Evaluation of Technology and Equipment for Clean Heating (TECH) Initiative

Workplan

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Subcontractor(s)

Opinion Dynamics

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1. Initiative Overview

Building energy consumption is responsible for a quarter of California's greenhouse gas (GHG) emissions. To address these emissions, the California Legislature passed Senate Bill (SB) 1477, which calls on the California Public Utilities Commission (CPUC) to develop the Technology and Equipment for Clean Heating (TECH) Initiative. The TECH Initiative is designed to accelerate market adoption of low-emissions space conditioning and water heating technologies for existing single and multifamily residential homes across California. Given the potential of heat pump technologies to reduce GHG emissions, the CPUC is looking to heat pump technologies as a key element to meeting the state's mission to achieve carbon neutrality by 2045. The TECH Initiative is designed to address and reduce market barriers to accelerate the longer-term adoption of high-efficiency heat-pump based technology, and ultimately transform the market over time while striving for cost-effectiveness and regulatory simplicity.

1.1 Evaluation Goals

The overarching goals are to evaluate the TECH Initiative implementation and assess short-term and long-term market and program impacts. The Opinion Dynamics team will use an embedded evaluation[1] approach to our research which allows us to adapt our approaches early in the program design and implementation process and provide insights at key decision points. This approach allows us to develop relationships with Energy Solutions, the prime implementer for the Initiative, and its team of sub-contractors early on 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, effectiveness of program strategies, and opportunities for course correction. As such, we have designed this evaluation to achieve the following goals and research objectives:

- Goal #1: Evaluate the effectiveness of TECH Initiative Implementation
  - **Identify, measure, and track program performance metrics.** The Opinion Dynamics team will gauge installation experience, identify areas for equipment improvement (such as noise or performance issues), measure contractor program satisfaction, and track other program metrics. At a minimum, metrics will include: the market share for eligible technologies, projected utility bill savings, and cost per metric ton of avoided GHG as specified in Senate Bill 1477. We also propose metrics around customer satisfaction, marketing, outreach, and training that will be key to scaling heat pump adoption in California. We will embed evaluation in implementation as much as possible by consulting with implementers to recommend data they can capture from program applicants and to share data on program performance as it becomes available.
  - **Assess effectiveness of initiative design, initiative scalability, and policy design.** The TECH Initiative is designed to develop valuable market experience for the purpose of decarbonizing space conditioning and water heater in California homes. We will assess the program design, implementation, and the policy design to determine lessons learned and best practices to inform the scalability of this pilot initiative into a full-scale program and inform future program designs and implementation.

[1] Embedded Evaluation is based on the principles of Developmental Evaluation as defined by Dr. Michael Quinn. It is an approach to insert evaluation within the program design, implementation, and reporting processes to support evidence-based decision-making as well as informed ongoing decision making.

- Goal #2: Evaluate TECH Initiative Impacts
  - **Identify and track market metrics.** We will identify market metrics that align with the program theory and logic model (PTLM) of the TECH Initiative. We will utilize primary and secondary data to baseline key metrics and will conduct ongoing measurements of the market over time. Where market effects are detected and to the extent possible, we will discern how much the TECH Initiative efforts contributed to those effects in relation to other programs with similar goals in the marketplace.

Goal #3: Ensure implementers comply with CARB rules regarding Cap-and-Trade funds

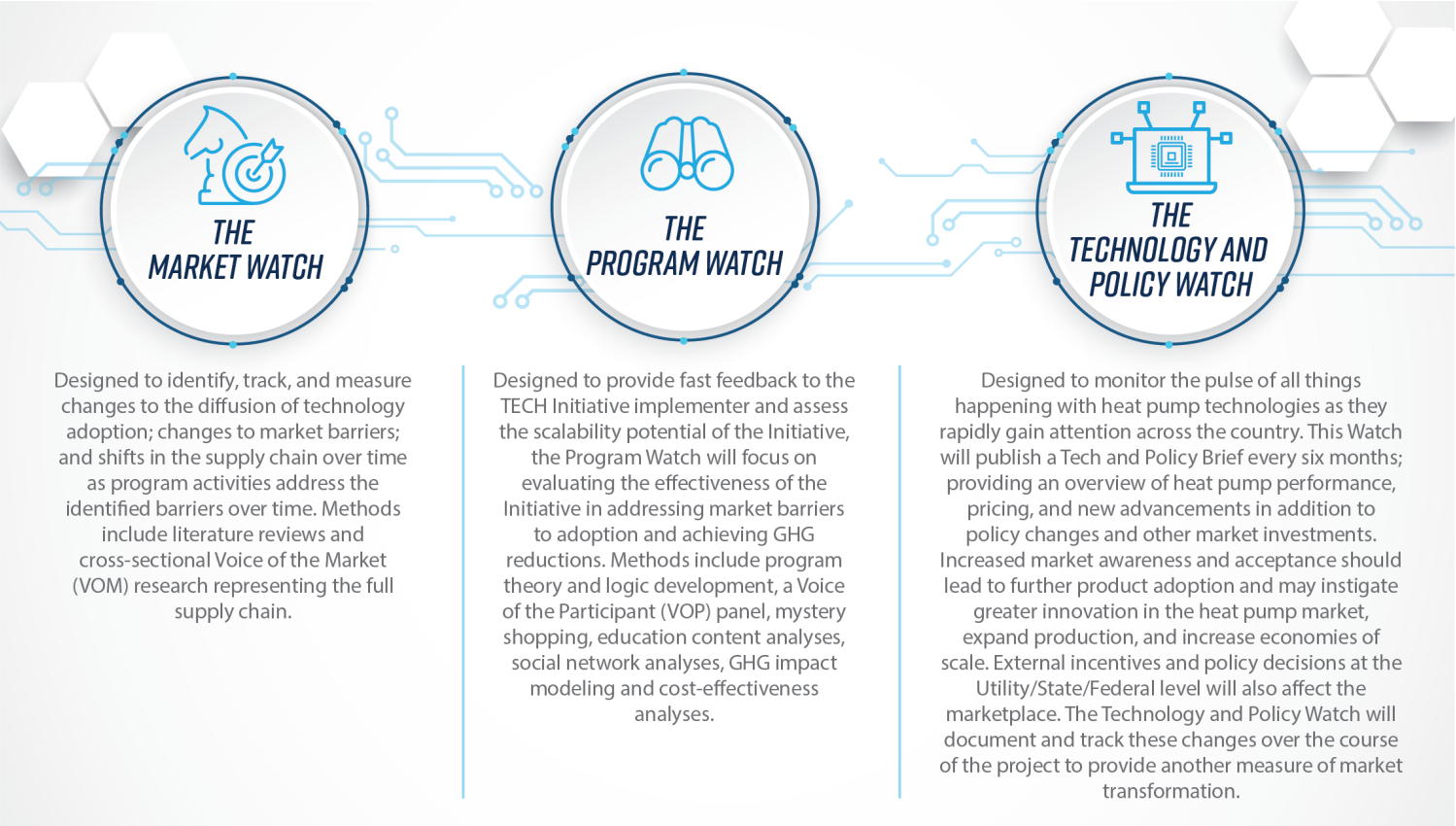
- **CARB Reporting.** We will report to the gas companies in May of each year, the total TECH Initiative expenditures and the total avoided GHG emissions from those expenditures from the prior calendar year in accordance with the California Cap on Greenhouse Gas Emissions and Market-Based Compliance Mechanisms, Title 17, California Code of Regulations (CCR), section 95893.

In addition to achieving the goals outlined above, the scope of work outlined within this evaluation plan conforms to requirements set forth in Senate Bill 1477 and the California Public Utilities Commission ("CPUC") Decision 20-03-027. As described throughout, we will embed our evaluation activities within the TECH Initiative to the extent possible so that we can provide real-time data and results to support understanding of lessons learned and inform program evolution. All data will be handled according to privacy and protection guidelines as established in past CPUC decisions.

1.2 Overview of Evaluation Approach

The evaluation team will monitor the following three key areas: the market, the TECH Initiative, and the technology and policy landscape (Figure 1).

Figure 1. TECH Evaluation Areas



1.3 Program Theory and Logic Model

Our evaluation approach is grounded in the PTLM of the TECH Initiative to ensure the proposed program and market metrics are in direct alignment with the theory and logic of the TECH initiative. The TECH Initiative is entering a market with significant barriers to adopting heat pump technology for space conditioning and water heating in existing homes. Table 1 highlights many of the key market barriers to adopting heat pump technology, all of which are significant and justify the need for rate-payer investments to help address these barriers.

