figures.

Figure 29. Annual GGH HVAC Heat Pump and HPWH Loan Volume (TECH Clean California + Non-TECH Clean California-Funded)

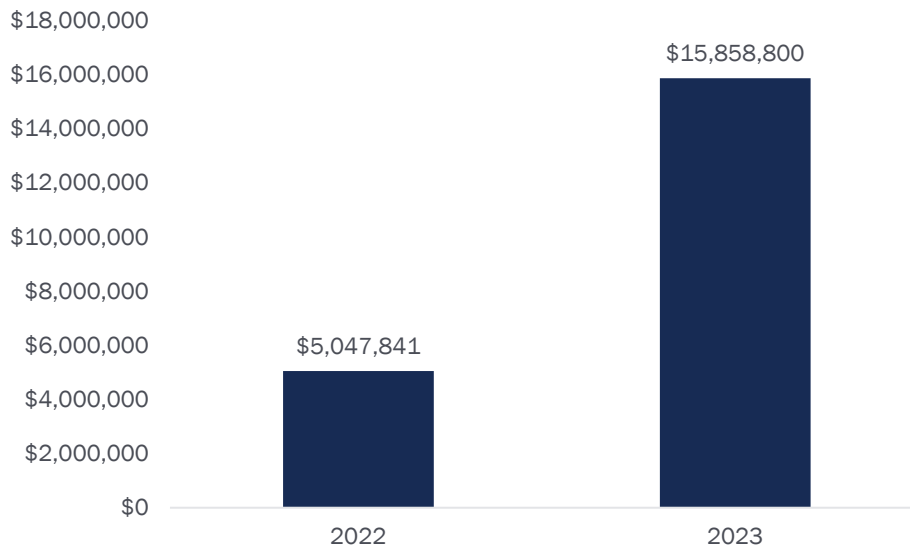
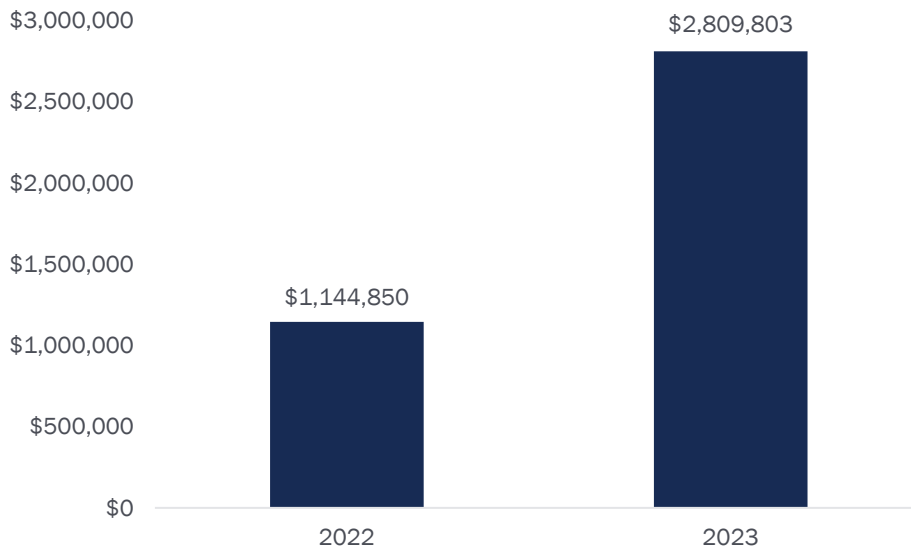


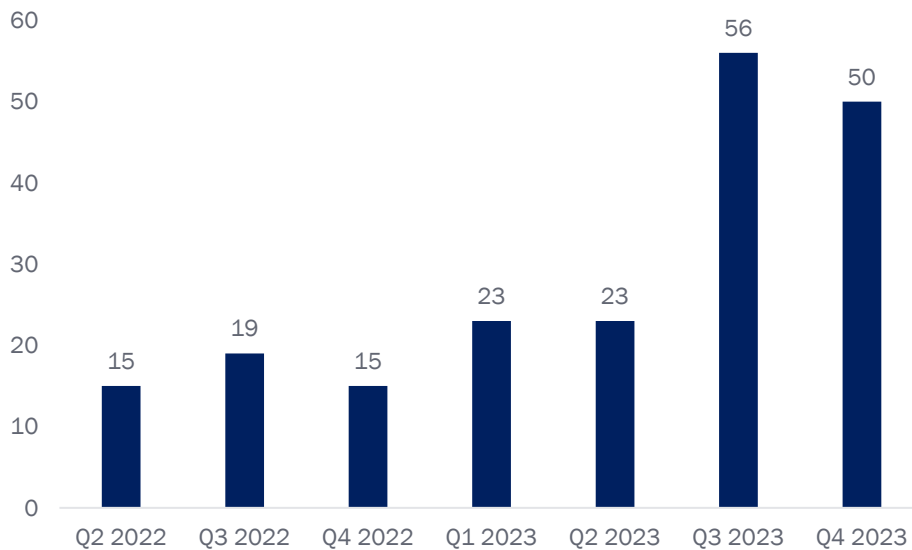
Figure 30 below shows that TECH-funded GGH HVAC heat pump and HPWH projects continues to grow but at a more modest level in proportion to total GGH financing activity.

