DOCKETED	
Docket Number:	23-ERDD-01
Project Title:	Electric Program Investment Charge (EPIC)
TN #:	259214
Document Title:	Presentation - California Battery Pilot Manufacturing Line Scoping Workshop
Description:	Presentation for the 9/20/24 California Battery Pilot Manufacturing Line Scoping Workshop
Filer:	Misa Werner
Organization:	California Energy Commission
Submitter Role:	Commission Staff
Submission Date:	9/19/2024 9:41:09 AM
Docketed Date:	9/19/2024

California Battery Pilot Manufacturing Line Scoping Workshop

Anthony Ng and Elyse Kedzie

September 20, 2024

Housekeeping

- This workshop is being recorded and will be posted to the CEC website.
- Participation during the public comment and Q and A sessions is available via Zoom or telephone.
- This presentation and other related documents will be available online (https://www.energy.ca.gov/event/workshop/2024-09/scoping-workshop-california-battery-pilot-manufacturing-line-funding-concept).

Workshop Agenda

- Policy Background and Overview of Battery R&D Funding
- Battery Pilot Manufacturing Line Concept
- Open Comment and Q&A

Policy Background

PRIMARY FUNCTIONS OF THE

CALIFORNIA ENERGY COMMISSION

Advancing State Energy Policy

Investing in Energy Innovation

Developing Renewable Energy

Preparing for Energy Emergencies

Achieving Energy Efficiency

Transforming Transportation

Overseeing Energy Infrastructure

Intergovernmental Collaboration

California's Climate Goals

SB 100: requires that 100% of retail sales of electricity to California end-use customers and 100% of electricity procured to serve all state agencies come from renewable energy resources and zero-carbon resources by 2045.

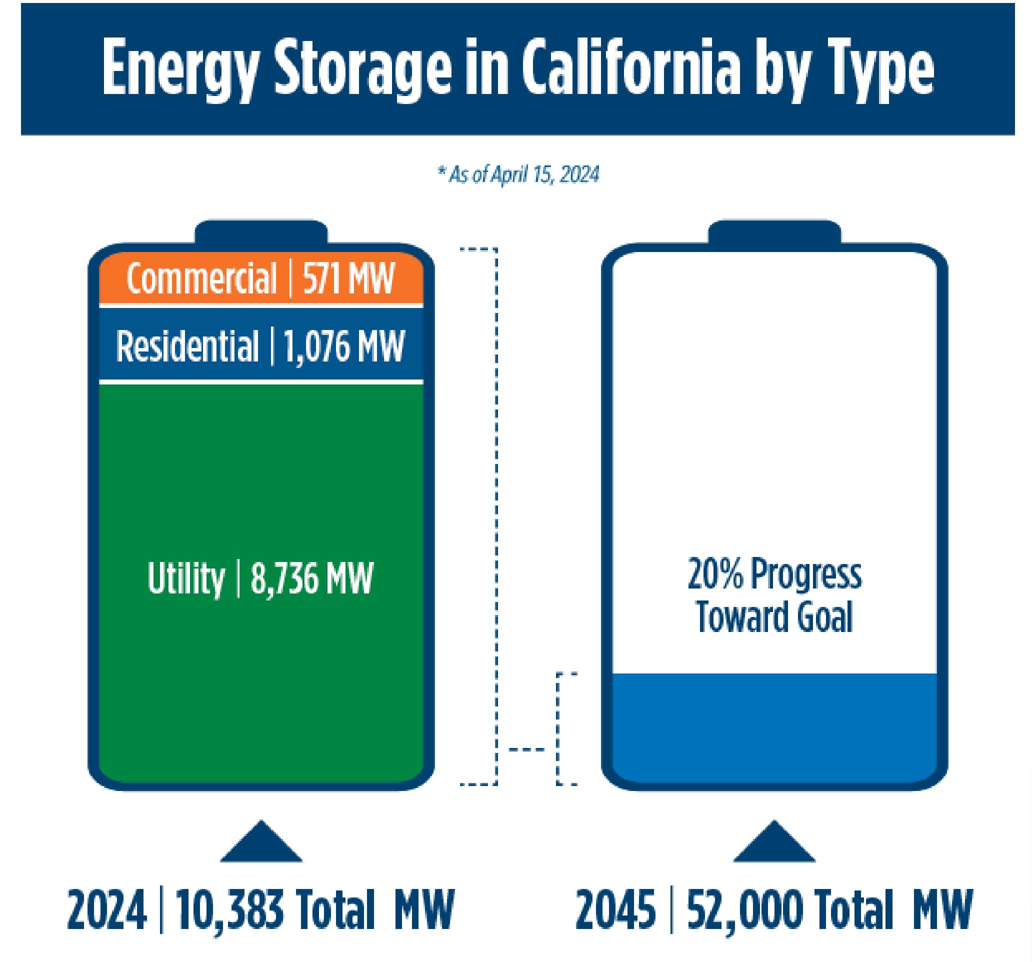
AB 32 & SB 32: require statewide greenhouse gas emission reduction to the 1990 GHG level by 2020 and to 40% of the 1990 level by 2030.

