

Geothermal Energy: Mining a Secure Future

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Image: Calpine



Mining a Secure Future of Domestic Critical Materials

Geothermal Overview

- What is Geothermal?
- Critical Materials from Geothermal Brines

Department of Energy Vision for Critical Materials

Programatic Updates

Questions and Answers

Why Geothermal?

Beneath our feet lies vast, untapped energy potential. Geothermal...

- ...is an **always-on** renewable energy source that harnesses the earth's natural heat.
- ...improves domestic energy **security and flexibility**.
- ...provides **baseload power** with flexible on/off.
- ...creates thousands of **valuable energy sector jobs** and strengthens local economies.
- ...is on path to becoming a widely available renewable energy source. An **everywhere solution**.

GTO is built on a legacy of innovation.

Geothermal (DOE) research and investment led to development of the **PDC drill bit**, a game-changing technology that has delivered more than **\$15 billion in cost savings** – primarily in the oil and gas industry – since 1982.



Diversity of Geothermal

Geothermal Diversity

Heat Pumps

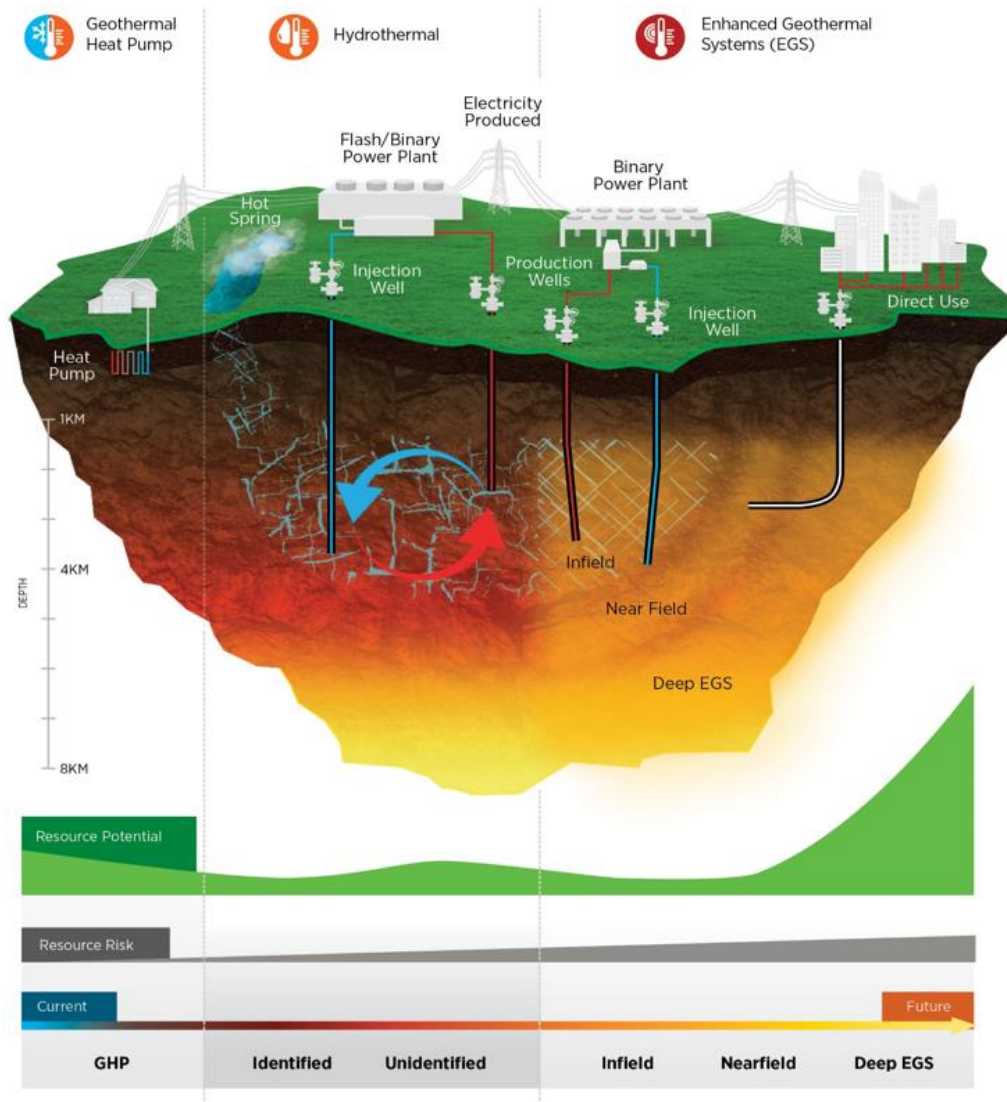
- Near-ambient temperatures (40-80 °F)
- Shallow trenches to wells hundreds of feet deep
- Residential, light commercial

