2022 Focused Pilot Technology Priority Map

Final Report

ET22SWE0041

Prepared by:

Greg Barker Energy Solutions

May 12, 2023

Executive Summary

The 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 2020. This Final Report documents the methodology used by the CalNEXT Program Team to develop a new Focused Pilot TPM by consulting with appropriate stakeholders to reorganize the existing technology families and subgroups.

Acknowledgements

This Final Focused Pilot Technology Priority Map (TPM) was developed by the Focused Pilot Subject Matter Expert (SME) Team of the CalNEXT Program, which is responsible for the production of this document, background research, stakeholder engagement of the Technical Advisory Committee, and management of the TPM development process. We thank the Focused Pilot SME team members and our facilitation team for their contributions:

CalNEXT Focused Pilot Team Members
(SMEs, Facilitators, & Supporting Staff)

Greg Barker, Energy Solutions
Tim Minezaki, Energy Solutions
Yao-Jung Wen, Energy Solutions
Zoe Mies, Energy Solutions
Chris Bomberger, Energy Solutions
Ted Jones, Energy Solutions
Ryan Bird, Energy Solutions
Josh Chanin, Energy Solutions
Chris Granda, Energy Solutions
Bryan Boyce, Energy Solutions
James Hanna, Energy Solutions
Evan Kamei, Energy Solutions
Teddy Kisch, Energy Solutions
Sandy Fischler-Laube, Energy Solutions
Howard Merson, Energy Solutions
Carey Oster, Energy Solutions
Kitty Wang, Energy Solutions
Kyle Booth, Energy Solutions
David R. Vernon, U.C. Davis
Keith E. Graeber, U.C. Davis
Johnathan Thibeault, VEIC
Nicole Duquette, VEIC
Gwelen Paliaga, TRC
Chris Rogers, AESC/ASK Energy

Focused Pilot TPM Advisory Committee
(Attendees & Other Key Advisors)

Cassie Rauss, SCE
Jerine Ahmed, SCE
David Rivers, SCE
Charles Kim, SCE
Sean Gouw, SCE
Hsin-Hao Lin, SCE
Gary Barsley, SCE
Jeff Barnes, SDGE
Kate Zeng, SDGE
Merry Sweeney, SDGE
Eric Con, SDGE
Briana K Bracamonte, SDGE
Ed Reynoso, SDGE
Ben Brown, PG&E
Mark Alatorre, PG&E C&S
Pat Eilert, PG&E, C&S
Thomas Mertens, PG&E
Bach Tsan, CEC

Peter Biermayer, CPUC

David Alberts, Resource Innovations

Jeff Mitchell, Resource Innovations

Devan Johnson, KW Engineering

Graham Lierley, KW Engineering

Joshua Butzbaugh, PNNL

Eric Olsen, NEEA

Aaron Daly, Clean Energy Services

Disclaimer

Table of Contents

Abbreviations and Acronyms

Acronym	Meaning
CA	California
CA eTRM	California Electronics Technical Reference Manual
CARB	California Air Resources Board
CEC	California Energy Commission
CPUC	California Public Utilities Commission
C&S	Codes and Standards
DC	Direct Current
DER	Distributed Energy Resources
DOE	Department of Energy
DR	Demand Response
EC	Electronically Commutated
EE	Energy Efficiency
EPA	Environmental Protection Agency
ET	Emerging Technology
EU	European Union
EV	Electric Vehicle
EVSE	Electric Vehicle Supply Equipment
HP	Heat Pump
HPWH	Heat Pump Water Heater
HVAC	Heating Ventilation and Air Conditioning
HWaaS	Hot Water as a Service
IOU	Investor-Owned Utility
L1	Level 1
L2	Level 2

MT	Metric Ton
NASRC	North American Sustainable Refrigeration Council
NEEA	Northwest Energy Efficiency Alliance
NOPR	Notice of Proposed Rulemaking
NREL	National Renewable Energy Laboratory
OEMs	Original Equipment Manufacturers
PG&E	Pacific Gas and Electric
PM	Permanent Magnet
PNNL	Pacific Northwest National Laboratory
PTSD	Preliminary Technical Support Document
RFI	Request for Information
SCE	Southern California Edison
SDGE	San Diego Gas & Electric
SGIP	Self-Generation Incentive Program
SME	Subject Matter Expert
SWHC041	Software-Controlled Switch Reluctance Motor
TOU	Time-Of-Use
TPM	Technology Priority Map
TSB	Total Systems Benefits
UC Davis	University of California, Davis
VFD	Variable Frequency Drive
WH	Water Heating

Introduction

The Technology Priority Maps (TPMs) provide the CalNEXT Program a framework to externally communicate priorities of the program, clearly define the central focus areas of the program, and assist with project screening. They will document the impact potential, programmatic research needs, and market readiness of all technology families across each of the end-use technology areas which 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, branded as CalNEXT, has established the Focused Pilot project type to focus on high-impact technologies that identify market barriers, conduct pilot tests to address market barriers, collaborate with other programs, and determine whether the technology should be transferred to energy efficiency (EE) resource programs and/or the Market Transformation portfolio. The Focused Pilot TPM is a specialized TPM for specific technologies—single technology family, or subarea(s) within a project family—that focuses on market barriers and potential activities to address the barriers.

