Commercial Rooftop Units Market Transformation Initiative

Appendix F: Evaluation Plan

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List of Abbreviations

Abbreviation	Definition
BMA	Baseline market adoption
CalMTA	California Market Transformation Administrator
C&S	Codes and standards
CCC	Connected Controls and Commissioning
CEDARS	California Energy Data and Reporting System
CET	Cost-effectiveness tool
CPUC	California Public Utilities Commission
CRTU	Commercial Rooftop Unit
DAC	Disadvantaged Community
EM&V	Evaluation, measurement, and verification
ESJ	Environmental and social justice
HP	Heat pump
HVAC	Heating, ventilation, and air conditioning
IOU	Investor-owned utility
IVEC	Integrated ventilation, economizing, and cooling
IVHE	Integrated ventilation and heating efficiency
MPI	Market Progress Indicator
MTI	Market Transformation Initiative
PA	Program Administrator
PTLM	Program theory and logic model
QPL	Qualified products list
RTU	Rooftop unit
TBE	Theory based evaluation
TMA	Total market adoption
UEI	Unit energy impacts
V&E	Virtual Compliance Assistant and EnergyPro

1 Introduction

The evaluation approach to the Commercial Rooftop Unit (CRTU) Market Transformation Initiative (MTI) will follow the guidelines outlined in the CalMTA Market Transformation Initiative Evaluation Framework for assessing MTI performance and market progress. As indicated in the logic model, the envisioned long-term market outcome of the CRTU MTI is an increase in heat pump rooftop units (HP RTUs) installed in California that have variable-speed fans, include diagnostics and controls, and perform 20% above the minimum cooling efficiency standard.[1] Another envisioned long-term outcome is that installed RTUs meet manufacturer installation best practices and are capable of responding to DR signals. In this future, previously undetected faults and inefficiencies are identified and resolved, increasing the operational efficiency and overall performance of RTUs.

Evaluation is essential to the development and successful management of market transformation programs. California Public Utilities Commission (CPUC) Decision 19-12-021 (the Decision), which authorized funding for and the creation of a statewide Market Transformation Administrator (CalMTA), includes guidance regarding evaluation of MTIs and the overall market transformation portfolio. It calls for setting clear savings goals and other MTI metrics at the time the CPUC initially approves the MTIs to ensure a high level of accountability and ongoing evaluation to reduce program performance risk.

CalMTA and the CPUC's Energy Division will oversee implementation of rigorous and strategically focused evaluation, measurement, and verification (EM&V) practices that will enable CalMTA management and stakeholders to gauge the performance of the MTIs, verify incremental impacts, and improve the design and success of future MTIs. The Decision calls for "real-time" market evaluation, which will provide MTI program managers and implementers with continual feedback, allowing them to pivot strategies as needed to maximize the value delivered to California ratepayers. Tracking of proximate and longer-term market progress indicators (MPIs) that are tightly aligned with the MTI's market transformation theory will reduce MTI performance risk and support timely decisions regarding ongoing investment, or termination of investment, in MTIs.

This document identifies the indicators third-party evaluators will assess to demonstrate movement toward those long-term outcomes, the data sources and approaches used to evaluate the market progress metrics, and the approach for validating incremental impacts and cost effectiveness.

[1] Depending on the timeframe and system capacity, the relevant cooling efficiency metric could be the seasonal energy efficiency ratio 2 (SEER2), integrated energy efficiency ratio (IEER), or integrated ventilation, economizer, and cooling (IVEC).

This document describes CalMTA's preliminary plan for third-party evaluation of the CRTU MTI. Per the MTI Evaluation Framework, CalMTA developed this preliminary evaluation plan with input from the Evaluation Advisory Group, a group of three independent evaluation experts; the CPUC CalMTA project manager; and the CalMTA market research and evaluation lead. Final evaluation plans will be developed by an independent third-party evaluator to be selected via a competitive bidding process after the MTI advances to Phase III: Market Deployment. CalMTA expects that the third-party evaluator may recommend refinements to the approach and metrics described in this document. It is expected that for CRTUs, this competitive bid will occur either in the second half of 2026 or early 2027, and market progress evaluations will be completed by the third-party evaluator on an annual basis.

1.1 Overview

The approach described in this preliminary evaluation plan employs theory-based evaluation (TBE), which is widely accepted as a best practice for market transformation program evaluation. TBE relies upon the MTI to have a program theory that clearly identifies the specific market outcomes associated with the MTI strategic market interventions, along with their approximate timing. TBE also assesses causality between the market interventions and observed outcomes.

In addition to the proposed MPIs, this preliminary evaluation plan identifies data sources and evaluation approaches that the third-party evaluator can use to assess market progress, MTI causality, and CalMTA's estimates of MTI incremental impacts and cost effectiveness. This plan focuses on third-party evaluation activities over the first five years of Phase III (that is, through CalMTA's initial funding period). It does not describe ad hoc market research studies, which CalMTA and/or the third-party evaluator will conduct to inform "real-time" strategy decisions.

1.2 Evaluation objectives

The third-party evaluator will employ a TBE approach to assess observed market outcomes in relation to what was anticipated in the CRTU MTI Plan. It will use the MTI program theory as the point of reference, assessing market progress against the theorized short-, medium-, and long-term outcomes and corresponding MPIs, and the extent to which the market interventions caused the outcomes theorized in the logic model. The evaluator will conduct ongoing market monitoring via secondary data analysis and primary research to evaluate market progress and causality and, importantly, to provide ongoing market insights that provide real-time information to inform MTI strategy and improve performance. The evaluation will address the following high-level objectives:

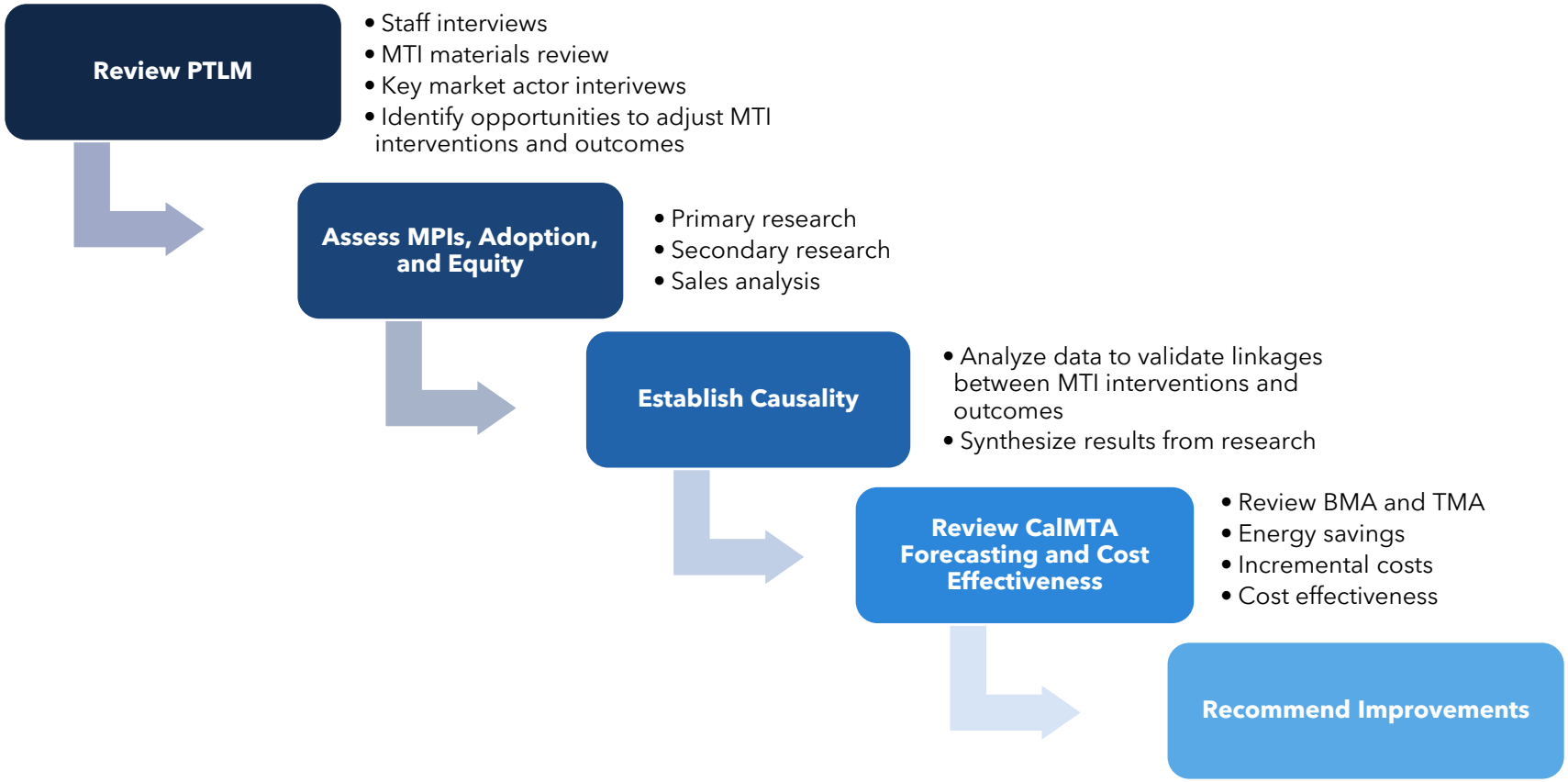
- Monitor market dynamics and characteristics; assess market developments
- Review and assess the MTI program theory and logic model (PTLM)
- Measure market progress and equity, per the MPIs

- Assess MTI causality per the logic model, using evidence-based assessments that use a "preponderance of evidence" approach and established market transformation evaluation best practices
- Identify gaps in implementation and opportunities to adjust MTI strategy and tactics, to improve MTI effectiveness
- Assess ancillary benefits and costs
- Review CalMTA's baseline market adoption (BMA) and total market adoption (TMA) forecasts, unit energy savings, incremental net MTI impacts and co-created MTI impacts,[2] and cost-effectiveness inputs and assumptions

Figure 1 shows the evaluation approach for the first year. First, the evaluator will review the PTLM, identify gaps in the interventions and logic, and assess whether the PTLM accurately captures the implemented MTI interventions and outputs. During this step, the evaluator will also determine what data are needed to assess causality based on the MTI's theory of market transformation. Next, the evaluator will conduct primary and secondary research to measure actual units of adoption and other MPIs. Third, the evaluator will synthesize the evidence gathered through multiple lines of research to establish causality. Then, the evaluator will review CalMTA's models for calculating incremental impacts and cost effectiveness and make recommendations for improvement, including whether and how resources should be reallocated. Finally, the evaluator will provide recommendations to the team for improving the effectiveness of the MTI.

[2] Co-created impacts are the total impacts resulting from an MTI's interventions, including those resulting from collaborations with resource acquisition programs.

Figure 1. Evaluation Process



1.3 Market progress indicators and milestones

During Phase II: Program Development, indicators and milestones were established for the MTI:

- The **CRTU MTI strategy manager** created a program theory of market transformation and a logic model informed by product and market characterization research.
- The **CRTU MTI evaluation lead** worked with the team and evaluation advisors to develop a set of MPIs against which market progress and MTI performance can be assessed, along with data sources that can be used to track progress against those MPIs.

Table 1 outlines the MPIs derived from the PTLM interventions and outcomes, along with associated milestones. Equity-focused MPIs are denoted with an "EQ" to highlight their relevance to the environmental and social justice (ESJ) goals of the MTI (see EQ1 and EQ19). CalMTA also created a comprehensive evaluability map (see the table in Section 5) that includes the MPIs and milestones shown in Table 1, along with the associated data sources that will be used to evaluate the MPIs, milestones, and causality.