Direct Use

- Moderate temperatures (100-300 °F)
- Wells hundreds to thousands of feet deep
- Large buildings, agriculture

Electric Power

- High temperatures (>300 °F)
- Wells up to many thousands of feet deep
- Grid power



Electric Sector Current Market Status

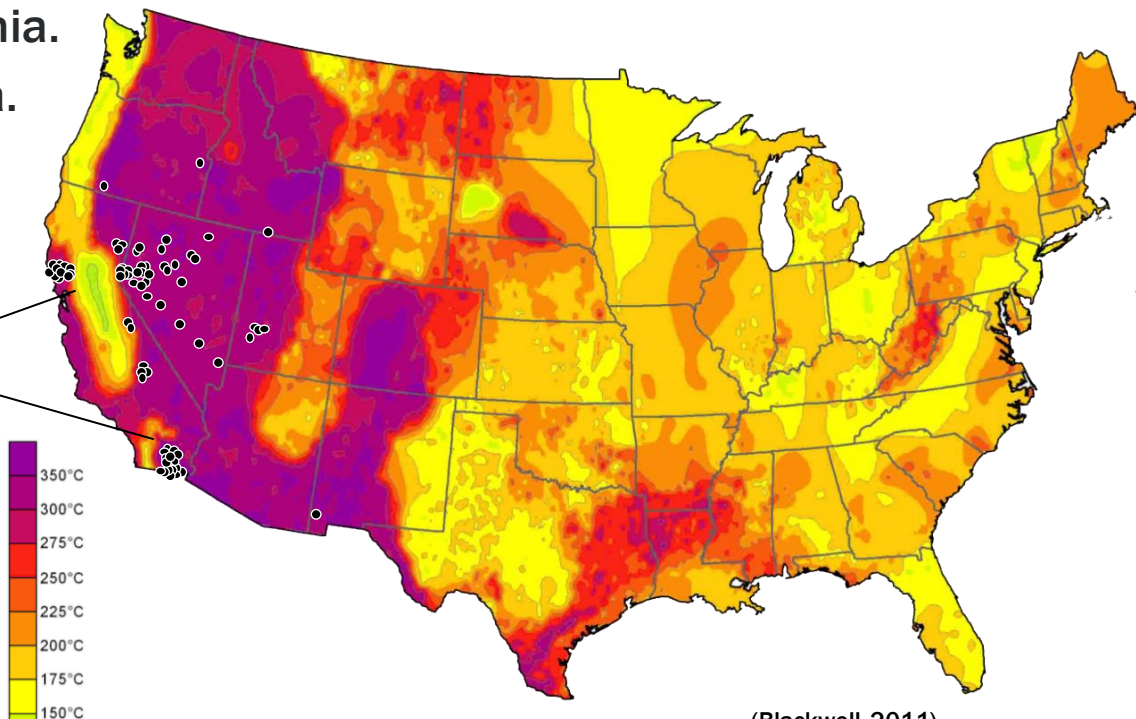
The United States has about **3.8 GWe** of geothermal installed capacity.

- Capacity has been growing at a rate of $\sim 2\%/yr$.

That capacity generates **15,920 GWh**, representing about **0.4% of US total electricity generation**.

- 6% of generation in California.
- 8% of generation in Nevada.