Figure 30. TECH-Funded GGH HVAC Heat Pump and HPWH Loan Volume



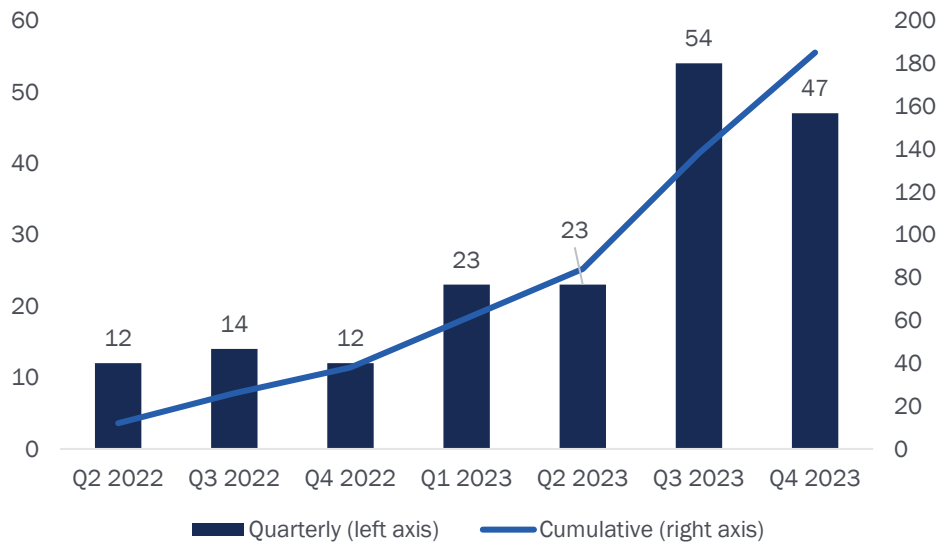
The number of HVAC-only TECH Clean California-funded GGH projects that also received a TECH incentive (Figure 31) is a tracked quarterly KPI. Data provided by Energy Solutions shows a substantial jump in these kinds of financed projects in the third quarter of 2023 compared to prior quarters.

Figure 31. Number of TECH-Incentivized, TECH-Funded GGH HVAC Heat Pump Loans by Quarter



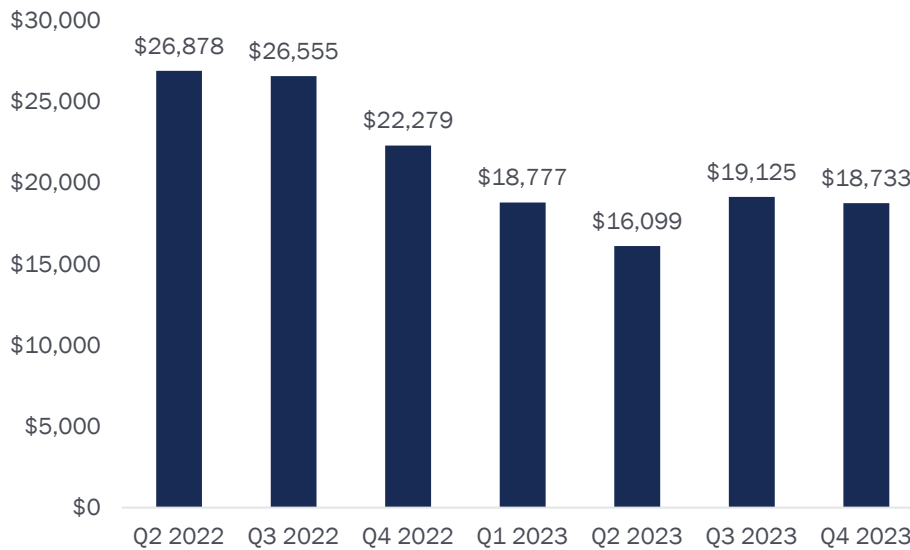
The total number of TECH-funded GGH heat pump projects increased from TECH 1.0 to TECH 2.0. The fourth quarter count declined somewhat compared to the third quarter of 2023 (Figure 32). These are TECH-funded GGH heat pump projects and may have not received a TECH incentive.

Figure 32. Number of TECH-Funded GGH Loans by Quarter



The average quarterly value of TECH-funded GGH projects declined during TECH 2.0 as compared to TECH 1.0. (Figure 33). The figure shows HVAC heat pump loans and no HPWH loans.

Figure 33. Average Value of TECH Clean California-Funded GGH HVAC Heat Pump Loans by Quarter



8. WORKFORCE EDUCATION AND TRAINING

TECH Clean California partners with multiple organizations to offer optional technical and sales training to the enrolled contractors. The training sessions aim to enhance the knowledge and skills of market players in designing, installing, and operating heat pumps, at little or no cost. According to the Program Theory, once the market actors are knowledgeable of and skilled with heat pumps, they will be comfortable specifying heat pumps for their projects, leading to more sales through the TECH Clean California Initiative.

The trainings from the National Comfort Institute (NCI) focused on the technical side of HVAC equipment. Electrify My Home's (EMH) training focused on the contractors' business and whole-home electrification. AEA's trainings focused on heat pump systems in multifamily buildings, covering central and individual systems for space conditioning and water heating. The ENERGY STAR® Heat Pump Water Heater Manufacturers Action Council (ESMAC) offers an introductory course to HPWHs. A description of each optional training offered in 2022 and 2023 follows:

