

United States Energy Association

## Coal and Critical Minerals: Unlocking Rare Earth Elements from U.S. Coal Resources

### OVERVIEW

Coal remains a foundational component of the United States' energy and industrial system, particularly in major producing regions such as the Powder River Basin, Appalachian Basin, and Illinois Basin. While coal's share of U.S. electricity generation has declined over the past decade, its strategic importance is evolving.

The United States faces significant and well-documented vulnerabilities in critical mineral supply chains. Rare earth elements (REEs) are essential for energy systems, defense technologies, and high-performance manufacturing. The United States is 100% import-reliant for at least 12 critical minerals and more than 50% import-reliant for an additional 31 minerals (USGS, Mineral Commodity Summaries 2025), underscoring the scale of supply chain exposure. These vulnerabilities are further compounded by the global concentration of processing capacity, particularly in China, which dominates key stages of rare earth refining and manufacturing. As demand accelerates, driven by artificial intelligence, electrification, advanced manufacturing, and defense applications, the need for secure, domestic sources of critical minerals has become a central pillar of U.S. energy, security and industrial policy.

In 2025-2026, under renewed federal emphasis on energy dominance, supply chain security, and industrial resilience, coal is increasingly being reconsidered as a strategic domestic source of rare earth elements and critical minerals. Emerging research and federal initiatives suggest that coal deposits, coal waste streams, and combustion byproducts may provide a pathway to strengthen domestic supply chains, reduce reliance on foreign suppliers, and support the development of next-generation energy and manufacturing systems.

### WHAT ARE RARE EARTH ELEMENTS AND WHY DO THEY MATTER

Rare earth elements (REEs) are a group of 17 chemically similar metallic elements, including neodymium, dysprosium, praseodymium, lanthanum, and yttrium (USGS, 2025). While relatively abundant in the Earth's crust, they are rarely found in concentrations that are economically viable to extract and process, making secure supply chains both technically and geopolitically complex. REEs are indispensable to a wide range of strategic, high-value applications that underpin modern energy systems, advanced manufacturing, and national defense capabilities:

- **Energy technologies:** wind turbines, electric vehicles, grid infrastructure, and energy storage systems
- **Electronics and digital infrastructure:** smartphones, semiconductors, data centers, and advanced computing systems
- **Defense systems:** precision-guided munitions, radar, jet engines, and secure communications technologies
- **Industrial applications:** catalysts, high-performance alloys, batteries, and permanent magnets

Among these uses, rare earth permanent magnets (particularly those using neodymium and dysprosium) are among the most critical. Demand for rare earth elements is expected to grow significantly in the coming decades, driven by the expansion of electrification, renewable energy deployment, artificial intelligence infrastructure, and advanced

manufacturing systems. At the same time, supply chains remain highly concentrated and vulnerable to disruption. As a result, ensuring secure, reliable, and domestically anchored supply chains for rare earth elements has become a central priority for U.S. energy policy, industrial strategy, and national security planning.

## COAL RESOURCES AS A SOURCE OF CRITICAL MINERALS

Coal deposits across the United States contain measurable and potentially recoverable concentrations of REEs and other critical minerals, positioning coal as a previously underutilized domestic resource within emerging supply chains. These materials occur naturally within coal seams as well as in associated geological formations, including clay layers and surrounding sedimentary rock. Recent research conducted by the U.S. Department of Energy (DOE) and the National Energy Technology Laboratory (NETL) confirms that coal and coal-related materials represent a technically viable and potentially scalable source of rare earth elements.

In addition to raw coal deposits, significant concentrations of REEs have been identified in:

- Coal ash produced by power plants
- Coal refuse from historical mining operations
- Acid mine drainage residues
- Processing waste streams from coal preparation facilities

These unconventional sources are particularly important because they often contain elevated concentrations of rare earth elements and are more accessible for processing than primary coal deposits, reducing both technical and economic barriers to recovery. Research by the U.S. Geological Survey and DOE indicates that certain U.S. coal basins may contain rare earth concentrations comparable to or exceeding those found in some conventional mineral deposits (USGS; NETL). This finding is significant, as it suggests that coal-related materials could supplement (or in some cases compete with) traditional mining sources under the right technological and market conditions.