The TPM will support the creation of Focused Pilots, which will address a comprehensive set of barriers associated with a specific technology. During the TPM development process, the Program team will create Blueprints that map the end-to-end market barriers for each high-potential technology being considered for a Focused Pilot. The Blueprints will suggest cost-effective and scalable approaches to incorporating the Focused Pilot technology into the portfolio. This may be through resource acquisition programs, the market transformation (MT) framework, Codes & Standards (C&S), other portfolio structures, or a combination of the above. Each Focused Pilot Project will test a hypothesis on how to overcome these documented market barriers for the technology along with metrics to determine whether the hypothesis is plausible or should be rejected. Focused Pilots will address true end-to-end market pain points for the technology with a holistic view of how each market pain point or barrier can be solved by building on previously solved pain points.

Objectives

The development of the Focused Pilot TPM will define comprehensive sets of barriers and potential activities associated with five technology areas identified through the 2022 TPM process. The TPM will give guidance for the development of Focused Pilot Projects in 2023 and beyond.

Methodology

The external TPM Advisory Committee provided feedback on the Focused Pilot Draft TPM when it was presented to them on February 15th, 2023. Their feedback is presented in the Stakeholder Feedback section of this report. This feedback and input from internal stakeholders have been incorporated into this draft of the TPM.

Additional information was also gathered from technology experts and program implementers who could not attend the Technical Advisory Committee (TAC) meeting in person, including Eric Seilo who is leading SCE's Electrification Strategy and Program Development around EVSE.

Draft Report Feedback

Following the submission of all TPM Draft Reports, the CalNEXT program team solicited additional feedback from SCE. No Comments were received on the Draft Report.

Revised 2022 Focused Pilot TPM

Focused Pilot Category Overview

The Focused Pilot TPM covers five specific technology areas identified during 2022 end-use TPM development as potentially high-impact and relatively well-understood, in terms of the knowledge indices that score understanding of the technology, market, program intervention.

This TPM process also serves to begin a conversation among CalNEXT Partners, the California (CA) Investor-Owned Utilities (IOUs), industry experts including the external SMEs who offered suggestions during development of the 2022 End Use TPMs, and California Program Implementers. This conversation will continue as CalNEXT publishes a TPM outlining barriers and potential activities to undertake in upcoming Focused Pilot Projects, to be published at https://calnext.com/resources/ .

The TPM itself will be directly followed by Focused Pilot Project development. CalNEXT plans to initiate three Focused Pilots in 2023. Given the Focused Pilot goal of contributing to the EE portfolio, the Team will continue to work directly with Program Implementers of current IOU Portfolio programs (for example, Statewide HVAC (Heating, Ventilation, and Air Conditioning), Statewide Grocery, IOU-specific Beneficial Electrification, and Statewide Market Transformation) and non-IOU programs supporting measure that may be significant future IOU portfolio contributors (for example, TECH and IOU Electrification Strategy efforts). The Focused Pilot Projects will aim to resolve barriers and test intervention strategies that will allow these measures to reach their full potential under long-term stewardship by other programs.

Unique Opportunities and Barriers

Because the Focused Pilot TPM technology areas are, by definition, potentially high-impact, CalNEXT is not the only program to concentrate efforts in these areas. The Focused Pilots will need to coordinate closely with current efforts such as TECH and Statewide HVAC, as well as with new and upcoming programs such as Statewide Market Transformation, Self-Generation Incentive Program (SGIP), and IOU Electrification.

Technology Family (1): Electric Vehicle Supply Equipment (EVSE)

Electric Vehicle Supply Equipment Family Definition:

EVSE is defined as the conductors, connectors, related equipment, and control software that deliver energy to an electric vehicle (EV).

Note: Mobile battery charging applications outside of traditional passenger vehicles such as e-bikes, wheelchairs, and forklifts are covered in separate technology families.

Scope

Within the EVSE technology family, the SMEs identified the highest market transformation need for the Level 2 (L2) EVSE to be in the single-family residential sector. In the residential sector, EVSE is expected to be one of the appliances that draws the highest power in a fully electrified home, especially in a single-family residential building. An Edison Electric Institute report forecasted that Residential L2 EVSE will need to comprise 74% of the overall EV charging infrastructure to support more than 26 million EVs projected to be on the road nationwide in 2030 (Satterfield 2022). From the EE perspective, EVSE plays a key role in whole-home electrification in that its operation needs to be coordinated with other major electrical appliances, including clothes dryers, heat pumps, heat pump water heaters, and electric stoves to ensure the overall electricity use and demand is supported by both the electric panel of the building and the distribution infrastructure within the same community. Widespread in-home EV charging is also one of the most important factors to passenger vehicle electrification, thereby contributing significantly to decarbonization in the transportation sector. Therefore, the Focused Pilot should demonstrate technologies and strategies that can enable EVSE for whole-home coordination to help evolve and broaden the scope of future EE resource portfolio.

