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United States Energy Association:
A Catalog and Survey of Critical Materials Research Collaboration Between Industry and National Laboratories

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Battelle: Our Mission and Purpose

Gordon Battelle, Founder

OUR MISSION: To translate scientific discovery and technology advances into societal benefits

- Nonprofit, charitable trust formed in 1925
- Continuous investment in science & technology and charitable causes
  - Contract Research
  - Laboratory Operations
  - STEM Education and Philanthropy

Battelle By **The Numbers**

~3,500 Contract Research employees

$8.2B Revenue for Battelle and its affiliated national laboratories

10 Major U.S. locations with **headquarters** in **Columbus, Ohio**

8 National Laboratories in which **Battelle** has a **management role**

$10M annual **philanthropic investment**

405 Battelle and National Lab R&D 100 Awards since inception

2,650 Patents secured by Battelle inventors since 1929

2,575 Papers written or **co-written** by employees since 2000

1,000+ employees with advanced degrees

~300,000 students impacted by Battelle programming each year

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Report Objective

To identify potential barriers of collaboration between stakeholders in critical material research and provide mitigation recommendations

Report Contents:

- Summary of the types of critical materials research being done by the National Laboratories
  - Including the Critical Materials Institute that pulls together researchers from 4 National Laboratories with academic and industry partners.
- Federal funding towards CM research
- National Laboratory and stakeholder outreach
  - Discussion and survey responses conducted with industry and national laboratories stakeholders on the current efficacy of CM Research collaboration.

Critical Materials Research in the National Laboratories

- National Labs
  - Catalog of scientists, engineers, and project managers doing Critical Materials Research at the national laboratories with their contact information and research interests
  - A list of patents from the past five years coming from national laboratories
- User Facilities
  - 28 Office of Science user facilities
  - Advanced computing (ASCR), Basic energy sciences (BES), Biological and Environmental (BER), Fusion energy (FES), High energy physics (HEP), Nuclear physics (NP)

https://science.osti.gov/User-Facilities/User-Facilities-at-a-Glance

National Laboratory Resources

- Critical Materials Institute
  - DOE Energy Innovation Hub housed at Ames National Laboratory launched in 2013 to seek innovations in CM research for domestic supply chain security.
  - 4 national laboratory, 30 industry, 15 university members, many affiliate members
  - 156 invention disclosures, 57 patent applications
  - Catalog of research and currently funded projects (FY21) under the CMI, and technology transfer award information

NL – industry collaboration projects (FY20)

Entities	Mechanism	Project
Ames National Laboratory + Electron Energy Corporation	TCF	Mechanically robust high magnetic performance Sm-Co sintered magnets
Oak Ridge National Laboratory + Idaho National Laboratory + All American Lithium	TCF	Recovery of lithium from geothermal brine with lithium-aluminum-layered double hydroxide chloride sorbents
Lawrence Livermore National Laboratory + MolyWorks	TCF	Materials Design Simulator: A practical tool for advanced alloys development
TdVib (with Ames' technology)	STTR	Scale up acid-free dissolution recycling of critical materials from e-waste
Quantum Ventura Inc. (with INL's technology)	STTR	Scale up electrochemical recycling electronic constituents of value (E-RECOV)

CMI Research Initiatives

Diversifying Supply
Expanding sources, transformative processes, new uses for co-products

Driving Reuse and Recycling
Learning to use available materials more efficiently by reducing waste in manufacturing and increasing recycling

Developing Substitutes
Synthesizing materials that meet needs but use less critical resources e.g. magnets with reduced rare earth content

Cross-cutting Research
Developing new research tools and forecast what materials might become critical in the future. Sustainability and supply chain analysis are components.

https://iastate.app.box.com/v/cmi-annual-report

Government Engagement

- Bipartisan, with support spanning across white house administrations
- Government agency support is requiring more of a holistic approach than we have seen in the past.
  - DOE; CM research largely funded by FECM expanding from carbon ore based feedstocks to e-waste and CM alternatives through the EERE office.
  - DOD; Large investments in conventional mining for REE and CM through the various office's under the Office of Industrial Policy
  - EPA; hasn't had a lot of funding in recent years but there is still interest in how they can utilize different waste streams to help from a waste perspective as well as REE production
- Congressional support; Bipartisan Infrastructure Bill (BIL) with large investments in Demonstration facilities, USGS mapping, battery recycling, etc.

National Laboratory and Stakeholder outreach

- We asked the National Laboratories and relevant industry stakeholders their perspectives on the collaborative environment for critical materials research.
  1) What is your current impression of the collaboration process with (national laboratories/industry) in the CM space?
  2) Have you collaborated with a (national laboratory/industry) before on CM research? What was that process like, and were there desirable outcomes for your organization?
  3) Are you aware of funding mechanisms for collaborative efforts between industry and national laboratories in CM research? Is the process of securing funding straightforward?
  4) Can you think of any ways the collaborative efforts between industry and national labs could be improved?
  5) What do you believe are important next steps in commercialization of CM technologies?

Response from industry stakeholders

- Main themes
  - Friendly relations but do not often seem to materialize into organized research projects.
    - Industry interests and national laboratories interests are not always aligned
    - National laboratories research focuses should be shaped by identification of buyers/users of downstream technologies and solving issues related to supply-chain issues
    - Not equipped to help industry solve quick issues
  - Difficult to identify the right partners without prior knowledge or working relationships
  - Current funding mechanisms are limited in their ability to incentivize or facilitate collaboration
    - Small businesses may be more amenable than large businesses in collaborating with national laboratories, but funding mechanisms seem to be limited to SBIR/STTR calls
    - Cost share is always a challenge, especially for smaller businesses
    - Industry stakeholders are not always aware of current funding opportunities
  - Existing national laboratories commercialization strategies are lacking that benefit industry

Response from National Laboratory stakeholders

- Main Themes
  - The issues industry stakeholders face and potential researchable solutions are unclear to the national laboratories
  - Industry, generally, does not appear interested in the national laboratories technologies despite the potential for helpful analytical techniques and R&D advances
  - There are challenges getting members of industry to collaborate with one another
  - National laboratories' collaboration with industry in the battery field appears to be more mature than for other critical materials (examples: Li Bridge, MERF, EcoCar EV challenge)
  - There are user facilities at some national laboratories where industry can do proprietary research
  - The CMI has partner and teaming opportunities at various levels as well as a technology commercialization process where industry can license the IP from the national laboratories
    - The CMI does not issue RFPs but statements of work can be developed for organizations to work with the CMI, and this also allows flexibility for entities to work with the CMI on new issues

Recommendations

- Project managers experienced with commercialization should help manage the finances of collaborative research
- Targeted outreach program
- Successful and documented cooperation with industrial partners should be given the same weight as published scientific papers.
- Requests-for-information (RFI) open to national laboratories, academic, and industry researchers
- Proposal preparation should be short and fast with more programs funding 6-12 month projects with more focused goals
- Effective mechanisms for linking R&D and commercialization should be considered (e.g., FOAs to further TRLs, connect fundamental research with industry)
- More open sharing of technology development through key performance indicators without revealing trade secrets
- Catalog lessons learned from collaborative efforts between national laboratories, academics, and industry in other research areas (e.g., pharmaceuticals, O&G, etc)?
- DOE could facilitate CRADA-protected consortia for open discussions on technology

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It can be done