Table 1. CRTU PTLM Outcomes, MPIs, Milestones, and Current Baseline

Intervention	PTLM Outcome	Timing	Market Progress Indicator (MPI)	Program Milestone/Trend[a]	2025 Baseline
Engage with manufacturers to develop affordable RTUs, support trade ally business case, and continue the advancement of HP RTUs for replacement market	Demonstration project that documents business case and validates savings for CCC, variable speed, and efficient cooling	Short (1-3 yrs)	1 - Number of manufacturers partnering with CalMTA on demonstration project	**Three or more manufacturers (of mass-market equipment, not custom equipment) engage with CalMTA to implement demonstration project by 2028**	TBD
			EQ1 - Number of demonstration project CRTUs installed in disadvantage communities (DACs)	**40% of demonstration project CRTUs installed in DACs by 2029**	0
			2 – Number of demonstration project CRTUs installed with CCC, 20% improved cooling efficiency, or all CRTU features	**150 demonstration project CRTUs are installed in California by 2029, of which 20 include all CRTU features**	0
			3 - Percent of demonstration project end-users who have installed and used the mobile or desktop app to examine CRTU performance.	Majority of users to engage with app	TBD
			4 - Number of demonstration project HVAC installation contractors who agree there is a compelling business case for CCC	Majority of contractors to agree there is a business case	TBD
	Manufacturers see value in partnership and engage on product refinement	Short (1-3 yrs)	5 - Number of manufacturers meeting with CalMTA after demonstration project completion to discuss product refinement	**Two or more mass-market manufacturers meet with CalMTA after demonstration project completion to discuss product refinement by 2030**	TBD
	Upstream incentives address incremental cost barrier for CRTUs	Med (4-8 yrs)	6 - Incremental equipment price of code-min HP RTUs with and without CCC to distributors from partner manufacturers	**No incremental equipment price for CCC feature to distributors for equipment produced by partner manufacturers by 2031**	TBD
	Multiple manufacturers incorporate CCC	Med (4-8 yrs)	7 - Number of minimum efficiency product lines including CCC as a standard feature (not as an add-on option)	**Three minimum-efficiency product lines include CCC as a standard feature by 2031. At least two product lines are from these major equipment manufacturers: Trane, Carrier, Lennox, Johnson Controls, Daikin.**	TBD
	Easy-to-use customer and contractor interfaces	Med (4-8 yrs)	8 - Percent of customers and contractors that self-report that CRTU interfaces (mobile and desktop app) are easy-to-use (e.g., intuitive, user-friendly)	Self-reported usability improves over time.	TBD
	Customers understand and see value in CCC	Med (4-8 yrs)	9 - Percent of potential RTU buyers (building owners and facility managers of buildings with RTUs) ~~who~~*~~demonstrate~~*who *demonstrate awareness of CCC, its capabilities, and its value*	RTU buyer awareness increases over time	TBD

	Customers prefer products offering CCC and general adoption of HP RTUs increases	Long (8-10 yrs)	10 - Market share of all single-zone HP RTUs with CCC (denominator is all single-zone HP RTUs)	**Market share of all single-zone HP RTUs with CCC hits 50% by 2035**	TBD
	Market share of RTUs with CCC increases and equipment costs are on par with competing product	Long (8-10 yrs)	11 - Installed price of HP RTUs with CCC	**Installed price of HP RTUs with and without CCC are within 5% by 2035**	TBD
	Market share of product incorporating variable speed fans, CCC, and IVEC+20% grows	Long (8-10 yrs)	12 - Market share of RTUs with variable speed fans, CCC and IVEC+20% (denominator is all single-zone HP RTUs)	**Market share of CRTUs with all features is over 30% by 2040**	TBD
Engage with distributors & contractors to build availability and comfort with CRTU features	Distribution and standard supply chain channels stock, sell, and promote CalMTA CRTU product	Med (4-8 yrs)	13 - Percent of distributors stocking CRTUs	**60% of distributors stock CRTUs by 2032**	TBD
	HVAC installers and workforce embrace and market benefits of CCC	Med (4-8 yrs)	14 - Percent of HVAC contractors that include CCC in customer bids by default	**90% of contractors include CCC in 50% or more bids by 2032**	TBD
	HVAC installers and workforce leverage fault detection and controls, increasing overall HP adoption	Med (4-8 yrs)	15 - Percent of HVAC companies that access customers' CCC to support diagnostics, optimization, and repairs. (Accessing the CCC interface off-site as a step towards addressing the service call.)	**50% of contractors utilize customer CCC by 2035**	TBD
Coordinate with energy efficiency programs (outside California) to encourage manufacturers to include CRTU features when developing products	Shared industry tiers/specification incorporate CCC, variable speed fans, and efficient cooling	Short (1-3 yrs)	16 - Number of EE programs outside of California that incorporate CCC, variable speed fans, and efficient cooling after engagement with CalMTA	**Two EE programs adopt after engagement with CalMTA by 2029**	TBD
	Decreased costs through competition	Med (4-8 yrs)	17 - Installed price of CRTUs (all tiers) compared to code-minimum HP RTU	**Average price premium of Tier 2 and Tier 3 CRTUs is no more than 38% by 2040.** **Average price premium of Tier 2 and Tier 3 CRTUs is no more than 30% by 2040.**	TBD
Increase training for contractors and marketing to business owners to increase awareness and comfort with CCC	Education & training materials developed and incorporated into industry trainings/education; inclusive of ESJ communities	Med (4-8 yrs)	18 - Number of HVAC training organizations (manufacturers, distributors, HVAC industry groups, education institutions, EE programs) that include CRTU in trainings	**Four HVAC training organizations cover CRTU in trainings targeted to California HVAC workers by 2031**	0
	HVAC Installers and workforce are trained, trusted, and available for installations	Med (4-8 yrs)	19 - Percent of HVAC companies with staff trained on CCC in each investor-owned utility (IOU) service territory	**75% of contractors report staff can support CCC installations and service by 2033**	TBD