AB 1279: Achieve net zero GHG emissions by 2045.

Energy Policy Drives Storage in California

California must reach goal of powering all retail electricity with renewable and zero-carbon resources by 2045.

- Battery storage build rates need to increase by eightfold.
- **15 GW** of battery storage needed by 2032 per the CPUC.
    - 1 GW identified as long-duration storage.
- **52 GW** of battery storage needed by 2045.
- Over **10.3 GW** of storage is deployed on the grid today.



Source: CEC Energy Storage Dashboard

Transportation Policy Drivers

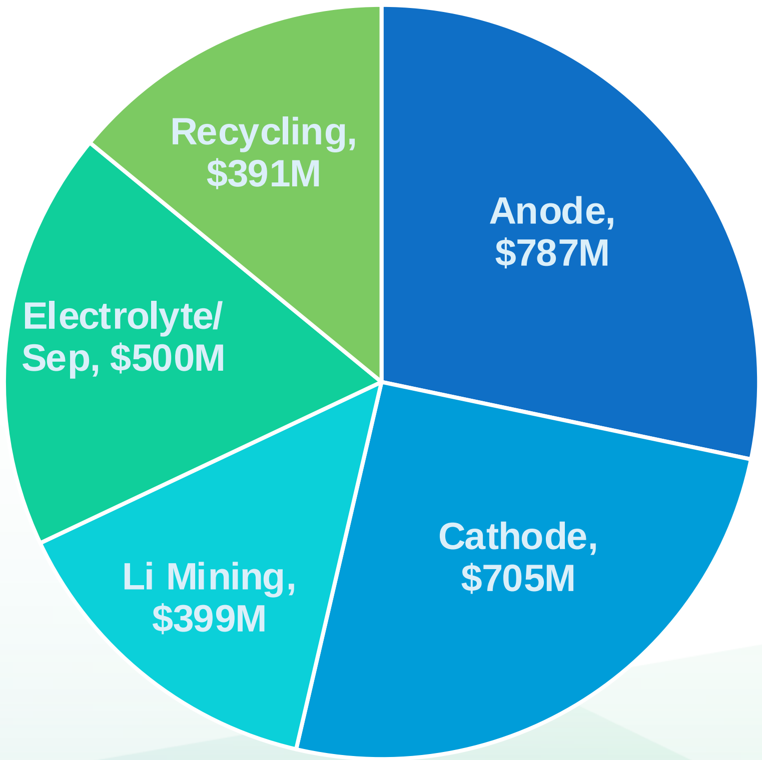
Source: CA Governor's Office

- **EO N-79-20** requires all new in-state passenger vehicle sales to be zero-emission by 2035;
  - All medium- and heavy-duty vehicles to be zero-emission by 2045 where feasible and by 2035 for drayage trucks;
- CA has >1 million EVs on the road today.
- 25% of new passenger vehicles sold in 2023 were zero-emission vehicles.
- Other sectors like heavy duty transportation, aviation, and shipping are harder to electrify.

