Item 6: Information Item – Lawrence Berkeley National Laboratory Presentation on Lithium Valley Resource Study

March 13, 2024 Business Meeting

Chuck Gentry, Mechanical Engineer
Energy Research and Development Division
Energy Supply Branch

Previous CEC Investments

Electric Program Investment Charge (EPIC)

- $11M+ in grants to Salton Sea region or lithium recovery
- Bringing lithium recovery systems to the field

Geothermal Grant and Loan Program

- $6M+ to Salton Sea region, including geothermal projects
- SB 125 (2022) lithium recovery from geothermal brine added as eligible

Upcoming CEC Investments

EPIC Solicitation - $23M

GFO-23-304 - Geothermal Energy Operations and Lithium Innovation (GEO/LI)

- Reduce operations and maintenance costs by reducing scaling and corrosion
- Optimize lithium recovery
  - Pre-treatment
  - Co-products
  - Address waste

Upcoming CEC Investments Continued

Geothermal Grant and Loan Program Solicitation - $4.6M

GFO-23-402 – Two Phases to advance geothermal energy and lithium recovery from geothermal brine

1. Phase One: application support for local jurisdictions (including California Native American tribes)
2. Phase Two:
    - R&D
    - Lithium recovery project deployment
    - Planning and policy development
    - Technical and economic assessment
    - Geothermal and related activities in public services

Characterizing the Geothermal Lithium Resource in the Salton Sea Region

March 13, 2024 Business Meeting

Patrick Dobson
Lawrence Berkeley National Laboratory

Characterizing the Geothermal Lithium Resource in the Salton Sea Region

Briefing for the CEC

March 13, 2024

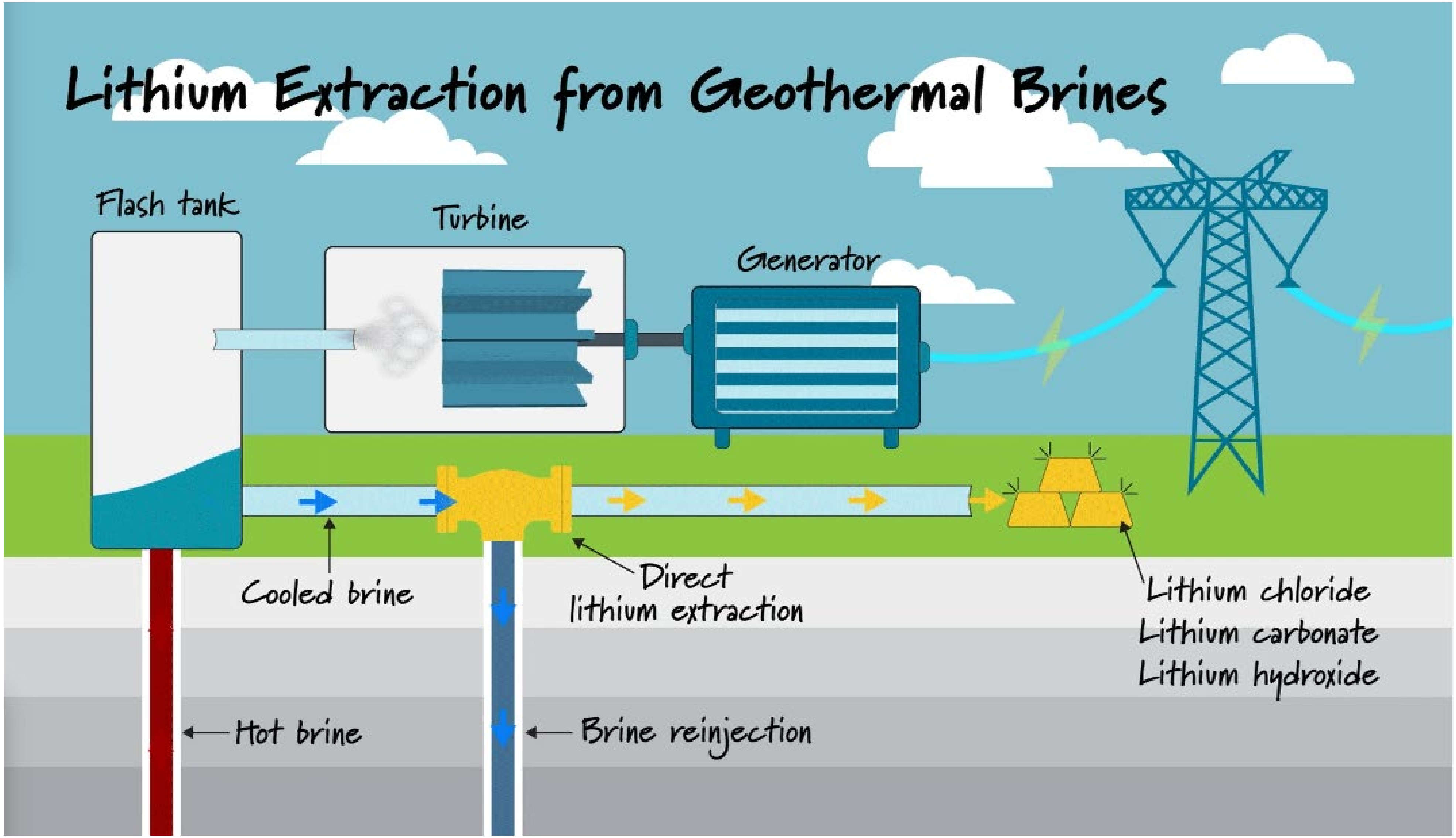
P. Dobson, M. Slattery, W. Stringfellow, J. Humphreys, M. McKibben, M. Brounce, E. Sonnenthal, N. Spycher, J. Stokes-Draut, D. Millstein, M. Busse, M. Camarillo, N. Nakata, A. Nayak, M. White, V. Rodríguez Tribaldos, S. Garg, K. Kim, N. Araya, J. O'Sullivan, T. Renard, J. Popineau, J. Riffault, J. Snyder, C. Ulrich, P. Nico https://escholarship.org/uc/item/4x8868mf

