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Financial and non-financial barriers to achieving building decarbonization

Additional submitted attachment is included below.

CALIFORNIA ENERGY COMMISSION

CALIFORNIA NATURAL RESOURCES AGENCY

Electric Program Investment Charge 2026–2030 (EPIC 5) Research Concept Proposal Form

The California Energy Commission (CEC) is currently soliciting research concept ideas and other input for the Electric Program Investment Charge 2026–2030 (EPIC 5) Investment Plan. For those who would like to submit an idea for consideration, please complete this form and submit it to the CEC by **August 8, 2025**. More information about EPIC 5 is available below.

To submit the form, please visit the e-commenting link: https://efiling.energy.ca.gov/EComment/ECommentSelectProceeding.aspx and select the Docket **25-EPIC-01**. Enter your contact information and then use the "choose file" button at the bottom of the page to upload and submit the completed form. Thank you in advance for your input.

Title: Financial and non-financial barriers to achieving building decarbonization

1. Please provide the name, email, and phone number of the best person to contact should the CEC have additional questions regarding the research concept:

   Loren Schmidt, lschmidt@rff.org, (202) 328-5081

2. Please provide the name of the contact person's organization or affiliation:

   Resources for the Future

3. Please provide a brief description of the proposed concept that you would like the CEC to consider as part of the EPIC 5 Investment Plan. What is the purpose of the concept, and what would it seek to do? Why are EPIC funds needed to support the concept?

   Achieving widespread building decarbonization requires many households and businesses to each individually make decisions to adopt new technologies for space and water heating and cooling. Studies have identified some financial barriers to adoption, such as high retail electricity prices (e.g. Davis, 2021) and upfront upgrade costs (e.g., Casquero-Modrego et al., 2025) and non-financial barriers, such as contractor inexperience, a limited trained workforce, and poor customer information (e.g. Antononpoulos et al., 2024; Casquero-Modrego et al., 2025; Knittel

et al. 2023). However, more barriers likely exist, and there has been little research on optimal policy design or the impacts of specific policies aimed at addressing these barriers on widespread adoption of heat pumps.

This concept is focused on further identifying barriers to heat pump adoption and analyzing potential policy solutions to overcome these barriers. In particular, there is value in further exploring barriers related to lack of contractor knowledge and incentives, time to technology replacement, and difficulty accessing available financial incentives. Policymakers and regulators may also benefit from a comparison of the relative adoption impacts of existing and potential future policies. In addition, affordability of energy bills is key to effective building decarbonization policy, so we propose studying how to proactively conduct electrification at the community level with full community support to avoid natural gas pipeline investments and help keep energy bills affordable.

EPIC funds are critical to advancing research on building electrification due to the lack of other funders, the importance of this research for California policy, and the position of California as a world leader in this field. At Resources for the Future, we have developed research proposals and partnerships to pursue this research agenda, but we have found that it is a difficult environment for funding long-term decarbonization research given the many competing priorities of foundations and the rejection of climate science in the federal government under the Trump administration. In addition, California is the ideal place to study these issues.

There is a critical policy need for this research in California since adoption of heat pumps remains low despite a statewide goal of 6 million heat pumps by 2030. At the same time, California is a leader in the building electrification space, and there are many existing incentives across California jurisdictions that researchers can leverage to conduct analysis on the causal impacts of certain policies. California's leadership in the building decarbonization space has influenced – and we hope will continue to influence – the rest of the country and the international community to advance building decarbonization.

4. In accordance with Senate Bill 96[i], please describe how the proposed concept will "lead to technological advancement and breakthroughs to overcome barriers that prevent the achievement of the state's statutory energy goals." For example, what technical and/or market barriers or

customer pain points would the proposed concept address that would lead to increased adoption of clean energy technology or innovation? Where possible, please provide specific cost and performance targets that need to be met for increased industry and consumer acceptance. For scientific analysis and tools, provide more information on what data and information gaps the proposed concept would help fill, and which specific parties or end users would benefit from the results, and for what purpose(s)?

The proposed concept would address numerous market barriers, barriers related to contractor technical skill, and customer pain points. Financial barriers to heat pump adoption include upfront technology costs and electricity rate design. Non-financial barriers include frictions related to filing to receive incentives, the time it takes to replace a natural gas water heater or HVAC system with a heat pump relative to a natural gas alternative, gaps in consumer knowledge, and insufficient contractor workforce knowledge and training. There are also information and communication barriers to coordinating heat pump adoption to more cost-effectively achieve building electrification by avoiding natural gas pipeline investments. We propose analyzing the relative contributions of these financial and non-financial barriers to slowing adoption and the role and design of policies that target specific barriers on adoption decisions. We also propose to develop and test methods for coordinating building electrification to maximize its benefits and avoid untenable natural gas bills for the remaining natural gas utility customers.

We believe the research is not sufficiently advanced to identify cost and performance targets required for industry and consumer acceptance. Instead, this concept focuses on identifying costs and non-financial factors that are typically not included in engineering models yet nonetheless act as important barriers to building electrification.

This research addresses important information gaps regarding how well contractors and customers understand the opportunities to get incentives to install heat pumps and the opportunities that this relatively new technology provides to reduce energy costs and improve delivery of heating and cooling services.

The research described in this concept would benefit multiple parties. Households and businesses will benefit from having more efficient

heating, ventilation, and air conditioning (HVAC) technologies. Contractors will benefit from being able to access incentives and get more customers. In addition, the entire state and world will benefit from the resulting mitigation in climate change and from California reaching its clean energy targets.

