center for
ENERGY STUDIES
Rice University's Baker Institute for Public Policy

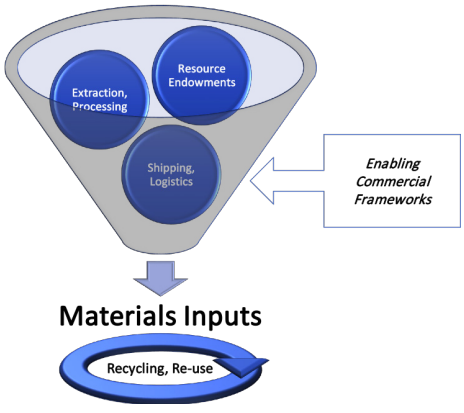
CES Focus on Energy, Minerals & Materials

Metals and non-fuel minerals are critical to the success of industries and economies around the globe. In the energy sector their impact is far-reaching, with applications spanning from conventional oil and gas production to renewable resource technologies. ***And as nations supplement conventional energy with low-carbon alternatives, new requirements will be added to current ones, potentially raising the cost of existing energy industrial and consumer products.*** Massive quantities of metals and minerals such as platinum, copper, zinc, and iron—in addition to aluminum and concrete—will be needed to build solar and wind facilities that can match the power generated by fossil fuels and nuclear energy, according to the journal *Nature Geoscience*.[1]

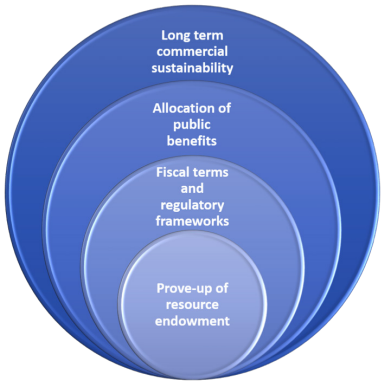
In a shifting energy landscape, a new initiative at the Baker Institute's Center for Energy Studies (CES) will improve understanding of minerals resource development, opportunities and constraints, and their effect on energy markets and geopolitics. ***We aim to combine the center's expertise in energy supply and demand with non-fuel mineral dynamics to produce an integrated framework of data and analysis***—one that informs the development of effective energy policies, now and in the future.

Mineral supply chains are complex and, in many cases, less transparent than those for oil and gas commodities. While major metals, iron ore, and steel products are traded on major exchanges, many critical minerals crucial to both conventional and alternative energy applications are priced in closely held arrangements. Processing and dominance of bi- and co-products add complexity to mineral value chains and their underlying economics. In recent years, numerous concerns have been raised about, for instance, the availability of rare earth elements, which impacted conventional energy operations (refining and chemicals) and spilled into international trade negotiations.

Attention to the need for minerals that support alternative energy systems has put new focus on resources and supply chains for "critical" minerals that feed into materials essential for components. The scope is broad, ranging from components for wind turbine equipment and photovoltaics to pathways for solving persistent problems such as battery storage for balancing intermittent energy sources and for use in transportation. ***Overall, every advanced design for both conventional and alternative energy technology design that would enhance performance and efficiency of energy systems involves some combination of critical minerals.*** This extends across advanced hydrocarbon-based composites for vehicles and consumer products, catalysts for refining and petrochemicals, metallurgies for industrial equipment and infrastructure, fourth and next generation PV for improved conductivity and scale, superconducting materials for power grids, and battery chemistries that might achieve theoretically optimal performance while extending life.



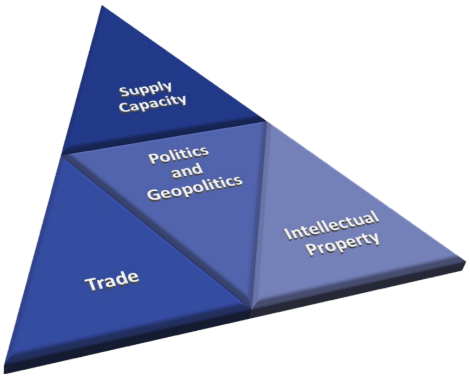
As demand for minerals grows, pressures on minerals supply chains, particularly as societies attempt to grow alternative energy capacity, will almost certainly mount. Opportunities may exist to satisfy incremental demand with recycling and re-use, which could have the most significant bearing for battery technologies. But more complicated battery chemistries and designs could limit these options. In 2017, the World Bank[2] initiated the task of quantifying potential impacts and constraints given different scenarios for shifting the global energy mix, using carbon reduction as a proxy. In their estimate, the increase in a selection of metals for batteries (aluminum, cobalt, iron, lead, lithium, manganese and nickel) could grow by 1,000 percent in the most stringent case.



Like oil, gas, coal and uranium, ***energy minerals and non-fuel resource supply chains originate with native endowments***, which can raise issues with ownership and terms of access to the resources. The global distribution of minerals resources is uneven and they are often in challenging environments far from market areas. Economic rents are created from minerals extraction and processing, and the allocation of rents between mining companies and the public creates demands on host governments. Mining and processing operators will seek long-term commercial viability within the context of volatile commodities prices, intense public scrutiny and shifting commercial frameworks, including presence of state-owned enterprises (SOEs), evolving fiscal terms and agreements, and environmental and social regulation.

A key strength of the Baker Institute's CES lies in its ability to develop expert networks and assemble high-level government and industry discussions that contribute to foundational research and ongoing commentary. Initiated by Energy, Minerals and Materials Fellow Michelle Michot Foss, Ph.D., and drawing on the expertise of other fellows and scholars at the Center for Energy Studies, we envision a selection of core activities to launch and position the minerals research program.

- ***Collaborations*** to leverage U.S. and international experience on critical minerals and materials, including key assumptions, such as battery chemistries.
- ***Research*** to build cohesive views on criticality and related metrics.[3]
- ***Overlay of extractive industry considerations***, including commercial frameworks, SOEs, taxation, regulation, access, and transparency.
- ***Integration*** of global energy, minerals and materials outlooks via periodic forums and research papers.
- ***Dissemination*** of research and information through legislative testimony and written commentaries.



Endnotes

1. As cited by Tim Radford, "Renewable Energy Needs Huge Mineral Supply," *Climate News Network*, November 2, 2013, http://www.climatecentral.org/news/renewable-energy-needs-huge-mineral-supply-16682.
2. The World Bank, *The Growing Role of Minerals and Metals for a Low Carbon Future*, June 2017, https://bit.ly/2vxe2Sn.
3. National Research Council, *Minerals, Critical Minerals, and the U.S. Economy* (Washington, D.C.: The National Academies Press, 2008), https://doi.org/10.17226/12034; Government Accountability Office, "Strengthened Federal Approach Needed to Help Identify and Mitigate Supply Risks for Critical Raw Materials," 2016, https://bit.ly/2G7y6OM; The White House, National Science and Technology Council, "Assessment of Critical Minerals: Screening Methodology and Initial Application," 2016, https://bit.ly/2WtY8kI and https://bit.ly/2WuiMRH, 2018 update.