2024 Focused Pilot Technology Priority Map

Final Report

ET24SWE0018

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Acknowledgements

This Focused Pilot technology priority map (TPM) was developed by the Focused Pilot subject matter expert (SME) teams of the CalNEXT program, who were responsible for producing this document, conducting background research, engaging stakeholders of the Technical Advisory Committee (TAC), and managing the TPM development process. We thank the Focused Pilot SME team members, our facilitation team, and other advisors for their contributions.

Focused Pilot TPM Advisory Committee Organizations

California Energy Commission

California Market Transformation Administrator

California Public Utilities Commission

California Technical Forum

Pacific Gas and Electric

San Diego Gas & Electric

Southern California Edison

Executive Summary

Technology priority maps (TPMs) are an important part of the CalNEXT program to help define and communicate priorities that inform project selection. The TPMs were last updated in 2024, and this Final Report documents the methodology used by the CalNEXT program team thus far to develop a Focused Pilot TPM. The Research Initiatives identified under each technology family within the six end-use-oriented 2024 TPMs were reviewed by the subject matter experts (SMEs), and the high-impact and ready-for-deployment ones were prioritized to be further developed into research topics included in this Focused Pilot TPM. The CalNEXT SME teams refined the scopes of the prioritized Focus Pilot TPM research topics, consulted with appropriate stakeholders and literature, and mapped barriers to the technology adoption and portfolio impact, suggesting activities to address identified barriers.

The research topics included in the 2024 Focused Pilot TPM are:

- Increasing Standardized HVAC Control Implementation and Streamlining Retro-Commissioning Processes for Energy Savings
- Micro Heat Pumps
- Strategies for Residential Electrification with Minimal Electrical Upgrades by Controlling Primary Loads
- Decarbonizing Household Appliances: Opportunities and Limitations with 120V Appliances
- Central Heat Pump Water Heater Retrofit Readiness Through Hot Water Distribution System Optimization

The intended next steps are also included in this Final Report.

Disclaimer

Table of Contents

Tables

Figures

Abbreviations and Acronyms

Acronym	Meaning
ADU	Accessory dwelling unit
AHJ	Authority having jurisdiction
BAS	Building automation system
BRO	Behavioral, retro-commissioning, operational
CA	California
CARB	California Air Resources Board
Cal TF	California Technical Forum
CalMTA	California Market Transformation Administrator
CEC	California Energy Commission
CHPWH	Centralized heat pump water heater
CPUC	California Public Utilities Commission
C&S	Codes and standards
DAC	Disadvantaged communities
DEER	Database of Energy Efficiency Resources
DOE	Department of Energy
DR	Demand response
DHW	Domestic hot water
EE	Energy efficiency
ET	Emerging technology
eTRM	Electronic Technical Reference Manual

Acronym	Meaning
EV	Electric vehicle
GHG	Greenhouse gas
HP	Heat pump
HPWH	Heat pump water heater
HTR	Hard-to-reach (communities)
HVAC	Heating, ventilation, and air conditioning
IOU	Investor-owned utility
M&V	Measurement and verification
MHP	Micro heat pump
MMV	Master mixing valve
MT	Market transformation
NEEA	Northwest Energy Efficiency Alliance
PA	Program administrator
PG&E	Pacific Gas and Electric
RCx	Retro-commissioning
SCE	Southern California Edison
SDG&E	San Diego Gas & Electric
SME	Subject matter expert
SOO	Sequence of operation
SWEETP	Statewide Electric Emerging Technology Program
TAC	Technical Advisory Committee
TPM	Technology priority map

Acronym	Meaning
TSB	Total system benefit
VRF	Variable refrigerant flow
WH	Water heating

Introduction

Technology priority maps (TPMs) provide the CalNEXT program a framework to externally communicate the priorities of the program, clearly define the central focus areas of the program, and assist with project screening. TPMs are a tool to document the impact potential, programmatic research needs, and market readiness of all technology families across each of the end-use technology areas. These TPMs will drive product ideation and inform project selection. This Final Report covers the development process for the Focused Pilot TPM.

Background

The Statewide Electric Emerging Technology Program (SWEETP), branded as CalNEXT, has established the Focused Pilot project type as a way to focus on high-impact technologies by identifying market barriers, conducting pilot tests to address those barriers, collaborating with other programs, and determining whether the technology should be transferred to energy efficiency (EE) resource programs or the market transformation (MT) portfolio. The Focused Pilot TPM is a specialized TPM for specific technologies — a single technology family, subarea(s) within a technology family, or a synergetic area across multiple technology families — that focuses on market barriers and potential activities to overcome barriers.

The TPM supports the creation of Focused Pilot projects, which address end-to-end market barriers associated with specific technologies. During the TPM development process, the program team creates blueprints that map the identified market barriers for each high-potential technology being considered for a Focused Pilot. The blueprints serve as an initial roadmap for future Focused Pilot projects to develop into recommended cost-effective and scalable approaches to incorporate the technology into the portfolio. These approaches can include resource acquisition programs, the MT framework, codes and standards (C&S), other portfolio structures, or a combination thereof. Based on the Focused Pilot TPM, each Focused Pilot project tests a hypothesis on overcoming documented market barriers for the technology. It also includes metrics to determine whether the hypothesis is valid or should be rejected. Focused Pilots address a targeted set of market barriers for the technology while documenting barriers that are not in the scope of the project but are possibly better suited to other pilots or market interventions, such as Market Transformation Initiatives (MTIs) led by the California Market Transformation Administrator (CalMTA). The goal of the Focused Pilot is to provide a holistic view and assessment of whether the market interventions have impacted the targeted market barriers, and, if not, what additional steps should be considered for future study.

Objectives

The development of the Focused Pilot TPM defines barriers and potential activities associated with the high-impact and ready-for-deployment technology families identified through the 2024 TPM process. This TPM gives guidance on the development of Focused Pilot projects in 2025 and beyond. Focused Pilots are large, deployment-focused projects aimed at testing new program intervention strategies to overcome barriers. As with the end-use TPMs, the TPM process here is used to gather

subject matter expert (SME) input from the partner teams and solicit feedback from the California energy efficiency community — with a particular emphasis on statewide implementation teams. In-depth, primary research activities, supply chain interviews, and solidification of the blueprints, based on the TPM, commence under the Focused Pilot planning.

Methodology

The TPM focuses on technologies that are both high-impact and ready for deployment in a Focused Pilot project. High impact is defined as a technology family having a "high" rating in the 2024 TPM SWEETP priority, indicating significant potential for energy savings, decarbonization, demand flexibility, or a combination thereof. A Focused Pilot's readiness-for-deployment is assessed at the Research Initiative level, based on whether there is a high understanding or ongoing research related to the technology's performance and market awareness, as documented in the Research Initiative table within the technology family.

To engage stakeholders in the Focused Pilot TPM, the CalNEXT project team established and refined the process below during the development of the first six TPMs.

1. **Energy Solutions and partners (VEIC, AESC, TRC, UC Davis, and Ortiz Group)**: For TPM development, technical SMEs on each of the Focused Pilot technology families from Energy Solutions and our program partners, identified in Table 1, held working sessions for each Focused Pilot TPM topic to provide technical expertise and market insights. Each SME team was responsible for developing the first draft of the TPM for the topic(s) related to its area of expertise. The SME teams identified market barriers based on leading regional and national technology research, industry efforts focused on technology advancements, and the team's insights. The SME teams then conceptualized activity ideas for addressing the identified barriers. These efforts were documented in the Preliminary Findings Report.
2. **Statewide initiatives**: The SME teams consulted with staff from statewide initiatives, such as the CalMTA and California Energy Design Assistance (CEDA) program, to identify opportunities where the Focused Pilot TPM topics could complement these programs. Further, staff from these statewide initiatives provided feedback on and helped refine the Focused Pilot TPM topics, and their associated barriers and activities. This effort is reflected in the Draft and Final Report as part of the Technical Advisory Committee (TAC) outreach.
3. **Southern California Edison (SCE)**: Staff reviewed the TPM at the Preliminary Findings Report and the Draft Report stages, providing feedback through edits.
4. **California investor-owned utilities (IOUs) (SCE, PG&E, and SDG&E) program administrators (PAs)**: The project team solicited feedback from multiple California-based IOUs through Focus Pilot TPM TAC outreach. These PAs represent a broad range of technologies, including EE, C&S, as well as other statewide emerging technology (ET) programs — Demand Response Emerging Technologies (DRET), Gas Emerging Technology (GET), and the Vehicle-Grid Integration Program.

   The Focused Pilot TAC emphasized the inclusion of statewide implementers and IOU PAs and statewide leads, to address delivery barriers in current programs. There was less focus on

inviting manufacturers and the supply chain stakeholders to the TAC, as their input was designated for the Focused Pilot project development instead of the TPM development stage. The draft Focused Pilot TPM, as documented in the Preliminary Findings Report, was sent to the TAC for feedback. California IOU PAs were also given the opportunity to provide feedback on the research priorities identified by the SME teams. The feedback from the TAC is incorporated into the Focused Pilot TPM and documented in this Final Report.

5. **Other ET Programs and Other Key Stakeholders**: The Focused Pilot TPM covers a collection of diverse, high-potential technology areas, which allows for incorporating feedback from stakeholders both within and outside the TPM TAC. The TPM TAC outreach consisted of sending the report to stakeholders with broad ET interests, including California IOU PAs, C&S stakeholders, and other experts with interest across broad technology groups, such as those from the California Energy Commission (CEC), California Technical Forum (Cal TF), Northwest Energy Efficiency Alliance (NEEA), and U.S. Department of Energy (DOE). Other ET experts with specific technology or market assessment expertise in one or more of the Focused Pilot technology families were consulted separately. Both types of stakeholders are identified in the Draft Report.

Upon the approval of the 2024 Focused Pilot TPM Draft Report, the SME team incorporated additional feedback and finalize its assessment of the barriers and activities associated with each Focused Pilot topic idea. The SME team then created an initial blueprint for each topic idea. The blueprint maps out the end-to-end relationships between the barriers, activities, and outputs from the activities. These blueprints are included in this Final Report.

Table 1: Technical Advisory Committee (TAC) Organizations

Organization
CalMTA
CalTF
CPUC
PG&E
SCE
SDG&E

Stakeholder Feedback

TPM Advisory Committee Outreach

The TPM Advisory Committee outreach began in November 2024, when stakeholders were invited to provide feedback via email. This outreach allowed Advisory Committee members to provide candid written comments and suggestions. Suggestions were reviewed by the TPM coordinator and the 2024 Focused Pilot TPM SME teams and incorporated into the Revised 2024 Focused Pilot TPM section below. The stakeholder feedback received and addressed throughout the development of the Focused Pilot TPM is documented in the matrix in Appendix A: Advisory Committee Feedback & Resolution Matrix.

2024 Focused Pilot TPM

Five Focused Pilot topics across six technology families are included in the 2024 Focused Pilot TPM. The barriers and activities identified for each of the five topics are detailed in the following sections.

The identified barriers are classified into four high-level categories: technology barriers, market actor barriers, IOU program design barriers, and supply chain barriers. Such categorization helps guide the development of activities to address the barriers, as well as the expected outputs and outcomes, which will be further identified in the blueprints. However, some barriers may be cross-cutting and span multiple high-level categories. In these cases, the barriers are classified under the category deemed to be the best fit, but aspects in other relevant categories are still considered in identifying activities for the topic.

Focused Pilot Topic (1): Increasing Standardized Commercial HVAC Control Implementation and Streamlining Retro-commissioning Processes for Energy Savings

Technology Family: Commercial Installation, Operation, and Maintenance [HVAC TPM]

This technology family is focused on advancements in commissioning tools, techniques, and practices that improve the installation, operation, and maintenance of HVAC equipment. The goal is to optimize the performance and efficiency of HVAC equipment at the time of installation through quality installation practices and commissioning, while sustaining optimal performance through continuous commissioning and maintenance.

Focused Pilot Topic Background

The Focused Pilot topic aims to increase standardized control implementation and retro-commissioning (RCx) processes for commercial HVAC systems by leveraging ASHRAE Guideline 36 and streamlining the program incentive process to increase control measure adoption. Control improvement projects must follow the CPUC custom project review process to get incentives due to uncertainty in the measure performance. In 2023, Cal TF affirmed a custom measure guidance for HVAC RCx measures and referenced ASHRAE Guideline 36 to streamline custom project savings claims and incentive processes. This pilot will simplify and expedite RCx project screening, preapproval, and implementation by making RCx program participation more cost-effective and attractive to the market. Guideline 36 provides standardized, manufacturer-tested control sequences to streamline operations, enhancing energy savings and reducing greenhouse gas (GHG) emissions. Through in-field validation of an easy-to-use existing saving estimation tool and prequalifying vendors through verification procedures for Guideline 36 capabilities, the pilot will demonstrate the cost-effectiveness and streamlined approach to implementing optimized building automation system (BAS) measures.

Barriers

Technology Barriers:

- **Implementation challenges associated with existing building conditions and energy savings potential —** ASHRAE Guideline 36 offers a promising path to implementing optimized control sequences for a wide range of HVAC system types. When considering the implementation of Guideline 36, there is still a need to identify the applicable sequence of operations (SOOs) based on the existing mechanical infrastructure and verification of the existing controls and control devices. This results in the potential energy savings estimations that are widely varying and difficult to predict at the onset.

