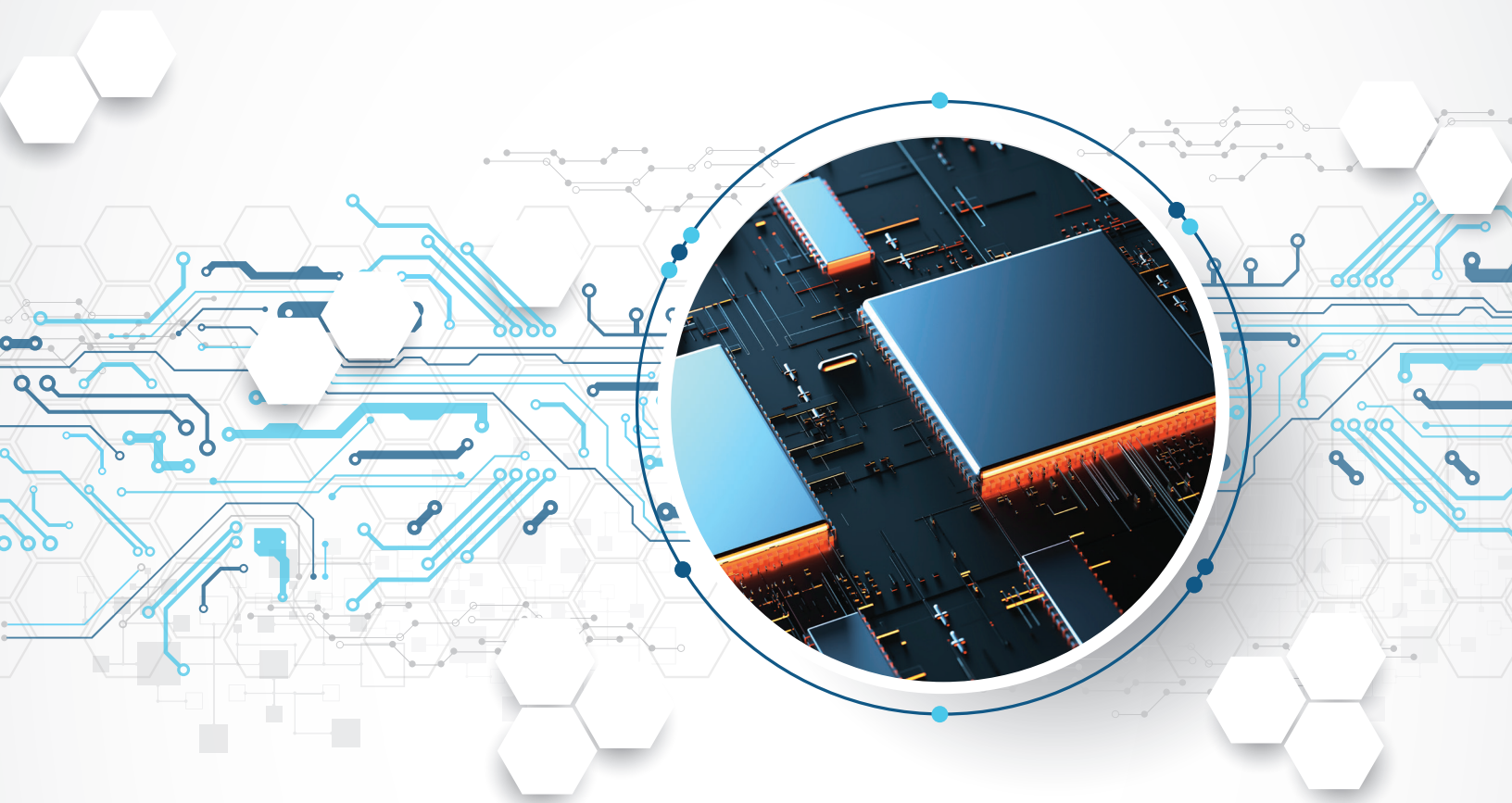




Opinion **Dynamics**



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

EVALUATION PLAN

NOVEMBER 24, 2020

Subcontractor(s)



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1. TECH Initiative Evaluation Plan

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), in consultation with the California Energy Commission (CEC), to develop two programs with a combined annual budget of \$50 million per year focused on reducing direct GHG emissions from buildings: the BUILD Program and the TECH Initiative. The TECH Initiative is designed to accelerate adoption of new heat-pump based technologies for space and water heating. These technologies are in the early phases of adoption, and are therefore, scarce in the residential market today. Given the potential of heat-pump based technologies to reduce GHG emissions, the CPUC, in consultation with the CEC, is looking to heat-pump based technologies as a key element to meet its carbon-free goal.

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. Below, we propose an approach to evaluate the effectiveness of the TECH Initiative over the next four years.

1.1 Evaluation Goals

The overarching goals are to evaluate the program development and implementation of the TECH Initiative, as well as assess short-term and long-term impacts. We will use an embedded evaluation approach to our research which allows us to adapt our methods early in the program design and implementation process and provide insights at key decision points. This approach allows us to develop relationships with implementers early on so that we can infuse real-time evaluation insights into every step of program design and implementation. This 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:

1. Evaluate the effectiveness of Implementation

- Identify, measure, and track program performance metrics. The Opinion Dynamics team will measure customer satisfaction, outreach, and other program metrics that will be key to scaling all-electric adoption in California. We will embed evaluation in implementation as much as possible by consulting with the implementation team to recommend data they can capture from program participants, such as existing equipment replaced, and program questions received. We will also provide early feedback to program managers. For example, as program materials are developed, we will help evaluate that content to ensure it adequately addresses market barriers and will resonate with the target audience. Further, we will provide early feedback on the customer experience with the Initiative and associated technologies as a positive customer experience is needed to create a “ripple effect” and is key to scaling this technology.
- **Conduct Impact Evaluation**
 - Assess the volume of GHG emission reduced and avoided
 - Assess the cost per metric ton of avoided GHG
 - Assess the increase or decrease in source GHG due to curtailed natural gas pipeline, increased electric loads, increased transmission or distribution losses, or other factors

- Discern the impact of the TECH Initiative on GHG savings from other programs with similar goals and account for cross-program interactions
- Assess and recommend appropriate set point schedules for installed equipment
- Assess projected utility bill savings
- **Assess Coordination.** The Opinion Dynamics team will identify and evaluate whether the pilot programs successfully coordinated with and leveraged other parallel programs, such as ratepayer-funded programs, federal and state tax credit programs, and air quality management district programs.
- **Assess effectiveness of program design, program scalability, and policy design.** The TECH Initiative pilot is designed to develop valuable market experience for the purpose of decarbonizing California’s residential buildings. 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.

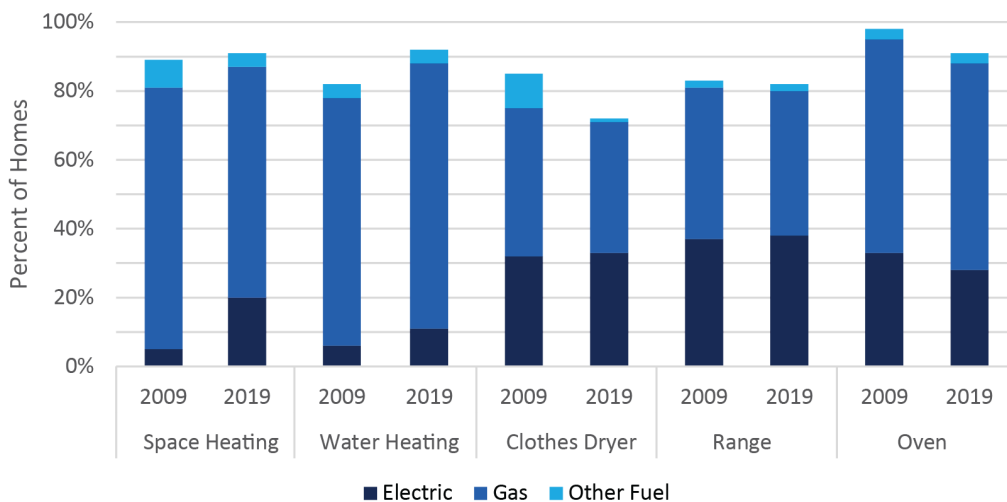
2. Evaluate the Long-Term Market Impact

- Identify market metrics
- Conduct a baseline market assessment
- Conduct ongoing measurements of the market over time
- Identify, document, and where possible, quantify market effects

1.2 Marketplace Entry and the Technology Adoption Lifecycle

When considering how to best assess the market for space and water heating technology, it is important to consider where the technology is right now in terms of market adoption. Based on the most recent market data available, the TECH Initiative is entering a nascent, but growing, heat pump marketplace in California with large potential for decarbonization. Appliance saturation studies in California show residential electric use for space heating has quadrupled and water heating has doubled over the last 10 years (Figure 1).

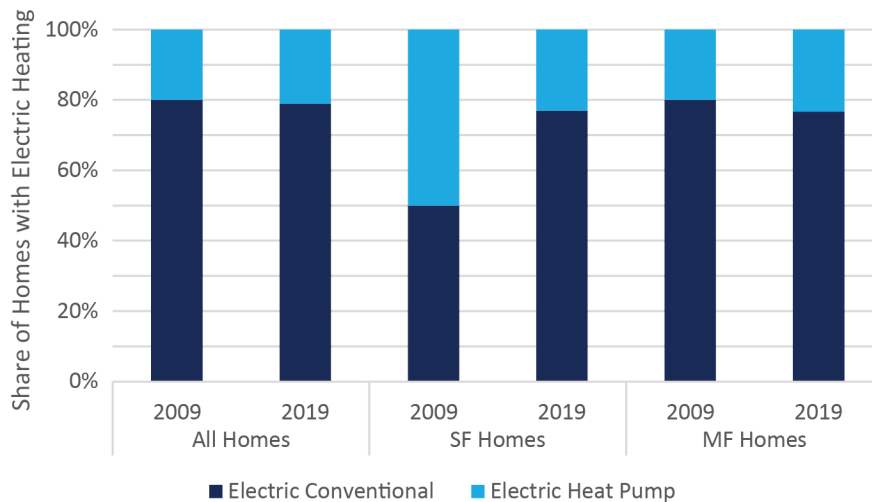
Figure 1. 10-Year Comparison of Electric vs Gas Appliance Saturation in CA



Source: RASS 2009 and RASS 2019

Despite the large growth in electric space heating, the proportion of electric space heating provided by heat pumps (as opposed to conventional electric heating) has not significantly changed in the residential sector. Figure 2 shows heat pumps holding a relatively stable share of the electric heating market, at roughly 20%. Data for single-family homes shows the share of heat pumps has decreased. While there has been growth in the total stock of heat pumps in the installed base, it has been far outpaced by the growth in conventional electric space heating.

Figure 2. 10-Year Comparison of Share of Electric Heating by Technology Type



Source: RASS 2009 and RASS 2019

Now, 20% of the market has electric space heating while 11% have electric water heating. However, most of the electric space and water heating technology in homes today is not considered highly efficient. There are 12.2 million space heating units across residences in the CA IOU territories and only 4% of that equipment is electric heat-pump technology. In the water heating market, there are 12.1 million water heating units and only 1% of that equipment is electric and high efficiency¹.

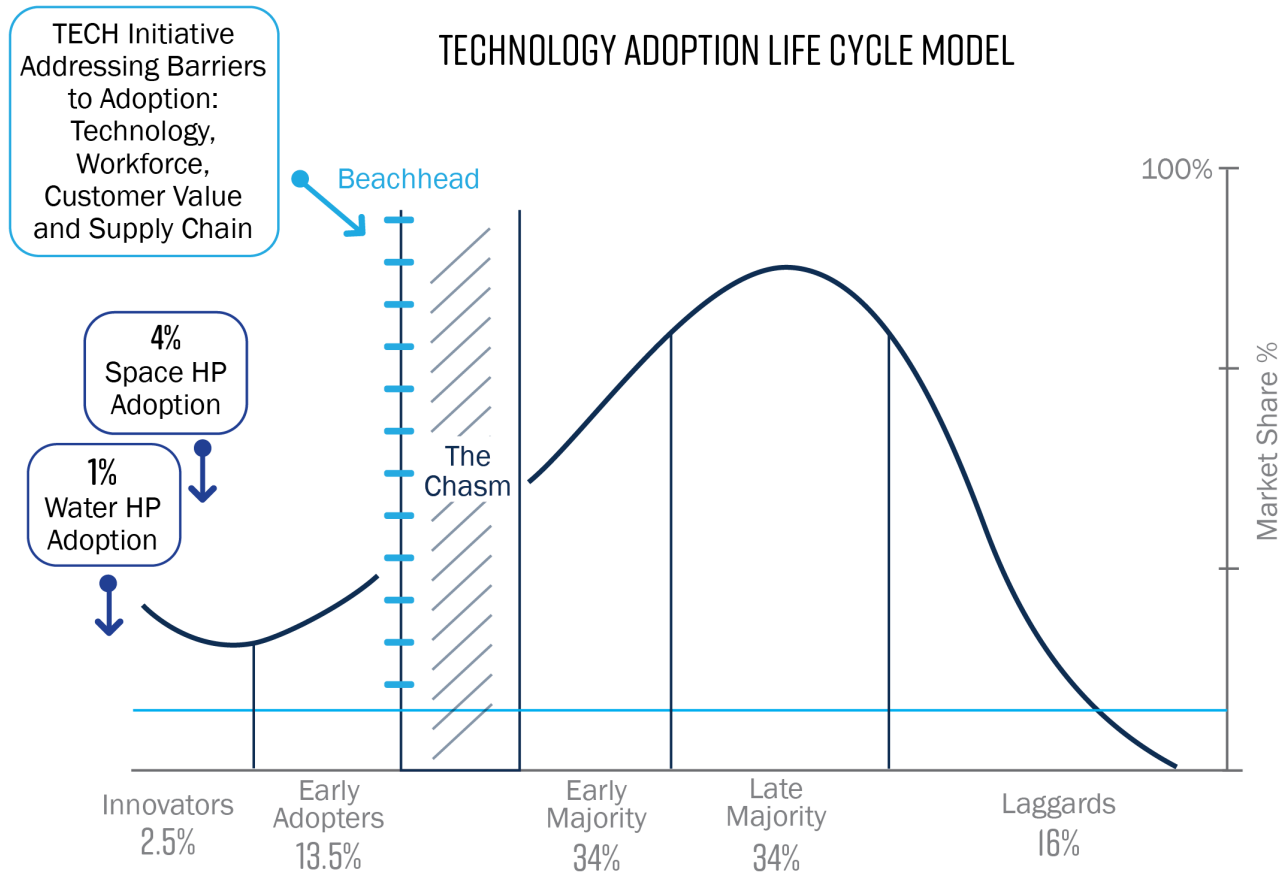
When considering how to assess market transformation for innovative technologies such as heat pumps, Roger’s Diffusion of Innovation model (2003) provides a solid foundational adoption model framework for how to characterize where the market is in the adoption curve and what market metrics are most important to track given the market adoption stage. Rogers’ Diffusion of Innovation model describes stages of market adoption through defining a progression in the types of consumers that the technology will likely attract throughout its adoption lifecycle. This classification includes five adopter stages from innovators to laggards (Figure 3).