Presentation Overview

- Background
- Lithium and geothermal resource
- Environmental impacts
- Community engagement
- Q&A

John L. Featherstone Power Plant
Photo credit: Jeremy Snyder/LBNL

Solution for U.S. lithium supply & demand



Current status of geothermal and lithium projects

Berkshire Hathaway Energy (BHE) Renewables

- Lithium[1] demonstration plant planned for construction

Energy Source Minerals

- Commercial-scale lithium[3] recovery facility planned for 2024 construction, operation in 2026, 19 ktons of $LiOH•H_2O$ produced annually (3.1 ktons Li/year)

Controlled Thermal Resources (CTR)

- 50 MW power plant and lithium[3] recovery facility, 25 ktons of $LiOH•H_2O$ produced annually during first phase (4.1 ktons Li/year)

BHE Renewables LiCl[2] demonstration plant in operation since June 2022

Groundbreaking ceremony for new CTR facility on 1/26/24

[1] Lithium Carbonate
[2] Lithium Chloride (LiCl)
[3] Lithium hydroxide monohydrate ($LiOH•H_2O$)

Research Questions

- How much lithium is present?
- Where does it come from?
- How much is recoverable, and how long will it last?
- What are the potential environmental impacts?
- What are the priorities of local stakeholders, and how can researchers address them?

OUT OF SCOPE: Economic impact, evaluation of effectiveness of Li recovery technologies, public participation, job creation and training, public health.

