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Researching alternative solutions to the boiler problem

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.

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:

   Sasha Baroiant
   sasha.baroiant@qualuscorp.com
   916-216-7939

2. Please provide the name of the contact person's organization or affiliation:
   Qualus, LLC (www.Qualuscorp.com)

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?

   With the passage of Senate Bill 48, California is progressing toward enacting existing building standards that will promote substantial decarbonization of buildings larger than 50,000 ft^2 by 2045. While many single-story buildings can decarbonize using heat pumps, a significant portion of large properties rely on central boilers for space heating. Currently, cost-effective options for electrification lacking due to:

   - High operating costs of electric boilers compared to gas.

- Limited availability of qualified design/build firms for heat pump systems.
- Performance gaps due to lacking experience in design or installation.
- Space constraints for air-to-water heat pumps.
- Inability of some heat pumps to meet high-temperature water needs without costly retrofits.

Thus, we have “the boiler problem.” The market lacks cost-effective solutions to electrify buildings with central plants.

This project aims to solve the “boiler problem” by identifying and evaluating integrated, cost-effective electrification strategies for central plants. The study will include two phases. Phase I will explore the technical, economic, and social feasibility of electrical integration solutions such as:

- Electric boilers coupled with on-premises or shared generation and storage
- Waste heat recovery from small data centers with water-cooled chips.
    - The data center may serve as a load flexibility resource in summer, and a heating source in winter. It is a load flexibility resource that offers free computing, rather than vice versa.
    - Explore a business model where companies with intensive computing needs may opt to push computing to these small heating data centers to reduce their carbon footprint.
- Waste heat recovery from commercial refrigeration.
- Two-way EV charging to offset peak heating load.
- Gathering and disseminating best practices for air-to-water heat pump design and installation.

If funding and time are available, a second phase (Phase II) would involve field testing a subset of the solutions that were studied in Phase I. The field test would provide valuable real-world experience with these novel solutions. And could serve as a road map implementation at the scale necessary for California to meet its statutory goals in building decarbonization.

EPIC funds are needed because most commercial solutions advocate a single-technology or approach. All our proposed solutions involve the coordination of multiple systems that, traditionally, are not provided by a single firm. The project goal is to educate the market and to develop prescriptive approaches or model business partnerships that can facilitate

efficient, unified approaches to solving the boiler problem. The cost would be $500,000 to $900,000. Phase II would have higher costs, $1M to $4M, to allow for recruitment, incentives to offset design and implementation costs, and in-depth analyses, and reporting.

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 directly addresses several critical technical and market barriers currently limiting the decarbonization of large buildings with central plants:

- **High cost and inefficiency of existing electrification options:** Electric boilers are affordable but costly to operate and may require upgrades to the building's electric service. Air-to-water heat pumps also require significant retrofits, physical space, and often fail to meet high-temperature water needs without added expense. By exploring integrated solutions, including staged electric boilers paired with shared storage, waste heat recovery from data centers and commercial refrigeration, and two-way EV charging, we seek to unlock economically viable pathways for electrification that go beyond single-technology approaches.
- **Fragmented market and lack of unified solutions:** Currently, electrification efforts are siloed by technology providers, making it difficult to coordinate systems and business models that leverage multiple resources efficiently. Our concept will fill this gap by researching integrated, multi-system solutions and developing prescriptive frameworks and partnership models to facilitate market adoption.
- **Data and knowledge gaps:** There is limited real-world data on techno-economic performance and applicability conditions of combining these diverse technologies in commercial buildings. This project will generate valuable insights into cost-performance tradeoffs, operational strategies, and tenant impacts that will benefit building owners, utilities, policymakers, and technology providers in making informed decisions.

Performance and cost targets that would drive broader adoption include:

- Electric boiler operation cost reduced by at least 20–30% through strategic pairing with storage and load flexibility.
- Demonstrated feasibility of waste heat capture from data centers and refrigeration at scale, recovering at least 50% of heating load during winter months.
- Viable two-way EV charging integration reducing peak electric heating demand by 10–20%.

The project will particularly benefit tenants and owners of large multifamily and commercial buildings, utilities managing grid impacts of electrification, and policymakers advancing California's decarbonization goals.

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 successful, this project will:

- Accelerate decarbonization of large buildings by validating integrated electrification strategies.
- Provide multiple solutions to retrofits of boilers in large commercial buildings, which account for 20% of all commercial gas usage.
- Improve affordability through cost-effective retrofits and reduced energy costs.
- Enhance environmental sustainability by reducing GHG and pollutant emissions.
- Support equity by minimizing tenant displacement and enabling upgrades in disadvantaged communities.
- Improve safety and reliability by leveraging flexible resources (e.g., batteries, EVs) to manage grid impacts and reduce peak loads.
- Reduce grid impacts from large, standalone data centers by creating small, distributed data centers.