Given that only 1-4% of the market has adopted heat pump technology to date, the market is mainly in the early innovator stage but nearing the early adoption stage. At these stages, there are many barriers to address before the market can cross the chasm into the early majority which is where the TECH initiative is beginning its journey towards market transformation. Geoffrey Moore, in his book *Crossing the Chasm* (2014), states that the most difficult step for emerging technology is making this transition between early adopters and the early majority. Innovators and early adopters are dominated by a small group of visionary customers who are

¹ Market penetration of electric heat pump technology based on 2019 RASS Data. For space heat, 20% of the market is electric and 20% of the electric equipment is heat-pump based. For water heat, 11% of the market is electric and we estimate that 10% of that is likely potentially high-efficiency equipment.

quick to appreciate the nature and benefits of the new technology; whereas the early majority represents the mainstream market who are largely pragmatists in nature.

Figure 3. Technology Adoption Life Cycle Model for Water and Space Heat Pumps



In our significant experience evaluating market transformation programs across the country, we have observed that workforce and program implementation strategies are critical to successful programs that effectively “cross this chasm.” We anticipate that customers with existing electrical space and water heating systems and those with central air conditioning are more apt to be early adopters as the barriers to install heat pumps are much lower. Customers with solar PV also are likely to be part of this group once they connect the advantages of owning both heat pumps or solar thermal equipment and solar technologies. However, when the market starts to move into the early majority, these customers will want to see well-established case studies of heat pump technologies before investing. The time of adoption tends to take significantly longer than the innovators and early adopters. Capturing the attention of pragmatists and encouraging them to adopt decarbonization technologies, will require contractors to be aware of the technologies, understand the features of the technologies, and be able to communicate the value propositions. Contractors will need compelling case studies to demonstrate the value of the technologies and calculators to estimate bill savings over time to convince these customers to adopt decarbonization technologies.

As such, for the TECH Initiative, the following characteristics across the technology, workforce, supply chain and customers involved constitute the beachhead that will be needed to cross the chasm into early majority

stage of market adoption. As such, much of the program and market metrics that are important to capture and track in the first four years of the program revolve around these areas:

- **Technology:** The technology will need to perform as we hope it will. It needs to prove it can be a clean energy solution by showing GHG emission reductions while also being a quality and reliable alternative to other fuel technology options. The relative advantage of heat pump technology over other space and water heating options and compatibility with existing home characteristics are key issues for technology adoption in California.
- **Workforce:** The workforce needs to be aware of and knowledgeable about the technology; they need the skills to install it and to realize the value in selling and promoting it. While this seems like an easy task, our research has uncovered that water heater installers believe with conviction that it is not possible for a water heater to be more efficient than a tankless water heater. The Initiative will need to debunk this belief system first and then teach them the merits of the replacement system. At this early stage in the marketplace, the role of the installer will be paramount to market adoption. Installers are the voice for the technology, and they frame the perceptions of the technology for customers. Given that space and water heater purchases occur every 10 to 15 years, installers often act as the “trusted advisor” in making this infrequent purchase decision. To make the jump from early adopters to early majority, the TECH Initiative must consider not just the consumer diffusion curve, but also the workforce diffusion curve.
- Opinion Dynamics is currently conducting a market characterization study of the heat-pump market in CA as part of our Group B contract. In this study, we are exploring barriers to heat pump adoption focusing on the supply-side of the market. We have learned that the workforce and supply chain actors generally have little awareness of heat pump technologies; do not have the skills to sell, install, or maintain it; and are not actively promoting it because they do not see the value of it in relation to other space and water heating technology choices. Interviews with HVAC trade allies uncovered that education, both on the part of the customer and contractor, is a key barrier. Distributors report that contractors are reluctant to adopt new, unfamiliar technologies and contractors that are familiar with the technology report some customers are hesitant to adopt heat pumps because of their unfamiliarity with the product. Another common concern is the cost of electric technologies as compared to the cost of gas technologies and whether customers will save money by switching to an electric system that is running year-round. Up-front cost of the heat pump equipment itself is also a barrier. The heat pump equipment is more expensive for customers, especially when they have an older home and require an electrical panel upgrade. Finally, according to trade allies, customers are more concerned about up-front costs than they are about the cost-benefit over time.
- **Supply Chain:** The product needs to be available through manufacturers and distributors. While our research has uncovered this is a minimal challenge for space heating and cooling technologies, it is definitely a challenge on the water heater side. Most customers are not willing to go without hot water for days at a time which is a significant barrier in this market. Given that customers often purchase space and water heating equipment every 10-15 years, coupled with the significant market barriers that must be overcome to accelerate market adoption, it may take several years before we see the heat pump saturation significant increase and move into the early and late majority stages of the market. However, there are several market signals that indicate this technology might lead to a major paradigm shift in how Californian’s heat their homes and water needs. For example, air source and

warm air heat pumps shipped in the United States over the last 20 years² have grown from 27% of all space heating technology shipments to 47%.

- **Customer Value:** Customers need to be aware of and knowledgeable about this new technology and when they try it, they need to have a positive experience that sparks a ripple effect in the marketplace. Our research indicates that residential customers are overwhelmed by the technical complexity of space and water heating systems and thus, tend to select “like for like” replacements, unless contractors can make a compelling case for the new technology.

1.3 Program Theory and Logic Model

Our evaluation approach will be grounded in the program theory and logic of the TECH Initiative. The TECH Initiative, directed by SB 1477, aims to advance the market for low-emission space and water heating equipment in existing buildings by identifying and targeting technologies that would assist the state in achieving its greenhouse gas emission goal by 2030. The TECH Initiative will achieve this goal through upstream market development, consumer education, contractor and vendor training, and the provision of upstream and midstream incentives to install low-emission space and water heating equipment.

As noted in the previous section, the TECH Initiative is entering a market with significant barriers to adopting heat pump technology for space 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 |

To address many of these market barriers, the TECH Initiative is expected to include the following main activities:

- Provide incentives and create partnerships with supply-side market actors to promote electric space and water heating equipment (upstream);
- Design and manage market facilitation activities, including workforce development, education, and outreach (midstream);

² AHRI. *Historical Data*. <http://www.ahrinet.org/Resources/Statistics/Historical-Data>

- Manage the procurement and administration of a portfolio of high-impact pilot projects and strategy-testing engagements with local, regional, and other third-party implementers (quick start grants); and,
- Manage a prize program for innovative programs for building decarbonization.

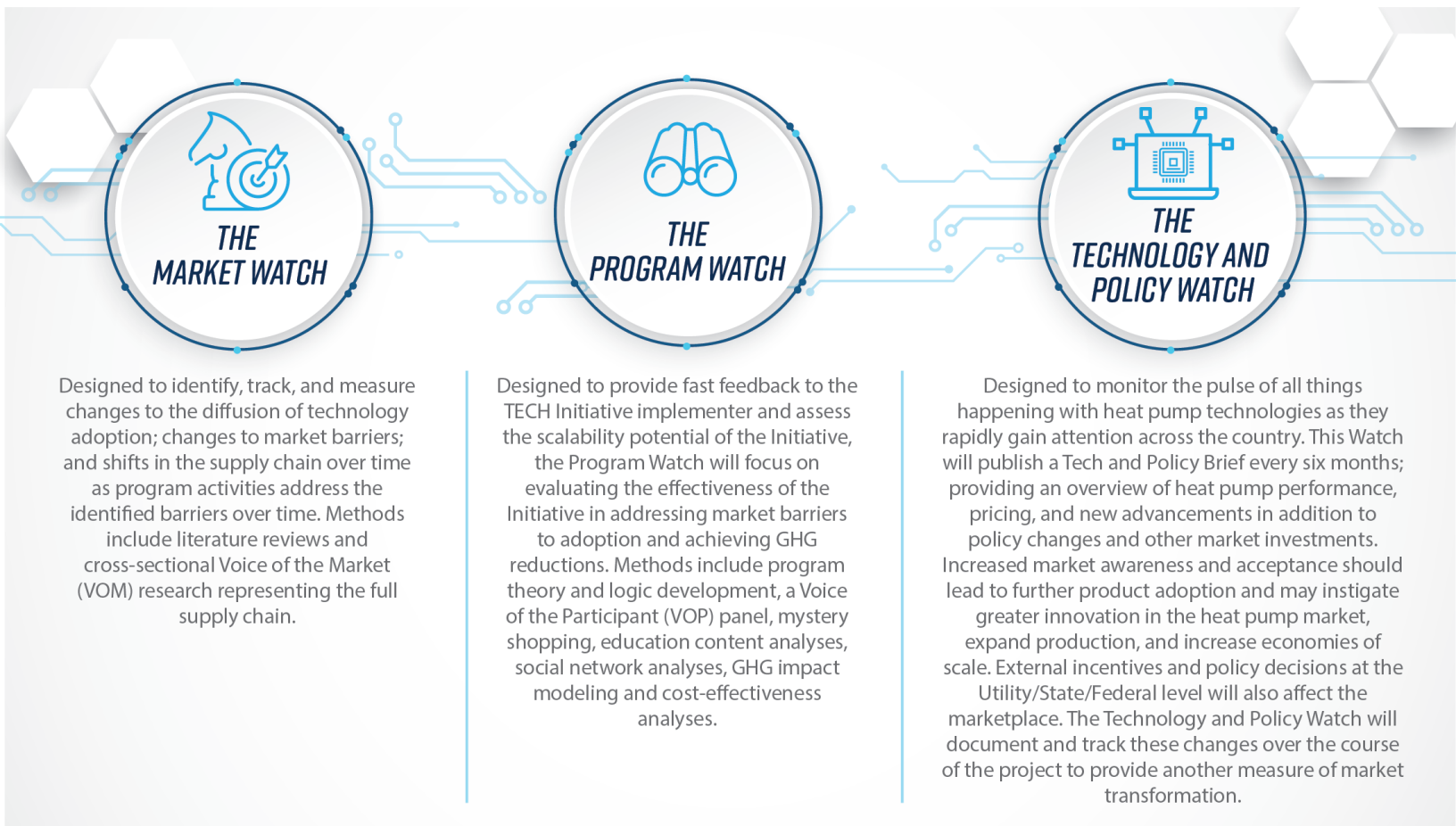
Below (Figure 4) is an illustrative Program Theory and Logic Model (PTLM) based on what we could gather from the publicly available materials that describe the intent of the initiative. This represents the barriers the TECH Initiative plans to address, the program activities, and the outcomes expected. For the purpose of this proposal, we suggest an evaluation plan based on this preliminary PTLM. Our first step in the evaluation will be to better understand the actual program logic model in its entirety. One of our first proposed tasks will be to review the TECH Initiative's logic model with implementation staff and recommend improvements and updates where necessary and align our evaluation plan with the final PTLM.

Figure 4. (Illustrative) TECH Initiative PTLM

| TECH Initiative | | | | | | | | |
|--|--|---|--|--|--|--------------------------------------|---|-------------------------------------|
| <p>Key market barriers to the TECH Program:</p> <ul style="list-style-type: none"> ▪ Low interest and awareness ▪ Low perceived contractor value ▪ Low perceived customer value relative to price and other technologies ▪ High upfront costs | | | | | | | | |
| Activities | Create partnerships with supply-side market actors | Design and manage workforce development education and outreach (Distributors, Contractors, Consumers) | Manage the procurement and administration of high-impact pilot projects and strategy-testing engagements with local, regional and other third-party implementers | Manage a prize program for innovation (quick start grants) | Upstream and midstream incentives for equipment | Coordinate with synchronous programs | Assess further technology | |
| Awareness & Knowledge Outcomes | Market actors promote electric space and water heating equipment | | Customers, builders, contractors and policy makers are aware of and encourage BD tech | | Contractors realize the value BD compared to fossil-fuel heating | | Skilled, trained, and motivated workforce to install and service the technologies | |
| Behavior Outcomes | Customers choose BD equipment | Positive customer experience causes ripple effect | Increased availability and lowered cost of technologies | Supply-chains and delivery agents can meet demand for BD | GHG Reductions | Accelerate deployment of BD measures | Energy Savings | Contribute to market transformation |

1.4 Overview of Evaluation Approach

The Opinion Dynamics team proposes research methods to monitor three key areas: the market, the TECH Initiative, and the technology landscape.



1.5 Identification of Market and Program Metrics

The ultimate metrics measured should directly align with the Program Theory and Logic Model and tie directly to the market barriers that the TECH Initiative is attempting to address to accelerate adoption. In addition, the metrics we measure should align with the stage-gate criteria defined for market transformation initiatives in Decision 19-12-021.³ These stage-gate criteria include: greenhouse gas reductions, energy savings, workforce development, and equity. When determining metrics and how to measure them most effectively, there are a number of factors we will need to consider.

- **Temporal aspects of metric tracking.** The timing of realized energy impacts, greenhouse gas reductions, and workforce development advances matter at several temporal scales. Most notably, the time of day in which impacts occur. A program is most effective if it is reducing load when the grid most needs it, and conversely, not adding load when the grid is already strained. When the system reaches its peak, more fossil fuel intensive supply-side resources are typically called upon. This means

³ <https://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M321/K507/321507615.PDF>

the TECH Initiative should strive to support minimizing the use of fossil-fuel peaker plants and measure progress toward that goal. Research on the transition to all-electric homes suggests that significant changes to the grid infrastructure will be needed. By combining DR controls with EE equipment, a program can have greater load-shaping capabilities and ultimately serve California's GHG reduction goals most effectively. Workforce development advances will take longer to materialize. As a result, defining key market indicators to measure progress in the short term and longer term will be necessary.

- **Locational aspects of metric tracking.** Due to the power energy mix of the load serving utility, GHG savings from a given project depend on where that project is located. Consequently, the TECH Initiative may achieve varying results depending on where projects are completed. According to the CPUC's draft R.19-01-011 Phase II Staff Proposal, the RFP for the TECH Initiative implementer instructs the implementer to build a database "...to track an appliance, using its serial number, from where it is manufactured through the supply chain to where it is installed." Assuming this database is fully implemented, our team would be able to track locational metrics including installed service territory, relation to DACs, climate zone (for weather sensitive analysis), and further locational reporting, as necessary. We outline alternative strategies to fill the gap in Task 3. Program Watch if this database is not fully implemented.
- **Short-term needs for the TECH Initiative and long-term metrics for scaling decarbonization pilots and strategic planning.** As Decision 20-03-027 states, "Scalability is a critical criterion of evaluation different program design and implementation options." When considering metrics for the TECH Initiative, we will ensure we are measuring the key strategies underlying the TECH Initiative to understand the potential for scaling these strategies across the portfolio. We will also carefully consider the needed level of confidence and precision for shorter-term TECH Initiative metrics as well as longer-term scalability metrics to ensure we right size our investment in evaluation, measurement, and verification research.
- **Interplay of resource acquisition with market transformation initiatives.** We also must consider the interplay of shorter-term resource acquisition programs and longer-term workforce training, demonstration projects, and other market transformation initiatives, like the TECH Initiative. Resource acquisition programs are generally designed to achieve high levels of energy savings as quickly as possible. Market transformation efforts necessarily take longer to generate savings and realize workforce outcomes, since the early phases of those efforts often involve recruitment and training of trade allies to deliver the measures in question. Historically, research acquisition programs have played a key role in implementing market transformation initiatives, particularly when long supply chains exist between the manufacturer and the customer, which is true for space and water heating technologies. Financial incentives encourage customers to purchase targeted products which motivates contractors to understand the value propositions of these products. In turn, this can lead to increased stocking of these products which, in turn, can incent increased competition in the marketplace, driving down costs. Market transformation initiatives can enhance the results of resource acquisition programs by driving increased consumer and trade ally awareness. Recent changes to energy efficiency programs and the Self-Generation Incentive Program (SGIP) allow the Program to push heat pumps into the market. It will be important to understand the push and pull effects of the entire eco-system of interventions in the space and water heating markets and the sustainability of those market changes.

