



# Portable/Window Heat Pumps

Market Transformation Advancement Plan

CalMTA is a program of the California Public Utilities Commission (CPUC)  
and is administered by Resource Innovations

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This Advancement Plan describes CalMTA's recommendations for information to be developed and research conducted during Phase II: Program Development for the Portable/Window Heat Pump Market Transformation Initiative (MTI). CalMTA will finalize the Advancement Plan after reviewing comments received from the Market Transformation Advisory Board (MTAB) and the public via the California Public Utilities Commission (CPUC) Energy Division's Public Documents Area website.

CalMTA will use data and research collected in Phase II to further inform and refine the Market Transformation (MT) theory, proposed intervention strategies, and metrics and data that will be used to assess incremental impact for this MTI to determine if it should advance to Phase III: Market Deployment. CalMTA will prepare a full MTI Plan for approval by the CPUC if it recommends advancing this MTI to Phase III. This MTI Advancement Plan contains:

- 1) Key characteristics of the proposed MTI (e.g., description, target market, barriers, opportunities, MT theory, and possible interventions)
- 2) Identified gaps in knowledge that need to be filled before CalMTA can determine whether to recommend advancing the MTI Phase III: Market Deployment
- 3) Initial cost estimate and work plan for activities in Phase II that will fill the knowledge gaps.

## 1 Executive Summary

Heating and cooling represent the largest energy consumption end-uses for homes in California, with more than 50% of households still using gas appliances for heating. In coordination with California's decarbonization goals and targeted reduction in natural gas usage, portable and window heat pumps (HPs), described in Section 2, offer an affordable and highly efficient alternative for certain applications. These units are self-contained, do not require professional installation, and can heat or cool spaces up to 1,000 square feet making them ideal for single rooms, apartments, or small homes. They can replace the need for a single-function air conditioning (AC) unit or electric resistance space heater. In addition, these units can be owned by tenants to create independence from less efficient gas heating or electric resistance when adding air conditioning.

Consumers of this technology enjoy several benefits including:

- 1) Reduced energy consumption from relatively inefficient central and baseboard heating
- 2) Independence from landlord-owned HVAC equipment

### 3) Improved comfort in their homes.

While portable/window heat pumps face barriers related to consumer awareness, higher upfront cost compared to separate window AC and space heater units, desired product improvements, and product availability, this technology fills a gap for renters and owners in multifamily and smaller spaces, especially for residents of environmental and social justice (ESJ) communities. By eliminating the need for expert installation or electrical panel upgrades, the technology can significantly improve comfort, remove reliance on inefficient HVAC units, and create space-heating flexibility for single- and multi-family homes.

Several points of market leverage can accelerate the adoption of this technology, including:

- Current market momentum and national focus on portable/window heat pumps, resulting in responsive manufacturers to develop products for this market
- Coordinating with California's Codes and Standards Advocacy program team and subject matter experts to build upon their foundational work on United States Department of Energy (DOE) test procedures and eventual specifications for an ENERGY STAR® label
- Leveraging the existing program data and infrastructure of the ENERGY STAR Retail Product Platform (ESRPP).

As this product improves, portable/window heat pumps could offer significant additional benefits to leverage. They could be grid-enabled to offer peak grid energy reductions or modified to use ultra-low Global Warming Potential (GWP) refrigerants<sup>1</sup> that would improve indoor air quality (IAQ). CalMTA's preliminary analysis finds that this MTI has an estimated Total System Benefit (TSB)<sup>2</sup> of \$4.028 billion over the 20-year lifecycle of the initiative.

The long-term market impacts of an MTI focused on portable/window heat pumps will be widespread adoption by single- and multi-family households as a readily available and cost-effective alternative to electric-resistance space heating and AC/cooling-only appliances. In addition, the proliferation of this technology will reduce reliance on natural gas used in centrally heated homes. Consumers will gain the advantage of a single unit that can both heat and cool their interior spaces and can be moved between rooms or residences to create long-term savings. This Advancement Plan describes several research activities and two pilots to understand the long-term potential of this technology before CalMTA recommends whether to advance this MTI to a full MTI Plan for eventual implementation following approval by the CPUC.

## 2 Product, Service, or Practice Definition

Portable and window heat pumps, also known as micro heat pumps, are self-contained consumer products that provide efficient heating and cooling for small spaces ranging from a single room, a

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<sup>1</sup> Although there is no universally accepted definition for low-GWP refrigerants, recently adopted legislation defines ultra-low refrigerants as having a GWP of 10 or less:

[https://leginfo.ca.gov/faces/billNavClient.xhtml?bill\\_id=202120220SB1206](https://leginfo.ca.gov/faces/billNavClient.xhtml?bill_id=202120220SB1206)

<sup>2</sup> Further details and explanation on TSB inputs and assumptions can be found in Appendix 1.

modest apartment or small home. They are similar in shape and size to typical window units and portable AC products. The product type targeted by this MTI uses inverter technology that allows for variable speed operations providing more efficient cooling in the summer and heating in the winter. These products can be self-installed and plugged into a 110-volt outlet. They offer a cooling capacity of up to 18,000 BTUs and a similar heating capacity in most California climate zones, allowing them to heat or cool spaces smaller than 1,000 square feet. Through the Portable/Window Heat Pump MTI, CalMTA will work with manufacturers to push for product improvements including expanded cold or cool-climate capability, dual ducting to provide balanced air circulation, enhancements to improve IAQ, use of ultra-low GWP refrigerants and connected controls to allow the units to be grid-enabled.

Currently, available products fall into two different categories. The first category contains plug-in, moveable products from manufacturers like Frigidaire (pictured below) or Midea. They offer some of the features needed like dual ducting, but none currently offer all the features this MTI would target over time. The second category of products covers “window” units that fit into a double-hung window from new manufacturers like Gradient. These products are self-installed with their outdoor and indoor components “saddled” over the window (pictured on the cover of this document). While offering a variety of features (like low temperature capability), these products are still premium, expensive items and the MTI will work to help bring costs down.



*Photo: Frigidaire*

## 3 Market Transformation Theory and Opportunity

### 3.1 Market Opportunity

Existing multifamily and smaller single-family households often suffer from higher energy burdens and impacts from increasingly frequent climate events such as heat waves and cold snaps. This market needs an efficient and affordable electric alternative to resistance and gas heat while also providing air conditioning, and possibly air filtration to improve IAQ. Consumers in this market often purchase inefficient space heaters and window AC units to supplement their heating and

cooling needs and buy separate air filtration products. Many AC units are not recycled properly and pose a risk for high-GWP refrigerant leakage after disposal.

## 3.2 Target Market

This MTI targets existing residential multifamily and small single-family homeowners and renters.

## 3.3 Key Market Barriers

Some models of efficient portable and window heat pumps that serve up to 18,000 BTUs of capacity are commercially available and can be self-installed. However, more work needs to be done on this market to overcome the following barriers:

- **Product improvements:** Most units currently lack the ability to improve IAQ and need controls for possible grid-enabled capability, as well as cold climate capability, condensate management, noise abatement, and use of ultra-low GWP refrigerants.
- **Product differentiation:** No ENERGY STAR label exists for the heating cycle of these units. DOE, California's Codes and Standards Advocacy team, and other partners are currently working on a test procedure and specification which paves the way for an ENERGY STAR designation.
- **Consumer awareness:** Consumers are unaware of these products and the benefits they could provide.
- **Higher costs:** Portable and window heat pumps still cost more than window AC units and electric resistance heaters.
- **Inclusion in utility programs:** Portable and window heat pumps are not yet promoted as a solution in utility programs.