Table 1. Key Market Barriers to Heat Pump Technology Adoption

Space and Water Heating Building Decarbonization Technology Market Barriers
1. High capital investment, tech itself, and potential electric panel upgrades 2. Market preference for gas 4. Low familiarity with heat pump technology 5. Lack of awareness and education 6. Lack of exposure to technology 7. Lack of flexibility in rate design to allow for negative price signals and peak periods 8. Low perceived customer value and consumer demand 9. Low perceived contractor value 10. Low product availability 11. Perceived vulnerability to power outages 12. Lack of workforce licensing and certification 13. Disparate building trades (plumbing, electrical, and HVAC) who typically do not work together

Utilizing the TECH Clean California Work Plan (November 5, 2021), the TECH Initial Incentive Plan, the TECH Clean California Program Implementation Manual and discussions with the Energy Solutions team, the Opinion Dynamics team developed a PTLM for the Tech Initiative. Notably, this PTLM and proposed evaluation plan represents current planning and strategy as of December 2021. Modifications will likely be made to the TECH Initiative as the program evolves; new strategies are tested and implemented; and existing strategies are modified based on lessons learned.

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 labeled with numbers and these arrows represent linkages between activities, outputs, and outcomes. Figure 1 presents the TECH Initiative logic model.

Figure 2. TECH Initiative PTLM

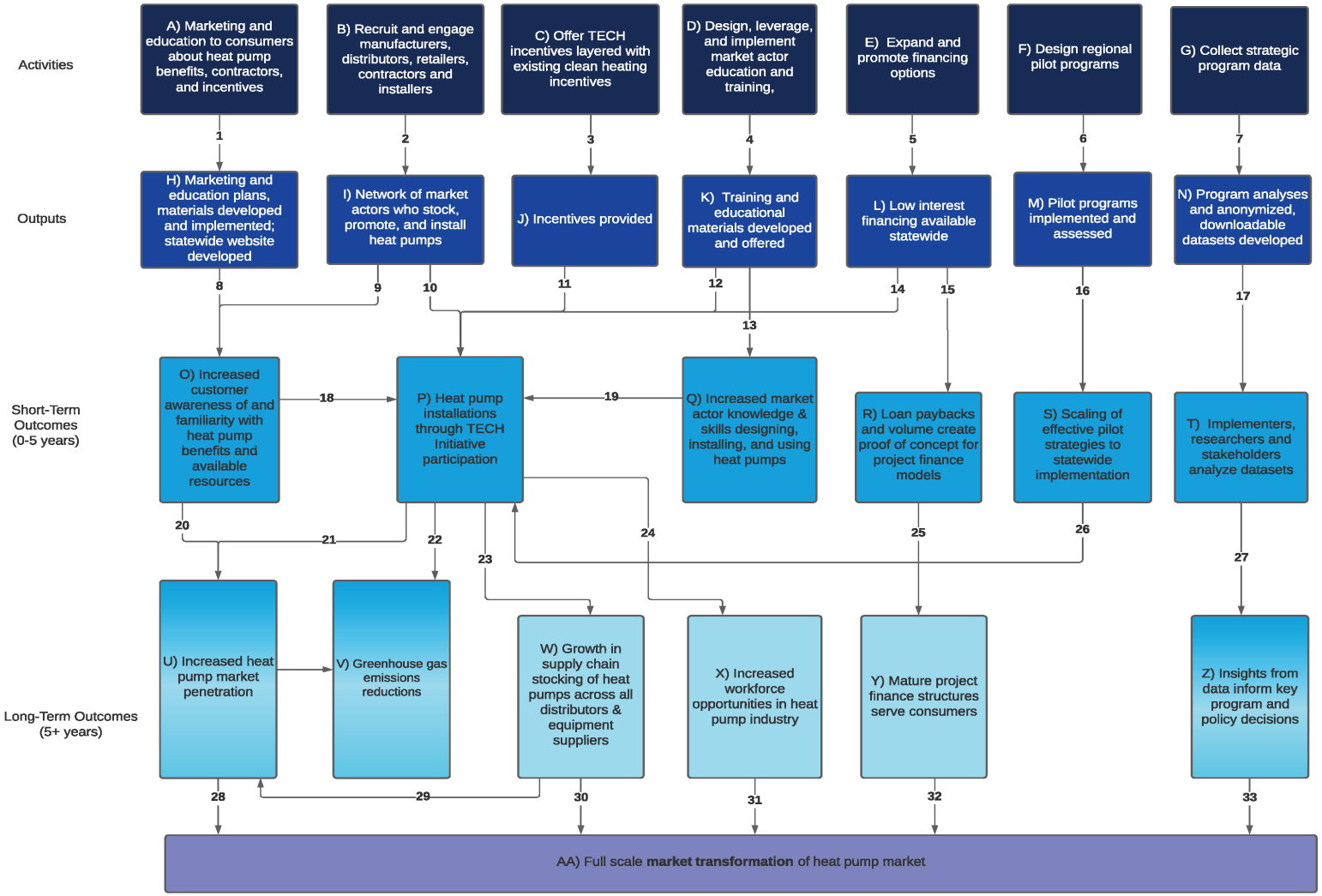


Table 2 below shows how the activities, outputs, and short-, medium-, and long-term outcomes in each component of the PTLM are interconnected. We include a description of the "Segment Theory" for each linkage. We then identify relevant metrics for each linkage. The key market metrics are noted in green text and the program metrics are noted in black text. We expect the list of metrics to evolve throughout the program implementation. The table is organized by the link numbers.

Table 2. Explanation of Linkages in TECH PTLM

Link	Segment Theory	Metrics
1	The output of the activity ***Marketing and education to consumers about heat pump benefits, contractors, and incentives (A)*** is ***Marketing and education plans and materials developed and implemented; statewide website developed (H).*** The Implementer will launch a multi-media campaign across California and work with CBOs and existing low-income programs to develop materials targeted for low-income, non-English, and disadvantaged communities. The Implementer will also leverage the statewide consumer-facing "The Switch Is On" website. One resource on the Switch is On website will be the Find a Contractor tool.	▪ # of marketing materials developed in total, and by audience, climate zone, language, zip code, DACs, and by category (e.g., email outreach, webinars, brochures, etc.) ▪ # of marketing channels (e.g. social media, billboards, radio advertisements, etc.) employed ▪ # of impressions, clicks, etc. on "The Switch is On" website and "Find a Contractor" webpage
2	The output of the activity ***Recruit and engage manufacturers, distributors, retailers, contractors, and installers (B)*** is a ***Network of market actors who stock, promote, and install heat pumps (I).*** The implementer will create a network of skilled contractors who will use TECH Initiative incentives and be responsible for the installation of clean space and water heating technologies. The Implementer will recruit contractors and assign then an account manager. The Implementer will also collect sales data from them.	The following metrics will be evaluated in total and by climate zone, zip code, and DACs: ▪ # of manufacturers engaged in the pr ▪ # of distributors engaged ▪ # of retailers engaged ▪ # of distributors providing sales data ▪ # of enrolled contractors
3	The output of the activity ***Offer TECH incentives layered with existing clean heating incentives (C)*** is the number of ***Incentives provided (J).*** The incentives will be processed through a centralized Incentive Clearinghouse. The incentives provided by the TECH Initiative will vary per region, with a base amount available for a region without any existing incentives, along with an enhanced measure structure for regions with other clean heating incentives. Market actors will also be eligible for a bonus incentive if they complete a certain number of installations.	The following metrics will be evaluated in total and by climate zone, zip code, and DACs: ▪ # of separate incentive program administrators with whom the TECH Implementer signs an MOU enabling data sharing and incentive layering ▪ # of TECH incentive applicants by incentive type ▪ # of and amount ($) of HVAC heat pump incentives distributed ▪ # of and amount ($) of HPWH incentives distributed ▪ # of and amount ($) of panel upgrade incentives distributed ▪ # of and amount ($) of enhanced incentives distributed ▪ # of and amount ($) of bonus incentives distributed