Federal Efforts for Battery Supply Chain

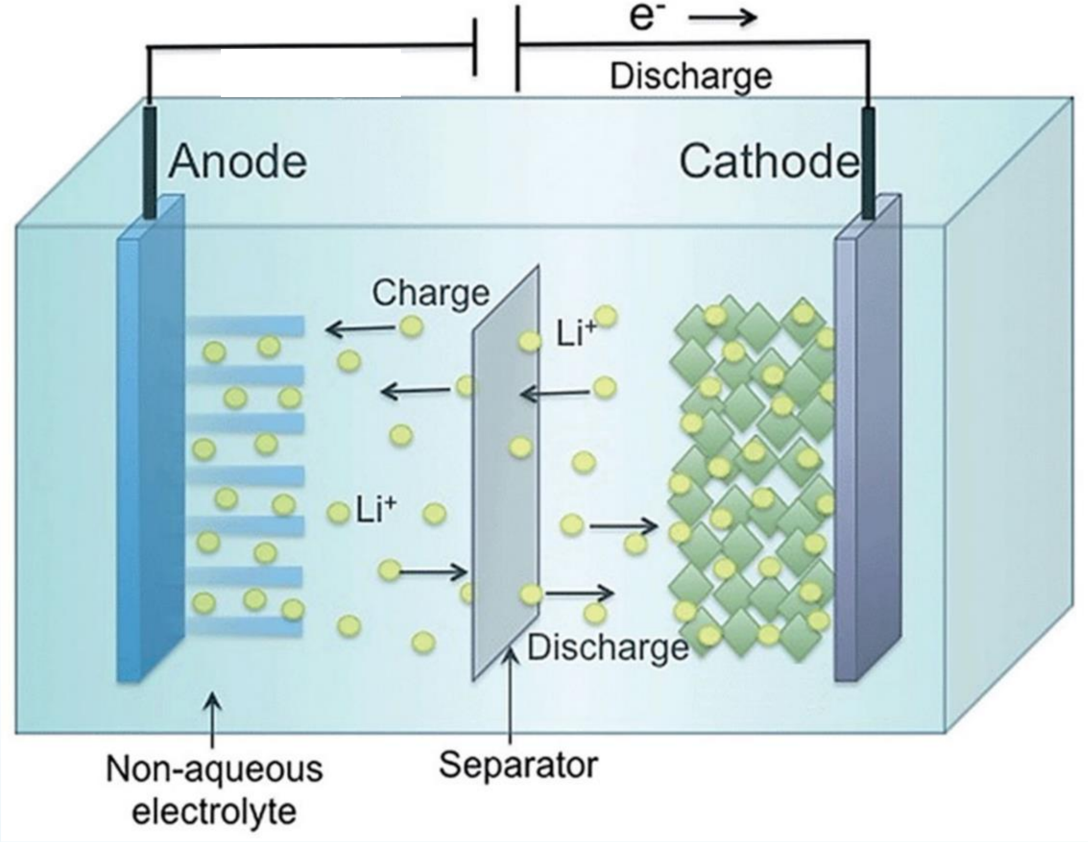
- Large investment in building a domestic supply chain for Li-ion batteries
- $7 billion allocated for battery supply chain development through DOE BIL
  - $2.8 billion awarded in 2022
  - $3.5 billion expected in 2024

DOE Domestic Battery Manufacturing Funding in 2022 ($2.8B Total)



