Testimony of Dave Howell

Acting Director and Principal Deputy Director

Office of Manufacturing and Energy Supply Chains

Director, Vehicle Technologies Office

Office of Energy Efficiency and Renewable Energy

U.S. Department of Energy

For a Hearing on

Critical Mineral Demand

Before the

United States Senate

Energy and Natural Resources Committee

April 7, 2022

Washington, D.C.

Introduction

Chairman Manchin, Ranking Member Barrasso, and members of the committee, thank you for the opportunity to testify before you today. My name is Dave Howell, and I am the Director of the Vehicle Technologies Office (VTO) in the Department of Energy's (DOE's) Office of Energy Efficiency and Renewable Energy (EERE) as well as the Acting Director and Principal Deputy Director of the Office of Manufacturing and Energy Supply Chains (MESC). As the Director of VTO, I direct applied research, development, demonstration, and deployment (RDD&D) activities.

In addition to these roles, I also serve as chair of the Federal Consortium for Advanced Batteries (FCAB). FCAB brings together Federal agencies that are collaborating to ensure a domestic supply of lithium batteries and are committed to accelerating the development of a robust and secure domestic industrial base. FCAB encourages cooperation and coordination across the U.S. Government agencies' advanced battery efforts and seeks to develop a healthy domestic ecosystem. The consortium is led by the Departments of Energy, Defense, Commerce, and State and includes many organizations across the government.

Importance of Critical Materials

Climate change is one of the greatest challenges facing our nation and our planet today. DOE stands ready to work to address the climate emergency and lead through the power of example, by doing its part to ensure that the U.S. builds a 100% clean energy economy and reaches net-zero emissions no later than 2050.[1]

The USGS Critical Mineral List includes critical materials that are key building blocks for a transition to a net-zero energy future. DOE prioritizes material criticality based on importance to energy and the potential for supply risk. DOE priorities include battery materials, rare earth elements for magnets in wind turbine generators and electric vehicle motors, platinum group metals for fuel cells and electrolyzers for very low greenhouse-gas hydrogen production, as well as gallium and germanium for semiconductors that enable smart manufacturing. Global efforts to meet climate goals are expected to increase the demand for critical materials by at least four times by 2040.[2]

The Department's critical materials strategy has three pillars: diversification of supply, development of substitutes, and recycling and efficient use. The Department's research, development, and demonstration portfolios, which include EERE's Critical Materials Institute (CMI), promote increasing American access to responsibly and sustainably sourced raw materials, lessening dependence on imports, and strengthening competitiveness of our domestic manufacturers at all stages of the supply chains for these critical materials.

The knowledge generated by DOE research, development, demonstration, and deployment drives down the costs of new technologies, supporting the efforts of U.S. industries, businesses, and

[1] The Long-Term Strategy of the United States, Pathways to Net-Zero Greenhouse Gas Emissions by 2050 (whitehouse.gov)
[2] https://www.iea.org/reports/the-role-of-critical-minerals-in-clean-energy-transitions

entrepreneurs in growing and commercializing innovative energy technologies. These technologies also reduce harmful emissions that disproportionately affect lower income and minority populations.

Our domestic innovation capacity is contingent on a robust and diversified industrial base. When manufacturing heads offshore, innovation follows. The President's Executive Order 14017 on Securing America's Supply Chains directed the government to focus initially on four key sets of products during the first 100 days following its signing, including both large capacity batteries and critical minerals and materials.[3] In February, the U.S. Department of Energy published a new inter-agency supply chain strategy and report for the energy industrial base, which also included recommendations for Congress. This report and strategy were informed by 13 issue-specific one-year deep-dive assessments also under the Executive Order, including reports on rare earth magnets, platinum group metals, and semiconductors, which are informing the Department's critical materials strategy.