	across the state without cost-premiums in ESJ communities	Med (4-8 yrs)	EQ19 - Percent of HVAC companies serving DACs reporting staff are trained on CCC	**Percent of HVAC companies with CCC-trained staff serving customers in DACs comparable (within 10%) to general population by 2031**	TBD
Coordinate with California voluntary programs (CalNEXT, Comfortably CA) to create consistent incentive offerings	Applicable California programs supporting RTUs align with CalMTA product definition	Med (4-8 yrs)	20 - Number of California EE programs (non-residential HVAC) align with at least one CRTU tier for incentive eligibility after engagement with CalMTA	**Three California EE programs that target non-residential HVAC align with at least one CRTU tier (CCC, 20%+ cooling efficiency, or all CRTUs features) by 2029**	TBD
Coordinate with California regulatory programs (CASE, Code Readiness, and CEC) to incorporate elements of CCC into applicable codes and standards	CCC elements of CalMTA CRTU product definition are adopted into applicable codes or standards	Long (8-10 yrs)	21 – Adoption of CCC into applicable codes or standards	Accelerated adoption of CRTU specifications into applicable codes or standards	Not in code

Notes:

[a] CalMTA uses milestones to specify expected performance, which is also reflected in its TSB and cost-effectiveness forecasts; these **milestones are designated using bold type**.

Expected trends are included in this table to guide real-time evaluation and adaptive management efforts; they represent directional trends that are consistent with the PTLM and would be consistent with market progress.

1.4 Data collection and analysis activities

CalMTA identified primary and secondary data collection activities and analysis tasks that would allow the third-party evaluator to evaluate the CRTU MTI. Table 2 lists the evaluation research objectives along with associated data collection and analysis activities, which are described in the text that follows. We look forward to seeing proposals that improve upon what is laid out here by identifying good sources of data and/or offering detailed descriptions of innovative methods that will be used.

Within six months of the evaluation initiation, the evaluator will identify data gaps and potential options for filling those gaps.

Table 2. Research Objectives and Evaluation Activities

Research Objective	Secondary Data/ Literature Review	Customer/ Decision-Maker Surveys	Market Actor Surveys and Interviews	PA & Stakeholder Interviews	Collect and Analyze Secondary Data	Distributor and Manufacturer Sales Data	PA Program Data Review	CalMTA Forecasting and C/E Model Reviews
Assess the theory of market change per the MTI logic model	X	X	X	X	X	X	X	
Monitor market dynamics and characteristics	X	X	X	X	X	X		
Track units of adoption	X	X	X	X	X	X	X	
Measure market progress, per MPIs and milestones		X	X	X	X	X	X	
Measure equity MPIs	X	X	X		X	X		
Assess MTI causality	X	X	X	X	X	X	X	
Assess incremental MTI impact	X		X		X	X	X	X

2 Data sources

CalMTA conducted a Market Characterization study[3] of the California RTU market between mid-2024 and early 2025 to broadly characterize the market conditions and types of RTUs recently installed in California; however, as it was mostly completed prior to the CRTU product being defined, many baseline MPI values still need to be established. This preliminary evaluation plan includes data collection activities that build on the early research conducted in that study. Proposals recommending additional data sources and innovative methods are encouraged.

2.1 MTI program data and materials

The evaluator will review CalMTA's program-tracking data to assess MPIs and milestones. This data includes information on incentives, program coordination activities, market partner agreements (e.g., participating manufacturer data from upstream incentives), and other materials related to CalMTA's program activities. CalMTA and its eventual implementation contractor(s) will capture data that aligns with the activities outlined in the MTI logic model, such as outreach and engagement. Demonstration project materials will be provided to the evaluator. CalMTA anticipates either maintaining a qualified products list (QPL) or leveraging a QPL maintained by a market partner to support identification of market adoption. CalMTA may also pursue purchases of HVAC sales data from third parties, such as HARDI or Encentive Energy.

2.2 Secondary data and literature review

The Market Characterization study included an extensive literature review drawing from various secondary data sources including RTU or commercial HVAC market characterization studies in California and other states. These sources provided insights into barriers, standard market practices, and decision making relevant to RTU supply chain actors.

The team also analyzed a mechanical systems database, the Virtual Compliance Assistant and EnergyPro (V&E) Database, which is maintained by the Codes & Standards (C&S) Compliance Improvement Subprogram that collects permitting data statewide. The database includes thousands of permit applications, including RTUs, and documents attributes such as heating fuel efficiency metric, construction type, compliance pathway, capacity, and climate zone. Although it is a rich source of data, it is also limited, as CalMTA surmises about ¾ of RTU installations are not captured in this source. This dataset may be requested by the C&S program administrator.

The evaluator will leverage some of the same data sources to inform the MTI Market Progress Evaluation. During the literature and secondary data review, and throughout the course of their work, the evaluator will also attempt to identify additional relevant data sources or literature, including new evaluations or market studies.

[3] Appendix D, Market Characterization Report for Commercial Rooftop Units.

2.3 California sales and program data

The evaluator will analyze sales data from multiple sources (program and shipment data) and make recommendations on how to use the data to determine market adoption of CRTUs and any other relevant MPIs.

- **Manufacturer Shipment Data (Source CalMTA data agreements with manufacturers, analyzed periodically).** CalMTA will design an upstream incentive targeted at manufacturers, establishing a pathway to obtain shipment data that informs program design and market tracking. The evaluator will work with CalMTA to access these data annually.
- **Program Administrator and California Energy Data and Reporting System Data (CEDARS).** The evaluator will assess program participation by compiling program data and CEDARS data to account for market interventions by PAs. The evaluator will incorporate net-verified program participation into total market adoption estimates to avoid double-counting. This is discussed further below.
- **Other Sources of Purchase or Shipment Data.** The evaluator will work with CalMTA to gather shipment and sales data to assess sales across all channels. This may involve sources such as CalMTA-negotiated data-sharing agreements with market actors and purchasing organizations.