Link	Segment Theory	Metrics
		▪ Contractor Satisfaction with incentive distribution process ▪ Contractor Satisfaction with incentive levels
4	The output of the activity ***Design, leverage, and implement market actor education and training (D)*** is the number of ***Training and educational materials developed and offered (K).*** The TECH Initiative Implementer will enhance existing training in partnership with manufacturers, distributors, and existing WE&T efforts. The Implementer will also provide specialized business model training to high-potential and engaged contractors and will host training materials online for contractor access. Implementer will ensure that low-income residents and those living in DACs have equitable access to job trainings, by coordinating recruitment efforts with CBOs. The Implementer will work with CBOs and workforce development boards to develop clear guidance for contractors to obtain the licenses necessary to work on electrification projects. The Implementer will also build electrification knowledge and capacity among multifamily market actors through basic, intermediate, and advanced trainings.	The following metrics will be evaluated in total and by climate zone, zip code, and DACs: ▪ # of trainings offered ▪ # of trainings offered in high unemployment zip codes ▪ # of training attendees ▪ # of training attendees who reside in high unemployment zip codes ▪ # of training attendees who work in high unemployment zip codes ▪ # of disadvantaged worker[2] attendees ▪ # of CBOs assisting with disadvantaged worker recruitment ▪ # of installers receiving TECH training certificates
5	The output of the activity ***Expand and promote financing options (E)*** is that ***Low interest financing is available statewide (L).*** The TECH Implementer will offer financing mechanisms that offer customers pathways to electrification that significantly reduce upfront costs and increase financial leverage. Implementer will collaborate with California Alternative Energy and Advanced Transportation Financing Authority (CAEATFA) to expand the Residential Energy Efficiency Loans (REEL) and Affordable Multifamily Financing (AMF) financing programs statewide. Currently, only California electric IOU customers are eligible for REEL and AMF financing programs.	The following metrics will be evaluated in total and by climate zone, zip code, and DACs: ▪ # of financing offerings available ▪ # of projects financed through REEL/AMF that would have otherwise not been eligible (e.g. SMUD customers, LADWP customers, etc.) ▪ # of and amount ($) of REEL/AMF loans issued
6	The output of the activity ***Design regional pilot programs (F)*** is the number of ***Pilot programs implemented and assessed (M).*** The role of regional pilots is to experiment with strategies to overcome specific barriers and refine the customer journey for key customer segments. Regional pilots will address specific areas of the market and major adoption barriers to meeting California's GHG reduction goals. The pilots include activities such as offering tariffed on-bill financing; technical assistance offerings for multifamily market actors; streamlined permitting processes;	▪ # of pilots implemented ▪ # of pilots assessed ▪ # of quick-start grants provided ▪ Lessons learned from pilot implementation ▪ Lessons learned from quick-start grants

[2] A Disadvantaged Worker, as defined in 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."

Link	Segment Theory	Metrics
	HPWH load-shifting best practices; customer targeting; and quick-start grants. After pilots have demonstrated strategy feasibility, typically after one to two years, the implementation team will utilize the data gathered and proof points provided by these pilots to scale these strategies statewide (years three and four).	
7	The output of the ***Collect strategic program data (G)*** activity is ***Program analyses and anonymized downloadable datasets developed (N).*** The TECH Implementers will conduct analyses of program data and provide anonymized program data on a public website. Examples of these analyses include bill savings analysis and quantification of electrification benefits.	▪ # of analyses and other public materials developed and posted on public reporting site ▪ # of participants whose data is catalogued 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
8	A short-term outcome of ***Marketing and education plans, materials, developed and implemented; statewide website developed (H)*** is ***Increased customer awareness of and familiarity with heat pump benefits and available resources (O).*** The consumer-facing education and outreach will expose more people to the benefits of electrification and the resources available to help them electrify buildings, such as incentives and installers.	The following metrics will be evaluated in total and by climate zone, zip code, and DACs: ▪ Program awareness by target audience ▪ Percent of target audience who attribute awareness of TECH Initiative to marketing, education and outreach activities ▪ Customer familiarity with heat pump benefits in total and attributable to program activities ▪ Customer familiarity with heat pump resources, such as project financing, in total and attributable to program activities ▪ # of appointments made through the Find a Contractor portal to initiate electrification projects ▪ # of impressions, clicks, etc. on "The Switch is On" website and "Find a Contractor" webpage
9	A short-term outcome of the creation of a ***Network of market actors who stock, promote, and install heat pumps (I)*** is ***Increased customer awareness of and familiarity with heat pump benefits and available resources (O).*** The network of engaged actors will expose customers to heat pumps, increasing their customers' awareness and familiarity of electrification benefits and technologies.	▪ Customer familiarity with heat pump benefits in total and attributable to the TECH network of market actors ▪ Customer familiarity with heat pump resources, such as project financing, in total and attributable to the TECH network of market actors
10	Another short-term outcome of the ***Network of market actors who stock, promote, and install heat pumps (I)*** is ***Heat pump installations through TECH Initiative participation (P).*** As the network of market actors promote and install heat pumps, they will generate participation in the TECH Initiative.	▪ The following metrics will be evaluated in total and by building type, climate zone, zip code, and DACs: ▪ # of TECH incentive applications submitted, approved, and denied ▪ # of HVAC heat pump installs ▪ # of HPWH installs ▪ Measures of changed contractor promotion strategies and/or frequency

Link	Segment Theory	Metrics
11	A short-term outcome of the ***Incentives provided (J)*** is ***Heat pump installations through TECH Initiative participation (P).*** The incentives will be submitted and processed through a simplified and streamlined website with quick turnaround times. This process and the support provided to market actors will motivate them to increase their promotion and sales of heat pump equipment, resulting in TECH-incented installations. These installations will also occur in Disadvantaged Communities.	▪ Number of heat pump purchases incented by the TECH Initiative in total and by building type, climate zones, zip code, and DACs ▪ Number of heat pump purchases incented by the TECH Initiative and other funding sources (layered funding) in total and by building type, climate zones, zip code, and DACs ▪ Number of HPWH purchases incented by the TECH Initiative in total and by building type, climate zones, zip code, and DACs ▪ Time of Incentive fulfillment
12	A short-term outcome of ***Training and educational materials developed and offered (K)*** is the ***Heat pump installations through TECH Initiative participation (P).*** The technical and sales training available at low to no cost to market actors will ensure they are aware of TECH participation benefits and will sell heat pumps that are rebated through the TECH Initiative. The trainings and resulting installations will also occur in Disadvantaged Communities.	▪ Measures of changed contractor promotion strategies and/or frequency ▪ # of TECH incentive applications collected, approved, and denied for HVAC heat pumps in total and by building type, climate zones, zip code, and DACs ▪ # of TECH incentive applications collected, approved, and denied for HVAC heat pumps in total and by building type, climate zones, zip code, and DACs attributable to TECH-supported education and training ▪ # of TECH incentive applications collected, approved, and denied for HPWHs in total and by building type, climate zones, zip code, and DACs ▪ # of TECH incentive applications collected, approved, and denied for HPWHs in total and by building type, climate zones, zip code, and DACs attributable to TECH-supported education and training

13	Another short-term outcome of ***Training and educational materials developed and offered (K)*** is ***Increased market actor knowledge and skills, designing, installing, and using heat pumps (Q).*** Once the market actors are knowledgeable and skilled about heat pumps, they will be comfortable specifying heat pumps for their projects, leading to sales through the TECH Initiative. The skilled market actors will also install heat pumps in Disadvantaged Communities.	▪ # of market actors with the knowledge and skills related to:
		  ▪ Value propositions of HVAC heat pumps
		  ▪ HVAC heat pump sales strategies
		  ▪ Designing heat pump systems
		  ▪ Installing heat pumps systems
		  ▪ Maintaining heat pump systems
		▪ # of market actors confident in selling, installing, servicing, and maintaining HVAC heat pumps and HPWHs
		▪ # of workers licensed to install, service, and maintain HVAC heat pumps
		▪ # of disadvantaged workers licensed to install, service, and maintain HPWH
		▪ Proportion of market actor jobs fulfilled by disadvantaged workers

Link	Segment Theory	Metrics
14	A short-term outcome of the ***Low interest financing available statewide (L)*** is ***Heat pump installations through TECH participation (P)*** from reduced financial barriers.	▪ # of and percent of TECH participants using financing for HVAC heat pumps by building type, climate zones, zip code, and DACs ▪ # of and percent of TECH participants using financing for HPWHs by building type, climate zones, zip code, and DACs ▪ Influence of financing availability on participation
15	Another short-term outcome of the ***Low interest financing available statewide (L)*** will be ***Loan paybacks and volume [of loans issued] create proof of concept for project finance models (R).*** Once sufficient customer demand for project financing is demonstrated and the loans are paid back (instead of defaulted on), then a proof of concept will be available to financiers that this service is needed in the market.	▪ # of and amount ($) of loans issued by building type, climate zones, zip code, and DACs ▪ Proportion of loans paid back vs defaulted by climate zones, zip code, and DACs
16	***Pilot programs implemented and*** **assessed, *(M)*** will lead to ***Scaling of effective pilot strategies to statewide implementation (S)*** as the TECH Initiative is also scaled. We expect this scaling to start in the third year of the program after sufficient data on the pilot strategies has been collected and assessed. These pilot activities include HPWH load-shifting, customer targeting, multifamily design team assistance, and quick-start grants, among others.	▪ # of pilots scaled
17	A short-term outcome of the ***Program analyses and anonymized downloadable datasets developed (N),*** is that ***Implementers, researchers, and stakeholders analyze datasets (T).*** A centralized database with electrification data will provide a rich source for anyone to analyze and develop insights about the Initiative's impacts. It is expected that this outcome will start to occur in third year of the Initiative after installations have made, and sufficient data and/or analyses has been assembled and made available. Examples of analyses may include bill savings analysis, participant motivations and satisfaction, and quantification of electrification benefits.	▪ # of site visits and downloads of the TECH Working Data Set and Electrification Value Stream Analyses webpages ▪ # of unique visitors