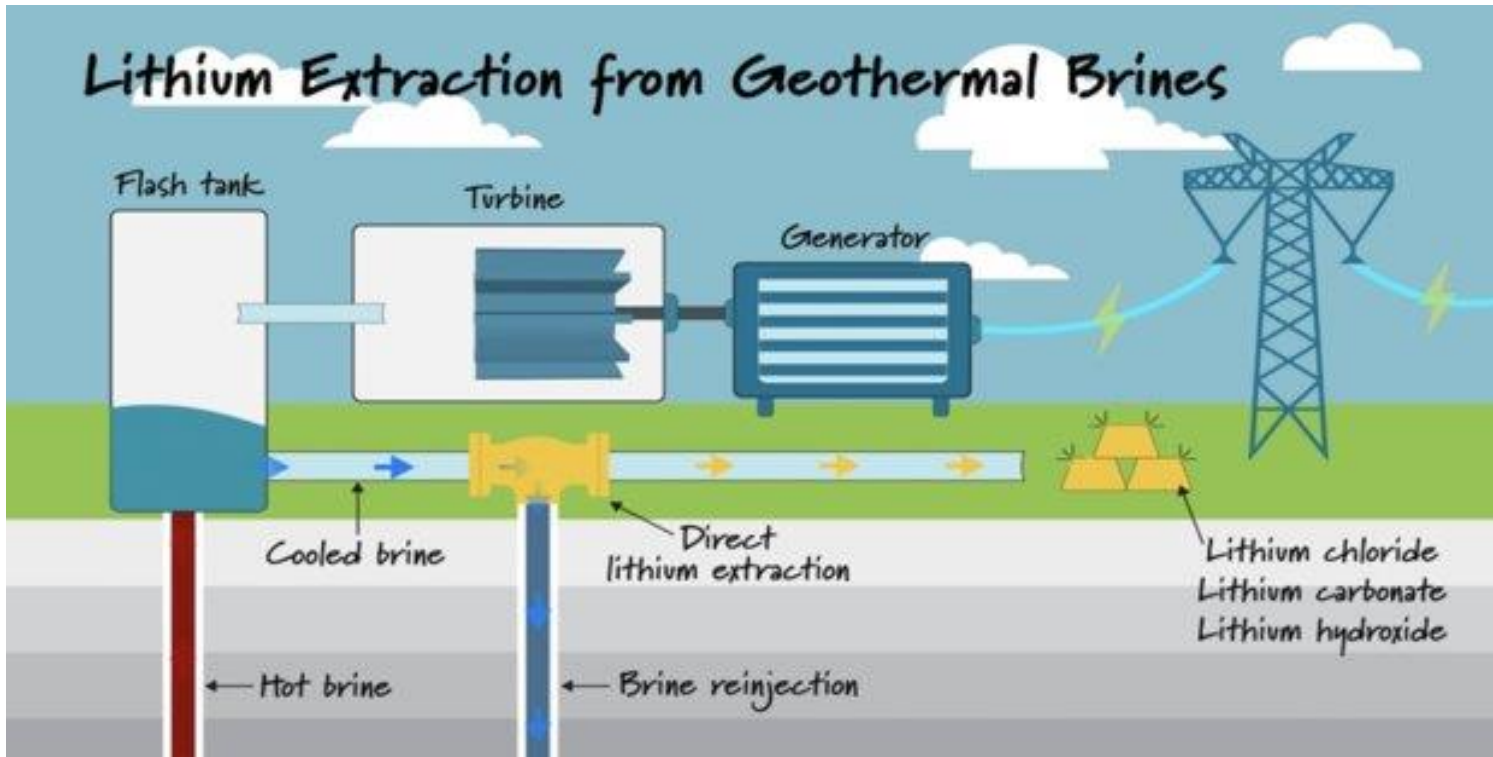
California has more installed capacity than any country in the world.



