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Enabling Closed-Loop Battery Innovation Co-Locating an Advanced Dismantling Line with Californiaâ€™s Pilot Manufacturing Faciliti

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:

   Weikang Li
   weikangli@exposttechnology.com
   858-214-8579

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

   ExPost Technology Inc.

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 an **R&D-centered initiative** to develop and deploy a **fully-automated, self-adaptive battery disassembly line** for lithium-ion batteries, designed to interface seamlessly with California's battery production pilot lines. This platform will feature robotic automation, intelligent material identification, and integrated environmental safety systems, enabling the **safe, precise, and chemistry-agnostic dismantling** of battery packs and cells.

By integrating this system with the state's manufacturing efforts, California can establish a **true closed-loop battery lifecycle**—where scrap and spent batteries from the pilot production lines are efficiently disassembled and prepared for high-yield material recovery. The system will enable the **comprehensive recycling** of cathode and anode active materials, aluminum and copper foil, separator plastics, electrolyte components, and even metal-based casings. This minimizes battery-related waste and environmental risk at the source.

Rather than relying on traditional recycling methods that are energy-intensive, waste-generating, and pollution-prone, this solution offers a **next-generation, high-efficiency, low-impact alternative**—laying the foundation for a **100% recyclable and sustainable electrified future**.

Once the disassembly line is operational, **ExPost's patented direct recycling technology** will process the recovered materials—including production scrap, used cells, and post-consumer batteries—restoring them to **battery-grade quality**. These R&D-driven systems will ensure that **no part of the battery lifecycle leaves California's clean energy ecosystem**, maximizing both environmental and economic benefits for the state.

Realizing this fully automated and environmentally safe battery disassembly system—integrated with ExPost's direct material regeneration technology—requires substantial investment in **R&D, capital equipment, and environmental engineering**. While the technical foundation is in place, **bridging from laboratory validation to real-world deployment** demands public investment to de-risk and accelerate development.

EPIC support will empower ExPost and its partners to:

- Build and pilot the core disassembly infrastructure tailored for California's battery production ecosystem;
- Co-develop and validate recycling integration pathways with the state's manufacturing initiatives;
- Advance and scale direct regeneration processes for cathodes, electrolytes, and other key materials;
- Create **dozens of high-quality R&D jobs** in robotics, automation, chemistry, materials science, and clean process engineering—especially within California's emerging cleantech hubs.

This investment will help **anchor a zero-waste, closed-loop battery economy in California**, reinforcing the state's leadership in sustainable electrification and domestic supply chain resilience.

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)?

To achieve a truly **sustainable battery ecosystem** in California, we must move beyond legacy recycling methods that rely on destructive shredding ("black mass") or thermal incineration. These approaches are not only energy-intensive and environmentally risky, but also waste the remaining functional and structural value of batteries—especially as battery chemistries improve and applications diversify.

Our proposed concept tackles this fundamental technical and market barrier by introducing an **intelligent, automated disassembly platform** into California's battery pilot manufacturing ecosystem. This platform will serve two core purposes:

1. **Processing in-line scrap** from pilot-scale manufacturing (cells/modules not meeting QA/QC standards), enabling closed-loop material flow from Day 1;
2. **Repurposing and recycling of used batteries** (EV and stationary storage), allowing high-quality cells to be rapidly screened and reused, while non-reusable cells are safely dismantled and prepared for high-value direct material recovery.

By integrating adaptive robotics, rapid diagnostics, and format-agnostic design, this system creates a new category of **value-preserving battery processing** that enables:

- Second-life cell reuse pathways for repurposing companies;
- Safer handling of degraded or damaged batteries;
- High-purity material recovery without the pollution or loss of structure inherent in current methods.

Key Technical and Market Barriers Addressed

- **Outdated, low-value recycling methods:**
  Conventional "black mass" or incineration-based processes are inherently destructive, eliminating the possibility of reuse, degrading material quality, and producing secondary pollution.
- **Lack of format flexibility and intelligent sorting:**
  Many recyclers reject batteries that lack high metal value or standardized formats. Our platform is adaptable to pouch, prismatic, and cylindrical cells, and supports a wide range of chemistries—including LFP, LMFP,

and emerging sodium-ion technologies—enabling future-proof recycling infrastructure.

- **Limited support for reuse and repurposing pathways:**
  Today's systems offer no efficient mechanism to identify and recover functional cells for second-life applications. Our solution performs automated pre-sorting and qualification to divert reusable cells from destructive processing, maximizing economic and environmental value.
- **Data gap in real-world degradation and reuse potential:**
  There is limited structured data on battery failure modes and residual performance. Our system collects and generates standardized diagnostic data during disassembly, providing insights for battery design optimization, policy development, and safe second-life deployment.