Several coal-producing regions have been identified as particularly promising for critical mineral recovery:

- **Appalachian Basin (Pennsylvania, West Virginia, Kentucky):** High concentrations in coal refuse and legacy waste streams
- **Illinois Basin:** Large volumes of coal combustion byproducts with industrial-scale potential
- **Powder River Basin (Wyoming and Montana):** Lower concentrations per ton, but an exceptionally large resource base, producing approximately 40% of total U.S. coal output (EIA, 2025)
- **Western coal regions (Utah and Colorado):** Emerging opportunities linked to regional industrial and energy systems

These regions contain decades' worth of accumulated coal waste and byproducts, representing a potential strategic resource. Recovering critical minerals from these materials offers a dual benefit: resource recovery and site remediation, transforming legacy coal infrastructure into a foundation for new industrial activity. The potential scale of these resources is substantial. The United States generates approximately 70-90 million tons of coal ash annually (American Coal Ash Association, 2024), much of which is stored in surface impoundments and landfills. Within these materials, rare earth element concentrations have been measured at 200 to over 500 parts per million (ppm) in certain deposits (DOE/NETL studies). Taken together, DOE and NETL analyses suggest that U.S. coal resources and associated byproducts may contain millions of metric tons of rare earth elements, although the economic viability of large-scale recovery remains dependent on continued advances in extraction, separation, and processing technologies (DOE NETL, Critical Minerals Initiative). In the current policy and market environment, coal is viewed

as a potential strategic domestic feedstock capable of supporting critical mineral supply chains, industrial development, and long-term resource security.

---

## Trump Administration Policy Focus: Energy Security, Critical Minerals, and Industrial Strategy (2025-2026)

The current administration has placed renewed and explicit emphasis on energy dominance, industrial self-sufficiency, and supply chain security, positioning critical minerals as a central pillar of U.S. economic and national security strategy. Key priorities include:

- Energy dominance and fuel-secure electricity systems
- Rebuilding domestic industrial and manufacturing capacity
- Reducing reliance on foreign partners for critical minerals
- Revitalizing coal and legacy industrial regions through advanced materials and processing industries

In February 2026, the White House underscored this approach, stating:

*"Maintaining a fuel-secure electricity system and strengthening domestic energy and industrial supply chains, including the strategic role of America's coal fleet." (White House, Fact Sheet, February 11, 2026)*

### Scaling Domestic Critical Mineral and Materials Supply Chains

Recent federal funding announcements demonstrate a decisive shift from research and pilot programs toward full-scale commercial deployment of domestic critical mineral supply chains. On March 13, 2026, DOE announced a \$500 million Notice of Funding Opportunity (NOFO) to expand domestic:

- Critical mineral processing
- Battery material manufacturing
- Recycling capacity

Administered through the Office of Critical Minerals and Energy Innovation, this initiative targets supply chains supporting defense systems, grid resilience, transportation, advanced manufacturing, and data center infrastructure (DOE, 2026). Energy Secretary Chris Wright emphasized the strategic importance of the initiative:

*"This effort will position the United States to win the AI race, meet rising energy demand, and achieve energy dominance." (DOE, March 13, 2026)*

This represents one of the most significant recent federal investments focused on midstream and downstream processing capacity, historically the most vulnerable segment of U.S. critical mineral supply chains.

---

## TARGETED INVESTMENT IN RARE EARTH ELEMENT SUPPLY CHAINS

Complementing this broader effort, DOE announced a \$134 million funding opportunity on December 1, 2025, specifically focused on strengthening domestic rare earth element supply chains (DOE, Energy.gov, December 1, 2025). This program is particularly relevant to coal-based resources, as it supports:

- Recovery of REEs from unconventional feedstocks, including:
  - Mine tailings
  - Coal ash and coal refuse
  - Industrial waste streams
  - Electronic waste
- Development of commercial-scale extraction and separation facilities

The initiative is part of DOE's Rare Earth Demonstration Facility program, designed to establish end-to-end domestic REE processing capability. Secretary Wright stated:

*"We have these resources here at home... we are rebuilding America's ability to mine, process, and manufacture the materials essential to our energy and economic security." (DOE, December 1, 2025)*

This funding directly aligns with DOE and NETL research demonstrating the viability of extracting rare earth elements from coal and coal byproducts, reinforcing coal's emerging role as a strategic mineral resource.

## BROADER INDUSTRIAL STRATEGY: NUCLEAR FUEL SUPPLY CHAINS AND ENERGY SECURITY

In parallel, the U.S. Department of Energy has announced and advanced multi-billion-dollar investments to restore domestic uranium enrichment and nuclear fuel supply chains, with funding commitments totaling approximately \$2-3 billion across multiple programs and fiscal years (DOE, Energy.gov, 2025-2026). These initiatives are focused on rebuilding U.S. capacity across the nuclear fuel cycle and reducing reliance on foreign enrichment services.

