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Advanced Joint Routing and Charging Optimization to Accelerate Commercial Fleet Adoption

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:

   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?

   The **Intelligent e-Fleet Operation Platform (IFOP)** is an AI-driven optimization system that simultaneously coordinates vehicle routing and charging infrastructure utilization for commercial electric fleets, especially for large-scale fleets. The platform integrates real-time grid conditions, dynamic electricity pricing, charging infrastructure availability, and operational constraints to minimize total cost of ownership while ensuring reliable fleet operations.

EPIC funds are needed because current fleet management systems treat routing and charging as separate optimization problems, leading to suboptimal decisions that increase costs and reduce grid stability. This research requires significant computational resources, multi-stakeholder coordination, and field demonstrations that are beyond typical private sector R&D capabilities.

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)?

   Technical Barriers:
   - Computational complexity of joint optimization at scale (NP-hard problems with millions of variables)
   - Real-time coordination between transportation and grid systems
   - Uncertainty in charging infrastructure availability and grid conditions

   Market Barriers:
   - High total cost of ownership deterring fleet electrification
   - Range anxiety and operational reliability concerns
   - Lack of integrated tools for fleet operators

   Performance Targets:
   - 15-25% reduction in total fleet operating costs compared to current systems
   - 30% improvement in charging infrastructure utilization rates
   - 95% fleet availability despite charging constraints
   - Integration with 10+ charging network APIs and grid operators

   Data Gaps Addressed:
   - Real-world performance of coordinated routing-charging optimization
   - Grid impact quantification of optimized fleet charging
   - Scalability limits and computational requirements

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:

Cost Reduction:

- 20% decrease in fleet energy costs through optimized charging timing
- 15% reduction in vehicle downtime through predictive charging scheduling
- $1,000,000-8,000,000 annual savings per 100 heavy-duty-vehicle fleet

Performance Improvements:

- Enhanced grid stability through coordinated fleet charging
- Reduced peak demand charges for fleet operators
- Improved charging infrastructure ROI through higher utilization

Ratepayer Benefits Alignment:

- Safety: Reduced grid stress during peak periods, improved wildfire risk management
- Reliability: Vehicle-to-grid capabilities provide emergency backup power
- Affordability: Lower electricity rates through reduced peak demand
- Environmental: Accelerated fleet electrification and renewable energy integration
- Equity: Priority algorithms for disadvantaged community deliveries and services

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

Quantitative Metrics:

- Total cost of ownership reduction (%)
- Charging infrastructure utilization rate (%)
- Grid peak demand reduction (MW)
- Fleet availability/uptime (%)
- Computational efficiency (solutions per second)
- GHG emissions reduction (tons CO2e)

Qualitative Metrics:

- Fleet operator satisfaction surveys
- Grid operator feedback on demand patterns
- Charging network provider adoption rates
- Disadvantaged community service improvement assessments

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] Volteum. (2023). *Route planning for EVs and electric fleets: Why it's different and why it matters*. Volteum. Retrieved August 8, 2025, [Online] https://www.volteum.io/blog/Route-planning-for-EVs-and-electric-fleets-Why-its-different-and-why-it-matters

[2] Anon Y. (2022). *How to decarbonize heavy-duty transport and make it affordable.* [Online] https://www.weforum.org/agenda/2021/08/how-to-decarbonize-heavy-duty-transport-affordable/

[3] Bac, U., & Erdem, M. (2021). Optimization of electric vehicle recharge schedule and routing problem with time windows and partial recharge: A comparative study for an urban logistics fleet. Sustainable Cities and Society, 70, 102883. [Online] https://www.sciencedirect.com/science/article/pii/S2210670721001736

[4] Foda, A., Abdelaty, H., Mohamed, M., & El-Saadany, E. (2023). A generic cost-utility-emission optimization for electric bus transit infrastructure planning and charging scheduling. Energy, 277, 127592. [Online] https://www.sciencedirect.com/science/article/pii/S0360544223009866

[5] Bragin, M. A., Ye, Z., & Yu, N. (2024). Toward efficient transportation electrification of heavy-duty trucks: Joint scheduling of truck routing and charging. Transportation Research Part C: Emerging Technologies, 160, 104494. [Online] https://www.sciencedirect.com/science/article/pii/S0968090X24000159

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 accelerates commercial fleet electrification adoption by reducing barriers and costs. Addresses range anxiety through intelligent charging coordination. Supports California's Advanced Clean Fleets Regulation compliance.

b. Distributed Energy Resource Integration (Supporting)
Enables fleet vehicles as mobile grid resources through V2G capabilities. Coordinates charging with renewable energy availability. Provides grid services through aggregated fleet batteries.

c. Building Decarbonization (Supporting)
Supports electrification of delivery and service fleets serving buildings. Integrates with building energy management systems for holistic optimization.

d. Achieving 100% Net-Zero Carbon Emissions (Supporting)
Accelerates transportation sector clean energy adoption. Optimizes renewable energy utilization through smart charging. Increases overall system efficiency through coordinated operations.

e. Climate Adaptation (Supporting)
Provides mobile power resources for emergency response. Adapts to extreme weather impacts on grid and transportation systems. Supports resilient logistics networks during climate events.

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