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]

Anticipated Outcomes and Ratepayer Benefits
If successful, this research concept will demonstrate that **fully automated, intelligent battery disassembly**—paired with ExPost's direct regeneration process—can dramatically improve the economics, safety, and environmental performance of battery lifecycle management in California.

Quantifiable Outcomes (Full or Partial Success):

- **Cost Reduction**:
  Recycling costs will be reduced from ~$2–5/kg to **under $1.5/kg**, and in some scenarios, the process may even become **net-profitable**, fundamentally shifting battery recycling economics in California and globally.
- **Material Recovery Efficiency**:
  Increase in functional material recovery from ~60–70% (mass-based) to **>90%** (functionality-based), especially for cathodes, anodes, foils, enclosures, and even electrolyte.
- **Reuse Enablement**:
  Up to **20–30%** of incoming cells qualified for second-life applications, creating a new supply source for low-cost stationary energy storage.

- **Environmental Benefit**:
  VOC emissions reduced to <10 ppm during disassembly with integrated capture systems; elimination of high-temperature or acid-based processing, which is not favorable in California.
- **Operational Safety**:
  Reduced fire and chemical hazard risk through automation and cell-level diagnostics—compared to manual labor or shredding-based approaches.

Scalability and System-Level Impact:

- The disassembly platform is **modular and chemistry-agnostic**, enabling deployment across multiple battery formats (EVs, BESS, residential storage).
- When scaled statewide, this approach could process **significant amount** of battery waste annually—**generating local jobs, retaining material value**, and reducing California's reliance on foreign raw materials.
- The innovation is also exportable: once validated, the system can be replicated across the U.S. and internationally to promote global battery circularity.

Alignment with EPIC Guiding Principles:

- **Safety**:
  Automation and diagnostics drastically reduce worker exposure to toxic chemicals and thermal runaway risks during battery disassembly.
- **Reliability**:
  Enables reliable supply of recovered materials for California's clean energy infrastructure, particularly grid-scale storage and EV manufacturing.
- **Affordability**:
  Drives down lifecycle costs for battery producers and operators, ultimately reducing ratepayer costs through lower energy storage and disposal fees.
- **Environmental Sustainability**:
  Eliminates secondary waste streams; supports closed-loop circular economy with near-zero emissions and no hazardous effluents.
- **Equity**:
  Localized systems can be deployed in underserved communities near energy infrastructure or e-waste hubs, bringing **high-quality green jobs** to regions historically excluded from clean tech growth.

Even if only partially successful, the project will still deliver:

- A validated, safer disassembly framework that can be extended statewide;
- Diagnostic datasets to inform policy, safety standards, and design-for-reuse strategies;
- Pilot-scale deployment experience to accelerate commercialization and investment readiness;

- A demonstration line capable of processing pilot-line scrap batteries, directly reducing waste management costs for California's battery innovation centers.

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

Metrics for Evaluating Project Impacts
The impact of this research concept will be evaluated through a combination of **quantitative performance metrics** and **qualitative indicators** related to cost, environmental benefit, technology readiness, and social outcomes. Key evaluation metrics include:

Quantitative Metrics
• **Recycling Cost per kg of Battery Material**
Baseline: $2–5/kg (conventional methods)
Target: *<$1.5/kg*, with potential for net profitability in selected chemistries (e.g., LFP)
• **Material Recovery Efficiency (%)**
Baseline: 90% valuable metal recovery rate, including Co, Ni.
Cathode/anode material recovery: *>90%* (by function, not just mass)
Copper/aluminum foil recovery: *>95% purity*
Electrolyte capture and reuse rate: *>50%*
• **Cell Reuse Qualification Rate**
Baseline: none
Percentage of tested cells diverted to second-life applications: *20–30%*
• **VOC / Emissions Concentration During Disassembly**
Baseline: none
Target: *<10 ppm* with integrated capture and monitoring systems
• **Job Creation in R&D and Manufacturing**
Target: *10–20 high-skill R&D and technical positions* in California during the project period
• **Technology Readiness Advancement**
Initial TRL: 5 pre-pilot operation
Target TRL by end of project: *7 (pilot operational scale)*

Qualitative Indicators
• **System Adaptability and Modularity**
Demonstration of disassembly across formats (cylindrical, pouch, prismatic) and chemistries (NMC, LFP, LMFP, sodium-ion)
• **Safety and Risk Mitigation**
Documented reduction in manual handling and fire/explosion risks through automation and diagnostics