We propose metrics under the Market and Program Watch detailed in Evaluation Tasks 2 and 3. These metrics are a starting point for consideration as part of this proposal while recognizing that the metrics captured in this evaluation will be identified and refined as part of the early evaluation initiation tasks once program logic models are solidified.

1.6 Evaluation Tasks

Task 1. Baseline Market Assessment & Evaluation Plan

The initiative preparation tasks are designed to establish relationships with SCE as the contracting agent, the CPUC, CEC, the TECH Initiative implementer, and other key stakeholders where needed to best coordinate efforts; learn about the entire design and implementation strategy; solidify the market, program, and technology metrics we plan to measure in the evaluation; and finalize the evaluation plan. In addition, Task 1 includes a baseline assessment within the first six months from issuance of a notice to proceed.

Task 1a. Conduct Contract and Project Kickoff Meetings

Opinion Dynamics will conduct an early contract kickoff meeting with SCE to finalize the scope of work needed for the contract, specify invoicing/progress reporting protocols, and discuss any further specifics needed to establish the contract with SCE. We will then schedule a second project kick-off meeting with the Commission, California electric IOUs, and the implementer. Opinion Dynamics believes that the kickoff meeting is essential to establishing rapport between our team and the TECH Initiative team members to ensure smooth project execution and completion. All key staff across Opinion Dynamics, Guidehouse, and Mitchell Analytics will attend. The objectives of this project kickoff meeting will include: (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, (6) establish protocols around when and how we engage with stakeholders, and (7) begin discussing the current logic model and its potential need for refinement.

Task 1b. Conduct TECH Initiative Implementer Interviews

The Opinion Dynamics team will conduct up to four group interviews with TECH Initiative implementation staff to inform the logic model revision and subsequent research activities and establish data sources.

Task 1c. Conduct Logic Model Review and Revise as Necessary

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. For example, in a review of the logic model for the Northwest Energy Efficiency Alliance's (NEEA's) Heat Pump Water Heater program, the program had identified two outputs: (1) "Advanced Water Heater Specification, qualified product list, verified savings and customer satisfaction;" and (2) "Providing a set of possible incentives and financing options" for qualified products resulting in the short-term outcome of utilities providing incentives for heat pump water heaters. This implied several hypotheses that the evaluation could test:

1. Demonstrating savings in a pilot project influences utilities to adopt an incentive program for advanced water heaters.
2. Providing a qualified product list will influence utilities to adopt an incentive program.

3. Demonstrating customer satisfaction with qualified heat pump water heater will influence utilities to adopt an incentive program.
4. Presenting a series of fully developed potential incentive (and financing) packages to utilities will facilitate their adoption of such programs.

We will apply a similar assessment to the TECH Initiative logic model to identify testable hypotheses and work with stakeholders to revise the logic model, if needed, for purposes of linking research objectives, market indicators, data sources, and methodology to the program theory. We will use the logic model to finalize market, program, and technology metrics to capture the impact of the TECH Initiative.

Task 1d. Conduct Secondary Data and Literature Review (Baseline Assessment within 6 months of Contract Award)

An understanding of existing information and data sources relevant to the HVAC and water heating market, as well as the equity and workforce literature in California is essential to providing the greatest research benefit at the lowest cost. Our secondary data and literature review will include:

1. Literature review
2. Inventory of ongoing California research related to space and water heating
3. Inventory of existing data sources
4. Inventory of currently available tools, both nationally and in California, that we can utilize in our evaluation research
5. Inventory existing programs with space and water heating measures

Literature Review

We will build on literature reviews already conducted by our team to extend our understand of the existing information relevant to the TECH Initiative. Potential sources for technologies, workforce, and equity data include:

- Industry professional associations, organizations, and websites. Examples: American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE), Air-conditioning, Heating & Refrigeration Institute (AHRI), American Supply Association (ASA), Heating, Air-conditioning & Refrigeration Distributors International (HARDI), The NEWs, HVACR Business, American Society of Plumbing Engineers, Plumbing Contractors of America, Plumbing Heating Cooling Contractors Association, Plumber Magazine, Center of Energy Workforce Development, the Coalition for Clean Air, California Stewardship Network, California Environmental Justice Alliance, and California Regional Environmental Education Community (CREEC).
- Manufacturers. Examples: Rheem, A. O. Smith, Bradford White, American Water Heater, Trane, Daikin, Carrier, Honeywell, Johnson Controls.
- Organizations that conduct research. Examples: Lawrence Berkeley National Laboratory (LBNL), Oak Ridge National Laboratory, National Renewable Energy Laboratory (NREL), Pacific Northwest National Laboratory (PNNL), Department of Energy (DOE), U.S. Census surveys of housing and new construction, Energy Justice Network, Energy Action Coalition, EPA Environmental Justice Research, National Environmental Education Foundation, California Air Resources Board.

- University-based research. Examples: University of California Berkeley Labor Center, University of Southern California Equity Research Institute, University of Maryland, Purdue University, University of Illinois, Texas A&M University, California Community Colleges.
- Energy efficiency organizations. Examples: ENERGY STAR, Northwest Energy Efficiency Alliance (NEEA), American Council for an Energy Efficient Economy (ACEEE), Association of Energy Services Professionals (AESP), International Energy Program Evaluation Conference (IEPEC), Northeast Energy Efficiency Partnerships (NEEP), Midwest Energy Efficiency Alliance (MEEA), CEC's Electric Program Investment research.

Inventory of Ongoing California Research Related to Space and Water Heating

There are several electrification research efforts underway in California. The Opinion Dynamics team will review the research efforts identified in the CPUC Group B Heat pump study; update our understanding of these research efforts and their timelines; and add any additional studies to the list. We will codify what the industry knows and with what certainty we know it to ensure that this study furthers our collective understanding of the decarbonization market.

Inventory of Existing Data Sources

We will synthesize information to identify the market indicators that have valid and reliable estimates, then focus on measuring the indicators where data is lacking. For example, Opinion Dynamics and Guidehouse are working collaboratively to update the Potential and Goals study for 2020. Part of this study collected residential and non-residential customers data on customer characteristics, behaviors, and attitudes, as well as willingness-to-adopt select technologies and participate in energy programs. Our team will combine this information with the 2019 Residential Appliance Saturation Survey (RASS) for key statistics on the residential heat pump market. We expect to be able to quantify metrics such as: fraction of homes by type with electric vs. gas space heating, fraction of homes by type with electric vs. gas water heating, and fraction of electric heating and water heating that are heat pumps. Provided the sample frame is sufficiently large to allow for stratification by between low-income and non-low-income homes, we will examine variance for these subpopulations. We will extrapolate sample data to the full IOU service territories to estimate the total number of heat pumps installed in the residential market. Our team has extensive experience with processing and interpreting this data and is currently extracting such data from RASS for the purposes of the CPUC Potential and Goals Study. In fact, at the time of writing this proposal, our team is actively mining RASS data for this purpose. We will review the following secondary data sources to support the market characterization:

- **HARDI Trends Report:** HARDI reports monthly distributor shipment data for HVAC technologies by state. The data report unit and dollar value of shipments of heating and cooling equipment starting in 2013 to the present. The HARDI data report shipments of air source heat pumps, air conditioners, furnaces, boilers. HARDI reports air conditioner and ASHP technologies by efficiency (SEER), size (BTU), ducted/ductless, refrigerant type, and package type. HARDI separates heating equipment by efficiency (AFUE), capacity, and fuel. HARDI data report total shipments by distributors, and therefore, do not account for direct sales from manufacturers to retail (e.g. Home Depot) or to large contractors.
- **AHRI Data:** AHRI compiles statistical data on the scope, size, and growth of the heating, air conditioning, and commercial refrigeration industry. This data includes U.S. manufactured shipments for heating and cooling equipment including storage hot water heaters. AHRI also offers other key data such as the Low-GWP Alternative Refrigerant Evaluation Program. AHRI monthly report of combined U.S. manufactured shipments of central air conditioning, air source heat pump systems, and water heaters

- **ENERGY STAR** data: The EPA collects national shipment data for ENERGY STAR units. This data includes light commercial HVAC, dehumidifiers, furnaces, geothermal heat pumps, room air conditioners, ceiling fans, and water heaters. This data will further supplement an understanding of the types of products that flow into California.
- **The DOE's Building Energy Data Book:** This provides a compendium of different data sources and includes statistics related to construction, building technologies, energy consumption, and building characteristics. This information is helpful for determining trends.
- **2018 California RASS Study** to understand appliance saturations and energy use.
- **2021 Potential and Goals Study Update.** This study develops estimates of energy and demand savings potential in California.
- **California Public Utility Commission California Energy Data and Reporting System (CEDARs)** that provides information for programs, energy savings claims, cost-effectiveness data, budgets, and history of changes to programs.
- **CPUC Group B Heat Pump Market Characterization and Baseline Study.** Opinion Dynamics is conducting interviews with manufacturers, distributors, and trade allies involved with the selling and installation of air source heat pumps, ground source heat pumps, and heat pump water heaters to understand market barriers and baseline key metrics. We are also conducting a Delphi study of installation and labor costs for air source heat pumps and heat pump water heaters.
- Reports and other data sources on market trends such as the **JPMorgan HVACR Analysis**, the **HARDI Trends** report mentioned above, the **HVAC Control Systems Market Research Study** by ARC Advisory Group, the **HVAC and Refrigeration Systems Market Snapshot** by Transparency Market Research, and **U.S. Census surveys** of housing and new construction

Inventory of existing evaluation research tools both nationally and in California

We do not intend to reinvent the wheel and will work to avoid having to develop yet another savings calculation methodology, calculator, or tool. We aim to leverage existing state-agency approved tools, methods, and data sources as much as possible. With this goal in mind, we will also conduct an inventory of tools that are currently available, including their current state and the schedule of proposed updates. This review will include, but is not limited to, California's Analysis Tool for Locational Energy Assessment (CATALENA), California Utility Allowance Calculator (CUAC), CPUC's Fuel Substitution Calculator, EPA's Avoided Emissions and generation Tool (AVERT), EPA's Co-Benefits Risk Assessment (COBRA) Health Impacts Screening and Mapping Tool, CPUC's Refrigerant Avoided Cost Calculator, and CARB's PATHWAYS model among many others.

Inventory existing programs with space and water heating measures

We will conduct an inventory of existing programs—such as Self-Generation Incentive Program (SGIP) and PG&E's and SCE's Wildfire Rebuild Programs—with space and water heating incentives and collect program documentation data and program tracking data to understand the current landscape of related program interventions. Program documentation data will include design and implementation plans, program logic models (if available), program marketing and outreach materials, as well as past program filings, reports, and past evaluations. Program tracking data will be used to evaluate the number, types, and degree of savings of the projects processed through these programs, as well as identify the key market actors who interfaced with program, the timing and sequence of these interactions, and the potential overlap among programs. We will pay special attention to program theories of change and incentive strategies.

In executing this task, we will bring our knowledge of HVAC and water heating technologies, equity considerations, and workforce challenges to bear, which will allow us to quickly identify and narrow data sources and spend more time reviewing the studies in-depth, as opposed to seeking them out. Furthermore, we will bring insights we have already gathered on market dynamics, gleaned from thousands of interviews we have completed with key market actors across the country. We will summarize our analyses in a memo six months from issuance of a notice to proceed. We will update this memo annually.

Task 1e. Develop Final TECH Initiative Evaluation Plan

Following the first revision of the logic model, Opinion Dynamics will submit a final project workplan that outlines the testable hypotheses, market indicators, and project research tasks. The workplan will describe the research, data collection, analysis, and other proposed activities, as well as the schedule. To develop the plan, we will draw from this proposal, discussions during the kickoff meeting, interviews with TECH Initiative staff, and our secondary data review. Our workplan will tie our evaluation and market research activities to the logic model.

Task 2. Market Watch



The Market Watch will provide a baseline snapshot and ongoing measurements of the marketplace. Key methods include literature reviews and conducting Voice of the Market (VOM) research representing the full supply-chain of upstream, midstream, and downstream players. Recruitment efforts for the VOM research will fill gaps in the baseline snapshot of existing market data and provide context to the data gathered through secondary sources. All data in the Market Watch will be centralized and accessible as it becomes available.

It is essential that we weave equity and workforce considerations into the theories of change underlying both the TECH Initiative and the Build Program. The Climate Policy Equity Framework puts forth three principles: Environmental Justice, Economic Equity, and Public Accountability.⁴ Table 2⁵ outlines equity goals for each principle—many of which specifically speak to workforce policy, training, and standards.

Table 2. The Climate Policy Equity Framework Principles and Goals

| |
|---|
| Environmental Justice - Equity Goals |
| <ul style="list-style-type: none"> ▪ Reduced environmental and public health risks to disadvantage communities ▪ Expanded access to benefits in disadvantaged communities ▪ Protection from adverse economic consequences for disadvantaged communities. |
| Economic Equity - Equity Goals |
| <ul style="list-style-type: none"> ▪ High-quality, career-track jobs in clean economic growth sectors ▪ Just transitions for workers and communities in sectors at risk of decline due to climate policy |
| Public Accountability - Equity Goals |
| <ul style="list-style-type: none"> ▪ Enhanced participation in public decision-making ▪ Transparent monitoring of equity outcomes ▪ Continuous learning and improvement |

⁴ Zabin, C. Martin, A. Morello-Frosch, R. Pastor, M. and Sadd, J. (September 13, 2016). Advancing Equity in Climate Policy: A New Social Contract for Low-Carbon Transition. Retrieved April 18, 2019 from: <http://laborcenter.berkeley.edu/pdf/2016/Advancing-Equity.pdf>

⁵ Ibid.

We propose to capture the following metrics Table 3 as a starting point for consideration as part of this proposal while recognizing that the metrics captured in this evaluation will be solidified and refined as part of the early evaluation initiation tasks once the program theory and logic model is finalized.