## 3.4 Points of Leverage and Intervention Strategies

The market offers multiple points of leverage for an MTI targeting portable/window heat pumps, which can be addressed through the following strategic interventions:

- CalMTA will leverage growing interest in this product, as well as research and manufacturer engagement efforts already conducted by the California Codes and Standards Advocacy team, from other regional energy efficiency organizations including the Northwest Energy Efficiency Alliance (NEEA) and the New York State Energy Research and Development Authority (NYSERDA). CalMTA will coordinate and build upon product research work that the CalNEXT program has already completed.
- With partners, CalMTA will engage manufacturers to include technical improvements suitable for the California market.
- CalMTA will work in coordination with the California Codes and Standards Advocacy team on future DOE test procedures, the Consortium for Energy Efficiency (CEE) on their national specification, and eventually the United States Environmental Protection Agency (EPA) on the ENERGY STAR certification process.

- ESRPP and other online marketplaces offer an entry point for engaging retailers on this product.
- CalMTA will partner with multiple existing California programs to align on efficient, high-quality standards for qualifying products and to ensure portable/window heat pumps are included as a solution in relevant programs, especially for those targeting ESJ consumers.
- This MTI provides a significant opportunity to deliver benefits to ESJ communities, including enhanced household occupant comfort, a gradual reduction of reliance on natural gas for heating and cooling and reduced energy burdens from separate window AC units and baseboard electric and plug-in resistance heating. Community partnerships and the expertise of community-based organizations (CBOs) will be vital to making this technology more accessible to ESJ communities.
- Strategies for this MTI will couple proper recycling of older AC units that pose risk for refrigerant leakage and long-term disposal interventions for portable/window HP products.
- These products can serve as an entry point into the journey to electrification, especially for multifamily and small residential households.

### 3.5 Market Vision/End-State

Driven by the multiple benefits and affordability of portable/window heat pumps, this MTI seeks to achieve a market where this an improved version of this technology dominates product sales over separate window AC-only units, portable electric resistance heaters, and possibility air purifiers. There will be an ENERGY STAR label, federal test procedures and standards in place, and multiple affordable products on the market that use ultra-low GWP refrigerants, offer the ability to improve IAQ, and include the ability to be grid-enabled.

### 3.6 Key Market Assumptions

The following market assumptions inform this MTI and Advancement Plan:

- California will continue to invest in electrification programs that target limited-income multifamily and single-family homes. These programs can be leveraged to reach target audiences.
- California will continue to invest in online and retail midstream programs.
- California and the United States will continue to enact policies that push manufacturers to use ultra-low GWP refrigerants in all HP technology and consider end of life and proper decommissioning of window AC units and portable/window HPs.
- Extreme weather events will persist, making the need for air conditioning and air filtration an increasingly critical public health concern.
- California programs will continue to invest in affordable technologies that work to increase comfort, improve IAQ, move towards electrification, and reduce overall energy burdens for ESJ communities.

### 3.7 Diffusion and “Lastingness” Mechanism

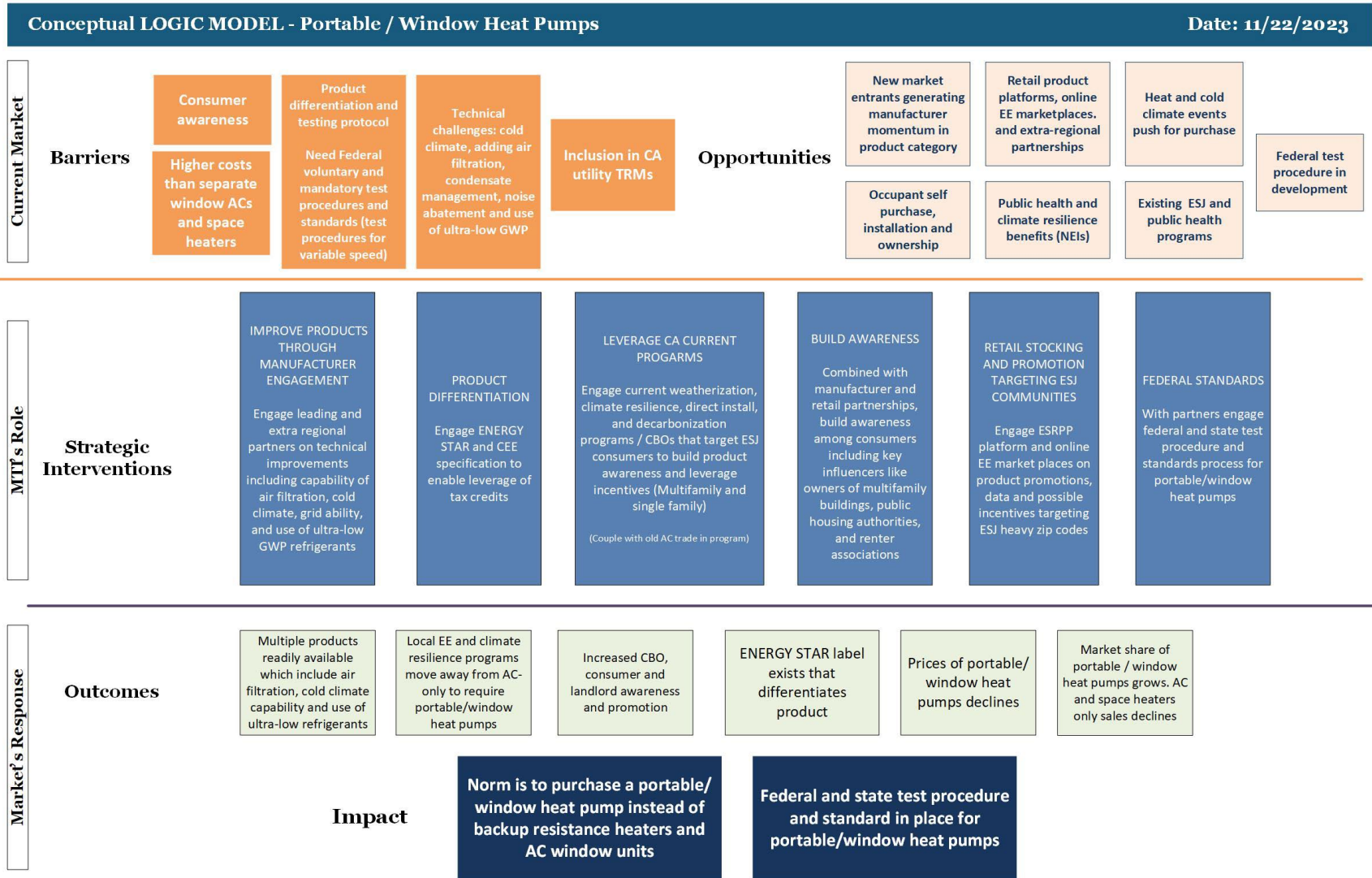
The benefits of portable/window heat pumps will be well known, and the units will be affordable and utilized across all appropriate single and multifamily households. The final diffusion mechanism will be federal standards that regulate the energy performance and EPA standards that regulate the use of ultra-low GWP refrigerants in portable/window heat pumps at levels that support California’s clean energy goals. Achieving this goal may require multiple DOE standard review cycles.

### 3.8 Conceptual Logic Model

Figure 1 features the logic model developed to provide a preliminary visualization of the Portable/Window Heat Pump MTI program theory. It includes high-level market barriers and opportunities that inform the draft interventions, as well as expected outcomes and long-term impacts. This model represents the entire “market,” with many parties contributing to the advancement of portable/window heat pumps. CalMTA’s role in each of these possible interventions will become clearer after the research phase is complete. The proposed market characterization, product assessment, and pilot conducted in Phase II will verify this logic model’s assumptions and draft interventions. Once this work is completed in Phase II, CalMTA will develop a more refined and formal logic model for Phase III: Market Deployment.