Barriers

- **Limited L2 EVSE penetration.** Most chargers installed in households are Level 1 (L1) EVSE, creating the general perception of needing the entire overnight hours to fully charge a vehicle and potentially contributing to the resistance of EV adoption.
- **Loose grid integration through time-of-use (TOU) rate.** Time-of-use rate structure, including the EV rates specifically designed for EVSE owners, provides the grid only a passive connection to the household EVSE. Most L2 EVSE models do not provide a way for programming the TOU rate and specifying how the charge should behave in response to TOU rates. This loose grid integration relies entirely on the manual and consistent behavior of the owners.
- **Connectivity is not a default feature in residential L2 EVSE.** Due to cost considerations and fierce competition from L1 EVSE, L2 EVSE for household use typically does not feature connectivity. This renders any active connection and automatic interaction between the EVSE and the grid impossible.
- **Capacity constraint at the electrical service panel.** The current electrical service panel in single-family buildings poses significant constraints in supporting L2 EVSE and all other high-power household electric appliances, especially in highly electrified houses.

- **Capacity constraint at the distribution level.** The current distribution substations and distribution transformers are not designed and sized to support the concurrent use of L2 EVSE as well as other high-power electric appliances in all or most households they serve.
- **Difficulty in obtaining financing**. L2 EVSE is not considered viable collateral by financial institutions for underwriting a loan. EVSE installation cost is typically unknown at the time of the equipment purchase, which further exacerbates the difficulty in financing both the purchase and installation of EVSE.

Activities

- **Provide point-of-sales incentives**. The incentives can bring the cost of connected L2 EVSE closer to L1 EVSE and L2 EVSE without connectivity. Residential EVSE incentives are available in a small number of California municipals and public utilities. However, programs by California IOUs currently only provide incentives for EVs but not EVSE, although some programs do provide a marketplace for EVSE. Providing point-of-sales incentives will accelerate the market penetration of connected L2 EVSE and unlock benefits, both to the consumers and the grid, enabled by connectivity.
- **Point-of-sales bundled offering**. The bundle will be offered at the time of EV purchase at the dealership. The bundled offering will combine several EVSE purchasing considerations, including convenience, financing, end-to-end service, incentives, demand response (DR) program enrollment, value-added service sign-up, etc. This will improve consumer experiences, reduce friction in vehicle fuel conversion, and significantly increase the chance for consumers to enroll in relevant utility programs and charging networks.
- **Develop managed charging network.** The charging network will coordinate and manage the aggregated residential vehicle charging load to prevent overload at all power delivery stages or components. This will alleviate capacity constraints at the distribution level while ensuring vehicles have a full charge when owners need to use the car.
- **Deploy residential load controllers.** Residential load controllers may be in the form of smart panels or smart circuit breakers that coordinate load-sharing among multiple 240V high-power electrical appliances on a circuit that is not sized to simultaneously support these loads. This will eliminate costly panel upgrades as homeowners adopt major electrical appliances.
- **Develop standalone point-of-sales loan products.** The existing EVSE loan product on the market currently covers only the EVSE material cost but not installation cost. The loan will cover the cost of both EVSE equipment and installation. The product will need to include a workflow for identifying key loan parameters for EVSE installation so that the financial institution can underwrite a loan independent of the exact knowledge of the actual installation. This will mitigate consumer financial burden when purchasing connected L2 EVSE and allow the loan to be offered as part of the vehicle purchase.
- **Incentivize DER-supplemented EVSE deployment.** When onsite distributed energy resources (DER) are already in place or being planned, DER-supplemented EVSE could

contribute to the effective use of renewable energy from the DER. Currently, customers with self-generation are eligible for the same rate options as other EV customers, which does not provide additional motivations to better coordinate between home self-generation and EV charging. Encouraging EVSE that can draw energy from DER will help mitigate capacity constraints both at the building panel level and the distribution level.

Reference Materials

Alameda Municipal Power. Level 2 Electric Vehicle Charger. Rebates and Incentives. Accessed February 24, 2023. https://www.alamedamp.com/407/Rebates-and-Incentives

Anaheim Public Utilities. Personal Use EV Charger Rebates. Accessed February 24, 2023. https://www.anaheim.net/593/Personal-EV-Charger-Rebate

Antoun J., M. E. Kabir, B. Moussa, R. Atallah and C. Assi. 2020. Impact Analysis of Level 2 EV Chargers on Residential Power Distribution Grids. Proc. 2020 IEEE 14th International Conference on Compatibility, Power Electronics and Power Engineering (CPE-POWERENG), pp. 523-529. Setubal, Portugal. https://ieeexplore.ieee.org/document/9161463

