COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
SUBCOMMITTEE ON ENERGY
U.S. HOUSE OF REPRESENTATIVES
HEARING CHARTER

Research and Innovation to Address the Critical Materials Challenge
Tuesday, December 10, 2019
10:00 AM EST
2318 Rayburn House Office Building, Washington, D.C. 20015

PURPOSE

The purpose of this hearing is to examine research, development, and demonstration (RD&D) needs to support the sustainable supply of critical materials for energy technologies and other applications. The hearing will focus on two topics 1) H.R. 4481 the Securing Energy Critical Elements and American Jobs Act of 2019, which would authorize Department of Energy (DOE) RD&D activities to improve critical materials recycling, reduce the reliance on critical materials through greater efficiency and material substitutes, find sustainable new critical materials sources, and better understand the critical materials supply chain and adverse impacts caused by shortages; and 2) the importance of a reliable, affordable supply of helium, which is needed as an energy technology input and for various research applications.

WITNESSES

- **Dr. Adam Schwartz,** Director, Ames Laboratory
- **Dr. Sophia Hayes,** Professor, Department of Chemistry, Washington University in St. Louis
- **Mr. David Weiss,** Vice President, Engineering and R&D, Eck Industries, Inc.
- **Dr. Carol Handwerker,** Reinhardt Schuhmann Jr. Professor, Materials Engineering & Environmental and Ecological Engineering, Purdue University

BACKGROUND

Critical Materials

Many technologies, including solar photovoltaic panels, magnets, and batteries, require materials that are only found and produced in select countries and in limited quantities. Due to these factors, the supply chains of these "critical materials" are often vulnerable to geopolitical and market forces that could ultimately inhibit the manufacture and deployment of important downstream technologies.

For example, lithium is a key input to many of the batteries found in current electric vehicles and grid-scale storage devices, and only a small number of countries have access to economically viable reserves and processing facilities. In fact, Australia, Chile, China, and Argentina produce 97.1% of the world's lithium supply, with Australia accounting for 59% of total production.[1] Without a diverse supply chain, lithium availability is particularly affected by geopolitical and market events in these producing countries. In 2010, China heightened the concerns related to critical materials supply chains when it restricted their export to Japan, which is reliant on imports to meet its domestic demand.[2]

Increasing demand for products requiring critical materials, like electric vehicles, can also strain critical materials supply. According to a 2017 report, global lithium and cobalt production would have to increase annually by 7.5% and 3%, respectively, to meet demand if there was a market breakthrough in the use of electric vehicles containing lithium batteries.[3]

Long-term, critical materials supply chains are threatened by potentially limited geologic reserves, insufficient production and facility investment, and a lack of trained professionals to support production or relevant RD&D activities.

Federal policy meant to address the critical materials challenge has traditionally focused on bolstering supply chains for defense related technologies. However, the Obama and Trump Administrations have both acknowledged the impact of critical materials on U.S. industry more broadly. Beginning in 2010, DOE published Critical Materials Strategy reports outlining demand forecasts for energy and electronics critical materials[4,5]. Further, in 2017, President Trump issued Executive Order 3817, "A Federal Strategy to Ensure Secure and Reliable Supplies of Critical Minerals", which asked the Department of Interior to coordinate with other relevant agencies to publish a list of U.S. critical minerals.[6]

In addition to helping identify critical materials in energy and electronics applications, DOE is conducting RD&D to mitigate U.S. vulnerabilities to global critical materials supply chains.

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[1] Critical Minerals and U.S. Public Policy. Humphries, Marc. June 28, 2019. https://www.crs.gov/Reports/R45810?source=search&guid=daa965a106df488f83f501284bb61297&index=1
[2] Amid Tension, China Blocks Vital Exports to Japan. Bradsher, Keith. September 22, 2010. https://www.nytimes.com/2010/09/23/business/global/23rare.html
[3] Critical Minerals and U.S. Public Policy. Humphries, Marc. June 28, 2019. https://www.crs.gov/Reports/R45810?source=search&guid=daa965a106df488f83f501284bb61297&index=1
[4] Critical Materials Strategy. U.S. Department of Energy. December 2010. https://www.energy.gov/sites/prod/files/edg/news/documents/criticalmaterialsstrategy.pdf
[5] Critical Materials Strategy. U.S. Department of Energy. December 2011. https://www.energy.gov/sites/prod/files/DOE_CMS2011_FINAL_Full.pdf
[6] Executive Order 13817. Federal Register. December 20, 2017. https://www.federalregister.gov/documents/2017/12/26/2017-27899/a-federal-strategy-to-ensure-secure-and-reliable-supplies-of-critical-minerals

Critical Materials Institute

In 2013, DOE established the Critical Materials Institute (CMI), an energy innovation hub led by Ames Laboratory and overseen by DOE's Advanced Manufacturing Office. DOE awarded CMI up to $120 million for five years and renewed the Institute for another, final five-year funding period extending from 2018-2023. CMI prioritizes critical materials RD&D that:

- Diversifies supply – RD&D to advance sustainable, economically viable sources of critical materials and to identify new uses for production by-products.
- Develops substitutes – RD&D to find new materials that can functionally replace critical materials and to design systems that can use such alternatives.
- Improves reuse and recycling – RD&D to enhance critical materials efficiency and to develop technologies that advance sustainable, economically viable reuse and recycling.
- Encourages cross-cutting approaches – Coordinating critical materials RD&D activities with diverse stakeholders to promote multidisciplinary approaches.[7]