Table 3. Proposed Market Watch Metrics

| Customer Value, Workforce, Supply Chain and Technology Market Metrics | Secondary Data & Literature Review | Program Tracking Data | Market Interviews/ Surveys | Mystery Shopping |
|---|------------------------------------|-----------------------------|----------------------------|------------------|
| | Annually – Beginning of Each Year | Annually – End of Each Year | Years 2 & 4 | Years 2 & 4 |
| Market awareness, understanding, attitudes and preferences | ✓ | | ✓ | ✓ |
| Costs including equipment, labor, infrastructure, design, operational and maintenance, and incremental | ✓ | | | |
| Number of workers trained to install, service, and maintain | ✓ | | ✓ | |
| Number of workers with appropriate licenses to install, service, and maintain | ✓ | | | |
| Saturation of low-emission systems by building type, efficiency rating, capacity, climate zone, Disadvantaged Community | ✓ | | | |
| Market size/share of new installations | ✓ | | | |
| Number of technologies by type and end-use | ✓ | ✓ | ✓ | |
| Types of refrigerants used and their associated Global Warming Potential (GWP) | ✓ | ✓ | ✓ | |
| Life cycle of technologies | ✓ | | ✓ | |
| New technologies entering the market and their specifications | ✓ | | ✓ | |
| Availability of product | ✓ | | ✓ | |
| Number of programs offering technologies | ✓ | | ✓ | |
| National, state, regional, and local policy, regulation, codes, and standards | ✓ | | ✓ | |
| Incentives available for technologies including components | ✓ | ✓ | ✓ | |

Task 2a. Conduct initial baseline market assessment and characterization

The TECH Initiative is entering a nascent heat pump marketplace in California. To evaluate the TECH Initiative's ability to achieve targeted market effects and longer-term market transformation, our team will collect and analyze market data and intelligence on a continuing basis. We will work closely with the TECH Initiative implementer to integrate our findings into program strategies and to support mid-cycle course corrections.

The TECH Initiative will achieve greenhouse gas reductions, energy savings, equity goals, and workforce outcomes by changing the structure of the market and the behavior of market participants. Market effects are those changes to the market supply and demand that can be attributed with some certainty to the program interventions over time. Examples of market effects include, but are not limited to, changes in awareness and preferences, specification practices, product stocking and shipments, and manufacturing output. To measure market effects, the team will conduct a market assessment to establish baseline estimates of the market indicators defined as part of the logic model review against which program accomplishment can be measured.

Supply Chain Characterization/Market Model

As is the case with many public purpose market interventions, increasing the market share of decarbonized buildings and the capacity of the market to grow that share over time will require understanding and addressing relevant market barriers, while taking advantage of positive market trends that can be leveraged to accelerate adoption and market transformation. We will first 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.

The HVAC supply chain has been described as “an ever-changing entity.”⁶ This descriptor can also be applied to the water heating supply chain, especially with the entry of newer technologies such as heat pump water heaters. Using the information from the literature review, 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. We will then utilize quantitative data from secondary sources and primary sources as necessary to overlay estimates of the flow of HVAC and HPWH products through the California supply chain.

Opinion Dynamics will estimate the total market size for each technology based on a variety of published primary data sources as described above. 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. The Opinion Dynamics team will reconcile information provided by the Voice of the Market interviews and surveys (described below) to identify housing, technology, economic, and other characteristics that influence segmentation of technology distribution by discernable housing and demographic characteristics. 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.

For water heating, we will also utilize AHRI manufacturer shipments data. We will rely on published data regarding the total housing stock in each climate zone and apply California Lighting and Appliance Saturation

⁶ Harris, Angela D. Developing Programs to Improve Supply Chain. *The NEWS*. Retrieved July 9, 2018 from <https://www.achrnews.com/articles/124809-developing-programs-to-improve-supply-chain>

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.

In addition to the current state, the baseline will also explore how the market is projected to change over the next decade. One method of evaluating the impact of a market transformation program is to conduct a business as usual (BAU) forecast at the beginning of the implementation of a market transformation program. This BAU forecast is a tool that can be used to measure the overall impact of a market transformation program in future years. By assessing the actual adoption of a measure in the later years and comparing it to the BAU forecast, one can quantify the transformative impact of the program. This is a common method for setting a program baseline that our team has used for other clients in evaluating market transformation programs, such as for NEEA, DTE, Ameren IL, and ComEd. We will utilize the data collected in previous evaluation tasks described above to develop this BAU forecast. Our team is better suited than any other bidder to develop this as we can adapt and leverage the CPUC Potential and Goals (PG) model to develop this forecast.

We will use the CPUC Potential and Goals model to estimate natural turnover (eligible opportunities for TECH Initiative to target) for gas furnaces and gas water heating technologies. We can also calculate this for electric space heating and water heating technologies. This will give us two views of the size of the target market that are both important to track:

- Volume of fuel substitution opportunities (replacing gas with electric appliances); this is the segment of the market the TECH Initiative is attempting to influence.
- Volume of like-for-like opportunities (replacing electric appliance with electric appliances); this segment of the market may be influenced by the TECH Initiative, though it is not the primary target. Nevertheless, converting an electric storage water heater to a heat pump water heater will still reap some carbon benefits to California.

These data are already being calculated in the current Potential and Goals Study and can be easily leveraged to develop a forecast of the adoption of heat pumps. The current PG Model will develop a fuel substitution forecast under the influence of program intervention; the model could even be used to forecast adoption absent of program intervention. Adapting the Potential and Goals Model, we can develop 4- and 10-year forecasts of heat pump adoption. These forecasts can be used as baselines for evaluating the long-term impacts of the TECH Initiative, which we will utilize in our annual assessment.

We will track changes in shipments, specification practices, awareness, product acceptance through 2025. As program activity increases, program supported sales should be reported in shipment data as well as program tracking data. The differential between total shipments and program supported sales include sales that reflect untracked spillover resulting from market effects. We will rely on the Voice of the Market interviews and surveys (described below) to inform assumptions regarding program induced changes to specification practices, product awareness, acceptance, and other key performance indicators.

Task 2c. Voice of the Market Research to Confirm Baseline Assessment and Track Market Watch Indicators

The team will develop and utilize a voice of the market (VOM) approach that includes customers, trade allies, as well as midstream and upstream market actors. We will confirm the findings of the baseline supply chain assessment and the inputs into the BAU scenario. We will track and assess additional baseline metrics and assess progress on market indicators. Research conducted with the VOM will help us understand the “why” behind any change in market metrics that are observed.

Semi-Structured Interviews with HVAC and Plumbing Manufacturers and Distributors Attending the International Air-Conditioning, Heating, Refrigeration Exposition (AHR Expo)

Distributors are the most knowledgeable market actors in the supply chain that can provide insight into market activities and how the market is adopting heat pump technologies. Manufacturers can give us insight into national trends and upcoming R&D. We will utilize the manufacturer and distributor interviews already conducted as part of the CPUC Group B Heat Pump Study for the initial baseline assessment.

In years two, three and four, we will conduct these interviews by attending the AHR Expo.⁷ The Expo provides an opportunity to assess new technologies, progress with existing technologies, and anticipated changes in the technology and the market. We have used a similar method for assessing changes in the commercial lighting market by attending Light Fair and have found it to be an efficient and cost-effective way to gain market intelligence.

Prior to attending, we will prepare a plan of which manufacturers and distributors to meet and interview. The three-day Expo is held in a different city each year and includes hundreds of manufacturers for heating, air conditioning, refrigeration, and water heating equipment, as well as regional and national distributors for these products and their components.⁸ The list of exhibitors is available prior to the Expo allowing us to prepare our interview schedule.

Three people will attend the Expo in 2022, and two people at least two more times in the evaluation period with at least one engineer as a member of the team each year. We will prepare a list of questions to be answered based on a review of program experiences, the forecast model needs, our Electric Technology Briefings (described below), and suggestions from the oversight team. We will prepare a summary of findings from the interviews providing input on each of the identified questions.

HVAC and Plumbing Trade Allies – 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. We will utilize the trade ally interviews we conducted for the CPUC Group B Heat Pump Market Characterization survey to inform the market baseline. We will then conduct interviews or surveys with non-participating trade allies in years 2 and 4 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. We will utilize this survey to understand where the general population falls in terms of Rogers' Diffusion of Innovation model. We will use the survey to classify the population into the five adopter categories: innovators, early adopters, early majority, late majority, and laggards (see Figure 3). As an example, for the BPA Momentum Savings contract the Opinion Dynamics team used permit data to identify households that had installed heat pumps and recruited them for a survey. The purpose of the survey was to clarify some factors of usage and existing conditions prior to the installation, information that could not be gained from the permit or from secondary sources of market data. A benefit of obtaining permit data, is the ability to locate households that have installed targeted equipment outside of the program and be able to conduct surveys, interviews, or site visits to address important modeling questions about market conditions for the equipment. We will use a mail push to web approach to recruit these non-participating customers to

⁷ The AHR Expo is 2021 was cancelled due to the ongoing COVID-19 Pandemic. Conference organizers are optimistic about holding the event in 2022.

⁸ The 2022 event is planned to take place in Las Vegas, Nevada.

take the survey. We anticipate conducting such research in years 2 and 4 of the program. We will offer a \$50 incentive for survey completion and anticipate receiving 200 responses.

Task 2d. Conduct Mystery Shopping Study

Mystery shopping provides a way to hear and assess the messages that consumers hear from trade allies directly, 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 challenges, they perceive that are associated with installing or servicing low-emission equipment compared to standard or slightly less efficient equipment. 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 year 2 and year 4. For each mystery shopping round, Opinion Dynamics will seek to interview up to 200 HVAC and 100 plumbing/water heater firms. For HVAC, we have identified 10 conditions that could affect contractor response for ducted and 10 for un-ducted systems, and for hot water we have identified 10 conditions that could affect contractor response. Our goal is to obtain five responses for each condition and to vary the firms across the IOU service territories. Half of each sample will be program participating contractors and half will be non-program contractors of similar size to program contractors.

Table 4. Sampling for Mystery Shopping

| Technology Condition | Program | Non-Program |
|----------------------|---------|-------------|
| Un-ducted HVAC | 50 | 50 |
| Ducted HVAC | 50 | 50 |
| Hot water | 50 | 50 |

Sales occur based on different household conditions: a replacement/retrofit due to pending breakdown, a replacement due to existing equipment failure, or replacement intended to convert from gas to electric. In addition, whether there is a ducting system will affect equipment choice suggestions for HVAC. The responses by the gatekeepers are likely to be different depending on the type of replacement. Calls to request information can include a specific request for low emissions equipment or product type, or they can be more general. We plan to vary these conditions in making calls as shown in the Table below.

Table 5. Household Conditions for Mystery Shopping (Illustrative)

| Existing Equipment Fuel Type | Condition of Equipment | Request H-EE Choices |
|------------------------------|------------------------|----------------------|
| Gas | Replace/retrofit | No |
| Gas | Replace/retrofit | Yes |
| Gas | Replace on failure | No |
| Gas | Replace on failure | Yes |
| Gas | Conversion to Electric | No |

| Existing Equipment Fuel Type | Condition of Equipment | Request H-EE Choices |
|------------------------------|------------------------|----------------------|
| Gas | Conversion to Electric | Yes |
| Electric | Replace/retrofit | No |
| Electric | Replace/retrofit | Yes |
| Electric | Replace on failure | No |
| Electric | Replace on failure | Yes |

When a mystery shopper calls and describes their situation the responses from gatekeepers as to what they suggest the shopper consider or not consider are likely to change over the course of the program period. These can be used to assess the degree to which program and nonprogram contractors are adopting new practices. For instance, if the shopper notes that they have a gas furnace and want to consider a low emissions furnace they are likely to hear different responses than if they say they want to convert to electric heat pump or they just say they want to replace their gas furnace. Gatekeepers might say they do not carry high efficient equipment or they might say that the heat pumps are expensive and gas furnaces cost less to run, yet over time we might expect this message to change to where all contractor gate keepers tell shoppers that the shopper should consider a heat pump as well. Similarly, with hot water heaters if the shopper has an electric water heater if the gate keeper asks about the size of space where their water heater is, that might indicate a willingness to offer a heat pump water heater as space requirements are a major barrier to installation, and water heater contractors often like to price they system and implement the installation in a single visit to the home.

Task 3. Program Watch



The Program Watch will provide fast feedback to the TECH Initiative implementor and provide the M&V necessary to evaluate the impact and cost-effectiveness of the Initiative, while assessing what is key to scaling all-electric adoption. Key methods under the Program Watch include program theory and logic development, depth interviews, a Voice of the Participant panel, outreach and education content analyses, social network analyses, GHG impact estimates, energy savings estimates, bill savings estimates, 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 design to assist in ongoing program refinement. We propose to capture the following metrics (Table 6) as a starting point for consideration as part of this proposal while recognizing that the metrics captured in this evaluation will be solidified and refined as part of the early evaluation initiation tasks once the program theory and logic model is finalized.

Table 6. Proposed Program Watch Metrics

| Volume, Effectiveness in Address Market Barriers, Workforce and Impact Program Metrics | Program Tracking Data | Participant Panel Interviews/ Surveys | Content Analysis | Outreach & Education Material Testing | Social Network Analysis | Impact Analysis |
|--|-----------------------|---------------------------------------|---------------------------|---------------------------------------|-------------------------|-----------------|
| | Annually | Annually | Once in evaluation period | Annually as needed | Year 4 | Annually |
| Number of technologies by type and end-use | ✓ | ✓ | | | | |
| Number of Program Participants and their demographics | ✓ | | | | | |
| Number of incented low-emission systems installed by efficiency rating by capacity by climate zone and by Global Warming Potential (GWP) | ✓ | | | | | ✓ |
| Program and technology experience, satisfaction, and value perception | ✓ | ✓ | ✓ | ✓ | | |
| Participant understanding of benefits of technologies | | ✓ | | ✓ | | |
| Participant decision-making drivers | | ✓ | | | | |
| Program impact on participation in other programs | ✓ | ✓ | | | | |
| Cross-program coordination | ✓ | ✓ | | | ✓ | |
| Effectiveness of incentive levels | ✓ | ✓ | | | | |

| Volume, Effectiveness in Address Market Barriers, Workforce and Impact Program Metrics | Program Tracking Data | Participant Panel Interviews/ Surveys | Content Analysis | Outreach & Education Material Testing | Social Network Analysis | Impact Analysis |
|--|-----------------------|---------------------------------------|---------------------------|---------------------------------------|-------------------------|-----------------|
| | Annually | Annually | Once in evaluation period | Annually as needed | Year 4 | Annually |
| Number of training promotions, training materials created, trainings offered and attendees | ✓ | | | | | |
| Number of trainings offered in high unemployment ZIP codes in top 25 percent of unemployment indicator in CalEnviroScreen Tool | ✓ | | | | | |
| Number of Disadvantaged Worker ⁹ attendees | ✓ | | | | | |
| Effectiveness of education, outreach and training provided | ✓ | ✓ | ✓ | ✓ | | ✓ |
| Worker performance | ✓ | ✓ | | | | ✓ |
| Number of jobs created, and proportion of jobs created fulfilled by Disadvantaged Workers | ✓ | ✓ | | | | ✓ |
| Types of refrigerants used and their associated Global Warming Potential (GWP) | ✓ | ✓ | | | | |
| Lifecycle of technologies | | ✓ | | | | ✓ |
| Volume of GHG emissions reduced or avoided | ✓ | | | | | ✓ |
| Cost per metric ton of avoided GHG | ✓ | | | | | ✓ |
| GHG Site and Source Savings | ✓ | | | | | ✓ |
| Projected utility bill savings | ✓ | | | | | ✓ |
| Energy savings | ✓ | | | | | ✓ |

⁹ 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.”

| Volume, Effectiveness in Address Market Barriers, Workforce and Impact Program Metrics | Program Tracking Data | Participant Panel Interviews/ Surveys | Content Analysis | Outreach & Education Material Testing | Social Network Analysis | Impact Analysis |
|--|-----------------------|---------------------------------------|---------------------------|---------------------------------------|-------------------------|-----------------|
| | Annually | Annually | Once in evaluation period | Annually as needed | Year 4 | Annually |
| Peak demand savings | ✓ | | | | | ✓ |

Task 3a. Develop and Utilize Voice of the Participant Panel to Track Program Watch Indicators

The goals of building a Voice of the Participant Panel are to capture the initial program experience amongst 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 BD technology and the initial installation experience. Over time, we will want to capture further feedback such as technology performance over time, quality issues, and maintenance issues. This panel may include full participants and semi-participants, for example upstream or midstream actors that engage with the program initially but do not fully participate in the incentives. 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 as part of their efforts. According to the CPUC’s draft R.19-01-011 Phase II Staff Proposal, the RFP for the TECH Initiative implementer states, “In order to track appliances as they move through the supply chain, bidders should propose a method for tracking appliances that the TECH Initiative incentivizes, such as a database of appliance serial numbers.” This database will be able to track an appliance, using its serial number, from where it is manufactured through the supply chain to where it is installed. We will utilize this database to recruit our panel.

