

U.S. DEPARTMENT OF ENERGY

Office of ENERGY EFFICIENCY & RENEWABLE ENERGY

ADVANCED MATERIALS & MANUFACTURING TECHNOLOGIES OFFICE

The Role of Research & Innovation to Strengthen Clean Energy Supply Chains

Kate Peretti

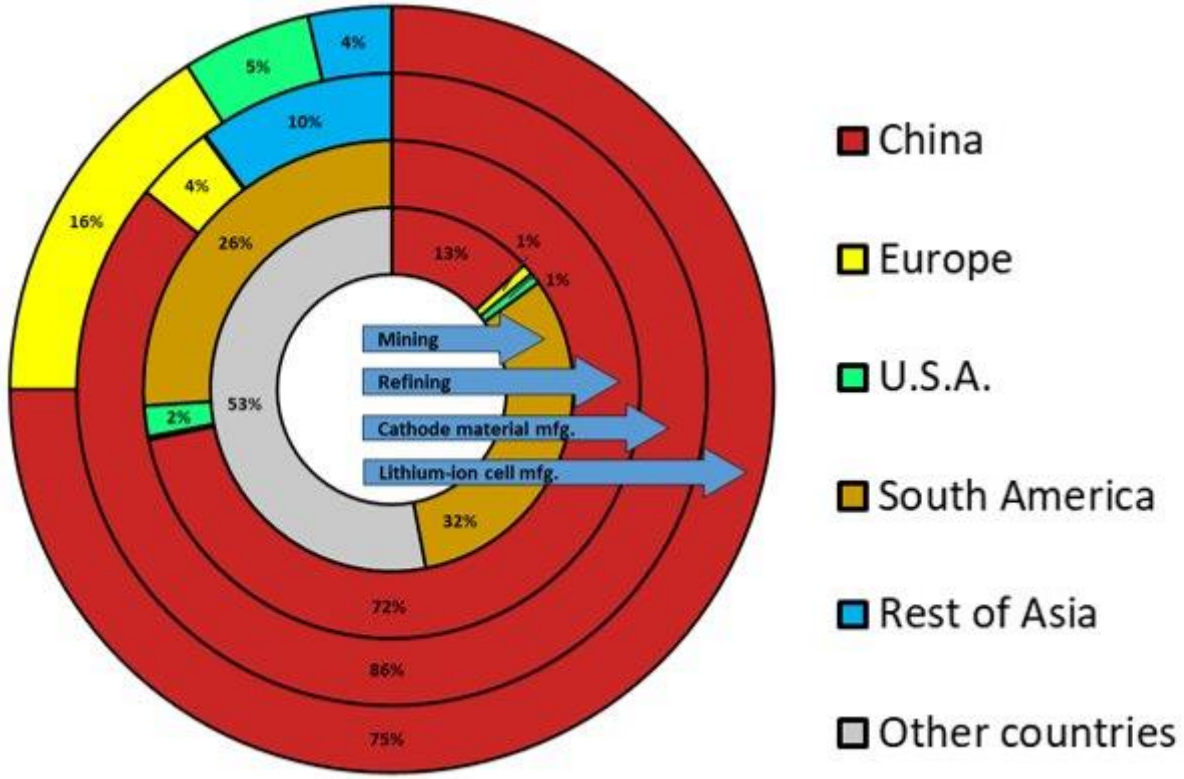
Program Manager on Secure & Sustainable Materials

December 12, 2023

The US is Motivated to Build Capacity to Produce Materials and Components for Clean Energy Technologies

The world is highly dependent on a very limited set of countries for several steps in the supply chain for clean energy materials

Geographic concentration of supply chain stages for lithium in lithium-ion batteries



https://www.energy.gov/policy/supplychains

Innovation is Needed to Ensure Sustainable Material Production



The next generation of mining, processing, and manufacturing plants need advanced technologies that lower the emissions and environmental burden.

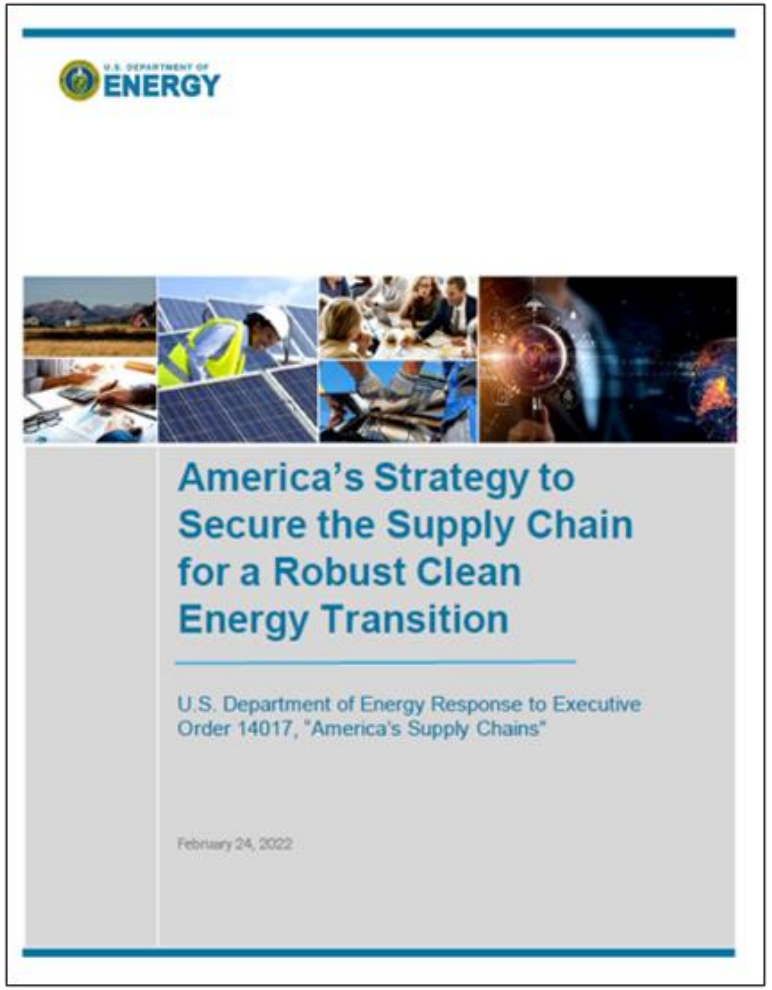
Goals of DOE Innovation

- Need to innovate more **sustainable** approaches to **build US supply chains**
- **US competitiveness** hinges on development of sustainable approaches across the entire supply chain and life cycle of critical materials
- Advancements are targeted at:
  - Increased efficiency
  - Increased circularity
  - Decreased environmental impact
  - Decreased health impacts



