

DOCKETED

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Whole-Life Carbon Calculations and Refrigerant Management for Heat Pump Systems

Additional submitted attachment is included below.



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.

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:

William Healy
Whealy@trccompanies.com
(609) 824-1852

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

TRC

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?

Whole-Life Carbon Calculations and Refrigerant Management for Heat Pump Systems

Heat pump technology is a key technology for decarbonizing the building sector by eliminating on-site combustion, but current refrigerants used in those systems are themselves potent greenhouse gases when released into the atmosphere. Additionally, next-generation refrigerants require different designs that may impact the embodied carbon of the equipment

using them. A challenge faced by the industry is developing standardized approaches to represent the carbon impact of heat pump space and water heating systems that consider both the embodied carbon of manufacture, emissions associated with the operation of the systems, and the impact of potential refrigerant leaks. Research would be undertaken to determine the best ways to develop metrics for a range of interested parties (e.g., policy makers, program developers, equipment vendors, designers). A key aspect of this work is the challenge in using new low- and ultra-low GWP refrigerants, and a parallel research track should be undertaken on identifying the barriers to adoption of these new refrigerants, obtaining data on leakage of refrigerants, and developing guidance and standards for the effective use of these refrigerants.

EPIC funding would accelerate research on both carbon metrics for HVAC and water heating by applying this R&D to determine its viability. Likewise, the use of next-generation refrigerants would benefit from lessons learned via technology demonstration and deployment, and a path to market could be accelerated with EPIC funding through the development of guidelines and standards on the implementation of carbon metrics for building systems and the use of alternative refrigerants.

4. In accordance with Senate Bill 96ⁱ, 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 concerns that the movement towards refrigeration-based heating systems may not achieve building decarbonization goals because of life-cycle impacts that are not considered when focusing purely on Tier 1 and Tier 2 emissions. Additionally, the research would mitigate emissions associated with refrigerants by collecting data on leakage and developing guidelines for use of low- and ultra-low-GWP refrigerants. It would be expected that demonstrations and guidance would identify ways for building owners to incorporate advanced heat pumps. Ideally, costs, efficiency, and capacity

of equipment using new refrigerants would match those of equipment currently used.

The information developed on assessing life cycle carbon emissions would improve estimates of life-cycle emissions for policy makers and program developers, in particular. Information on refrigerant leakage rates would inform the development of life cycle assessments and could provide program implementers a target to assess their efforts. Improved guidelines developed from the research would aid building designers, installers, and owners in deciding on the use of equipment with alternative refrigerants.

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}

Development of clear methods for determining carbon impact will minimize the chance of unintended environmental sustainability consequences from a movement towards heat pump technology for space and water heating. Developing this information on whole-life carbon and refrigerant management could save ratepayers costs in the long-run by minimizing the need for future changes to heat pump systems should there be a desire to move toward ultra-low GWP refrigeration. The research would improve the safe implementation of technologies and could open up opportunities for implementation of systems with lower first costs and maintenance costs if more refrigerant options are identified.

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

Revised estimates of leakage rates and emissions impacts from systems using a variety of refrigerants.

Development of a draft method to assess carbon emissions from heat pump systems that could be shared with an appropriate developer of standards or guidelines.

Demonstration of use of ultra-low GWP refrigerants and development of guideline for their appropriate application.

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.

Mies, Z., Barker, G., Okada, D. CalNEXT: 2024 Portfolio Enhancements TPM, Report #ET24SWE0050, December 11, 2024.

[2024-Portfolio-Enhancements-TPM-December-27-2024.pdf](#)

Discussions on pp. 16-18 and pp. 22-25 highlight the immediate research needs for refrigerants and embodied carbon, respectively.

ASHRAE Position Document on Building Decarbonization, January 2024:
[pd-on-building-decarbonization-english.pdf](#)

Recommends

“standardization of measurement and labeling of embodied carbon in building materials, systems, and equipment.”

“Develop the data and methods needed for calculating practical, repeatable, and verifiable procedures for estimating embodied carbon in HVAC&R equipment and mechanical systems.’

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.

This idea would focus on Building Decarbonization by considering whole-life impact of heat pump systems and minimizing impacts associated with refrigerant leakage.

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>

i See section (a) (1) of Public Resources Code 25711.5 at:

https://leginfo.legislature.ca.gov/faces/codes_displaySection.xhtml?lawCode=PRC§ionNum=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>