Link	Segment Theory	Metrics
18	Once there is ***Increased customer awareness of and familiarity with heat pump benefits and available resources (O),*** that will lead to ***Heat pump installations through TECH Initiative participation (P)***. When customers are aware of heat pump benefits and the incentives available to them, as well as the resources such as the Find a Contractor tool, they will be more likely to participate in the TECH Initiative.	The following metrics will be evaluated in total and by climate zone, zip code, and DACs: ▪ Customer familiarity with heat pump benefits in total and attributable to TECH program activities ▪ Customer familiarity with heat pump resources, such as project financing, in total and attributable to TECH program activities ▪ Customer awareness of TECH program ▪ # of appointments made through Find a Contractor portal ▪ Number of HVAC heat pump purchases incented by the TECH Initiative ▪ Number of HPWH purchases incented by the TECH Initiative ▪ Occupant experience with HVAC heat pumps and HPWHs
19	***Increased market actor knowledge and skills, designing, installing, and using heat pumps (Q).*** leads to ***Heat pump installations through TECH Initiative participation (P)***. The knowledgeable and skilled market actors will be confident specifying heat pumps for their projects, leading to installations through the TECH Initiative.	▪ # of incented HVAC heat pump installations by contractors training participation status (participated/did not participate) ▪ # of incented HPWH installations by contractors training participation status (participated/did not participate) ▪ # of market actors confident in selling, installing, servicing, and/or maintaining HVAC heat pumps and HPWHs
20	The ***Increased customer awareness of and familiarity with heat pump benefits and available resources (O)*** will lead to ***Increased heat pump market penetration (U)*** in the short and long term. Once the key barrier of limited customer awareness is overcome, they will be more demanding and/or accepting of heat pumps, causing heat pumps to be more prevalent in buildings.	▪ Annual market size/share of HVAC systems that are HVAC heat pumps and by building type, climate zones, zip code, and DACs ▪ Annual market size/share of water heaters that are HPWHs and by building type, climate zones, zip code, and DACs
21	***Heat pump installations through TECH Initiative participation (P)*** will lead to a long-term outcome of ***Increased heat pump market penetration (U),*** including in Disadvantaged Communities. The heat pump installations incentivized through the TECH Initiative will increase the penetration of heat pumps in single-family and multifamily residential buildings.	▪ Annual market size/share of HVAC systems that are HVAC heat pumps and by building type, climate zones, zip code, and DACs ▪ Annual market size/share of water heaters that are HPWHs and by building type, climate zones, zip code, and DACs
22	***Heat pump installations through TECH Initiative participation (P)*** will lead to ***Greenhouse gas emissions reductions (V).*** Once heat pumps are installed and replace gas-based systems or less efficient electric systems, greenhouse gas emissions reductions will be achieved.	▪ Cost per metric ton of greenhouse gas emissions reductions in total and by and by building type, climate zones, zip code, and DACs
23	***Heat pump installations through TECH Initiative participation (P)*** will lead to ***Growth in the supply chain stocking of heat pumps across all distributors and equipment suppliers (W)*** in the long term. Once heat pumps are selling in greater	The following metrics will be evaluated in total and by climate zone, zip code, and DACs: ▪ # of distributors, suppliers, and retailers stocking HVAC heat pumps

Link	Segment Theory	Metrics
	volumes, distributors and equipment suppliers should respond to the market cues and stock more heat pumps.	▪ # of distributors, suppliers and retailers stocking HPWHs ▪ # of HVAC heat pumps stocked ▪ # of models of HVAC heat pumps stocked ▪ # of HPWH stocked ▪ # of models of HPWH stocked ▪ Percent of HVAC heat pumps of all space conditioning systems stocked ▪ Percent of HPWHs of all water heaters stocked ▪ Percent of efficient systems (SEER) stocked by equipment type
24	***Heat pump installations through TECH Initiative participation (P)*** will lead to a long-term outcome of ***Increased workforce opportunities in heat pump industry (X).*** As heat pumps are more frequently installed in homes, property owners will be satisfied with their performance and energy savings, leading to greater demand for heat pumps, which translates into more workforce opportunities in the heat pump industry.	The following metrics will be evaluated in total and by climate zone, zip code, and DACs: ▪ Percent of available positions selling, installing, maintaining, and/or servicing HVAC heat pumps ▪ Percent of available positions selling, installing, maintaining, and/or servicing HPWHs ▪ Percent of workers employed in positions selling, installing, maintaining, and/or servicing HVAC heat pumps ▪ Percent of workers employed in positions selling, installing, maintaining, and/or servicing HPWHs ▪ Percent of disadvantaged workers employed in positions selling, installing, maintaining, and/or servicing HVAC heat pumps ▪ Percent of disadvantaged workers employed in positions selling, installing, maintaining, and/or servicing HPWHs ▪ Percent of trade allies with appropriate licenses to install, service, and maintain HVAC heat pumps ▪ Percent of trade allies with appropriate licenses to install, service, and maintain HPWHs
25	As the ***Loan paybacks and volume [of loans offered] create proof of concept for project finance models (R),*** that will contribute to a long-term outcome of ***Mature project finance structures that serve consumers (Y).*** Once the proof of concept is demonstrated and financiers see the opportunity of serving residential customers interested in electrification, they will develop and make available project financing, helping to mature this part of the market.	The following metrics will be evaluated in total and by climate zone, zip code, and DACs: ▪ # of new financing offerings available ▪ # of financiers offering electrification project financing ▪ # of and amount ($) of REEL/AMF loans issued ▪ # of projects financed through REEL/AMF that would have otherwise not been eligible (e.g. SMUD customers, LADWP customers, etc.)

Link	Segment Theory	Metrics
		▪ Proportion of loans issued as part of TECH in good standing compared to those defaulted on ▪ Proportion of REEL/AMF loans that received TECH incentives
26	The ***Scaling of effective pilot strategies to statewide implementation (S)*** will lead to a short-term outcome of ***Heat pump installations through TECH Initiative participation (P).*** Once the pilot strategies have been determined to be successful and are expanded, the barriers they address will be reduced and more customers will participate in the TECH Initiative. These include customers in Disadvantaged Communities and at multifamily properties.	▪ # of TECH incentives issued to customers influenced by a scaled pilot strategy
27	A long-term outcome of ***Implementers, researchers, and stakeholders analyze datasets (T)*** is that they will produce ***insights from data inform key program and policy decisions (Z)***. The data-supported insights will allow stakeholders to effectively make a case in policy proceedings and advance beneficial electrification objectives.	▪ Number of policy and regulatory decisions that advance TECH objectives
28	***Increased heat pump market penetration (U)*** will lead to a long-term outcome of ***Full-scale market transformation of the heat pump market (AA).*** Once heat pumps are more widely installed in the market and customers are comfortable with them as a water heating and space heating/cooling technology, it will support the transformation of the heat pump market. Market transformation will occur when heat pumps have 50% of market share by 2030 and gas space/water heating is phased out by 2032; plus when heat pump installed costs decline and electrification value streams make it cost competitive with gas.	▪ Annual market size/share of water heating sales that are HPWHs in total and by property type, climate zones, zip codes, and DACs ▪ Annual market size/share of HVAC system sales that are heat pumps in total and by property type, climate zones, zip codes, and DACs ▪ Cost of installed HVAC heat pumps (equipment cost and labor) in total and by property type, climate zones, zip codes, and DACs ▪ Cost of installed HPWHs (equipment cost and labor) in total and by property type, climate zones, zip codes, and DACs
29	***Growth in supply chain stocking of heat pumps across all distributors and equipment suppliers (W)*** will lead to a long-term outcome of ***Increased heat pump market penetration (U).*** With greater availability of a variety of heat pumps at distributors and suppliers, heat pumps will more accessible and become a more commonly selected choice of equipment, leading to more market penetration.	The following metrics will be evaluated in total and by climate zone, zip code, and DACs: ▪ Annual market size/share of water heating sales that are HPWHs ▪ Annual market size/share of HVAC system sales that are heat pumps ▪ Cost of installed HVAC heat pumps (equipment cost and labor) ▪ Cost of installed HPWHs (equipment cost and labor) ▪ # of distributors, suppliers, and retailers stocking HVAC heat pumps ▪ # of distributors, suppliers and retailers stocking HPWHs ▪ # of HVAC heat pumps stocked ▪ # of models of HVAC heat pumps stocked