The supply chain assessments found that the United States has appreciable resources of many critical elements, but domestic production is frequently limited by a dated and often unclear legal and regulatory structure for mining coupled with a lack of midstream capacity to process and refine the raw materials, even in cases where it has active mining. As a result, U.S. ores frequently are shipped to other countries for refinement, relegating mid-stream profits to others and making the U.S. vulnerable to supply disruptions. For platinum group metals, we depend on South Africa and Russia. Russia's invasion of Ukraine has caused prices to spike over fears of supply disruptions. For rare earth magnets the United States produces 15% of the global supplies of rare earth ore concentrates, but currently ships those concentrates to China for processing. Currently, battery material processing chains are similarly dominated by China.

Moving Forward on an Electrified Clean Energy Economy

As outlined in President Biden's "Tackling the Climate Crisis at Home and Abroad" Executive Order, the President has launched a whole-of-government effort to combat the climate crisis. He has set major goals for the U.S., including a 50-52 percent reduction in greenhouse gas emissions by 2030;100 percent carbon pollution free electricity by 2035; and net-zero carbon emissions economy-wide by 2050.

The transportation sector is the largest source of greenhouse gas emissions in the U.S., accounting for approximately 30 percent of total U.S. energy needs.[4] Transportation sector decarbonization is therefore critical to achieving the overall goal of economy-wide decarbonization by 2050. The DOE Vehicle Technologies Office (VTO) is playing a key role in decarbonizing the transportation sector by driving clean transportation technologies innovation and deployment, including by funding research, development, demonstration, and deployment (RDD&D) of new, efficient, and clean mobility options that are affordable for the majority of Americans. VTO also leads DOE's Li-ion research as well as Transportation Electrification research and development (R&D). As coordinated through the Energy Storage Grand Challenge,

[3] "Building Resilient Supply Chains, Revitalizing American Manufacturing, and Fostering Broad-Based Growth: 100-Day Reviews under Executive Order 14017". The White House. June 2021. Online.
[4] Ibid. Table 2.2. U.S. Consumption of Total Energy by End-use Sector, 1950-2018.

the Office of Electricity leads other advanced battery research, including for grid and stationary applications. Battery R&D supports batteries across clean energy applications, including developments such as earth abundant cathodes, lithium anodes, and solid-state systems to reduce dependence on scarce materials; technologies that can enhance environmental sustainability; and the advancement of a U.S.-based circular lithium battery supply chain. Electrification R&D addresses the challenges of vehicle and fleet electrification through the development of electric drive systems and vehicle-grid interaction technologies.

Strengthening America's Critical Material Supply Chain

Pursuant to Executive Order 14017, "America's Supply Chains," DOE published a 100-day review of the large-capacity-battery supply chain, pursuant to Executive Order 14017.[5] The review recommended establishing responsible and sustainable domestic production and processing capabilities for critical materials to support a fully domestic end-to-end battery supply chain. In February 2022, the Department of Interior launched an interagency working group to implement directives from the 100-day supply chain report and Bipartisan Infrastructure Law (BIL). That group will make recommendations to reform the General Mining Law of 1872 to promote the sustainable and responsible domestic production of critical minerals. The Administration also released the "Biden-Harris Fundamental Principles for Mining Law Reform," to guide the need for updates to this 150-year-old law as well as regulations currently governing extraction. A request for Public Comment on this process was opened last week.[6] Also, the BIL allocates nearly $6 billion to strengthen the U.S. battery supply chain, which includes producing materials from extracted feedstocks, domestic battery manufacturing and recycling critical minerals.[7]

The National Blueprint for Lithium Batteries 2021–2030, developed by the Federal Consortium for Advanced Batteries (FCAB), lays out a holistic approach to accelerate the development of a robust, secure, and healthy domestic research and industrial base for lithium based batteries.[8] The Blueprint lays out five critical goals and key actions to guide federal agency collaboration to secure the nation's long-term economic competitiveness and create good-paying jobs for American workers, while supporting the Biden Administration's decarbonization goals. The five critical goals are as follows:

- Secure access to responsibly and sustainably produced raw and refined materials and discover alternatives for critical minerals for commercial and defense applications;
- Support the growth of a U.S. materials-processing base able to meet domestic battery manufacturing demand;
- Stimulate the U.S. electrode, cell, and pack manufacturing sectors;
- Enable U.S. end-of-life reuse and critical materials recycling at scale and a full competitive value chain in the United States; and

