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Project List for the September 30, 2021 Lithium Valley Commission Meeting Discussion of Market Opportunities

This document provides a list of selected projects funded by the California Energy Commission (CEC). The purpose of this list is to inform discussion of lithium market opportunities during the September 30, 2021, Lithium Valley Commission meeting. This document includes Electric Program Investment Charge (EPIC) and Clean Transportation Program (CTP) projects related to the following topics: vehicle and battery manufacturing, battery efficiency and safety, lithium-ion battery recycling, and lithium-ion battery reuse.

More information is available online from the California Sustainable Energy Entrepreneur Development Initiative ([CalSEED](https://calseed.fund/spotlight/)) (<https://calseed.fund/spotlight/>). With funding from EPIC, New Energy Nexus runs the CalSEED initiative, which assesses applications from clean energy startup companies, submits proposed small grant awardees for consideration by the CEC, and provides business development training for participating startup companies. CalSEED provides a concept award of \$150,000 or prototype award of \$450,000. Additional information can be viewed at the CEC [Energy Innovation Showcase](http://innovation.energy.ca.gov/) (<http://innovation.energy.ca.gov/>).

Information on the CTP's grant funding can be found online from the CTP Investment Plans [webpage](https://www.energy.ca.gov/programs-and-topics/programs/clean-transportation-program/clean-transportation-program-investment) (<https://www.energy.ca.gov/programs-and-topics/programs/clean-transportation-program/clean-transportation-program-investment>).

CTP-Funded Vehicle and Battery Manufacturing Projects

- Since 2009, the CTP has invested \$55 million across 27 zero-emission vehicle (ZEV) manufacturing and technology development projects. Most of these have been zero-emission truck and bus projects, which included the design and manufacturing of battery-pack and battery management systems using third-party lithium-ion cells. With expanded funding from this year's Governor's Budget, the CTP will allocate nearly \$250 million for ZEV manufacturing projects over the next two fiscal years. Three CTP projects with battery elements are summarized below:
 - **Proterra** is an electric bus company that received two manufacturing grants from the CTP totaling \$4.8 million (ARV-14-044 for \$3 million, completed: December 2018 and ARV-18-026 for \$1.8 million, expected completion: May 2022). These grants enabled Proterra to expand its bus development and manufacturing facilities located in Burlingame and City of Industry. The grants also enabled creation of Proterra's automated battery-pack assembly facility, which assembles various sizes of battery backs and battery management systems using lithium-ion cells.
 - **Zero Motorcycles** is an electric motorcycle company located in Santa Cruz. As part of its manufacturing grant ARV-18-027 (\$1.8 million, expected completion: October 2022), Zero Motorcycles developed two new lithium-ion battery pack assembly lines as part of its initiative to reclaim component assembly from

offshore contractors. The assembly lines allow Zero Motorcycles to obtain more design and production control over critical powertrain components.

- **Quallion, LLC**, received two grants for automated lithium-ion cell assembly for ZEV applications totaling \$8.6 million (ARV-10-010 for \$6.7 million, completed: March 2016 and ARV-12-010 for \$1.9 million, completed: December 2015). Quallion, LLC, successfully expanded its automated cell assembly capacity.

EPIC-Funded Battery Efficiency and Safety Projects Including CalSEED Awards

- **Caban Systems, Inc.** received grant EPC-18-018 (\$1.88 million, expected completion: March 2024) to produce a lithium-ion ruggedized modular battery platform for California critical infrastructure.
- **Coreshell Technologies, Inc.** Received a \$150,000 CalSEED award (completed: July 2021). Coreshell Technologies develops thin-film battery electrode coating for lithium-ion batteries. This proprietary coating technology is a key enabling solution to making cost-effective, longer-lasting batteries. The CalSEED award will be used to evaluate improved cycle lifetime, improved capacity retention at elevated temperatures, and reduced potential for thermal runaway.
- **Cuberg** has two current EPIC grants: EPC-18-015 (\$1.57 million, expected completion: December 2022) and EPC-20-027 (\$3.5 million, expected completion: March 2024). Cuberg is developing innovative lithium metal batteries with a robust and non-flammable electrolyte that enables the safe use of energy-dense lithium anodes. This increases energy density by up to 80 percent and also enhances the battery safety profile compared to lithium-ion batteries. Using this innovation in electric vehicles (EVs) can address two serious barriers to EV adoption: driving range and powertrain safety.
- **DAE Technologies** received a \$150,000 CalSEED award (expected completion: December 2021). DAE Technologies is developing an advanced, low-cost rechargeable lithium carbon monofluoride (LiCFx) battery chemistry with high energy density and inherent safety. The CalSEED award will be used to prepare cell components, demonstrate the basic operating mechanism, and demonstrate performance.
- **EndLiS Energy** received a \$150,000 CalSEED award (expected completion: 2021). This company is developing next generation, environmentally friendly lithium carbon batteries. These batteries have lower costs, higher energy density, and faster recharge times (1 hour or less) than other lithium batteries. With the CalSEED award, the company will develop an electrode coating line that can coat 5-20 micron electrodes on roll to roll processing equipment using commercially available electrostatic spray deposition equipment adapted to the materials used.
- **EPC Power Corp** received an EPIC grant, EPC-20-039 (\$3.5 million, expected completion: March 2025) to design and construct an innovative integrated power electronics and energy storage system to serve the grid-tied energy storage market. The system will be rated for 1 megawatt power and 1 megawatt-hour energy capacity and will integrate solid-state DC-DC power electronics with repurposed lithium EV