R&D Investments in Advanced Batteries

Battery Basics

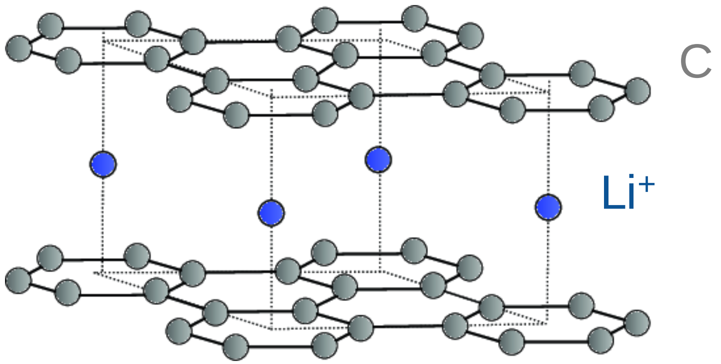


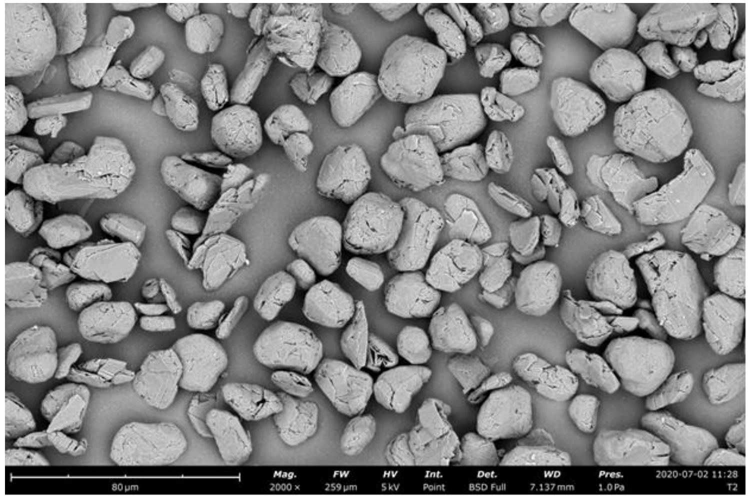
- **Key components**: anode, cathode, electrolyte, and separator
  - Anode: loses electrons
  - Cathode: gains electrons
  - Electrolyte: allows ions to flow to reaction sites
  - Separator: prevents contact of anode and cathode, which would cause short circuit
- During discharge: electrons flow from the **anode** (high energy) to the **cathode** (low energy) via an external circuit that powers a load.

Source: Tycorun

Commercial Li-ion Cells

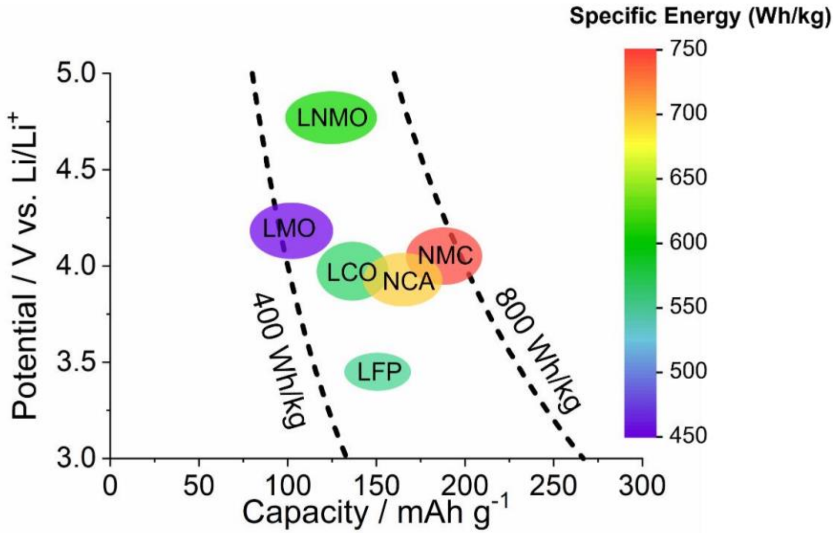
Anode: graphite (carbon)





Electrolyte: organic liquid or gel

- Lithium salt
- Carbonate solvents



Cathode: many materials

- Lithium cobalt oxide (LCO)
  - Small portable devices
- Lithium iron phosphate (LFP)
  - Stationary storage, EVs
- Nickel manganese cobalt oxides (NMC)
  - EVs

Sources: Pistorio et al., Thermo Fisher, Muralidharan et al.