[5] Ibid.
[6] Interior Department Launches Interagency Working Group on Mining Reform | U.S. Department of the Interior (doi.gov)
[7] President Biden's Bipartisan Infrastructure Law | The White House
[8] https://www.energy.gov/sites/default/files/2021-06/FCAB National Blueprint Lithium Batteries 0621_0.pdf?msclkid=8aeb8a52aa0911ec9ecad07d6ee4f445

- Maintain and advance U.S. battery technology leadership by strongly supporting scientific R&D, STEM education, and workforce development.

Department of Energy's Work on Critical Materials

Executive Order 14017 also called for the Department of Defense with input from DOE, to submit within 100 days a "Review of Critical Minerals and Materials,"[9] and recommend a strategy centered on the following:

- Developing and Fostering New Sustainability for Strategic and Critical Material-Intensive Industries
- Expanding Sustainable Domestic Production and Processing Capacity, Including Recovery from Secondary and Unconventional Sources and Recycling
- Deploy the Defense Production Act (DPA) and Other Programs
- Convene Industry Stakeholders to Expand Production
- Promote Interagency Research & Development to Support Sustainable Production and a Technically-Skilled Workforce
- Strengthen U.S. Stockpiles
- Work with Allies and Partners and Strengthen Global Supply Chain Transparency

In addition, the DOE drafted 13 issue-specific one-year deep dive assessments under the Executive Order, including reports on rare earth magnets, platinum group metals, and semiconductors, which inform the Department's critical materials strategy. A consistent finding across the supply chain assessments was that the United States has significant resources of a number of the most critical elements, but often lacks the midstream capacity to process and refine these raw materials, even in cases where it has active mining.

As a result of this review, the President issued a Presidential Determination on March 31, 2022, to deploy the Defense Production Act.

DOE assesses material criticality based on importance to energy and the potential for supply risk, given expected demand trajectories. In addition to battery materials, other critical materials that DOE is focusing on include rare earth elements for magnets in wind turbine generators and electric vehicle motors, platinum group metals for fuel cells and electrolyzers for green hydrogen production, and gallium and germanium for semiconductors that enable smart manufacturing. Global efforts to meet climate goals are expected to increase the demand for these materials by at least four times by 2040. DOE's critical materials strategy has three pillars: 1) diversification of supply; 2) development of substitutes; and 3) recycling and efficient use.

Critical minerals and materials work is supported by DOE's Office of Energy Efficiency and Renewable Energy EERE's VTO, Advanced Manufacturing Office (AMO), and Geothermal Technologies Office (GTO), the Fossil Fuel and Carbon Management Office FECM), the Nuclear Energy Office (NE), the Advanced Research Projects Agency – Energy (ARPA-E), and

[9] "Building Resilient Supply Chains, Revitalizing American Manufacturing, and Fostering Broad-Based Growth: 100-Day Reviews under Executive Order 14017". The White House. June 2021. Online.

the Office of Science's Basic Energy Sciences (BES), among other offices. Additional offices involved include the Solar, Wind, Nuclear Energy and Policy Offices.

The Critical Materials Institute (CMI) led by Ames National Laboratory and a team of research partners, and overseen by AMO, is a sustained, multidisciplinary effort that has been ongoing for nearly a decade. CMI seeks to accelerate innovative scientific and technological solutions to develop resilient and secure supply chains for rare-earth metals and other materials critical to the success of clean energy technologies.[10] CMI addresses all three pillars of DOE's critical materials strategy. AMO is also supporting a portfolio of research, development, and demonstration (RD&D) projects focused on diversification of supply through field validation and demonstration, as well as next-generation extraction, separation, and processing technologies for critical materials.

