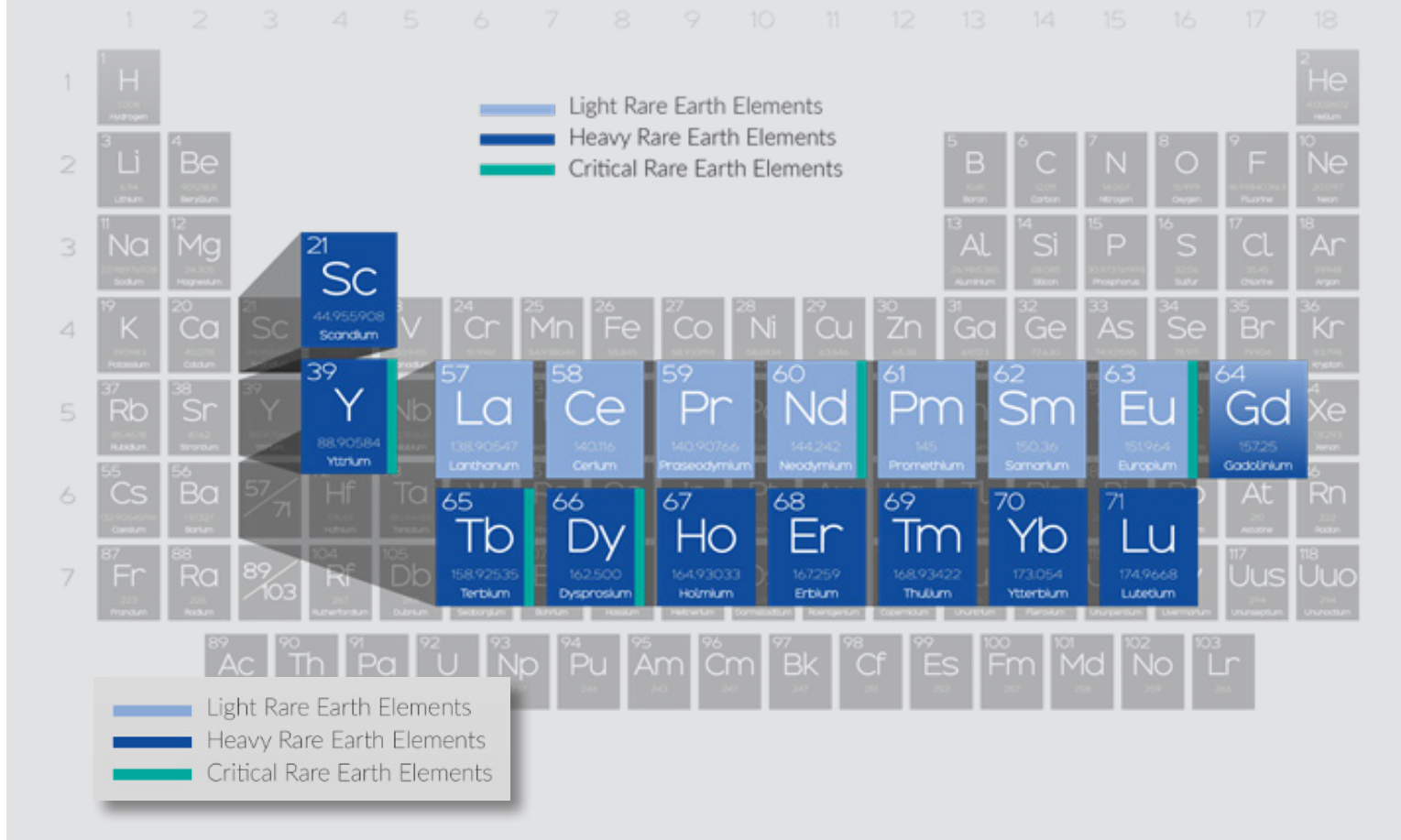


# RARE EARTH ELEMENTS



# NETL

## NATIONAL ENERGY TECHNOLOGY LABORATORY

The **Feasibility of Recovering Rare Earth Elements (REEs) program** within NETL's **Coal Research and Development Portfolio** focuses on developing REE separation and recovery technologies, addressing the current global REE separations market and process economics, and demonstrating the generation of environmentally benign REE separation processing capabilities. The quantities of REEs located in our nation's vast coal resources and available within the coal value chain, offer the potential to serve as an economically competitive domestic supply of REEs and other critical minerals. This will reduce U.S. dependence on foreign sources, create new industries and revitalize the workforce in coal-producing regions, and assist in maintaining economic growth, U.S. competitiveness in the global marketplace, and national security.

This body of work will enhance conventional extraction and separation processes to enable the domestic production of economically competitive and environmentally benign, market-ready, rare earth element oxides (REOs) from domestic coal value chain feedstocks (i.e., produced coals, coal refuse, power generation ash, clay and/or shale coal seam over-/under-burden materials, acid mine drainage sludge [AMD]). In addition, second-generation and transformational REE extraction, separation and recovery concepts are being developed to further enhance the economic viability of U.S.-based REO production.

NETL is conducting REE research on the following three platforms: enabling technologies, separation technologies, process systems.

## ENABLING TECHNOLOGIES

NETL is pursuing the following research pathways to find the most promising coal and coal byproduct materials.

- Field Sampling & Characterization
- Field & Process System Sensor Development
- Techno-Economic Analysis

These efforts support future commercial REE production. Field sampling and characterization are vital in developing viable REE process systems. Rapid and accurate REE sensors are being developed for field, laboratory, and process applications. Techno-Economic Analysis assists in determining REE markets, new system cost performance targets, and potential job creation.

## SEPARATION TECHNOLOGIES

Separation technologies include using or modifying current commercial physical separation systems, hydrometallurgy, mineral beneficiation and pyrometallurgy techniques to separate and concentrate REEs from coal-based resources. Transformational concepts and breakthrough technologies are also being pursued to further enhance the economic and environmental performance of domestic REE production.

## PROCESS SYSTEMS

Developing and demonstrating technologies to extract, separate, and recover REEs from coal-related sources includes validating the performance of bench- and pilot-scale technologies and determining the economic feasibility of these processes. Achieving affordable, high-purity domestic production of REEs may lead to commercialization of new and advanced materials and equipment.

## REE STRATEGIC PERFORMANCE MEASURE

This program supports achievement of an important Office of Fossil Energy strategic objective to mature technologies that maximize the value gained from fossil energy resources, including their production and use. Research investments are guided by developing technologies capable of advancing our knowledge, reducing techno-economic risk, and achieving the following near-term performance measure:

*By 2020, validate the technical and economic feasibility of small, domestic, pilot-scale, prototype facilities to generate, in an environmentally benign manner, 10 lbs./day, 1,000 pounds, high purity 90-99 wt.% (900,000-990,000 ppm), salable REOs from 300 ppm coal-based resources.*

## RESEARCH IN PRODUCING REEs FROM U.S. COAL RESOURCES HAS THE FOLLOWING ECONOMIC AND NATIONAL IMPACTS:

- Creates a secure and reliable domestic source of REEs and critical materials to fuel a thriving economy.
- Provides value to our national security, energy independence, environmental future, and economic growth.
- Advances sensor development for the rapid identification of new and large sources of REE.
- Develops new industries and high-value jobs in coal producing regions.

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