Participants will be asked to join the panel over the course of four years as soon as they start participation 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 studies for additional incentives throughout the four years. For budgeting purposes, we are assuming a total of 150 participants participating in multiple years with a potential total incentive of \$500.

Task 3b. Process Evaluation Research

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

- A review of the data that the implementer plans to capture in light of the program theory and logic, and the third-party evaluation scope and suggested areas of improvement where needed.
- 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.

- Outreach and educational material testing with the target audience for feedback prior to roll-out. We will utilize some of the VOM research efforts above to test various messaging and educational approaches, to gather feedback from the intended audience in terms of effectiveness, and gather ways to improve messaging and educational materials based on market feedback.
- Rapid-feedback surveys and depth interviews with participants. We will gather feedback from participants early in their participation process to determine what is going well and what needs improvement, based on their initial engagement with the TECH Initiative. This will allow us to both gather initial feedback and recruit participants into the Voice of the Participant Panel which will allow us to gather further feedback on other market and program metrics over time as a way to gain initial performance feedback and also understand the experience with this technology over time.
- Identification of potential case studies. As we discussed above, developing compelling case studies are going to be essential to moving from the early adopter stage to the early majority stage on the Diffusion of Innovation curve. We will identify potential case studies for the implementer that are particularly convincing that can be used by contractors to support their sales strategies.

Draft feedback from this task will be provided to BUILD 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.

Task 3c. Conduct Social Network Analysis

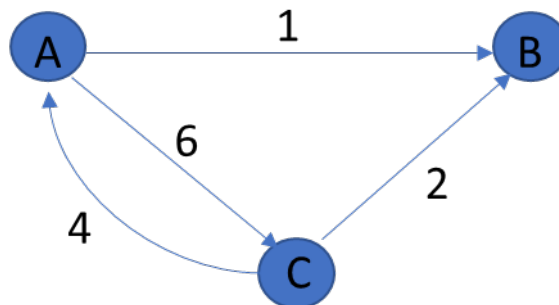
Social network analysis (SNA) is a powerful methodology for assessing a wide range of questions related to relationships between various organizations, people, or other entities. As such, SNA is an ideal approach for assessing coordination between the TECH Initiative and other synchronous programs, and between the TECH Initiative and other partners, including community-based organizations and DAC key staff. The SNA is a great method to identify and evaluate whether the TECH Initiative successfully coordinates with and leverages other synchronous programs, such as ratepayer-funded programs, federal and state tax credit programs, and air quality management district programs.

Fundamentally, SNA relies on a technique called graph theory which refers to the organizations, people, or other entities as “actors” (or sometimes nodes) and represents them as points on a graph. Relationships between actors are referred to as “ties” and are depicted by lines connecting actors. The collection of actors and ties is referred to as a network map. For example, the figure below shows a hypothetical map of a small network depicting communications among three actors. The simple conclusion from this network map is that all three actors have communicated.



However, a great deal more complexity and richness can also be captured through SNA. Two ways of doing so involve assessing the directionality of the ties and valuing the ties. For example, the figure below shows the same network depicting the flow of information among the same three actors. However, in this case the

direction of the ties is shown (the arrowed tie from A to B shows that A reached out to B). The ties are also value-depicting. In this example, the value indicates how many times the actors have communicated. Thus, from this we can expand far beyond our earlier conclusion and now infer that the volume of communications between A and C are far more common than between A and B or B and C. Further, communications between A and C are reciprocal (i.e., communications are flowing both ways between A and C, though slightly more commonly flowing from A to C). In contrast, the communications with B are much fewer (only one from A and two from C). Further, none of the communications with B are reciprocated, meaning B is “taking” from the network, but not “giving back.” In this example, it is also important to note that A and C hold unique positions in the network and either could be leveraged to access the entire network, which could have implications for the allocation of resources or the development of strategic communications.



Though the hypothetical examples show the flow of communication between actors, the types of ties or relationships that can be assessed through SNA vary widely. In the context of the TECH Initiative, we will design an SNA to assess whether the TECH Initiative successfully coordinates with and leverages other synchronous programs, such as ratepayer-funded programs, federal and state tax credit programs, and air quality management district programs, as well as whether the TECH Initiative develops partnerships with key organizations. In-depth interviews with program staff and structured surveys with key organizations will inform the SNA.

We will also incorporate non-participating organizations into the analyses to answer questions such as: Is the participant network denser (i.e., contain more ties) than the non-participant network? Are there non-participants that should be targeted for TECH due to their unique positions? Are there non-participants that fulfill roles that are not filled in the participant network?

The results of the SNAs will provide unique insights into the structure and functioning of the complex infrastructure developing under the TECH Initiative. These results will not only show if key partnerships are being formed (a key logic model output/outcome) but will also go further and describe the nature and intensity of these partnerships to ensure they are helping to build the partnerships necessary to transform the marketplace.

SNA data is collected via surveys. If the entire population of actors is known— as we expect is the case with at least some of the participant network by coordination with the implementer— the approach typically involves asking all respondents if they have “X” (where X is accessed capital from, or transferred executive expertise with, or built a strategic relationship with, or provided key business support to) each of the known actors. These responses can be dichotomous (i.e., yes or no as in the first example) or valued by adapting the question to ask “how many times” or “how often” they have “X” with each actor (as in the second example). If the population is not known ahead of time— as is likely the case for the non-participants— we ask the respondents to list each of the actors with which they have “X.” Snowball sampling is then used to reach out to actors mentioned by respondents until an adequate map of the network is developed.

For this task, we will develop an SNA survey to be conducted with TECH Initiative partnership participants and non-participants. We will develop the questions so that we can quantify the strength or intensity of the relationship and, where applicable, assess reciprocity. The SNA questions will then be presented as web surveys. Compelling incentives are often needed to boost response rates for SNA questionnaires as they can appear redundant. As such, the Opinion Dynamics team will offer \$100 as an incentive for completion of this SNA survey. We will analyze the SNA data, including the development of graphical network maps for each issue explored as well as the computation of a range of relevant SNA-specific statistics that help to summarize and better understand the nature of the network being explored. Results of the SNAs will be included in annual reporting deliverables. The preliminary findings will be shared with the implementation team as soon as they are available as an interim deliverable.

Task 3e. Assess availability of skilled labor with proper licensing.

The transition to a zero-carbon society will see some jobs disappear and new jobs created. Workers in high carbon industries will become more at risk of underemployment, unemployment, and redundancy. The workforce needed to support a decarbonized economy will need: (1) knowledge of new electric technologies, (2) an understanding of the electric infrastructure needs, and (3) the ability to effectively communicate the value propositions of decarbonization. The quality of the new jobs must be addressed ensuring that new positions mirror incomes, safe work conditions, and stability often found in fossil fuel-based jobs. The availability of skilled labor with proper licensing will be essential for the TECH program to meet its market transformation goals.

Skilled Labor

Achieving California's climate goals will transform the state's energy economy, likely creating jobs in some sectors and eliminating jobs in other sectors. Jobs in coal, oil/petroleum, natural gas, corn ethanol, woody biomass, other ethanol/non-woody biomass and other fuels employ 74,974 workers in California.¹⁰ Petroleum and other fossil fuels make up the largest segment of employments related to fuels.¹¹ Many scenario analyses found that decarbonization of the US economy has a net positive impact on the overall economy in terms of jobs, GDP, and income per household.¹² In these scenarios, while the overall economic benefits at a nationwide level outweigh the costs, some sectors that rely heavily on fossil-fuel based energy and industries likely will face job losses due to decarbonization.

The threat of labor shortages is more acute in blue-collar and low-pay services occupations than in more highly educated white-collar occupations, the exact opposite of the prevailing trends in recent decades. Since the 2008 financial crisis, demand for hard-hat and entry-level blue-collar jobs has grown steadily. Retiring Baby Boomers, lower-income workers leaving the workforce on disability claims, and more high school seniors going to four-year colleges have led to increasingly weak numbers in blue-collar job applicants. According to a report released in December 2018 by The Conference Board, "Amid tightening labor markets, some companies are expanding the supply of talent by lowering education requirements during recruitment and providing basic internal training to make up for an applicant's lack of a vocational high school diploma or secondary education in a technical training school."¹³

10 <https://static1.squarespace.com/static/5a98cf80ec4eb7c5cd928c61/t/5c7f40531905f46e120fcb79/1551843411700/California.pdf>

11 Ibid.

12 <https://nextgenpolicy.org/wp-content/uploads/2015/11/ICF-Study-Summary-of-Findings-Decarb-Econ-Analysis-Nov-5-2015.pdf>

13 <https://www.forbes.com/sites/kenrapoza/2018/12/16/in-2019-blue-collar-workers-disappearing-and-in-hot-demand/#603d3c13441b>

According to the U.S. Energy and Employment Report 2019, California energy-related employers reported difficult hiring. Employers in California gave the following as the top three reasons for their reported difficulty: (1) Lack of experience, training, or technical skills, (2) Insufficient qualifications (certifications or education), and (3) Competition/ small applicant pool. Employers reported the following as the three most difficult occupations to hire for: (1) Sales, marketing, or customer service, (2) Management (directors, supervisors, vice presidents); and (3) Electrician/construction laborers.

These trends were also identified in the Advanced Energy Economy Institute Advanced Energy Jobs in California 2016 study. The majority of the 831 California companies surveyed reported difficulty in hiring—with 73% reporting difficulty in finding qualified workers in 2015. The top two reasons were lack of experience, training or technical skills (44%), and insufficient qualifications, certifications, or education (31%). About a quarter of the firms report difficulty hiring managers, directors, and supervisors (24%) and sales, marketing, or customer service representatives (24%), while almost two in 10 firms reporting difficulty hiring installation (18%) and technician or technical support workers (18%).

In an ongoing study for the CEC, multiple homebuilders reported that current labor constraints in California coupled with updates to the building code make it increasingly difficult for homebuilders to recover the costs of building in the state. A significant barrier to the construction of high-efficiency homes is the constraint of the skilled labor pool in the California new home construction market. After the economic downturn ten years ago, the real estate market saw a significant reduction in the labor force, which has not fully recovered in the ensuing years. The new home production rate has slowly recovered to around sixty percent of its production level prior to 2008.¹⁴ The number of skilled workers who are familiar with high performance and decarbonization building practices represent an even smaller proportion of the overall labor pool.

The lack of skilled labor is especially prominent in the HVAC industry, where contractors continually struggle to find qualified technicians. The Bureau of Labor Statistics predict significant growth in the field (15% from 2016 to 2026), much faster than the average for all occupations. California is second only to Florida in the highest expected number of new openings for HVAC mechanics and installers.¹⁵ This demand for HVAC labor is driven by an increase in new building construction, retrofitting or replacement of old systems, evolving environmental laws, more efficient HVAC systems with increased technical sophistication, and aging baby boomers retiring at a quickening pace.

We will utilize our Market Watch and Program Watch research efforts to assess how the efforts of the BUILD program and the TECH initiative address this barrier. Given the significance of this barrier, we will also interview 10 key subject matter experts at the beginning of both programs and during year 4 to provide context to the quantitative measurements of the availability of skilled labor.

Licensing

The Contractors State License Board (CSLB), under the Department of Consumer Affairs, protects California consumers by licensing and regulating the state's construction industry. The CSLB was established in 1929 and today licenses about 290,000 contractors in 44 different licensing classifications. All businesses or individuals who construct or alter any building, highway, road, parking facility railroad, excavation, or other structure in California must be licensed by the CSLB if the total cost (labor and materials) of one or more contracts on the project is \$500 or more. Licenses are issued to individuals, partnerships, corporations, joint ventures, and limited liability companies (LLCs). Each license requires a "qualifying individual" who must undergo a background check and meet experience and exam requirements. In addition, the licensee must submit documentation to prove they meet insurance and bond requirements. CSLB licenses are separated

¹⁴ California Department of Housing and Community Development, 2018

¹⁵ Projections Central. <http://www.projectionscentral.com/Projections/LongTerm>

into three classifications – Class A (General Engineering Contractor), Class B (General Building Contractor) and Class C (Specialty Contractor). Within the Class C license classification, there are 42 Class C licenses for work that requires specialized skills. The key licenses potentially needed for the replacement of gas with electric appliances include a C-20 HVAC license, a C-36 Plumbing license, a D-34 Prefabricated Equipment license, and a C-10 Electrical license.

Opinion Dynamics estimated, by type, the number of active contractors in good standing in California in 2019 using data obtained from the California State License Board (Table 7). The small numbers of cross-licensed contractors suggest that the single-license contractors will need to work together on electrical service upgrades necessitated by end-use electrification. This is notable because the trades typically do not work together on homeowner projects; we will explore this issue in our in-depth interviews, as relevant.

Table 7. Number California Contractors by License Type – Active and In Good Standing in 2019

| License | Number of Contractors |
|--|-----------------------|
| C10-Electrical classification | 24,131 |
| C20-HVAC classification | 11,620 |
| C36-Plumbing classification | 15,188 |
| D34-Prefabricated Equipment classification | 1,255 |
| C10 AND C20 | 1,555 |
| C10 AND C36 | 1,505 |
| C36 AND C20 | 1,960 |
| C10, C20, AND C36 | 613 |
| D34 AND C10 | 57 |

We will conduct this analysis annually to see how licensing trends change over time to provide context for understanding progress of market watch indicators.

Task 3e. Conduct Program Impact Evaluation

Impact evaluation of a market transformation program is complex, especially when the savings metrics is GHG (an output dependent on hourly energy use). Our impact evaluation is primarily structured to verify the savings from program participants. 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 2, we will extrapolate evaluated savings from the program population to the spillover population.