- **NCI Airflow Testing and Diagnostics:** Intended for HVAC contracting firm owners, managers, and technicians, this eight-hour, in-person class provides technical training on performing static pressure testing, how to professionally install static pressure test ports, and how to measure and interpret static pressures.
- **NCI Refrigerant-Side Performance:** This 16-hour long residential and commercial certification class provides students with real-world lessons and hands-on training. It is based on proven techniques on how to best approach refrigeration-side issues. Students learn to apply NCI's performance-based, systematic approach to refrigeration-side diagnostics, including strategies for mitigating non-refrigerant faults prior to attaching refrigerant gauges.
- **NCI Residential System Performance and Electrification:** This 20-hour certification course teaches students how to test, diagnose, and improve total residential HVAC performance. This course features numerous hands-on demonstrations that include how to use the test instruments, proper testing locations, and live testing and interpretation of readings. This class is offered in both in-person and live webinar formats.
- **EMH Residential Space Conditioning and Water Heating Electrification:** Designed for construction trade personnel of all levels, this three-day class informs students of near-term and far-reaching changes in the home building industry and driving forces of such, including California's regulatory and legislative framework. Students gain in-depth knowledge about heat transfer mechanisms, functionality, and benefits of heat pumps in residential electrification, as well as how to transition from traditional gas heating to modern electric heat pumps without negatively impacting their bottom line. This course is conducted in-person in a classroom.
- **AEA Electrification 101 Multifamily:** This 90-minute webinar reviews the benefits of electrification and policy and code considerations. It also provides an overview of what should be considered in an all-electric multifamily project (both new and retrofit), and explores electrification technologies for all end uses, as well as the role of solar PV and electric vehicles.
- **AEA Multifamily Electrician Retrofits and Assessments for Building Professionals:** This three-hour webinar explores how to approach an electrification retrofit, what the constraints and opportunities there are for multifamily buildings with different configurations, and how projects are shaped by electrical infrastructure and available technology. Attendees work through example projects in class.
- **AEA Multifamily Electrification Retrofits for Property Owners:** This two-hour webinar is aimed at educating multifamily property owners about what they need for a successful retrofit project. Attendees learn how to approach an electrification retrofit, what the team can look like, the constraints and opportunities for different property configurations, and how projects are shaped by electrical infrastructure and available technology. Attendees work through example projects in class.

- **AEA Individual Heat Pump Water Heater Installation:** This two-hour webinar is aimed at educating contractors, consultants, and engineers on design considerations for individual HPWHs, particularly for multifamily developments. This course provides an overview of HPWHs, code requirements, and takes a deep dive into design considerations discussing sizing, venting configurations, load shifting, and installation best practices.
- **ESMAC Introduction to Heat Pump Water Heater Education:** In this two-hour webinar, the instructors provide an overview of TECH; an ENERGY STAR® overview; and a manufacturers HPWH education session focused on technology features and benefits, appropriate applications, energy efficiency comparison to other water heater types, installation techniques and best practices, service support and warranty, proper maintenance, troubleshooting, and selling strategies.

The KPIs we measured for this TECH Clean California activity area included:

- # of trainings offered through TECH Clean California and their locations
- # and % of training attendees who reside in high unemployment ZIP Codes
- # of trainings offered in high unemployment zip codes in California
- Scores from post-training surveys

8.1 TRAINING ACTIVITY BY LOCATION

The three organizations partnered with TECH Clean California held 36 in-person trainings, with the activity relatively steady from 2022 to 2023 (Table 11). One-third of the trainings were in Sacramento (12 of 36), but otherwise were spread throughout the state.

Table 11. In-Person Training Location by City

In-Person Training Location City	2022	2023
Los Alamitos	8	0
Sacramento	6	6
Anaheim	0	5
Stockton	1	0
Indio	1	0
Los Angeles	1	0
Monterey Park	1	0
Redding	1	0
San Diego	1	0
Brea	0	1
Chatsworth	0	1
Fresno	0	1
San Leandro	0	1
Santa Rosa	0	1
Total	20	16

In 2023, there were more online training sessions compared to 2022 (Table 12). All of the 2022 and some of the 2023 online webinars were hosted by the Association for Energy Affordability and focused on electrification or HPWH

installations for multifamily properties. The additional online trainings in 2023 were hosted by TECH Clean California and ESMAC, which was an introductory course to HPWHs.

Table 12. Online Webinar Training Sessions by Year

Training Type	2022	2023
Training Webinar/Online	10	36

8.2 TRAINING ACTIVITY FOR HIGH UNEMPLOYMENT AREAS

Training activities that introduce contractor employees and potential future hires to installation practices are one component of the TECH Clean California initiative, including a focus on hard-to-reach populations in DACs.

The number of training events being held in high-unemployment zip codes remained relatively stable for the two periods of TECH 1.0 and TECH 2.0 operations (Figure 34). The first quarter of 2022 saw the highest number of these trainings at eight. A total of 18 trainings were held in these zip codes between 2022 and 2023, according to data provided by Energy Solutions. As shown above, a much larger number of online training events were held in 2023 that may provide easier access to potential attendees who reside in high unemployment zip codes, though this detailed level of personal data were not reported for these events and an online event cannot be linked to a physical location.