- **Lack of information on the cost-effectiveness of control system retrofit projects and lack of an implementation pathway for customers to reference —** While Guideline 36 covers a wide range of HVAC system types and SOOs, the cost associated with retrofitting the control system with an optimized control strategy depends on the selected SOOs and the existing system conditions. The market lacks a uniform characterization of control retrofit roadmap and the cost-effectiveness of the various potential implementation pathways needed for building owners to make decisions. For example, depending on their budget and timeline, a customer

may consider a full control retrofit including upgrading the BMS system or a step-by-step incremental improvement approach that include implementation of selected high impact SOOs with minimal sensor upgrade and existing system tuning.

- **Deferred maintenance, controller, and device upgrades** — Many buildings have deferred the maintenance and upgrades of their controllers and control devices, making it challenging and costly to apply optimized control SOOs. In these cases, BAS and device upgrades are necessary before implementing improvements, adding to the expense and complexity of the project.

Market Actor Barriers:

- **Limited familiarity among control vendors and building engineers** — Many control vendors and contractors are not familiar with the capabilities and requirements of Guideline 36. A lack of access to widespread uniform knowledge, expertise, and technical skills in this area is a barrier to the successful deployment and adoption of Guideline 36 and optimized control strategies for energy savings.

- **Lack of prequalification for trade allies** — While many control vendors are skilled in control implementation and commissioning, introducing a streamlined process and specialized tools necessitates minimal but essential training to ensure alignment of program requirements. This prequalification and training process represents a market readiness challenge, as vendors, e.g., trade allies, must meet these updated standards to participate effectively in the program.

- **Asymmetric information and opportunism** — Customers are reluctant to pursue an investment in commissioning their existing HVAC control system based on the claim of energy savings. Building owners may lack the expertise of understand their HVAC system operating principles, leading to these concerns.

Program Implementation Barriers:

- **Existing RCx implementation workflow for performance verification may contribute to low market uptake** — The current RCx process does not always align with the customer's decision-making process or support immediate action to make system corrections. For example, data collection, analysis, and reporting are resource and time intensive, and the deliverables are not tied to a clear path forward. The program structure lacks clarity on the measure application type needed to streamline the workflow. There is a lack of definition regarding whether a BAS upgrade should be considered behavioral, retro-commissioning, and operational (BRO) or normal replacement, and how the program encourages control upgrades that focus on achieving energy saving.

Activities

- **Validate energy savings estimation tools** — Validate and refine existing tools, such as the PG&E HVAC Tool and Guideline 36 Savings Calculator, for accurately estimating energy savings outcomes from high-impact Guideline 36-based implementations. These tools will help provide consistent, reliable savings estimates across different building types and operational contexts. Recently completed CalNEXT projects, ET23SWE0060 PG&E HVAC Tool Validation and ET22SWE0043 Standardized HVAC Control Sequence Savings Estimation Calculator, used

energy simulation to characterize and validate energy savings for a wide range of conditions. The Focus Pilot would focus on validate the robustness of those existing tools using field data for saving estimation and identify improvement needs. In addition, there are various site screening tools from Electric Program Investment Charge (EPIC) projects (Hwakong, Eubanks, Singla, 2022) used to identify energy saving opportunities from improving controls in existing buildings. The compilation of a large data set including energy saving and project cost data from previously completed control projects would support the validation of existing tools. The Focused Pilot would also evaluate the potential of leveraging these tools to streamline the implementation process.

- **Develop control retrofit and implementation guide —** Characterize typical existing HVAC system types, control conditions, and control retrofit needs. Draft a streamlined workflow with the goal of identifying specific control improvements that will yield cost effective energy savings and operational value to the customer. The goal is to document the retrofit options and the associated implementation process and cost effectiveness to meet customer needs, whether it includes BMS replacement together with control improvement or just implementation of selected high impact and low cost SOOs. The outcome could include a roadmap for deploying the measures, implementation guidance, as well as potential program pathways such as deemed, hybrid, custom, or direct install depending on HVAC system type, project size, and control sequences to be implemented. Simplifying and standardizing customer screening and preliminary savings calculations would more effectively influence and engage with customers. Appropriate measurement and verification (M&V) should be based on the required level of rigor as defined by the CPUC and Cal TF RCx Custom Measure Practice (CMP). Streamlining the process to support verification and performance assurance will encourage market participation.

- **Demonstrate the implementation process** — Conduct a pilot demonstration of the streamlined retro commissioning process that includes a selection of new sequence of operations to implement for energy savings. The demonstration may include the documentation of identified operational deficiencies, proposed hardware upgrade and programming, and testing and verification of improvements. This will be used to demonstrate a systematic process for RCx, validate energy savings, showcase cost-effectiveness and operational impact, and inform program incentive delivery pathways.

  Demonstration of a project implementing standardized control sequences should include pre-approval of using a validated savings estimation tool. This activity will involve implementing standardized high-impact control measures and commissioning to validate the efficiency and scalability. The target building characteristics, baseline systems, and anticipated benefits will be documented to provide reference data to support the scaling of the RCx process.

- **Prequalify vendors for Guideline 36 compliance** — Develop a prequalification process for vendors capable of control implementation verification procedures aligned with ASHRAE Guideline 36. This effort will help ensure that all participating vendors have the knowledge and technical skills to execute and validate standardized control sequences.

- **Develop workforce training for equity focus** — Collaborate with CEC-funded EPIC projects focusing on workforce training to train building engineers in DACs and HTR communities. This

training will augment existing services by control vendors as standardized control sequences and commissioning processes would enable them to expand into more complicated HVAC systems and scale their business, equipping engineers with the skills needed to manage HVAC load and energy efficiency in commercial buildings, thus supporting equitable access to these benefits.

Initial Blueprint

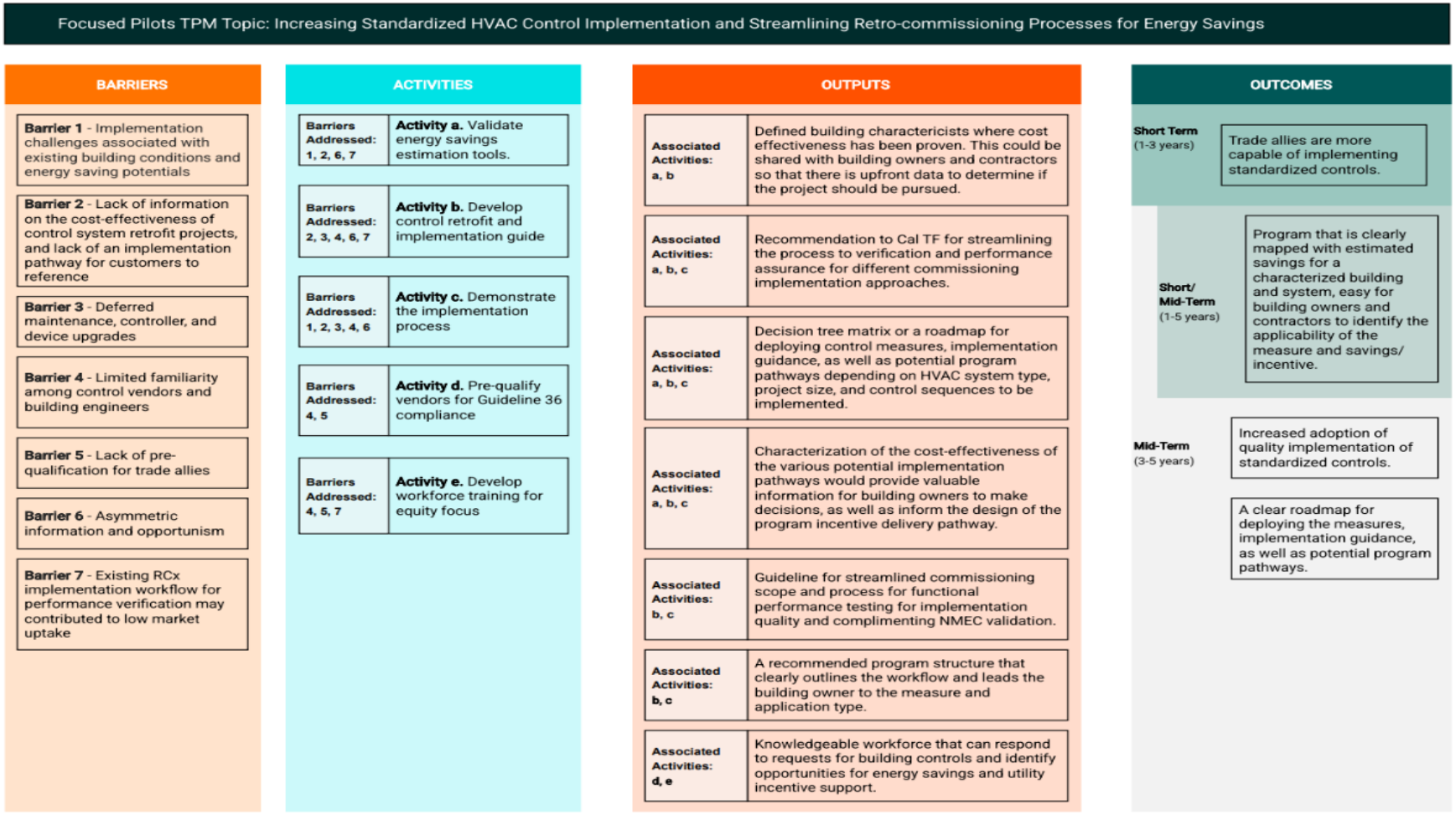

Figure 1: Increasing Standardized HVAC Control Implementation and Streamlining Retro-commissioning Processes for Energy Savings[1]

[1] Due to the complex relationship and association between the barriers, activities and outputs, the blueprint is presented in an alternative way that is slightly different from a typical logic model diagram to provide better readability. Instead of using arrows between the blocks like typical logic models, the linkages are labeled in front of each block.

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Focused Pilot Topic (2): Micro Heat Pumps

Technology Family: Micro Heat Pumps [HVAC TPM]

Micro heat pumps (MHPs) are efficient, rapidly deployable heat pumps that require minimal professional installation. They are suitable for compact spaces where heat pumps can replace or displace existing room air conditioners and space heating, or where traditional split or central systems are too costly or difficult to install. Packaged micro heat pumps connect to standard 110V/120V NEMA 5-15 outlets without field-installed refrigerant lines. They are available in several form factors such as saddle, window, portable, and through-the-wall. The window and portable units are generally do-it-yourself (DIY), while through-the-wall units require additional wall penetration. Typical uses include single-family and multifamily housing, accessory dwelling units (ADUs), mobile homes, hospitality, assisted living facilities, garages, and schools. The condensate in these units is managed through simple drain lines, drip-free melt water atomization, or water dispersion into the internal air or outside air. They offer the potential for improved thermal comfort and air-filtration capabilities.

Focused Pilot Topic Background

California has set an ambitious goal to install six million heat pumps by 2030. Still, the diversity of building applications and ownership, complexity of installations, and affordability of clean heating and cooling solutions pose obstacles to its achievement. Emerging packaged MHP technology covers a variety of products such as portable heat pumps, room heat pumps, through-the-wall heat pumps, window heat pumps, and reverse cycle room air conditioners. This new generation of plug-in, packaged window or through-the-wall heat pumps has the potential to rapidly displace polluting in-unit gas-fired furnaces, inefficient window air conditioners, and electric resistance space heaters by eliminating many cost barriers associated with the design, installation, and permitting required for traditional heat pumps. MHPs could be highly beneficial to DACs by giving tenants new options for heating and cooling with lower impact on energy bills, improved indoor air quality relative to current inefficient heating options, and lower installed costs relative to central systems for spaces up to 1,000 square feet. In addition, some MHPs, i.e., window heat pumps, can be tenant-owned assets that can be relocated when moving apartments.

This MHP topic aligns with CalMTA's Room Heat Pump market transformation initiative (Room Heat Pumps MTI Plan — CalMTA). The outputs from the identified activities will complement CalMTA's efforts and provide data or market insights for CalMTA's interventions. The Focused Pilot outputs could also directly support the initiative's short-term outcome, such as enabling programs to include MHP as one of the measure offerings.

Barriers

Technology Barriers:

- **Installation limitations due to weight, window types, and structural limitations —** The unit weight can be as high as 140 lbs., which is relatively heavy for a DIY installation. Current saddle-bag window heat pump designs can be installed in single- or double-hung and possibly casement window types in the United State. However, there is an opportunity for manufacturers to extend these products to other window types.

- **Limited product availability and diversity —** Emerging MHP models are addressing some critical barriers to adoption, but continued investment in innovation is required to support diverse applications across California buildings and climates, the transition to low- GWP refrigerants, and increased options for air filtration and heat recovery for improved indoor air quality. A limited set of new MHP models are now commercially available that use refrigerant R-32 and meet California Air Resources Board (CARB) requirements. There is limited availability of MHPs suitable for colder climates and cities in California, e.g., Tahoe, although equipment manufacturers have developed new cold-climate window heat pump models in response to a New York City Housing Authority RFP. Developing longer-term and nationwide opportunities for smaller packaged heat pumps is crucial to support ongoing growth in the number and diversity of models.

- **Lack of energy performance test procedures** — The U.S. Environmental Protection Agency's (EPA's) heating test procedure for room air conditioners, i.e., window heat pumps, released in July 2024, doesn't cover portable heat pumps, while through-the-wall units are rated according to the test procedure for central air conditioners and heat pumps, not room heat pumps. The DOE standard covers portable and through-the-wall units for cooling purposes only, not heating. Therefore, there is a lack of appropriate test procedures to adequately cover both portable and through-the-wall units as room heat pumps for their heating performance and ENERGY STAR® designation. While DOE published its last rulemaking in 2021, the new rulemaking is not expected until 2028.