Midstream and upstream delivery programs create implementation efficiencies since they generally simplify data requirements for program participants, and potentially increase claimable energy savings and program impacts by capturing and quantifying a larger portion of efficient sales that occur in the market. The installation conditions and participant baselines, however, are usually unknown. For example, the implementer will likely lack information to know whether the new technologies are replacing gas or electric equipment for each installation, which may create barriers to evaluation. The data collection trade-offs for midstream vs. downstream rebate programs should be considered as they relate to verifying program impacts, since the installation baseline conditions affect the energy and GHG impacts claimable by the program. Table 8 summarizes the advantages and considerations for midstream vs. downstream program models, as they relate to program evaluation.

Table 8. Midstream vs. Downstream Evaluation Considerations

| Program Model | Data Availability | Advantages | Considerations |
|---|---|---|--|
| Downstream Rebate Program | <ul style="list-style-type: none"> ▪ Installation location (climate zone) ▪ Baseline equipment and fuel type ▪ Installation conditions (building type) ▪ Product-specific details (unit capacity) | <ul style="list-style-type: none"> ▪ Provides end-user customer information needed to confirm baseline conditions and installation-specific details ▪ Ability to verify that efficient products are installed within the program’s service territory (i.e., no leakage) | <ul style="list-style-type: none"> ▪ Requires time and effort from market actors to collect end-user installation information |
| Midstream/Upstream Incentive Program | <ul style="list-style-type: none"> ▪ Product-specific details (unit capacity) | <ul style="list-style-type: none"> ▪ Simplifies data requirements for program participants ▪ Potentially increases savings by capturing more sales in the market | <ul style="list-style-type: none"> ▪ Eliminates end-user customer information needed to confirm installation-specific details ▪ Difficult to verify that efficient products are installed within the service territory |

Energy Usage Impacts

Unit energy savings (UES) for the efficient technologies are calculated as the difference between the baseline and efficient energy consumption. In the case of conversion from gas to electric technologies, impacts for both electric and gas use should be quantified. California’s electronic technical reference manual (eTRM) provides guidance on the inputs and methods for calculating UES for residential heat pump technologies incentivized through energy efficiency programs. Furthermore, the residential heat pump and heat pump water heater entries include scenarios for fuel substitution from existing gas heating equipment to electric energy equipment.¹⁶ For electric heat pumps, the eTRM also provides guidance on calculating impacts for normal replacement scenarios (as opposed to accelerated replacement) for midstream and upstream delivery models, where baseline conditions are unknown. The eTRM specifies that the implementer should provide the following information for heat pumps:

- Retailer or distribution location where the product was sold
- Rated capacity
- Proposed building type where the product will be installed (single-family, multifamily, or mobile homes)
- Cooling and heating efficiency

In addition, eTRM advises the implementer to survey 10% of the midstream baseline existing conditions and fuel type to determine the actual gas/electric baseline proportions; the survey results should inform the claimed savings adjustments. Data collection requirements are similar for heat pump water heater fuel replacement calculations,¹⁷ yet the eTRM elaborates that a survey will not be issued for upstream delivery methods. Conducting a survey requires that the implementer (or the evaluator) has end-user contact

¹⁶ For example, Heat Pump HVAC, Residential, Fuel Substitution – eTRM: <https://www.caetrm.com/measure/SWHC045/01/>

¹⁷ Heat Pump Water Heater, Residential, Fuel Substitution – DEER: <https://www.caetrm.com/measure/SWWH025/01/>

information needed to conduct the survey research, so the program delivery model must account for data collection at some point in the transaction process.

In the absence of end-user information, the evaluation team can consider several approaches to better understand where efficient technologies are sold, to inform energy savings estimates. A summary of potential approaches is provided in Table 9.

Table 9. Verification Approaches for Upstream/Midstream HVAC Programs

| Verification Approach | Description | Pros | Cons |
|-------------------------------|--|--|---|
| GIS Analysis | Define a radius and map each distributor’s reach, informed by primary or secondary data collection | Can produce estimates of product installations by climate zone and utility service territory | Accuracy depends on the data used to inform the model |
| Distributor Interviews | Ask distributors how qualifying units are sold and where they end up | Will provide a first-hand account of where units end up | Requires distributor participation and accuracy, will result in an estimated IRAF |
| Contractor Interviews | Ask contractors how qualifying units are sold and where they end up | Will provide a first-hand account of where units end up, could supplement the GIS Analysis or Distributor Interviews | Requires contractor participation and accuracy, will result in an estimated IRAF |
| Photo Geotagging | Geotagging photos of installed HVAC equipment to identify end-user location | Streamlines data collection requirements for contractors | Requires contractor participation and end-user permission to submit photos |

According to the CPUC’s draft R.19-01-011 Phase II Staff Proposal, the RFP for the TECH Initiative implementer states, “In order to track appliances as they move through the supply chain, bidders should propose a method for tracking appliances that the TECH Initiative incentivizes, such as a database of appliance serial numbers.” This database will be able to track an appliance, using its serial number, from where it is manufactured through the supply chain to where it is installed.

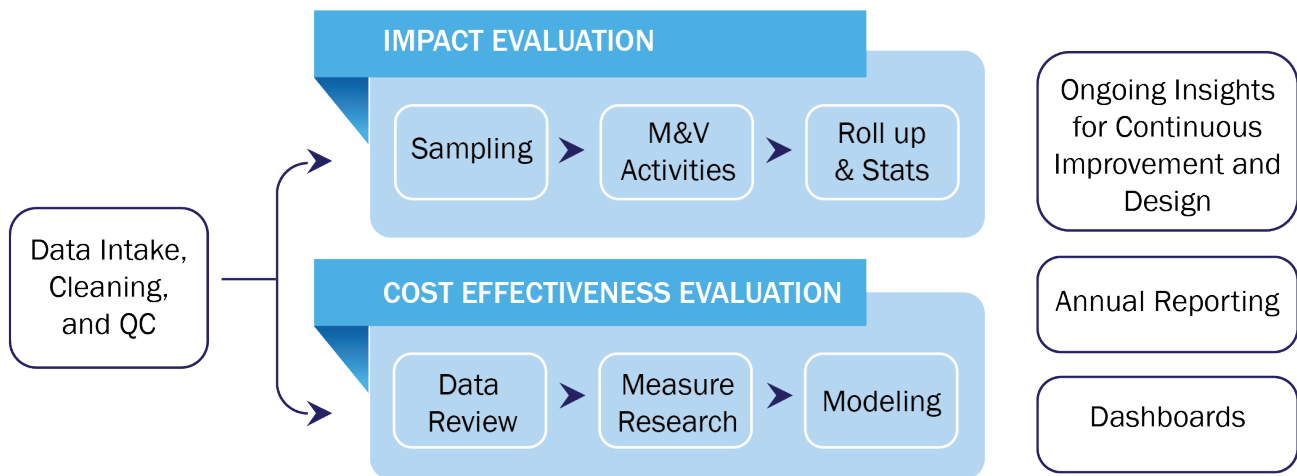
If such a tracking system is developed, it would be possible for our evaluation team to conduct surveys, energy savings calculations, and end-user verification activities as part of the program evaluation. Thus, negating the need to implement the strategies outlined in Table 9. However, these activities will depend on the level of detail and quality of the data in the tracking system.

The evaluation team will consider the proposed program design with the evaluation requirements, and will work alongside the CPUC, program administrator, and implementation teams to determine the appropriate data collection and verification approaches that are needed to estimate gas and electric impacts for the TECH Initiative based on available program data. We will leverage the data collection instruments described in the Market and Program Watch sections above to achieve economies of scale. Evaluation activities and impact reporting will occur annually unless directed by the CPUC to proceed less frequently

For typical programs when end-user installation information is available to the evaluator (as is often the case with downstream programs), the measurement approach involves a number of activities to estimate gas and

electric program impacts and the program cost effectiveness, as described in Figure 5 below. The process is further described in the section that follows.

Figure 5. Impact Measurement Approach



After downloading and cleaning the data from implementers, the evaluation team will review each program component across the portfolio to determine the most efficient sampling design that will achieve a 90/10 or better level of confidence and relative precision (taking guidance from the California Energy Efficiency Evaluation Protocols). We have at our disposal a wide range of sampling techniques and will apply the best sample design strategy for a particular application based on the objectives of the study and the availability of the population data. For example, we often use the following sampling strategies for a portfolio of programs and program components:

- **Simple random sampling** involves selecting randomly from a population such that every participant has an equal chance of being selected.
- **Stratified random sampling** splits the population into subgroups (i.e., strata) based on a known characteristic of interest, such as savings level or installed measures. Stratified random samples can produce estimates with smaller coefficients of variation than simple random samples, making the final sample much more efficient. We will use stratified samples when possible because of their sampling efficiency.
- **Ratio estimation** is a sampling and analysis method that can achieve increased precision and reliability by taking advantage of a relatively stable correlation between verified and reported savings. We will use ratio estimation for programs components with good estimates of savings through tracking databases.

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 propose these methods can still be followed and will be the most broadly acceptable by stakeholders and more easily reviewable. Depending on data availability, we can provide verification and due diligence reviews of sampled projects and measures through a variety of methods, including engineering desk reviews, phone and virtual verification, onsite verification visits and metering, calibrated simulation models, and site-specific engineering regression analysis with billing or AMI data. The outputs of these analyses would be verified gross energy and

peak demand savings for each of the sampled projects. Our full suite of M&V methods is shown below in Table 10.

Table 10. M&V Methods

| M&V Method | What is it? | Typical Use Case | Pros | Cons |
|---------------------------------------|--|--|---|--|
| Engineering Desk Review | Due diligence review of implementer project files and calculations | All sampled projects and measures. Can operate as standalone method or as a first step. | <ul style="list-style-type: none"> ▪ Lowest cost verification method ▪ Fast results ▪ No customer disruption ▪ No safety concerns | Least rigorous of all verification methods |
| Telephone Verification | Phone call with customer to confirm measure quantities and basic project characteristics | Simple measures with low savings uncertainty | <ul style="list-style-type: none"> ▪ Low to medium cost ▪ Easy to catch big issues, such as non-installation or large operating hour discrepancies ▪ Minimal customer disruption ▪ No safety concerns | <ul style="list-style-type: none"> ▪ Low rigor method ▪ Not suitable for measures with high complexity ▪ Can be difficult to communicate with customers not versed in energy efficiency |
| Virtual Verification | Live or recorded video conversation with customer to confirm measure installation | Relatively simple measures with low to medium savings uncertainty | <ul style="list-style-type: none"> ▪ No safety concerns ▪ Low to medium cost ▪ Medium rigor ▪ Can catch more nuanced issues with the EEM | <ul style="list-style-type: none"> ▪ Potential technical difficulties can be frustrating for customer ▪ Not sufficient for highly complex measures ▪ May be viewed as invasion of privacy |
| Onsite Verification | “Boots on the ground” physical confirmation of measure installation | All measure types | <ul style="list-style-type: none"> ▪ Suitable for some highly complex measure ▪ High rigor ▪ Easy to verify measure quantities and nameplate data | <ul style="list-style-type: none"> ▪ Safety may be a concern ▪ Higher customer disruption |
| Onsite Verification + Metering | 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 | <ul style="list-style-type: none"> ▪ Can catch operating irregularities that would otherwise go unnoticed ▪ Highest rigor method ▪ Controls for self-report bias on | <ul style="list-style-type: none"> ▪ Safety can be a significant concern ▪ Highest cost ▪ Highest level of customer disruption ▪ May require multiple trips to customer |

| M&V Method | What is it? | Typical Use Case | Pros | Cons |
|--|---|--|--|---|
| | | | equipment operation | <ul style="list-style-type: none"> Short metering periods may not be representative of full year |
| Calibrated Simulation Modeling | Parametric runs of building simulation models to determine pre- and post-installation building energy use | Residential and commercial new construction projects | <ul style="list-style-type: none"> Best for determining savings from building envelope measures Easy to capture savings from a suite of measures | <ul style="list-style-type: none"> Best to pair with another verification method, which increases cost and customer disruption Can be high cost if the model must be built from scratch |
| Site-Specific Engineering Regression Analysis (including IPMVP Option C and NMEC methods) | Uses monthly billing, AMI, or equipment trend data to determine savings | Large custom or HVAC measures | <ul style="list-style-type: none"> Minimal customer disruption if using billing or AMI data High confidence in results if sufficient data | Must correlate with independent variable such as TMY weather data or production data |

Without knowing the exact implementation plan for the TECH Initiative, our team’s thinking on which of these methods may be deployed for various aspects of this evaluation follows:

- 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.

NMEC Designed Programs

Should the TECH Initiative implementer specifically design an NMEC program (either site- or population-based) our team has the necessary tools and skills to conduct the evaluation. An NMEC program design implies the implementer knows the customer location and utility meter numbers of the installed equipment for both the gas and the electric meters. Further, NMEC programs should ensure the avoided gas usage, and added electric usage, can each be measured sufficiently accurately to comply with California rules for valuation of the fuel switch.

We would start by reviewing the implementer’s embedded M&V plan, including the approach for gas meters and electric meters, and the implementer models. The M&V approach for gas and electric meters should

ideally be similar, however the implementer may demonstrate in the M&V plan that substantially different methodologies for assessing gas and electric meter impacts may yield the most accurate results. As an example, if the displaced gas equipment comprises a large percentage of the facility gas usage and therefore the impacts may be easily measured at the gas meter, the corresponding electric usage may not be easily discernable relative to the electric loads at the building, resulting in “zero” perceived electric load increase at the electric meter. Therefore, the M&V plan should describe the approach for changes at the gas meters and the electric meters since both types of impacts are required by the program rules. A true NMEC-designed program would have a template M&V plan that we can review in the first several months of this evaluation contract. We would provide constructive feedback to the implementer to improve the plan before the program is fully launched.

After the program is launched, we would then conduct independent evaluation of the impacts using approved methods. As NMEC methods require collecting at least 12 months of post-intervention energy consumption and at least 12 months of pre-intervention energy consumption, we would need to time the first cycle of our impact evaluation accordingly. Should implementers use submetering we would need to gain access to this data as well.

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 factor to energy use estimates. While this seems like a simple task on paper, it can be complex in execution.

Multiple existing tools are available to convert energy to emissions (CEC’s CBECC, CPUC’s CET, CPUC’s Fuel Substitution Calculator, CPUC’s Refrigerant Avoided Cost Calculator, CARB’s PATHWAYS model, etc.), however, these may not be consistent with each other. Examples of variation in analysis methods include:

- Conducting calculations varying levels of granularity (hourly vs. quarterly vs. annual, IOU vs. statewide, etc.)
- Sources of emissions factors are varying and may not be fully consistent (CARB, CPUC, CEC)
- Future electric grid emissions factors are estimated via forecasts and thus have a range based on forecast scenario
- Some tools only assess site-level emissions while others assess source emissions

We do not intend to reinvent the wheel; we aim to avoid having to develop 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 BUILD Program and TECH Initiative so their benefits can be presented in an “apples to apples” manner. As described above, we will review existing tools and methods as part of the secondary data and literature review and discuss the most appropriate path forward with CPUC staff. The following are some of the considerations that will feed into this process:

- Ideally a tool will be able to assess the hourly variation in emissions over the year. This could be via 8760 hourly emissions factors or an end-use load shape weighted annual emissions factor that was built up from hourly emissions factors applied to heat pump-specific load shapes.
- It is necessary to report source emissions savings (at the power plant). Tools must include (or add) line loss factors to accomplish this.