battery packs (2nd-life battery). EPC Power Corp will conduct a one-year technology demonstration at a facility located in a disadvantaged community in San Joaquin, California.

- **Nextech Batteries, Inc.** received EPIC grant EPC-20-028 (\$3 million, expected completion: March 2025) to advance its lithium sulfur battery technology. This battery packages a non-cobalt design with improved energy components and a battery management system to create a safe energy storage system with double the energy density and optimal cycle life of incumbent lithium-ion technology. The project will advance the production design of lithium-sulfur based cells, develop a high-capacity battery module prototype, and demonstrate cost-effective grid-integration of the lithium-sulfur battery energy storage system with the University of California (UC), San Diego's microgrid.
- **NanoDian, Inc.** received a \$150,000 CalSEED award (completed: June 2021). NanoDian, Inc. is a Los Angeles startup applying nano-fabrication technology to cathodes of lithium-ion batteries to achieve 40 percent cost reduction in active materials in energy storage solutions for solar energy integration and EV applications. The CalSEED award will be used to build pilot production of cathode material to supply batteries for a grid energy storage system.
- **Innovasion Labs PINC, Inc.** received a \$150,000 CalSEED award (expected completion: January 2022). The goal of this project is to complete the development of a rechargeable battery solution that improves the energy density, battery cycle life, safety, and stability. The company's proprietary Parallel Integrated Nano Components (PINC) methodology is a breakthrough nanotechnology based on self-assembled integration of trillions of independent nanoscale batteries. This innovation uses nanowires leading to a paradigm shift in energy storage that allows a more than ten-fold increase in nominal cell voltage through incomparable utilization of surface area, thus achieving a dramatic reduction in ion current density within the device. During the CalSEED agreement, the team plans to complete a prototype device for significantly advanced energy storage.
- **Parthian Energy** received a \$150,000 CalSEED award (expected completion: April 2022). The goal of the project is to reduce the cost of battery manufacturing with an intelligent screening technology. The innovation is a novel electromagnetic battery testing device and process that may reduce the cost of lithium-ion battery manufacturing by up to 15 percent. This technology has been validated in the lab to improve the battery testing accuracy by orders of magnitude beyond the conventional voltage monitoring-based technologies used today. This technology may reduce cell formation/testing time from 14 days to 5 days, alleviating a major bottleneck of battery manufacturing. The CalSEED award will be used to finalize the engineering design and validate the technology for suitability in the manufacturing process with a project partner.
- **Seption Technologies** has two active EPIC grants: EPC-18-017 (\$2.68 million, expected completion: March 2024) to scale-up production of a low-cost polymeric membrane separator, a key component in current and next-generation battery storage

technologies; and EPC-20-015 (\$1.4 million; expected completion: March 2024) to advance the development of safe "anode-free" hybrid lithium-metal cells from a lab-scale validation to a pre-prototype. Sepion is advancing technologies for hybrid lithium-metal batteries for low-cost and long-range EVs. Sepion's lithium battery membrane technology advances safety and enables a 400-mile range at an equitable price.