Antoun J., M. E. Kabir, R. Atallah, B. Moussa, M. Ghafouri and C. Assi. 2020. Assisting Residential Distribution Grids in Overcoming Large-Scale EV Preconditioning Load. IEEE Systems Journal, vol. 16, no. 3, pp. 4345-4355. https://ieeexplore.ieee.org/document/9546665

Bank of America. 2023. BofA to Offer Financing for Residential Electric Vehicle Chargers. Charlotte, NC: Bank of America. Accessed February 8, 2023. https://newsroom.bankofamerica.com/content/newsroom/press-releases/2023/02/bofa-to-offer-financing-for-residential-electric-vehicle-charger.html

Cooper, A and K. Schefter. 2018. Electric Vehicle Sales Forecast and the Charging Infrastructure Required Through 2030. Edison Electric Institute. https://www.edisonfoundation.net/-/media/Files/IEI/publications/IEI_EEI-EV-Forecast-Report_Nov2018.ashx

Ge, Y., C. Simeone, A. Duvall and E. Wood. 2021. There's No Place Like Home: Residential Parking, Electrical Access and Implications for the Future of Electric Vehicle Charging Infrastructure. Golden, CO: National Renewable Energy Laboratory. NREL/TP-5400-81065. https://www.nrel.gov/docs/fy22osti/81065.pdf.

Home Charging Stations. Dynamic Load Balancing for EV Charging – Everything You Need to Know. Accessed February 8, 2023. https://www.homechargingstations.com/dynamic-load-balancing-ev-charging/

Lee, H., and A. Clark. 2018. Charging the Future: Challenges and Opportunities for Electric Vehicle Adoption. Harvard Kennedy School Faculty Research Working Paper Series. RWP18-026. https://projects.iq.harvard.edu/files/energyconsortium/files/rwp18-026_lee_1.pdf

Salcido, V. R., M. Tillou and E. Franconi. 2021. Electric Vehicle Charging for Residential and Commercial Energy Codes. Richland, WA: Pacific Northwest National Laboratory. PNNL-31576. https://www.energycodes.gov/sites/default/files/2021-07/TechBrief_EV_Charging_July2021.pdf

Satterfield, C. and K. Schefter. 2022. Electric Vehicle Sales and the Charging Infrastructure Required Through 2030. Edison Electric Institute. https://www.eei.org/-/media/Project/EEI/Documents/Issues-and-Policy/Electric-Transportation/EV-Forecast—Infrastructure-Report.pdf

Southern California Edison. Southern California Edison Market Place. Accessed February 24, 2023. https://marketplace.sce.com/ev-chargers/

Southern California Edison. Frequently Asked Questions. Charging your EV. Accessed February 24, 2023. https://www.sce.com/residential/ev-charging

Technology Family (2): Commercial Refrigeration

Commercial Refrigeration Technology Family Definition:

Commercial refrigeration equipment utilized for cooling and freezing applications in commercial and institutional end uses including stationary, low, medium, and high temp refrigeration systems, supermarket food storage, food preparation rooms, and retail sales equipment. Includes compressor heat recovery systems, advanced controls, and scalable thermal storage systems.

Scope

Within the Commercial Refrigeration technology family, the SMEs recommended a Market Transformation approach to addressing refrigerant leakage detection & mitigation and investigated two potential delivery mechanisms, incorporation of refrigerant leakage spot detection into existing delivery channels & a technology-focused approach of automated leak detection. The new Total Systems Benefits (TSB) metric from the (California Public Utilities Commission) CPUC indicates that reducing refrigerant leakage has the potential to be credited from future utility program designs. Additionally, maintaining the proper charge will lead to improved energy performance. The CalNEXT program is continuing to conduct research to understand the most appropriate building sectors to conduct interventions in and will clarify scope should these efforts move forward into an Emerging Technology (ET) Focused Pilot project.[1]

Barriers

The barriers within the market sector include:

- Spot Detection:
  - Spot leak detection is not a part of all refrigeration maintenance practices.
  - There is a lack of experienced service technicians.
  - Expensive (time intensive = high labor costs).
  - Expensive (specialized tools = high equipment cost for service providers).
  - Limited number of services, high costs to go to market.
  - Low customer understanding of benefits (significant number of laggards in the sector).
  - Need for technical support to implement repair.
- Automated leak detection:
  - Automated leak detection is not a part of all refrigeration maintenance practices.
  - Expensive (high first cost to install equipment).
  - Need for technical support to implement repair.
  - Low customer understanding of benefits (significant number of laggards in the sector).

Activities

- Spot Detection:

- **Market study on handheld leak-detection devices.** This activity will research the cost, availability, and performance of high-quality refrigerant leak detection devices and assess the degree to which their availability and cost is a barrier for maintenance service providers.
- **Interview Refrigeration Contractors.** Interviews with contractors will inform the degree of workforce developmental needs and contractor upselling practices.
- **Interview facility operators (scope dependent: supermarket, small grocery store, convenience store, etc.)** This activity will identify the current market understanding on the perceived value of preventative maintenance and collect information on the maintenance practices related to refrigerant recharge and refrigeration system repair for the targeted building sector.
- **Value chain analysis.** This activity will document business-as-usual maintenance practices related to existing refrigeration leakage and document opportunities for key market actors.
- **Provide incentives on leak detection equipment for refrigerant maintenance providers.** This activity will address the high costs of high-quality refrigerant-leak spot-detection equipment and may test multiple deployment models focused such as loan programs or other financing programs.
- **Develop contractor best practices guide.** This activity will provide educational resources on the benefits of leak detection including how to effectively communicate those benefits to their prospective clients.
- **Develop standardized contract templates.** This activity will address the lack of standardization regarding refrigeration maintenance contracts.