Link	Segment Theory	Metrics
		▪ # of HPWHs stocked ▪ # of models of HPWH stocked ▪ Percent of efficient systems (SEER) stocked by equipment type ▪ Annual proportion of distributors, suppliers. and retailers stocking heat pumps
30	***Growth in supply chain stocking of heat pumps across all distributors & equipment suppliers (W)*** will also lead to a long-term outcome of ***Full-scale market transformation of the heat pump market (AA).*** The greater availability and accessibility of heat pumps at suppliers will help transform the market. Market transformation will occur when heat pumps have 50% of market share by 2030 and gas space/water heating is phased out by 2032.	The following metrics will be evaluated in total and by climate zone, zip code, and DACs: ▪ Annual market size/share of water heating sales that are HPWHs pumps ▪ Annual market size/share of HVAC system sales that are heat pumps ▪ Cost of installed HVAC heat pumps (equipment cost and labor) ▪ Cost of installed HPWHs (equipment cost and labor) ▪ # of distributors, suppliers, and retailers stocking HVAC heat pumps ▪ # of distributors, suppliers and retailers stocking HPWHs ▪ # of HVAC heat pumps stocked ▪ # of models of HVAC heat pumps stocked ▪ # of HPWHs stocked ▪ # of models of HPWH stocked ▪ Percent of efficient systems (SEER) stocked by equipment type ▪ Annual proportion of distributors, suppliers. and retailers stocking heat pumps
31	***Increased workforce opportunities in heat pump industry (X)*** will lead to a long-term outcome of ***Full-scale market transformation of heat pump market (AA).*** Market transformation will occur when sustained customer demand for heat pumps creates significant job growth in the electrification industry, especially in Disadvantaged Communities.	▪ Percent of available positions selling, installing, maintaining, and servicing HVAC heat pumps ▪ Percent of available positions selling, installing, maintaining, and servicing HPWHs ▪ Percent of workers employed in positions selling, installing, maintaining, and servicing HVAC heat pumps ▪ Percent of workers employed in positions selling, installing, maintaining, and servicing HPWHs ▪ Percent of disadvantaged workers employed in positions selling, installing, maintaining, and servicing HVAC heat pumps ▪ Percent of disadvantaged workers employed in positions selling, installing, maintaining, and/or servicing HPWHs ▪ Percent of trade allies with appropriate licenses to install, service, and maintain HVAC heat pumps in total and by climate zones, zip codes, and DACs ▪ Percent of trade allies with appropriate licenses to install, service, and maintain

Link	Segment Theory	Metrics
		HPWHs in total and by climate zones, zip codes, and DACs
32	***Mature project finance structures serve customers (Y)*** and will lead to a long-term outcome of ***Full-scale market transformation of heat pump market (AA).*** The widespread availability of electrification project financing options will be evidence of a transformed market.	▪ Accessibility of heat pump project financing ▪ # of new financing offerings available ▪ # of financiers offering electrification project financing ▪ # of and amount ($) of REEL/AMF loans issued in total and by property type, climate zones, zip codes, and DACs ▪ # of projects financed through REEL/AMF that would have otherwise not been eligible (e.g. SMUD customers, LADWP customers, etc. in total and by property type, climate zones, zip codes, and DACs ▪ Proportion of loans issued as part of TECH in good standing compared to those defaulted on in total and by property type, climate zones, zip codes, and DACs ▪ Proportion of REEL/AMF loans that received TECH incentives
33	***Insights from data that inform key program and policy decisions (Z)*** will lead to ***Full-scale market transformation of heat pump market (AA).*** The data-based policy decisions will maximize the impact of the TECH Initiative. For example, market transformation will occur when heat pumps are optimized with Time-of-Use rates controls as a standard offering.	▪ Proportion of heat pumps sold that are optimized with Time-of-Use rate controls ▪ Proportion of low-income programs that require electrification ▪ Number of policy and regulatory decisions that advance TECH objectives

2. Evaluation Tasks

2.1 Task 1: Baseline Assessment and Project Kickoff

The initial preparation tasks are designed to establish relationships with the implementation team, the CPUC, and other key stakeholders to best coordinate efforts; learn about the TECH design and implementation strategy; solidify the metrics we plan to measure in the evaluation; and finalize the evaluation plan. The second task will be to conduct a baseline assessment of key market metrics.

2.1.1 Task 1a. Conduct Project Kickoff Meetings

The Opinion Dynamics team will schedule project kick-off meetings and updates with the Tech implementation team, Southern California Edison, the CPUC, and relevant stakeholders. The objectives of these meetings are to: (1) gain additional background on the TECH Initiative implementation plan, (2) refine the research questions by task where needed, (3) request existing materials and documents, (4) establish points of contact and communication protocols, (5) discuss overall project management and expectations, and (6) establish protocols around when and how we engage with stakeholders.

2.1.2 Task 1b. Develop PTLM

The Opinion Dynamics team believes strongly in the value of well-conceived logic models accompanied by an elaborated theory of what a program should and can do to generate the desired outcomes. Logic models are an essential part of any strategic plan to reach specified goals. They zero in on the essential program activities that program implementers think will have direct effects on producing desired outcomes. Logic models are not concerned with program processes and do not account for each specific step associated with program delivery. They are limited to program activities that directly or indirectly influence short-term and long-term outcomes. In the case of indirect effects, the model depicts the causal path through mediating or moderating factors. One major advantage of developing logic models is that the very process of developing the model forces program staff to explicate what they are doing, what each activity will achieve, and why. The PTLM we developed above is the foundation of the Baseline Assessment described in Task 1c and this Evaluation Plan.

2.1.3 Task 1c. Conduct Baseline Assessment

The baseline market assessment will assess existing market conditions to establish a baseline for TECH based on primary and secondary research. The initial step to the baseline assessment is to identify market metrics. The market metrics align with the Program Theory and Logic Model included above and tie directly to the market barriers that the TECH Initiative is attempting to address. The Market Metrics are identified in Table 2 above in green text.

We will initially conduct a secondary data review to establish what data exists for identifies market metrics. The secondary data sources we will leverage includes the Heating, Air-conditioning & Refrigeration Distributors International (HARDI) trends report, Air Conditioning, Heating, and Refrigeration Institute (AHRI) HVAC system shipping data, AHRI low-Global Warming Potential alternative refrigerant evaluation program data, and data from the California Residential Appliance Saturation Survey (RASS). These estimates, coupled with other sources, will allow us to construct the historical baseline level of activity.

Using this secondary data review, we will conduct an analysis of the supply chain structure. This analysis will identify the key groups of market actors involved in the design, product specification, production and delivery of space and water heating technologies. Using information from secondary sources, we will develop supply chain maps. Understanding the supply chain is essential for identifying and understanding market effects, how those effects will manifest through different market actors and ultimately what data are necessary for measuring the effects.

Opinion Dynamics will estimate the total market size for each technology based on a variety of published primary data sources. Secondary sales data will provide the essential input to the total market size for incented technologies, where possible. The Heating, Air-Conditioning Refrigeration Distributors International (HARDI) maintains monthly state sales data for over 73 distributors nationally from 2013 to the present for Central Air, Air Source Heat pumps, furnaces, and boiler technologies. HARDI reports these data reflect roughly 55% to 60% of the total market. The remaining 40% to 45% are products sold direct from manufacturers to retailers (e.g., Home Depot) or directly to construction firms. We will incorporate manufacturers shipment data provided by the Air-conditioning, Heating & Refrigeration Institute (AHRI), and data reported by the distributor research discussed below to adjust the HARDI data estimates to account for direct sales to retailers and contractors. We will combine these insights with saturation information provided by the 2019 RASS and the 2021 Potential & Goals Update data, and housing stock information from other published sources to establish the baseline level of adoption by key segments. We will also work with the implementation team to confirm estimates with manufacturer and distributor TECH participants.

For water heating, we will also utilize manufacturer shipments data. We will also rely on published data regarding the total housing stock in each climate zone and apply California Lighting and Appliance Saturation Study (CLASS) and RASS saturation data to estimate total stock of water heaters by type. We will estimate annual sales installations by assuming a stock turnover rate. We will also work with the implementation team to confirm estimates with manufacturer and distributor TECH participants.

We will then identify the specific primary data collection needed to fill in gaps in our baseline market, including our supply chain analysis. We will utilize semi-structured interviews and surveys to develop estimates for market metrics not available in the secondary data. The goal is to submit the first draft of the baseline assessment draft report to the CPUC and SCE for review on April 29, 2022.

2.2 Task 2: Evaluation Plan

This document represents the first iteration of the evaluation plan. As the program design is finalized and the program begins there will be further iterations based on TECH Initiative adjustments. We will monitor changes to the program, iterating on the PTLM and evaluation plan as needed in consultation with the CPUC, the Energy Solutions Team, and SCE. We will make any necessary revisions/amendments to this evaluation plan upon request by SCE or the CPUC to align with current program activities.