Anode - Silicon

Benefits:

- Si can store more Li atoms than graphite.
- ~8x capacity compared to graphite

Challenge: large volume expansion leads to degradation over cycling.

Strategies:

- Si/C composite anodes
- Solid electrolytes (polymers/composites)
- Design silicon structures to expand

Anode Material	Theoretical Capacity (mAh/g)
Graphite	372
Silicon	2000-3000

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SOLID ENERGIES.

AMERICAN LITHIUM ENERGY

Source: Choi et al.

Anode – Li Metal

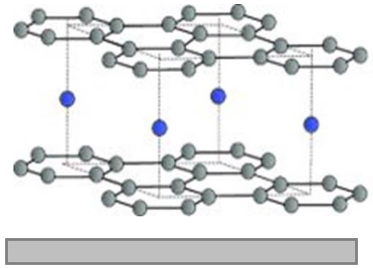
Benefits: Pure metallic Li has highest energy density and no dead weight.

***Challenges*:** Li dendrites easily form, short circuiting the battery.

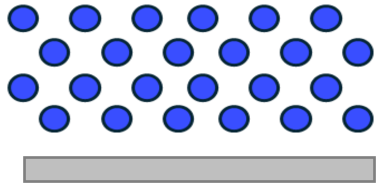
***Strategies*:**

- Solid separator/electrolyte to prevent dendrites
- New electrolyte additives or formulations

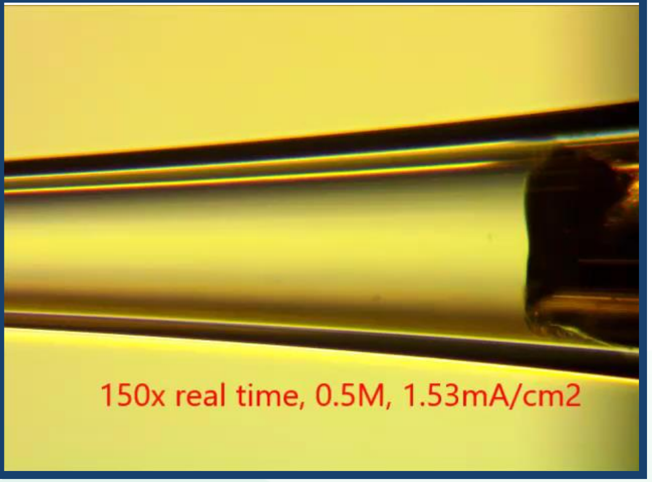
Graphite



Li metal



Anode Material	Theoretical Capacity (mAh/g)
Graphite	372
Silicon	2000-3000
Lithium metal	3860



Video Source: Bai, et al.

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Cathodes

Cobalt Free Cathodes

- ***Benefits:*** Co-free is less expensive and avoids volatile international Co supply chain.
- ***Challenges*:** Removing Co lowers energy density and stability of cathode.
- ***Strategies*:**
  - LFP (lithium iron phosphate)
  - LMFP (lithium manganese iron phosphate)
  - NFA (nickel iron aluminum oxide)

Li-Sulfur Battery

- ***Benefits:***
  - Sulfur is cheap, abundant, and light.
  - High theoretical energy density
- ***Challenges*:** Low conductivity of S, poor cycle life
- ***Strategies*:** additives and solid-state separators/electrolytes

	Energy Density (Wh/kg)	Cost
LFP	170	Low
*LMFP	230	Low
LCO	150-300	High
NMC	300	High
*NFA	650	Low
*Sulfur	2600	Low