Market Actor Barriers:

- **Lack of technology awareness in the DAC and HTR communities** — To enhance DAC and HTR alignment, partnerships with community-based organizations or affordable housing associations are needed to raise awareness of the technology's suitability and support outreach efforts during implementation. Overall consumer awareness needs to be increased.

- **Uncertain performance due to interacting with central condition systems** — MHPs, when installed in buildings that are still connected with inefficient and unreliable centralized space conditioning systems, may interfere with the controls of the central systems, resulting in lower performance and possibly higher energy bills. This relates to two critical features: 1) MHP performance with respect to other systems, and 2) consumer education on how best to install and use these products.

- **Unverified noise level and condensation management** — MHPs are supposed to be quiet while operating and must have a self-managed condensation system. These attributes need further investigation to ensure they hold true.

Supply Chain Barriers:

- **Cost may add up quickly when multiple MHP units are needed** — While central systems can cost up to $18,000, including installation, MHPs can cost upwards of $3,000 per unit. Although more affordable than central systems, the high cost of MHPs and the potential need to have multiple MHPs to serve an apartment can limit affordability. While MHPs are expected

to be a more economical solution, there is a strong need for lower-cost models and incentives specifically for HTR communities and DACs to drive rapid uptake.

IOU Program Design Barriers:

- **Not adequately supported by eTRM for being included in EE programs** — IOU programs and eTRMs currently do not account for unique attributes of MHPs, including the variable-speed compressor for both cooling and heating, and will need to be updated to better support programs and measure characterizations. Also, window heat pumps are not currently included in the Database of Energy Efficiency Resources (DEER) residential prototype.
- **Existing performance data is not sufficient to support program design** — Verification of usage and savings will be required for accurate representation of performance and impact.

Activities

- **Confirm energy performance in all California climate zones** — MHPs use variable-speed compressors that are designed to provide, for example, 9,000 Btu/h at both 95°F (cooling) and 17°F (heating), and achieve considerably high performance with regard to energy efficiency metrics, including combined energy efficiency ratio (CEER), heating energy efficiency ratio (HEER), and coefficient of performance (COP). It is important to verify the capability to deliver heating and cooling in different California climate regions.
- **Quantify electric bill impact —** Electric bill impacts, especially for DACs and HTR communities, need to be quantified to ensure that transitioning from gas-fired heating units to electric MHPs will not cause undue economic burden.
- **Conduct field demonstration to confirm consumer comfort** — MHPs need to be tested in consumers' homes to evaluate their comfort, the heating and cooling capacity delivered, noise levels, condensation-related issues, measured energy savings, and any operational issues that customers may experience.
- **Identify the most effective application areas to target MHP deployment** — Evaluating market sector opportunities for targeted application areas of MHPs, including single-family and multifamily housing, small offices, mobile homes, ADUs, hospitality, assisted living facilities, garages, and schools.
- **Identify the optimal incentive delivery, installation pathways, and community engagement to promote MHP adoption** — Assess incentive delivery pathways and non-professional installation options to reduce upfront equipment and installation costs, i.e., affordability, and increase accessibility. Provide technical support and assistance for DIY installations to ensure proper setup, operation, and maintenance. Foster partnerships with community-based organizations and affordable housing associations, and organize workshops/live demonstrations to educate communities about MHPs, their benefits, and proper usage.

Initial Blueprint

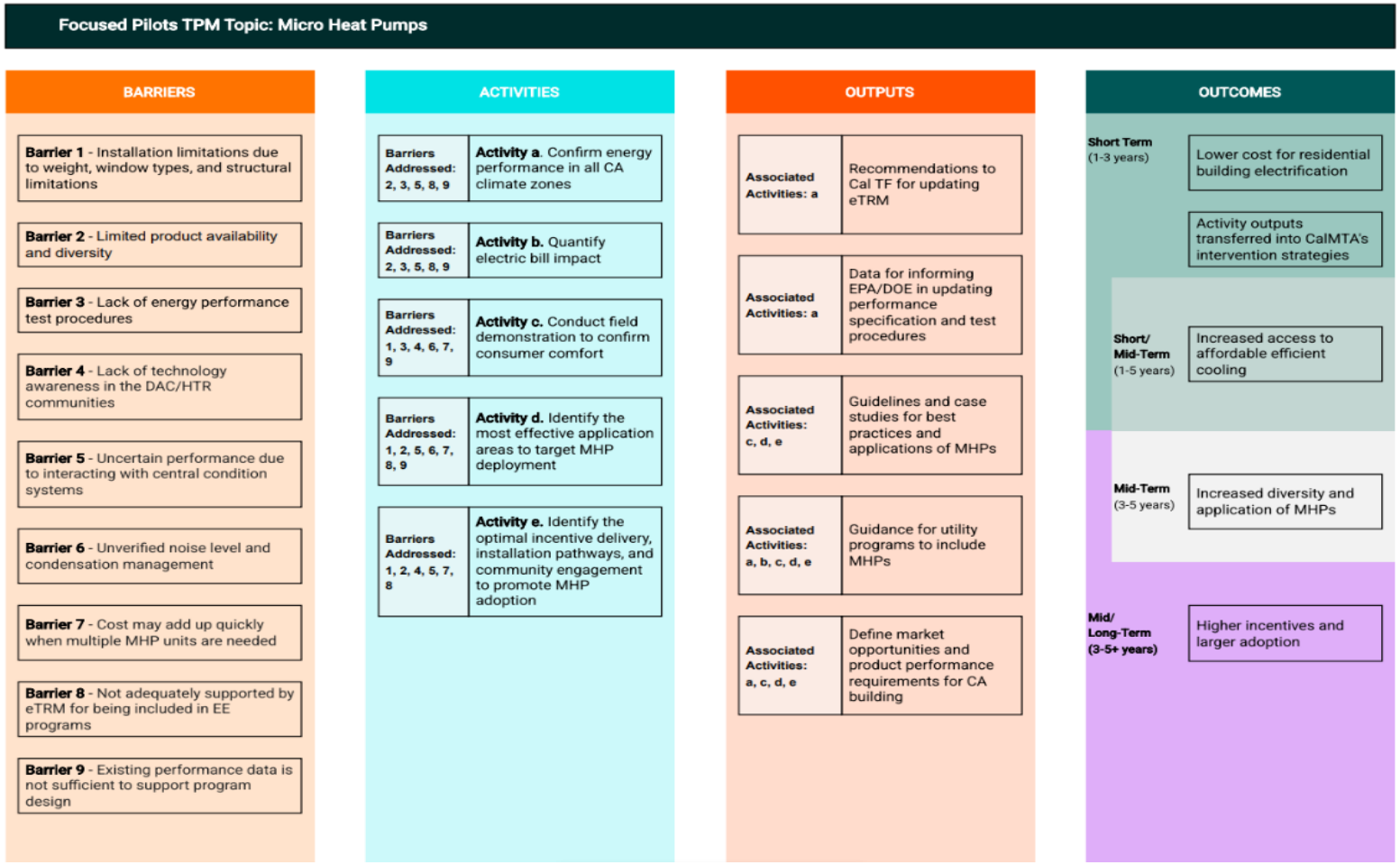

Figure 2: Micro Heat Pumps[2]

[2] Due to the complex relationship and association between the barriers, activities and outputs, the blueprint is presented in an alternative way that is slightly different from a typical logic model diagram to provide better readability. Instead of using arrows between the blocks like typical logic models, the linkages are labeled in front of each block.

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Focused Pilot Topic (3): Strategies for Residential Electrification with Minimal Electrical Upgrades by Controlling Primary Loads

Technology Family: Electrical Infrastructure [Whole Buildings TPM]

This technology family refers to single- and multi-structure sites that share a common utility connection and encompasses the electrical infrastructure needs and capabilities to enable energy-efficient and low- or carbon-neutral buildings, demand-flexible end uses, distributed energy resources, and grid harmonization.

Focused Pilot Topic Background

Cost-effective and scalable electrification is becoming increasingly critical in California with the adoption of Senate Bill (SB) 1221, which will pilot 30 neighborhood community-scale electrification projects. The bill requires gas IOUs to invest in zonal electrification pilots instead of expensive fossil fuel pipeline replacements. CalNEXT, with its 2024 pilot focused on electrification enablement with load balancing technologies, will gather information on California garages, load-balancing technologies, electric vehicle (EV) loads, and which loads could be shared with EVs. HVAC loads are the second-highest loads on the panel, after EVs, and currently require more attention.

This Focused Pilot topic explores residential HVAC load-balancing strategies with smart controls, control automation, and load-balancing capabilities. The pilot will primarily focus on space heating with optional additional assessment of water heating, laundry, or cooking load-balancing opportunities. This Focused Pilot will serve as a phase two pilot, with the addition of multifamily applications, to the current electrification enablement Focused Pilot project. This comprehensive approach to decarbonization is intended to showcase strategic methods to property owners with an intent to develop a whole-building cost-effective electrification program.

Barriers

Technology Barriers:

- **Minimal market feedback for technology and controls advancement** — Power-efficient design is a new concept, and while there are load-balancing technologies like smart panels and circuit breakers in the market, they have not been fully validated for building electrification. These technologies and their manufacturers need feedback from the market on end-use draw patterns, control automation requirements, end-use electrification technology, and their load-balancing potential, as well as customer and utility impacts. Load-balancing potential depends on customer openness to load-shifting strategies, such as precooling.
- **Undefined regulatory compliance requirements and lack of monetary means for funding adoption of these technologies —** Currently, there is no regulatory guidance for load-balancing technologies regarding what can be throttled or paused and at what percentage, which circuits can be shared, and which circuits need to be on dedicated outlets for retrofit applications. The electrical code is not fully up-to-date, potentially prohibiting the emerging load-balancing solutions. In the meantime, the authority having jurisdiction (AHJ) is not familiar with the correct code interpretation. In addition, there are no present incentives or energy efficiency policy guidelines for energy-efficient load management. In other words, there are no market incentives for encouraging load management schemes and market participation by customers.

While these types of market participation incentives may exist for demand response (DR), as in event-based market load shed, they do not apply for non-event 24/7 load shifts outside of DR events.

Market Actor Barriers:

- **Lack of customer and contractor awareness —** Load-balancing technologies and electrification are both emerging as methods to decarbonize buildings. However, there is little awareness or education in the market regarding economical and accessible ways to electrify with existing electrical infrastructure. Customers and contractors also lack awareness of existing panel capacities and load distribution across circuits. Overall, there is a general lack of awareness about economical approaches to electrification.
- **Lack of research and tools/guidance —** There are no standardized tools or guidance materials available in the market about different load balancing technologies, their capabilities, end-use technology competence, and installation guidance. Both customers and contractors also lack the tools needed to objectively assess their electrification options and make informed decisions.

IOU Program Design and Policy Barriers:

- **Lack of validated pilots to develop a program for the IOUs** — The technologies need a comprehensive pilot program that will shed light on products and their capabilities, opportunities and limitations with each, HVAC load-shifting capabilities and throttling needs, and more.
- **Lack of building energy codes and standards support –** Existing building energy codes and appliance standards may not fully support, motivate, or incentivize electrification upgrades.

Supply Chain Barriers:

- **Risk-averse and business-as-usual mindset by contractors** — The supply chain typically adheres to business-as-usual practices and is reluctant to adapt to new approaches and technological advancements. For example, with business-as-usual, contractors would default to panel upsizing without performing load analysis or considering load-sharing devices or strategies.

Activities

- **Conduct technology and market assessment** — This will include review of the single-family and multifamily housing stock review in California to understand the current installations of load-balancing technologies and the barriers they address. We will leverage research groups who may have useful data or tools, e.g., the UCLA group mentioned above, Lawrence Berkeley National Laboratory's (LBNL's) work or Build It Green's CEC project research. The appliance coverage for the current building stock, and customer considerations around load balancing that would affect the HVAC load balancing decisions, will also be assessed. We will also analyze Title 24 and the California Electrical Code to identify HVAC electrical requirements. We will consider an additional assessment of other critical loads, e.g., water heating, cooking, and laundry, based on alignment with the primary HVAC load-balancing strategies.

- **Demonstrate successful installations —** This activity aims to develop staged demonstrations for single-family and multifamily homes, from feasibility planning to completed load-control upgrades, with supporting metering and evaluation. Lessons learned from the demonstration projects can be used to develop a roadmap for pilot partners and serve as a model for others to create actionable electrifications plan for low-load single-family and multifamily buildings.
- **Increase awareness through electrification roadmaps and guides —** This activity aims to support knowledge transfer and technology market commercialization efforts. It will include case studies, interviews with the project team, data gathering, and best practices gathering that can be leveraged by policymakers and programs in California. Tools and guidance will be based on the empirical results of the Focused Pilot to help controls and home automation manufacturers develop algorithms for effective load balancing.
- **Develop the workforce** — This activity will help inform new single-family and multifamily training programs through utility energy training centers that educate developers. The training may include how to properly perform load analysis using advanced metering infrastructure (AMI) data and Green Button data, as well as how to best apply load- sharing and load-balancing devices and strategies.
- **Assess and update energy codes and electrical standards** — This activity will update the current CA energy codes and electrical code for single-family retrofit buildings. The updates may include electrical infrastructure readiness requirements, upcoming low-power technologies, and controls integration for load balancing.