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

Quantitative Metrics:

- Solution applicability (% of market saturation)
- Site energy impacts, both gas and electric
- Greenhouse gas reductions
- Economic feasibility indicators such as IRR, SIR, simple payback, NPV, as well as comparison of first cost

Qualitative / Semi-Quantitative Metrics

- Likelihood of tenant displacement due to retrofit (we expect many solutions to be superior to air-to-water heat pump installation) in this regard
- Increased power resiliency for solutions with load flexibility or energy storage.
- Business process risk: the risk that disparate market actors do not come together to develop a systemic approach. For example, EV warranties that may disallow bidirectional charging or utility companies having rigid or punitive terms related to battery backup availability.

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.

Research Merits

Recent studies and demonstration projects have identified significant barriers to electrifying central plants in large buildings, validating the need for targeted research and innovation. However, these efforts often focus on single-technology solutions or lack integration across systems. The proposed concept builds on this foundation by exploring multi-system coordination, novel business models, and prescriptive frameworks to overcome market fragmentation.

1. **ETCC Demonstration Project: Electrifying Large Commercial Central Plants (2024)**
   The ETCC's TIER concept demonstrates the potential of integrated systems like heat recovery chillers and thermal storage but highlights the need for design support and market coordination.
   Source: ETCC California (https://etcc-ca.com/reports/electrifying-large-commercial-central-plants-demonstration-tier-and-program-delivery)
2. **Better Buildings Summit 2025 – Central Plant Retrofit Working Group**
   This national initiative underscores the importance of phased central plant upgrades for emissions reduction and resilience, reinforcing the need for prescriptive planning and stakeholder alignment.
   Source: Better Buildings Solution Center

(https://betterbuildingssolutioncenter.energy.gov/sites/default/files/2025-05/2025Summit-Prioritizing_Central_Plant_Efficiencies-Slides.pdf)

Technical Potential

According to data from the 2022 California Commercial End-Use Survey (CEUS), approximately 4 x 10^{13} BTU are attributable to boilers in the commercial sector (excluding multifamily housing). This is approximately 20% of all commercial gas usage.

Source: 2022 California Commercial End-Use Survey (CEUS): Final Report | California Energy Commission (https://www.energy.ca.gov/publications/2023/2022-california-commercial-end-use-survey-ceus-final-report)

Market Barriers

The DOE Boiler Electrification Guide (2023) outlines the challenges of retrofitting large commercial buildings with electric heating systems, emphasizing the lack of cost-effective and scalable solutions for existing central plants.

Source: U.S. Department of Energy (https://www.energy.gov/eere/buildings/articles/large-commercial-building-boiler-electrification-guide)

Equity Benefits

According to the VEIC Low-Income Multifamily Housing Characteristics Study, over 90% of LMI households in California's multifamily buildings are renters, and many reside in buildings with centralized gas-fired DHW systems. These buildings often face space and infrastructure constraints that complicate electrification. Retrofit efforts must be designed to avoid tenant displacement and minimize cost burdens.

Source: CalNEXT Low-Income Multifamily Housing Characteristics Study (https://www.veic.org/Media/Default/Reports/CalNEXT%20-%20Low-Income%20Multifamily%20Housing%20Characteristics%20Study.pdf)

The REALIZE-CA program demonstrated that integrated retrofit packages could reduce emissions and improve tenant comfort while preserving affordability. Our proposal builds on these insights by exploring novel, space-efficient solutions—such as waste heat recovery and two-way EV charging—that can be deployed with minimal disruption in disadvantaged communities.

Source: REALIZE-CA Report (https://www.energy.ca.gov/sites/default/files/2025-06/CEC-500-2025-028.pdf)

8. The EPIC 5 Investment Plan must support at least one of five Strategic Goals:[vii]
    a. Transportation Electrification
        i. One of our proposed solutions would involve cost sharing for EVSE, as bi-directional chargers would be needed to offset electric boiler loads.
    b. Distributed Energy Resource Integration
        i. One of our proposed solutions would involve shared generation and storage resources.
        ii. The heating-focused data centers could be a source of load flexibility. For example, the load could be reduced, managed, or shed entirely in the summer season.
    c. Building Decarbonization
        i. The project goal is to solve the most challenging economic problem associated with building decarbonization. The study will calculate the lifetime GHG benefits associated with acceleration of retrofits, compared to waiting for conventional solutions to the “boiler problem” to reach scale and maturity.
    d. Achieving 100 Percent Net-Zero Carbon Emissions and the Coordinated Role of Gas
        i. If cost-effective alternatives exist for changing boilers in central plants, then this could minimize the occurrence of large multifamily communities or even other buildings, particularly in urban areas, becoming “stranded” on gas infrastructure.
    e. Climate Adaptation:
        i. Solutions that involve behind-the-meter storage and two-way charging are more resilient to extreme weather, grid stress, and public safety power shutoffs. In addition, this project strives to accelerate building decarbonization.

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

This concept represents a timely and necessary step toward solving one of California’s most persistent building-decarbonization challenges. By leveraging EPIC 5 funding, we aim to deliver scalable, equitable, and cost-effective solutions that will benefit ratepayers, reduce emissions, and support the state’s climate and energy goals.

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