* Not yet commercialized

CEC-funded companies

Co-free

sparkz

Li-S

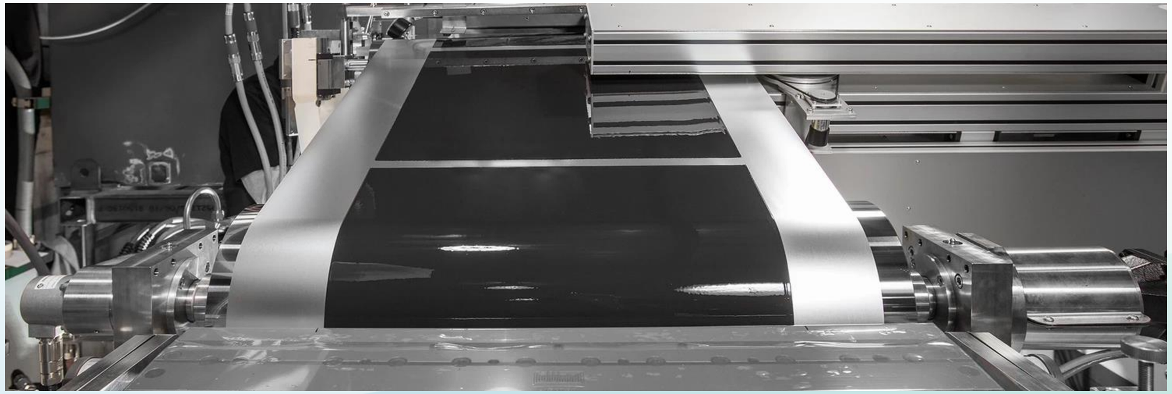
NexTech Batteries

Battery Manufacturing

Challenge: Battery manufacturing is energy, water, and emissions intensive.

***Strategies*:**

- Waterless process to make LFP cathode material
- Solvent-less process for casting electrodes removing toxic solvent and heating requirements
- Ultrasound inspection for battery production quality control
- Acoustic wave generation to improve mixing inside battery and prevent dendrite formation



Source: Dürr

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SVX

LICAP

SONOCHARGE

liminal

Advancing Lithium Recovery

Salton Sea Geothermal Resource Area aka Lithium Valley

- Geothermal brine in this area has lithium concentrations of 200-400 ppm.
- Estimated 15 million metric tons of Li
- Capable of producing about 600,000 metric tons of lithium carbonate per year
- Production estimate exceeds global lithium demand as of 2021.

CEC-funded Companies

Materials Research LLC

BHE RENEWABLES

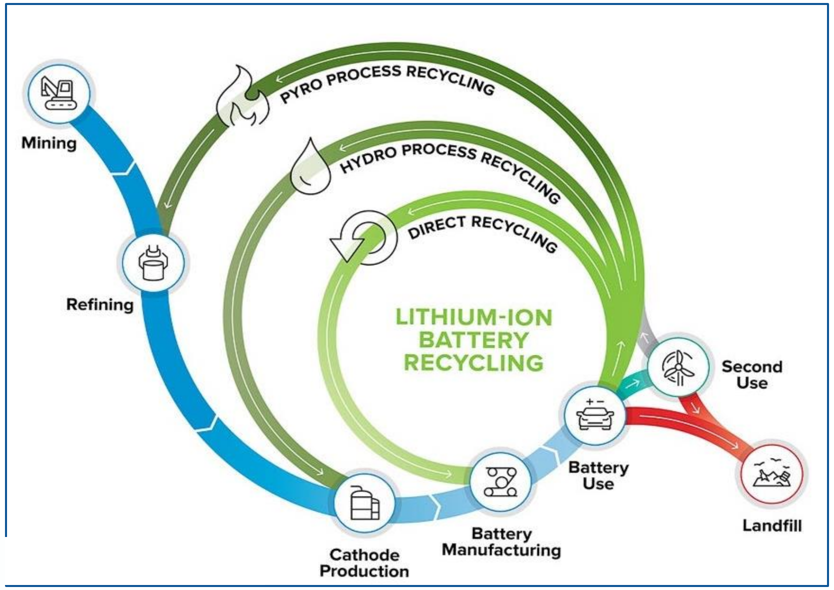
SRI

Sources: NREL, DOE

End-of-Life Battery Reuse & Recycling

Second Life Battery Solutions

- End-of-life batteries typically have 80% capacity remaining.
- These can still be useful in stationary applications.
- Must be graded and integrated into a system