- **Automated leak detection:**
  - **Market study on permanent leak-detection devices.** This activity will research the cost, availability, and performance of automated refrigerant leak detection devices and assess the degree to which their availability and cost is a barrier.
  - **Develop installer best practices guide.** This activity will provide educational resources on the appropriate installation guidelines for automated leak detection.
  - **Interview facility operators (scope dependent: supermarket, small grocery store, convenience store, etc.)** This activity will identify the current market understanding on the perceived value of preventative maintenance and collect information on the maintenance practices related to refrigerant recharge and refrigeration system repair for the targeted building sector.
  - **Value chain analysis.** This activity will document business-as-usual maintenance practices related to existing refrigeration leakage and document opportunities for key market actors.

- **Provide incentives automated leak detection equipment** This activity will address the high costs of automated leak-detection devices and may test multiple deployment models focused on either the manufacturers, contractors, or customers based on the market study.
- **Develop standardized contract templates.** This activity will address the lack of standardization regarding refrigeration maintenance contracts.

Reference Materials

CEC (California Energy Commission) (2021). California Building Decarbonization Assessment. Energy Efficiency in Existing Buildings. Retrieved from https://efiling.energy.ca.gov/GetDocument.aspx?tn=239311.

CARB (California Air Resources Board)(2009). Final Regulation Order: REGULATION FOR THE MANAGEMENT OF HIGH GLOBAL WARMING POTENTIAL REFRIGERANTS FOR STATIONARY. Refrigerant Management Program Rulemaking. Retrieved from https://ww2.arb.ca.gov/our-work/programs/hfc-reduction-measures/rulemaking.

CARB (2015). Stopping Leaks: Performing a refrigerant leak inspection. Refrigerant Management Program, Compliance Assistance Series. Retrieved from https://ww2.arb.ca.gov/resources/documents/stopping-leaks.

EPA (Environmental Protection Agency) (2022). 15th Anniversary Report: Greenchill – Keeping Cool for Fifteen Years. GreenChill Advanced Refrigeration Partnership program. Retrieved from https://www.epa.gov/system/files/documents/2022-09/GreenChill-Keeping-Cool-for-15-Years-2022_1.pdf.

EPA (2011). GreenChill Best Practices Guideline: Commercial Refrigeration Leak Prevention & Repairs. U.S. Environmental Protection Agency Stratospheric Protection Division. Retrieved from https://www.epa.gov/sites/default/files/documents/leakpreventionrepairguidelines.pdf.

EU (European Union) (2018). Financial, environmental, safety & reliability costs of leakage Alternative Refrigerants & Leakage. L'Instrument Financier pour l'Environnement (LIFE) Program. Retrieved from https://static1.squarespace.com/static/55a672f1e4b06d4dd52f83de/t/5ad9e51e1ae6cf93cb8bd084/1524229407853/Module8_LeakageCosts_2018.pdf.

NASRC (North American Sustainable Refrigeration Council) (2020). Leak Reduction Initiative: A Proactive Approach To Reducing Leaks Over The Lifetime Of Commercial Refrigeration Systems. Retrieved from https://nasrc.org/leak-reduction.

Technology Family (3): Advanced Motors

Advanced Motors Technology Family Definition:

Advancement of highly efficient electric motor types and associated control technologies with an emphasis on enhancing new advanced electric motor market awareness, stocking, deployment, and scalability.

Scope

Within the Advanced Motors technology family, the SMEs recommended a Market Transformation focused pilot aimed at 1 to 50 horsepower (hp) advanced motors (permanent magnet (PM), Synchronous Reluctance, brushless direct current (DC) motors, and Switched Reluctance motors) in the commercial HVAC sector. This scope is informed heavily by the recent Department of Energy (DOE) Advanced Motors Study (https://motors.lbl.gov/) which found the largest savings opportunity from the 1-50hp motor size range where eighty percent of the commercial sector motor system electricity use is. The DOE report suggested the commercial market due to its relative ease of access when compared to the industrial and agricultural markets.

