CRITICAL MATERIALS

The United States is heavily reliant on imports of certain critical materials vital to the Nation's security and economic prosperity. This dependency on foreign sources creates a strategic vulnerability to foreign government action, natural disaster, and other events that can disrupt supply of these key materials. Critical materials are defined in Executive Order 13817 as materials vital to the economic or national security of the U.S., vulnerable to supply chain disruption, and serving an essential function in the manufacture of a product, whose absence would have significant consequences.[1]

A comprehensive policy to address critical materials will be necessary as the global economy continues to grow and the U.S. grapples with unequal global allocations of certain critical materials, as well as the safety and environmental hazards associated with extraction and processing. Critical materials available at a reasonable cost are essential for national security, renewable energy, electrification of transportation, and the U.S. economy. Developing and maintaining a sustainable critical materials industry requires a robust increase in supply, systematic analyses of life cycle costs and benefits, including the financial and environmental impacts of exploration, discovery, extraction, and processing.

Each critical material presents different economic, environmental, or national security challenges. For example, the chemical properties of the various critical materials are widely divergent, and a policy to address shortages in rare earth elements may be strikingly different from a noble gas (e.g. Helium). One-size-fits-all solutions are not applicable.

Policymakers should prioritize long-term research and development to address these challenges. The ACS supports using the following core objectives to drive critical materials policy and use in the U.S.:

- Provide a resilient and sustainable supply of critical materials from multiple sources.
- Develop primary sources, downstream processing capability (including ore processing), recycling, and conservation capabilities of critical materials where practicable.
- Invest in research and workforce development in the entire life cycle of critical materials and alternative technologies via coordinated interagency programs.
- Balance economic needs with human health and environmental sensitivities of extraction, processing and use of critical materials.
- Inform the public and stakeholders on the economic, political, and scientific issues involved with critical materials supplies.

As such, ACS encourages policy development in the following areas:

[1] Department of the Interior. Final List of Critical Minerals 2018. *Fed. Regist.* **2018**, *83*, 23295-23296.

The American Chemical Society (ACS) Board of Directors Committee on Public Affairs and Public Relations adopted this statement on behalf of the Society at the recommendation of the Committees on Environmental Improvement and Science. ACS is a non-profit scientific and educational organization, chartered by Congress, with more than 150,000 chemical scientists and engineers as members. The world's largest scientific society, ACS advances the chemical enterprise, increases public awareness of chemistry, and brings its expertise to state and national matters.

Research and Workforce Development

Addressing our critical materials challenges will require long-term, coordinated support for industry, government, and university research and development of cost-effective technologies for environmentally sensitive extraction and processing. The ACS recommends prioritizing research into new and existing geological sources, recycling, conservation, and alternatives. Importantly, critical materials challenges should be viewed as research opportunities in chemical science and engineering; expanding our capabilities in their recovery, efficacy, and alternatives is the best policy for ensuring cost-effective access.

Scientific and engineering knowledge is of limited effectiveness without considering and implementing economic, environmental, and social factors inherent to the development of mineral resources. Integrating economic and social research with the physical sciences is necessary to ensure a successful critical materials policy. Therefore, a sustainable strategy should emphasize long-term interdisciplinary research projects and commercialization efforts spanning the life cycle of the materials of interest. Projects should include evaluations for commercial viability and include plans of transition from basic research to the marketplace.

The ACS recognizes a need for comprehensive workforce development and stresses interdisciplinary research and education go hand-in-hand especially in areas such as mineral exploration, traceability, hydrometallurgy, and product development. Education of a new generation of professionals with the capacity to work in multi-disciplinary teams across academic, industry and government entities will be critical to success. Training a broad array of scientists and engineers with business acumen will be necessary to ensure the sustainable development of domestic supplies, including new sources, supply chain resiliency, recycling, conservation, and alternative technologies.

Sustainable Resource Recovery, Recycling, Conservation, and Alternatives

The ACS urges the U.S. to increase research and development efforts and funding for the recovery and recycling of critical materials from scrap and end-of-life products, mitigating reliance on depleting, inconsistent, and non-domestic sources of critical materials. Recovery and recycling of critical materials also lessens the social and environmental impacts from the extraction of primary resources. Additionally, federal scientific programs relying on critical materials should seek to optimize use, conservation, and recovery to maximize sustainability.

Realizing a low/zero carbon future to address climate change requires extensive use of alternative energy production, including renewable and nuclear energy, advanced distribution, and large scale storage technologies. [2] Mass deployment of these technologies calls for significant innovations in the recycling of critical materials and identifying/developing alternatives. Environmentally benign techniques for recovery and recycling processes should be explored for their sustainability. In addition, critical materials recovery from unconventional resources (e.g., ocean water, seafloor, and highly saline subsurface brines) should be explored.

Interagency Coordination

[2] Arrobas, Daniele La Porta; Hund, Kirsten Lori; Mccormick, Michael Stephen; Ningthoujam, Jagabunta; Drexhage, John Richard. *The Growing Role of Minerals and Metals for a Low Carbon Future;* International Bank for Reconstruction and Development/The World Bank: Washington, D.C., 2017.

*"*Increasing America's critical materials exploration, mining, processing, and manufacturing base requires an integrated, government-wide strategy.*" (Executive Order 13817).* ACS agrees an integrated approach is necessary. Critical materials availability is foundational to economic prosperity, social stability, and national security. Consequently, the technical issues involved cross many branches of science and engineering, and the non-technical issues require expertise in economics, political and social sciences. U.S. funding for research and development is compartmentalized, making interagency collaboration inefficient. The "integrated, government-wide strategy" should involve updating U.S. funding infrastructure such that it is more adaptable and able to support long-term, comprehensive research.

Public and Stakeholder Outreach

The ACS recommends federal efforts to foster business, government, and university collaborations to inform the public and stakeholders of critical materials issues regarding needs and sources. The public is generally unaware of the numerous critical materials we rely upon for our technology. The process of discovery, processing, and production is behind the scenes, and there is scant concern over potential supply chain disruptions. In order to create public sentiment for a national critical materials strategy, outreach efforts are necessary to inform our citizens of the needs and possible risks to our economy, societal stability, and national security. Government, industry and academia each have their own avenues of outreach to the public and specific stakeholders, and a coordinated collaboration will be most effective in disseminating this information.