Source: ReCell

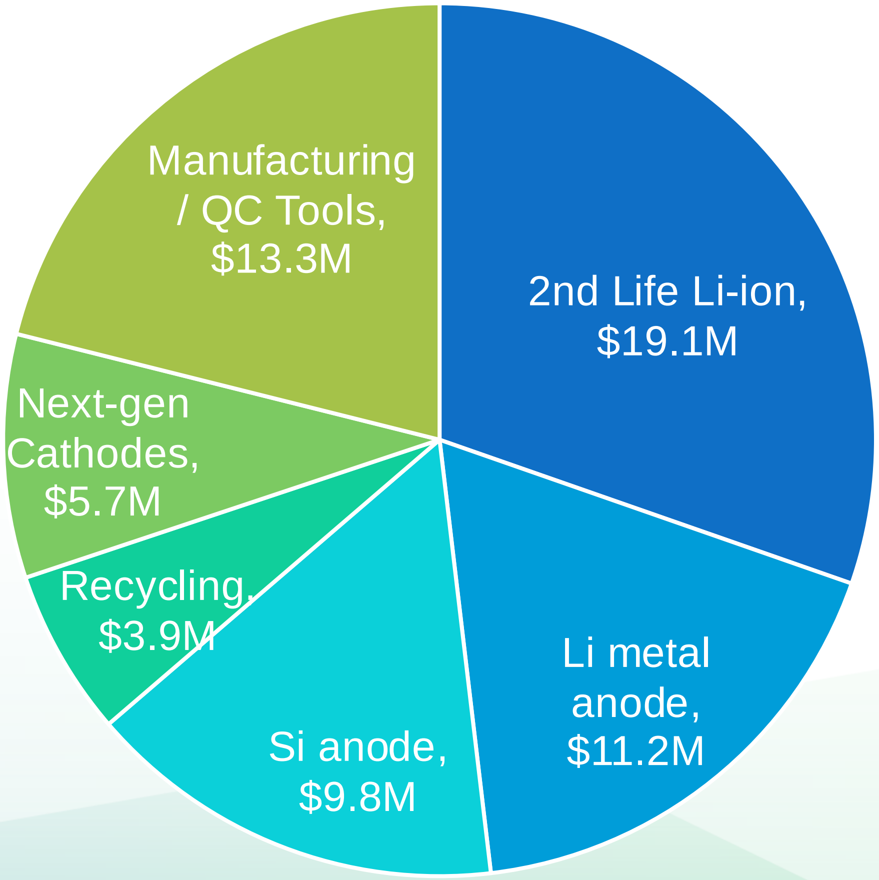
Direct Recycling of Li-ion

- ~50% of cost of Li-ion cell is cathode material.
- Li-ion battery recycling only extracts Co, Ni, Mn today.
- Direct recycling regenerates the whole cathode material.

Summary

- Many innovations happening across Li-ion battery industry
- EPIC is investing heavily in advancing battery storage technologies across the R&D spectrum.
  - Invested over $60 million to date

EPIC's Portfolio of Battery Investments (2014-Present)



California Battery Pilot Manufacturing Line Proposal

Fostering Innovation Across the Energy Sector

Mission: strategically invest funds to catalyze change and accelerate achievement of policy goals

Strategy: advance energy technology, facilitate customer learning, and strategic targeted intervention

Funding:

- Electric Program Investment Charge (EPIC),
  $160 million annually
- Gas Research, Development and Demonstration Program,
  $24 million annually

EPIC 4 Investment Plan

Topic 40 – Supporting Advanced Battery Scale-Up in California

This topic seeks to accelerate the scale-up and industry acceptance of next-generation battery technologies and battery technology designs used in transportation and BESS applications.

Providing a battery pilot production environment for battery technology start-up companies to demonstrate the ability of their technologies to slot into existing battery manufacturing processes.