Initial Blueprint

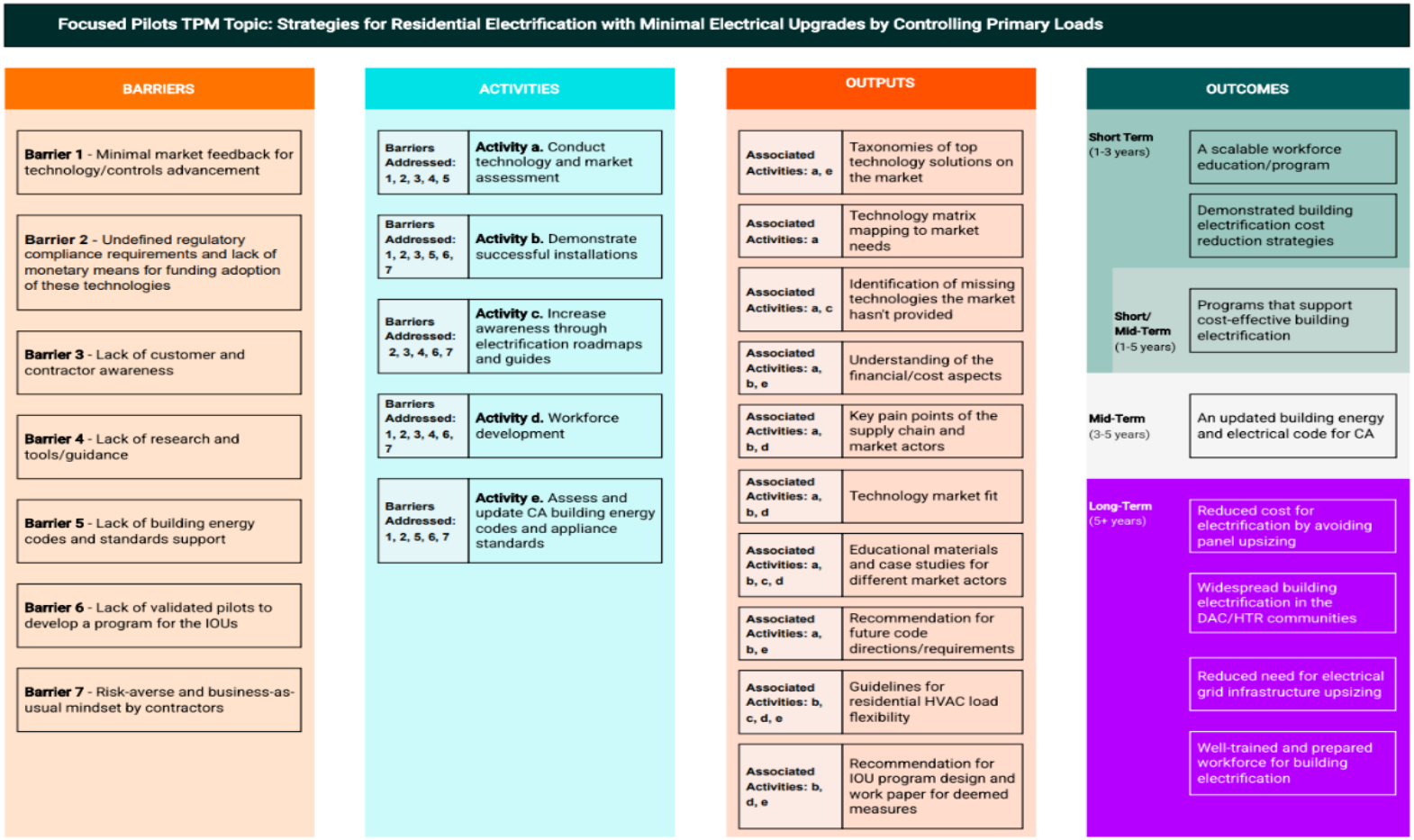

Figure 3: Strategies for Residential Electrification with Minimal Electrical Upgrades by Controlling Primary Loads[3]

[3] Due to the complex relationship and association between the barriers, activities and outputs, the blueprint is presented in an alternative way that is slightly different from a typical logic model diagram to provide better readability. Instead of using arrows between the blocks like typical logic models, the linkages are labeled in front of each block.

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Focused Pilot Topic (4): Decarbonizing Household Appliances: Opportunities and Limitations with 120V Appliances

Technology Family:

This Focused Pilot topic involves technologies from the following three technology families:

Unitary Electric Water Heaters and Single-Family Systems [Water Heating TPM]
Energy-efficient, load-shifting capable, electric heat pump water heaters (HPWHs) are designed to meet the hot water demands of residential households or small businesses. HPWHs pull heat from the surrounding environment and transfer it into the water inside the tank. HPWHs typically run off electricity and deliver hot water two to five times more efficiently than electric resistance, standard gas water heaters, or other fossil fuel-fired water heaters. Larger unitary systems such as 12 kW integrated HPWHs for commercial applications are included.

Decarbonizing Household Appliances [Lighting, Plug Loads, and Appliances TPM]
This technology family focuses on the replacement of gas appliances used in housekeeping tasks, i.e., white goods, such as cooking and clothes drying, with high-efficiency electric ones. Products include cooking ranges, cooktops, ovens, clothes dryers, and combination washer-dryers.

Micro Heat Pumps [HVAC TPM]
Micro heat pumps (MHPs) are efficient, rapidly deployable heat pumps that require minimal professional installation. They are suitable for compact spaces where heat pumps can replace or displace existing room air conditioners and space heating, or where traditional split or central systems are too costly or difficult to install. Packaged micro heat pumps connect to standard 110V/120V NEMA 5-15 outlets without field-installed refrigerant lines. They are available in several form factors such as saddle, window, portable, and through-the-wall. The window and portable units are generally DIY, while through-the-wall units require additional wall penetration. Typical uses include single-family and multifamily housing, ADUs, mobile homes, hospitality, assisted living facilities, garages, and schools. The condensate in these units is managed through simple drain lines, drip-free melt water atomization, or water dispersion into the internal air or outside air. They offer the potential for improved thermal comfort and air-filtration capabilities.

Focused Pilot Topic Background

California has set an ambitious goal to install six million heat pumps by 2030. Still, the diversity of building applications and ownership, complexity of installations, and affordability of clean heating and cooling solutions pose obstacles to its achievement.

This Focused Pilot aims to validate and demonstrate successful installations of low-power, plug-in, shared circuit 120V appliances, i.e., HPWHs, packaged heat pumps for space conditioning, and combination washer and heat pump dryers in power-constrained households. This plug-in, 120V appliance replacement pilot will demonstrate an alternative, lower cost, and simplified electrification pathway for households with limited electrical capacity due to panel or service constraints. The Focused Pilot can confirm interoperability between the 120V appliances and home management systems and strategize ways to address any issues to ensure they do not become a barrier to adoption. Ideally, the plug-in 120V heat pump appliance replacement could be accomplished through a single, non-specialized trade with minimum electrical and plumbing installation needs.

Induction stoves are a critical replacement option to achieve full household electrification. However, limited commercialized plug-in 120V induction models, the lack of verified performance, and high costs may present barriers to inclusion in the Focused Pilot.

Barriers

New plug-in 120V HPWHs, packaged window heat pumps, and combination washer and heat pump dryers are designed to address barriers to electrification, primarily the significant additional cost and complexity associated with household electrical panel, wiring, and service upsizing. However, additional barriers must be overcome to achieve the potential of plug-in 120V appliances.

Technology Barriers:

- **Installation limitations due to size, noise, and vibration in indoor living areas** — Limited model diversity and typically larger sizes create barriers for plug-in 120V appliance installations in some households. Additionally, the proximity of the heat pump to indoor living areas can require moving the appliance and service components to another location inside or outside the home. For example, plug-in 120V window heat pumps are currently limited to single- and double-hung window types, while there is an opportunity for the manufacturers to extend these products to other window types. However, to support greater product diversity, manufacturers will want identified and sustainable product market opportunities.
- **Installation complexity requires multiple contractors for 120V appliance upgrades —** Although plug-in 120V appliances have removed barriers and costs associated with 240V electrical upgrades, the larger size and complexity of some of the heat pump installations can require multiple contractors to complete. Simple and plug-and-play designs can allow a single contractor or skilled homeowner to complete the installation in a single day. Soft Costs are an associated issue, including non-technology costs, such as permitting, labor, and marketing, which can add significantly to the overall expenses.
- **Lack of energy performance test procedures** — As plug-in 120V appliances are still new to the market, representative and standardized specifications and test procedures are needed to ensure high efficiency and performance of the heat pump technology, including designs for cold climates.

Market Actor Barriers:

- **Lack of technology awareness among DACs and HTR communities** — To enhance DAC and HTR alignment, partnerships with community-based organizations or affordable housing associations are needed to raise awareness of the technology's suitability and support outreach efforts during implementation.
- **Incentives provided may not result in sustained savings in tenanted units** — There is a concern about the incentives on heat pump appliances in tenanted units and potential cost shifts or new unplanned costs for operating or maintaining the equipment.
- **Unknown customer satisfaction with 120V heat pump performance** — The lower power consumptions of 120V heat pumps offer cost and energy savings, but potentially reduced recovery or heating and cooling performance in certain situations. It is critical that products are

tested in different climates and applications to support strong homeowner satisfaction and verify cost and energy savings on utility bills.

Supply Chain Barriers:

- **120V heat pump appliance upfront costs are high and have limited availability in the market** — Although plug-in 120V appliances offer a less expensive alternative to 240V models due to the electrical requirements, limited product availability and awareness present barriers to greater adoption. Also, the currently high upfront costs of 120V models remain a barrier to greater adoption as an electrification solution.

IOU Program Design Barriers:

- **Revised eTRMs are needed to address changes in 120V product options and performance** — While eTRMs currently include 120V products, e.g., induction stoves, HPWHs, and heat pump clothes dryers, rapid changes in 120V appliance electrification solutions require updates to utility programs and measure characterizations to support market development.
- **Existing performance data is insufficient to support program design** — Verification of usage and savings will be required to accurately represent performance and impact.

Activities

- **Perform technology and market assessment —** This includes single-family and multifamily stock assessment for California to develop an estimate and needs assessment for low-load, plug-in 120V appliances. This also includes creating a technology matrix of all the plug-in 120V appliances and their specifications, code requirements, and electrical requirements.
- **Demonstrate successful installations** — This activity includes pilot demonstrations to validate and identify the right market sector for a range of 120V appliances. Demonstrations in DACs and HTR communities will also help address the awareness barrier and concerns about utility bill impacts. In addition to assessing the right opportunities and limitations of the technologies, this activity will also assess how this multi-trade approach could be streamlined by a single contractor. The goal is not only to validate the applications of the technologies, but also to streamline the installation process to a single trade.
- **Document applicability, opportunities, and limitations of plug-in 120V appliances in panel constraint applications** — This effort will use the demonstrations to document lessons learned, opportunities, and limitations of the technologies and to assess a streamlined approach to installations.
- **Model avoided costs and energy savings of 120V appliances upgrade compared to different baseline scenarios** — Avoided costs due to electrical and panel upsizing and energy savings will be documented. The streamlined installations are expected to showcase additional cost and time savings.
- **Develop electrification road mapping guides and tools for low-cost, low-load retrofits —** This activity aims to help with knowledge transfer and technology market commercialization efforts.

This will include case studies, interviews with the project team, data gathering, and best practices gathering that can be leveraged by policymakers and programs in California.

Initial Blueprint

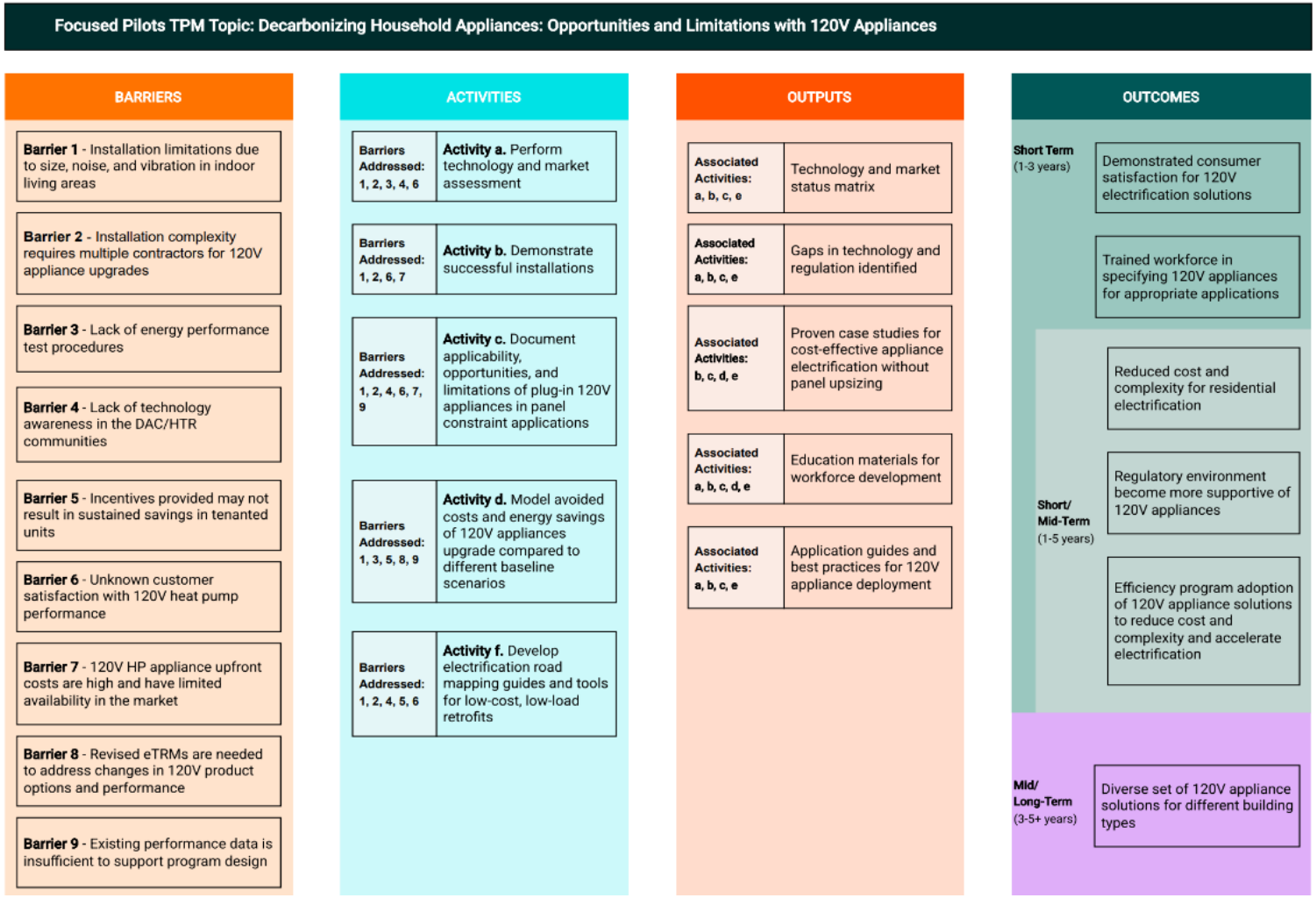

Figure 4: Decarbonizing Household Appliances: Opportunities and Limitations with 120V Appliances[4]