(Blackwell, 2011)

Critical Materials From Geothermal Brines

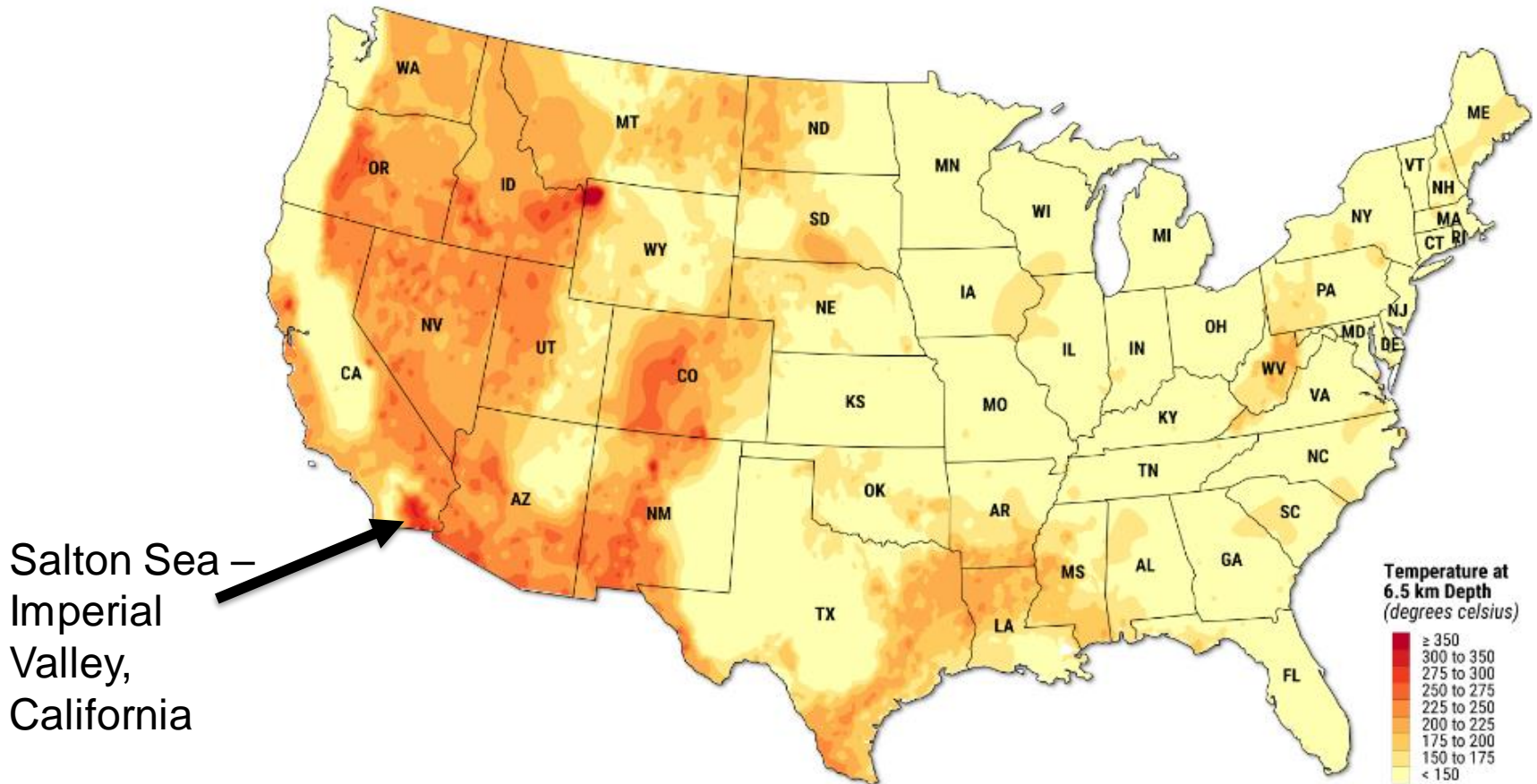
Geothermal brines may contain dissolved solids such as minerals and valuable resources such as critical materials like lithium.



Geothermal power plant operators, engineers, and scientists are working to economically extract critical materials from geothermal brines with a significantly smaller footprint compared to traditional mining before the geothermal fluid is returned to the reservoir.

Challenges to Extracting Critical Materials from Geothermal Brines

Finding locations where with both geothermal power production potential as well as economic amounts of critical materials is rare. DOE is currently funding work on locating these areas, and extraction technologies to pull out critical materials.