Study was limited to the Salton Sea Geothermal Field

Salton Sea Region, California, with box highlighting location of SSGF

Lithium and Geothermal Characterization

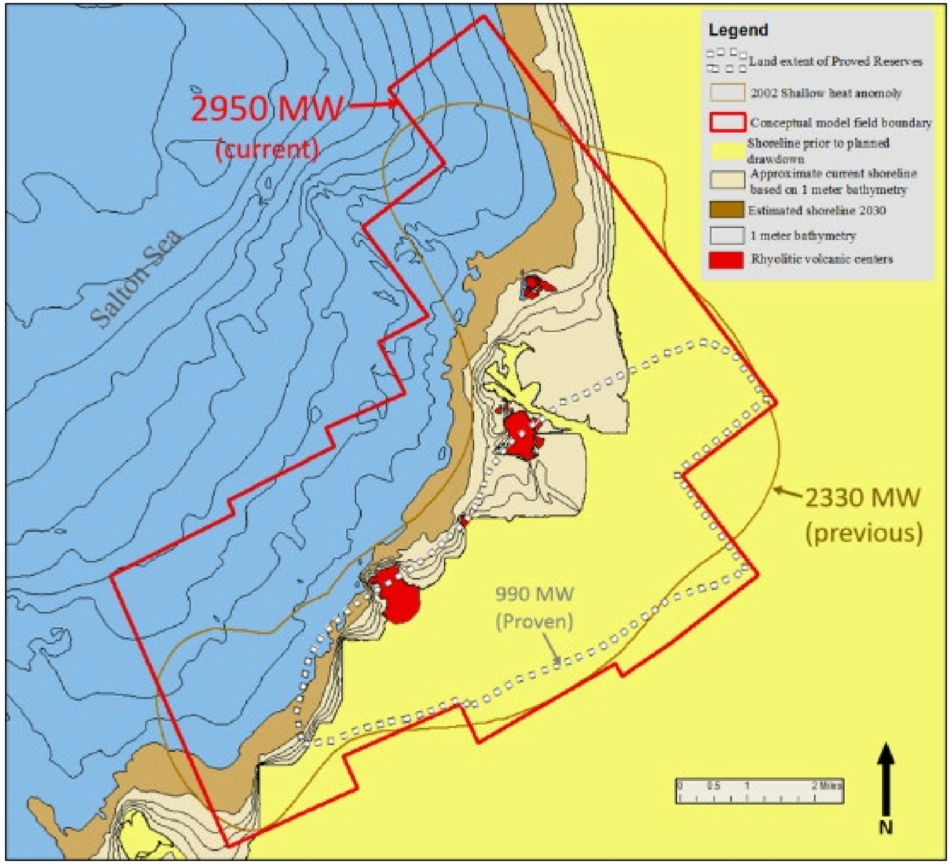
How much lithium is present?

- **Lithium (Li) resource =** volume of geothermal brine × brine lithium concentration.

	Li (millions of tons)	Lithium carbonate equivalent (millions of tons)	*Millions of EV batteries
Proven	0.76	4.1	85
Accessible	2.6	13.7	290
Probable	3.4	18.0	380

* Assuming 8.9 kg Li/vehicle (IEA, 2021)

- The brine volume depends on the areal footprint of the reservoir, its thickness, and the porosity.
- These numbers represent lithium in place; recoverable lithium will be less.
- The "probable" scenario is an upper bound on **the total amount of lithium that exists**.
- The "accessible" scenario is the total amount that is not currently underneath the Salton Sea.



Proven and probable resource extent of Salton Sea geothermal field
(Kaspereit et al., 2016)

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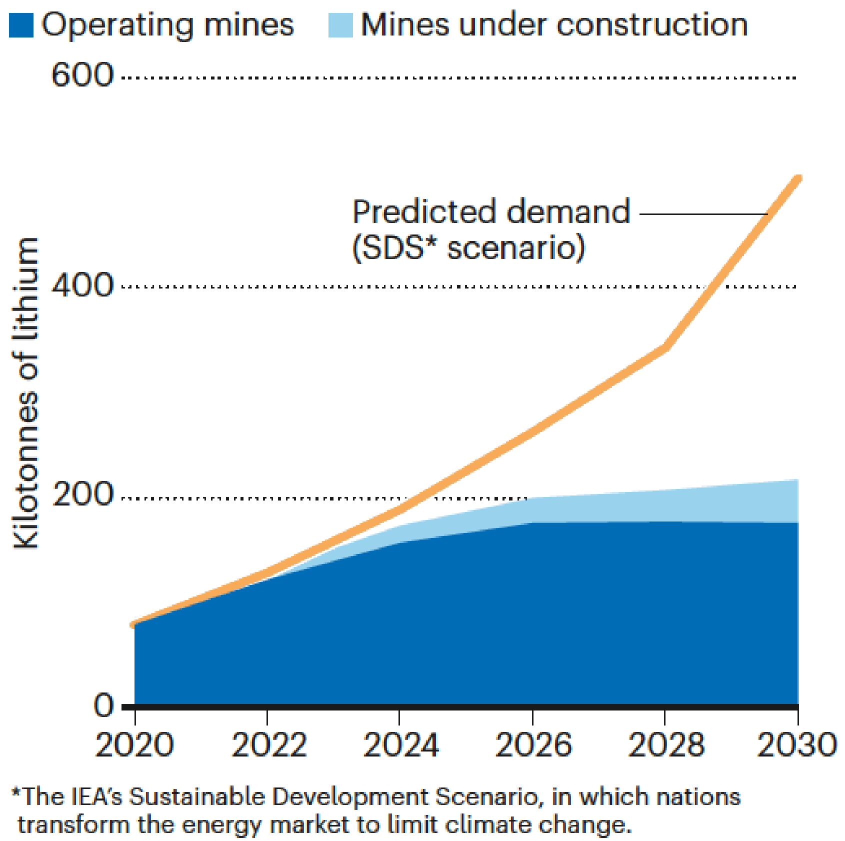
Salton Sea geothermal resource in context