2.3 Task 3: Evaluation Work

The evaluation team will implement the activities outlined in the sections below to evaluate the TECH Initiative and provide feedback and recommendations to improve program design.

2.3.1 Task 3a. Market Watch

The Market Watch will provide ongoing measurements of the baseline market metrics listed above in Table 2. Key methods may include secondary data analysis, Voice of the Market (VOM) research, and program tracking data assessments. All data in the Market Watch will be centralized and accessible as it becomes available. Building on the baseline market study conducted in 2022 (see Task 1b above), we will conduct two additional market assessments in 2023 and 2025 that will include additional primary research with stakeholders to capture updated market metrics as well as update data from secondary sources. Through this research, we will collect information on the market progress, drivers, and progress on alleviating barriers for installation of heat pump technologies. We plan to conduct surveys and interviews with the general population, manufacturers, distributors, installers, and end-users.

Our team will collect and analyze market data and intelligence on a continuing basis to evaluate the ability of the TECH Initiative to achieve targeted market effects and longer-term market transformation. We will work closely with the TECH Initiative implementer to integrate our findings into program strategies and to support mid-cycle course corrections.

Market Actor Interviews/Surveys

Semi-Structured Interviews with HVAC and Plumbing Manufacturers and Distributors

In years 2022 and 2024, we will conduct interviews with distributors and manufacturers. We will utilize the TECH Initiative implementer to help us recruit participants in our study. We will also interview distributors and manufacturers by attending the AHRI Expo. The Expos provides an opportunity to assess new technologies, progress with existing technologies, and anticipated changes in the technology and the market.

HVAC and Plumbing Trade Ally Interviews/Surveys

Installers are the best positioned to provide insight into the market response to the technologies such as observed barriers to adoption and installation. They can also provide insight into the perceptions of risk to install the technologies within their firms. As part of the Market Watch, we will conduct interviews or surveys as appropriate with participating and non-participating trade allies in 2022 and 2024 of the implementation period with a target of 30 interviews each time. We will offer an incentive of $150 to participants as a thank you for their time, with the option of donating the incentive to charity if they so choose.

General Population Survey

We will conduct an annual general population survey to assess awareness, familiarity, interest, usage characteristics, and decision drivers around space conditioning and water heating. We will utilize this survey to understand where the general population falls in terms of Rogers' Diffusion of Innovation model. We will use a mail push to web approach to recruit customers to take this survey in years 2022 and 2024 of the Initiative. We will offer a $50 incentive for survey completion and anticipate receiving 200 responses.

Mystery Shopping

Mystery shopping provides a way to hear and assess the messages that consumers hear from trade allies, in real time. Large trade allies use layers of their own organization to vet out real customers from the curious to those interested in installation, maintenance, and service. The gatekeepers who answer the phones know what services their firm offers, what equipment they sell, and what the company is most successful at selling and servicing. For instance, if you call three or four contractors to get a bid and mention that you want a high efficiency product, only those that really want to sell the product will schedule a time to visit and provide a bid.

The sales team who visits customers in home to assess their needs and provide equipment bids, tells consumers their perception of the reliability and effectiveness of the functionality of different equipment options. They price the product based on what they think the customer is willing to pay as well as what the firms considers the risk of installing the low-emission equipment in the home. It is common when receiving a bid that trade allies will mention the challenges, they perceive to be associated with installing or servicing low-emission equipment compared to standard or less efficient equipment. As such, over time, mystery shopping calls and visits to receive a bid, can inform the team of the degree to which the trade ally market is changing and becoming more comfortable with heat pumps and heat pump water heaters. This mystery shopping task will be conducted in 2023.

2.3.2 Program Watch

The Program Watch will provide fast feedback to the TECH Initiative implementer team and provide the M&V necessary to evaluate the impact and cost-effectiveness of the Initiative, while assessing what is key to scaling heat pump adoption. We will track the program metrics identified in Table 2 (in black text). Key methods under the Program Watch include a Voice of the Participant panel, outreach, and education content analyses, GHG impact estimates, bill savings estimates, training impacts, and cost effectiveness analyses. The Program Watch allows the Opinion Dynamics team to deliver key information regarding observed responses to program activities, their impact on barriers to adoption, and changes in the dynamics within the supply chain. This will help inform program implementation and ongoing program refinement.

Develop and Utilize Voice of the Participant Panel to Track Program Watch Indicators

We will build a Voice of the Participant Panel to capture the initial program experience among the upstream, midstream, and downstream participants in terms of program activities, the workforce, and the technologies while also allowing us to go back to a pool of participants and collect further metrics that require some time to pass before they can be measured. For example, when a contractor first installs this equipment, we will want to capture everything from the customer and contractor that allows us to identify what is going well and what is needed to improve the program at key moments, such as the decision to switch fuels to building decarbonization technology and the initial installation experience. Over time, we will want to capture further feedback such as technology performance, quality issues, and maintenance issues.

This panel may include full participants and semi-participants (e.g., upstream or midstream actors that engage with the program initially, but do not fully participate in the Initiative). If the TECH Initiative has a difficult time getting the market to participate, then adding semi-participants will allow us to help explore why people drop out of the participation process and what is needed to motivate them to re-engage.

We anticipate working closely with the implementer for ongoing recruitment of participants. The implementer is tasked with creating a centralized database for all TECH incentives. This database will track an appliance, using its serial number, from where it is manufactured through the supply chain to where it is installed. We will use the information in this database to support participant recruitment.

Participants will be asked to join the panel as soon as they begin participating in the TECH Initiative. Participants will receive an incentive for completing a quick survey to join the panel and then will be asked to participate in at least three more surveys for additional incentives throughout the four years of the TECH Initiative. For budgeting purposes, we are assuming a total of 150 participants participating in multiple years with a potential total incentive per participant of $500.

Conduct Process Evaluation Research

To give program managers information to help improve implementation approaches in real-time, we will conduct a variety of tasks that may be employed where needed depending on the actual implementation strategy and schedule for the TECH Initiative. Tasks may include:

- Interviews with Energy Solutions and their relevant subcontractors to develop relationships and establish communication procedures to stay informed of outreach, marketing, education, and implementation plans that are currently in development.
- A review of the data that the implementer plans to capture in light of the PTLM, and the third-party evaluation scope and suggested areas of improvement where needed.
- Rapid-feedback surveys and in-depth interviews with participating contractors. We will gather feedback from participating contractors early in their participation process to determine what is going well and what needs improvement. This will also allow us recruit participants into the Voice of the Participant Panel discussed above.
- Surveys with participating installers and salespeople. We will survey participating installers and sales professionals to assess the effectiveness of the training they receive through the Initiative. We will also explore their overall training experience.
- Surveys with participating end use customers. We will gather feedback from consumers on the installation process and areas for improvement, as well as their perspectives on technology performance and quality.
- A content analysis of the outreach materials, educational content, and training materials as they are developed against a market barrier "yard stick" to determine how well the materials address key market barriers to heat pump adoption.
- Review of data collected by TECH implementers on quick-start grants and regional pilots and interviews with quick-start grant recipients and regional pilot activity partners to assess effectiveness of these activities (focusing on both the process as well as the outcomes.

Draft feedback from this task will be provided to TECH implementors via briefings and presentations to expedite the feedback process. Formal reporting will still occur, but our goal is to get information back to the implementors as fast as possible without waiting for multiple rounds of report edits to call a product final.

Conduct Program Impact Evaluation

Impact evaluation of a market transformation program is complex, especially when the savings metric is GHG emission reductions (an output dependent on hourly energy use). Our impact evaluation is structured to verify the GHG savings from program participants, with the ultimate output of a statistical estimation of the program's total emissions reduction.

Measurement and Verification Methods

Our measurement and verification (M&V) engineering methods will adapt guidance from the California Energy Efficiency Evaluation Protocols and other requirements as identified in collaboration with the CPUC. While the protocols expressly focus on energy savings and do not mention GHG savings methods, we believe these methods can still be followed and will be the most broadly acceptable by stakeholders, as well as more easily reviewable. The analysis team will primarily use actual metered data for the analysis, but other methods including engineering desk reviews, phone and virtual verification, onsite verification visits, and site-specific engineering regression analysis with billing or AMI data may also be used as supplemental methods. While

the final goal of these analyses is to calculate GHG reductions, the preliminary outputs are verified gross electricity consumption and peak demand savings, as well as natural gas savings for each of the sampled projects. Our full suite of M&V methods and when we will possibly utilize this is shown below in Table 3.