Figure 1. Draft MTI Logic Model for Portable / Window Heat Pumps



### 3.9 Measuring Market Outcomes

The conceptual logic model depicted in Figure 1 shows CalMTA’s current thinking on envisioned MTI outcomes. We expect to refine the logic model during Phase II based on the research we conduct to address current knowledge and data gaps, as described in [Section 5: Research and Program Development Plan](#). This Phase II research will inform the development of an evaluation plan that includes clearly defined market progress indicators, the data sources for tracking those, and the expected timeframe for realizing market transformation progress.

While Phase II research is needed to fill information gaps before we can establish clearly defined MTIs and measurement plans, Table 1 shows our preliminary thinking on likely market progress indicators, some of the possible associated data sources, and the Phase II research that will further inform our evaluation plan.

**Table 1. Possible MTI Market Progress Indicators and Data Sources**

<b>Likely Market Progress Indicator</b>	<b>Possible Data Sources</b>	<b>Phase II Research that will Inform the MTI</b>
Market share of portable/window heat pumps compared to other portable ACs and space heaters	Retailers Manufacturers	Secondary research Market actor (manufacturer, retailer, multifamily building owner) interviews Sales data obtained through ESRPP pilot
Prices of portable/window heat pumps	Retailer data Store visits/ shopping Web scraping	Market actor interviews Store visits/shopping Web scraping
ENERGY STAR specification	ENERGY STAR	Subject matter expert (SME) interviews with ENERGY STAR staff
Share of products that include air filtration, cold climate capability, use of ultra-low GWP refrigerants	Retailers Manufacturers ENERGY STAR database	Manufacturer interviews SME interviews Web scraping
Local programs move away from AC-only incentives and require qualified portable/window heat pumps	Program documentation	Program administrator/SME interviews
Awareness of product and benefits	Consumer survey Landlord survey	Consumer survey

	CBO partner survey	
Multiple products are available that meet basic or advanced energy efficiency features and have other premium features/benefits		Manufacturer interviews Store visits/shopping SME interviews Web scraping

In addition to the preliminary market progress indicators shown in Table 1, CalMTA is working to develop metrics specifically focused on equity. During Phase I we kicked off a long-term engagement plan with CBOs and other organizations that serve ESJ communities. Although additional, ongoing engagement will be required to establish the most appropriate equity metrics, Table 2 shows our preliminary thinking on possible equity metrics.

**Table 2. Possible MTI Equity Metrics and Data Sources**

Possible Equity Metric	Possible Data Sources	Notes
ESJ partner engagement: Number of CBOs/other ESJ market partners engaged in MTI design  Number of CBOs/other ESJ market partners engaged in MTI implementation	CalMTA Stakeholder Engagement Database (Salesforce data)	
Awareness of product and benefits among ESJ communities	Consumer survey Landlord survey CBO/partner survey	
CBO/ESJ partner satisfaction	CBO/partner survey	Could also include qualitative feedback, such as success stories and lessons learned
Equity programs move away from AC-only incentives and require qualified portable/window heat pumps	Program documentation	
Market adoption among ESJ communities	Program data (coordinated/partner programs)	ESRPP sales data (note: this may be difficult/costly to measure quantitatively)
Non-energy impacts among adopters in ESJ communities (e.g., energy burden, home comfort)	Local/partner program participant evaluation	Would likely be conducted by or in collaboration with the local/partner program evaluation

## 4 Gap Analysis

CalMTA has identified critical knowledge gaps surrounding California customer use-cases for this technology, as well as the feasibility of future product capabilities that will directly inform program strategy (e.g., cool/cold climate capability, use of ultra-low GWP refrigerants, grid interactivity, and air filtration capabilities). In the next phase of MTI development, the following research will be needed:

- **A full market characterization** will describe the supply and demand-side market actors, dynamics as well as barriers and solutions. This work will also answer questions about various state and federal program eligibility. Topics will be explored with a specific focus on low-income and ESJ audiences.
- **Product-specific research** will provide a deeper understanding of current cooling and heating capacity; the feasibility of future product evolution, such as the addition of grid connectivity, cold climate operation, and air filtration capability; and the use of ultra-low refrigerants.
- **Two pilots have been identified** for this technology. One will gather data and test an intervention using ESRPP as a channel for targeting ESJ communities. The second will test the value proposition of “self-installation,” primarily in ESJ communities.

The research will inform a full MTI Plan and allow CalMTA to refine savings and cost-effectiveness model assumptions and the baseline market adoption forecast. It will also inform the development of an evaluation plan that includes clearly defined market progress indicators, the data sources for tracking those, and the expected timeframe for realizing market transformation progress. Research objectives, research activities, and strategic interventions are outlined in Sections 5.1 and 5.2.

## 5 Research and Program Development Plan

### 5.1 Market and Technology Research

The CalMTA team will first work with research partners to ensure the development of this MTI leverages what California, regional, and national partners like NEEA, NYSERDA, DOE and EPA have already researched on portable/window heat pumps. Data and information needed to develop the full MTI Plan are shown in Tables 3, 4, 5, 6, and 7.

Table 3. Research Objectives, Tasks, and Final Deliverables

Research Objective	Phase II Research Task						Deliverable informed by Research
	Secondary Research/Sales Data Purchase	Manufacturer, Retailer, MF Owner and SME Interviews	Retail Store Visits, Web-scraping, Online Shopping	Focus Groups	Customer and Tenant Surveys	Delphi Panel	
<p><b>Characterize the Portable/Window Heat Pump Market (supply side)</b>                      Calculate market share of various Portable/Window Heat Pump sales, compared to other portable ACs and space heaters</p> <p>Create a full supply chain map</p> <p>Characterize the upstream market to understand sales volume, product availability, shelf stocking trends, pricing, challenges, and opportunities among manufacturers, distributors, retailers</p>	✓	✓	✓				1. MTI Plan 2. Evaluation and Data Collection Plans 3. Market Characterization 4. Baseline Market Forecast 5. Impact and Cost-Effectiveness Forecast
<p><b>Characterize the Portable/Window Heat Pump Market (demand-side)</b>                      Assess awareness of technology, benefits, and the value proposition for portable/window heat pumps</p> <p>Understand customer purchase motivations and use of appliances for space heating vs. space cooling</p> <p>Access to financing for those who lack capital</p>		✓		✓	✓		1. MTI Plan 2. Evaluation and Data Collection Plans 3. Market Characterization 4. Baseline Market Forecast 5. Impact and Cost-Effectiveness Forecast

Research Objective	Phase II Research Task						Deliverable informed by Research
	Secondary Research/ Sales Data Purchase	Manufacturer, Retailer, MF Owner and SME Interviews	Retail Store Visits, Web- scrapping, Online Shopping	Focus Groups	Customer and Tenant Surveys	Delphi Panel	
<p>Assess importance of cold-climate capabilities</p> <p>Explore specific barriers and opportunities for renters and landlords vs. homeowners.</p> <p>Identify home characteristics of the best-fit target market/target sector and identify specific barriers from an ESJ perspective</p>							
<p><b>Characterize Fitness/Relevance of Portable/Window Heat Pumps under Existing CA Programs</b></p> <p>Understand measure requirements for various funding/rebate programs</p> <p>Explore opportunities for CA utility programs and pilots</p>	✓	✓					<p>1.MTI Plan</p> <p>2. Evaluation and Data Collection Plans</p> <p>3. Market Characterization</p>
<p><b>Identify Technology Opportunities, Limitations and Use Cases</b></p> <p>Understand the current landscape and outlook for ENERGY STAR pathways</p> <p>Assess opportunities and costs of cold climate capabilities, air filtration, grid connectivity and use of ultra-low refrigerants</p>	✓	✓					<p>1. MTI Plan</p> <p>2. Impact and Cost-Effectiveness Forecast</p>