Figure 34. Number of Training Events Held in High Unemployment ZIP Codes

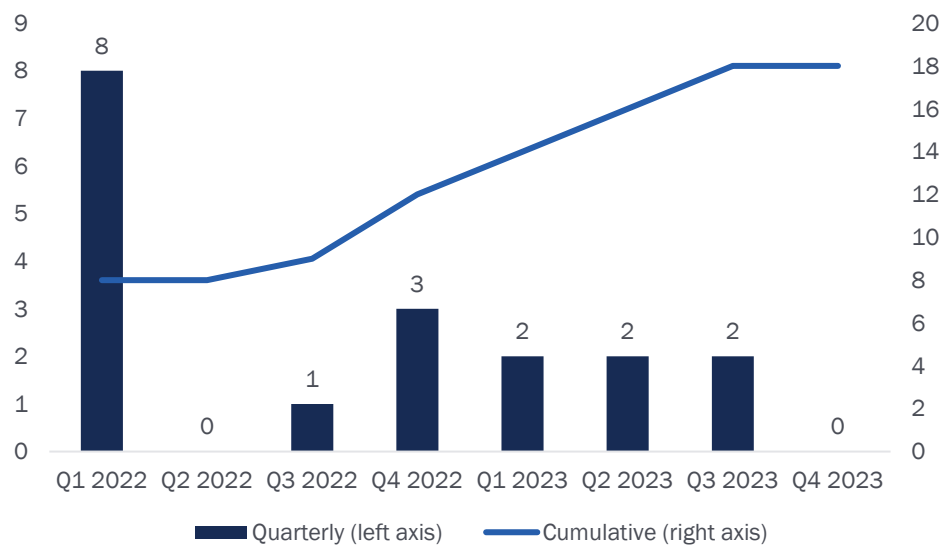
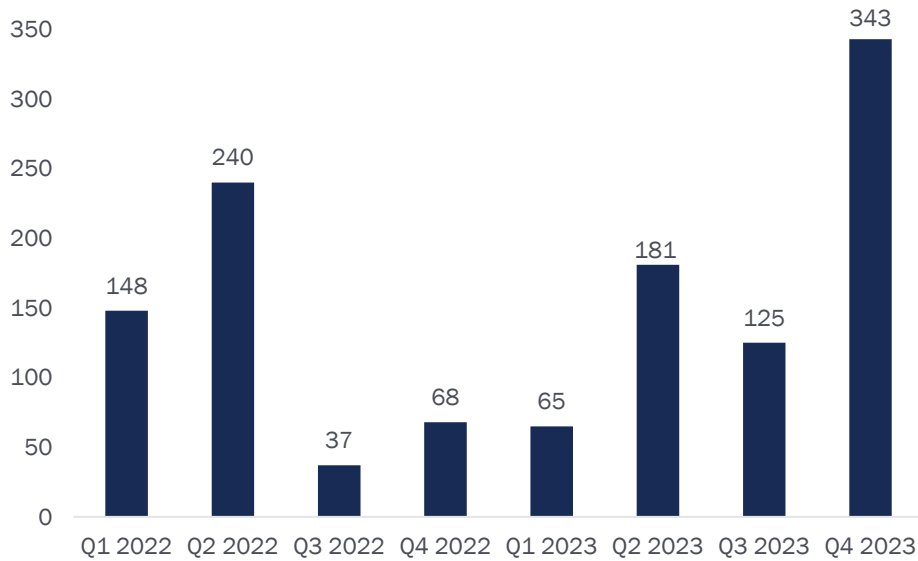


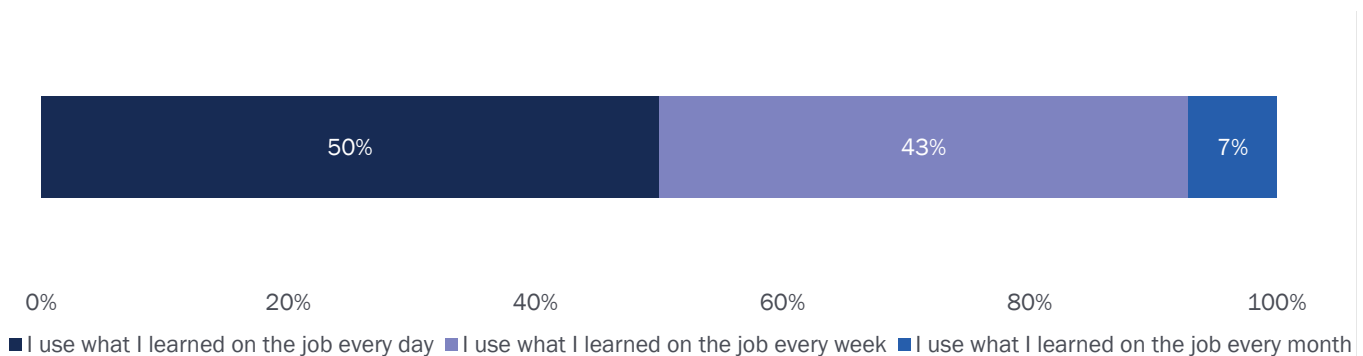
Figure 35 below shows growth in the number of training attendees who reside in high-unemployment zip codes. These attendees could have attended any online or in-person training, and these data were provided by Energy Solutions. If someone who lived in a high-unemployment zip code attended more than one training, they are represented more than once in the figure.

Figure 35. Number of Training Attendees who Reside in High-Unemployment ZIP Codes



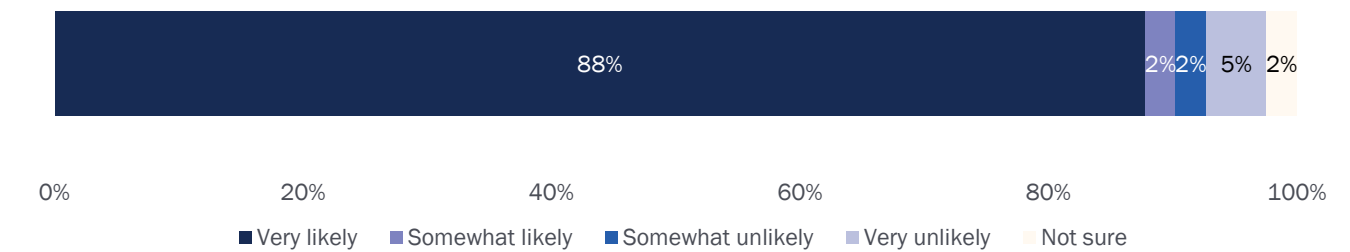
The contractors seemed to find the lessons in these trainings valuable. An Opinion Dynamics survey conducted in late 2022 of contractors who attended a TECH-sponsored training found that all trainees reported using the lessons learned from the training events on at least a monthly basis and half were using what they on the job learned every day (Figure 36).