FECM's Critical Mineral Sustainability Program accelerates production of critical materials from unconventional and secondary sources. These include legacy byproducts from fossil energy use (e.g., coal ash and refuse), acid mine drainage, and produced waters from natural gas and oil operations.[11] The program's RDD&D focuses on diversification of supply through the development of novel and advanced technologies to enable cost effective and sustainable extraction of rare earth elements and other critical minerals from unconventional and secondary sources. FECM's broader critical minerals and materials recovery efforts from unconventional and secondary sources include advancing direct lithium extraction from oil and gas produced waters and acid mine drainage waste.

ARPA-E has several programs which pertain to critical materials. The Mining Innovations for Negative Emissions Resources (MINER) program supports research to increase domestic supplies of, nickel, lithium, cobalt, and rare earth elements by increasing the mineral yield while decreasing the required energy, and subsequent emissions, to mine and extract these energy-relevant minerals. Specifically, the program will investigate potential CO2-reactive ores to unlock net-zero or net-negative emission technologies to mining. In addition, ARPA-E, through its Exploratory Topic Program, is researching novel approaches in microbiology, synthetic biology and process engineering in support of addressing mining industry challenges to ensure a robust mineral supply chain for clean energy applications. This includes the development of technologies to harness natural resources to produce a robust, clean, non-toxic, and low-cost supply of critical materials, such as using bacteria to recover manganese, a key mineral to several common battery technologies, from low-grade U.S. ores.

The Office of Science has for many years supported foundational theoretical and experimental science related to understanding unique chemistry and properties associated with rare earth elements, substitution for platinum group catalysts, and novel battery chemistries. This includes the Joint Center for Energy Storage Research Center (JCESR), which is exploring materials, chemistries, and architectures for transformative energy storage technologies beyond lithium-ion.

[10] https://www.energy.gov/eere/amo/critical-materials-hub
[11] https://www.energy.gov/fecm/critical-minerals-sustainability

The alternative chemistries advanced by JCESR have the potential to reduce demand for lithium-ion batteries in some end-use applications.

For lithium, EERE's RD&D project portfolio spans overcoming technical barriers to direct lithium extraction including geothermal brines (GTO and AMO), lithium processing from diverse domestic sources (AMO and VTO), materials separation, recovery, and processing from end-of-life batteries (CMI/AMO), direct recycling of lithium batteries at the ReCell Center (VTO) and developing substitute battery chemistries for both EVs (VTO) and stationary storage (AMO).

The DOE, along with the Department of State and Department of Defense, recently executed a memorandum of agreement (MOA) that sets the foundation for a critical minerals stockpile process to support the U.S. transition to clean energy and national security needs.[12] The MOA formalizes an interagency partnership to acquire and recycle selected materials for technologies that range from grid-scale batteries to wind turbines.

Department of Energy's Activities Related to Critical Materials Used in Batteries

Significant investments across the Department are addressing critical minerals and materials lithium-ion battery supply chain challenges including: Diversifying Supply Chains, Developing Substitutes, and Improving Reuse and Recycling. EERE works to mitigate supply chain risk through R&D to diversify supply, develop alternatives, improve reuse and recycling, and enable fundamental crosscutting research. These supply chain risk mitigation strategies are directly aligned with the Federal Strategy. The EERE R&D portfolio is quite extensive, covering the entire critical material supply chain from resource assessment through value-added manufacturing (including separation and production of metals, alloys, and value-added products) to system integration and including reuse, recycling, and more efficient use; safety, human, and environmental health considerations; and technology transition. Through coordination across EERE, supply chains for critical materials in magnets, energy storage, electronics, and lighting are addressed.

To mitigate potential lithium-ion battery critical materials supply risks, the Department of Energy has established a strategic goal to significantly reduce or eliminate the dependency on certain critical materials (such as cobalt) and to utilize recycled material feedstocks. To achieve this strategic goal and address potential critical materials issues, DOE is supporting key areas of R&D including:

- VTO supports competitive industry projects, innovative laboratory, and novel university research to develop active cathode materials for next-generation lithium-ion batteries and the processes to make them. Many projects focus on reducing or eliminating Cobalt from cathode materials, with significant success achieved in developing today's cathode materials.
- VTO supports the Lithium Battery Recycling R&D Center (ReCell), which focuses R&D to develop innovative, efficient recycling technologies to profitably recover critical battery materials and re-introduce them into the materials supply chain. Our research

[12] FACT SHEET: Securing a Made in America Supply Chain for Critical Minerals | The White House

shows that up to 40 percent of the materials for future batteries can come from recycled vehicle batteries. VTO and AMO support the Battery Recycling Prize to incentivize American entrepreneurs to find innovative solutions to address current challenges associated with collecting, storing, and transporting spent or discarded lithium-ion batteries for eventual recycling.