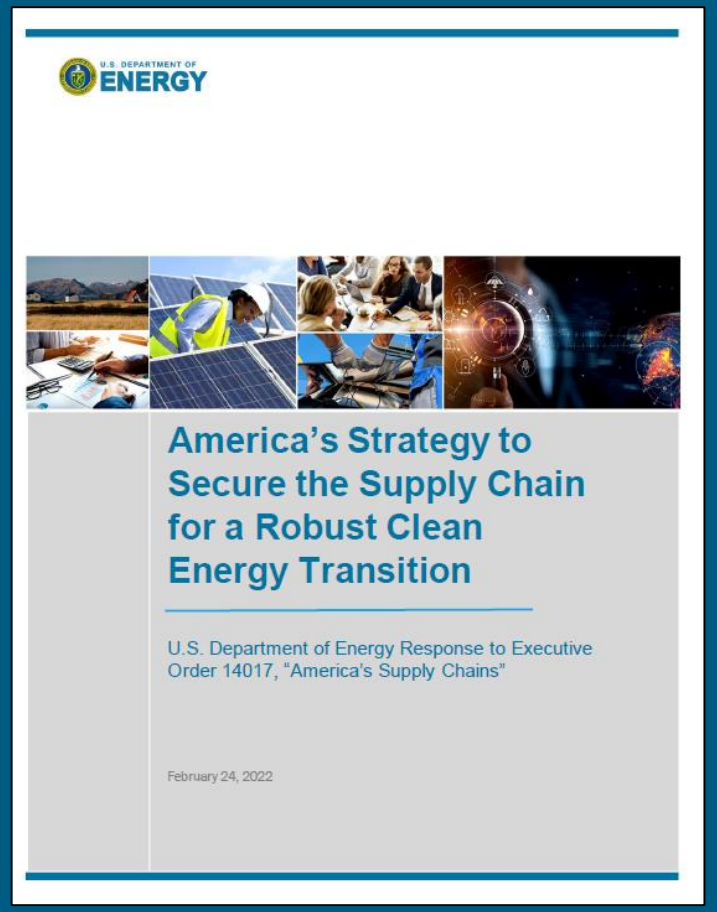
Administration Efforts to Secure the Clean Energy Supply Chain

- Unprecedented investment in critical materials:
  - **$211M in Fiscal Year 2023** funds for critical minerals & materials
  - **Bipartisan Infrastructure Law (BIL) provided over $8 billion** in funding dedicated to critical minerals and materials advancement.
- Inflation Reduction Act provides tax credits and dedicated loans for critical minerals processing, manufacturing, and recycling
- Executive Order 14017 on America's Supply Chains spurred analysis of supply chains for critical materials & large capacity batteries and resulted in DOE's 11 deep dive assessments.
- White House announced efforts to strengthen America's Supply Chains by:
  - Creating a Council on Supply Chain Resilience
  - Establishing new cross-government supply chain data-sharing capabilities.
- To support these initiatives, DOE is developing an assessment tool that accounts for raw materials, manufacturing, workforce, and logistics considerations.



https://www.energy.gov/policy/supplychains

Securing America's Clean Energy Supply Chain



https://www.energy.gov/policy/supplychains

11 deep dive assessment documents:

- carbon capture materials
- electric grid including transformers and high voltage direct current
- energy storage
- fuel cells and electrolyzers
- hydropower including pumped storage hydropower
- neodymium magnets
- nuclear energy
- platinum group metals and other catalysts
- semiconductors
- solar photovoltaics (PV)
- wind

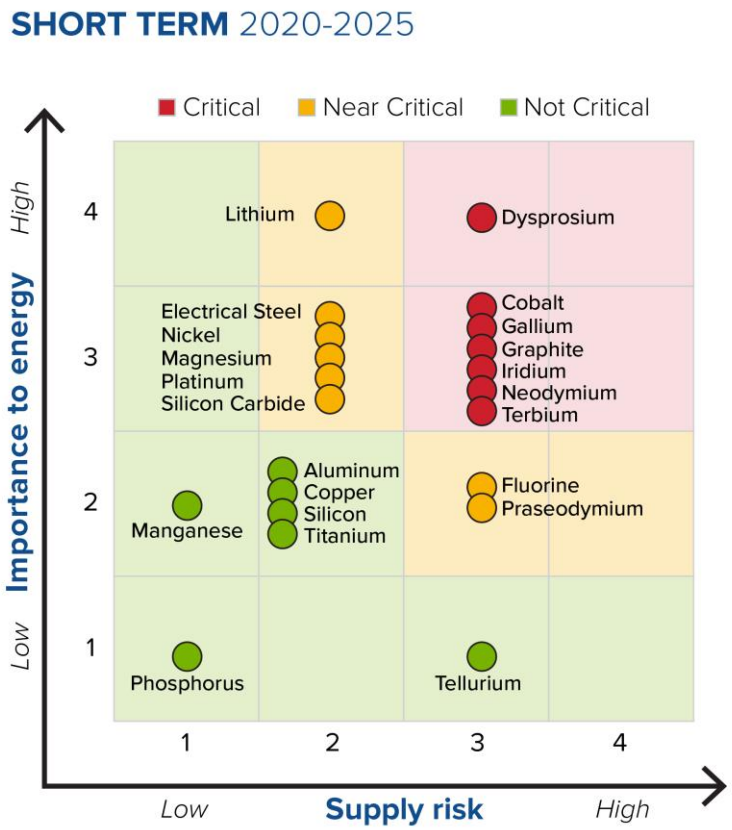
2 crosscutting topics:

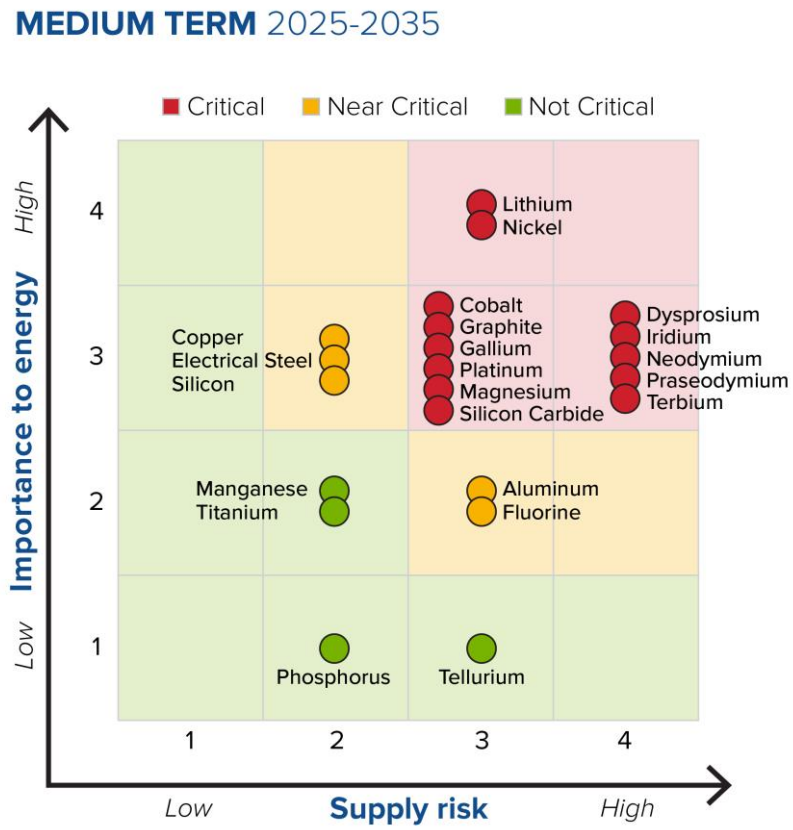
- commercialization and competitiveness, and
- cybersecurity and digital components.

Scoping US Supply Chain Vulnerabilities

Critical materials are materials that have high risk for supply disruption and serve an essential function in one or more energy technologies

The 2023 DOE Critical Materials Assessment was released using updated projections for clean energy needs and material production.