Barriers

The barriers within the market sector include:

- **Broad lack of industry awareness, understanding of benefits and demand.** There are several types of advanced electric motor technologies available on the market today. Electric motor customers, including commercial building owners, managers, HVAC contractors, and maintenance managers are generally not aware that advanced motors exist, what their performance benefits are, whether they are appropriate for their applications (e.g., HVAC air handlers), how to ask for them, or where to buy them. These are all significant barriers on the customer side but also more broadly for several market actors. As a result, most commercial and industrial consumers are not aware of advanced motors, including their energy savings, improved control/operation or their environmental benefits compared to regulated induction motors.
- **Availability.** Advanced motors are not stocked by distributors to the degree that standard efficiency induction motors are. Availability is a customer barrier.
- **Motor Replacement Size.** Customers do not know if advanced motors will be the same size, weight, and footprint as the induction motor it is replacing.
- **Price premium**. What is the incremental cost and how does the price premium compare to a standard efficiency induction motor.
- **Customer questions on product maintenance.** How difficult is the advanced motor to repair and will my technician/contractor/motor repair shop know how to repair/maintain the motor. Is the warranty the same?
- **Operation.** Will the motor operate in the same manner as a standard induction motor in terms of noise, vibration, torque, speed, etc. Does it take any additional training to install,

set up and operate the advanced motor? Is motor life the same? Do I need a new variable frequency drive (VFD)? Will the motor work with my current VFD?

- **Limited measure coverage within existing California Electronics Technical Reference Manual (CA eTRM).** While existing measures do address relevant advanced motor technologies[2,3,4], for the most part they do not address commercial HVAC applications directly. Electric motors used in residential HVAC systems are different in scope; they tend to be single phase, low horsepower motors (including fractional), and have smaller National Electrical Manufacturers Association (NEMA) frame sizes. Commercial refrigerated display cases and walk-in coolers/freezers evaporators are good opportunities, but niche compared to the size of commercial HVAC systems. The measure for software-controlled switch reluctance motors in fans serving commercial packaged HVAC systems is relevant but incomplete as it leaves out other mature advanced motor technologies that are currently available on the market such as permanent magnet, synchronous reluctance, and brushless DC motors. For example, ABB offers a synchronous reluctance line of motors under its electronically commutated (EC) Titanium line that achieves IE5 levels of efficiency. Other advanced motors, in addition to software-controlled switch reluctance motors, will be assessed for applicability and energy savings under the proposed CalNEXT project.

Activities

Activities that could address the identified barriers include:

- **Targeted market engagement with advanced motor manufacturers:** Interview motor manufacturers such as WEG, Nidec, KSB, ABB, Grundfos, Hitachi, Turntide, Lafert, Regal Beloit.
- **Targeted market engagement with Fan and Pump original equipment manufacturers (OEMs):** Fans & pumps have been identified as strong matches for several advanced electric motor technologies in the recent DOE Advanced Motors study. Our engagement with these OEMs would be aimed at understanding their level of interest in adopting high efficiency advanced motors in new equipment and as upgrades to drop-in equipment and training their maintenance and repair networks for these motors as well as incorporating VFDs.
- **Recruit and engage key market actors (including incentives):** Manufacturers, Distributors, Retailers, Contractors, Installers, and end users need education and incentives to further develop this market. May test multiple deployment models focused on either the manufacturers, contractors, or customers based on market information.
- **Marketing and education to motor suppliers (repair shops/installers):** Provide education and market resources to help motor suppliers communicate operational and cost benefits of advanced motors and VFD controls. Training and education will also be needed to support maintenance and repair networks.

- **Motor/drive application compatibility:** Collaborate with industry to develop design guides and/or compatibility tools such that OEM advanced motors can be installed in retrofit or replacement applications.

Reference Materials

Rao, P., Sheaffer, P., Chen, Y., Goldberg, M., Jones, B., Crop, J., & Hester, J. (2022). U.S. Industrial and Commercial Motor System Market Assessment Report Volume 1: Characteristics of the Installed Base. Lawrence Berkeley National Laboratory. Retrieved from https://escholarship.org/uc/item/42f631k3.

Newkirk, A., Rao, P., & Sheaffer, P. (2021). U.S. Industrial and Commercial Motor System Market Assessment Report Volume 2: Advanced Motors and Drives Supply Chain Review. Lawrence Berkeley National Laboratory. Retrieved from https://escholarship.org/uc/item/2k1942nd.

Rao, P., Sheaffer, P., Chen, Y., Karki, U., & Fitzgerald, P. (2022). U.S. Industrial and Commercial Motor System Market Assessment Report Volume 3: Energy Saving Opportunity. Lawrence Berkeley National Laboratory. Retrieved from https://escholarship.org/uc/item/16x3d348.

SCE (Southern California Edison) (2018). Software-Controlled Switch Reluctance Motors. Emerging Technologies Coordinating Council. Retrieved from https://www.etcc-ca.com/reports/software-controlled-motors

SCE (2021). Permanent Magnet Synchronous Motors in Refrigerated Display Cases. Emerging Technologies Coordinating Council. Retrieved from https://www.etcc-ca.com/reports/permanent-magnet-synchronous-fan-motors-sfp.

Woldekidan, K., Studer, D., and Faramarzi R. (2020), Performance Evaluation of Three RTU Energy Efficiency Technologies. National Renewable Energy Laboratory (NREL). Retrieved from https://www.osti.gov/biblio/1756704.