- VTO's work includes longer term R&D on lithium batteries using earth-abundant materials including silicon, solid-state, lithium-metal, and sulfur, which offer promise to reduce critical materials use in batteries, and in particular lessening dependence on nickel and cobalt.
- AMO launched the Lithium RD&D Virtual Center in December 2021 to coordinate eight RD&D lithium projects awarded to advance next-generation technologies for lithium extraction from unconventional sources as well as demonstrate production of battery-grade lithium hydroxide from geothermal brines and claystone sources.
- GTO launched the Geothermal Lithium Extraction Prize in 2021 to advance cost-effective solutions for lithium extraction from geothermal brines in the Salton Sea, a disadvantaged community. The Office of Basic Energy Sciences (BES), within the Office of Science (SC), is advancing basic science research to develop new separations methods for lithium-ion purification.
- GTO has also partnered with the U.S. Geological Survey's Earth Mapping Resources Initiative (Earth MRI) to conduct airborne geophysical and lidar surveys over parts of Nevada and California to collect information on undiscovered geothermal, groundwater and critical mineral resources, including lithium.[13]
- EERE's Critical Materials Institute (CMI), an Energy Innovation Hub led by Ames National Laboratory and funded by AMO, advances R&D to diversify the supply of battery critical materials through recovery of lithium from mine waste, improved beneficiation of cobalt, graphitization of biomass, and recovery of battery critical materials from electronic waste.
- The Energy Storage Grand Challenge, a DOE-wide program with a goal to accelerate the development, commercialization, and utilization of next-generation energy storage technologies, includes a Manufacturing and Supply Chain track that focuses on scaling up innovative processing and separation of critical materials. It is also advancing the demonstration of alternative energy storage technologies for stationary storage that have the potential to reduce the overall demand for battery critical materials.

Department of Energy's Work on Battery Manufacturing and Recycling

At DOE, through the VTO our R&D investments – in conjunction with industry advancements throughout the past decade – have yielded breakthroughs in battery cost and performance; reducing lithium-ion EV battery pack costs by about 85% from approximately $1000/kWh in 2008 to $133/kWh in 2021; and driving down weight and enhancing manufacturability. DOE's goal is to lower the battery pack cost to below $75/kWh , allowing EVs to reach cost competitiveness with future internal combustion engine vehicles.

[13] GeoDAWN: Geoscience Data Acquisition for Western Nevada, https://www.usgs.gov/media/images/geodawn-geoscience-data-acquisition-western-nevada.

The United States currently manufactures only 9% of global battery cells.[14] As we advance battery technologies, we want to make sure that these batteries are being made domestically, so that we continue to see the growth of battery manufacturing jobs in the U.S. To meet the forecasted demand from light and heavy-duty EVs, the United States will need over one hundred (100) battery cell manufacturing locations in the U.S. by 2035. With the right combination of technological advances and policy signals, we can support U.S. manufacturing and workers.

Beyond EERE offices and across the entire RDD&D spectrum, the Advanced Research Projects Agency Energy (ARPA-E) supports lithium-based battery R&D and the Loan Programs Office (LPO) within DOE can also offer funding for commercialization to battery manufacturing and associated supply chain companies. Lastly, the newly announced Office of Manufacturing and Energy Supply Chains (MESC), as well as the Office of Clean Energy Demonstrations (OCED), which both report to the Office of the Under Secretary for Infrastructure (S3), will also establish new opportunities to support a domestic, robust, and secure a lithium-ion battery supply chain.