Research Objective	Phase II Research Task						Deliverable informed by Research
	Secondary Research/ Sales Data Purchase	Manufacturer, Retailer, MF Owner and SME Interviews	Retail Store Visits, Web- scrapping, Online Shopping	Focus Groups	Customer and Tenant Surveys	Delphi Panel	
Examine costs and benefits for heating and cooling scenarios							
Explore opportunities for improved product affordability and opportunities for alternative duct designs for buildings without double-hung windows							
<b>Characterize the Baseline Market Conditions and Develop Market Baseline Forecast</b> Segment the residential market by building type, climate zone, baseline heating and cooling system types and fuel types to understand market adoption potential and refine the target market for this MTI  Estimate proportion of residential building stock with double-hung windows	✓	✓	✓	✓	✓	✓	1. MTI Plan 2. Baseline Market Adoption Forecast

**Table 4. Research, Initial Cost Estimate, and Estimated Timeline**

<b>Research Task</b>	<b>Schedule (Estimated Weeks from Launch)</b>	<b>Initial Cost Estimate</b>	<b>Deliverables Informed by this Task</b>
(1) Secondary Research/Sales Data Analysis	Weeks 1-4	\$75,000	Market Characterization, BMA Forecast; Impact and CE Forecast; MTI Plan
(2) Manufacturer, Retailer, Multi-family Building Owner and SME Interviews	Weeks 3-12	\$84,000	Market Characterization, BMA Forecast; Impact and CE Forecast; MTI Plan
(3) Retail Store Visits and Online Shopping	Weeks 3-16	\$70,000	Market Characterization, BMA Forecast, MTI Plan
(4) Focus Groups	Weeks 10-22	\$120,000	Market Characterization; MTI Plan
(5) Customer and Tenant Surveys	Weeks 18-32	\$20,000	Market Characterization; MTI Plan
(6) Delphi Panel	Weeks 30-36	\$36,000	Baseline Market Adoption Forecast; MTI Plan
(7) Sales Data Purchase		\$5,000	
<b>Total Estimate:</b>		<b>\$410,000</b>	

## 5.2 Strategy Development and Testing

### 5.2.1 Technology

The CalMTA team will conduct technical assessments of portable and window heat pump products currently on the market, including those in the pre-commercialization stage (not yet available to the public).

These assessments will allow the CalMTA team to validate and refine assumptions about how the technology will be adopted and used, whether it will have the expected impact, and if there are any technical limitations that can reduce customer confidence or otherwise limit adoption and use that will need to be addressed during implementation of the MTI.

The table below outlines Technical Assessment Objectives (column 1) and describes Technology Assessment Methods (column 3). Purpose/Relevance (column 2) ensures that each research objective is necessary and directly relevant to the MTI. Most studies or lab testing described in the methods column will address multiple objectives and research questions.

Note: Interviews and literature reviews will be conducted in conjunction with the Market and Technology Research described in Table 3. Initial Cost Estimates are included in Table 6 below.



**Table 5. Summary of Technology Assessment Activities**

Technical Assessment Objectives	Purpose/Relevance	Technology Assessment Methods
<b>Seasonal Capacity - Cooling</b>		
Assess cooling capacity at maximum design day and maximum room/apartment size based on cooling capacity for each product in each California climate zone	Inform target market strategy	Literature review, data analysis and modeling
Determine what percentage of homes will stay comfortable and/or avoid health impacts of excessive heat by using 115V portable/window HPs as the sole source of air conditioning/cooling	Inform product specification, target market, savings potential, baseline energy consumption  Inform them of the need for product updates  Inform intervention strategies for midstream and manufacturer engagement	Data analysis and modeling, field study
<b>Seasonal Capacity - Heating</b>		
Determine heating capacity at max heating design day and maximum room/apartment size based on heating capacity for design heating day for each product in each CA climate zones.	Inform target market strategy	Literature review, data analysis and modeling
Determine what portion of the target market can stay comfortable by using 115V portable/window HPs as the sole source of heating	Inform product specification, target market, savings potential, baseline energy consumption  Inform them of the need for product updates  Inform intervention strategies for midstream and manufacturer engagement	Data analysis and modeling, field study
Assess the differences between products that can operate between 25-45°F vs. true "cold climate" portable and window HPs that can operate down to 5°F  Evaluate differences in operating efficiency between cold climate and cool climate HP technologies  Assess impacts on cooling capacity and efficiency	Inform cost baseline and projections  Inform incremental cost  Inform product specification and potential strategy to influence manufacturers to make product for California climate	SME and manufacturer interviews, lab testing and product tear down
Assess technical challenges related to cool climate performance, including disposal of condensate when outdoor air temperatures are below freezing, icicle formation from pumping condensate outdoors, and/or increasing humidity levels/mold risk from evaporating condensate indoors	Inform costs, product specifications, risks	SME and manufacturer interviews, lab testing

Technical Assessment Objectives	Purpose/Relevance	Technology Assessment Methods
<b>Refrigerant Impacts</b>		
Assess the typical life cycle of portable and window ACs, including disposal, refrigerant recapture programs, and estimated impacts of refrigerant released in landfills	Inform greenhouse gas (GHG) emissions baseline and MT impacts model	SME and manufacturer interviews, literature review
Evaluate GHG benefits of replacing and recycling existing portable and window ACs with ultra-low-GWP portable/window HPs	Inform program strategy and interventions	Data analysis and modeling
Assess the percentage of portable/window HP products using low-GWP refrigerants <sup>3</sup> and the technical feasibility of transitioning from low-GWP to ultra-low GWP products	Inform long-term intervention strategy	SME and manufacturer interviews, literature review
<b>Testing Labeling, Ratings, and Product Tiers</b>		
<p>In coordination with the California Codes and Standards Advocacy team track DOE test procedure development and AHAM RAC test procedure development</p> <p>Review and evaluate draft test procedures for alignment with CalMTA objectives, equipment uses cases, product definitions, suitability for California climate</p> <p>Identify, propose, and validate alternative approaches (if needed) to ensure that test procedure reflects CalMTA priorities, climate, and need for consumer differentiation between portable heat pump products</p> <p>Develop draft product-tier recommendations</p>	<p>Inform product specification</p> <p>Inform strategy for intervention in DOE rulemaking as needed</p> <p>Inform intervention strategies for manufacturer engagement and midstream</p>	<p>California Codes and Standards Advocacy team, SME and manufacturer interviews, technical specification and testing procedure review, lab testing (if needed)</p>
<b>Connectivity and Grid Flexibility</b>		
<p>Evaluate communication interfaces (CTA 2045, Wi-Fi) and controls of existing products to determine potential for demand flexibility</p> <p>Identify and recommend improvements</p>	<p>Inform need and approach for intervention strategy around control and communications</p>	<p>Literature review, lab testing</p>

<sup>3</sup> Although no universally accepted definition of low-GWP refrigerants exists, the EPA has consistently referred to “lower GWP refrigerants” as those with a global warming potential of 700 or less, while recent legislation in California defines low-GWP as 150 or less. California Air Resources Board (CARB) regulations already require room and portable air conditioning equipment (including heat pumps) to use refrigerants with GWP of 750 or less, although they do not explicitly describe these refrigerants as low-GWP: <https://ww2.arb.ca.gov/our-work/programs/california-significant-new-alternatives-policy-snap/air-conditioning-equipment> [https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill\\_id=202120220SB1206](https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=202120220SB1206) <https://www.epa.gov/climate-hfcs-reduction/technology-transitions-hfc-restrictions-sector#self-contained>

Technical Assessment Objectives	Purpose/Relevance	Technology Assessment Methods
<b>Indoor Air Quality</b>		
Test opportunities for adding air filtration, such as adding balanced exchange of outdoor air (with or without efficient heat recovery ventilation) or adding efficient/demand-controlled air filtration	Inform potential intervention strategies for manufactures to improve product performance and non-energy impacts (NEIs)	Product tear-down study