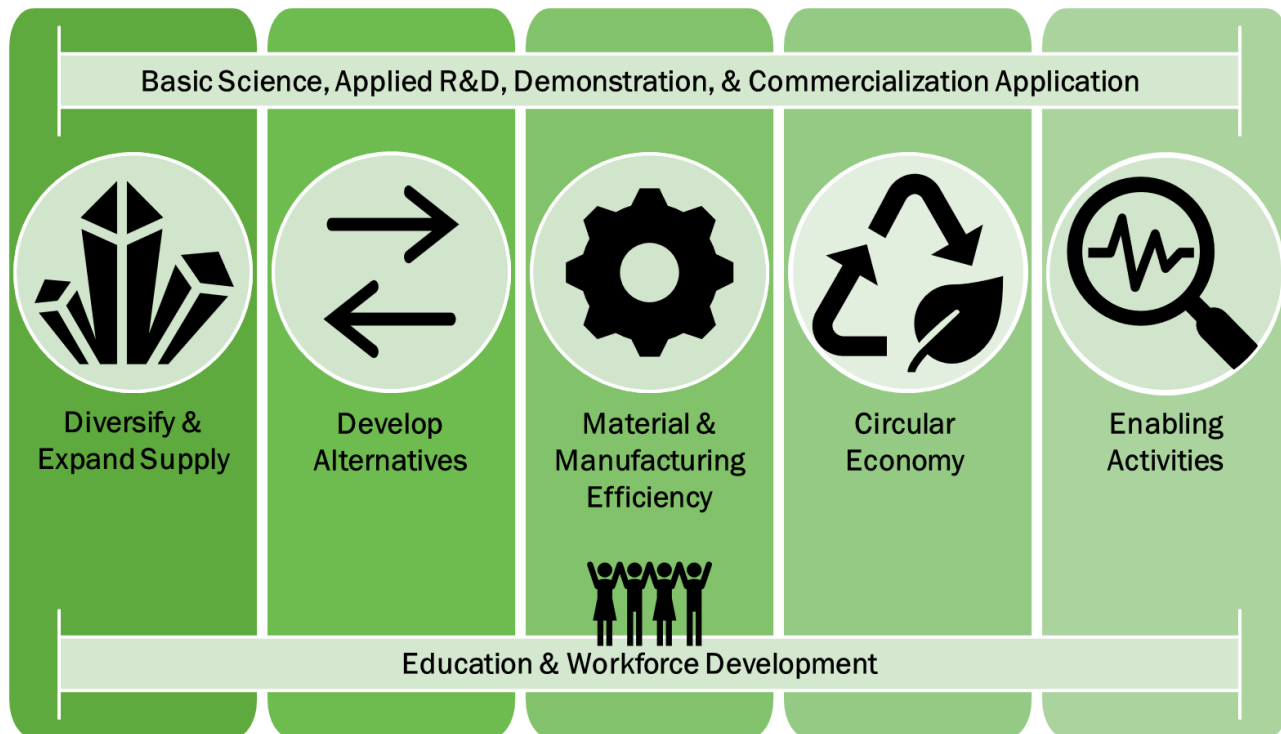


DOE Critical Materials Vision & Strategy

Vision:

- **Reliable, resilient, affordable, diverse, sustainable, and secure domestic critical mineral and materials supply chains**
- Support the clean energy transition and decarbonization of the energy, manufacturing, and transportation economies
- Promoting safe, sustainable, economic, and environmentally just solutions to meet current and future needs.

