



## Division of Minerals Sustainability

The Office of Fossil Energy and Carbon Management's (FECM's) Division of Minerals Sustainability (the Division) is advancing a research, development, and demonstration portfolio geared toward increasing the domestic production and processing of critical minerals and materials in the United States. Critical minerals and materials (CMM) are essential components of modern technologies and vital to our national security and economic prosperity.

### America's Need for and Potential to Supply Critical Minerals

The United States currently relies heavily on foreign sources for many CMM at all stages of the supply chain, from mining through processing and refining, to manufacturing. If unaddressed, this vulnerability threatens the Nation's security and economic well-being. Fortunately, the United States has untapped potential to support greater domestic production. A wealth of rare earth elements and other CMM can be obtained from primary, secondary and ore

- More than 95 percent of the U.S. demand for rare earth elements comes from foreign sources.
- More than 50 percent of most critical minerals (43 of 50) comes from foreign sources.
- At least 12 critical minerals come exclusively from foreign sources.



Nickel ore

unconventional resources, including coal-based feedstocks. There is an opportunity to create regional, reliable, robust, and responsible critical mineral supply networks, spurring economic growth and creating enormous job opportunities.

### Accelerating the Domestic Production of Critical Minerals and Valuable Carbon Products

The Division's mission is focused on promoting environmentally and economically sustainable critical minerals and materials resource recovery and carbon products industries in the United States, by implementing the following goals:

1. Develop technology to characterize and assess domestic CMM and carbon ore from fossil energy-related byproducts, other secondary and

unconventional feedstocks, and critical material-containing ores;

2. Develop advanced resource extraction, processing, extractive metallurgical, and refining technologies; and
3. Evaluate the technical and economic potential for co-production of CMM, carbon products, and other materials from primary, secondary, and unconventional feedstocks.

FECM works to achieve these goals through engagement with industry, technology developers, nongovernmental organizations, communities, and other stakeholders.

### Secondary and Unconventional Sources

Initial estimates suggest that unconventional and secondary sources

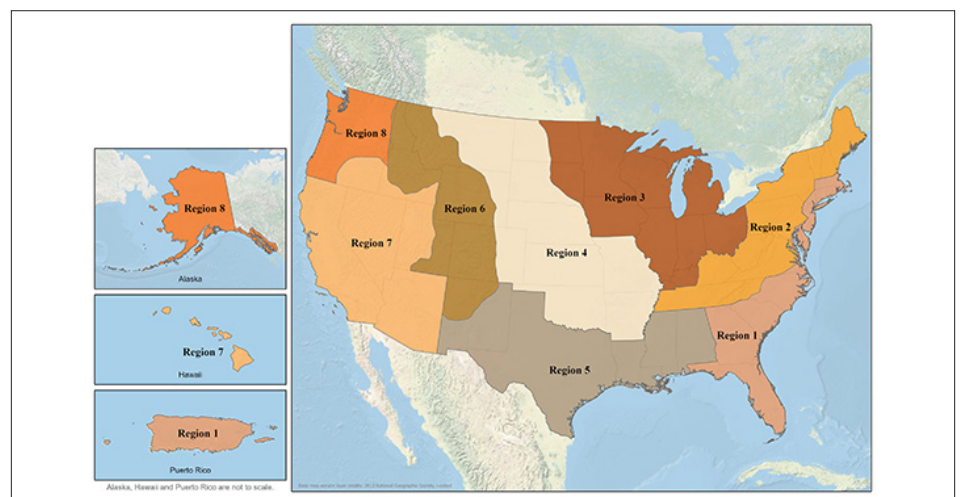


Figure 1. CORE-CM: Developing National Prospectus by Assessing Regional Opportunities

could provide significant amounts of rare earth elements and other critical minerals and materials. For example, wastes and byproducts from known fossil fuel reserves and other industries nation-wide currently contain more than 10 million tons of rare earth elements, which is equivalent to more than a 300-year supply at the current rate of U.S. consumption. FECM has established the Carbon Ore Rare Earth and Critical Minerals (CORE-CM) Initiative, which seeks to:

- Build broad-based regional coalition teams, including miners and producers
- Investigate regional resources (e.g., materials, facilities, infrastructure, workforce), opportunities, and challenges;
- Catalyze regional economic growth and job creation,
- Enable production of rare earth elements, critical minerals, and high-value, nonfuel, carbon-based products.

Mission success also requires demonstrating the ability to upscale the production of high-purity rare earth elements and critical minerals. Several small-scale projects (see figure 2) were designed to demonstrate the technical feasibility to produce rare earth elements from unconventional sources. In the last few years, the projects went from producing grams to kilograms of mixed rare earth oxides (MREO), while also increasing purity of the MREO to nearly 100 percent.

The pilots inform front-end engineering and design studies with the goal of leading to a demonstration project that will produce MREO and other critical minerals. These projects will inform future full-scale production of CMM, while optimizing the circuits for co-production and cost reduction.

These projects create opportunities for the United States to bring manufacturing back to the country and expand crucial energy jobs. By remediating existing sites and plugging into existing



Figure 2. Small pilot facilities for processing rare earth elements from coal-based resources. Clockwise from top left lead performer and feedstock (University of North Dakota, lignite; Winner Water Services, coal ash; University of Kentucky, coal refuse and lignite; West Virginia University, acid mine drainage

operations, we have the potential to meet substantial demand (feasibly as much as 50 percent).

## Advanced Carbon Material Production

The Division also examines new applications and new markets for carbon from coal. Current research focuses on innovative pathways to produce advanced products like graphite for anodes. Research has shown potential in using synthetic graphite from these feedstocks in production of a polymer-derived ceramic to produce commercially viable anodes that can rival the performance of graphite in lithium-ion batteries. Other research focuses on the production of graphene, nanotubes, carbon fibers, carbon-based building materials, and other high-value or volume carbon products.

## New Research Areas

FECM is establishing an advanced critical materials recovery program that will develop innovative technologies to revolutionize mining by using a more surgical approach while decreasing the environmental and community impacts.

Working with experts in drilling, geophysics, chemistry, biology, robotics, artificial intelligence, and other fields to develop cutting-edge technologies will enable precision extraction of critical materials from deep underground without the need for digging giant pits, sending people underground, or significantly impacting the land, water, and air in local communities.

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To learn more about the Division of Minerals Sustainability's ongoing efforts, visit FECM's Office of [Resource Sustainability website](#). You can also [sign up to receive news alerts](#) to learn about future FECM funding opportunity announcements and project selections. ■



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