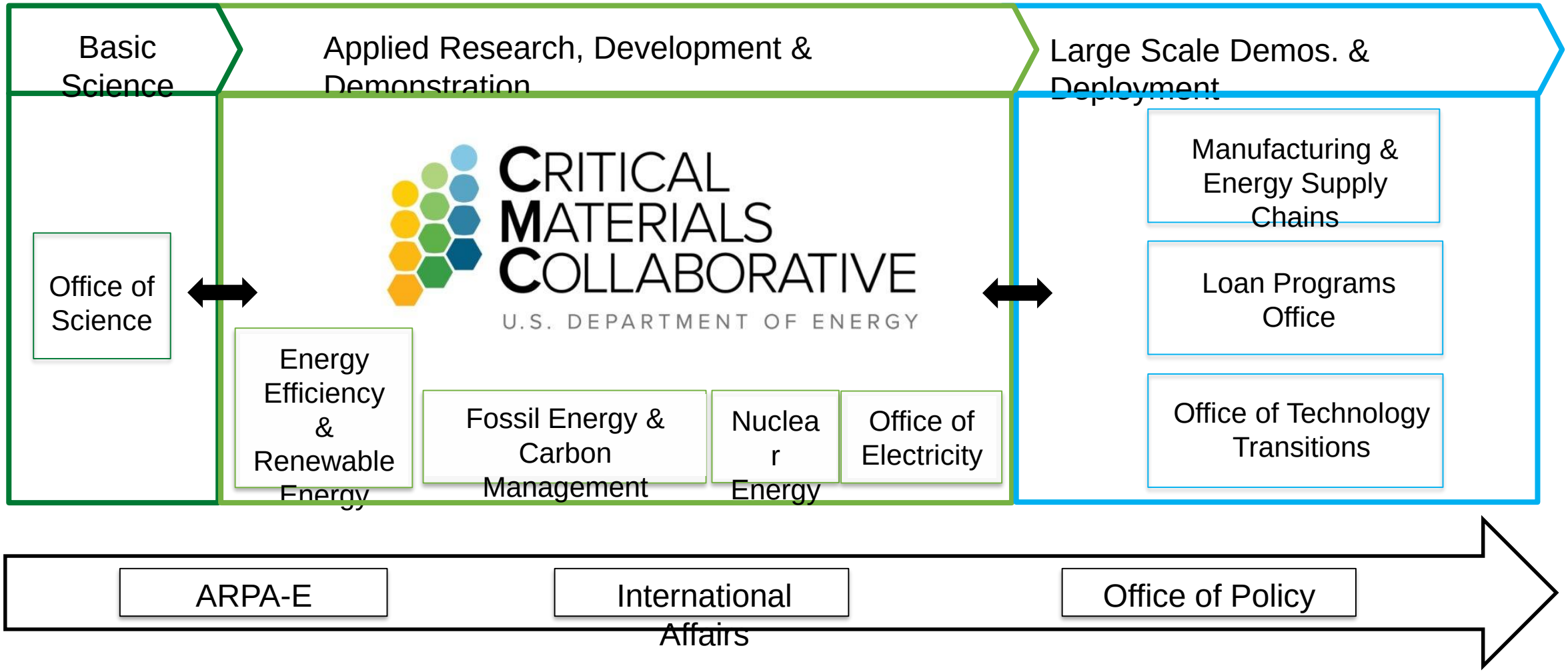




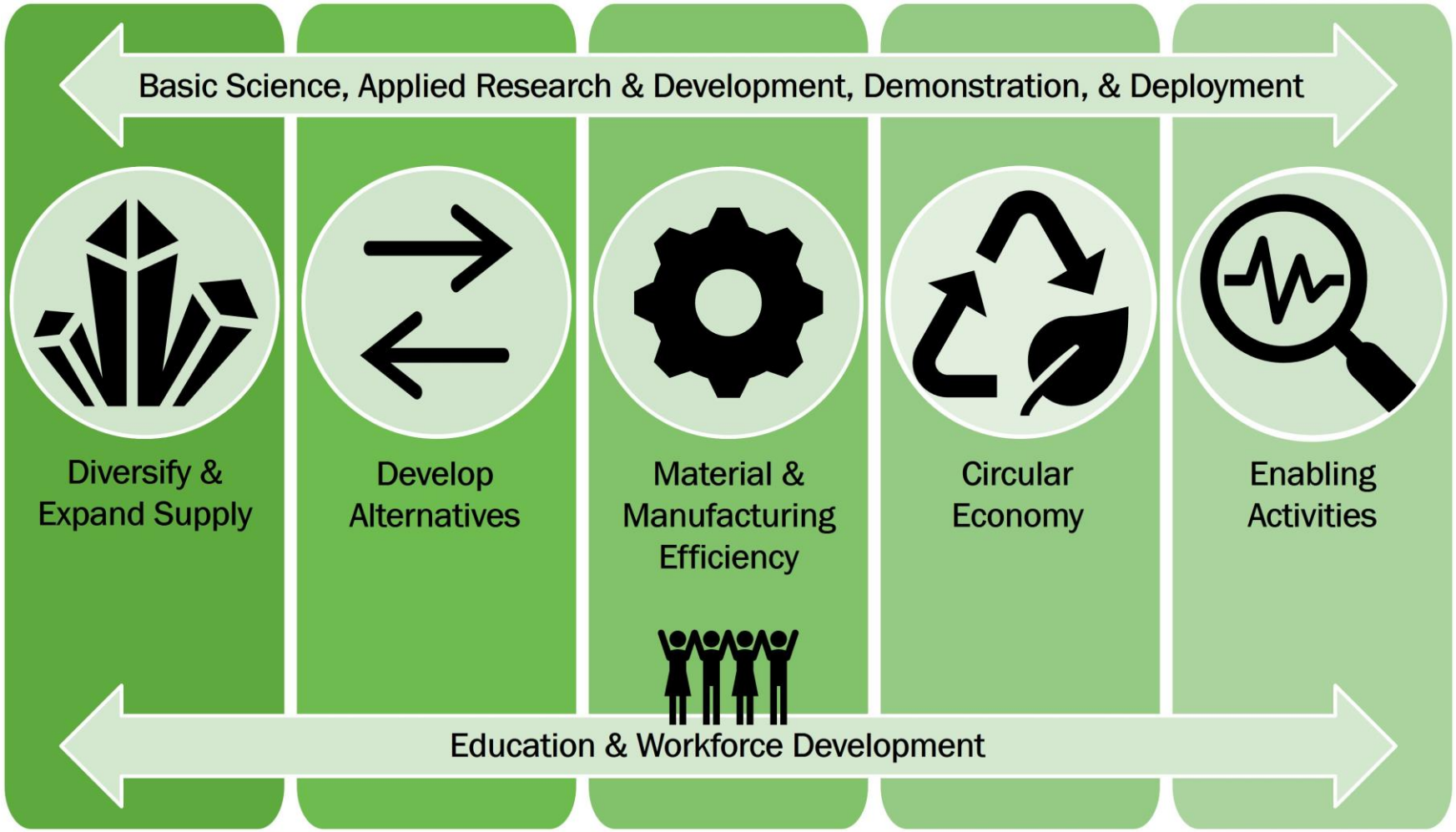
https://www.energy.gov/cmm/what-are-critical-materials-and-critical-mineral

Critical Materials RDD&D Program

The Program coordinated efforts funded by annual appropriations, Bipartisan Infrastructure Law (BIL), and the Inflation Reduction Act (IRA) – spanning basic science to deployment – with support from cross-cutting efforts



DOE Critical Minerals & Materials Strategy



DOE is an integral part of an <u>All-of-Government Strategy</u>

https://www.energy.gov/critical-minerals-materials

Cross-Cutting Effort: Critical Materials Innovation Hub (CMI)

CMI is a public-private partnership that leverages expertise across academia, industry, and the National Labs to solve technical challenges related to critical materials.