Key program priorities include: expansion of low-enriched uranium (LEU) production capacity, development of high-assay low-enriched uranium (HALEU) to support advanced reactor technologies, competitive awards and cost-shared funding to U.S. companies to establish and scale domestic enrichment capabilities. These efforts are designed to support the continued operation of the existing U.S. nuclear fleet, comprising more than 90 commercial reactors. Secretary Wright emphasized:

*"This Administration is committed to restoring a secure domestic nuclear fuel supply chain capable of producing the fuels needed to power the reactors of today and tomorrow." (DOE, January 5, 2026)*

## STRATEGIC IMPLICATIONS FOR COAL AND CRITICAL MINERALS

Taken together, these initiatives, representing over \$3 billion in recent federal commitments and program funding, reflect a coordinated national strategy to:

- Build end-to-end domestic supply chains, from resource extraction to processing and manufacturing
- Reduce reliance on foreign suppliers and geopolitical competitors
- Strengthen energy system resilience and industrial competitiveness
- Support emerging demand from: artificial intelligence and data centers, advanced manufacturing, and electrification and defense technologies

In this framework, coal is increasingly positioned as a critical enabling resource, not only for energy production but for materials supply. The inclusion of unconventional feedstocks, such as coal ash, coal refuse, and other mining byproducts, in federal funding programs signals a clear policy direction: coal is being redefined as a strategic input into next-generation U.S. industrial and critical mineral supply chains. Furthermore, these policies reinforce the role of coal-producing regions as future hubs for mineral processing, advanced manufacturing, and supply chain development, aligning economic revitalization with national security priorities.

## REGIONAL DISTRIBUTION OF COAL-BASED CRITICAL MINERALS IN THE UNITED STATES

Coal-associated critical minerals are distributed across several major U.S. basins, with resource potential varying based on geology, legacy waste volumes, and infrastructure. In many cases, coal ash and mining byproducts represent the most viable near-term sources due to higher rare earth element (REE) concentrations and easier processing pathways.

### Key U.S. Coal Basins and Critical Mineral Potential

Region	Key States	Resource Characteristics	Strategic Significance
<b>Appalachian Basin</b>	PA, WV, KY	High concentrations in coal refuse and ash; some deposits exceed 300-500 ppm REEs (DOE/NETL)	Most promising near-term recovery potential due to legacy waste volumes and established infrastructure
<b>Illinois Basin</b>	IL, IN, KY	Large volumes of coal combustion byproducts from decades of generation	Strong potential for industrial-scale processing and co-location with manufacturing
<b>Powder River Basin</b>	WY, MT	Produces approximately 40% of U.S. coal output (EIA, 2025); lower REE concentrations per ton	Massive resource base supports long-term supply potential and scalability
<b>Western Coal Regions</b>	UT, CO	Identified deposits with favorable mineral content	Opportunity to integrate with regional energy and industrial corridors

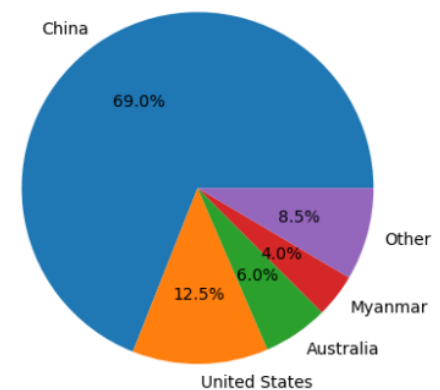
## GLOBAL CRITICAL MINERALS SUPPLY CHAINS

Global critical mineral supply chains, particularly for rare earth elements (REEs), are highly concentrated and increasingly recognized as a strategic vulnerability. China dominates multiple stages of the rare earth value chain, including mining, processing, and refining, giving it a competitive and geopolitical advantage.

- China accounts for approximately 69% of global rare earth mine production (USGS, 2025)
- China controls an estimated 85-90% of global rare earth processing capacity (IEA, 2024)
- The United States produces approximately 12-13% of global rare earth mining output and maintains limited domestic processing capacity (USGS, 2025)

Even domestically mined materials are often dependent on foreign processing, reinforcing supply chain exposure.

Global Rare Earth Mine Production Share (Approximate, 2025)



This concentration has elevated critical minerals to a central issue in U.S. national security, trade policy, and industrial strategy, with similar concerns emerging across Europe and allied economies. In response, both the United States and its partners have accelerated efforts to diversify supply sources, expand domestic production, and build resilient, allied supply chains. At the same time, global demand for critical minerals is projected to grow significantly. The International Energy Agency estimates that demand for rare earth elements used in clean energy technologies could increase by 3 to 7 times by 2040, depending on the pace of energy transition and electrification (IEA, World Energy Outlook 2024; Critical Minerals Market Review). Developing domestic sources of rare earth elements (including unconventional resources such as coal, coal ash, and mining byproducts) offers a pathway to reduce supply chain risk, strengthen industrial resilience, and enhance long-term resource security.

## CONCLUSION

The development of coal-based critical mineral supply chains presents a significant opportunity to revitalize coal-dependent regions while advancing U.S. energy and industrial strategy. As electricity markets shift and coal plant retirements continue, many coal-producing regions have experienced economic decline. At the same time, these regions retain skilled workforces, industrial infrastructure, and resource bases that position them well for participation in emerging critical mineral industries.