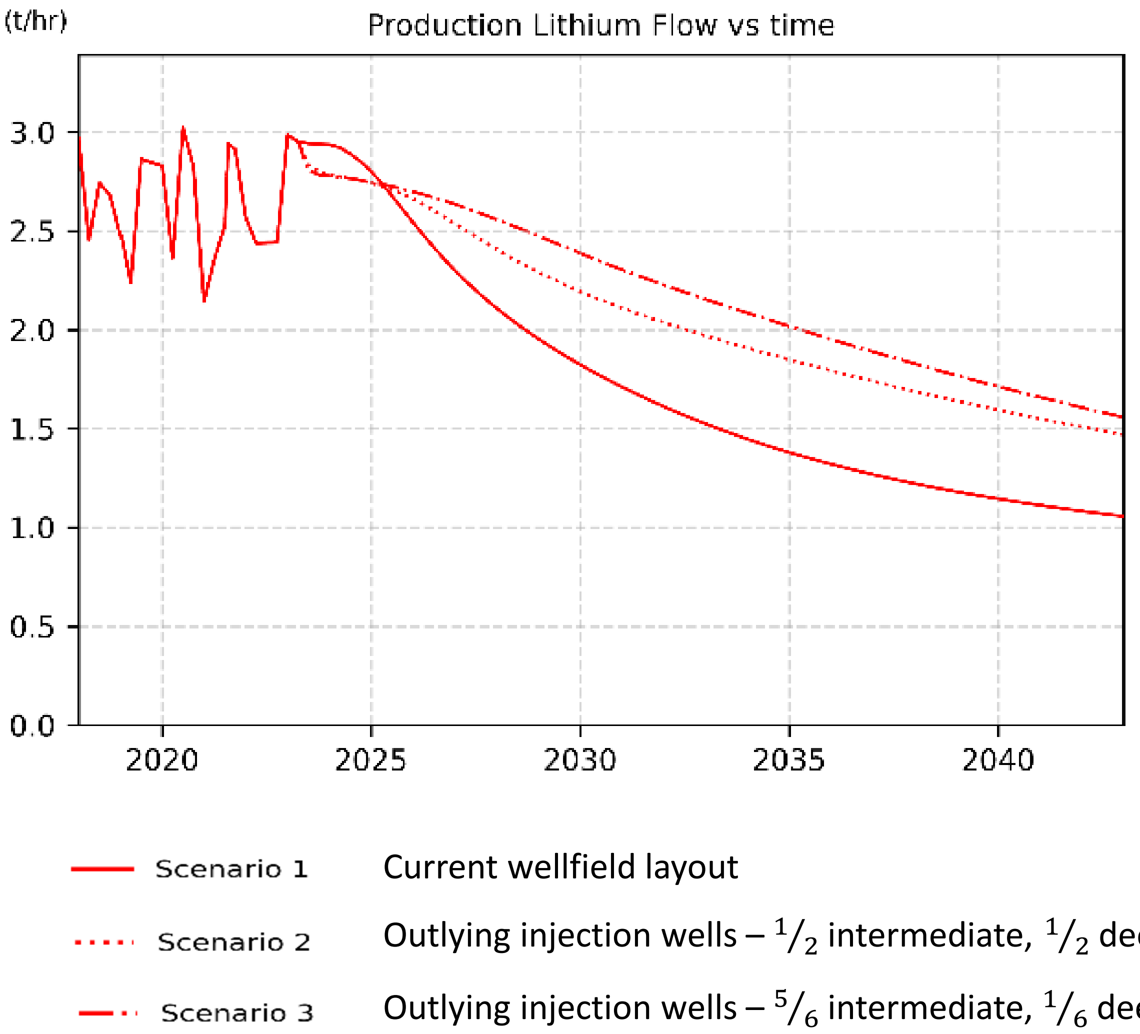
- Current brine flow = **21,500 metric tons (mT) lithium per year [114,000 mT Lithium Carbonate Equivalent (LCE)]** (currently not being recovered)
- Planned doubling of geothermal field could lead to doubling of Li in brine flow **(43,000 mT Li, 228,000 mT LCE)**
- Global demand for lithium expected to be **~190,000 mT per year (1.01 million mT LCE)** in 2024 (Haddad et al., 2023)
- The Salton Sea geothermal brines could help fill the gap between growing demand and current production from mines.