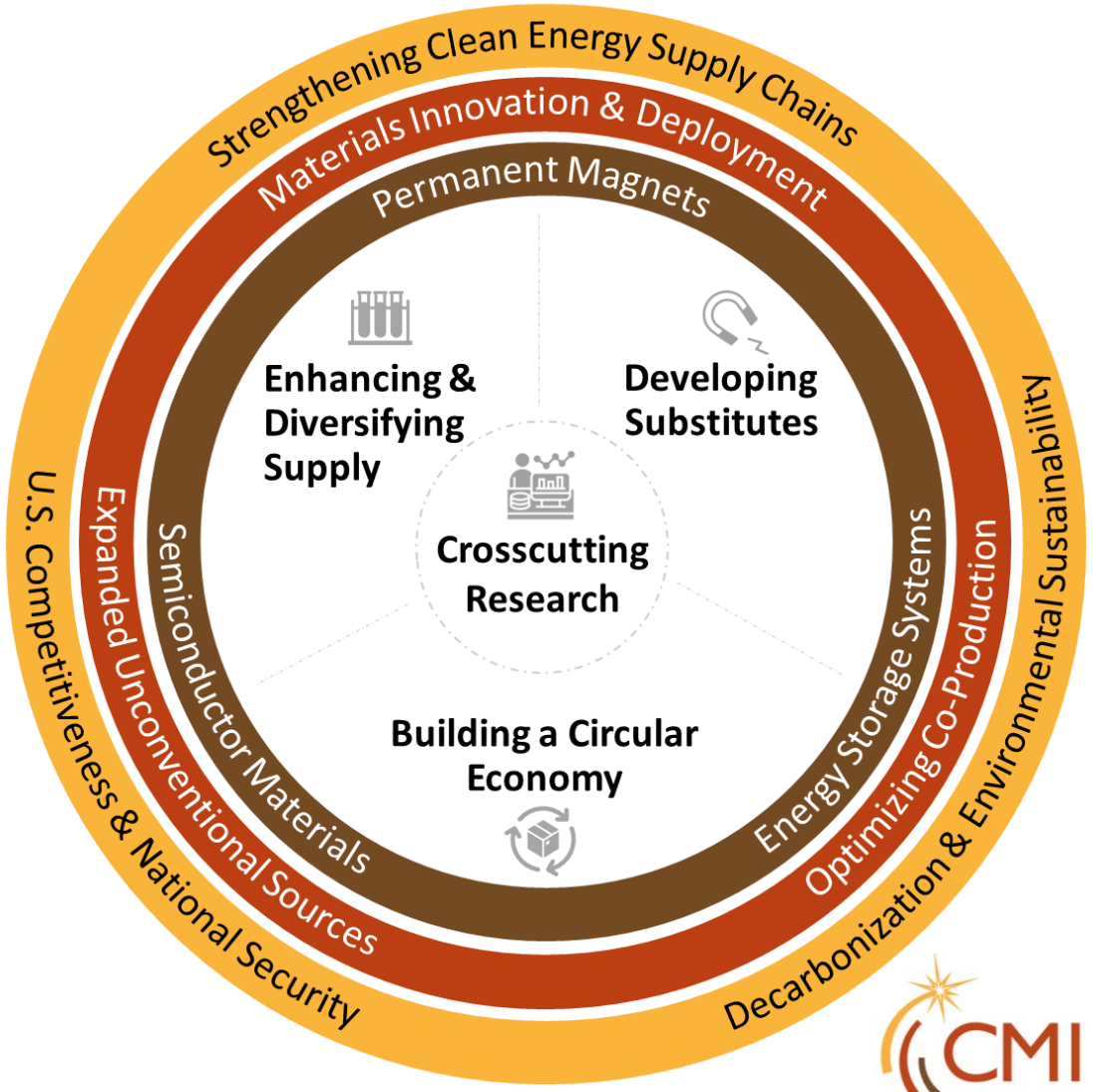
Over 10 years leading early-applied research in:

- Extraction
- Separation, processing and metallization
- Material development for substitution
- Recycling

People: CMI develops the workforce of the future through R&D engagement, targeted training, and internships.

Innovative Ecosystem: network of 45+ active team members across critical material supply chains

Portfolio: >30 research projects building on 10 years of research resulting in 500+ publications, 12 R&D100 Awards, 47 patents, and licensed 20 technologies to industry.



Critical Materials Innovation Hub

Diversify and Expand Supply

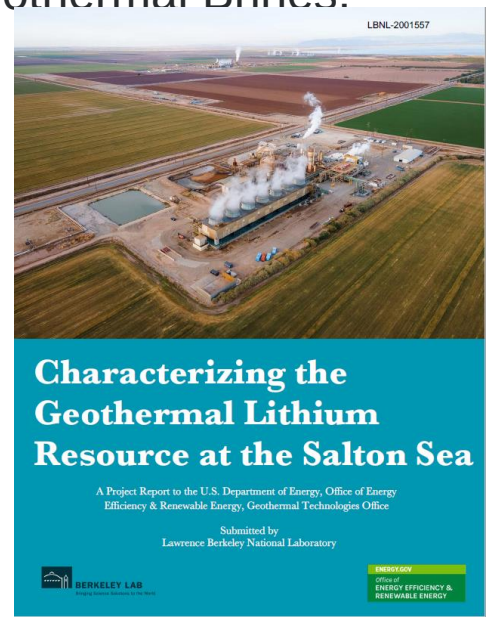


Lithium RD&D Virtual Center promotes collaboration and information sharing of lithium RD&D activities and supply chain-related information throughout the United States.

- Includes 10 projects selected from the Joint AMMTO-GTO FOA on Lithium Extraction & Conversion from Geothermal Brines.

AMERICAN MADE GEOTHERMAL PRIZE

U.S. DEPARTMENT OF ENERGY

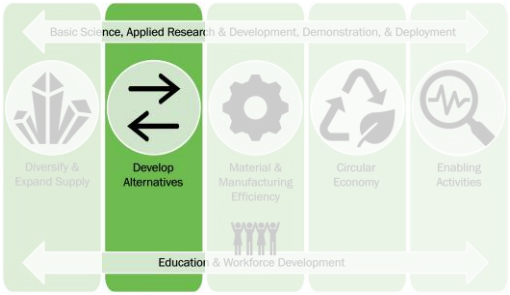


Mining Innovations for Negative Emissions Resources (MINER) Program seeks to increase the U.S. domestic supplies of Cu, Ni, Li, Co, and rare earth elements.