**Table 6. Summary of Technology Assessment Needs, Initial Cost Estimates, and Estimated Timeline**

Assessment Task	Schedule (Estimated Weeks)	Initial Cost Estimate	Deliverables Informed by this Task
(1) Product Tear-Down Study	Weeks 1 - 32	\$110,000	Updated Portable/Window HP Product Plan
(2) Technical Specification and Testing Procedure Review	Weeks 1-16	\$25,000	Updated Portable/Window HP Product Plan
(3) Lab Testing	Weeks 4-12	\$75,000	Updated Portable/Window HP Product Plan
(4) Data Analysis and Modeling	Weeks 16-40	\$85,000	Updated Portable/Window HP Product Plan
(5) Field Study	Weeks 20-40	\$148,000	Updated Portable/Window HP Product Plan
<b>Total Estimate:</b>	<b>40 weeks</b>	<b>\$443,000</b>	

### 5.2.2 Strategy Pilots

Non-labor costs associated with program strategy testing or pilot deployment will be authorized by written approval from the CPUC Energy Division after:

- MTAB review of the pilot cost estimate and workplan
- Posting of pilot cost estimate and workplan to the CPUC Energy Division's Public Document Area (PDA) for 15 calendar days to solicit public comment
- CalMTA response to public comments and public webinar to share the final cost estimate and workplan and discuss comments and resulting changes.

The following descriptions are provided to illustrate initial pilot concepts and are not meant to represent the pilot cost estimate or workplan. Proposed pilot cost estimates and workplans will be posted for review by MTAB and the public following the initial review of the MTI Advancement Plans by MTAB. Additional pilots may be identified and proposed based on research findings or other relevant inputs.

### **Strategy Pilot 1: Retail Pilot Using Current ENERGY STAR Retail Product Platform (ESRPP)**

As called out in the logic model, national retailers represent one key potential channel for influencing adoption of portable/window heat pumps. CalMTA has an opportunity to utilize the ESRPP platform as a tool to gather data and target ESJ communities. This pilot will help us understand if this is a viable intervention in the market development phase. In addition, this pilot can be implemented in tandem with a pilot for affordable induction stoves and cooktops, leveraging the implementation and data-gathering budget. The primary purpose of this pilot is to gather retail sales data and test manufacturer, retailer, and customer engagement on portable/window HPs in retail stores targeted by zip code in ESJ communities. It will test how easily the ESRPP platform can be adapted to target identified zip codes of ESJ communities and provide insight into this target audience's interest in portable/window heat pumps. Through this pilot, CalMTA will gain insight into current sales and an understanding of both manufacturer and retailer systems to better engage ESJ communities.

Pilot objectives include:

- **Objective 1: Learn how ESRPP can be adapted to target identified zip codes that primarily serve ESJ communities.** Typically, national retailers have very limited variation of products across territories: store inventory in one neighborhood will typically be very similar to inventory in any other. This premise informs the standard ESRPP incentive approach, with the same incentive level offered to retail partners regardless of store location. CalMTA's proposed Strategy Pilot features the following possible modifications to ESRPP interventions:
  1. **Retail stocking and promotion targeting ESJ communities:** The study will yield insight into retailers' willingness and ability to adapt ESRPP to target more affordable products in specific zip codes. CalMTA will gain an understanding of both manufacturer and retailer systems to target these audiences, understand stocking practices and messaging/marketing tactics in retail stores, and gain insight into possible layering of local and Inflation Reduction Act (IRA) incentives.
  2. **Awareness- and acceptance-building:** Pilot activities will identify standard instore promotions and messaging that can be leveraged or enhanced to build consumer awareness in targeted ESJ communities during the MTI market deployment phase.
  3. **Product improvements through manufacturer engagement:** CalMTA will share lessons learned with manufacturers to inform product development strategies for improvements or new features that may increase adoption in ESJ communities.
- **Objective 2: Gather full product category sales data.** ESRPP's ability to provide full category sales data on all portable/window heat pumps, air conditioning (AC)-only units, and induction cooking products sold at participating retail locations will assist CalMTA in

developing baseline estimates for the two target MT ideas. This data will also provide valuable insight into consumer purchasing decisions in areas where traditional sales data can be harder to obtain, such as the rural communities served by many ESRPP retail partners.

- **Objective 3: Learn how CalMTA can leverage “AC turn-in” events.** Many leaky, older AC units are improperly recycled or discarded, resulting in unsafe disposal of refrigerant. To promote portable/window heat pump adoption in targeted retail locations, CalMTA can use the Strategy Pilot to coordinate with retailers and community partners and retailers to offer a discount coupon for a new portable/window heat pump to customers who bring in an old window AC unit to be recycled at an in-store or community event. The event would also include education on the benefits of efficient portable/window heat pumps and the importance of properly recycling older window units. Using the Strategy Pilot to gain an understanding of retailers’ systems and consumer awareness of the need for proper AC unit recycling will help CalMTA determine the feasibility of this promotional event.

Success will be measured by the degree to which retailers are able to adapt ESRPP to targeted zip codes and retailers’ agreement on future engagement targeting portable/window heat pumps, as well as the interest of other regions to adapt the ESRPP platform as an approach to reach ESJ communities. We will also gauge uptake of portable/window heat pump purchases in targeted zip codes.

Steps to develop this pilot will include:

- Engaging California stakeholders who are currently engaged with ESRPP, the ESRPP national collaborative, and ESRPP implementers to acquire current data on portable/window heat pump sales and program-specific adjustments needed to target specific ESJ zip codes
- Scanning current California databases and engaging local partners to determine which zip codes to target during the pilot
- Engaging leading manufacturers on available products for possible co-marketing support
- Implementing testing in partnership with ESRPP
- Analyzing and assessing results to inform future MTI intervention strategies.

**Strategy Pilot 2: Portable/Window Heat Pump Self-Installation Practices** CalMTA has identified several opportunities and barriers that warrant further research into how consumers interact with and utilize this technology. This pilot will initially focus on two primary assumed benefits that are part of the consumer value proposition of this technology: 1) its purported “self-installation” potential and 2) the relative portability of systems for tenants who own them. The pilot proposed by CalMTA seeks to verify these claims, particularly for ESJ communities that face unique barriers to adoption. The pilot findings will inform the potential development of strategic

interventions to be included in the MTI, with the intent of addressing barriers to adoption for the target market of renters and ESJ communities.

Pilot objectives include:

- **Objective 1: Verify opportunity of portable/window heat pump self-installation.** Manufacturers of both portable and window heat pumps claim that the products can be quickly self-installed by customers in multifamily units and homes. Yet feedback from several pilots currently running in California indicates that these products can be heavy, bulky, and tricky to self-install, especially for some consumers.  
  
Other potential challenges include the fact that even 110V products like these portable/window heat pumps may need to be the only device plugged into a circuit to prevent overloading, as well as differences in installation practices between plug-in models that use hoses to connect with outside air and those that saddle the window frame. In addition, the “saddled” products can only be installed in specific window types.
- **Objective 2: Verify the consumer value proposition,** including the value of self-ownership. Because the technology is relatively new, CalMTA seeks to better understand the benefits that portable/window heat pumps offer to consumers, especially renters and homeowners in multifamily and small single-family properties. The current value proposition assumes that consumers will value the ability to own and easily move the heat pump unit. As with window AC units, renters could purchase this product when supplemental heating or cooling is needed during a weather event and take it with them whenever they move.
- **Objective 3: Understand the impact of technology usage on consumer behavior.** Use of a portable/window heat pump will inherently affect the way consumers interact with functioning wall heaters, central heaters, and window AC units. It will also impact the household’s energy bill.
- **Objective 4: Build manufacturer engagement and CalMTA understanding of technical and supply-chain barriers.** The pilot will allow CalMTA to engage manufacturers as partners and gain a deeper understanding of technical and supply-chain barriers that impact adoption, including product specifications, availability, and installation practices.