Slipstream (2022). Switched-Reluctance Motor Field Evaluation, Final Report. ComEd Energy Efficiency Program: Emerging Technologies. Retrieved from https://turntide.com/resource-hub/comed-srm-field-report-2022/.

California Electronic Technical Reference Manual (CA eTRM). Software-Controlled Switch Reluctance Motor (SWHC041). Retrieved from https://www.caetrm.com/measure/SWHC041/03/.

CA IOUs Electric Motors Standards and Test Procedure Advocacy (June 2020 to May 2022)

- DOE Electric Motors Standards Rulemaking RFI (June 2020). https://www.regulations.gov/comment/EERE-2020-BT-STD-0007-0007
- DOE Electric Motors Test Procedure Rulemaking RFI (July 2020). https://www.regulations.gov/comment/EERE-2020-BT-TP-0011-0003.
- DOE Electric Motors Test Procedure Rulemaking NOPR (Feb 2022). https://www.regulations.gov/comment/EERE-2020-BT-TP-0011-0032
- DOE Electric Motors Standards Rulemaking PTSD (May 2022). https://www.regulations.gov/comment/EERE-2020-BT-STD-0007-0030

Technology Family (4): Residential-Duty Water Heating

Scope

Within the Residential heat pump water heater (HPWH) technology family, the SMEs recommended focusing on barriers within a Market Transformation approach to promoting HPWH. SMEs included representatives from TECH Clean California and the California Self-Generation Incentive Program, providing up-to-date information on current milestones and barriers and their regular conversations with the supply chain.

Barriers

The barriers within this technology family include:

- **Contractor inventory limitations.** Contractors in California are relying on their own limited inventory more than full distributor inventory for the key segment of urgent replacement, which limits HPWH availability.
- **Contractor familiarity and experience.** Contractors' lack of experience with HPWH compared to natural gas units limits their comfort with recommending them broadly and could lead to improper sizing or installation with negative customer experience.
- **Potential negative customer experience and bill impacts.** Customers substituting natural gas units with HPWHs without appropriate sizing considering first-hour rating and optimizing their heating mode and time-of-day usage may end up with costlier-than-anticipated electric bills, low COP, and/or insufficient hot water.
- **Lack of customer education and marketing.** Customers are not broadly aware of HPWH offerings and their benefits, nor their proper operation and maintenance.
- **Retail availability.** Retailers in some parts of the state are not ready to support HPWH inventory until they see greater demand.
- **Electrical Upgrade Complexity.** Electrical upgrades required for a HPWH fuel substitution often cause complications in timing—for an appliance that customers do not feel they can live without—as well as cost.
- **Cost.** HPWH units sell at a premium over natural gas water heaters.

Activities

Activities that could address the identified barriers include:

- The Upcoming SGIP will address the cost barrier.
- Focus on the lowest barrier customers. Pilot initiative to converting electric resistance WH sales to HPWH. Capturing a significant share of this market will boost HPWH sales volumes greatly and activate supply chain for HPWHs. These can be geographically targeted where electric WH is common.

- Temporary Loaner Gas water heating program to address timing issues around fuel substitution with HPWH. Electric upgrades and product availability can be addressed while the customer still has hot water.
- Consigned inventory initiative. Project-supported inventory is split between distributors and manufacturers, so that contractors get inventory without upfront investment.
- Hot water as a service (HWaaS) program could address customer indifference to the benefits of HPWH.
- Bill savings support: initiative to support users and installers of HPWH to optimize bill impacts of fuel substitution and address low or non-existent bill savings.
- Follow-up on CalNEXT TSR ET22SWE0056 to promote 120V HPWH products and evaluate contractor demonstration activities.
- Customer HPWH retrofit guidelines to outline potential upgrades and cost ranges for full HPWH retrofit, including panel, breaker, wiring, and ducting.

Reference Materials

NEEA (Northwest Energy Efficiency Alliance) (2022). Plug-In Heat Pump Water Heaters: An Early Look to 120-Volt Products. Northwest Energy Efficiency Alliance. Retrieved from https://neea.org/resources/plug-in-heat-pump-water-heaters-an-early-look-to-120-volt-products

NEEA (2021) Laboratory Assessment of Rheem Generation 5 Series Heat Pump Water Heaters. Northwest Energy Efficiency Alliance. Retrieved from https://neea.org/resources/laboratory-assessment-of-rheem-generation-5-series-heat-pump-water-heaters

Opinion Dynamics (2022). California Heat Pump Residential Market Characterization and Baseline Study. CPUC TECH program. Retrieved from https://apppack-app-tech-reporting-prod-privates3bucket-z0onruvirqb2.s3.amazonaws.com/documents/OD-CPUC-Heat-Pump-Market-Study-Report-5-17-2022_NAZGH4Q.pdf

Opinion Dynamics (2022). Technology and Equipment for Clean Heating (TECH) Initiative Baseline Market Assessment. CPUC TECH program. Retrieved from https://apppack-app-tech-reporting-prod-privates3bucket-z0onruvirqb2.s3.amazonaws.com/documents/TECH_Baseline_Market_Assessment_Final_Report.pdf