The BIL includes more than $6 billion to fund domestic battery materials processing, manufacturing, and recycling that will help improve grid resilience and scale up the electrification of cars, trucks, and buses. On February 11, 2022, DOE issued two notices of intent (NOIs) to provide $2.91 billion to boost production of the advanced batteries that are critical to rapidly growing clean energy industries of the future, including electric vehicles and energy storage, as directed by the BIL. The Department intends to fund battery materials refining and production plants, battery cell and pack manufacturing facilities, and recycling facilities that create good-paying clean energy jobs. The funding is expected to be made available in the coming months and will ensure that the United States can produce batteries, as well as the materials that go into them, to increase economic competitiveness, energy independence, and national security.

Key Challenges Remaining

The rationale for supporting the U.S. supply chain now is clear: demand for EVs and grid energy storage is increasing, investors are increasing investment in the clean energy economy, and the pandemic has underscored the fragility of some U.S. supply chains. China and the European Union (EU) – in contrast to the U.S. approach – have developed and deployed ambitious government-led industrial policies that are supporting their success across the battery supply chain. China has also moved beyond conventional policy support with practices involving questionable environmental policies, price distortion through state-run enterprises to minimize competition, and large subsidies throughout the battery supply chain. However, the opportunity for the United States to secure a leading position in the global battery market is still within reach if the Federal Government takes swift and coordinated action.[15]

Among the critical materials, lithium, cobalt, nickel, and graphite face supply constraints. With regard to nickel, according to the U.S. Geological Survey (USGS), there are significant resources

[14] Ibid.
[15] Ibid.

both globally and in the United States. However, refining capacity may lead to supply constraints.[16] Sustainable domestic extraction from economically viable primary and secondary sources, increased recycling capacity, coordination with allies and trading partners, and R&D to identify earth abundant substitutes can all help prevent critical material shortages. In concert with these levers to increase critical material supply, investments and other policy support for domestic refining, processing, and manufacturing can help prevent gaps or bottlenecks in the supply chain that can create shortages and other supply risks.[17] To address these supply chain bottlenecks, DOE released two NOIs to provide $2.91 billion to boost production of the advanced batteries that are critical to rapidly growing clean energy industries of the future, including electric vehicles and energy storage, as directed by the Bipartisan Infrastructure Law.[18]

A skilled and supported workforce will be needed for extraction, processing, purification, and recycling, as well as researching, developing, designing, manufacturing, and deploying advanced batteries in a variety of applications, including EVs, stationary, consumer electronics, industrial, and defense. Education and training will be needed across the battery ecosystem including skilled trades (e.g., machinists, welders, technicians, operators, designers), engineers, analysts, and researchers. And we'll need to ensure that this domestic workforce is populated by people in family-sustaining jobs and who have the option to remain in or join a union. On March 18, 2022, DOE, in coordination with the U.S. Department of Labor and the AFL-CIO, announced the launch of a national workforce development strategy for lithium-battery manufacturing.[19] As part of a $5 million investment, which is funded by both VTO and AMO, DOE will support up to five pilot training programs in energy and automotive communities and advance workforce partnerships between industry and labor for the domestic lithium battery supply chain. Lithium batteries power everything from electric vehicles to consumer electronics and are a critical component of President Biden's whole-of-government decarbonization strategy. This workforce initiative will support the nation's global competitiveness within battery manufacturing while strengthening the domestic economy and clean energy supply chains.

For critical materials more generally across multiple clean energy technologies, there is a consistent supply chain vulnerability of a lack of domestic separations and refining. Filling this gap will strengthen our domestic manufacturing enterprise to deliver the clean energy technologies demanded by the clean energy transition. Another common vulnerability for critical materials is the geographic concentration of multiple stages of the supply chain – often the upstream raw material production and midstream separation and refining. In the case of battery critical materials and rare earth elements, midstream capabilities are heavily concentrated in China.

---

[16] Ibid.
[17] Ibid.
[18] DOE Establishes $6 Billion Program to Preserve America's Clean Nuclear Energy Infrastructure | Department of Energy
[19] Ibid.