Table 3. M&V Methods

M&V Method	What is it?	Typical Use Case	Pros	Cons
Engineering Desk Review [Will be used for all sampled projects]	Due diligence review of implementer project files and calculations	All sampled projects and measures. Can operate as standalone method or as a first step.	▪ Lowest cost verification method ▪ Fast results ▪ No customer disruption ▪ No safety concerns	Least rigorous of all verification methods
Onsite Verification + Metering [Direct onsite metering will be used for all sampled projects]	Onsite verification with data logging to determine operating characteristics	Measures with high savings and/or high uncertainty Projects with savings greater than the metering thresholds established in the Phase IV TRM	▪ Can catch operating irregularities that would otherwise go unnoticed ▪ Highest rigor method ▪ Controls for self-report bias on equipment operation	▪ Safety can be a significant concern ▪ Highest cost ▪ Highest level of customer disruption ▪ May require multiple trips to customer ▪ Short metering periods may not be representative of full year
Telephone Verification [May be used for supplemental information on sampled projects]	Phone call with customer to confirm measure quantities and basic project characteristics	Simple measures with low savings uncertainty	▪ Low to medium cost ▪ Easy to catch big issues, such as non-installation or large operating hour discrepancies ▪ Minimal customer disruption ▪ No safety concerns	▪ Low rigor method ▪ Not suitable for measures with high complexity ▪ Can be difficult to communicate with customers not versed in energy efficiency
Virtual Verification [May be used for supplemental information on sampled projects]	Live or recorded video conversation with customer to confirm measure installation	Relatively simple measures with low to medium savings uncertainty	▪ No safety concerns ▪ Low to medium cost ▪ Medium rigor ▪ Can catch more nuanced issues with the EEM	▪ Potential technical difficulties can be frustrating for customer ▪ Not sufficient for highly complex measures ▪ May be viewed as invasion of privacy

M&V Method	What is it?	Typical Use Case	Pros	Cons
Onsite Verification [May be used for supplemental information on sampled projects]	"Boots on the ground" physical confirmation of measure installation	All measure types	▪ Suitable for some highly complex measure ▪ High rigor ▪ Easy to verify measure quantities and nameplate data	▪ Safety may be a concern ▪ Higher customer disruption

Below are considerations that produced the final analysis methods:

- Primary analysis will be informed by connected, circuit-level, real-time meter data via equipment installed at each sampled site.
- Real-time metering will be possible via connected add-on circuit-level devices. Major end uses of interest (HVAC and water heating) are likely to be on individual circuits as required by building codes.
- Telephone verification can help verify basic data points like fuel (gas vs. electric) of replaced technology, baseline presence/absence of electric space cooling, occupancy characteristics, household demographics, and equipment setpoints
- Engineering desk reviews can confirm efficiency level of equipment, coupled with data collected from telephone verification it could produce a low rigor estimate of savings
- On site verification may be needed for larger or more complex projects (multiple units installed in a multifamily buildings) and could be used to submeter systems if deemed necessary
- Site specific regression analysis (adapting NMEC methods) on both gas and electric consumption data can verify fuel substitution impacts.

Embedded Evaluation Approach

The program evaluator is implementing an embedded evaluation approach so that real-time, robust data and results can continuously inform program design, implementation enhancements, and policy decisions. This approach will enable data-based course correction with short feedback loops as envisioned in D.20-03-027. One aspect to the TECH Initiative that make it viable for tracking energy use data in real-time is that metering devices can be installed at the same time as equipment installation. Installing web-enabled metering devices after the original incentivized equipment has been placed in service adds cost of labor and materials while also being disruptive to the building occupants. The incremental cost would be significantly less than installing these separately and after the equipment has been installed. The Opinion Dynamics team is working with the implementation team to determine if this is feasible. If it is not determined feasible, the Opinion Dynamics team will work with the implementation team to recruit participants and visit homes to install add-on circuit-level metering devices after-the-fact.

Discussion of Add-on Circuit-Level Metering Devices

Add-on circuit-level metering devices are installed within a traditional electrical panel (after the panel's installation) and can log both the power main lines within the panel (ie: whole house energy usage), as well

as the energy used by individual circuits. This includes both 240V circuits (such as for HVAC and other large equipment) or 120V circuits (such as for plug loads and smaller equipment). Aside from the device's presence within the breaker box, installation is unobtrusive, largely relying on current transducers (CTs) that simply clamp *around* existing wires. Depending on the unit, up to 30 channels might be available to monitor different end uses. These types of meters are also web connected.

Circuit-level meters can meter and transmit both whole home and circuit-level metering data to the web. For TECH, this would mean specific, accurate data on heat pumps and heat pump water heaters, as well as data for the whole residential unit.

Circuit-Level Add-on Device Advantages

- Circuit level meters are less costly than entire smart panels. Material costs might range from $150 to over $500.
- Using capturing circuit-level data provides good data quality, particularly for end uses of high importance.
- The evaluation team has extensive experience conducting evaluations with eGauge meters (one common vendor) but is still evaluating the reliability and accuracy of meters from other vendors.

Circuit-Level Add-on Device Disadvantages

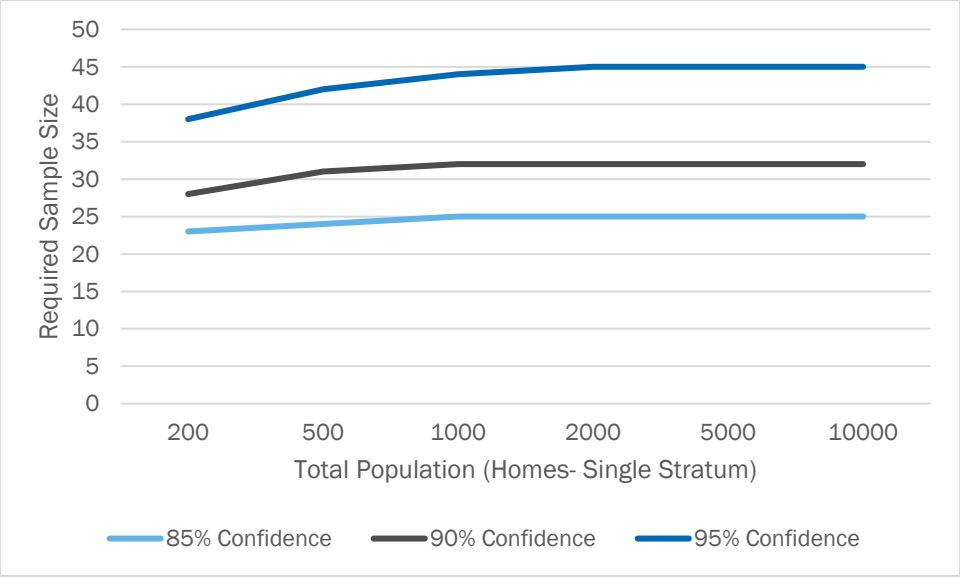
- Circuit-level metering devices may be subject to tampering and/or removal by homeowners or other entities. Such behavior has sometimes been observed in the past by the evaluation team.
- Typically, a licensed electrician is required to install such devices, and after construction has been completed. This might take up to two hours per site for installation and configuration, offsetting the seemingly low material cost.

Sampling Approach

After downloading and cleaning the data from implementers, the evaluation team will work to determine the most efficient sampling design that will achieve a 85/15 or better level of confidence and relative precision (taking guidance from the California Energy Efficiency Evaluation Protocols).

Participant sampling will follow a dynamic sampling methodology executed on an annual basis to achieve the required relative precision targets for defined sampling groups. Sampling necessarily requires knowledge of specific population sizes but will be designed to achieve an 85/15 or better level of confidence and relative precision. Figure 3 depicts required total sample sizes, given population size and confidence targets (with 15% relative precision and 0.5 coefficient of variation). Note that this assumes that the population is a single stratum of homes and only represents a minimum sample to achieve statistical confidence.

Figure 3. Required total sample sizes, given population size and confidence targets (with 15% relative precision and 0.5 coefficient of variation)



Based on the final population of installed units, there may be some cause for stratification of the sample – by climate zone, building type, or DACs. Stratified random samples can produce estimates with smaller coefficients of variation than simple random samples, making the final sample much more efficient and more representative of the overall population. We will use stratified samples where possible because of their sampling efficiency. As such the evaluation team will stratify the sample if significantly different groups of participants emerge during program implementation. (At a minimum, there will be different sampling strata for heat pump HVAC units versus heat pump water heaters.) When incorporating multiple strata, the require total sample size will be perhaps slightly higher than the total number of sampled units outlined in Figure 4.

Our approach to dynamic sampling when evaluating on a yearly basis is to draw a "wave one" sample in the third quarter of the program year and a "wave two" sample at the end of the program year. Actual sample sizes will depend on program participation and stratification decisions and will be determined at a later date but will ensure a representative snapshot of the program period being evaluated, 'trued-up' to account for any projects that emerge late in the program year(s). Our team will draw a random sample to select projects for review and analysis.

GHG Impacts

SB 1477 requires TECH Initiative metrics to include an assessment of cost per metric ton of avoided GHG emissions. The basic approach to estimating GHG savings is to apply emissions factors to estimates of the change in gas and electric energy use. While this seems like a simple task on paper, it can be complex in execution.