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Focused Pilot Topic (5): Central Heat Pump Water Heater Retrofit Readiness Through Hot Water Distribution System Optimization

Technology Family: Commercial Domestic Hot Water System Design [Water Heating TPM]

Domestic water heating is among the largest end-uses poised for decarbonization. With all-electric HPWH options, HPWHs have a higher efficiency than electric resistance alternatives and can achieve dramatic energy and greenhouse gas (GHG) savings compared with natural gas alternatives. This technology family covers efficient, demand-flexible, non-unitary DHW systems for non-residential applications, such as offices, hotels, healthcare, and foodservice, as well as multifamily applications. Hot water system components in this group may include primary heat generation (e.g., heat pump), primary storage, distribution system, pumps, valves, controls, temperature maintenance systems, heat recovery systems, and alternative heat sources, such as solar or geothermal.

Focused Pilot Topic Background

Many incentive programs in California are targeting the decarbonization of water heating end uses with central heat pump water heaters (CHPWHs). While this is a much-needed effort, and multiple manufacturers are in the market, this technology can have disappointing results if the hot water distribution system hasn't been optimized. This Focused Pilot topic focuses on developing a streamlined and standardized distribution system optimization approach for contractors and installers to ensure the successful design, installation, and operation of CHPWHs in targeted end uses with moderate- to high-temperature maintenance system energy use profiles. Many CHPWH systems in multifamily and nonresidential buildings have oversized plumbing, poor pipe insulation and controls, and poor maintenance, resulting in higher heating loads, elevated thermostat setpoints, higher recirculation flow rates, hot water delivery performance issues, and lower heater and system operating efficiency. Many of these facilities are in DACs and HTR communities, and they are most motivated for an energy efficiency retrofit when their existing heater is close to its end of life to reduce capital replacement costs. During this period, there is a high likelihood that the distribution system and mechanical room are in poor shape, with issues such as crossflow and system accessibility hindering participation in CHPWH incentive programs. These issues also impede high-performance retrofits and the ability to achieve operating cost offsets.

Optimizing the distribution system will achieve energy savings as well as GHG and TSB impacts, while improving cost-effectiveness and feasibility for decarbonizing medium to large hot water systems. This can be accomplished by reducing the hot water load associated with pipe heat losses and the tank water temperature stratification. The added benefit is that these sites become ideal candidates for CHPWH incentive programs for immediate proactive replacement, ensuring heat pumps and storage tanks can be right-sized, associated benefits are clearly understood, and cost overruns are minimized. Alternatively, if the site is not ready for a retrofit, this optimization project would render it retrofit-ready and prequalified for CHPWH replacement when the existing system reaches its end of life.

Optimization options include assessing and resolving crossflow, monitoring the system to quantify peak hot water use and pipe heat losses, and identifying retrofit options for the system. Underutilized and under-supported distribution system optimization measures include:

- Automatic balancing valves
- Digital master mixing valves
- Variable-speed recirculation electronically commutated motor (ECM) pump with pressure-based control with select high-performance thermal balancing valves for riser distribution systems
- ECM pump with constant return temperature control for non-riser distribution systems
- Demand pump control where appropriate
- Distributed isolating valves
- Continuous pipe insulation per 2025 Title 24 multifamily requirements where viable
- Crossover and check-valve remediation
- Continuous monitoring of the distribution system and operation of heat pumps
- Heater and master mixing valve (MMV) setpoint optimization

This Focused Pilot topic addresses hot water distribution, one of the most complex and fundamental components of the hot water system, accounting for approximately 33 percent of the hot water load. Hot water distribution greatly impacts hot water delivery performance and the efficiency of the water heater, especially in configurations with CHPWHs.

Barriers

Technology Barriers:

- **Lack of familiarity with optimization measures** — While some recently completed and ongoing studies have explored the benefits of specific optimization measures or combination of a few, this research is limited. Additionally, knowledge transfer with primary stakeholders, including contractors, incentive program developers, and implementers, is infrequent. This pilot will help boost understanding through demonstration and take a proactive approach to reduce barriers to CHPWH technology adoption.
- **Limited knowledge of high-performance, cost-effective valves and pumps** — This lack of knowledge leads to a trial-and-error approach with inferior valves and pumps, resulting in poor outcomes. There is a lack of understanding regarding operational barriers and the necessary monitoring and controls required for a successful installation. Unfamiliarity within the contractor community leads to minimal uptake of high-performance mixing, balancing, and check valves, as well as ECM pumps with DHW circulation controls. Contractors may dismiss high-cost pumps that are more efficient and reliable due to the lack of understanding that the benefits outweigh the incremental cost.
- **Lack of adequate valve performance test standards** — Many plumbing-focused test standards do poorly in differentiating real-world valve performance in CHPWH applications with dynamic water draw conditions and high recirculation return temperatures. The most commonly

adhered-to standards are a catch-all for almost all manufacturers' equipment and do not guide contractors or designers in a meaningful way to select appropriate valves for this application.

Market Actor Barriers:

- **Lack of aggregated guidance on central hot water distribution system optimization —** Gathering optimization approaches into accessible guidance materials can encourage a comprehensive systems approach focused on distribution system optimization.

IOU Program Design Barriers:

- **Lack of retrofit-readiness programs** — A distribution system optimization program is a prerequisite for a successful CHPWH retrofit incentive program; otherwise, there will be a higher likelihood of poorly performing existing buildings, higher bills, and upset customers. Some measures are available in existing eTRM measure packages, and others could be developed as new or updated measures. This Focused Pilot topic can quantify combined savings from numerous optimization measures implemented at each site to develop semi-custom incentive programs or combination deemed rebates.

Supply Chain Barriers:

- **Risk-averse and business-as-usual mindset by contractors** — The supply chain typically adheres to business-as-usual practices and is reluctant to adapt to new approaches and technological advancements.
- **Lack of training within contractor community** — Contractors may be aware of some optimization practices and high-performance valves and pumps but are likely not familiar with a comprehensive systems approach focused on distribution system optimization.

Activities

- **Develop a repository of guidance materials on hot water distribution system optimization approaches —** This activity will consolidate best practices and include data collection and analysis techniques.
- **Develop a guidance tool to streamline and standardize hot water distribution system optimization —** The target audience will include engineers designing and specifying central HPWH systems, as well as those designing new or retrofitted distribution systems. This tool will ensure upcoming building plans provide all the necessary procurement, installation, and startup guidance for builders and contractors. For contractors in the field, a downloadable guidance tool application for tablets, supplemented by public documents that include infographics with if/then flow chart style guidance, would be effective. A training webinar with case studies could also be developed, ideally designed for plumbers and engineers to receive continuing education credits.
- **Validate, refine, and demonstrate the tool to streamline and standardize sites for CHPWH retrofit readiness** — Pilot demonstrations will use early versions of the guidance tool, which have been refined based on feedback from the DHW system design and research community to shape the distribution retrofit project. Lessons learned from the optimization studies will help refine the tool further.

- **Document successful optimizations** — The project team will install monitoring equipment to gather pre- and post-optimization data to quantify savings from each individual optimization and combined optimization, as well as overall benefits to the DHW system performance. Case studies and project reports will document energy savings, hot water delivery performance, lessons learned, limitations of various practices and technologies, and a streamlined approach RCx installations. This activity will prepare sites for a streamlined retrofit CHPWH design, installation, and start-up process. It will also help right-size heat pump retrofit solutions with or without DR, reduce risk, and optimize the planning process with a focus on improving overall performance, reliability, while achieving electrification cost offsets as we decarbonize existing buildings. To quantify the right-sizing benefits, data on the existing DHW system and building information will be provided to three experienced design firms, which will size for the replacement heat pump system. This sizing information will be compared to the right-sizing approach based on monitored data pre- and post-retrofit.

- **Design a workforce training and awareness building campaign program** — This activity will set the stage for comprehensive training programs that certify installers and expand the toolbox of standard solutions for contractors and incentive program designers and implementers.

- **Model avoided costs and energy savings using EnergyPlus compared to baseline** — This proactive approach reduces the hot water load of existing conventional systems, downsizes and right-sizes them, further reducing the design and installation costs of a future CHPWH system. Additional avoided costs may include electrical and panel upgrades, infrastructure upgrades, and troubleshooting costs during start-up. Overall system energy savings will be documented with a conventional heater, with projected additional savings from a future HPWH retrofit. The intent of this task is to feed the cost and energy savings estimates into eTRM development and program design using an EnergyPlus model.

- **Clarify energy savings potential for missing components in existing eTRM packages** — The eTRM has five measures related to centralized hot water distribution systems, however, some have very narrow eligibility requirements. The pipe insulation measure requires existing systems with bare pipes, thereby disqualifying many sites that have minimal or inadequate insulation. Moreover, the requirements for insulating pipes are unclear for contractors and don't lead to consistent and continuous pipe insulation installations. The eTRM also lacks measures for several modern control options, including proportional pressure control and constant return temperature control. Other missing components in the portfolio of eTRMs include master mixing valves, continuous recirculation pump controllers, pipe insulation of DHW system heating plants, continuous pipe insulation, thermal balancing valves, mitigating check valve and crossflow issues, and combined savings estimates from multiple measures.

Initial Blueprint

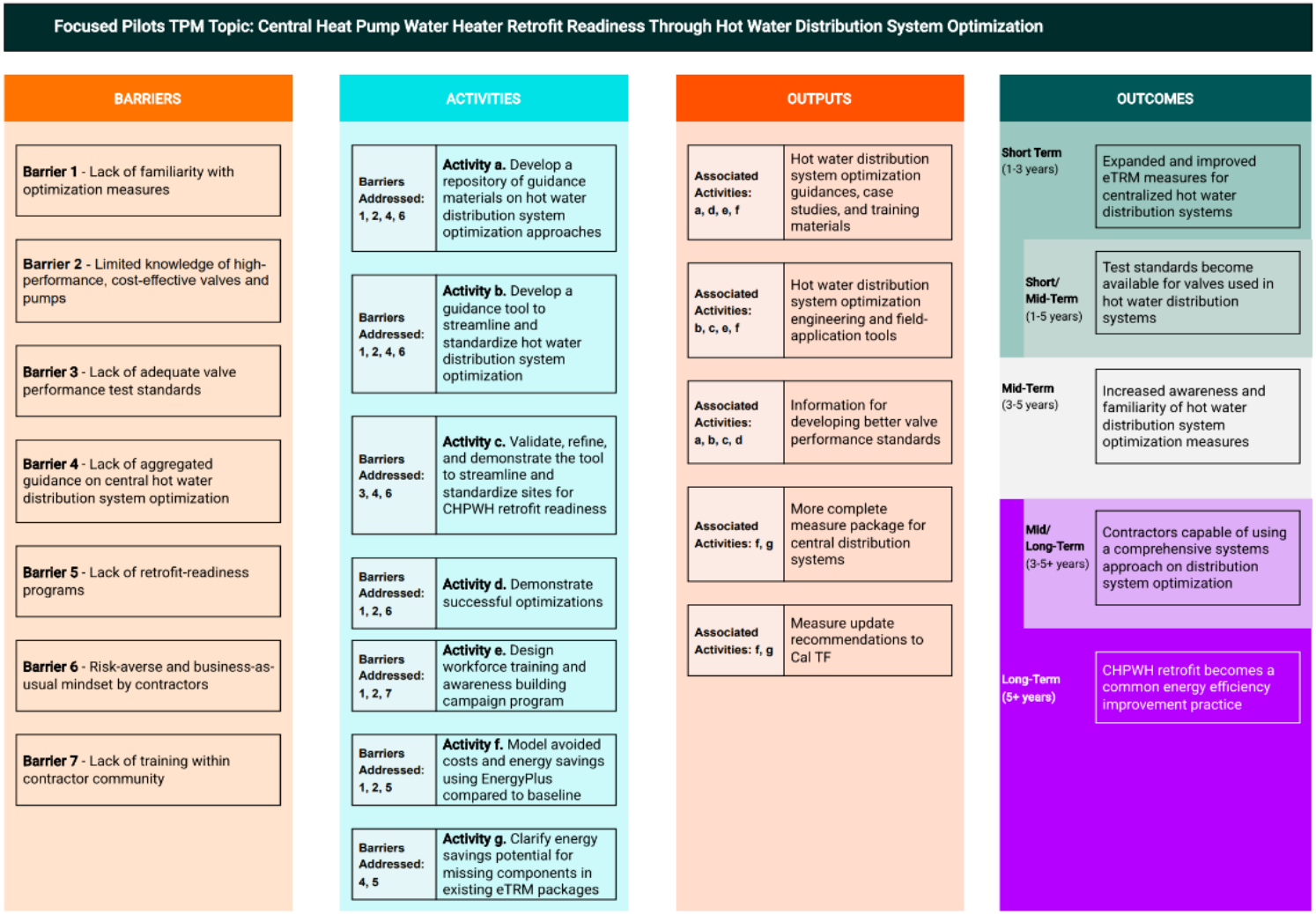

Figure 5: Central Heat Pump Water Heater Retrofit Readiness Through Hot Water Distribution System Optimization[5]

[5] Due to the complex relationship and association between the barriers, activities and outputs, the blueprint is presented in an alternative way that is slightly different from a typical logic model diagram to provide better readability. Instead of using arrows between the blocks like typical logic models, the linkages are labeled in front of each block.