For full topic description see EPIC 4 Investment Plan pp. 201-204
https://www.energy.ca.gov/publications/2021/electric-program-investment-charge-proposed-2021-2025-investment-plan-epic-4

ENERGY COMMISSION

New Technologies are Addressing Challenges to Current Lithium-ion Batteries

Cost and performance: improve key metrics such as energy density, charge time, cycle life, and $/kWh.

Supply chain security: reduce cobalt, nickel, and reliance on imported lithium.

Safety: reduce thermal runaway and other safety concerns.

End-of-Life Management: increase the economic feasibility of repurposing and recycling lithium-ion batteries.

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ENZINC

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sparkz

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SEPION TECHNOLOGIES

Coreshell

Problem Statement

- Upcoming battery companies with innovative technologies face challenges de-risking their technology.
- Innovations often take place at the battery component level, but **customers need to see performance demonstrated in cells and modules**.
- Investing in manufacturing capacity to produce cells is expensive and time-consuming, while not the focus of the innovation.
- The result is inefficient investments and a slower time to market, which can hinder commercialization and scaling of new battery technologies.

Proposed Approach

Establish a Battery Pilot Manufacturing Line in California that will provide full-service battery cell fabrication and testing services for battery innovators.

Allow battery innovators to bring their innovative component, leverage the manufacturing capacity and on-site staff of the pilot line and leave with fully formed battery cells.

The pilot line will support rapid prototyping, accelerate customer evaluation, and support overall commercialization of new battery technology.

Proposed Solicitation

Anticipated Solicitation Details:

- Funding: $20 million
- One awardee – must be a non-profit entity
- Anticipated solicitation release: mid-November

Unique considerations from standard EPIC practice:

- Funds spent in California requirement
  - Expect most equipment and raw materials to be sourced outside of California initially
- Reimbursable expenses
  - Expect the project to be highly capital expenditure intensive in the beginning

Critical Features

- Manufacturing capacity to produce up to 10,000 cells per year
- Minimum 30,000 sq. ft facility
- Capability to produce pouch and cylindrical cells
- Focus on next-generation technologies (lithium metal, silicon anodes, novel electrolytes, emerging cathode chemistries etc.)
- Ability to conduct a range of battery testing (performance characterization, cycling, abuse testing, failure mode analysis, etc.)

Critical Features

- Processes and procedures to protect intellectual property of users
- Self-sustainable operation model (raw material sourcing, revenue model, staffing, etc.)
- Partnership with labor group and/or academic institution to leverage the pilot line for workforce training/curriculum development

Questions for Attendees

- What additional critical features should the pilot manufacturing line include?
- What additional critical partners should be part of a project team?
- Are any of the critical features presented not feasible with the proposed budget?
- Any additional feedback for the CEC on this solicitation concept?

Questions and Answers

Two ways to ask questions:

1. Use the raise hand feature in Zoom:
   - Zoom phone controls:
     - *6 – Toggle mute/unmute
     - *9 – Raise hand
   - Introduce yourself by stating your name and affiliation
   - Keep questions under 3 minutes to allow time for others.
2. Type questions in the Q&A Box in Zoom:
   - Please provide your name and affiliation.

Written Comments and Workshop Materials

- Please submit written comments to Docket Number 23-ERDD-01 (https://efiling.energy.ca.gov/EComment/EComment.aspx?docketnumber=23-ERDD-01).
  - Please include “California Battery Pilot Manufacturing Line Concept” in the subject line of your comment.
  - Please see the notice for this workshop for instructions for mailing or emailing comments. (https://efiling.energy.ca.gov/GetDocument.aspx?tn=259083&DocumentContentId=95139)
- Written comments are requested by **October 4, 2024**.
- The workshop presentation and recording will be posted on the workshop webpage (https://www.energy.ca.gov/event/workshop/2024-09/scoping-workshop-california-battery-pilot-manufacturing-line-funding-concept).

Thank You