2.4 Primary data collection

The evaluator will develop a sampling and research plan that allows for longitudinal tracking of key characteristics to measure progress toward achieving MPIs. The evaluator will clearly document data sources, the sampling strategy, and sample frame development process. The first-year measurement will serve as a baseline for future year comparisons.

2.4.1 Demonstration project interviews and surveys

The demonstration project will take place during the first three years of the MTI. The evaluator will interview demonstration project manufacturers, distributors, HVAC installation companies, and end-users to assess short-term MPIs and gather early feedback on CCC systems, installation and ongoing costs, and market reactions to this feature. The evaluator will interview distributors and contractors participating in the demonstration project to capture their feedback about CCC systems, areas needing additional support, sales and customer education practices, whether customer CCC is being accessed and used to monitor performance remotely, and whether the contractor sees a clear business case for CCC being included as a standard feature. The evaluator will review program data and survey or interview end-users to gather feedback about using CCC, determine the number of demonstration project RTUs installed in disadvantaged communities (DACs) (and any differences in DAC installations), the percent who have installed and used the mobile or desktop app to examine RTU performance, how users responded to or plan to respond to fault alerts, and other aspects of their experience with CCC. Given the extra support and education provided to demonstration project participants and partners, results from the

demonstration project are expected to be better than what may naturally occur without such bespoke support.

Also of interest is the long-term performance of CCC and persistence of savings. The evaluator will conduct follow-up surveys or interviews with demonstration project end-users every other year to assess how CCC usage evolves over time, as well as understand impacts and frequency of occupant turnover. This will require CalMTA to maintain multiple contacts for each demonstration project installation.

2.4.2 Commercial rooftop unit buyer survey

The evaluator will field a survey for potential RTU buyers in the second year and in alternate years following that. The survey should differ from the survey used in the market characterization research to focus on awareness and preferences for CCC and other features. The evaluator will build upon the sampling strategy that includes different types of decision makers, including building owners and facility managers.

2.4.3 HVAC contractor surveys

During the first year, and in alternate years following that, the evaluator will survey HVAC contractors who sell RTUs to commercial customers to establish baseline adoption and understanding of business practices and installations of CRTUs, barriers to equipment installation, awareness of efficient products, market trends, installed fuel types, and pricing. During the Market Characterization study, CalMTA completed 18 interviews with HVAC contractors and 5 with distributors across California. Ideally, the evaluator will survey at least 70 HVAC companies statewide, utilizing strategies to maximize response rates and market coverage, and to provide sufficient representation of contractors serving end-users in DACs.

2.4.4 Distributor surveys

The evaluator will survey distributors about CRTU awareness of value proposition, stocking practices, HP market share, lead times for products that are not stocked, and wholesale costs of CRTUs. While CalMTA will provide referrals to distributors that have been contacted by the MTI, the distributor surveys should be representative of the market and potential customers.

2.4.5 MTI staff, stakeholder, and partner program interviews

The evaluator will conduct interviews with CalMTA staff, stakeholders, and partner programs coordinating with CalMTA on CRTUs. Stakeholders and experts will include program administrators and implementers of programs that promote efficient HVAC technologies, and organizations conducting HVAC training, education, standard setting, and pilot efforts supporting deployment of the technologies. These interviews will inform an understanding of current program offerings and future program changes influenced by CalMTA, barriers to adoption, and market and technology trends. The evaluator will conduct up to 10 interviews per year, although the relevant stakeholders or partners may change from year to year as the MTI progresses.

2.4.6 Manufacturer interviews

The evaluator will conduct manufacturer interviews to assess the causal relationship and impact of interventions aimed at increasing CCC availability as a standard or default feature on entry-level RTUs, to assess other product trends and related influence of the MTI and to investigate any other research questions that would provide useful feedback to the MTI team.

2.4.7 Timeline for data collection and analysis activities

Table 3 outlines the initial timing recommended for evaluation activities. MPIs correspond with MTI market interventions and associated activities and outputs, which occur at different times and result in logic model outcomes that are achieved over different time horizons. The timing and frequency of data collection and other evaluation activities will be planned accordingly to allow timely assessment of MPIs and to provide market insights that will support improvements to the MTI. This timeline will be updated to address any changes in MTI implementation or if MPIs need additional review or no longer need to be evaluated. The data collection activities in the first and second years will be critical for measuring market baselines.

CalMTA anticipates a formal report every other year. On alternate years, findings may be presented in either a memo or slide deck format, which will be incorporated into the next year's formal report.

Table 3. Timeline for Data Collection Activities

Data Collection Activities		Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8
Review CalMTA program data and materials review		X	X	X	X	X	X	X	X
Secondary data and literature review		X	X	X	X	X	X	X	X
Analyze sales and program data	Manufacturer data	X	X	X	X	X	X	X	X
	PA program and CEDARS data	X	X	X	X	X	X	X	X
Primary data collection: market actor data gathering	Demonstration project interviews/surveys	X	X	X		X		X	
	RTU buyer survey		X		X		X		X
	HVAC contractor surveys	X		X		X		X	
	Distributor surveys	X		X		X		X	
	Manufacturer interviews	X		X		X		X	
MTI staff, stakeholder, and partner interviews		X	X	X	X	X	X	X	X

3 Program theory and program implementation review

The evaluator will compare the MTI PTLM and MPIs against the market interventions implemented by CalMTA and the resultant outputs. After conducting MTI staff interviews and reviewing program documents, the evaluator will make recommendations on how to improve the PTLM and MPIs. The program theory should provide a feasible explanation of how the interventions will lead to increased CRTU adoptions.