Figure 36. How Often Surveyed Contractors Use What They Learned on the Job (n=42)



Most surveyed contractors (36 of 41; 88%) were very likely to continue using knowledge they acquired from the training in their current work (Figure 37). Moreover, nearly all surveyed contractors (40 of 41; 98%) intend to continue to apply what they learned in the training as a standard practice in their work moving forward.

Figure 37. Surveyed Contractors' Likelihood to Continue to Use Learnings from Training in Work (n=41)



9. PILOTS

TECH Clean California supported seven regional pilots that are each testing potential solutions to specific market barriers limiting heat pump installations. Once tested, the solutions that prove effective can inform statewide policy and are intended to be scaled into statewide approaches. Three of the seven pilots focus on barriers for low-income households and multifamily housing. The remaining three pilots address key barriers along the customer journey: identifying the customers most likely to save money by switching to heat pumps, streamlining permitting, and managing the new electrical load once the appliance is installed. The seventh pilot consists of a competitive solicitation to award Quick Start Grants, which also focus on removing barriers to heat pump installations.

The KPIs we tracked related to pilots were:

- # of pilots implemented
- # of pilots scaled

TECH Clean California and its partner VEIC implemented the same seven pilots in 2022 and 2023. One pilot was close to completion at the end of 2023. No pilots have been scaled statewide.

Except for the Quick Start Grantees, the Pilot teams submitted quarterly update reports to VEIC. These reports describe accomplishments for the prior quarter, challenges encountered, and lessons learned. There was no dedicated space in the quarterly report for pilot teams to describe changes to their timelines. Nevertheless, our review of the quarterly reports found some commonalities in the challenges reported by the pilot teams that likely contributed to delays:

- Challenges receiving or sharing data across pilot partner organizations.
- Uncertainty or inconsistencies in TECH incentives and budgets.
- Inability to recruit sufficient numbers of contractors or participants.
- Need for additional staff, and challenges hiring needed staff.

In 2024, Opinion Dynamics plans to conduct an evaluation of the pilot approach and how it contributed to TECH Clean California's goals.

10. PUBLIC REPORTING

The TECH Clean California team regularly updates a publicly accessible database of project activities, which has been utilized in this report to provide additional insights into the annual and quarterly KPIs. The public-facing webpage with data is accessible at <https://techcleanca.com/heat-pump-data/>.

The KPIs we measured in this TECH Clean California activity area included:

- # of visits and downloads on the TECH Working Data Set webpage
- # of participants whose data are cataloged on the public reporting site
- # of unique data points published via downloadable datasets
- # of data products, including downloadable datasets and charts, graphs, and maps posted to the public reporting website
- # of different organizations attending stakeholder meetings
- # of proceedings the TECH Clean California team monitors and engages in
- # of policy and regulatory decisions that advance TECH Clean California objectives
- # of policy forums created/regularly attended by TECH Clean California team members
- # of analyses and other public materials developed to influence policy work and posted on the public reporting site

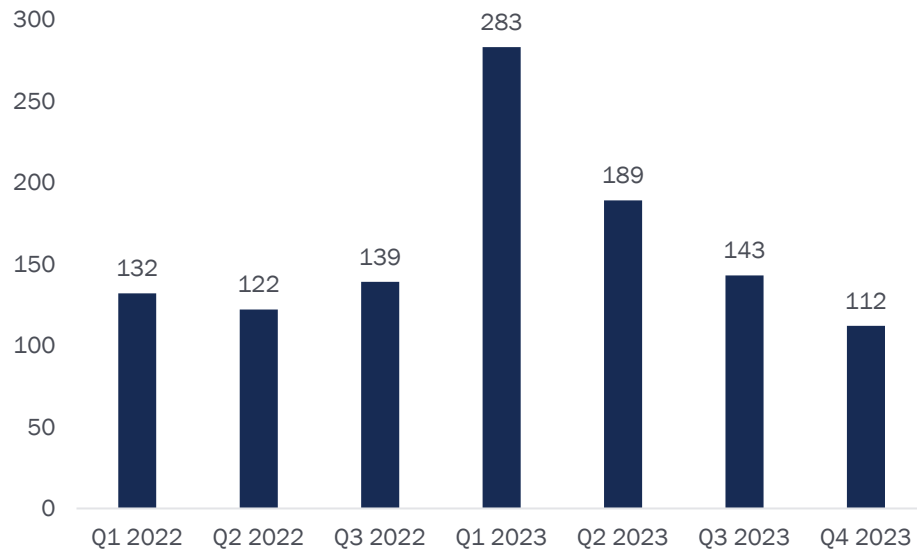
The number of views and downloads of this public database increased from 2022 to 2023, while the number of participants in the public database increased as TECH Clean California activities continued (Table 13). The number of downloads is not unique visitors and could represent the same individual downloading the data multiple times. The number of public database downloads has been reviewed to remove any Energy Solutions staff who downloaded the data. These summary statistics were provided by Energy Solutions.

Table 13. TECH Public Database KPIs

KPI	2022	2023
Public database visits	1,058	2,704
Unique public database visitors	281	1,416
Public database downloads	592	1,126
Number of TECH customers whose data are cataloged on public reporting site	10,446	20,640
Unique data points in TECH database	720,774	1,370,002
Number of data products	13	15

The TECH Clean California program holds quarterly stakeholder meetings in a webinar format to share updates and accomplishments. TECH Clean California held seven quarterly stakeholder meetings in 2022 and 2023, skipping Q4 of 2022. There was a spike in the number of organizations attending in Q1 2023 following that lapse (Figure 38), according to Energy Solutions data.