Pacific Gas and Electric (PG&E) (2022). Midstream Heat Pump Water Heater (HPWH) Market Study and Field Test. Emerging Technologies Coordinating Council. Retrieved from https://etcc-ca.com/reports/midstream-heat-pump-water-heater-hpwh-market-study-and-field-test

SCE (Pending 2022). ET21SCE0018 - Residential Water Heating Cost Comparison Tool/Calculator. Emerging Technologies Coordinating Council. More information at https://etcc-ca.com/reports/residential-water-heating-cost-comparison-toolcalculator

SCE (Pending 2024). ET19SCE1100 - Grid Responsive Heat Pump Water Heater (WH) Study Emerging Technologies Coordinating Council. More information at https://etcc-ca.com/reports/grid-responsive-heat-pump-water-heater-wh-study https://etcc-ca.com/reports/smart-water-heater-controller-study

SCE (2019). DR17.06 - Smart Water Heater Controller Study. Emerging Technologies Coordinating Council. Retrieved from https://etcc-ca.com/reports/smart-water-heater-controller-study

Technology Family (5): High Efficiency Heat Pumps for Space Heating and Cooling

Scope

Within the High-efficiency HVAC Heat Pumps technology family, the SMEs suggested focusing on Commercial HVAC HP unitary and hydronic equipment.

Barriers

The barriers within this technology family include:

- Low Perceived Customer Demand and Awareness
- Low Product Availability / HP units frequently not stocked because they are seen as less popular alternative to Gas models. HP units may have low availability due to surge in demand for HPs; 50-100% cost increases, double wait time creating a particular for replacement on failure scenarios[7]
- Lack of workforce familiarity, training & education: particularly electric resistance backup settings[8]; thermostat setbacks
- System Performance Uncertainty[9]. Shortcomings in existing ratings is well-known. DOE negotiation is looking very closely at heating rating improvement, existing capacity measured at 47F rather than temperature closer to maximum heating demand.
- Operating Cost increase: Based on gas vs. electric heating bill impact and demand charges.
- Hot Water Temperature difference for retrofit HP hydronic units. Lower hot water setpoints may require design changes.

Activities

Activities that could address the identified barriers include the following[10]:

- Marketing and Education to Consumers about HP benefits, incentives
- Recruit and Engage Manufacturers, Distributors, Retailers, Contractors, Installers
- Training and Education for Manufacturers, Distributors, Retailers, Contractors, Installers
- Promote existing Financing and Incentives, including documenting installation data availability barriers to program participation[11]
- Produce and promote a Design guide, to include comprehensively Cooling/Heating/Setback/Backup electric heating/Exhaust Air Heat Recovery.
- Segmentation focus study. Look at Incentives and their impact on participation rates. Collect site data to determine 2nd-stage resistance configurations, real-world operating performance/controls interplay.

- Design Guidelines and Best Practices for HP Hydronic retrofits, including Hot Water Temperature Reductions

Reference Materials

https://neea.org/resources/plug-in-heat-pump-water-heaters-an-early-look-to-120-volt-productshttps://neea.org/resources/laboratory-assessment-of-rheem-generation-5-series-heat-pump-water-heaters Opinion Dynamics (2022). California Heat Pump Residential Market Characterization and Baseline Study. CPUC TECH program. Retrieved from https://apppack-app-tech-reporting-prod-privates3bucket-z0onruvirqb2.s3.amazonaws.com/documents/OD-CPUC-Heat-Pump-Market-Study-Report-5-17-2022_NAZGH4Q.pdf

Opinion Dynamics (2022). Technology and Equipment for Clean Heating (TECH) Initiative Baseline Market Assessment. CPUC TECH program. Retrieved from https://apppack-app-tech-reporting-prod-privates3bucket-z0onruvirqb2.s3.amazonaws.com/documents/TECH_Baseline_Market_Assessment_Final_Report.pdf

PG&E (2022). Packaged Roof Top Unit with Integrated Heat Pump and Indirect/Direct Evaporative Cooling. Emerging Technologies Coordinating Council. Retrieved from https://etcc-ca.com/reports/packaged-roof-top-unit-integrated-heat-pump-and-indirectdirect-evaporative-cooling

Next Steps

In preparation for finalizing the Focused Pilot TPM, the Program Team will do the following:

1. Develop supporting graphics and additional media copy which will support upcoming dissemination efforts.
2. Finalize website design for the 2022 Focused Pilot TPM.
3. Review and resolve any comments on 2022 Focused Pilot TPM Final Report
4. Update CalNEXT website with new 2022 Focused Pilot TPM.
5. Launch email announcement through email outreach.
6. Develop and submit Distribution Report.
7. Begin initial planning for Focused Pilot Projects, including feedback from IOUs and stakeholders on which of the 5 technology areas presented in this TPM are best suited for one of the 3 Focused Pilot Projects in 2023.