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Develop a next-generation nonflammable lithium-ion battery

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:

   Dr. Yongchun Tang, tang@peeri.org, 626-695-4539

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

   Power Environmental Energy Research Institute (PEERI)

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?

   We propose a next-generation **nonflammable lithium-ion battery** that uses an **ionic liquid-based electrolyte** and a **silicon/carbon (Si/C) composite anode**, fully compatible with existing manufacturing processes and supply chains. The concept enhances safety by eliminating flammable solvents, while enabling fast charging, high-temperature stability, and excellent compatibility with **high-nickel cathodes** to achieve higher energy densities. EPIC funding is needed to optimize the electrolyte formulation, validate full-cell performance, and demonstrate seamless integration into current EV platforms—accelerating the deployment of safer, high-

performance batteries across California's zero-emission transportation sector.

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 addresses key technical and market barriers to the broader adoption of clean transportation by developing a nonflammable, fast-charging lithium-ion battery that is drop-in compatible with existing EV systems. Conventional lithium-ion batteries use flammable organic electrolytes, creating fire risks—especially under fast charging or thermal stress. These safety concerns undermine consumer confidence, slow fleet electrification, and limit deployment in disadvantaged communities with limited emergency response capacity due to fire safety concerns. Our ionic liquid-based electrolyte provides inherent thermal stability, non-flammability, and high-voltage tolerance, enabling safer, longer-lasting batteries that are compatible with high-nickel cathodes for targeting energy densities of ~300 Wh/kg and charging times under 20 minutes.

   This concept supports Senate Bill 96 by delivering a technological breakthrough in battery safety without requiring new manufacturing infrastructure, thereby lowering costs and accelerating deployment. It also fills critical data gaps in electrolyte performance at elevated temperatures, abuse tolerance, and long-term cycling under fast-charging conditions. The results will benefit battery manufacturers, EV OEMs, and fleet operators by enabling safer, high-performance battery systems and will advance California's goals for transportation electrification, GHG reduction, and energy equity in frontline communities.

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, the proposed research will deliver a nonflammable, fast-charging lithium-ion battery that improves safety, performance, and cost-effectiveness without requiring changes to existing EV manufacturing infrastructure. By replacing flammable electrolytes with thermally stable ionic liquids, the technology significantly reduces fire risk, lowering system-level insurance, cooling, and safety management costs. It also targets ~300 Wh/kg energy density and <20-minute charging, enhancing vehicle range, fleet efficiency, and user convenience. At scale, the innovation could reduce total battery system costs by 10–20%, while improving lifespan and operational safety—translating into lower EV and charging infrastructure costs for consumers and fleet operators.

Aligned with EPIC's guiding principles, the technology improves safety and reliability in energy storage, enhances environmental sustainability by enabling longer battery life and reduced material waste, and promotes equity by supporting safer EV deployment in disadvantaged communities. It strengthens California's clean transportation ecosystem while maximizing ratepayer value through cost reductions, emissions mitigation, and resilient infrastructure development.

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

Quantitative Metrics

- Cell-level energy density: Targeting ≥ 300 Wh/kg
- Fast-charging performance: Achieving < 20-minute charge to 80%
- Cycle life: >2,000 cycles with >80% capacity retention
- Thermal stability: No thermal runaway up to ≥ 150 °C
- Nail penetration test: No fire or explosion under standard abuse conditions
- Cost impact: ≥ 10–20% reduction in system-level battery cost
- Adoption readiness: Compatibility with ≥ 90% of existing EV platforms or production lines

Qualitative Indicators

- Ease of manufacturing integration (drop-in compatibility with current processes)
- Stakeholder feedback from battery OEMs, EV manufacturers, and fleet operators

- Progress toward commercialization (e.g., pilot-scale validation, industry partnerships)
- Equity impact: Potential for deployment in frontline or underserved communities

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.

   (1) **Cost Targets:** NREL projects pack-level battery costs dropping to ~$100/kWh by 2030, with improvements in energy density and safety being key enablers (NREL, 2023).
   (2) **Technical Potential:** DOE Battery500 Initiative targets ≥300 Wh/kg using high-nickel cathodes and Si/C anodes, validating the proposed energy density and materials approach (DOE, 2020).
   (3) **Market Barriers:** DOE Energy Storage Grand Challenge and Storage Shot identify fire risk, fast-charging limitations, and safety concerns as major adoption barriers (DOE Energy Storage Grand Challenge,2020)
   (4) **Scalability:** The proposed concept builds on existing lithium-ion production lines, avoiding retooling costs and enabling rapid deployment. Ionic liquids can be synthesized at scale through modular chemical processes. The DOE Industrial Base and Supply Chain Report emphasizes the importance of drop-in, manufacturing-ready innovations for accelerating domestic battery deployment (DOE, 2022).
   (5) **Equity benefits:** CEC EPIC Investment Plan and DOE Justice40 Initiative emphasize the need for clean, safe, and affordable energy solutions in frontline and underserved communities. The proposed nonflammable, drop-in battery technology aligns directly with these goals. (DOE Justice40 Initiative, CEC EPIC Program).

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 directly supports the EPIC 5 Strategic Goal of Transportation Electrification by enabling the development of a nonflammable, fast-charging, high-energy-density lithium-ion battery that is drop-in compatible with current EV platforms. By replacing flammable organic solvents with a thermally stable ionic liquid electrolyte, the battery significantly improves operational safety, particularly under fast-charging and high-temperature conditions—addressing a major barrier to the widespread deployment of electric vehicles in both consumer and commercial sectors.

The use of high-nickel cathodes and a Si/C composite anode allows the battery to target cell-level energy densities of ~300 Wh/kg, while maintaining charging times under 20 minutes. These improvements enhance driving range, fleet efficiency, and user convenience, which are critical to achieving mass adoption of EVs, especially in transit, last-mile delivery, and rideshare applications.

Furthermore, the battery's nonflammable and robust thermal properties make it ideal for deployment in public charging hubs, disadvantaged communities, and high-traffic fleet depots, where fire safety, durability, and resilience are essential. By offering a solution that enhances safety, performance, and integration ease, the concept supports the scale-up of electric transportation infrastructure, reduces emissions, and ensures more equitable access to clean mobility—advancing California's goals under SB 100, SB 96, and the ZEV Action Plan.

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