- Existing tools must be transparent in their source of emissions factors and be able to be updated as factors are updated over time.
- The CPUC's CET already produces first-year and lifetime GHG savings of programs and is used to roll up and report the GHG impact of Energy Efficiency programs. CET is updated on a regular basis with new emissions factors and reflection of policy changes. Should CPUC want to have consistent methods with how EE GHG savings are calculated, the CET is a strong contender.
- The CPUC's Fuel Substitution Calculator provides guidance to EE program administrators on whether a fuel substitution measure has a net lifetime GHG reduction. It operates using annual emissions factors with no consideration of hourly load shape of equipment. Should CPUC want to have consistent methods with how fuel substitution measures are vetted for EE programs, this calculator could be considered.
- The emissions savings from low GWP systems also needs to be calculated. To our team's knowledge none of the current versions of existing tools quoted above calculate both electricity emissions AND refrigerant emissions in one comprehensive tool.

Once a tool or method is selected and adapted/updated, the evaluation team will run the evaluated kWh and Therm impacts through the tool to estimate program-wide emissions savings. If site-specific evaluation is conducted, we can first calculate emissions for each site and then extrapolate at the stratum level 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.

Bill Impacts

There are several methods to assess bill impacts based on availability of data. Our team will explore which method is best suited upon review of the final TECH Initiative implementation plan. The two general methods are to develop a bill savings calculator or to conduct analysis on actual customer billing information.

Developing a bill savings calculator would leverage much of the same methods as the Bill Savings tool that CEC staff will develop for the BUILD Program. The calculator would develop an estimate of bill impacts (amount of increase or decrease). CEC staff's proposed methodology relies on using hourly estimates of energy impacts combined with the applicable utility rates to determine the expected energy bill. We would deliver a similar tool here with a few noted differences:

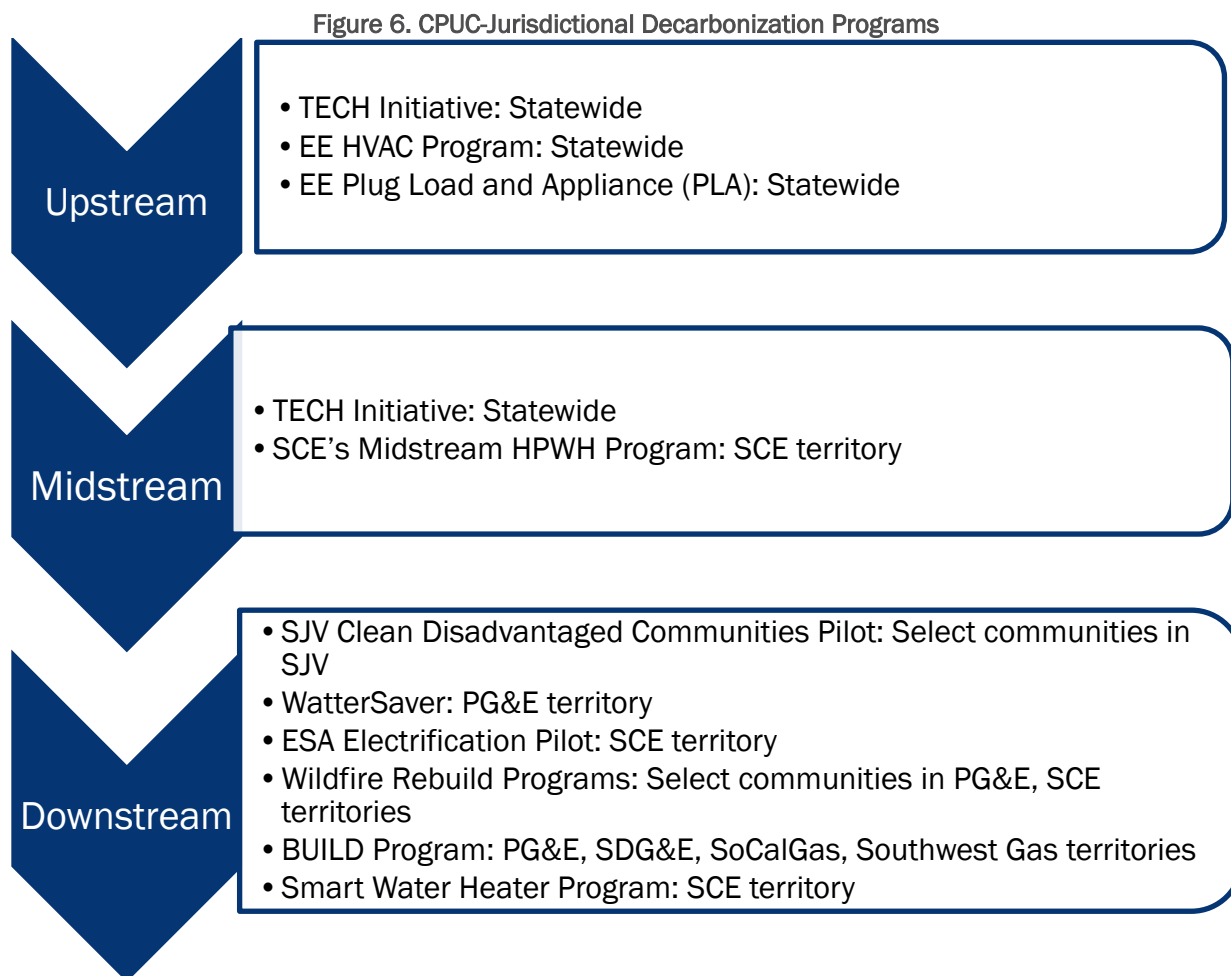
- Rates may vary and could include non-low-income rate classes. We would build a tool that allows flexibility for different rate classes.
- The calculator would focus on the change in customer bill amounts (based on the changes in energy use) rather than estimating the total bill amount. This leverages our impact analysis results (increased electric use, decreased gas use).

Conducting analysis on customer billing data would attempt to quantify the difference between pre-and post-installation bill amounts. While we believe this is a viable path, its rife with confounding factors such as changes in use patterns, occupancy, and rate schedules. Conducting this analysis would require additional data collection and a sufficient period of pre- and post-installation billing data. Finally, we believe this analysis may seem less transparent to stakeholders. While we do not currently recommend it, we have the capabilities to explore it should CPUC staff and stakeholders deem it worthy.

Incentive Layering

In the CPUC’s draft R.19-01-011 Phase II Staff Proposal, staff recommends layering incentives across the many, varied DER programs that target decarbonization in such a way that “the cost of an appliance to the customer is sufficient to encourage fuel substitution.” Staff further recommends using a formula that attributes program impacts proportionally based on the total incentive amount contributed to a single appliance by each contributing program. If the TECH Initiative provides a \$500 incentive while other programs provide a \$1000 incentive for the same appliance, the TECH Initiative will be allocated 33% of the benefits.

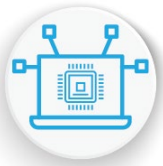
We understand the TECH Initiative implementer RFP states, “In order to track appliances as they move through the supply chain, bidders should propose a method for tracking appliances that the TECH Initiative incentivizes, such as a database of appliance serial numbers.” We also understand the TECH Initiative implementer is expected to coordinate with other CPUC jurisdictional programs (Figure 6) and is strongly encouraged to develop MOUs for data sharing with non-CPUC jurisdictional programs.



Source: R.19-01-011 Phase II Staff Proposal

Without knowing the construct of this database, we assume it will be able to not only log which customers receive a rebate from the TECH Initiative, but also cross reference (or be set up to easily cross reference) to other programs providing information on any other incentives the customer received.

We propose to review this database for accuracy and leverage it for this this savings attribution exercise. Should the database fall short in its ability to cross reference information from other programs, we will work with CPUC to collaboratively resolve how this aspect of the evaluation can proceed.



Task 4. Technology and Policy Watch

This task will allow evaluators, Commission staff, program managers, implementers, and stakeholders stay informed of the evolution of heat pump (HP) technologies, solar thermal technologies, and other related technologies as well as the markets for space and water heating 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 task can also inform the inclusion of newer technologies into the TECH Initiative. We propose to accomplish this through “Electric Technology Briefings” developed approximately every six months. These briefings will provide valuable insights on the latest updates in electric technologies, markets, and research across the U.S. A presentation (via teleconference) and associated slide deck for future reference will result in improved understanding by program designers and policy makers of the other various drivers that contribute to changes in the market. This will help shape the impact evaluation design, provide context to our evaluation results, and help guide program design evolution as appropriate.

The Opinion Dynamics team proposes to tap into our cross-functional team of experts to source information and generate the content to achieve the desired results. The Opinion Dynamics team includes heat pump and solar technology SMEs who serve a wide range of clients, including, but not limited to manufacturers, utilities, R&D organizations (for example, the Department of Energy), federal and state policy makers, the California Energy Commission, and regional efficiency organizations.

We will begin the task each period by convening internally with a selected group of SMEs from across the organization, including colleagues supporting manufacturers, public sector organizations, utilities, and other relevant players (for example, regional efficiency organizations, such as NEEA). As appropriate, we can tap into similar experts for international insights when such updates are newsworthy.

The group of SMEs will utilize two methods to identify and gather relevant insights for the CPUC:

1. Summarize known changes/updates/news across utilities, government agencies, manufacturers for further review and analysis
2. Leverage the literature review (described above) of key publications, conference proceedings, and research funding announcements, as well as participation in webinars from select organizations like ACEEE or DOE National Laboratories on relevant topics

Direct outreach and data gathering from contacts may be pursued if, from the selected topics for that 6-month period, the team determines that outreach may be appropriate as a method to streamline data gathering and reduce labor burden. In all other cases, data gathering will be based on secondary sources reviewed and analyzed by the Opinion Dynamics team. We will utilize ongoing VOM research to inform our insights when timelines align.

The length of the slide deck in MS PowerPoint format (and teleconference) will vary from briefing to briefing depending on the activity during the preceding 6-month period. The Opinion Dynamics Team proposes that each Technology and Policy Briefing contain the following sections:

1. **Headlines** (1-2 slides): Executive summary of key updates during the six-month period

2. **Technology** (5-10 slides): Performance and costs for available residential technology
 - a. **Available products:** New product releases for both typical/average products as well as the newest best-in-class products (including regional notes as appropriate); technology spotlight for new releases that are notable for cost, performance, or configuration
 - b. **Performance and cost updates:** Advances of best-in-class products and typical or baseline products, including best-in-class technology performance tracker updates across a range of heating capacities for the following equipment types: central split HP, mini and multi-split HP, HPWH, VRF Heat pumps, commercial unitary HP, and solar thermal technologies
3. **Market** (5-10 slides): National shipment volumes and market evolution insights for both residential and commercial segments
 - a. **Shipments:** Overview of HP and solar thermal markets relative to other benchmarks
 - b. **OEM/Supply chain/contractors:** New market entrants or big moves by existing players
 - c. **Incentive and Policy:** Substantive changes in incentives/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
4. **Research, development, and demonstration (RD&D)** (5-10 slides): Latest RD&D funding announcements and news on outcomes
 - a. **Announcements:** allocation of funds, new programs, and associated goals and objectives
 - b. **RD&D outcomes:** Summary and analysis of notable RD&D outcomes key outcomes

Task 5. Management

Our team brings over two decades of experience successfully managing complex projects involving multidisciplinary teams to respond to client needs in a timely and competent manner. Our team includes a senior experienced Overall Executive-In-Charge, Megan Campbell, Vice President with Opinion Dynamics and a seasoned Overall Portfolio Director, Dr. Ellen Steiner, Vice President with Opinion Dynamics.

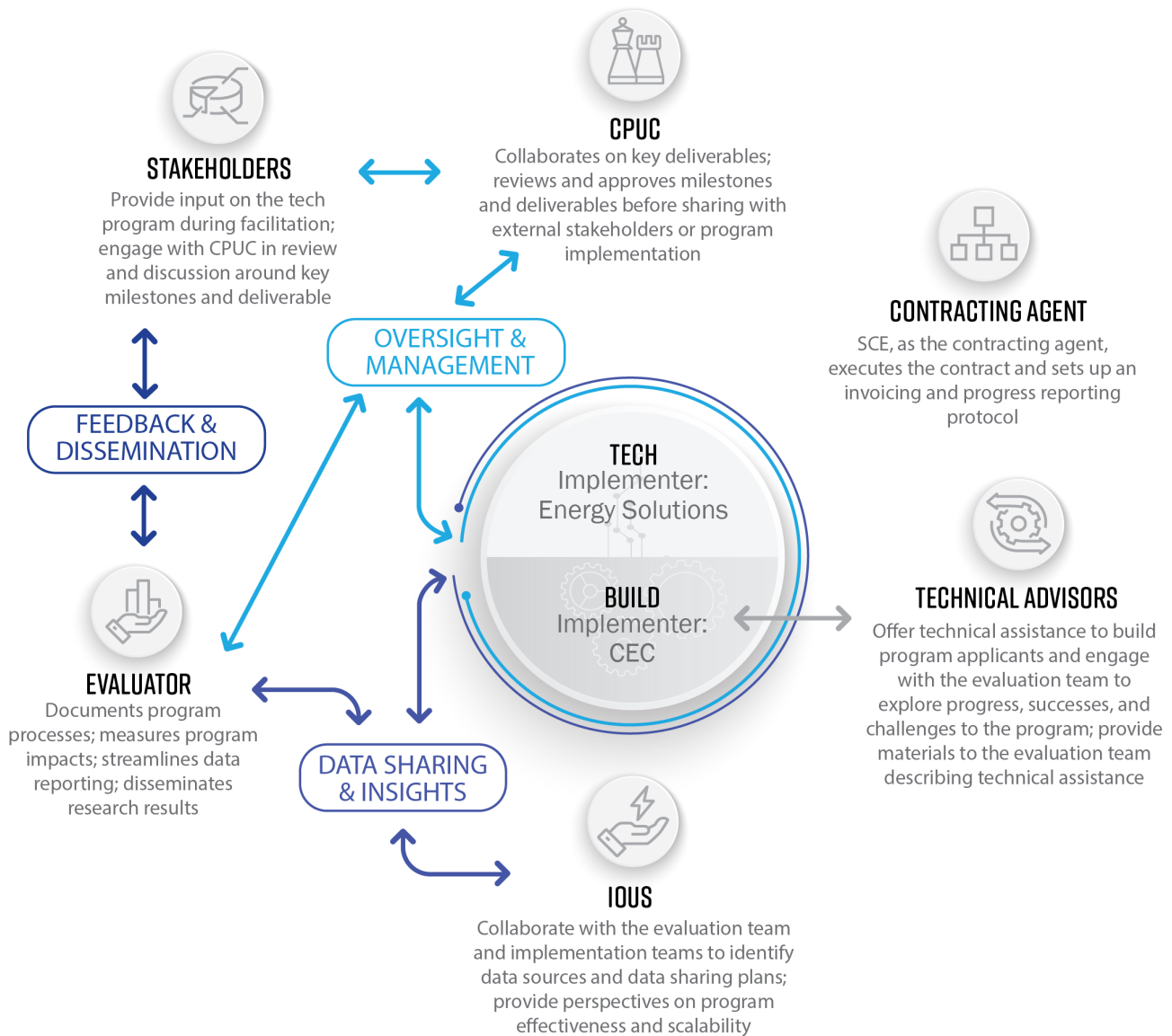
Megan Campbell is based in California and, as Vice President, can draw on the full resources of the Opinion Dynamics team to fulfill this contract. Megan will oversee general administration, project coordination, evaluation planning, and report preparation tasks with the support of her team. She will also facilitate monthly check-in meetings and progress reports with SCE, CPUC, and CEC staff, in addition to communications on time-sensitive issues, as needed. Megan brings her proven and exceptional project management skills. She has an unmatched ability to activate teams to deliver actionable results on time and on budget. Megan has led numerous complex projects with multi-disciplinary teams, most recently Megan led a large multi-disciplinary team with multiple subcontractors to evaluate the PY2017-19 Group B Sector Non-Resource programs for the Commission. This is a very large and complex project and Megan successfully managed internal and subcontracted staff to effectively manage time and resources to meet all deliverable schedules. Megan is a master at bringing together the practical and theoretical, resulting in the implementation of thoughtful and well-grounded evaluations that produce actionable recommendations. She is also able to facilitate and advise the evaluation process (including stakeholder management) from planning through final deliverables.