• **Community and Stakeholder Engagement**
Inclusion of *local hiring, training programs*, and potential siting in *environmental justice communities*
• **Partnership Development**
Engagement with pilot line manufacturers, second-life battery companies, and public-sector recycling partners
• **Policy and Standards Contributions**
Generation of actionable data to support regulations in:
– Battery design-for-disassembly
– Safe reuse qualification
– Recycling permitting and tracking frameworks

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.

a. Cost and Recovery Efficiency Benchmarks
• U.S. Department of Energy (DOE), *Lithium-Ion Battery Recycling Prize and Battery Recycling R&D Program*.
https://www.energy.gov/eere/vehicles/battery-recycling
→ Provides national recycling cost benchmarks (~$2–5/kg) and outlines performance gaps in existing technologies.
• Circular Energy Storage (2023), *Global Lithium-ion Battery Recycling Market Report*.
→ Indicates that most current recycling solutions are cost-negative and struggle with LFP and non-Ni chemistries.
• ExPost internal R&D data and results under DOE grant DE-EE0009926 (2023–2025).
→ Demonstrates functional material recovery >90% in cathodes, and active reuse potential for cells and foils.

b. Technical Barriers and Market Gaps
• Lawrence Berkeley National Laboratory (2022), *Direct Recycling of Lithium-Ion Batteries: Opportunities and Challenges*.
→ Highlights challenges of current black-mass methods and supports shift toward function-preserving, format-flexible recycling.
• Clean Energy States Alliance (CESA), *Second-Life Applications of EV Batteries for Energy Storage* (2021).
→ Identifies the lack of cell-level diagnostics and sorting infrastructure as a barrier to repurposing.

c. Equity and Workforce Development Benefits
• California Energy Commission, *EPIC 2021–2025 Investment Plan*, Equity Framework.

https://www.energy.ca.gov/publications/2020/electric-program-investment-charge-2021-2025-investment-plan
→ Emphasizes the importance of locating clean energy infrastructure in disadvantaged communities and supporting local job creation.
• UC Berkeley Labor Center (2020), *California's Clean Energy Workforce Needs Assessment*.
→ Forecasts demand for skilled technical jobs in battery and recycling sectors, especially through public-private innovation efforts.

d. Regulatory and Policy Context
• California Senate Bill 100 and Senate Bill 96
→ Define statutory goals for 100% clean electricity and investment in breakthrough clean energy R&D.
• AB 2832: Lithium-Ion Battery Recycling Advisory Group Final Report
→ Recommends investment in advanced, non-destructive recycling methods and second-life battery pathways.

e. Environmental and Safety Considerations
• U.S. EPA, *Managing Hazardous Waste from Lithium Batteries*
→ Documents risks associated with manual battery dismantling, thermal events, and VOC emissions.
• CAL/OSHA, *Battery Energy Storage System Hazards and Worker Safety* (2023)
→ Underscores the need for automation and risk-mitigating infrastructure in lithium battery recycling.

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 following EPIC 5 Strategic Goals:
    a. Transportation Electrification

As California aggressively transitions to zero-emission transportation, lithium-ion battery production and end-of-life management are scaling rapidly. This project supports transportation electrification by:

- Enabling **safe, cost-effective, and local recycling of EV batteries**, which reduces lifecycle costs and improves the long-term affordability of electric vehicles;
- **Unlocking second-life applications** for used EV cells, providing a low-cost pathway for stationary energy storage that complements transportation electrification;
- **Reducing environmental and fire risks** associated with improper EV battery disposal, thereby supporting safe infrastructure expansion (e.g., EV fleets, chargers, logistics depots).

d. Achieving 100 Percent Net-Zero Carbon Emissions

The concept also aligns with California's broader carbon neutrality goals through the following mechanisms:

- **Closing the materials loop** for critical battery components (e.g., cathodes, electrolytes, foils), significantly reducing emissions associated with virgin material mining, processing, and global transport;
- **Eliminating thermal and chemical processing** typical in conventional recycling, thereby avoiding CO_2 and toxic emissions from pyrometallurgy and hydrometallurgy;
- Supporting a **circular battery economy** that complements California's renewable energy and storage buildout, helping reduce embedded emissions across the energy system.

e. Climate Adaptation

While not the primary focus, the project contributes to California's climate adaptation goals by:

- **Enhancing resilience of energy storage systems** (through second-life deployment and circularity);
- **Reducing hazardous waste and community-level pollution risks**, particularly in high-risk climate zones or disadvantaged communities where e-waste and legacy infrastructure pose compounding risks.

By localizing battery dismantling and material recovery within California, the proposed project **lowers environmental impact, supports supply chain resilience, and creates high-quality technical jobs**—all essential for a just, scalable, and sustainable clean energy future.

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