Haddad et al. (2023)

How will lithium production change over time?

- Reservoir model constructed using geologic and wellfield data
- Model forecasts lithium production for 20 years using current injection and production rates with 95% of the lithium removed from reinjection brines
- Lithium decline rates vary in production wells
- Operators need to consider chemical breakthrough when siting injection



Current wellfield layout

Outlying injection wells – $^1/_2$ intermediate, $^1/_2$ deep

Outlying injection wells – $^5/_6$ intermediate, $^1/_6$ deep

Results generated using U. Auckland Waiwera geothermal simulator (O'Sullivan et al., 2024)

Environmental Impacts

Potential Environmental Impacts from Direct Lithium Recovery

Chemical Use

- Significant amounts of acids and bases

Solid Waste

- Existing geothermal operations produce 84,000 tons of solid waste per year. Up to seven tons of additional solid waste may be generated per ton of lithium carbonate equivalent (LCE) produced due to brine pretreatment.
- Some of this solid waste will contain heavy metals, including critical minerals
- Current landfill capacity is sufficient but would need to be expanded for maximum production scenario.

Air Emissions

- Very low emissions of carbon dioxide relative to fossil fuel power generation
- Relatively low emissions of particulate matter, hydrogen sulfide, ammonia, and benzene

Water Use

- Planned expansion will require an additional 3% of the region's *current* water allocation, for a total of 5.8%.

Induced Seismicity

- Past energy production in the region and modeling of future associated seismicity indicates no appreciable impact from lithium extraction

Chemical Use and Solid Waste are two areas of potential environmental impact worth investigating
Ongoing monitoring of all impacts should be conducted

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Water demand for geothermal and lithium recovery

Geothermal power

- Main water uses:
    - Cooling towers
    - Added to brine before reinjection to prevent solids from forming
    - Some water is supplied by steam condensate (50-80% in new facilities)
    - Water use varies by plant

Lithium recovery

- Main water uses:
    - Washing and stripping to remove lithium from the sorbent
    - Could be reduced through water recycling