- **South 8 Technologies** has two active EPIC grants: EPC-18-021 (\$1 million, expected completion: March 2024) to design and build a low-rate initial production pilot line for the manufacturing of liquefied gas electrolyte batteries, which yield a high energy density and increase safety; and EPC-20-016 (\$1 million, expected completion: August 2023) to develop and test liquefied gas electrolytes for use in lithium-ion cells and demonstrate high cell safety and recyclability.
- **SiLi-ion** has received two CalSEED awards: \$150,000 (completed: April 2021) and \$450,000 (expected completion: February 2023). The study of novel anode materials for lithium-ion batteries is currently the focus of intense efforts with the aim of developing batteries with higher storage capacity. Among the possible candidates, silicon-carbon composites are widely considered the most promising choice because of their higher lithium-ion storage capacity and cycling stability. This company developed a chemical vapor deposition method to produce a composite anode material comprising silicon nanoparticles with a conformal graphitic-carbon coating; this method is fully compatible with state-of-the-art lithium-ion battery industrial manufacturing.
- **Sonocharge** received a \$150,000 CalSEED award (expected completion: December 2021). The goal of the project is to develop a safe lithium metal battery (LMB) with fast charging capability, high energy density, and prolonged cycle life. The dendritic lithium growth and low Coulombic efficiency impede the commercialization of LMB, this innovation is the integration of a surface acoustic wave device into the LMB, which enables high Coulombic efficiency and dense lithium deposition at high charge current. This technology could solve the historical issue of LMB, fit customer needs, and show a clear pathway for mass production. During the CalSEED agreement, the team aims to translate its laboratory prototype to a commercial standard prototype and establish a relationship with the company's potential manufacturing collaborator.

EPIC-Funded Lithium-Ion Battery Recycling Projects

- **University of California, San Diego**, received EPIC grant EPC-21-008 (\$1.6 million, expected completion: March 2025) to develop efficient and scalable direct recycling technology for lithium-ion batteries. This project will improve the technology readiness, commercial scale-up pathways, and environmental benefits of high-value, direct recycling processes for lithium-ion batteries. Unlike today's industry recycling methods (pyrometallurgical and hydrometallurgical processes), this project will focus on the following: 1) addressing safety and environmental issues related to handling and treating spent batteries and their materials inside; and 2) achieving reasonable economic return by recovering high-value materials at high efficiency and low cost.
- **OnTo Technology, LLC**. received EPIC grant EPC-21-009 (\$1 million, expected completion: March 2026) to demonstrate, scale up, and build market acceptance of

cathode-healing direct recycling processing of lithium-ion batteries. This company's patented Cathode-Healing® process provides a low-cost and efficient method to recover electrode and other materials from used batteries and produce manufacturing-ready cathodes at one-tenth the cost and energy than incumbents. Cathode-healing is flexible to chemistry and has successfully demonstrated recycling on most major EV cathode chemistries. The method includes safety measures to remove hazards from end-of-life batteries, which improves public and worker safety during transportation, storage, and processing.

EPIC-Funded Lithium-Ion Battery Reuse Projects Including CalSEED Awards

- **Smartville** received EPIC grant EPC-19-038 (\$2 million, expected completion: March 2024) to develop a low-cost and easy-to-integrate second-life battery heterogeneous unifying battery energy storage system. Smartville is leveraging innovative battery management technology developed under a previous ARPA-e project.
- **RePurpose Energy** received EPIC grant EPC-19-039 (\$3 million, expected completion: December 2023) to install an integrated solar photovoltaic (PV) energy storage system that incorporates second-life batteries from EVs and conduct a series of laboratory-based cycling tests. This company previously received a \$150,000 CalSEED award (completed: April 2021) to develop and demonstrate an innovative lithium-ion battery fire suppression system.
- **California State University, San Diego**, received EPIC grant EPC-19-053 (\$2.8 million, expected completion: March 2024) to develop and integrate cost-effective second-life EV batteries with a solar photovoltaic system. This project plans to develop battery management system technologies, algorithms, and operation strategies to enable second life EV batteries to last for a minimum of 10 years with a degradation rate of 3 percent or less annually.
- **ReJoule** received EPIC grant EPC-19-055 (\$3 million, expected completion: December 2023) to develop novel battery grading tools to assess the health of repurposed EV batteries more quickly and accurately for stationary storage. This company is developing tools to quickly assess the state of health of used EV batteries and validating second-life EV batteries paired with solar for commercial buildings. The goal of the CalSEED project is to improve adaptability and repeatability of sensitive battery diagnostic measurements across varying battery pack designs by adding dynamic self-calibration, studying the effects of cable and connector degradation, and streamlining the hardware architecture.
- **UC Davis** received EPIC grant EPC-14-085 (\$1.2 million, expected completion: 2021). This project demonstrated a microgrid using PV, a smart electrical energy storage system that integrates retired electric vehicle batteries, and an advanced energy management system. RePurpose Energy, a company that reuses batteries from EVs, spun-off from this project.