During CMI's first funding period, it mostly focused RD&D activities on rare earth elements, a subset of critical materials dispersed throughout the Earth's crust that are typically difficult to economically extract in useful concentrations. It then expanded its work to include, cobalt, gallium, indium, manganese, platinum group metals, tellurium, vanadium, and battery-quality graphite for the current funding period.[8]

Rare Earth Elements Recovery

In 2014, DOE's Office of Fossil Energy began supporting the Feasibility of Recovering Rare Earth Elements Program, carried out by the National Energy Technology Laboratory in coordination with CMI, to extract critical materials from coal and coal byproducts. The program's RD&D focuses on rare earth element extraction, separation, and recovery technologies, which could "improve the economics and reduce the environmental impact of a domestic coal-based value chain." [9]

Helium

While helium is not always considered a "critical material", it was included in President Trump's list of 35 U.S. critical minerals issued in 2018.[10] Helium has a finite commercial supply and it is

[7] Critical Materials Hub. U.S. Department of Energy. https://www.energy.gov/eere/amo/critical-materials-hub
[8] CMI Factsheet. Ames Laboratory. U.S. Department of Energy. https://cmi.ameslab.gov/materials/factsheet
[9] Feasibility of Recovering Rare Earth Elements. National Energy Technology Laboratory. U.S. Department of Energy. https://www.netl.doe.gov/coal/rare-earth-elements
[10] Final List of Critical Minerals 2018. Federal Register. May 18, 2018. https://www.federalregister.gov/documents/2018/05/18/2018-10667/final-list-of-critical-minerals-2018

needed for many research applications and commercial processes, including the development and maintenance of rocket propulsion systems, MRIs, and optical fibers.

Large helium reserves were first discovered at U.S. natural gas extraction facilities in Texas, Oklahoma, and Kansas in the early 1900s. Due in part to helium's use in many defense related technologies, the Bureau of Land Management (BLM) came to control most U.S. helium supply through the Federal Helium Reserve.[11] As directed by the Helium Privatization Act of 1996, the Federal Helium Reserve is actively reducing its stockpile and BLM is required to sell the facility by 2021. The U.S. and Qatar currently account for 85% of global helium production.[12]

In the past decade, global helium demand has increased, namely from new uses by the aerospace and semiconductor industries, and the rate of helium disbursement from the Federal Helium Reserve has slowed as the stockpile's internal pressure diminishes. These factors, coupled with relatively flat global production growth, have caused prices to rise.[13]

Due to its unique chemical properties, helium is often used by researchers to cool specialty equipment needed for experiments, such as super-conducting magnets. However, since research only consumes a small fraction of the helium market and university labs tend to have smaller budgets than private industry, the scientific community has recently struggled to maintain access to reliable, affordable helium supplies. According to a 2016 report from the American Physical Society, Materials Research Society, and American Chemical Society, some researchers have seen helium prices spike 250% since 2010.[14] Shortages of helium in the lab can cause significant and sometimes irreparable damage to equipment. These damages can cost thousands of dollars to repair and delay experiments with strict schedules.

To counter these effects, some researchers are implementing helium conservation measures and improving helium efficiency, reuse, and recycling when possible. Despite these efforts, researchers are expected to encounter helium shortages and price increases in the immediate future.[15] RD&D activities could examine ways to improve helium's efficient production and use, reuse and recycling, and equipment operability with alternative materials.

[11] The Impact of Selling the Federal Helium Reserve. The National Academies of Sciences, Engineering, and Medicine. 2000. https://www.nap.edu/read/9860/chapter/4#15
[12] Critical Minerals and U.S. Public Policy. Humphries, Marc. June 28, 2019. https://www.crs.gov/Reports/R45810?source=search&guid=b96f9eae0f964472a1d24dcac946b9f4&index=1
[13] Helium Users Grapple with Supply Crunch. American Institute of Physics. April 9, 2019. https://www.aip.org/fyi/2019/helium-users-grapple-supply-crunch
[14] Responding to the U.S. Research Community's Liquid Helium Crisis. American Physical Society, Materials Research Society, American Chemistry Society. October 2016. https://www.aps.org/policy/reports/popa-reports/helium-crisis.cfm
[15] Helium Users Grapple with Supply Crunch. American Institute of Physics. April 9, 2019. https://www.aip.org/fyi/2019/helium-users-grapple-supply-crunch

<u>LEGISLATION</u>

H.R. 4481, the Securing Energy Critical Elements and American Jobs Act of 2019

The Act would authorize a DOE program to carry out RD&D activities on energy critical elements to improve recycling, reduce reliance through greater efficiency and materials substitutes, and grow economically viable, sustainable sources, as well as develop more comprehensive analyses of supply chains and their market impacts. The bill allows DOE to carry out much of these RD&D activities through an Energy Innovation Hub such as the existing Critical Materials Institute. It also directs the Secretary of Energy to establish a Critical Materials Information Center to collect, catalogue, disseminate, and archive information on energy critical elements.

The bill authorizes appropriations of $30,000,00 for fiscal year 2020 with annual 5% increases, reaching $36,465,188 for fiscal year 2024, to carry out the program.

H.R. 4481 also directs the President, acting through the National Science and Technology Council, to coordinate Federal agency actions regarding critical materials, including activities to establish scenario modeling for critical materials supply chains and to promote a strong energy critical elements workforce.