Reference Materials

- Garcia, J., Delagah, A., Stevens, M., Hacking, D. "Field Study of Master Mixing Valve Energy Efficiency Potential." CalNEXT, September 15, 2024. https://calnext.com/wp-content/uploads/2024/11/ET22SWE0047_Field-Study-of-Master-Mixing-Valve-Energy-Efficiency-Potential_Final-Report.pdf

- TRC Companies., Frontier Energy Inc. "Technical Design Guide for Advanced Water Heating within the Foodservice Industry." CalNEXT, 2023. https://calnext.com/wp-content/uploads/2024/10/Technical-Design-Guide.pdf

- Feng, D., Delagah, A., Garcia, J., Haile, J. "Multifamily Domestic Hot Water Codes and Standards Enhancement Initiative." California Energy Codes & Standards. August 2023. https://title24stakeholders.com/wp-content/uploads/2023/08/2025_T24_CASE-Report-_MF-DHW-Final-1.pdf

Appendix A: Advisory Committee Feedback & Resolution Matrix

Table 2: Advisory Committee Feedback and Resolution Matrix

Focused Pilot TPM Topic Idea	Section	Suggestion or Comment	Action Taken and Justification
Topic (1) Increasing Standardized HVAC Control Implementation and Streamlining Retro-commissioning Processes for Energy Savings	Topic	What type of customer sector will this Focused Pilot Topic target? Commercial, Residential, Industrial, etc.	Updated the topic title to more prominently highlight that the target of this focused pilot topic is the commercial building sector.
Topic (1) Increasing Standardized HVAC Control Implementation and Streamlining Retro-commissioning Processes for Energy Savings	Focused Pilot Topic Background	Helpful to note or acknowledge other recent or ongoing streamlining efforts. For instance, in 2023, Cal TF affirmed a custom measure guidance for HVAC RCx measures and referenced ASHRAE Guideline 36. See original presentation here: https://www.caltf.org/s/Cal-TF-Meeting_2023-10-26_PPT.pdf (Slide 77-86) and current guidance/tool: 1_Measure Guidance. The intent is to streamline common HVAC RCx measures being claimed through the custom incentive process by having this statewide guidance on calculation methods/tools, M&V requirements, etc. Cal TF also has ongoing initiative with the CPUC and other TF stakeholders aimed at streamlining custom project more broadly. See here for more info.	The provided information was incorporated into the section.
Topic (1) Increasing Standardized HVAC Control Implementation and Streamlining Retro-commissioning Processes for Energy Savings	Focused Pilot Topic Background	Has this tool (referring to the savings estimation tool) already been developed or will tool development be part of the FP?	There are several existing tools named in the later sections, Barriers and Activities. We added the word “existing” to signify that the tools already exist.

Focused Pilot TPM Topic Idea	Section	Suggestion or Comment	Action Taken and Justification
Topic (1) Increasing Standardized HVAC Control Implementation and Streamlining Retro-commissioning Processes for Energy Savings	Barriers	Could the following barriers also play a crucial role? 1) Hidden costs: Customers incur unexpected costs after adopting an energy efficiency (EE) measure. Unexpected frequent service requirements for a new Heating Ventilation & Air Conditioning (HVAC) control system. 2) Asymmetric information and opportunism: Customers have concerns about reliability and applicability of vendor claims but lack the expertise to resolve these concerns. Building managers are suspicious of vendor claims about an EE HVAC system but are unable to understand the underlying operating principles. 3) Limited capabilities of existing BAS hardware: Most existing buildings have sub-optimal HVAC controls, resulting in wasted energy and occupant discomfort. Retro-commissioning (RCx) addresses many of these issues, but it is a lengthy and highly customized process. Limited capabilities of existing BAS hardware restrict the scope of most RCx projects6. 4) High-capital investments for BAS hardware retrofits: Incentive programs consider BAS hardware retrofits to be high-capital investments and do not allow them in typical RCx programs	1) The SME team identified the primary barrier of how difficult it can be to develop a scope of work to improve and add controls because of the variability in the type and condition of the existing systems. However, we have not found evidence to support the perception that additional and hidden/ unknown operational costs required after the control sequence has been installed, optimized, and commissioned pose a significant barrier to adoption. 2) This has been added, with edits, as a new barrier under the “market actor barriers” category. 3) This aspect is captured in the “deferred maintenance, controller, and device upgrades” barrier as one of the technology barriers. 4) This is captured in the “lack of information on the cost-effectiveness of control system retrofit projects and lack of an implementation pathway for customers to reference’ barrier as one of the technology barriers. The description has been revised to more prominently reflect this aspect. The description for the “develop control retrofit and implementation guide” activity has also been revised accordingly to address the barrier.

Focused Pilot TPM Topic Idea	Section	Suggestion or Comment	Action Taken and Justification
Topic (1) Increasing Standardized HVAC Control Implementation and Streamlining Retro-commissioning Processes for Energy Savings	Barriers	[*Referring to the "Implementation challenges associated with existing building conditions and saving potentials" barrier*] Other aspect of this technical barrier is addressing what to do with those buildings that have systems or equipment which are *not* yet addressed by Guideline 36. Is there significant savings potential that may be lost in those buildings? If so, what kind of guidance can be developed to streamline RCx for them?	It is not that Guideline 36 does not support other system or equipment types. If a building has the control system or infrastructure needed to implement the control, Guideline 36 also covers those systems or equipment. So, the lack of a control system or infrastructure by itself is a barrier. We added a barrier, "Lack of information on cost-effectiveness of control system retrofit pathway for implementation," to more specifically highlight the challenges mentioned in this comment.
Topic (1) Increasing Standardized HVAC Control Implementation and Streamlining Retro-commissioning Processes for Energy Savings	Barriers	[Referring to the "Existing cumbersome incentive path for performance verification results in low market uptake" barrier] Suggest having a meeting with the IOU stakeholders from the Custom Team to see if long approval times have been mitigated through a streamlined process improvement.	The SME team met with the utility custom program team, and the barrier description was revised based on the insights gained from the discussion.
Topic (1) Increasing Standardized HVAC Control Implementation and Streamlining Retro-commissioning Processes for Energy Savings	Barriers	[*Referring to the "Existing cumbersome incentive path for performance verification results in low market uptake" barrier*] "RCx incentive process"?	We corrected the description to read "RCx incentive process" instead of "RCx incentive workflow."

Focused Pilot TPM Topic Idea	Section	Suggestion or Comment	Action Taken and Justification
Topic (1) Increasing Standardized HVAC Control Implementation and Streamlining Retro-commissioning Processes for Energy Savings	Barriers	[*Referring to the "Existing cumbersome incentive path for performance verification results in low market uptake" barrier*] See note above (referring to the comment on the Focused Pilot Topic Background section) regarding Cal TF efforts on streamlining both for the custom incentive process overall and for HVAC RCx specifically.	We modified the narrative to highlight that activities meant to address this barrier should include reviewing the current related efforts. We also added a related activity, "develop control retrofit and implementation guide," to include review and refinement of the existing efforts as part of the exercise.
Topic (1) Increasing Standardized HVAC Control Implementation and Streamlining Retro-commissioning Processes for Energy Savings	Activities	Could the following activities help with the acceleration of this Focused Pilot Topic? 1) Modernized BAS hardware and software: Facilitating technical and market innovation in the BAS industry to unlock large savings in existing commercial buildings through deep retrofits of BAS hardware and software. This includes leveraging ASHRAE's new Guideline 36 high-performance sequences of operation to achieve greater than 20 percent whole building energy savings. 2) Systematic process for RCx: Applying a rigorous testing, verification, and upgrade protocol to an existing building control system to identify and correct operational inefficiencies. This includes remedial design and construction to optimize HVAC systems, control systems, and electrical systems.	1) It's not clear at this point if additional hardware and software would increase the adoption of optimizing sequences that are already available. Some OEM equipment is available with the option of Guideline 36 sequences; still, the sequence typically needs to be optimized per building and system. As the market for this opportunity evolves, the demand for cost-effective hardware and software to serve small to medium-sized commercial facilities will increase; however, this activity seems premature for the 2025 Focused Pilot project. 2. This is partly captured in the 'demonstrate the implementation process' activity. The description has been revised to incorporate this recommendation more explicitly.

Focused Pilot TPM Topic Idea	Section	Suggestion or Comment	Action Taken and Justification
Topic (1) Increasing Standardized HVAC Control Implementation and Streamlining Retro-commissioning Processes for Energy Savings	Activities	How does the ET23SWE0060 - PG&E HVAC Tool Validation project that was recently completed contribute to this activity or address the barrier?	This report was already in the reference list. The description for the "validate energy savings estimation tools" has been revised to more explicitly highlight the relationship between the recent projects and the Focused Pilot topic.
Topic (1) Increasing Standardized HVAC Control Implementation and Streamlining Retro-commissioning Processes for Energy Savings	Activities	[*Referring to the "Demonstrate implementation process" activity*] Will this implementation only include traditional RCx activities or also include installation of new/upgraded energy management & information systems (EMIS)? EMIS, by definition, are designed to streamline and automate monitoring-based commissioning. If yes, LBNL's Smart Energy Analytics campaign put a lot of effort into characterizing EMIS costs and benefits. Their results may be useful benchmarks for any FPs related to RCx. See their final report here.	We did not revise the TPM narratives based on this comment. The team has noted the resource provided by the commenter and will pass it on to the Focused Pilot project team if this topic idea is selected to move forward as one of the 2025 Focused Pilot projects.
Topic (1) Increasing Standardized HVAC Control Implementation and Streamlining Retro-commissioning Processes for Energy Savings	Activities	[*Referring to the "Validate savings estimation tools" activity*] Cal TF would be most interested in documenting the capabilities of all the validated tools after this activity and socializing these tools with Tools Library: CUSTOM TOOLS — Cal TF	We did not revise the TPM narratives based on this comment. The team has noted that Cal TF would be one of the outlets of this activity's outputs. This note will be passed on to the Focused Pilot project team if this topic idea is selected to move forward as one of the 2025 Focused Pilot projects.

Focused Pilot TPM Topic Idea	Section	Suggestion or Comment	Action Taken and Justification
Topic (2) Micro Heat Pumps	General	This potential TFP is very similar to the CalMTA Room Heat Pumps MTI. A section noting the collaboration that will take place between this TFP and the CalMTA MTI should this move forward would be helpful and also a note on how this effort will differ or be complementary to that effort. An explanation on how this shorter term TFP will feed into the long-term MT effort would also be helpful.	We added a description to the "Focused Pilot Topic Background" section to signify the alignment with CalMTA's market transformation initiative. The SME team has also confirmed with CalMTA which Focused Pilot activity output will feed into which CalMTA initiation intervention strategy. These insights will be passed onto the project team if this topic is selected to move forward as a Focused Pilot project.
Topic (2) Micro Heat Pumps	General	It's helpful to note that these units are known with various names, including portable heat pumps, through-the-wall heat pumps, room heat pumps, window heat pumps, reverse cycle room air conditioner etc.	We added the other common names for micro heat pumps in the Focused Pilot Topic Background section.
Topic (2) Micro Heat Pumps	Focused Pilot Topic Background	Talks of this technology being a "game changer" for "older single-family and multi-family buildings." But it's unclear as to why the building age has anything to do with the potential. The potential benefits are more about what the MHP is replacing/offsetting. The most obvious tenant cost benefits will be replacing the heating of floorboard or in-wall resistance heaters. It's not clear if/why benefits are directly related to building "age."	We removed the sentence calling out older buildings specifically, as a later sentence identifies the specific heating and cooling technologies targeted, as well as why micro heat pumps are important alternatives.