5. Please describe the anticipated outcomes if this research concept is successful, either fully or partially. For example, to what extent would the research reduce technology or ratepayer costs and/or increase performance to improve the overall value proposition of the technology? What is the potential of the innovation at scale? How will the innovation lead to ratepayer benefits in alignment with EPIC's guiding principles to improve safety,[ii] reliability,[iii] affordability,[iv] environmental sustainability,[v] and equity?[vi]

   If this research concept is successful, it will create knowledge that will serve to increase adoption of heat pumps, reduced utility bills for many consumers due to more efficient heating and cooling and less investment in low-utilization natural gas pipelines, helps to meet the state's clean electricity and net zero greenhouse gas emissions goals, and improve resource adequacy and reliability by making electricity demand less sensitive to extreme temperatures.

6. Describe what quantitative or qualitative metrics or indicators would be used to evaluate the impacts of the proposed research concept.

   Metrics that could be used to evaluate the impacts of the proposed research concept include the number of heat pumps installed in California, the total dollar amount of incentives for heat pumps issued, and the number of contractors who install heat pumps, and the estimated share of contractors and customers with accurate knowledge about heat pumps and incentives, which could be determined in a survey.

7. Please provide references to any information provided in the form that supports the research concept's merits. This can include references to cost targets, technical potential, market barriers, equity benefits, etc.

   Antonopoulos, Chrissi A.,Tracy L. Fuentes, Kieren H. McCord, Adrienne L.S. Rackley, and Saurabh Biswas (2024). "Regional assessment of household energy decision-making and technology adoption in the United States." *Energy Policy*, 185: 2-13. DOI: https://doi.org/10.1016/j.enpol.2023.113940

Canary Media (2024). “California Unveils First State Plan to Unleash Heat Pumps.” *Canary Media*. April 19, 2024.

Casquero-Modrego, Núria, Chrissi Antonopoulos, Tracy L. Fuentes, Kieren H. McCord, and Iain S. Walker (2025). “Decarbonizing residential buildings in the United States: A comparative analysis of households and construction professionals.” *Energy Research & Social Science*, 120:1-12. DOI: https://doi.org/10.1016/j.erss.2024.103908.

Davis, Lucas W. “What Matters for Electrification? Evidence from 70 Years of U.S. Home Heating Choices.” *The Review of Economics and Statistics,* 107(3): 668–684. DOI: https://doi.org/10.1162/rest_a_01292

Knittel, Christopher R., Johnattan Ontiveros, Juan Palacios, and Siqi Zhen. “Learning by Doing: Contractors’ Learning in Heat Pump Installations.” Working Paper.

8. The EPIC 5 Investment Plan must support at least one of five Strategic Goals:[vii]
    a. Transportation Electrification
    b. Distributed Energy Resource Integration
    c. Building Decarbonization
    d. Achieving 100 Percent Net-Zero Carbon Emissions and the Coordinated Role of Gas
    e. Climate Adaptation

    Please describe in as much detail as possible how your proposed concept would support these goals.

The proposed concept would primarily focus on c., the Building Decarbonization goal. Heat pumps are critical to decarbonizing the building stock, and California is currently behind on its heat pump targets. For the reasons described above, this research concept would advance knowledge and, thereby, policy to achieve widespread building decarbonization

This work also supports d., the goal of Achieving 100% Net Zero Carbon Emissions and the Coordinated Role of Gas. By analyzing how to achieve support to electrify all buildings in a community, the research under this concept would help utilities and the CPUC identify which potential gas pipeline investments to avoid and how to cost-effectively coordinate community electrification with full support from the community.

About EPIC

The CEC is one of four EPIC administrators, funding research, development, and demonstrations of clean energy technologies and approaches that will benefit electricity ratepayers of California's three largest investor-owned electric utilities.

EPIC is funded by California utility customers under the auspices of the California Public Utilities Commission.

To learn more about EPIC, visit: https://www.energy.ca.gov/programs-and-topics/programs/electric-program-investment-charge-epic-program

EPIC 5 documents and event notices will be posted to: https://www.energy.ca.gov/proceeding/electric-program-investment-charge-2026-2030-investment-plan-epic-5

Subscribe to the EPIC mailing list to stay informed about future opportunities to inform the development of EPIC 5: https://public.govdelivery.com/accounts/CNRA/signup/31897

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i See section (a) (1) of Public Resources Code 25711.5 at: https://leginfo.legislature.ca.gov/faces/codes_displaySection.xhtml?lawCode=PRC&sectionNum=25711.5.

ii EPIC innovations should improve the safety of operation of California's electric system in the face of climate change, wildfire, and emerging challenges.

iii EPIC innovations should increase the reliability of California's electric system while continuing to decarbonize California's electric power supply.

iv EPIC innovations should fund electric sector technologies and approaches that lower California electric rates and ratepayer costs and help enable the equitable adoption of clean energy technologies.

v EPIC innovations should continue to reduce greenhouse house gas emissions, criteria pollutant emissions, and the overall environmental impacts of California's electric system, including land and water use.

vi EPIC innovations should increasingly support, benefit, and engage disadvantaged vulnerable California communities (DVC). (D.20-08-046, Ordering Paragraph 1.) DVCs consist of communities in the 25 percent highest scoring census tracts according to the most recent version of the California Communities Environmental Health Screening Tool (CalEnviroScreen), as well as all California tribal lands, census tracts with median household incomes less than 60 percent of state median income, and census tracts that score in the highest 5 percent of Pollution Burden within CalEnviroScreen, but do not receive an overall CalEnviroScreen score due to unreliable public health and socioeconomic data.

vii In 2024 the CPUC adopted five Strategic Goals to guide development of the EPIC 5 Investment Plan. A description of the goals can be seen in Appendix A of CPUC Decision 24-03-007 available at: https://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M527/K228/527228647.PDF