CalMTA will provide to the evaluator the following information (where available):

- PTLM
- Tools, fact sheets, and other MTI outputs
- Implementation and marketing plans

- List of key stakeholders and contact information
- List of MTI engagements and relevant Salesforce entries
- Forecast of incremental market adoption and cost effectiveness, including complete documentation of inputs, assumptions, and sources
- *Ex ante* impact calculations
- Written agreements/contracts with market actors and resulting data

The evaluator will review this data to identify information needs to be addressed in primary and secondary research tasks. It is expected that the PTLM review will be thoroughly conducted in the first year of the evaluation and revisited every other year.

4 Evaluating market progress

4.1 Market adoption by installation scenario

There are multiple CRTU installation cases that have unique energy-saving characteristics, but the market forecasting team has simplified the number of installations into six cases as shown in Table 4.

Table 4. CRTU Installation Cases

Installation Case	Existing Equipment
Code minimum HP RTU with CCC	Heat pump
HP RTU with 20% better than code cooling efficiency	
HP RTU with 20% better than code cooling efficiency, variable-speed fans, and CCC	
Code minimum HP RTU with CCC	Gas furnace with air conditioner
HP RTU with 20% better than code cooling efficiency	
HP RTU with 20% better than code cooling efficiency, variable-speed fans, and CCC	

Half of these cases have a code-minimum all-electric heat pump RTU as the existing equipment while the other half have code-minimum gas pack equipment. CalMTA will provide details on each of these cases as part of the complete forecasting model documentation. Determining units

of adoption for each case is a key focus of the evaluation because accurate measurement is essential for estimating the incremental energy impacts of the MTI.

Units of adoption refers to the CRTU installations that occur within California each year; the installation of a single CRTU in California's existing nonresidential building stock would count towards adoption of the applicable installation case. As RTUs come in different sizes, it is important to estimate not only the number of CRTUs installed, but also the affected square footage. The evaluator will independently estimate market adoption through the following steps.

1) Analyze Known Data Sources for Annual Number of RTUs Sold in California

To ensure measurement of the entire market, the evaluator needs to estimate annual units installed in California.

a. Most RTUs are sold by HVAC contractors who purchase through regional distributors, although a small share of equipment is shipped directly from the manufacturer to the end-user.

b. The evaluator will have access to data gathered through CalMTA's negotiated data-sharing agreements with manufacturers and other market actors, and data collected as part of the demonstration project. The evaluator will fill data gaps through a combination of primary research and secondary research, such as interviews with HVAC contractors.

2) Conduct Data Collection to Estimate Adoption Rates by Installation Case

Data sufficiently detailed to identify sales for each installation case may not be readily available. Should this be the case, the evaluator will need to conduct primary data collection with contractors, distributors, and manufacturers and extrapolate market shares to statewide RTU sales.

3) Calculate total Units of Adoption by Installation Case

The total units of adoption will be calculated by combining the market shares by installation case with the total RTU market size. The evaluator will review these market adoption estimates and update them annually.

4.2 Evaluating MPIs

The evaluator will take baseline measurements for the MPIs during the first year of the evaluation and then track MPIs over time, as applicable. The evaluator will note when measured MPIs do not follow expected trends.

4.3 Evaluating equity

Primary identification of ESJ communities is based on the location of the installed CRTU within California census tracts designated as DACs by CalEnviroScreen or otherwise classified as ESJ by the CPUC's definitions (e.g., tribal lands, low-income census tracts).

The evaluator will take a holistic approach to assessing equity. In addition to the two equity-specific MPIs identified in Table 1 (EQ1 and EQ19), the evaluator will research the following questions:

- What is the baseline awareness and adoption of CRTUs in ESJ communities?
- What is the experience of buyers in ESJ communities (identified via demonstration project), including installation quality, information/education provided and the buyers' takeaways, use of the CCC app, unit performance over time, bill impacts, and unintended consequences?
- How much investment is made into Community Based Organization partners to provide training and awareness of CRTUs? Were awareness building activities timely?
- What is the upfront cost and point of purchase incentives for CRTUs?

The evaluator will design sampling and data collection instruments to answer these and any other equity research questions. CalMTA anticipates that the research activities described in this plan (e.g., demonstration project interviews, RTU buyer survey, HVAC contractor interviews, and analysis of program tracking data) will be sufficient to assess equity MPIs, milestones, and research questions. The evaluator may make recommendations for additional data collection efforts required to assess equity.

4.4 Evaluating causality

Causality assessment in market transformation programs is required to link incremental adoption and other changes in the market to MTI interventions as firmly as possible. The PTLM includes theorized linkages between interventions and market outcomes. By conducting research to assess the MPIs, the evaluator will gather data from multiple lines of evidence to validate those linkages and establish causality between MTI activities and outcomes. The evaluator will assess causality for each MPI where practical, to support the overall causality assessment.

The evaluator will conduct the causality assessment based on a preponderance of evidence approach, with methods including document review; in-depth interviews with market actors, decision makers, and stakeholders; and historical tracing. Essentially, this approach uses empirical evidence to explain how changes in market adoption can be traced back to MTI interventions and non-MTI market drivers. For example, the CRTU intervention – *California program coordination* - has a corresponding MPI – *number of California energy efficiency programs that align with at least one CRTU tier (CCC, 20% improved cooling efficiency, or all CRTU features) for incentive eligibility after engagement with CalMTA*. Causality would be established

through evidence that the program's adoption of CRTU specifications was significantly influenced by CalMTA. Table 5 provides examples of some of the questions the evaluator may consider.