CMM Strategies:



<https://www.energy.gov/criticalmaterials>

DOE is an integral part of an All-of-Government Strategy

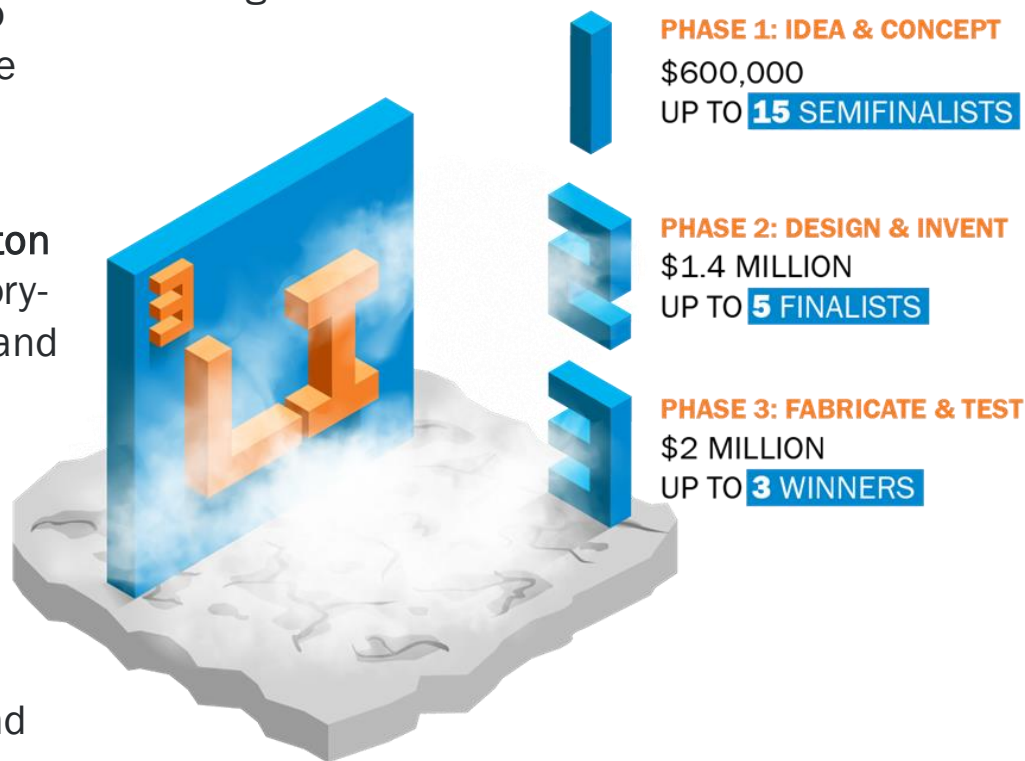
Geothermal Technologies Office (GTO)

GeoFlight: Salton Trough: Collaboration with USGS to collect data on hidden geothermal systems in California's Imperial Valley, using low-flying aircraft to help identify unique surface and near-surface characteristics to create more accurate geologic maps for the area.

Quantification of Lithium Resources in Salton Sea - Lawrence Berkeley National Laboratory-led project aiming better quantify sources and amounts of lithium present in geothermal brines within the Salton Sea geothermal reservoir.

GTO Lithium StoryMap – First-of-its-kind resource that lays out the relationship between geothermal energy and lithium and explores why DOE is investing in technologies supporting lithium extraction from geothermal brines. <https://www.energy.gov/eere/geothermal/lithium-storymap>

Geothermal Lithium Extraction Prize – Prize to find innovations that de-risk and increase market viability for direct lithium extraction from geothermal brines.



www.herox.com/GeothermalLithiumExtraction

Advanced Materials & Manufacturing Technologies Office (AMMTO)