Dr. Ellen Steiner is a Vice President at Opinion Dynamics who will direct the evaluations and help Ms. Campbell with administrative functions involved in contracting with the two subcontractors, planning resources, workflow tracking, and setting work schedules. Ellen will lead a team of technical and methodology subject matter experts, while also bringing her building decarbonization, zero net energy, and market characterization

expertise to bear on this important research. Ellen has had the honor of working with clients who reside in the states with the most aggressive decarbonization goals: California and New York. She has researched heat pump technologies dating back to 2011 and has provided policy guidance; commission testimony; market research; and market, process, and impact evaluations. She had directed potential, market baseline, and market characterization studies, as well as workforce, education, and training assessments of training focused on electrification technologies. She is currently leading of the CPUC Group B research in the Decarbonization/ZNE sector and the workforce education and training sector.

As part of managing this contract as the program evaluator for both the BUILD Program and TECH Initiative, we recognize that many actors will need to be involved in the planning, execution, and reporting stages. As such, we will be actively conducting market, program and technology research throughout evaluation period and working in collaboration with 7 other actors. A process flow chart showing the dependencies and expectations from the eight actors identified in the RFP is shown in Figure 7 below.

Figure 7. Process Flow Chart for Expectations and Dependencies Amongst the Market Actors Involved in Evaluation



Task 6. Cost Effectiveness

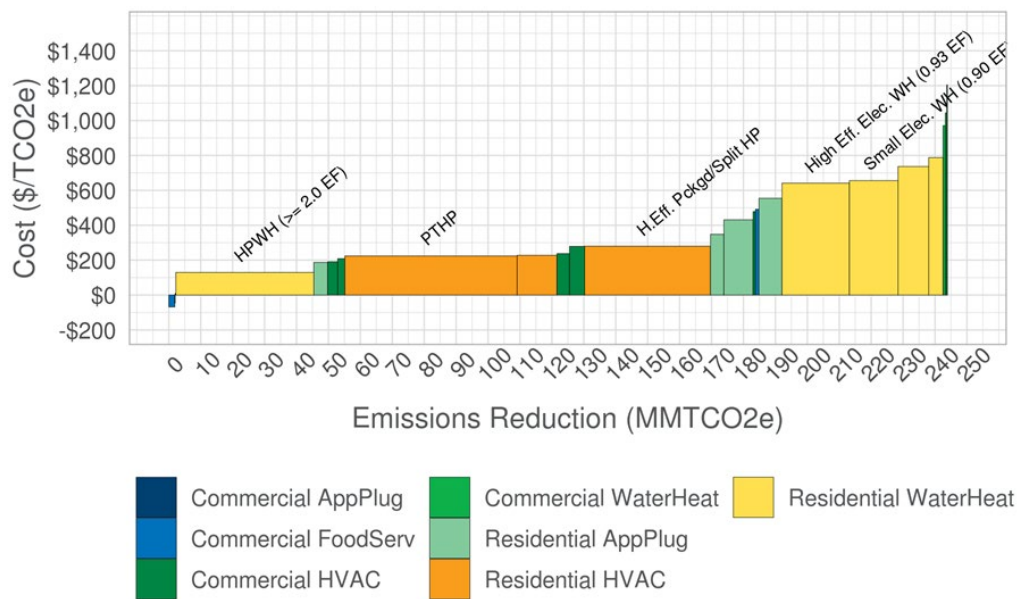
Our team will support in assessing cost effectiveness of the TECH Initiative. There are multiple metrics by which one could assess cost effectiveness. The BUILD Program and TECH Initiative are cap-and-trade funded, not utility-ratepayer funded. Our team is well versed in the cost effectiveness methods and metrics of both the “utility ratepayer-funded world” and the “cap-and-trade funded world.”

Following the utility ratepayer-funded definition of cost effectiveness leads us towards the CPUC’s Cost Effectiveness Tool (CET). Our understanding is that CET will be updated to better handle fuel substitution measures and further account for the global warming potential of refrigerants. Furthermore, our team is deeply

familiar with CET and the California Standard Practice Manual’s (CA SPM) methods through our work on the CPUC Potential and Goals Study. The PG study mines data from CET and replicates the CA SPM methods to calculate TRC, PAC, and RIM test results. We are currently in the process of updating the PG study to assess the potential for fuel substitution measures and with it, their cost effectiveness.

Following methods used in the cap and trade world leads us to greenhouse gas abatement curves and metrics of \$/ton of CO2 equivalent. Assessing the TECH Initiative and the BUILD Program through this lens allows the state to understand how these programs compare to other decarbonization programs, such as those in the transportation sector. Our team is deeply familiar with these methods too as we have produced this format of result for the California Energy Commission using our Fuel Substitution Scenario Analysis Tool (example below in Figure 8).

Figure 8. Building Decarbonization Measures Carbon Abatement Curve



Source: Guidehouse. 2020. Fuel Substitution Forecasting Tools. California Energy Commission. Publication Number: CEC200-2020 001.

Should an alternative or wholly new method of cost effectiveness be needed, our team can also provide deep expertise. Guidehouse has developed its own suite of cost effectiveness analysis models that have been employed by multiple utility clients across the U.S. We have also developed regional benefit cost analysis guidelines customized to other jurisdictions.

This analysis would need to address incentive layering. If the full benefit of the participant’s installation is split across multiple programs due to receiving multiple incentives, some amount of cost-allocation will also be needed. Otherwise we would “overburden” these decarbonization programs with cost and only value a fraction of the benefit. Our team is exploring a similar issue in the CPUC PG study as we address dual benefits accruing to EE and DR programs from a singular measure being installed.

Regardless of the ultimate methods preferred by CPUC, our team has the tools and expertise to execute.

Task 7. Stakeholder Coordination

The evaluation team will participate in stakeholder meetings facilitated by the TECH Initiative implementer and present evaluation status, findings, and recommendations as needed. We see the stakeholder process as critical to developing comprehensive and transparent evaluation and research. Our team has vast experience leading stakeholder workshops and working with energy stakeholders in a public regulatory process through our current contracts with the Commission to evaluate the PY2017-2019 Non-Resource sectors, including ZNE and Building Decarbonization, and conduct the 2021 Potential and Goals Study. As part of these contracts, our team successfully engages stakeholders in our studies via in-person meetings and webinars. Our team works with multiple stakeholders on a quarterly, and sometimes monthly basis to develop evaluation plans, communicate results, and gain valuable input. All proposed management and technical advising staff have presented and communicated evaluation results, recommendations, and findings to technical and non-technical audiences as part of their work to evaluate programs in California over the past two decades.

- Our Overall Portfolio Director, Dr. Ellen Steiner, and Executive-In-Charge, Megan Campbell, will work to make sure we perform all our work within scheduled timelines to solicit and engage stakeholder feedback. They will also work to assign relevant key staff to ensure we bring the appropriate resources to bear for any stakeholder issues that may arise. We understand the sensitivities of the various stakeholders involved and see it as our job to not only provide our methods, but also explanations of why we chose them. At the end of the day, we work at the pleasure of the Commission, but we understand communications to stakeholders are paramount to getting our work done effectively.
- Members of our team are active members of CEDMEC's Market Transformation Initiative Sub-Group where we have listened to stakeholder perspectives on how these initiatives should be designed and evaluated over the past year. Opinion Dynamics has played a critical role in working with the CPUC and PG&E to evolve the existing Zero Net Energy Program Coordination Group into a Decarbonization Program Coordination group and expanding the involvement of market actors in the group. Opinion Dynamics helps set the agenda of the group for each quarterly meeting, with a focus on activating insights and developing action plans to implement actions prompted by these insights. Guidehouse and Opinion Dynamics also led several stakeholder workshops throughout 2020 to inform the research and design of the 2021 Potential and Goals Study update much of which focused on the information and modeling needed to capture heat pump market potential in residential single-family and multifamily markets.

Task 8. Reporting

As requested in the RFP, we will develop and regularly update a system or process for reporting, monitoring, and providing feedback for the TECH Initiative and provide the CPUC, CEC, SCE, and the public with regular evaluation updates. We will also develop annual evaluation reports. As such, we anticipate both dynamic real-time reporting and static reporting. These options are further described below.

Dynamic Real-Time Reporting

Through our embedded evaluation approach, there are several opportunities that allow for dynamic, real-time reporting to program managers to ensure that the market feedback and experience with program efforts is captured quickly and provided to key stakeholders. Given the significant barriers to adopting this technology in the marketplace, it will be important to measure the market's perspective on the program's initial efforts to ensure they adequately address market barriers and motivate the market to accelerate adoption. Further, advancements in technology or national policy will likely occur rapidly in the next five years and will be important to monitor and share with the program team. We anticipate providing the following information to

the Commission and program management staff in real-time throughout the evaluation period as results are available (Table 11).

Table 11. Real-Time Dynamic Reporting

| Reporting | Timing |
|--|--|
| Program Theory and Logic Review & Proposed Evaluation Metrics | Within first 6 months |
| Secondary Data & Literature Review (Baseline Market Assessment) | Within first 6 months |
| Market transformation monitoring dashboard | Beginning with the baseline market assessment we will start to build a dashboard tool that captures key market metrics and is updated throughout the evaluation as new information becomes available |
| Technology & Policy Briefs | Every 6 months |
| Primary research results from interviews, surveys and mystery shopping tasks (interim memos or PPTs) | As results become available, at least once per year starting in Year 2 |
| Social Network Analysis | When results are available in Year 4 |

Baseline and Market Assessment Dashboard

Within the first six months of project award, we will publish a baseline study report in Word format that captures all data possible in that time period. We will also explore the use of a dashboard tool using Power BI to show the current state of the market across key market metrics. The dashboard would include all inputs, assumptions, and data sources for transparency. As the evaluation progresses, key inputs would be updated. For example, we would update the model based on the latest AHRI and HARDI data monthly. In year 4, when we plan to conduct another round of primary research to update the model and assess progress towards market transformation, we could then update this dashboard again so it always reflects the latest state of the market.

We can develop simple yet powerful dashboard solutions for timely feedback on program performance. We recognize that the implementer may also have plans for real-time reporting and potentially have plans for a dashboard or website to report on program performance. We will collaborate with the implementer where possible to embed our reporting into their planned activities. Upon contract award, we will work closely with the Commission to determine the format, structure, and content for any dashboard reporting.

The dashboard can be customizable and adaptable throughout the entire evaluation; it can start with limited data available in 2021 and we can then add more functionality and data as it becomes available. Eventually, the dashboard can be used as a market, and possibly program, monitoring tool that analyzes metrics and trends over time. We can customize the dashboard to analyze market adoption trends across time and overlay program participants on a map to analyze geographic trends, especially in DACs and key climate zones.

Static Reporting

As specified in the RFP and Q&A, we will provide comprehensive evaluation reports annually and a final report capturing the entire Pilot period. At Opinion Dynamics, we view reporting as a communications tool, designed to provide clear, concise, and actionable information for program development, refinement, and ultimately, program success. As such, our report will incorporate and synthesize findings from across the multiple research activities to tell the story of the current state of heat pump market transformation, program performance, and scalability potential.

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. Our team is prepared for multiple presentations of results and iterations at each reporting period. We anticipate presenting to the Commission first, then to the implementers, and then to external stakeholders allowing for time to address input from each stakeholder before progressing to the next stage.

In addition, we need to 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.

Table 12. Static Reporting

| Static Report | Calendar Year (Estimated Timing) |
|---|----------------------------------|
| Evaluation Plan (within first 6 months of Project Award) | Dec 2021 |
| Year 1 Annual Report (Baseline Market Assessment + All Task 1 Activities) | Dec 2021 |
| Year 1 Presentation | Dec 2021 |
| Year 2 Annual Report | Dec 2022 |
| Year 2 Presentation | Dec 2022 |
| Year 3 Annual Report | Dec 2023 |
| Year 3 Presentation | Dec 2023 |
| Year 4 Annual Report | Dec 2024 |
| Year 4 Presentation | Dec 2024 |
| Year 5 Comprehensive Report | Dec 2025 |
| Year 5 Presentation | Dec 2025 |

1.7 Milestones Schedule

| Major Milestones & Reporting Timeline for the TECH Initiative | YR 1 | | | | YR 2 | | | | YR 3 | | | | YR 4 | | | | YR 5 | | | |
|---|------|----|----|----|---|----|----|----|------|----|----|----|------|----|----|----|------|----|----|----|
| | 2021 | | | | 2022 | | | | 2023 | | | | 2024 | | | | 2025 | | | |
| | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 |
| Project Kick Off Meetings | | x | | | | | | | | | | | | | | | | | | |
| Evaluation Plan (including final metrics and PTLM) | | | | x | | | | | | | | | | | | | | | | |
| Baseline Market Assessment Literature Review | | | | x | | | | | | | | | | | | | | | | |
| Initiate and Continuously Update Market Monitoring Dashboard Tool | | | | x | Dynamic tool updated in real-time with market watch research | | | | | | | | | | | | | | | |
| Market Assessment Updates to Baseline | | | | | | | x | | | | | | | | | x | | | | |
| Technology and Policy Briefs | | | | x | x | | x | | x | | x | | x | | x | | x | | x | |
| Interim Memos and Presentations | | | | | As results become available from Program and Market Watch Efforts | | | | | | | | | | | | | | | |
| Annual Reporting | | | | x | | | | x | | | | x | | | | x | | | | x |
| Annual Presentations | | | | x | | | | x | | | | x | | | | x | | | | x |
| Stakeholder Communication/Engagement | | | | | Throughout evaluation | | | | | | | | | | | | | | | |

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