Success will be measured in how well the pilot was deployed and in alignment with its intended design for maximum learnings. Metrics may include:

- Successful engagement of CBOs operating in at least two main regions of the state
- Successful manufacturer engagement and acquisition of at least two product types (vented and saddle-style products)
- Target participants identified with CBOs are primarily renters and single-family homeowners in ESJ communities
- Installations involve a balanced split of window/portable heat pump products

- Installations are observed by the project team in at least 50% of the participating homes
- At least 75% of participants return data collection/ongoing monitoring forms
- Participants are satisfied with CBO partner interactions, as measured by survey.

**Table 7. Summary of Pilot Activities, Initial Cost Estimate, and Estimated Timeline**

<b>Pilot Activity</b>	<b>Schedule (Estimated Weeks)</b>	<b>Initial Cost Estimate</b>	<b>Intervention Strategies Informed by this Task</b>
Retail pilot using ESRPP	40 weeks (10 months)	~\$600,000*	<p>Inform data strategy for portable/window heat pumps through ESRPP platform</p> <p>Strategies to build sales and stocking practices that target ESJ communities</p> <p>ESJ consumer interest in portable/window heat pumps</p> <p>Inform messaging and awareness building strategies</p> <p>Inform ENERGY STAR specification process</p>
Portable/Window Heat Pump Self-Installation Practices	48 weeks (12 months)	~\$650,000	<p>Manufacturer engagement and improved technical enhancements to installation practices</p> <p>Awareness- and acceptance-building to inform consumer and program messaging</p> <p>ESJ consumer interest in portable/window heat pumps</p> <p>ESJ consumer use of this product in relation to other HVAC technology in their homes</p> <p>Leverage of existing programs: Results will provide California programs that target weatherization, climate resilience, and decarbonization with a better understanding of installation practices and the support needed to help consumers properly install the product</p>
<b>Total Estimate:</b>		<b>\$1,250,000</b>	

*\*This cost estimate will leverage ESRPP work for induction stoves if we execute both pilots in a similar timeframe.*

### 5.2.3 Environmental and Social Justice, Workforce Development, Education and Training Approach

Portable/window heat pumps fill a technology gap for ESJ communities. Because they are more affordable than central or mini-split heat pumps<sup>4</sup> and are portable, they are primed for adoption by renters, who represent more than 50% of households in California. They can also be easily purchased during climate events when supplemental heating or cooling is needed and serve as an entry point for modest-income customers into electrification and possible participation in demand response programs.

CalMTA will center equity and ESJ in multiple aspects of this MTI design and implementation, including:

- Manufacturer engagement to ensure quality affordable products are available
- Leverage of existing community partners and programs to reach ESJ communities
- Messaging and outreach tailored to ESJ community needs to build awareness and demand
- Targeted retailer promotions in ESJ-specific zip codes.

## 6 External Program Review and Stakeholder Engagement

For each MTI, CalMTA conducted an initial market analysis to identify areas of potential overlap and opportunities for collaboration between MTIs and existing programs focused on the market segment in question. Our external program review for the Portable/Window Heat Pump MTI revealed several local, state, and national programs that will require collaboration, although most of these programs offer potential leverage rather issues of overlap. CalMTA sees significant opportunities to accelerate adoption of this technology, primarily through manufacturer/upstream engagement, federal standards and engagement, ENERGY STAR designation and coordination with existing programs. Areas of coordination include:

- **Existing research and development projects/programs** provide leverage for CalMTA to develop and launch the MTI more quickly. This includes CalNEXT and partners outside of California like NEEA and NYSERDA.
- **Programs targeting affordable housing and income-qualified residents**, including weatherization programs and work led by climate resilience groups and CBOs, could be leveraged to include portable heat pumps. Some smaller climate resilience programs are already distributing versions of these products to renters for both HVAC and air filtration.

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<sup>4</sup> A mini-split is a type of air source heat pump - specifically, a ductless HVAC system offering highly efficient heating and cooling. A mini-split heats and cools a specific zone or room in your home, enabling you to cost-effectively manage and maintain temperatures to your comfort levels by room.



- **Online energy efficiency marketplaces and ESRPP** are also important channels to coordinate with to encourage inclusion of this product.
- **Collaboration with the California Codes and Standards Advocacy team** on their engagement with DOE’s new test procedure, the ENERGY STAR designation process, and CEE’s product qualification list.

Key stakeholders identified through this process are summarized in Table 8.

**Table 8. Summary of California Program Stakeholders**

<b>Program - Organization/ Stakeholder Segment</b>	<b>Coordination Approach</b>
California Codes and Standards Advocacy team and SMEs on DOE test procedures	Biweekly meetings with Codes and Standards Advocacy team and individual meetings with SMEs
“Market and Technical Evaluation of Multifamily In-Unit Heat Pumps,” which includes research on plug-in portable and window heat pumps (CalNEXT)  Research exploring micro heat pump design options including low-GWP refrigerants and developing an interim test method for the heating mode (CalNEXT)	Review CalNEXT research findings to identify areas of leverage and refine technology specifications as needed  Submit additional research needs through CalNEXT RFI
Income-qualified programs (e.g., IOU Energy Savings Assistance [ESA] programs and California Low Income Weatherization Program (LIWP) TECH Clean California QuickStart grant to evaluate portable heat pumps and air purifiers for low-income renters (implementer: 350 Bay Area)	Leverage rebates and educational/marketing efforts to address cost barriers; access end-use customer distribution channels
ESRPP Retail Product Platform	Engage ESRPP on data acquisition and engage on a possible pilot to learn about promotion of portable/window heat pumps targeting ESJ consumers through the platform
Online energy efficiency marketplaces (Administrators: Pacific Gas and Electric Company [PG&E], Southern California Edison [SCE], the Los Angeles Department of Water and Power [LADWP])	Coordinate introductory and regular meetings on possible inclusion of more induction stove models on online marketplaces

We will develop a regular cadence for communication and coordination with these program administrators and implementers to avoid duplication of efforts, facilitate mutually beneficial information/data-sharing, and identify key leverage opportunities to enhance each other’s program efforts.

## 7 Risks and Possible Mitigation Approach

Table 9. MTI Risk Review

Initiative Risk	Severity	Mitigation Approach
Product Availability	Low	Monitor demand levels and observe if supply increases to match
Product Efficiency Differentiation	Medium	ENERGY STAR specification may be challenging for many models; MTI will work with manufacturers and EPA to ensure multiple products meet environmental stewardship (ES) criteria to facilitate utility program incentive eligibility
Competition with mini-split heat pumps: If the price point for portable/window heat pumps does not come down, there is a risk that this MTI promotes a product that isn't quite as effective as an installed mini-split at a similar price point.	Medium	Refine target audience and interventions as MTI learns which applications are best served by a mini-split and which by a portable/window heat pump
If this MTI pushes a portable/window heat pump that does not improve air filtration in homes with gas central heating, occupants may turn off their central system and lose their existing air filtration system. This could adversely impact occupant IAQ.	Medium	Engage portable/window heat pump manufacturers on air filtration capability  Research feasibility and potential impacts
If users switch to the new technology, electricity usage will go up while gas consumption will be reduced. This could adversely affect monthly billing depending on the cost of each fuel source.	Low	Assess the bill impacts of using portable heat pumps over time as gas and electricity prices change

## 8 Initial Cost Estimate, Timing and Expected Results

Table 10 summarizes all budget items from Tables 4, 6 and 7 in Section 5.