Table 5. Causality Assessment

Example Causality Question	Example Data Sources/Evidence
Did the MTI lead manufacturers include CCC as a standard feature in code-minimum HP RTUs? How?	• *MTI salesforce documentation of meetings and conversations with manufacturers* • *Interviews with manufacturers (manufacturers indicate they didn't previously have firm plans or had different plans for CCC)*
Did the improved contractor training materials lead to increased availability of installers and workforce who are trained, trusted, and available for installations?	• *Interviews with training organizations* • *Interviews with HVAC workforce*
Did the MTI's upstream incentives and manufacturer engagement reduce the incremental cost of CRTUs and lead to greater adoption?	• *Interviews with distributors and contractors* • *Interviews with manufacturers (determine how they utilized upstream incentive)*
Were the observed market changes caused by non-MTI alternative market dynamics or interventions? What market results could have occurred in the absence of the MTI?	• *Historical tracing of observed market changes, including analysis of documentation, program materials, and timing of interventions* • *Interviews with California partner organizations* • *Interviews with market actors*

4.5 Forecasting, impacts, and cost-effectiveness review

This section describes the approach to evaluating the MTI's incremental energy impacts. CalMTA has developed forecasts for baseline market adoption (BMA) and total market adoption (TMA), along with estimates of unit energy impacts (UEI). CalMTA developed *ex ante* estimates of incremental MTI impacts using the formula below:

Net Incremental MTI impacts = [(TMA units – BMA units) * UEI] – utility verified impacts

The evaluator will review CalMTA's market adoption and cost-effectiveness forecasting models, including inputs and assumptions, and make recommendations for improvement. Net incremental MTI units of adoption will exclude adoption claimed by other efficiency programs.

4.5.1 Total market adoption forecast

CalMTA will regularly update its TMA forecast, updating its forecasting model with actual sales or shipment data as it becomes available. The evaluator will review the TMA forecast, using the most recent data available.

4.5.2 Baseline market adoption forecast

In the first year, the evaluator will review CalMTA's process for developing the BMA, including inputs and assumptions, and make recommendations for improvements based on:

1) Availability of new data.
2) Whether the causality assessment found adoption being driven by non-MTI market forces that are missing from the baseline.
3) Any other reasons given in the guidance in the evaluation framework.

The BMA should only be revised when evaluators have confidence that initial assumptions were incorrect and that the MTI did not significantly contribute to an observed change in market adoption. CalMTA identified three scenarios that warrant consideration of revising the BMA in the evaluation framework: an incorrect BMA assumption was discovered, an unanticipated exogenous event occurs, or an unanticipated product/technology advancement.

The evaluator will also provide recommendations to close any data gaps that were found in this review. CalMTA will request additional reviews in subsequent years as needed. Note that BMA includes adoption from established resource acquisition programs because they would have occurred absent the MTI, but excludes savings associated with collaborative efforts under the umbrella of the MTI.[4]

4.5.3 Unit energy impacts (UEI)

The methodology to develop UEI for CRTU technologies is detailed in Appendix B: Market Forecasting & Cost-Effectiveness Modeling Approach. The evaluator will review UEIs (including savings estimates, load shapes, and effective useful life), and assumptions and methodology to make recommendations for improvements, such as the appropriateness of fault rates used in modeling unit savings for CCC installations. This could also include updating the rate at which end-users connect CRTUs to the internet, thus enabling more timely detection of faults.

In 2029, a new efficiency metric, IVEC, and integrated ventilation and heating efficiency (IVHE), will be adopted; the UEI should be reviewed at that time to determine what adjustments, if any, are needed.

4.5.4 Program Administrator impacts

The evaluator will review net verified impacts attributable to the PAs based on claimed and verified data from CEDARS. These impacts will be subtracted from incremental adoption (TMA-BMA) as shown in the equation at the start of this section, ensuring no double-counting of impacts between CalMTA and other PAs.

[4] Per the CalMTA MTI Evaluation Framework, p. 11, footnote 15.

4.5.5 Cost-effectiveness model

As part of the ongoing evaluation, the evaluator will review the cost-effectiveness model, and the model inputs, assumptions, and data sources that CalMTA used to calculate cost effectiveness of the MTI. CalMTA's approach is fully documented in Appendix B of the MTI Plan.

Evaluating cost effectiveness involves outputs from the market-forecasting model as well as initiative costs, incremental measure cost, avoided cost, load shape, and UEIs. This application of inputs considers the baseline installation conditions, baseline and efficient technologies, fuel types, target sector, and costs incurred by all stakeholders in the MTI implementation. Moreover, both the costs and benefits change over time due to factors such as effective useful life, regulatory policy, electricity and gas rates, and initiative funding.

CEDARS' Cost-Effectiveness Tool (CET) is the official publicly available program to evaluate energy efficiency programs in California. However, the MTI focuses on relatively new technologies and some MTIs involving new technologies require custom 8,760 load shapes not currently supported by CET. Because of this, CalMTA developed its own cost-effectiveness model.

During the first evaluation year, the evaluator will review the inputs, assumptions, and the model used by CalMTA that inform the cost-effectiveness forecast; during subsequent years, the evaluator will review any updates made to the models. The review will include the following model inputs:

- **Incremental Adoption Forecast**. Incremental adoption will be forecasted as an input to the cost-effectiveness model. The evaluator will review this forecast and make recommendations for improvement.
- **Incremental Measure Costs.** Incremental measure costs reflect the difference in cost between the baseline HVAC technology and CRTU technology. For the full discussion of how the incremental cost was forecasted see Appendix B. The evaluator will review the incremental costs and cost trends applied in the CalMTA cost-effectiveness model. The evaluator will determine, given recent market data and market conditions, if the cost assumptions are reasonable or need to be adjusted.

5 Proposed MTI evaluability map

This is a proposed evaluability map. The evaluator is encouraged to make recommendations for improvement.