Figure 38. Number of Organizations Attending Quarterly Stakeholder Meetings



Statewide public agencies where regulatory and policy decisions are made provide opportunities to advocate for activities aligning with TECH Clean California goals. The regular interaction with decision makers and the communication of key takeaways expands awareness of obstacles and potential solutions that can facilitate future statewide electrification efforts.

TECH Clean California program administrators monitor and engage in proceedings at the California Energy Commission (CEC), The California Public Utilities Commission (CPUC), and the California Air Resources Board (CARB). Monitoring of proceedings indicates observation of docketed events. Engagement of proceedings is described as information filed within the proceeding docket either in response to a direct request or as a stakeholder in comments (Table 14).

Table 14. Agency Proceeding Activities of the TECH Clean California Program Administrators

	2022	2023
Proceedings Monitored	24	20
Proceedings Engaged	6	5

Engagement with regulatory and policy proceedings results in decisions that can directly affect future electrification efforts of the TECH Clean California Initiative. The three Decisions in 2022 shown in Table 15 were made by the CPUC. They related to the incentive design for a building decarbonization rulemaking and a Self-Generation Incentive rulemaking along with a Decision about an avoided cost calculator for a Distributed Energy Resources and Advanced Grid rulemaking. In 2023, three Decisions were made by the CPUC and related to clean energy financing options; approval of the 2024-2031 Energy Efficiency Business Plan and 2024-2027 Portfolio Plan; a Building Decarbonization Phase 3b Decision on the elimination of electric line extensions’ subsidies for mixed dual-fuel new construction (Final Decision); and another Self-Generation Incentive Program Proceeding Decision. The final Decision in 2023 was by the CEC and was a draft standard about a residential HVAC standard requiring heat pumps for central air conditioning in new construction and major rehabilitation.

Table 15. Policy and Regulatory Decisions Made Per Year that Affect TECH Program

	2022	2023
Policy Decisions Made that Affect TECH Program	3	4

Public policy forums and professional conferences offer TECH Clean California program administrators a way to share lessons learned. Attendance and presentations at professional conferences also provides interactions with other professional groups in the electrification space that can help disseminate lessons learned and increase the visibility of program activities. The TECH Clean California team had a slight increase in their presence in policy forums and conferences from 2022 to 2023 (Table 16). See Appendix B for a list of the 2023 policy forums and conferences.

Table 16. Public Forums Attended by TECH Program Administrators

	2022	2023
Policy Forums Attended	3	5
Professional Conferences and Forums attended	10	10

The TECH Clean California team developed public-facing analyses to share publicly that can inform policymakers with the goal of supporting beneficial policies. TECH program administrators developed four analyses that were disseminated to working groups and implementer agencies to inform policy and regulatory decisions (Table 17). In 2022, the TECH Clean California team produced preliminary modeled estimates of bill savings from electrification financed through TOB, which informed stakeholders and the CPUC Clean Energy Financing proceeding comments. In 2023, the TECH Clean California team completed a regression analysis to identify drivers for HVAC project costs and the need for electrical panel upgrades as well as a paper about Meter-Based Targeting for Beneficial Electrification at Scale.

Table 17. Analyses and Other Public Materials Developed for Policymakers and Public Reporting

	2022	2023
Number of Analyses	1	3

II. GREENHOUSE GAS EMISSIONS

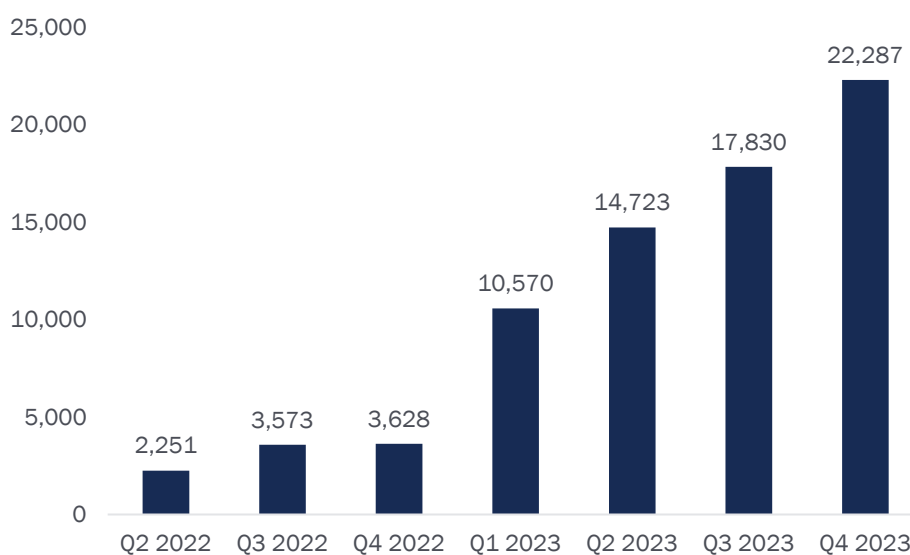
As a decarbonization program, the heat pump installations through TECH Clean California are intended to avoid greenhouse gas (GHG) emissions.

The KPI we measured for this TECH Clean California area included:

- Total volume of annual GHG emissions savings (metric tons of CO₂e)

Opinion Dynamics will apply the California Air Resources Board's (CARB) marginal GHG emissions factors and TECH's program costs to electric and gas energy impact results to develop lifetime GHG emissions reductions. The data in Figure 39 represent all GHG emissions savings from all single-family and multifamily TECH Clean California projects. The Energy Solutions team used CPUC work paper and statewide measure offering ID to estimate TECH Clean California's total emissions reductions.