- Increase energy-relevant mineral yield by capturing desired minerals in CO_2-reactive mineralogy
- Recover any remaining mineral value by reprocessing existing CO_2-reactive rock, soil layers, or tailings deposits
- Carbon-negative pathways by developing ore-to-metal reactions to carbonate CO_2-reactive ore
- Decrease mineral processing energy and reduce minerals tailing losses by 50%

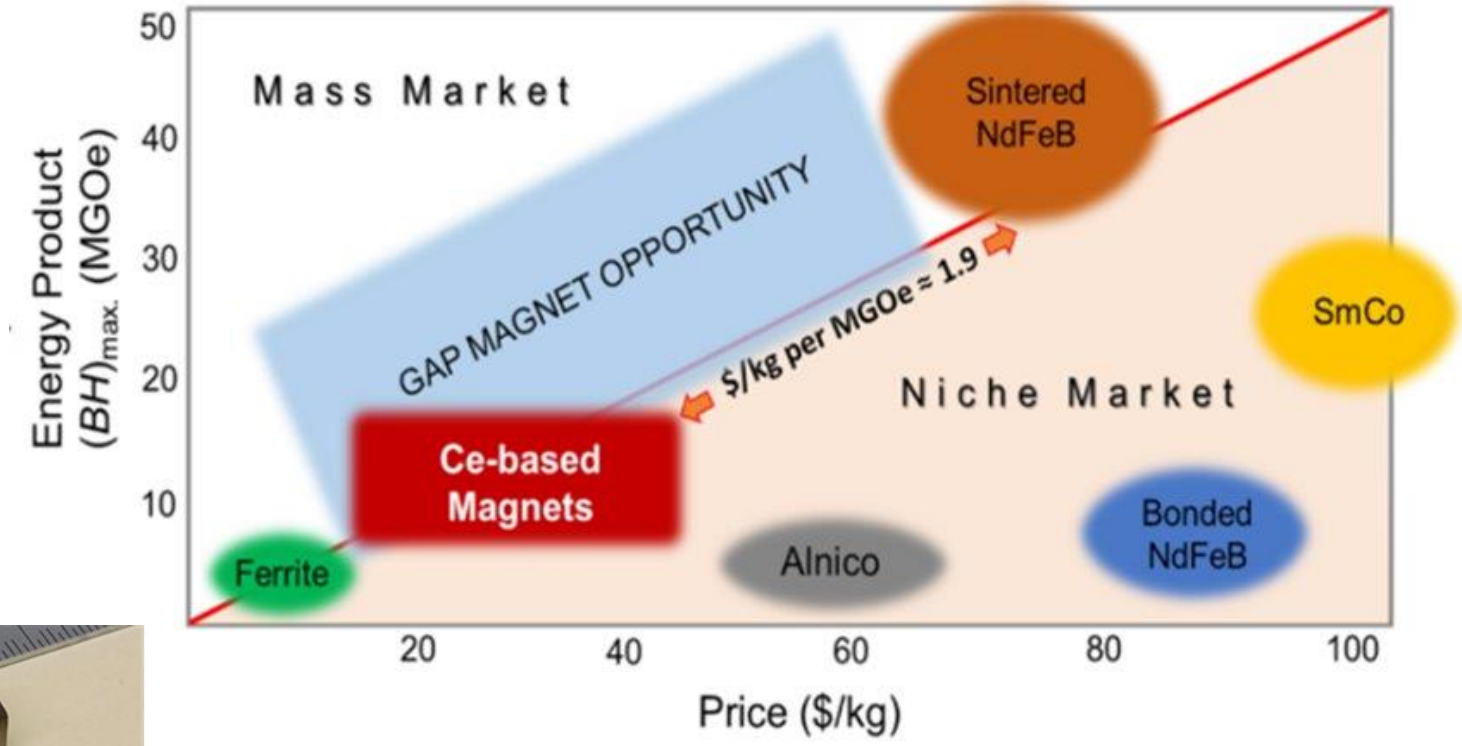


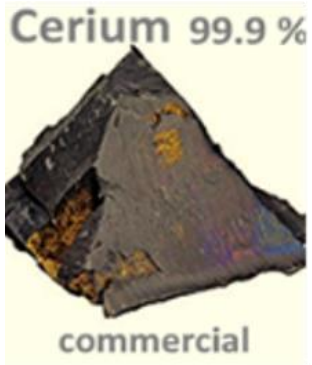
Develop Alternatives

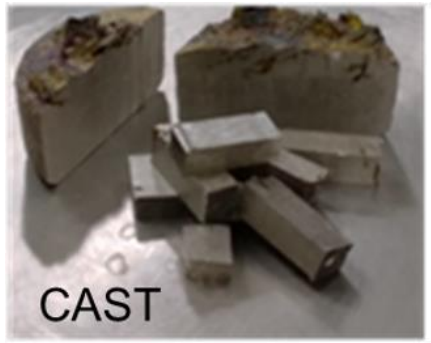


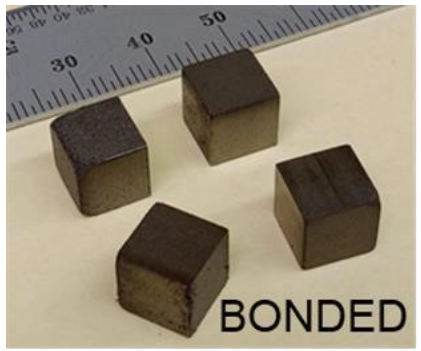
Reducing RE demand from permanent magnets

- One-step cast cerium-based “gap” magnet ingot
- 4 MGOe bonded magnet with 50% better remanence than bonded ferrite magnets
- Potential to address “rare earth balance problem”





