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UCSD Research Concept Proposal Form

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:

   Jan Kleissl, jkleissl@ucsd.edu, 619-376-3971

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

   University of California, San Diego

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?

The proposed concept is to develop advanced machine learning models for autonomous smart inverter operation leveraging high-resolution, time-domain power meter data. Unlike conventional power monitors—typically sampling once per power cycle—time-domain power meters collect data at kilo-samples-per-second rates, enabling the detection of rapid system phenomena such as sub-cycle transients, bidirectional energy flows, reverse power, and oscillations caused by nonlinear loads or distributed energy resources (DERs). The purpose of this concept is to enable smarter, more adaptive inverter controls to enhance grid stability and DER integration.

Development and testing of these novel approaches on a real-world programmable microgrid—such as the UCSD DERConnect facility—can rigorously validate algorithms under realistic operating conditions, helping to derisk technology performance, deployment, and industry adoption. By bridging the gap between simulation and field deployment, the project will accelerate commercialization and grid readiness for utilities and developers.

EPIC funds are necessary to support this concept because there is a lack of industry investment in fundamental, open-source research that addresses interoperability and system-wide coordination challenges at high DER penetrations.

4. In accordance with Senate Bill 96[1], 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)?

This concept will accelerate technological advancement by addressing the following barriers:

- Technical Barriers:
    - Today's smart inverters lack real-time coordination, potentially causing instability when distributed energy resources (DERs) reach high penetration levels.
    - Existing phasor-based meters miss rapid power system phenomena, limiting timely response and adaptive management.
- Market Barriers / Customer Pain Points:
    - Uncoordinated DER operation can cause grid instability, resulting in long interconnection approval times and slowing renewable energy adoption.

[1] 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.

        - CA ratepayers and DER developers face delays, increased costs, and uncertainty about project integration.
    - Cost and Performance Targets:
        - The project aims to reduce interconnection delays by at least 50% and improve grid reliability metrics (e.g., voltage/frequency excursion reduction by 30%).
        - Enable real-time collaborative control among DERs, matching or exceeding IEEE 1547.2018 compliance at scale.
    - Data Gaps and Beneficiaries:
        - The concept fills gaps in real-time system visibility and coordinated control capability. Utilities, DER operators, and grid planners benefit from actionable analytics, faster integration, and lower grid management costs.

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,[2] reliability,[3] affordability,[4] environmental sustainability,[5] and equity?[6]

If successful, the research will:

- Reduce risks and costs for DER grid integration by reducing the complexity of interconnection studies.

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[2] EPIC innovations should improve the safety of operation of California's electric system in the face of climate change, wildfire, and emerging challenges.
[3] EPIC innovations should increase the reliability of California's electric system while continuing to decarbonize California's electric power supply.
[4] 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.
[5] 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.
[6] 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.

- Increase grid stability and reliability at high DER penetration.
- Improve technology value by enabling autonomous coordination among DERs.
- Support scalable renewables and DER adoption, directly advancing California's statutory energy goals.
- Deliver ratepayer benefits in line with EPIC principles:
    - Safety: Minimized grid events and outages.
    - Reliability: Adaptive, stable grid operations.
    - Affordability: Lower integration and operational costs.
    - Environmental Sustainability: Higher renewable energy adoption.
    - Equity: High penetrations of smart, coordinated DERs can significantly reduce the need for costly grid infrastructure upgrades (such as new substations, transformers, or feeder expansions). By optimizing grid performance and minimizing congestion or overloading through real-time analytics and autonomous operation, these technologies lower overall system costs. This helps make energy more affordable for all ratepayers, including historically underserved communities, thereby supporting broader energy equity and access.

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

Metrics to evaluate the concept include:

- Reduction in DER interconnection time.
- Frequency and magnitude of grid stability events (voltage, frequency excursions).
- Accuracy and speed of detection for transients, reverse power flow, and oscillations.
- Cost per MW of DER integrated post-deployment.
- Improvement in DER/renewable capacity utilization.
- Qualitative metrics: Stakeholder satisfaction, equity of access, reproducibility of analytics.

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.

- IEEE 1547.2018 Standard: Criteria for DER Interconnection

- Official Standard: IEEE 1547-2018 https://standards.ieee.org/standard/1547-2018.html

8. The EPIC 5 Investment Plan must support at least one of five Strategic Goals:[7]
    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

This concept supports multiple EPIC 5 Strategic Goals:

- Distributed Energy Resource Integration: Improves grid management and DER adoption.
- Achieving 100 Percent Net-Zero Carbon Emissions: Accelerates renewable deployment by overcoming interconnection barriers.
- Climate Adaptation: Builds grid resilience using real-time analytics and adaptive control.

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

[7] 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

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:
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