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Proactive Power System Planning for Diverse EV Integration

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:

   Zuzhao Ye, PhD
   zye@amptrans.net
   (347)200-1848

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

   AmpTrans

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?

   This research concept develops advanced modeling and planning tools to proactively integrate diverse electric vehicle (EV) types and charging patterns into California's power grid. The concept addresses the critical need for utilities to anticipate and plan for heterogeneous EV adoption patterns, including passenger vehicles, commercial fleets, heavy-duty trucks, and emerging vehicle categories. EPIC funds are needed because current planning methodologies lack the sophistication to model diverse EV charging behaviors, spatial-temporal distribution patterns, and

grid interaction dynamics at the scale required for California's ambitious electrification goals.

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 barriers preventing optimal EV-grid integration:

   Technical Barriers:
   - Lack of predictive models for diverse EV charging demand patterns across vehicle types and use cases
   - Insufficient grid planning tools that account for bidirectional power flows from vehicle-to-grid (V2G) capabilities
   - Limited understanding of charging infrastructure optimal placement considering grid constraints

   Market Barriers:
   - Uncertainty in utility investment planning due to unpredictable EV adoption patterns
   - Suboptimal charging infrastructure deployment leading to grid stress and customer dissatisfaction

   Performance Targets:
   - Reduce grid upgrade costs by 20-30% through optimized planning
   - Increase grid hosting capacity for EVs by 40% without infrastructure reinforcement
   - Enable 95% EV charging demand accommodation during peak periods without grid reliability impacts

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]

Successful outcomes would include:

- **Affordability:** Reduced utility infrastructure costs passed to ratepayers through optimized grid investments
- **Reliability:** Enhanced grid stability through predictive load management and V2G integration
- **Safety:** Improved system operation during extreme weather events using distributed EV storage
- **Environmental Sustainability:** Accelerated clean transportation adoption through reduced grid barriers
- **Equity:** Optimized charging infrastructure placement prioritizing disadvantaged communities

Potential at Scale: System-wide implementation could save California ratepayers $2-4 billion in avoided grid upgrades while enabling seamless integration of 15+ million EVs by 2035.

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

   Quantitative Metrics:
   - Grid hosting capacity increase (MW/circuit)
   - Infrastructure cost reduction ($/EV integrated)
   - Peak demand reduction through managed charging (MW)
   - System reliability indices (SAIDI/SAIFI improvements)
   - V2G participation rates and grid services provided

   Qualitative Indicators:
   - Utility adoption of planning tools
   - Stakeholder satisfaction with charging infrastructure placement
   - Equity metrics for disadvantaged community access
   - Integration with existing utility planning processes

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] Panossian, N., Muratori, M., Palmintier, B., Meintz, A., Lipman, T., & Moffat, K. (2022). Challenges and opportunities of integrating electric vehicles in electricity distribution systems. Current sustainable/renewable energy reports, 9(2), 27-40. [Online] https://link.springer.com/article/10.1007/s40518-022-00201-2

[2] Kressig, A., Kapiloff, D., & Overturf, E. (2022). Overview of utility transportation electrification plans: Best practices and good examples from across the country. Western Resource Advocates. [Online] https://westernresourceadvocates.org/wp-content/uploads/2022/04/Overview-of-Utility-Transportation-Electrification-Plans_Final.pdf

[3] Zhang, Q., Yan, J., Gao, H. O., & You, F. (2023). A systematic review on power systems planning and operations management with grid integration of transportation electrification at scale. Advances in Applied Energy, 11, 100147. [Online] https://www.sciencedirect.com/science/article/pii/S2666792423000264

[4] Hernandez, M. (2022) Emerging best practices for electric vehicle charger interconnection. [Online] https://irecusa.org/wp-content/uploads/2022/06/EV-Paper-3-Charger-Interconnection_compressed.pdf

[5] Penrod, E. (2024). Grid, utility limits are biggest barrier to commercial EV charger deployment: Xendee survey. Utility Dive. [Online] https://www.utilitydive.com/news/grid-utility-ev-charger-development-xendee-survey/719708/

[6] New York Public Service Commission. (2024, August 15). Order establishing proactive planning proceeding (Case 24-E-0364). State of New York Public Service Commission. [Online] https://documents.dps.ny.gov/public/Common/ViewDoc.aspx?DocRefId=%7B80465791-0000-C51E-B4A0-7B56E347E0F5%7D

[7] California Public Utilities Commission. (2024, September 13). CPUC releases proposed decision to improve the utility distribution planning (R.21-06-017). [Online] https://www.cpuc.ca.gov/-/media/cpuc-website/divisions/energy-division/documents/infrastructure/distribution-planning/high-der-proposed-decision-fact-sheet-91324.pdf

[8] EPRI. (2024). eRoadMap. [online] http://eroadmap.epri.com/

[9] Ye, Z., Yu, N., & Wei, R. (2024). Joint planning of charging stations and power systems for heavy-duty drayage trucks. Transportation Research Part D: Transport and Environment, Volume 134. [Online] https://www.sciencedirect.com/science/article/pii/S1361920924002773

[10] Electric Trucks Now (2024). States adopting zero-emission truck rules. [Online] https://www.electrictrucksnow.com/states

[11] Wang, W., Ye, Z., Yu, N., & Chen, P. C. (2024). Prediction of electric vehicle penetration and its impacts on distribution systems: A real-world case study in Maryland. In 2024 IEEE Conference on Technologies for Sustainability (SusTech) (pp. 390-396). IEEE. [Online] https://ieeexplore.ieee.org/abstract/document/10553594/

[12] Ye, Z., Yu, N., Wei, R., & Liu, X. C. (2022). Decarbonizing regional multi-model transportation system with shared electric charging hubs. Transportation Research Part C: Emerging Technologies, 144, 103881. [Online] https://www.sciencedirect.com/science/article/pii/S0968090X22002947

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.

    a. Transportation Electrification (Primary):
    Directly enables large-scale EV adoption by solving fundamental grid integration challenges and optimizing charging infrastructure deployment.
    b. Distributed Energy Resource Integration (Primary):
    Treats EVs as distributed energy resources, developing tools to maximize their grid benefits through managed charging and V2G capabilities.
    c. Building Decarbonization (Supporting):
    Supports electrification of building-related transportation (delivery vehicles, residential charging) and enables building-grid coordination.
    d. 100% Net-Zero Carbon Emissions (Supporting):

Facilitates transportation sector decarbonization while maintaining grid reliability during the clean energy transition.

e. Climate Adaptation (Supporting):

Enhances grid resilience by utilizing distributed EV storage for emergency services and extreme weather response.

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