Focused Pilot TPM Topic Idea	Section	Suggestion or Comment	Action Taken and Justification
Topic (2) Micro Heat Pumps	Barriers	Could the following barriers also impact this Focused Pilot Topic? Environmental Impact: 1) Refrigerant Management: Ensuring the use of low-global warming potential (GWP) refrigerants and proper disposal of old refrigerants to minimize environmental impact. Infrastructure Limitations: 2) Electrical Capacity: Older buildings may not have the electrical capacity to support multiple MHP units, requiring upgrades to the electrical system. 3) Building Design: Some buildings may have structural limitations that make it difficult to install MHPs, such as lack of suitable window types or wall space. 4) Market Competition: Competition from other heating and cooling technologies can impact the adoption rate of MHPs.	Some of the suggestions appear to be the challenges that may arise after mass adoption of MHPs, which is not the focus of this Focused Pilot TPM topic. 1) The SME team does not think low GWP refrigerant disposal would have any significance on MHP adoption because R32 has a low GWP but not ultra low-GWP; however, the refrigerant amount in these systems is so small that it shouldn't be a major concern. 2) and 4) While the electrical capacity may be a concern for larger systems, given the low wattage these MHPs are rated at, the uptake of these systems would be significantly higher than that of competing systems without overloading the existing electrical system and without requiring any upgrades. 3) This barrier is part of the "installation limitations due to weight, window types, and structural limitations. The heading for the barrier was updated to better reflect this.
Topic (2) Micro Heat Pumps	Barriers	Not sure if you want to classify as a technology barrier or supply chain barrier, but limited availability of cold-climate versions of MHPs would be a barrier for some of the colder climates and cities in CA (e.g., Tahoe).	This was already addressed in the "product availability and diversity" barrier, which mentioned that cold climate window heat pumps are being developed in response to a New York City Housing Authority request for proposal (RFP). We revised the original description to make a clear linkage to California climate zones and cities.

Focused Pilot TPM Topic Idea	Section	Suggestion or Comment	Action Taken and Justification
Topic (2) Micro Heat Pumps	Barriers	[*Referring to the "Installation limitations due to weight and window types" barrier*] I would separate these two into two sperate barriers as they are both important. In the CalMTA's opinion, configurations of room heat pumps that fit in more window types is critical for this product to be of broad use in CA. And this is specific to a RHP that can fit into slider windows which dominate Ca MF.	We made no change based on this comment. We agree that both weight and window application type present barriers to micro heat pump installation. However, they both relate to the same primary barrier — installation limitations — and are appropriately highlighted.
Topic (2) Micro Heat Pumps	Barriers	[*Referring to the "Product availability and diversity" barrier*] I think the state of CA is working on phasing out R-410A starting in 2025? Is there a timeline on when models with compliant refrigerant could be available? If I google saddle heat pumps, I see some with R32 and heating on the market. Soleus Air WS5-10HW-301 10,000 BTU Saddle 115V Wi-Fi Window Air Condit – FactoryPure Gradient | Window Air Conditioner and Cold Climate Heat Pump	We revised the description of the barrier to clarify the current availability of different types of micro heat pumps and the low-global warming potential (GWP) refrigerant used. We also provided the expected availability of more models based on the SMEs' market insights.
Topic (2) Micro Heat Pumps	Barriers	[*Referring to the "Product availability and diversity" barrier*] Also need more models that offer air filtration capability.	We added air infiltration and heat recovery as additional options in the introductory sentence to the barrier.

Focused Pilot TPM Topic Idea	Section	Suggestion or Comment	Action Taken and Justification
Topic (2) Micro Heat Pumps	Barriers	[*Referring to the "Lack of energy performance test procedures" barrier*] Do we know when we can expect DOE to release their version? (*referring to the DOE test procedure for through-the-wall heat pumps*) For EE measure packages we will need published efficiency metrics for the heating side and baseline efficiency levels.	We clarified that, while DOE has not provided a definitive release date for the test procedure, it is expected to be by the end of 2025. We made no change based on the second part of the comment. The comment aligns with the narrative that the lack of test procedures is a barrier.
Topic (2) Micro Heat Pumps	Barriers	[*Referring to the "Lack of energy performance test procedures" barrier*] Along with ENERGY STAR designation.	We added the suggested verbiage to the barrier description.
Topic (2) Micro Heat Pumps	Barriers	[*Referring to the "Incentives provided may not result in sustained savings in tenanted units" barrier*] Isn't this only a major issue if the MHP is no longer used in CA?	After careful discussions, the SMEs agreed with the comment that this is indeed not a barrier specific to micro heat pumps and therefore does not need to be highlighted. We removed this barrier.
Topic (2) Micro Heat Pumps	Barriers	[*Referring to the "Uncertain performance due to interacting with central condition systems" barrier*] This is a highest-level priority for CalMTA's Room Heat Pump MTI. We also see it as a broader barrier from two lens. 1. It is also the RHP's performance in relation to other devices in the home used for heating and cooling. 2. Human behavior on how these products are operated in the home in relation to the other products they have in the home. This information would be a critical component of consumer education on how best to install and use these products.	We incorporated the two aspects highlighted by the commenter into the description of this barrier.

Focused Pilot TPM Topic Idea	Section	Suggestion or Comment	Action Taken and Justification
Topic (2) Micro Heat Pumps	Barriers	[*Referring to the "Cost may add up quickly when multiple MHP units are needed" barrier*] I think you are thinking of the saddle versions only. We expect that there will be models that are window box shaped that will serve Type 3 climate conditions in the range of 800-1000 coming to the market soon.	We modified the description to read "… upwards of $3,000 per unit" to make the equipment cost claim less definitive. The SMEs recognized that there is a range of costs, but they are still a barrier to affordability.
Topic (2) Micro Heat Pumps	Barriers	[*Referring to the "Not adequately supported by eTRM for being included in EE programs" barrier*] Room HPs are in eTRM. See Room Air Conditioner, Residential | ETRM. "As room HPs are considered room ACs with reverse cycle under federal and state code, and under ENERGY STAR, room HPs are considered as part of this measure."	We revised the description to more accurately and specifically acknowledge the existence of room heat pumps in the existing Room Air Conditioner electronic Technical Reference Manual (eTRM) measure while pointing out that eTRMs currently do not account for the unique attributes of micro heat pumps.
Topic (2) Micro Heat Pumps	Barriers	[*Referring to the "Not supported by eTRM for being included in EE programs" barrier*] Several are interested at this time and in fact, CalMTA is helping one program with modeling to develop a measure for micro heat pumps. But they are not currently supported at this time. But it is coming.	We made no changes to the TPM narratives based on this comment. The team noted this comment and will pass it on to the Focused Pilot project team to double-check the status of the eTRM when scoping the project and prioritizing which barriers need to be addressed.

Focused Pilot TPM Topic Idea	Section	Suggestion or Comment	Action Taken and Justification
Topic (2) Micro Heat Pumps	Activities	Could these additional activities that could support the implementation of Micro Heat Pumps (MHPs) 1) Partnerships: Foster partnerships with community-based organizations, affordable housing associations, and other stakeholders to promote MHP adoption. Community Engagement: 2) Workshops and Demonstrations: Organize workshops and live demonstrations to educate communities about MHPs, their benefits, and proper usage. 3) Collect feedback from users to understand their experiences and improve MHP designs and deployment strategies. Technical Support: 4) Installation Assistance: Provide technical support and assistance for DIY installations to ensure proper setup and operation. 5) Maintenance Services: Offer maintenance services to ensure MHPs operate efficiently and effectively over time. Policy Advocacy: 6) Advocate for Policy Changes: Work with policymakers to advocate for changes in building codes and regulations that support MHP installations. 7) Inclusion in Energy Programs: Push for the inclusion of MHPs in state and federal energy efficiency programs.	1), 2), 4) and 5) are partly covered by the "identify the optimal incentive delivery, installation pathways, and community engagement to promote MHP adoption" activity. Both the heading and description have been updated to better highlight these suggested points. 3) is already captured in the "conduct field demonstration to confirm consumer comfort" activity. 6) and 7) are the outputs and outcomes of this Focused Pilot topic idea (see the blueprint) rather than being explicitly called out as "activities" due to the expected timeline and budget of a Focused Pilot project. Outputs from all other identified activities will undoubtedly and significantly contribute to policy advocacy efforts.

Focused Pilot TPM Topic Idea	Section	Suggestion or Comment	Action Taken and Justification
Topic (2) Micro Heat Pumps	Activities	[*Referring to the "Confirm energy performance in all CA climate zones" activity*] This work would support multiple CalMTA RHP MTI interventions proposed in CalMTA's current draft plan. Room Heat Pumps MTI Plan - CalMTA Specifically, this information would help CalMTA with Interventions 1 - Manufacturer Engagement - Tech Challenge to ensure product availability for CA appropriate products. 3- Gather and share usage and bill impact data across program partners that have supported product installations. This will help us over time also with future ENERGY STAR Specifications 5- Support inclusion in CA programs to build market momentum on these products and 6 - Engagement with retailers to help with product stocking in different parts of the state.	We made no changes to the TPM narratives based on this comment. This comment resulted from the coordination effort where the team asked CalMTA to specifically point out where the Focused Pilot project would support CalMTA's initiatives. The team noted this comment and will pass it on to the Focused Pilot project team, which will consider this and engage CalMTA for further discussion as needed during project scoping.
Topic (2) Micro Heat Pumps	Activities	[*Referring to the "Quantify electric bill impact" activity*] This would also directly support CalMTA's RHP MTI - Intervention 3 (data collection) and 8 - Support of advancement of electrification rates structures to mitigate bill impacts of moving from gas to electric heating.	We made no changes to the TPM narratives based on this comment. This comment resulted from the coordination effort where the team asked CalMTA to specifically point out where the Focused Pilot project would support CalMTA's initiatives. The team noted this comment and will pass it on to the Focused Pilot project team, which will consider this and engage CalMTA for further discussion as needed during project scoping.

Focused Pilot TPM Topic Idea	Section	Suggestion or Comment	Action Taken and Justification
Topic (2) Micro Heat Pumps	Activities	[*Referring to the "Field demonstration to confirm consumer comfort" activity*] This would also directly support CalMTA's RHP MTI - Intervention 3 (data collection) and 8 - Support of advancement of electrification rates structures to mitigate bill impacts of moving from gas to electric heating.	We made no changes to the TPM narratives based on this comment. This comment resulted from the coordination effort where the team asked CalMTA to specifically point out where the Focused Pilot project would support CalMTA's initiatives. The team noted this comment and will pass it on to the Focused Pilot project team, which will consider this and engage CalMTA for further discussion as needed during project scoping.
Topic (2) Micro Heat Pumps	Activities	[*Referring to the "Identify the most effective application areas to target MHP deployment" activity*] Same as above. Supports CalMTA's MTI in terms of helping us best target this technology to appropriate customers and any awareness building and education around these products.	We made no changes to the TPM narratives based on this comment. This comment resulted from the coordination effort where the team asked CalMTA to specifically point out where the Focused Pilot project would support CalMTA's initiatives. The team noted this comment and will pass it on to the Focused Pilot project team, which will consider this and engage CalMTA for further discussion as needed during project scoping.

Focused Pilot TPM Topic Idea	Section	Suggestion or Comment	Action Taken and Justification
Topic (2) Micro Heat Pumps	Activities	[*Referring to the "Identify the optimal incentive delivery and installation pathways" activity*] This work will support CalMTA's intervention 5 Support inclusion in programs and 6 - deploying midstream incentives.	We made no changes to the TPM narratives based on this comment. This comment resulted from the coordination effort where the team asked CalMTA to specifically point out where the Focused Pilot project would support CalMTA's initiatives. The team noted this comment and will pass it on to the Focused Pilot project team, which will consider this and engage CalMTA for further discussion as needed during project scoping.
Topic (2) Micro Heat Pumps	Reference Materials	You could add a reference to the full MTI Plans for Room heat pump as these are out for public comment and public now. Room Heat Pumps MTI Plan - CalMTA	We added the provided reference to the Reference Materials section.
Topic (3) Strategies for Residential Electrification with Minimal Electrical Upgrades by Controlling Primary Loads	Focused Pilot Topic Background	Should this also address the role of energy storage in limiting maximum loads on existing circuits? For instance: Charlie - battery-equipped induction range Also good to acknowledge recent/relevant studies that can inform the FP. For instance, UCLA study for CARB on panel sizing: California's clean energy leap: Easy electrification for most homes — Institute of the Environment and Sustainability at UCLA https://doi.org/10.1016/j.enpol.2024.114238	We slightly restated the narrative to highlight that the primary focus is on space heating, with the optional assessment of other key electrification loads and load balancing strategies. Equipment utilizing energy storage in limiting maximum loads, e.g., 120V induction stoves, would be better addressed as part of the Focused Pilot TPM Topic (4). We reviewed the two references provided and added them to the Reference Materials section.

Focused Pilot TPM Topic Idea	Section	Suggestion or Comment	Action Taken and Justification
Topic (3) Strategies for Residential Electrification with Minimal Electrical Upgrades by Controlling Primary Loads	Focused Pilot Topic Background	[*Referring to the intent to develop a whole building cost effective electrification program*] Analyze the effect of shifting load on the marginal heat rate used for any load that was shifted. I.e., are we shifting load to a time when the load would be served by fossil fuel plants.	Specific consideration on marginal heat rate is not in the scope of this topic. However, it is fair to ask what the impact is from a total system benefits (TSB) perspective, i.e., by balancing loads, do we know what the shifted load impacts are? We added the aspect of customer and utility impact to the description of the "minimal market feedback for technology/controls advancement" barrier.
Topic (3) Strategies for Residential Electrification with Minimal Electrical Upgrades by Controlling Primary Loads	Barriers	Could this also be a barrier? **Building Energy Codes and Standards**: Existing building energy codes and appliance standards may not fully support or incentivize electrification upgrades	This has been added as one of the barriers under the IOU Program Design and Policy Barriers category.
Topic (3) Strategies for Residential Electrification with Minimal Electrical Upgrades by Controlling Primary Loads	Barriers	[*Referring to the "Undefined regulatory compliance requirements" barrier*] NEC and CEC do have requirements around dedicated vs. shared circuits--e.g., energy.ca.gov/filebrowser/download/5132#:~:text=Page 5-,Electric Ready Requirements–,ready requirements must be met. https://www.energycodeace.com/content/103-mandatory-requirements-1500-n-and-1500-t-v-electr#ra-chunk--160417	The National Electrical Code and California Title 24 cover new construction, whereas this technology family is targeting retrofits. In general, there is minimal guidance about load balancing technologies in construction practices.