Opportunities Ahead

Building on the 100-day supply chain report on high-capacity batteries issued by DOE last spring, Congress included in the BIL more than $6 billion to fund domestic battery materials processing, manufacturing, and recycling that will help improve grid resilience and scale up the electrification of cars, trucks, and buses.[20] These grants, starting with two NOIs recently released by DOE, will allow companies to expand and build new American factories with quality job opportunities in regions throughout the country. [21]

Both the newly established Manufacturing and Energy Supply Chains office and the Office of Clean Energy Demonstrations offer new opportunities to support the development of a domestic lithium-ion battery supply chain. The Office of Clean Energy Demonstrations will oversee more than $20 billion in federal investments in clean energy projects.[22] These projects will work towards the Biden administration's goal of reaching net-zero emissions by mid-century by investing in demonstration projects to allow the U.S. to test possible clean energy solutions that can provide innovative and effective solutions to real-world problems. The new Manufacturing and Energy Supply Chains office will focus on strengthening and securing energy supply chains needed to modernize the nation's energy infrastructure and support the clean energy transition.[23] This office will engage with private-sector companies, other Federal agencies, impacted communities, and other key stakeholders to collect, analyze, respond to, and share data about energy supply chains to inform future decision making and investment.

DOE is also ramping up work on critical materials and their supply chains more generally. On February 24, 2022, DOE released America's first comprehensive plan to ensure security and increase our energy independence.[24] The sweeping report, "America's Strategy to Secure the Supply Chain for a Robust Clean Energy Transition," lays out dozens of strategies to build a secure, resilient, and diverse domestic energy sector industrial base that will establish America's role as a global leader in clean energy manufacturing and innovation. In addition to the comprehensive strategy report, DOE developed 13 deep-dive assessments on specific technologies and crosscutting topics, conducted by researchers from DOE and several of its national laboratories, in consultation with energy sector stakeholders. Several of these touched directly on critical materials, including the reports on rare earth magnets, platinum group metal catalysts, and semiconductors.

DOE works to advance RDD&D as part of an all-of-government approach to address critical materials challenges and opportunities. The BIL appropriated DOE over $8 billion to

---

[20] President Biden's Bipartisan Infrastructure Law | The White House
[21] DOE Establishes $6 Billion Program to Preserve America's Clean Nuclear Energy Infrastructure | Department of Energy
[22] DOE Establishes New Office of Clean Energy Demonstrations Under the Bipartisan Infrastructure Law | Department of Energy
[23] Securing America's Clean Energy Supply Chain | Department of Energy
[24] DOE Releases First-Ever Comprehensive Strategy to Secure America's Clean Energy Supply Chain | Department of Energy

demonstrate and deploy solutions to meet such challenges for the many of the materials discussed above. This includes $600 million for Critical Material Innovation, Efficiency, and Alternatives. These funds will elevate the DOE Critical Minerals and Materials crosscut and facilitate the design of an integrated innovation pipeline and ecosystem – grounded in DOE's strategy for building resilient, diverse, and secure domestic critical material supply chains: diversify supply, develop substitutes, and drive reuse, recycling, and more efficient use in a safe, sustainable, and environmentally just way. In addition, DOE released a Request for Information on the design,[25] construction, and operation of a new facility to demonstrate the commercial feasibility of a full-scale rare earth element and critical minerals extraction and separation refinery using unconventional resources.

DOE also released a $44 million funding opportunity for the Mining Innovations for Negative Emissions Resources (MINER) program, which will provide commercial-ready technologies that give the United States a net-zero or net negative emissions pathway toward increased domestic supplies of copper, nickel, lithium, cobalt, rare earth elements, and other critical elements required for a clean energy transition.

Conclusion

Thank you for the opportunity to appear before the committee today. I look forward to working with you as we transition to a clean energy economy and ensure that the U.S. builds a 100% clean energy economy and reaches net-zero emissions no later than 2050. I look forward to your questions.

[25] https://www.netl.doe.gov/node/11558