**Table 10. MTI Advancement Plan Initial Cost Estimate Summary**

<b>Section</b>	<b>Initial Cost Estimate</b>
<b>Market and Technology Research</b>	<b>\$410,000</b>
(1) Secondary Research/Sales Data Analysis (Weeks 1-4)	\$75,000
(2) Manufacturer, Retailer and SME Interviews (Weeks 3-12)	\$84,000
(3) Retail Store Visits and Online Shopping (Weeks 3-16)	\$70,000
(4) Focus Groups (Weeks 10-22)	\$120,000
(5) Customer and Building Owner Surveys (Weeks 18-32)	\$20,000
(6) Delphi Panel (Weeks 30-36)	\$36,000
Data Purchase	\$5,000
<b>Technology Assessment</b>	<b>\$443,000</b>
(1) Product tear down study (Weeks 1- 32)	\$110,000
(2) Technical specification and testing procedure review (Weeks 1-16)	\$25,000
(3) Lab testing (Weeks 4-12)	\$75,000
(4) Data analysis and modeling (Weeks 16-40)	\$85,000
(5) Field study (Weeks 20-40)	\$148,000
<b>Strategy Pilots</b>	<b>\$600,000</b>
Strategy Pilot 1: Retail pilot using current ESRPP (Weeks 1- 40)	\$600,000
Strategy Pilot 2: Portable/Window Heat Pump Self-Installation Practices	\$650,000
<b>Total</b>	<b>\$2,103,000</b>

Figure 2 provides a preliminary Gantt chart for activities beginning in Q1 of 2024.

**Figure 2. Overall Timeline/Schedule of Activities**

Activity	Duration (Weeks)	Timeline (Months)											
		1	2	3	4	5	6	7	8	9	10	11	12
<b>Research Activities</b>													
(1) Secondary Research/ Sales Data Purchase	Weeks 1-4	█	█	█	█								
(2) Builder and Remodeler Interviews	Weeks 3-12	█	█	█	█	█	█	█	█	█	█	█	
(3) Manufacturer or SME Interviews	Weeks 3-16	█	█	█	█	█	█	█	█	█	█	█	█
(4) Focus Groups	Weeks 10-22				█	█	█	█	█	█	█	█	█
(5) Customer and Building Owner Surveys	Weeks 18-32				█	█	█	█	█	█	█	█	█
(6) Delphi Panel	Weeks 30-36								█	█	█	█	█
<b>Technology Assessment</b>													
(1) Project planning, outreach, and coordination	Weeks 1- 8	█	█	█	█	█	█	█	█	█	█	█	█
(2) Assess actual and potential IAQ benefits and technical solutions	Weeks 4-30	█	█	█	█	█	█	█	█	█	█	█	█
(3) Evaluate seasonal capacity limitations and technical solutions to improve performance in cold weather	Weeks 6-40		█	█	█	█	█	█	█	█	█	█	█
(4) Assess and identify strategies to reduce impacts of refrigerants from portable/window heat pump products	Weeks 30-42								█	█	█	█	█
(5) Assess proposed heating performance ratings and test procedures	Weeks 10-48			█	█	█	█	█	█	█	█	█	█
(6) Assess options and solutions for grid connectivity and demand flexible control	Weeks 20-40				█	█	█	█	█	█	█	█	█
(7) Analyze data to develop recommendations for final technical specifications and product tiers	Weeks 44-50											█	█
<b>Pilot Activities*</b>													
(1) Geographic Targeting Using ESRPP for Portable/Window Heat Pump and Induction Cooking	40 weeks	█	█	█	█	█	█	█	█	█	█	█	█
(2) Portable/Window Heat Pump Self-Installation Practices	48 weeks	█	█	█	█	█	█	█	█	█	█	█	█

\*Pilot activities and associated cost estimates will be authorized by written approval from the CPUC Energy Division after public review of pilot workplans.

Table 11 summarizes the MTI’s estimated lifetime deployment costs, initiative timeline and expected results.

**Table 11. MTI Deployment Initial Cost Estimate and Expected Results**

<b>Initiative Initial Cost Estimate (\$)</b>	>25 million	Portable heat pumps are likely to need significant funds for manufacturer engagement, flow down and non-consumer facing incentives, and consumer awareness.
<b>Initiative Timeline (Years)</b>	5-10 years	Given some product availability and possible leverage points, the timeline for this MTI is relatively quick.
<b>Estimated Expected Results</b>	TSB: \$4.082B TSB Energy: \$476M TSB Grid: \$1.183B TSB GHG: \$2.369B	Preliminary analysis shows this technology can result in significant energy, grid and GHG benefits.

## About CalMTA

CalMTA is a program of the California Public Utilities Commission and is administered by Resource Innovations. We work to deliver cost-effective energy efficiency and decarbonization benefits to Californians through a unique approach called market transformation. Market transformation is the strategic process of intervening in a market to create lasting change by removing market barriers or exploiting opportunities, accelerating the adoption of identified technologies or practices. CalMTA-developed market transformation initiatives also aim to advance state goals on demand flexibility, workforce development and equity. Learn more at [www.calmta.org](http://www.calmta.org).

# Appendix 1: TSB Estimation Approach

As adopted by the California Public Utilities Commission, Total System Benefit (TSB) is defined as “the sum of the benefit that a measure provides to the electric and natural gas systems.”

According to D.21-09-037

1, TSB accounts for increased supply costs as a reduction in benefits and expresses, in dollars, the lifecycle energy, ancillary services, generation capacity, transmission and distribution capacity, and greenhouse gas (GHG) benefits of energy efficiency activities on an annual basis. The 2021 Energy Efficiency Potential and Goals study states that TSB represents the total benefits, or “avoided costs,” that a measure provides to the electric and natural gas systems.

TSB is calculated using the savings and load shape of an energy efficiency resource by applying the hourly values for energy, capacity, and GHG compliance costs over the life of the resource, to enable development of the total net system benefits from an initiative.

## TSB Estimation by MTI Lifecycle Phase

CalMTA developed a preliminary 20-year estimate of TSB and cost-effectiveness for each market transformation initiative (MTI) submitted through the Request for Ideas (RFI) process that advanced to Stage 2 scoring. The estimates were based on readily available secondary research combined with a Bass modeling approach to estimate baseline and total market adoption curves. The CalMTA team will refine these estimates based on additional research and best practices during Phase II of the MTI Lifecycle, as shown in Figure 1.

**Figure 1. TSB Estimation by MTI Lifecycle Phase**



## Phase I – Preliminary TSB Estimation Approach

During Stage 2 scoring, the CalMTA team developed a preliminary estimate of TSB associated with Portable Heat Pumps. For this and all MTIs that advanced to Stage 2 scoring, the team used a systematic approach that included developing preliminary estimates of the following inputs needed for TSB calculations:

- **Preliminary baseline market adoption (BMA) forecast:** The team developed a preliminary BMA forecast gathered from a small panel of experts who relied on readily available secondary research and their industry knowledge. Adoption by single-family and multi-family households were forecasted independently using a Bass model framework.

<sup>1</sup> Adopted from Decision 21-05-031

- **Preliminary total market adoption (TMA) forecast:** This forecast estimated preliminary market adoption based on the size of the market (households) in each addressable market segment, and Bass model parameters (maximum market saturation, coefficients of innovation and imitation) based on a database of adoption curve parameters gathered from international experience with market diffusion of a variety of new technologies.
- **Preliminary per-unit energy, grid, and GHG impacts:** The team developed unit impact estimates using hourly simulation models.
- **Preliminary estimates of avoided costs:** The team estimated avoided costs for the 20-year period using the Avoided Cost Calculator.