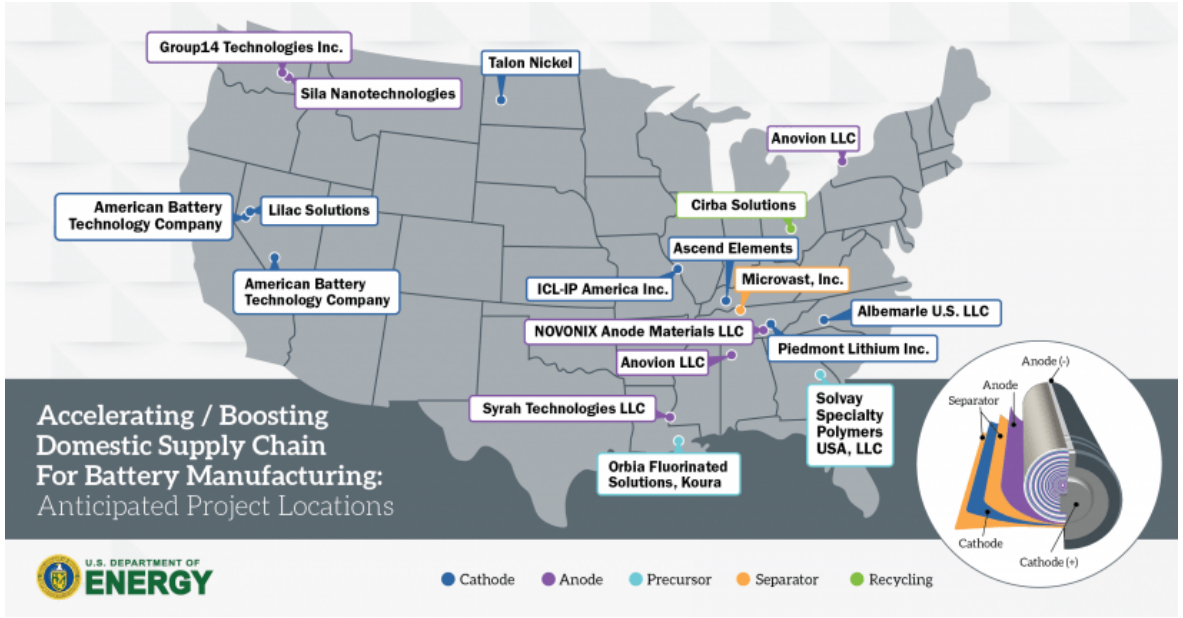




Material and Manufacturing Efficiency

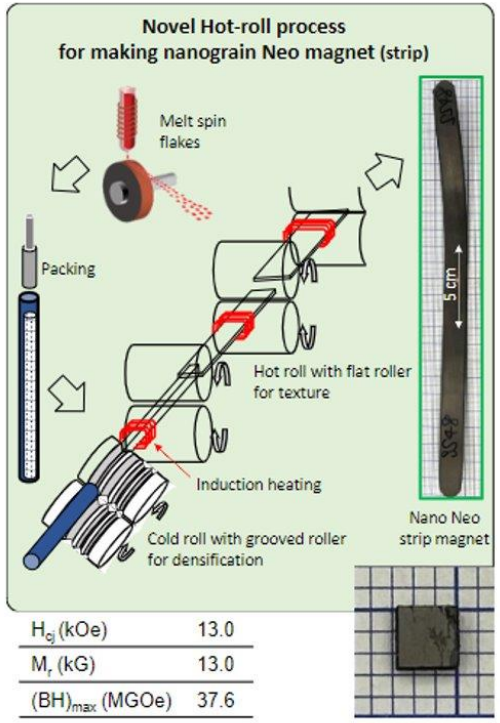


Bipartisan Infrastructure Law: Battery Materials Processing and Battery Manufacturing Recycling

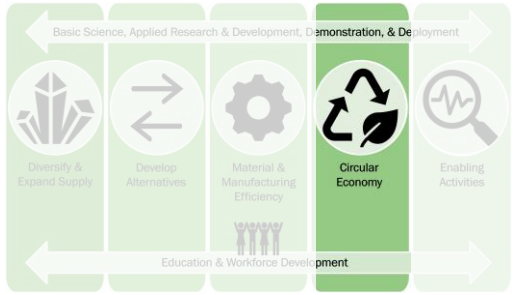


- First round of annual funding increases domestic production of battery-grade lithium, graphite, nickel, and other components needed for EV batteries.
- 15 of the 18 selected projects are collaborating with HBCUs to hire and train workers for the projected 5,000 jobs to be added.

- Semi-continuous magnet manufacturing process reduces complexity using a deformable die concept
- Functionality at high temperature without Dy



Circular Economy



Acid Free Dissolution of E-Waste

- Room temperature process using copper salts with high selectivity
- Eliminates need for pre-processing operations
- 65 kg of shredded hard disk drives were recycled to recover REE at >99.7% purity and >90% leaching efficiency.