We do not intend to reinvent the wheel; we aim to avoid developing yet another emissions savings calculation methodology or tool. Rather, we aim to leverage existing state-agency approved tools, methods, and data sources as much as possible. We also strive to apply consistent methods and emissions factors across both the Programs so their benefits can be presented in an "apples to apples" manner.

Emissions will be calculated for each sampled project. We will then extrapolate at the stratum level (or equivalent) to arrive at the program total emissions savings. The resulting total verified energy and emissions savings will be compared to the reported savings to determine the realization rates.

Spillover

This type of analysis alone will inevitably miss out on the spillover effects that we expect to see from market transformative initiatives. However, if any spillover is quantified through research described in Task 3, we will extrapolate evaluated savings from the program population to the spillover population.

Incentive Layering

There are currently several programs in California offering incentives for heat pump technologies. The TECH Initiative implementer is coordinating with some of these programs to advance building decarbonization. A recent CPUC Decision (21-11-002) offered non-binding guiding principles for how to allocate credit for program benefits when multiple programs are contributing incentives to the same measure. In our evaluation of the TECH Initiative's benefits, we will follow the Decision's principles. Specifically, we will:

- Acknowledge in our reporting the overlapping nature of building decarbonization incentives and the fact that multiple programs may be influencing uptake and market share increases.
- Attribute all credit for energy savings to Energy Efficiency programs alone.

The TECH Initiative aims to transform the market for clean heating technologies and avoid greenhouse gas emissions. Therefore, its goals are distinct from energy efficiency, and the TECH Initiative may receive full credit for the installation of measures it incentivizes. It is not necessary to allocate partial credit when a measure receives multiple incentives as part of the TECH Initiative.

All incentives supporting the measures installed through the TECH Initiative will be tracked in the single online platform that the TECH implementer will develop. We will use the information in this online platform to determine that the implementer has followed another key guiding principle in the Decision, specifically, that the sum of all incentives for a given measure do not exceed the total costs of the equipment and its installation.

2.3.3 Technology and Policy Watch

This task will allow evaluators, Commission staff, program managers, implementers, and stakeholders to stay informed of the evolution of heat pump (HP) technologies and other BD technologies throughout the course of the contract. Without a broader understanding of the changing markets and technologies, it is difficult to discern what changes are directly attributable to the TECH Initiative versus impacts associated with other changes in the marketplace. This can also inform the inclusion of newer technologies into the TECH Initiative and other BD programs. We will accomplish this through "Technology and Policy Briefings" developed annually. These briefings will provide valuable insights on the latest updates in BD technologies, markets, and research across the U.S. The Technology and Policy Briefings will result in improved understanding by program designers and policymakers of the other various drivers that contribute to changes in the market.

The Opinion Dynamics team will utilize our cross-functional team of experts to source information and generate the content to achieve the desired results. Data gathering will all be based on secondary sources reviewed and analyzed by the Opinion Dynamics team as well as program tracking data and relevant evaluation data. The length of the Technology and Policy Briefings will vary from briefing to briefing depending on the activity during the preceding year. The Opinion Dynamics Team proposes that each Briefing contain the following:

1. **Technology:** Performance and costs for available residential technology across both:
   1.1. **Available products**: New product releases for both typical/average products as well as the newest best-in-class products (including regional notes as appropriate); tech spotlight for new releases that notable for cost, performance, or configuration
   1.2. **Performance and cost updates**: Advances of best-in-class products and typical or baseline products
   1.3. **Research, development, and demonstration (RD&D)**: Latest RD&D funding announcements and news on outcomes
2. **Market:** National shipment volumes and market evolution insights for the residential segment
   2.1. **Shipments**: Overview of electric technology market relative to other benchmarks (for example, similar gas appliances)
   2.2. **OEM/Supply chain/contractors**: New market entrants or big moves by existing players
3. **Incentive and Policy:** Substantive changes in incentives and policy at Utility/State/Federal level to drive changes in public support of any type, as well as noteworthy changes in incentives by progressive utilities that have decarbonization goals

2.4 Task 4. Cost Effectiveness Analysis

The Evaluation Team will review the existing cost-effectiveness evaluation framework of California's ratepayer funded program and propose a cost-effectiveness evaluation approach that is appropriate for the program goals set by SB 1477. We will work the with CPUC, CEC, and other key subject matter experts to develop this approach. Our proposed methodology will be presented for stakeholder feedback. Depending on the outcome, the Opinion Dynamics team with work with the CPUC to determine if the cost-effectiveness methodology should be applied to the TECH Initiative.

2.5 Task 5. Stakeholder Communications

The evaluation team will participate in stakeholder meetings facilitated by the TECH implementation team and present evaluation status, findings, and recommendations as needed. As directed in CPUC D. 20-03-027, the Evaluation Team will also hold Project Coordination Group (PCG) meetings quarterly, beginning in Q1 2022, to facilitate the communication of evaluation insights and support coordination between the BUILD Program and the TECH Initiative.[3] The stakeholder process is critical to developing comprehensive and transparent evaluation and research.

2.6 Task 6: Evaluate Effectiveness of Technical Assistance, Education, and Outreach

Our team will evaluate technical assistance, education, and outreach through the metrics codified in Table 2 and the tasks outlined in Task 3 including interviews and/or surveys with manufacturers, distributors,

[3] CPUC D.20-03-027 at http://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M331/K772/331772660.PDF

contractors, installers,salespeople, and end-use customers, review of Initiative tracking data, a mystery shopping study, and content analysis of outreach and educational materials.

2.7 Task 7: Reporting and Feedback

Our team will develop and regularly update a system or process for reporting, monitoring, and providing feedback for the TECH Initiative. We will:

- Provide the CPUC, implementers, SCE, and the public with regular evaluation updates on each of the program metrics identified in this evaluation plan (including ones added due to programmatic evolution);
- Report to SCE information required by ED for semi-annual reports of expenditures incurred for BUILD and TECH evaluation; and
- Work with the CPUC, and SCE where applicable, to develop requirements for gas companies' CARB annual reporting in accordance with the California Cap on Greenhouse Gas Emissions and Market-Based Compliance Mechanisms, title 17, California Code of Regulations (CCR), section 95893. The report will be delivered by the Evaluator to the gas companies, in a timely manner, and must detail:
    a) Total avoided GHG emissions from that year's expenditures (evaluated); and
    b) Total expenditures.

Opinion Dynamics will lead monthly check-in meetings and progress reports with SCE, CPUC, and CEC staff, in addition to communications on time-sensitive issues, as needed.

Our team will provide comprehensive evaluation reports annually and a final report capturing the entire Pilot period. Our team will also present annually and again at the final stage, each time telling the story of the synthesized research findings across the entire study.

In addition, we will report to SCE information required by ED for semi-annual reports of expenditures incurred for the BUILD Program and TECH Initiative evaluation, and work with the CPUC, and SCE where applicable, to develop requirements for gas companies' CARB annual reporting in accordance with the California Cap on Greenhouse Gas Emissions and Market-Based Compliance Mechanisms, Title 17, California Code of Regulations (CCR), section 95893. We will deliver this report to the gas companies, in a timely manner, and detail (a) Total avoided GHG emissions from that year's expenditures (evaluated); and (b) Total expenditures.

3. Timelines and Deliverables

The Master Consulting Services Agreement for the TECH-BUILD Evaluator was made as of the following date June 28th, 2021, with a final Purchase Order issuance date of August 5, 2021, by Southern California Edison (SCE). As such, the contract year is defined as August 1 through July 30 of each year. Table 6 illustrates the estimated delivery of written reports, presentations, and PCG meetings throughout the first contract year—August 5, 2021, through July 30, 2022. We will develop a Year 2 contract schedule for delivery of written reports and presentations in Q4 of the preceding contract year.

Figure 4. Written Report and Presentation Schedule

Contract Year	Deliverable Milestone	Milestone (Estimated Timing)
1	Draft Evaluation Plan	December 2021
1	Draft Technology and Policy Brief #1	January 2022
1	Final Evaluation Plan	January 2022
1	Final Technology and Policy Brief #1	February 2022
1	PCG Meeting	February 2022
1	Semi-annual Progress Report	February 2022
1	Draft Baseline Market Assessment	April 2022
1	CARB Reporting Draft Report	April 2022
1	Final Baseline Market Assessment	May 2022
1	CARB Reporting Final Report	May 2022
1	Baseline Market Assessment Presentation at PCG Meeting	June 2022
1	Draft Early Finding Process Research Memo	June 2022
1	Contract Year 2 Deliverables, Presentations and Meetings Schedule	July 2022
1	Draft Early Finding Process Research Memo	July 2022
1	Semi-annual Progress Report	July 2022

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