Market Progress Indicator (MPI)	Program Milestone	Baseline	Data Source - MPI	Data Source - Causality
1 - Number of manufacturers partnering with CalMTA on demonstration project	Three or more manufacturers (of mass-market, not custom equipment) engage with CalMTA to implement demonstration project by 2028	TBD	Demonstration project agreements showing manufacturer partnership	Manufacturer interviews, salesforce documentation, demonstration project agreement
EQ1 - Number of demonstration project RTUs installed in DACs	50% of demonstration project RTUs installed in DACs by 2029	0	Demonstration project documentation	Demonstration project participant (contractor and end-users) interviews, project documentation
2 – Number of demonstration project RTUs installed with CCC, 20% improved cooling efficiency, or all CRTU features	150 demonstration project RTUs are installed in California by 2029, of which 20 include all CRTU features	0	Demonstration project documentation	Demonstration project participant (contractor and end-user) interviews, project documentation
3 - Percent of demonstration project end-users who have installed and used the mobile or desktop app to examine RTU performance.	No specific milestone	TBD	Demonstration project end-user interviews	Demonstration project end-user interviews
4 - Number of demonstration project HVAC installation contractors who agree there is a compelling business case for CCC	No specific milestone	TBD	Demonstration project contractor interviews	Demonstration project contractor interviews

Market Progress Indicator (MPI)	Program Milestone	Baseline	Data Source - MPI	Data Source - Causality
5 - Number of manufacturers meeting with CalMTA after demonstration project completion to discuss product refinement	Two or more mass-market manufacturers meet with CalMTA after demonstration project completion to discuss product refinement by 2030	TBD	Salesforce meeting records and demonstration project timeline	RTU manufacturer interviews
6 - Incremental equipment price of code-min HP RTUs with and without CCC to distributors from partner manufacturers	No incremental equipment price for CCC feature to distributors for equipment produced by partner manufacturers by 2031	TBD	HVAC distributor surveys and review of CCC costs for partner and non-partner manufacturers	HVAC distributor surveys and review of CCC costs for partner and non-partner manufacturers
7 - Number of minimum efficiency product lines including CCC as a standard feature (not as an add-on option)	Three minimum-efficiency product lines include CCC as standard feature by 2031	TBD	RTU technical documentation	RTU manufacturer interviews, product documentation showing change in CCC availability before and after CalMTA engagement
8 - Percent of customers and contractors that self-report that CRTU interfaces (mobile and desktop app) are easy-to-use (e.g., intuitive, user-friendly)	No specific milestone	TBD	HVAC contractors	HVAC contractors
9 - Percent of potential RTU buyers (building owners and facility managers of buildings with RTUs) who *demonstrate awareness of CCC, its capabilities, and its value*	No specific milestone	TBD	RTU buyer survey	RTU buyer survey
10 - Market share of all single-zone HP RTUs with CCC (denominator is all single-zone HP RTUs)	Market share of all single-zone HP RTUs with CCC hits 90% by 2035	TBD	Interviews/surveys with HVAC contractors; data from agreements with market actors	Interviews/surveys with HVAC contractors; data from agreements with market actors

Market Progress Indicator (MPI)	Program Milestone	Baseline	Data Source - MPI	Data Source - Causality
11 - Installed price of HP RTUs with CCC	Installed price of RTUs with and without CCC are within 5% by 2035	TBD	Contractor survey	Contractor survey
12 - Market share of RTUs with variable speed fans, CCC and IVEC+20% (denominator is all single-zone HP RTUs)	Market share of all single-zone HP RTUs with all features is over 30% by 2040	TBD	Interviews/surveys with HVAC contractors; data from agreements with market actors	Interviews/surveys with HVAC contractors; data from agreements with market actors
13 - Percent of distributors stocking CRTUs	60% of distributors stock CRTUs by 2032	TBD	HVAC distributor surveys	HVAC distributor surveys
14 - Percent of HVAC contractors that include CCC in customer bids by default	90% of contractors include CCC in 50% or more bids by 2032	TBD	HVAC contractor surveys	HVAC contractor surveys
15 - Percent of HVAC companies that access customers' CCC to support diagnostics, optimization, and repairs. (Accessing the CCC interface off-site as a step towards addressing the service call.)	20% of contractors who provide maintenance services utilize customer CCC where available by 2035	TBD	HVAC contractor surveys	HVAC contractor surveys
16 - Number of EE programs outside of California that incorporate CCC, variable speed fans, and efficient cooling after engagement with CalMTA	Two EE programs adopt after engagement with CalMTA by 2029	TBD	EE program administrator interviews, documentation of before and after specifications	EE program administrator interviews, documentation of before and after specifications
17 - Installed price of CRTUs (all tiers) compared to code-minimum HP RTU	**Average price premium of Tier 2 and Tier 3 CRTUs is no more than 38% by 2040.** **Average price premium of Tier 2 and Tier 3** CRTUs is no more than 30% by 2040.	TBD	Contractor interviews	Interview with manufacturers, contractors, and distributors

Market Progress Indicator (MPI)	Program Milestone	Baseline	Data Source - MPI	Data Source - Causality
18 - Number of HVAC training organizations (manufacturers, distributors, HVAC industry groups, education institutions, EE programs) that include CRTU in trainings	Four HVAC training organizations cover CRTU in trainings targeted to California learners by 2032	0	Salesforce tracking, training materials review, and interviews with training organizations	Salesforce tracking, training materials review, and interviews with training organizations
19 - Percent of HVAC companies with staff trained on CCC in each IOU service territory	75% of contractors report staff can support CCC installations and service by 2033	TBD	HVAC contractor surveys	HVAC contractor surveys
EQ19 - Percent of HVAC companies serving DACs reporting staff are trained on CCC	Percent of HVAC companies with CCC-trained staff located in or serving customers in DACs comparable to general population by 2031	TBD	HVAC contractor surveys	HVAC contractor surveys
20 - Number of California EE programs (non-residential HVAC) align with at least one CRTU tier for incentive eligibility after engagement with CalMTA	Four California EE programs (CPUC regulated) that target non-residential HVAC align with at least one CRTU tier (CCC, 20%+ cooling efficiency, or all CRTU features) by 2029	TBD	EE program administrator interviews, documentation of before and after specifications	EE program administrator interviews, documentation of before and after CalMTA engagement incentive specifications, salesforce documentation of meetings and communications
21 – Adoption of CCC into applicable codes or standards	No specific milestone	Not in code	C&S dockets and document review	C&S stakeholders involved in development; documentation provided in support of the C&S; salesforce tracking