Figure 39. Total Program Annual Emissions Reductions per Quarter (Tons CO₂e)



12. CONCLUSIONS AND RECOMMENDATIONS

The TECH Initiative has ambitious goals of market transformation for space-conditioning and water-heating heat pumps. Measuring the KPIs associated with the program goals explicated in the logic model allows us to assess how well TECH has performed in its first two years. We offer the following conclusions and recommendations.

Overarching

Conclusion: The variable availability of TECH Clean California incentives strongly influenced many downstream KPIs, particularly customer activity on the Switch Is On website, and the number of installations. When incentives were available, we saw more program-driven marketplace activity by customers and contractors. Upstream KPIs were more stable and did not vary along with the availability of TECH Clean California incentives; these included manufacturer engagement and public reporting activities.

Recommendation: TECH's supply of incentives that make their way to end-user customers needs to be more stable to ensure continued heat pump installations. Many of the emails TECH developed were about updates to incentives and the amount of incentives remaining. 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.

Marketing, Education, and Outreach

Conclusion: Activity on the Switch Is On website where customers can find electrification incentives, TECH-enrolled contractors, and request quotes aligns with availability of TECH Clean California incentives. In 2023 alone, the number of contractor quotes requested on the Switch Is On site grew from 1,116 in Q1 to 3,024 in Q4. We do not know, however, how satisfied customers are with these quotes or to what extent contractors honor those quotes after visiting the home. A total of 14,338 quotes were requested through the site in two years.

Recommendation: We recommend future evaluation assessments with website users who requested a quote to understand their experience of how effectively this website feature allowed them to find a contractor for their project and satisfaction with the quotes. This future work should also estimate how many of these contractor quotes led to a TECH-incentive heat pump project. This investigation can also reveal the extent to which this site is encouraging heat pump installations through other programs. We plan to undertake this assessment as part of the 2024 TECH Process Evaluation.

Supply Chain Engagement

Conclusion: TECH has engaged more manufacturers and distributors than store retailers. The results of this engagement are unclear, and the TECH Clean California team has collected limited sales data from two distributors over two years. TECH has not achieved their goal of obtaining data that allows them to track the sales and stocks of heat pumps in the state due to distributor reluctance to share the necessary data. Moreover, with limited retailer engagement, there may be missed opportunities to influence equipment choices among customers who shop at retail stores.

Recommendation #1: Efforts must be made to track total heat pump distributions in the state to gauge the success of this market transformation program. Though Energy Solutions has not had much luck, other entities in the state may be able to fill in this crucial data gap. One group that may be able to collect and share heat pump sales data is the newly formed California Heat Pump Partnership. Opinion Dynamics will follow this group to see what data they may be able to provide.

Recommendation #2: The evaluation team should work with the implementation team to develop new metrics to measure the progress and accomplishments of CBOs assisting with DAW recruitment. At a minimum, we recommend tracking the number of TECH-enrolled contractors the CBOs recruited that meet the criteria for a DAW.

TECH Clean California Incentives and Projects

Conclusion: The heat pump market in California is still in a stage of development where installations are strongly influenced by the availability of incentives. The KPIs tracking installations show dips and spikes associated with stoppages and re-launches of TECH Clean California incentives. At the same time, project costs also seem to increase with TECH Clean California incentives' availability. It is unclear why the average project costs for both HVAC heat pumps and HPWHs substantially decreased when TECH Clean California incentives were available in fewer places. Project costs are influenced by a variety of factors including an area's cost of living, cost of labor, and level of competition; the cost of equipment; and the relative size and efficiency of the installed equipment. Our KPI data in this report are unable to disentangle what is driving the variability in costs, and therefore future research is recommended.

Recommendation: Opinion Dynamics' incremental cost study planned for 2024 will investigate the extent to which contractors' pricing practices are influenced by the availability of incentives compared to other factors driving project costs.

Conclusion: Single-family incentives largely went to projects outside of DACs, while multifamily incentives were more likely to go to projects in DACs. Yet, the percentage of multifamily incentives going to DACs was not consistent and largely declined between Q3 2022 and Q3 2023.

Recommendation: The TECH Clean California team should explore ways to improve the amount of single-family incentives going to DACs.

Conclusion: The TECH Clean California team has increased the number of Program Administrators that participate in incentive layering with TECH Clean California incentives, but gaps remain that limit the true understanding of how heat pump incentives are affecting heat pump adoption in California. The seven Program Administrators TECH has an MOU with are all located in PG&E territory. Without visibility into how customers in Southern California have used other heat pump program incentives, such as those from the Los Angeles Department of Water and Power, we cannot know how incentive layering has influenced customer behavior and market performance.

Recommendation: The TECH Clean California team should make explicit efforts to pursue incentive layering with Program Administrators in SCG and SDG&E territory. If they have made efforts and have been unsuccessful, then they should produce a lessons learned report that describes their approach, the challenges, and what can be learned from their effort.

Customer Satisfaction

Conclusion: Customers' satisfaction with their TECH-enrolled contractors and their TECH-incented heat pump equipment was high. Customers' satisfaction with ductless heat pump equipment was a bit higher than with ducted heat pump equipment. As Opinion Dynamics has reported in our Insights Into Customer Experience and Satisfaction Report, it will be important to set customer expectations about their heat pump equipment operation and performance to maintain high satisfaction.⁶

⁶ The Insights Into Customer Experience and Satisfaction Report can be access here:
https://techcleanca.com/documents/2377/TECH_Customer_Experience_and_Satisfaction_Final_Report_9.15.23.pdf

Financing

Conclusion: TECH Clean California's support of CAEATFA GGH loans to facilitate heat pump projects has been fruitful. TECH's backing of a Loan Loss Reserve fund allowed GGH loans to be offered in parts of the state it was not previously. The amount of loans to TECH Clean California customers increased from \$1.14M in 2022 to \$2.81M in 2023. The amount of GGH-funded projects that received TECH incentives, however, is a small portion of total GGH loan volume: in 2023, \$2.8M of GGH loans were TECH projects out of a total GGH loan volume of \$15.9M.