Focused Pilot TPM Topic Idea	Section	Suggestion or Comment	Action Taken and Justification
Topic (3) Strategies for Residential Electrification with Minimal Electrical Upgrades by Controlling Primary Loads	Barriers	[*Referring to the "Lack of customer and contractor awareness" barrier*] Customers and contractors also lack awareness of: 1) Existing panel capacities and load distribution across circuits 2) New kinds of appliances that would be viable for electrification--e.g., the induction cooktop above, GE's combo washer/dryer heat pump, 120V HPWHs, combo HPs for space and water heating, etc. and the behavior modification that may go with these new appliances--e.g., longer drying cycles, faster cook times, adjusted recipes, new cookware, etc. Both customers and contractors also lack the decision tools needed to objectively assess their electrification options.	We made necessary changes to the narrative to incorporate points one and three here.
Topic (3) Strategies for Residential Electrification with Minimal Electrical Upgrades by Controlling Primary Loads	Activity	[*Referring to the "Technology and market assessment" activity*] Can be very expensive to complete. Recommend leveraging research groups who may have useful data or tools--e.g., UCLA group mentioned above, LBNL's work or Build It Green's current work for CEC: energy.ca.gov/filebrowser/download/6456?fid=6456#page=2.25	We addressed this comment in the narrative as necessary.

Focused Pilot TPM Topic Idea	Section	Suggestion or Comment	Action Taken and Justification
Topic (4) Decarbonizing Household Appliances: Opportunities and Limitations with 120V Appliances	Focused Pilot Topic Background	Although the document explains that 120V Induction stoves are not one of the foci of this Focused Pilot due to limited availability of commercialized plug-in 120V induction models and high cost, these are the types of barriers that Market Transformation can address when informed by data and learnings obtainable via Focused Pilots. We agree that the current state of the supply chain presents challenges for induction cooking in utility incentive programs, but informing California's Market Transformation programs would be a productive and valuable use of CalNEXT's emerging technology efforts, particularly if focused on panel-constrained multi-family applications. New 120V battery-equipped induction stoves are commercially available and scaling in production (and currently being researched via CalNEXT's Cher AE Heights study, ET23SWE0064) with prices showing opportunity for reduction (per NYSERDA/NYCHA's Induction Cooking Challenge results). Also, lower-priced non-battery equipped products are being explored by established cooking appliance manufacturers. With these developments in emerging technology and manufacturing, and with the acknowledgement within the TPM that induction cooking is "a critical replacement option to achieve full household electrification," inclusion of currently available 120V induction stoves in the Focused Pilot TPM would be very timely and informative to the efforts of CalMTA as well as other California organizations driving full household electrification.	The SME team acknowledges the important role 120V induction stoves could play in whole-home electrification. We revised the narrative accordingly, shifting from explicitly excluding them from the Focused Pilot topic to highlighting the present challenges to consider when including 120V induction stove in the Focused Pilot project. Therefore, if this topic is selected to move forward as one of the 2025 Focused Pilot projects, the project team will be informed and have the flexibility to review the status of the 120V induction stove market at that time to decide whether their inclusion in the project scope is appropriate.

Focused Pilot TPM Topic Idea	Section	Suggestion or Comment	Action Taken and Justification
Topic (4) Decarbonizing Household Appliances: Opportunities and Limitations with 120V Appliances	Barriers	[*Referring to the "Lack of technology awareness in the DAC/HTR communities" barrier*] Not just HTR/DAC lack sufficient awareness of technology options. All customers would benefit from being better informed of their options and related bill impacts. The DAC/HTR barriers that may be most acute for these communities are the adoption barriers related to unfamiliar behavior changes that some of the new technologies may require--e.g., adjusted cookware/cooking habits, longer clothes drying, etc. Customer resistance to various user tradeoffs would also need to be addressed--e.g., a customer may be made aware that their new heat pump dryer extends the life of their clothing due to its low temperature operation but they may still be resistant to the idea of waiting longer for the clothes to dry.	We made no changes to the narrative of this barrier based on this comment. This barrier focuses exclusively on the lack of awareness of these lower-installed-cost 120V options in the disadvantaged and hard-to-reach communities (DACs and HTR communities, respectively). Broader barriers related to customer satisfaction are addressed in the third market actor barrier related to 120V heat pump performance, "unknown customer satisfaction with 120V heat pump performance," so it is unnecessary to repeat here.
Topic (4) Decarbonizing Household Appliances: Opportunities and Limitations with 120V Appliances	Barriers	[*Referring to the "Customer satisfaction with 120V heat pump performance" barrier*] The effect on utility bill should be considered.	We agree that cost and energy savings with regard to utility bills are important knowledge gaps. We updated the description to reflect the need to verify the impact on utility bills.
Topic (4) Decarbonizing Household Appliances: Opportunities and Limitations with 120V Appliances	Barriers	Could there be a possibility of Interoperability Issues: Ensuring that new decarbonizing technologies can seamlessly integrate with existing household systems and smart home devices.	This is a possibility, but the SME team does not have evidence indicating that this is indeed a known issue. Therefore, confirming interoperability is identified as part of the scope but not as a barrier. The "Focused Pilot Topic Background" section was revised to more clearly address this aspect.

Focused Pilot TPM Topic Idea	Section	Suggestion or Comment	Action Taken and Justification
Topic (4) Decarbonizing Household Appliances: Opportunities and Limitations with 120V Appliances	Barriers	Cost Barriers? Soft Costs: These include non-technology costs such as permitting, labor, and marketing, which can add significantly to the overall expense	This is generally captured under the "installation complexity requires multiple contractors for 120V appliance upgrades" barrier. The description has been revised to highlight the soft cost aspect.
Topic (4) Decarbonizing Household Appliances: Opportunities and Limitations with 120V Appliances	Barriers	[*Referring to the "Not supported by eTRM for being included in EE programs" barrier*] Not strictly true. eTRM already includes several HPWH offerings that allow for 120V HPWHs--e.g., Heat Pump Water Heater, Residential, Fuel Substitution | ETRM There are also active measure offerings for 120V HP clothes dryers: Heat Pump Clothes Dryer, Residential, Fuel Substitution | ETRM Consider rephrasing this to say that more measure offerings for 120V appliance electrification solutions may be needed.	We revised the description of the barrier to be more accurate. We reviewed the two eTRM measures provided and added them to the Reference Materials section.
Topic (4) Decarbonizing Household Appliances: Opportunities and Limitations with 120V Appliances	Activities	Understanding customer experience with technology would be valuable, specifically for HPWH 120v. Will the pilot specifically address the housing stock these units are well suited for? We are curious about the total number of HPWH systems being installed, how the pilot will assess possible product failures and whether pressure testing and lifecycle testing of the technology is being conducted. Assuming the pilot is approved, when would results will be available?	The questions the comment sought to answer are specific to a single appliance type, i.e., heat pump water heaters, but not about the packaged 120V appliance solution. The SME team believes that these specific questions should best be answered through Technology Support Research projects rather than a Focused Pilot project. We made no changes to the TPM narrative based on this comment.

Focused Pilot TPM Topic Idea	Section	Suggestion or Comment	Action Taken and Justification
Topic (4) Decarbonizing Household Appliances: Opportunities and Limitations with 120V Appliances	Activities	[*Referring to the "Perform technology and market assessment" activity*] Depending on the amperage draw, some appliances will need a dedicated outlet.	We made no changes to the TPM narrative based on this comment. The SME team acknowledges this fact. For 120V appliances, there should be no need for circuit splitters, though there is potentially a need for a dedicated outlet/circuit depending on load and local code requirements.
Topic (4) Decarbonizing Household Appliances: Opportunities and Limitations with 120V Appliances	Activities	[*Referring to the "Demonstrate successful installations" activity*] Demonstrations can also help address the DAC/HTR awareness barrier - ensuring pilots are also happening in those communities will illuminate challenges specific to those communities (e.g., trust, financing, bill sensitivity, etc.).	We revised the narrative to call out that the activity can help address DAC and HTR awareness barrier and utility bill impact concerns when demonstrated in those communities.
Topic (4) Decarbonizing Household Appliances: Opportunities and Limitations with 120V Appliances	Barriers	Lack of quantified and verified non-energy benefits. Such as) improved air quality (induction - no gas burning in the middle of a room typically without a vent hood running),) better safety features (induction - no gas leak concerns, can't heat without pan in place),) more time saved (combo washer-dryer from not having to transfer loads from washer to dryer),) extends clothing lifetime (HP dryers), dehumidification benefits (HPWH),) potential improved home value (all of the above), easier to clean (induction - smooth top vs gas cooktop grates). All while still providing the same end-use to the user. Hot water when they want it, conditioned air, dry clothing, and a great cooking experience.	We made no changes to the TPM narrative based on this comment. At a high level, these non-energy benefits fall under the barrier related to "unknown customer satisfaction." Each non-energy benefit pointed out here is specific to a particular appliance but not the packaged 120V appliance solution as a whole. These appliance-specific non-energy benefits are best investigated through Technology Support Research projects, not a Focused Pilot project.

Focused Pilot TPM Topic Idea	Section	Suggestion or Comment	Action Taken and Justification
Topic (5) Central Heat Pump Water Heater Retrofit Readiness Through Hot Water Distribution System Optimization	Technology Family	FYI - the EE measures include the GWP of leaking refrigerants and if the refrigerant is recovered at the end of life. However, there is no provision to give credit if leakage is reduced.	We made no changes to the TPM narrative based on this comment. The team has noted this comment. Currently, refrigerant leak mitigation is a greater concern for HVAC systems, but a minor concern compared to all the other barriers to the technology. 99.99% of the air-source heat pump water heater products on the market use water, not refrigerant, as the fluid being distributed outside of the condensing unit for domestic hot water systems in centralized applications, thus the refrigerant amount is much lower than in HVAC systems.

Focused Pilot TPM Topic Idea	Section	Suggestion or Comment	Action Taken and Justification
Topic (5) Central Heat Pump Water Heater Retrofit Readiness Through Hot Water Distribution System Optimization	Barriers	Should these other barriers be considered or will they apply at the Focused Pilot level? Regulatory Barriers 1) Building Codes and Standards: Existing building codes and standards may not adequately support the installation and operation of CHPWH systems. 2) Permitting Challenges: The permitting process for retrofitting buildings with CHPWH systems can be cumbersome and time-consuming. Operational Barriers 3) Maintenance Requirements: Higher maintenance requirements for CHPWH systems compared to traditional water heaters. 4) Monitoring and Control: Challenges in implementing continuous monitoring and control systems to ensure optimal performance. Environmental Barriers 5) Impact on Water Quality: Potential impacts on water quality due to changes in temperature and flow rates in the distribution system. 6) Energy Source Reliability: Dependence on the reliability of the energy source, such as electricity, which can be affected by grid stability.	The regulatory barriers 1) and 2) were too big of a scope for a Focused Pilot project to explicitly address, considering the typical timeline and budget. However, the outputs and outcomes from the Focused Pilot project will feed into future code development. The operation barriers 3) and 4) are covered in the "limited knowledge of high-performance, cost-effective valves and pumps" barrier. The description has been updated to highlight the suggested aspects of maintenance, monitoring, and control. 5) Environmental impact on water quality will be addressed by increasing system temperatures and reliability and is not considered a barrier to adoption by itself. 6) Concerns regarding energy source reliability are outside the scope of the Focused Pilot topic. The results of the Focused Pilot project, if this topic is selected to move forward, will help utilities understand the power requirements.
Topic (5) Central Heat Pump Water Heater Retrofit Readiness Through Hot Water Distribution System Optimization	Barriers	Could these also be potential barriers? Performance in Various Climates: CHPWHs may have varying efficiency and performance depending on the climate, which can affect their adoption. Integration with Existing Systems: Challenges in integrating CHPWHs with existing building systems, especially in older buildings.	The information will feed into the heat pump replacement incentive program and help understand the full system needs in different climate. Instead of considering these to be barriers, the SME team believes they are the intention of this Focused Pilot topic.

Focused Pilot TPM Topic Idea	Section	Suggestion or Comment	Action Taken and Justification
Topic (5) Central Heat Pump Water Heater Retrofit Readiness Through Hot Water Distribution System Optimization	Activities	[*Referring to the "Model avoided costs and energy savings compared to baseline" activity*] Develop an EnergyPlus model to use in the measure packages.	We highlighted in the activity heading that EnergyPlus will be used in the modeling exercise.

Next Steps

The next steps following submittal of the 2024 Focused Pilot TPM will be the following:

- Develop supporting graphics and additional media copy which will support upcoming dissemination efforts
- Review and resolve comments, if any, on 2024 Focused Pilot TPM Final Report
- Update CalNEXT website with new 2024 Focused Pilot TPM
- Launch email announcement through email outreach
- Develop and submit Distribution Report
- Begin initial planning for Focused Pilot Projects, including feedback from IOUs and stakeholders on which of the five Focused Pilot topic ideas presented in this TPM are best suited for the three 2025 Focused Pilot Projects