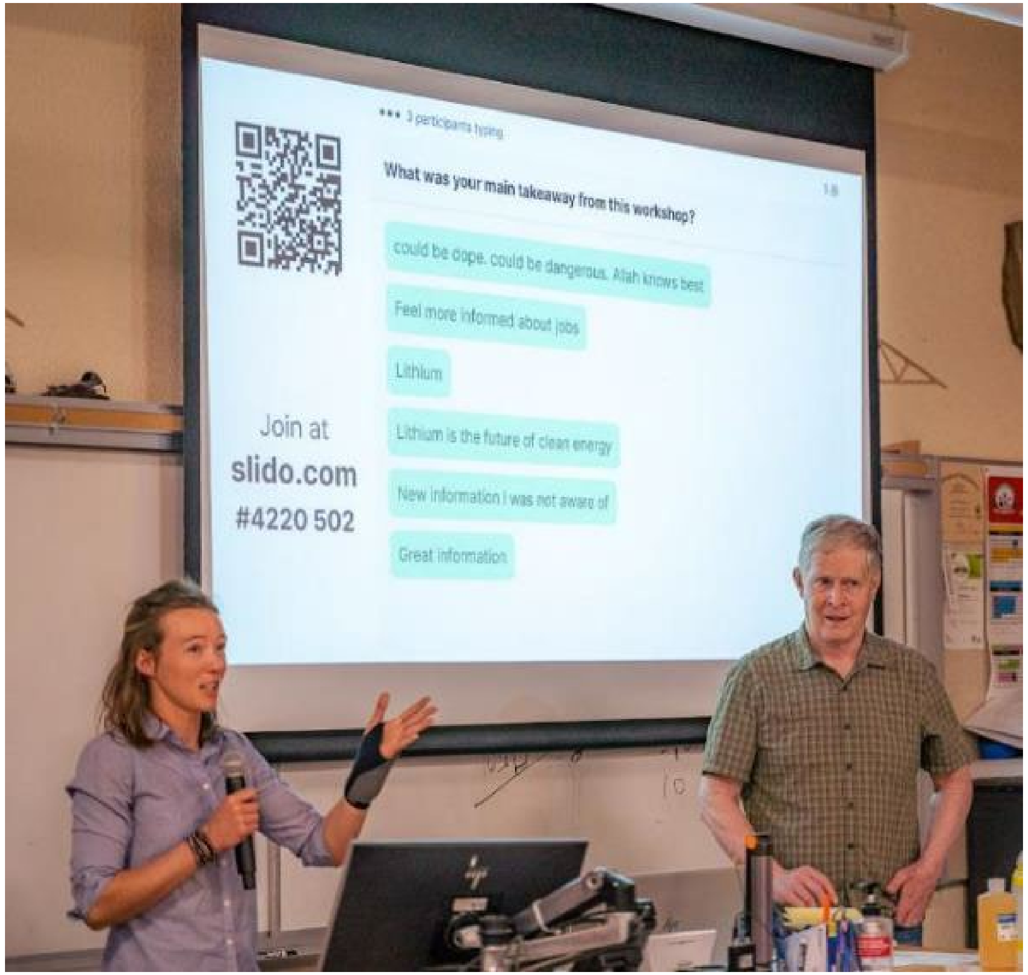
Community Engagement

Community Engagement

- **Purpose**
  - Make sure research is relevant to frontline communities and accessibly communicated
  - Gather input about how to incorporate community engagement in future research efforts
  - Contextualize lithium and geothermal energy production in the broader regional context
- **Deliverables**
  - FAQ document
  - Q&A outreach events
  - Regional history and social/environmental context included in report

Recommendations from Community Engagement

- Analyze public health impact and continue to monitor local emissions and seismicity.
  - Requests for a dashboard where residents could see the status of development and access information.
- Dedicate more resources to community engagement:
  - People and expertise.
  - Additional time and funding to develop materials for specific audiences.
- Establish formal partnerships with local organizations (vs. informal consultation):
  - Collaborate on events and outreach materials.
  - Community advisory board.
  - Partner with local organizations to co-create research.



Students' takeaways at Imperial Valley College, May 16, 2023
Photo credit: Jeremy Snyder/LBNL

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Key takeaways

- The Salton Sea Geothermal Field has a significant lithium resource , containing up to 18 million tons LCE.
  - It will be developed gradually and there are still unknowns (e.g., the feasibility of upscaling direct lithium extraction technology).
- Environmental assessment did not raise red flags, but ongoing monitoring and a baseline assessment of conditions near the development area is needed.
- Development beyond planned expansions should consider water availability and landfill capacity.
- Community members want more information and opportunities to participate in the project review and development process.
- Future work will build on the models and scenarios presented in the report and strive to deepen engagement with local communities.

Acknowledgements

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Questions

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Full Report: https://escholarship.org/uc/item/4x8868mf

Storymap: https://arcg.is/0X01u1

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