Recommendation: We recommend future research to assess how likely customers would have been to purchase the heat pump without the financing and their satisfaction with the loan process through CAEATFA. We plan to undertake this assessment as part of the 2024 TECH Clean California Process Evaluation.

Workforce Education and Training

Conclusion: The TECH Clean California team offered a range of trainings online and in-person. Some trainings were held in high unemployment zip codes (18), while some training attendees lived in high-unemployment zip codes. Evaluation findings indicate contractors applied what they learned on the job frequently and planned to continue using what they learned in the training at work.

Pilots

Conclusion: The regional pilots encountered challenges leading to delays; some challenges were internal to the pilot teams, some stemmed from fluctuating TECH incentives, and others were from lengthy waits for external data. As such, they have not been able to supply scalable solutions to the TECH Clean California team in a timely manner. The pilots were originally expected to be finalized by June 2023, and none had been completed by the end of 2023. As of this report's publication in summer 2024, only one of the seven pilots has been completed. Some learnings have come out of the pilots, but the protracted execution of the pilots has led to delays in their assessment and scaling of effective pilot strategies.

Recommendation: Opinion Dynamics' assessment of the pilots as a strategy within TECH Clean California has been postponed due to the pilots not finishing yet. Opinion Dynamics will investigate the value the pilots provide to TECH Clean California and make an assessment of whether the pilot activity should be expanded or contracted.

Public Reporting

Conclusion: TECH Clean California's quarterly stakeholder meetings have attracted the attention of hundreds of organizations. The public reporting website had fewer than 300 visitors in 2022, and this number grew to 1,416 unique visitors in 2023. The TECH Clean California team has continued to add customer datapoints and data products as more TECH-incented projects happen. It is too early to tell whether the public has downloaded datasets and analyzed them to develop insights that can inform policy decisions.

Recommendation: We recommend Energy Solutions implement a method for accurately tracking the number of unique visitors to the main pages within the public reporting website, including the data download page.

Conclusion: TECH Clean California team members have spread awareness of the TECH program and TECH program accomplishments at policy forums and conferences. They have also provided comments and created analyses informing policymakers.

APPENDIX A. DATA SOURCES

Table 18 lists the organizations that provided data to calculate the KPIs in this report. The table is organized by topic area.

Table 18. TECH Clean California Implementers That Provided KPI Data

Topic	Example KPIs	Data Source
Marketing, Education, and Outreach	Switch Is On Website Analytics	Building Decarbonization Coalition
	Outreach materials developed and marketing channels used	Energy Solutions
Supply Chain Engagement	Contractor enrollment and licenses held, work in DACs	Frontier Energy data, Opinion Dynamics calculations
	CBOs assisting with DAW recruitment	Ortiz Group
	Contractor training attendees in high-unemployment zip codes	Tre'Laine
	Distributors, manufacturers, and retailers engaged	Energy Solutions
TECH Clean California incentives and Projects	Project costs and incentives in and out of DACs	Frontier Energy data, Opinion Dynamics calculations
Incentive layering	Program Administrators who participate in data sharing and incentive layering	Energy Solutions
Consumer Satisfaction	Satisfaction with equipment and contractor	Opinion Dynamics
Financing	CAEATFA loan volume	CAEATFA data, Energy Solutions calculations
Workforce, Education, and Training	Number of trainings held, and trainees	Tre'Laine
Pilots	Pilots implemented and scaled	VEIC
Public Reporting	Policy forums attended	Energy Solutions
GHG emissions	Annual Emissions Reductions	Energy Solutions

APPENDIX B. POLICY FORUMS AND CONFERENCES ATTENDED

Energy Solutions reports that TECH Clean California staff attended the following **policy forums** in 2023:

- Viable Electric Alternatives Work Group (at California Public Utilities Commission [CPUC])
 - Fuel Substitution Infrastructure Cost Attribution Working Group (sub-group)
 - Viable Electric Alternative Measure Package Working Group (sub-group)
- Bay Area Air Quality Management District (BAAQMD) Implementation Working Group
 - August 2023 Presentation on TECH Clean California Initiative Insights to BAAQMD Implementation Working Group
 - October 2023 Presentation on TECH Clean California Multifamily Insights to BAAQMD Implementation Working Group
- Tariff-on-bill (TOB) Work Group (CPUC)
- Regular Meetings with California Air Resources Board (CARB) & California Energy Commission (CEC) staff related to appliance standards and/or codes, including briefings on full TECH Clean California data findings as of late 2023
- Low-Income Advisory Board quarterly meetings

Energy Solutions reports TECH Clean California staff attended the following **conferences** in 2023:

- Association of Energy Services Professionals (AESP) Annual Conference: February
- California Efficiency + Demand Management Council (CEDMC) Evaluation, Measurement, and Verification (EM&V) Conference: February
- National Home Performance Conference: April
- New Buildings Institute (NBI) Getting to Zero Forum: May
- International Energy Agency (IEA) Heat Pump Conference: May
- Electric Power Research Institute (EPRI) – CEC Building Electrification Symposium: October
- Institute of Heating and Air Conditioning Industries (IHACI) Annual Trade Show: November
- American Council for an Energy Efficient Economy (ACEEE) Behavior, Energy, and Climate Change (BECC) Conference: November



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