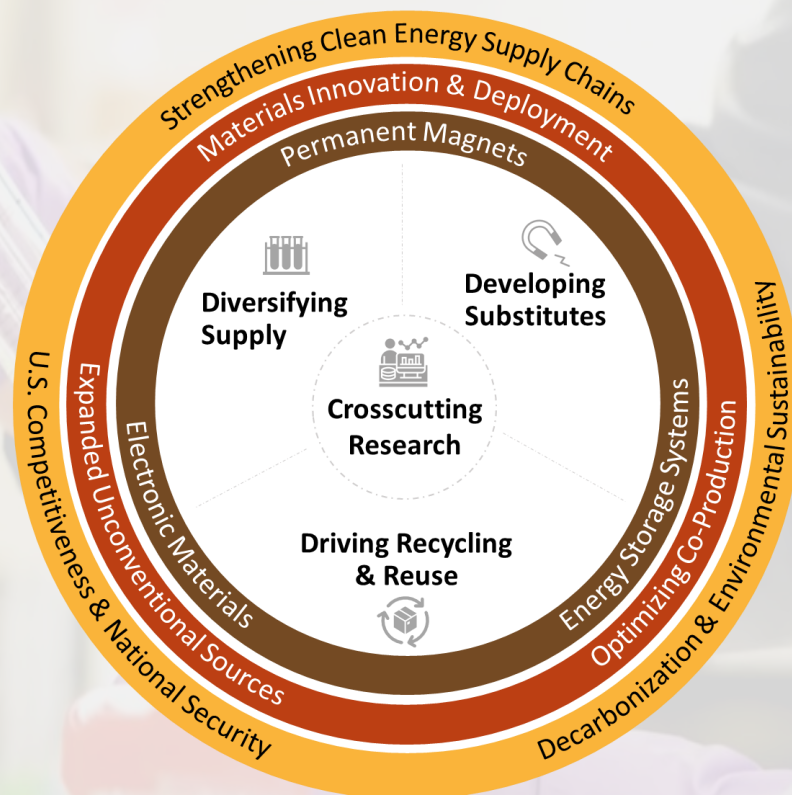
AMMTO's CMM portfolio addresses high-impact opportunities and challenges across the entire life cycle of high priority CMM for energy technologies

Critical Materials Institute (CMI Hub)

- Accelerates S&T solutions to develop resilient supply chains for critical materials for clean tech
- Innovation ecosystem, 10 years in the making

RD&D Project Portfolio

- Demonstrate improved industrial technologies to address supply chain gaps
- R&D to advance next-generation technologies, in coordination with the CMI Hub
- **Lithium RD&D Virtual Center**
- Scale up of lab-proven technologies to accelerate adoption through Small Business Innovation Research (SBIR) and Technology Commercialization Fund (TCF) Projects



Critical Materials Institute
AN ENERGY INNOVATION HUB

Joint AMMTO-GTO Funding Opportunity Announcement (FOA): Lithium Extraction & Conversion from Geothermal Brines

FOA Goals:

- Enable environmentally and socially responsible domestic manufacturing of battery-grade lithium hydroxide from geothermal brines;
- Diversify the domestic supply of lithium hydroxide;
- Validate and demonstrate domestic pilot plants and related technologies to support the transition to U.S. manufacturing; and
- Mature nascent technologies, processes, and methods that improve one or more unit operations of direct lithium extraction systems.

Topic Areas:



Field Validation of Lithium Hydroxide Production from Geothermal Brines

Seeks industry-led pilot or demonstration projects to validate cost-effective, innovative lithium extraction and lithium hydroxide conversion technologies from domestic geothermal brines.



Applied Research & Development for Direct Lithium Extraction from Geothermal Brines

Aims to mature nascent technologies, processes, and methods that increase efficiency, reduce the generation of waste, and/or reduce cost across one or multiple unit operations in the extraction, purification, and fluid trains

Questions?



The **Geothermal Technologies Office (GTO)** works to reduce costs and risks associated with geothermal development by supporting innovative technologies that address key exploration and operational challenges. By advancing the value stream for grid (electricity) production and direct-use applications, GTO aims to make geothermal energy a **cost-competitive, widely available, and geographically diverse** component of the national energy mix.

Learn More & Stay Connected: [geothermal.energy.gov](https://www.geothermal.energy.gov)



The **Advanced Materials and Manufacturing Technologies Office (AMMTO)** researches, develops, and demonstrates next-generation materials and manufacturing technologies needed to increase U.S. industrial competitiveness and to drive economy-wide decarbonization.

AMMTO supports the national plan to revitalize American manufacturing, **secure critical supply chains**, and develop diverse innovation ecosystems leading to new manufacturing jobs and increased economic strength of the nation.

AMMTO provides planning, management, and direction necessary for a balanced program of research, development, demonstration, technical assistance, and workforce development to support **domestic manufacturing** that is critical to achieving a clean, decarbonized economy.

Learn More & Stay Connected: [energy.gov/eere/amo](https://www.energy.gov/eere/amo)