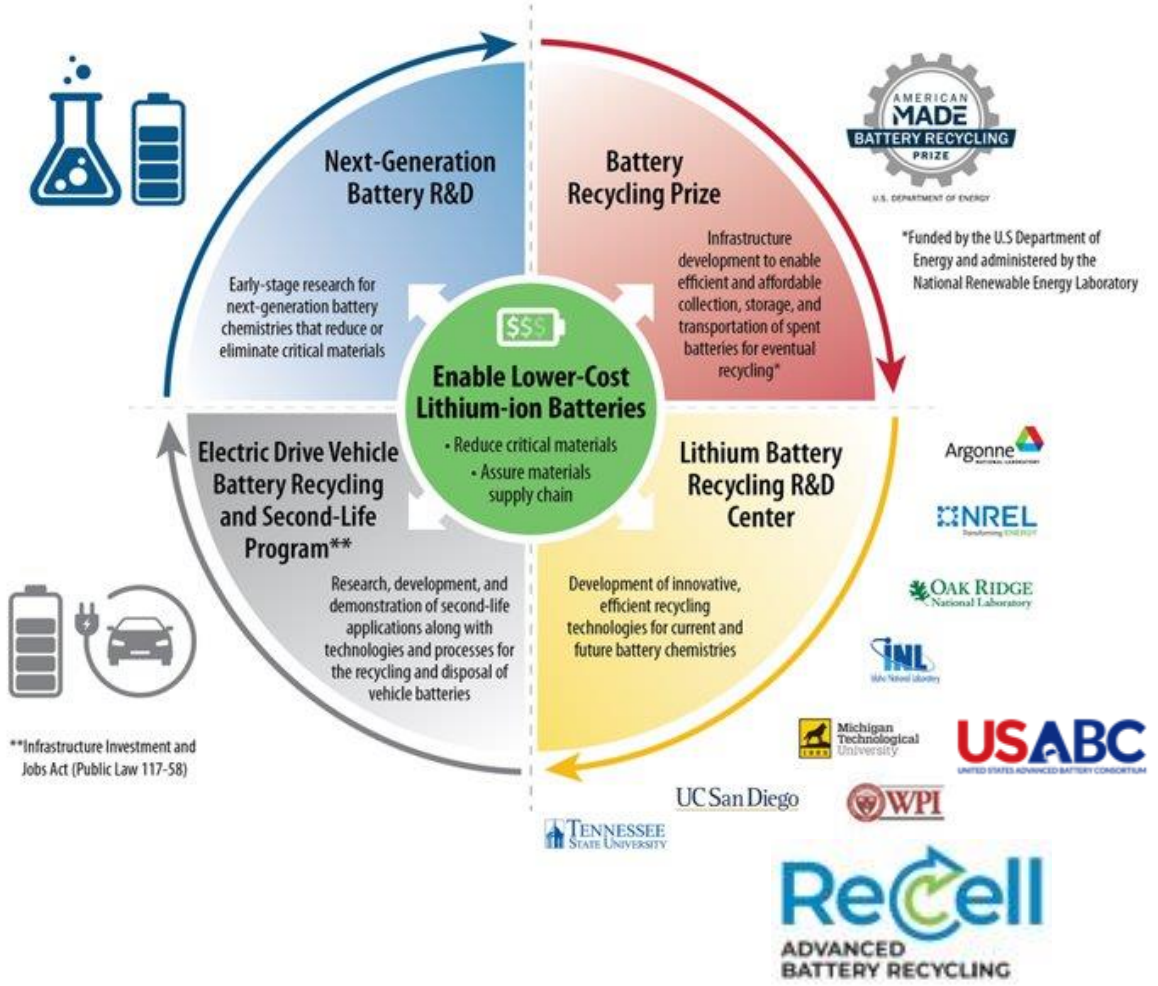
Shredded HDDs prior to recycling



Shredded HDDs after REEs leaching



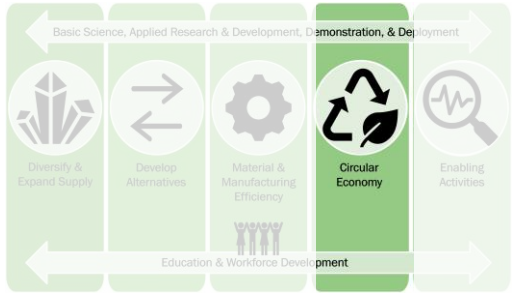
Sample of recovered rare earth oxide



Circular Economy







REMADE® INSTITUTE

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Next Steps

CRITICAL MATERIALS COLLABORATIVE
U.S. DEPARTMENT OF ENERGY

***Draft* Technical Objectives**

- Improve by-production of CMMs from industrial waste and operational mining waste.
- Accelerate materials discovery/prediction for emerging CMs/technologies
- Drive the use of smart and agile manufacturing to make the most of every atom along the supply chain, minimize waste and emissions.
- Advance concepts to design for circularity and new methods for material/component recovery.

- CMC Roadmap to define DOE RD&D priorities/implementation
- Funding Opportunities
  - Bipartisan Infrastructure Law (BIL) 40207(b) Battery Materials Processing & BIL 40207(c) Battery Manufacturing Grants Round II
    - Notice of Intent: $3.5 billion
  - Critical Materials Accelerator Program
    - Notice of Intent: $10 million







Thank you

Learn more about CMM at DOE:
energy.gov/criticalmaterials

Learn more about AMMTO & our CMM portfolio

Contact: Kathryn.Peretti@ee.doe.gov

Unprecedented Federal Investment in Critical Materials

Recent funding opportunities, selections, and awards include:



$150 million to **advance critical mineral innovation, efficiency, and alternatives**

$6 billion for **battery materials processing** and battery **manufacturing recycling**



$74 million to advance domestic **battery recycling and reuse**

$107 million to **expand critical materials production capacity for lithium-ion batteries**



$350 million for **long-duration energy storage** demonstration

$30 million lab call for **long-duration energy storage**



$16 million for front-end engineering design studies for the **REE demonstration facility**

$11 million for **lithium extraction and conversion from geothermal brines**



$39 million for **M**ining **I**nnovations for **N**egative **E**missions **R**esource Recovery **program**



$5.1 million to **develop cost-effective and sustainable recycling for wind turbines**

$17.5 million to **commercialize critical material-free permanent magnets**

Unprecedented Federal Investment in Critical Materials

- **~$211 million in Fiscal Year 2023** enacted on critical minerals and materials
- **Bipartisan Infrastructure Law (BIL) provided over $8 billion** in funding dedicated to critical minerals and materials advancement, such as:



Battery Materials, Manufacturing and Recycling Demos and Commercializati on



Rare Earth Elements Demonstration Facility

$140 million



Critical Materials RDD&D Program

$600 million



Critical Material Supply Chain Research Facility

$75 million



Clean Hydrogen Electrolysis Program

$1 billion