## MTI-Specific Analysis and Assumptions

### BMA Assumptions

The team used a Bass model framework to develop a preliminary forecast of baseline market adoption through 2045. We convened a mini-Delphi panel of experts to forecast market adoption using the three Bass Model parameters: maximum potential market saturation (*m*), coefficient of innovation (*p*), and coefficient of imitation (*q*), which capture the rate of adoption by early and late adopters, respectively. Panel members considered data for California and the impact of current and expected interventions outside of CalMTA in developing their forecasts. The panelists provided separate forecasts for single- and multi-family households.

For preliminary BMA adoption, forecasts by panel members yielded the maximum market saturation provided in Table 1.

**Table 1. Stage 2 Portable Heat Pumps - Estimate of Maximum Market Saturation (BMA)**

Segment	Maximum Market Saturation ( <i>m</i> )	Rationale
Single-Family	9.3% of households	Panel members expect adoption by households currently with portable ACs/heaters, but limited adoption by households with central cooling or heating.
Multifamily	21.0% of households	

### TMA Assumptions

To forecast total market adoption through 2045, the team estimated the maximum market saturation (*m*), coefficients of innovation (*p*), and coefficient of imitation (*q*) for both single- and multi-family segments based on the assumption that CalMTA were to adopt the MTI and implement the proposed market interventions. The team estimated maximum market saturation separately for single- and multi-family households, and for each of the following sub-segments: (a) Households with one or more portable heater and/or AC unit; (b) Households with central heating and/or cooling but no portable units; (c) Households without any space cooling. The team estimated overall maximum market saturation based on assumed technology saturation as shown in Table 2.

**Table 2. Stage 2 Portable Heat Pumps - Maximum Adoption Assumptions by Segment**

Segment	Households with One or More Portable Heater and/or AC Unit	Households with Central Heating/Cooling only	Households without Space Cooling
Single-Family	50%	10%	10%
Multifamily	67%	10%	10%

Based on the above market saturation and the proportion of households and technology saturation, based on the Energy Information Agency’s 2020 Residential Energy Consumption Survey,<sup>2</sup> the team estimated maximum market saturation as provided in Table 3.

**Table 3. Stage 2 Portable Heat Pumps - Estimate of Maximum Market Saturation (TMA)**

Segment	Maximum Market Saturation (m)
Single-Family	22.5% of households
Multifamily	33.7% of households

The team also estimated behavior of early and late adopters (“p” and “q,” respectively) based on a database of adoption curve parameters gathered from international experience with market diffusion of a variety of new technologies using 43 observations of adoption of electrical appliances and consumer electronics.<sup>3</sup>

#### *Additional TMA Assumptions*

The team used the following assumptions for number of portable heat pump units per household, based on current ownership of portable heaters/AC units:

<sup>2</sup> U.S. Energy Information Administration. (2023). Residential Energy Consumption Survey (RECS). Retrieved from <https://www.eia.gov/consumption/residential/>

<sup>3</sup> Multiple references were used to develop a dataset of ‘p’ and ‘q’ values. The three which provided most of the estimates for consumer electronics and electrical appliances are the following:  
 Lilien, G. L., Rangaswamy, A., & Van den Bulte, C. (2000). Diffusion Models: Managerial Applications and Software. Vijay Mahajan, Eitan Muller, Jerry Wind, eds. New-Product Diffusion Models. Chicago, Lavoie, J., Barham, H., Gupta, A., Lilja, T., Nguyen, T., Kim, J., & Daim, T. U. (2018). Forecasting Super-Efficient Dryers Adoption in the Pacific Northwest. Energy Management–Collective and Computational Intelligence with Theory and Applications, 41-64.  
 Gupta, R., & Jain, K. (2012). Diffusion of Mobile Telephony in India: An Empirical Study. Technological Forecasting and Social Change, 79(4), 709-715.



- Single-family households: 1.77 units
- Multifamily household: 1.55 units

The team used the following assumptions regarding timing of MTI initiation and initial impacts:

- Start year for initiation of CalMTA MTI: 2025
- Number of years until initial MTI incremental impacts begin: Two

### Incremental Market Adoption

To calculate the TSB for Portable and Window Heat Pumps, the team estimated baseline and total market adoption for existing single- and multi-family residences. The preliminary estimate of cumulative total market adoption was nine million units and approximately four million units for cumulative baseline market adoption.

### Incremental Adoption by Installation Condition

We identified eight representative installation conditions (residence type, adopted technology, baseline technology and fuel type) and estimated the proportion of incremental adoption (estimated at five million units) in each of these segments (Table 4). The team allocated incremental market adoption based on initial market research.

**Table 4. Stage Portable Heat Pumps - Installation Conditions**

<b>Segment</b>	<b>Technology</b>	<b>Baseline</b>	<b>Distribution of Market Adoption</b>
Multifamily	Window Heat Pump	Window AC with electric heat	10%
Multifamily	Window Heat Pump	Window AC with natural gas heat	11%
Multifamily	Portable Heat Pump	Portable AC with electric heat	3%
Multifamily	Portable Heat Pump	Portable AC with natural gas heat	4%
Single-Family	Window Heat Pump	Window AC with electric heat	8%
Single-Family	Window Heat Pump	Window AC with natural gas heat	41%
Single-Family	Portable Heat Pump	Portable AC with electric heat	4%
Single-Family	Portable Heat Pump	Portable AC with natural gas heat	19%

## Unit Energy Impacts

Impacts were calculated for adoption for each installation condition. Average annual energy impacts had significant differences depending on equipment specifications, baseline conditions and market segment. For instance, average energy savings per unit ranged from 288 KWh where the window heat pump displaced heating from a gas furnace to 856 KWh where the portable heat pump displaces electric resistance heating. Similarly, therm savings ranged from zero therms per unit in cases with an electric resistance baseline assumption to 30.67 therms per unit where the window heat pump displaced heating from a gas furnace.

## Incremental Costs

The team conducted secondary research to develop estimates of incremental costs for each of the installation conditions and developed preliminary program cost estimates to inform Total Resource Cost (TRC) and Program Administrator Cost (PAC) calculations.

## Preliminary Estimate

TRC and TSB are calculated in line with the IOU energy efficiency requirements. Costs and benefits were modified to accommodate a statewide value, with utility-/climate-zone-avoided costs averaged by the share of customers from each of the three largest state IOUs and with average values applied to the remaining portion of California served by other utilities. TRC includes all avoided costs categories, including electric/gas/greenhouse gas and refrigerant benefits, program costs, incremental measure costs, etc. The Avoided Cost Calculator and projected lifetime savings were also used to generate TSB. The preliminary TSB estimates are reported in Table 5, disaggregated for energy, grid, and GHG impacts.

**Table 5. Stage 2 Lifetime TSB Estimate - Portable Heat Pumps**

Idea Name	TSB (\$M)	Energy (\$M)	Grid (\$M)	GHG (\$M)
Portable Heat Pump	4,028	476	1,183	2,369

As shown in the table, more than half of the estimated TSB (\$2.4 billion) is associated with GHG emissions reductions, with another \$1.2 billion associated with grid benefits and nearly a half billion dollars in lifetime energy savings.

The team developed preliminary TRC and PAC ratios of 14.11 and 310.76 respectively for the initiative.

## Phase II – Refined TSB and Cost-Effectiveness Estimates

The CalMTA team will conduct additional market and technology research on portable heat pumps during Phase II of the MTI as described in the Advancement Plan. Based on that research, the team will refine TSB and cost-effectiveness estimates for the MTI. These refined estimates and their detailed methodology and assumptions will be included as part of the MTI Plan required for

advancement to Phase III. The MTI Plan will also include an evaluation plan and a data collection plan to support ongoing evaluation.

### **Phase III – Ongoing Updates to TSB and Cost-Effectiveness Estimates**

The team will update TSB and cost-effectiveness estimates based on newly available data collected as part of the ongoing data collection plan. An independent third-party evaluator will periodically review CalMTA's TSB and cost-effectiveness models and supporting data and assumptions and make suggestions for improvement, as needed.