Recovering rare earth elements and other critical minerals from coal and associated byproducts offers several key advantages:

- **Economic revitalization:** U.S. coal employment declined from over **90,000 workers in 2011 to approximately 40,000 in 2024** (EIA). Critical mineral development provides a pathway to create new, high-value jobs while leveraging existing mining and technical expertise.
- **Waste remediation:** The United States has over **1 billion tons of coal ash stored nationwide** (EPA estimates). Reprocessing these materials can generate economic value.
- **Supply chain security:** Domestic production of critical minerals reduces reliance on foreign suppliers (particularly China) and strengthens national resilience.
- **Industrial competitiveness:** Coal-derived rare earth elements can support domestic supply chains for **electric vehicles, advanced manufacturing, defense systems, and energy infrastructure**, aligning with broader federal industrial policy objectives.

In practice, these opportunities are already shaping regional development strategies, with coal-producing states exploring the co-location of mineral processing facilities, manufacturing hubs, and remediation projects near existing infrastructure. Taken together, coal-based critical mineral development offers a pathway to transform legacy coal regions into strategic centers of next-generation industrial activity, aligning economic redevelopment with national energy security priorities.

**THE UNITED STATES ENERGY ASSOCIATION** (USEA) Founded in 1924, the United States Energy Association (USEA) is a nonprofit, nonpartisan, and non-lobbying organization that serves as a neutral forum for dialogue across the global energy sector. USEA’s mission rests on two pillars: first, convening stakeholders to exchange insights on policy, regulation, science, technology and finance to advance reliable, affordable energy for economic growth and prosperity; and second, partnering with the U.S. Government, members, and international allies to expand access to U.S. energy resources and technology to strengthen energy security worldwide.

With over 100 member organizations, USEA’s members include government agencies, utilities, architect and engineering firms, nonprofits, think tanks, academic institutions, Fortune 500 companies, and leading engineering consultancies that span the breadth of energy sources and technology. As an industry convener, USEA provides a trusted, nonpartisan, and technology-neutral forum to inform policy discussions, highlight innovation, and chart pathways for strengthening U.S. energy leadership. USEA also hosts flagship events, webinars, briefings, and workshops to advance dialogue on emerging energy issues.

USEA’s team of international specialists partners with U.S. federal agencies, including the Department of Energy (DOE), Department of State, and other government entities, to strengthen U.S. competitiveness and open opportunities for U.S. businesses in global energy markets, including grid-enhancing technologies, liquified natural gas (LNG) exports, small modular reactors, and cybersecurity.

*Beata Bialy*  
*Non-Resident Fellow*  
*United States Energy Association*

*Beata Bialy is a Non-Resident Fellow with the United States Energy Association, where she produces research and publications on energy policy, and the strategic role of domestic energy resources in supporting U.S. economic competitiveness and energy security.*

## SOURCES

### United States Government and Federal Agencies

U.S. Energy Information Administration (EIA). Annual Coal Report 2024

<https://www.eia.gov/coal/annual/>

U.S. Energy Information Administration (EIA). Coal Data Browser - Production by State

<https://www.eia.gov/coal/data/browser/>

U.S. Energy Information Administration (EIA). Electric Power Monthly

<https://www.eia.gov/electricity/monthly/>

U.S. Energy Information Administration (EIA). Today in Energy: U.S. Coal Production and Consumption Trends

<https://www.eia.gov/todayinenergy/>

U.S. Energy Information Administration (EIA). State Electricity Profiles

<https://www.eia.gov/electricity/state/>

U.S. Geological Survey (USGS). Mineral Commodity Summaries 2025 – Rare Earth Elements

<https://www.usgs.gov/centers/nmic/mineral-commodity-summaries>

U.S. Geological Survey (USGS). Rare Earth Elements in Coal and Coal Fly Ash

<https://www.usgs.gov/publications>

U.S. Geological Survey (USGS). Critical Minerals and Mineral Commodity Data

<https://www.usgs.gov>

U.S. Department of Energy (DOE). Office of Fossil Energy and Carbon Management – Carbon Management Program

<https://www.energy.gov/fecm>

U.S. Department of Energy (DOE). Critical Minerals and Materials Program

<https://www.energy.gov>

U.S. Department of Energy (DOE). Office of Critical Minerals and Energy Innovation

<https://www.energy.gov>

U.S. Department of Energy (DOE). Funding Opportunity Announcement – Critical Minerals Processing and Battery Materials (March 13, 2026)

<https://www.energy.gov>

U.S. Department of Energy (DOE). Rare Earth Demonstration Facility Program (December 1, 2025 Announcement)

<https://www.energy.gov>

U.S. Department of Energy (DOE). Nuclear Fuel Supply Chain and Uranium Enrichment Programs  
<https://www.energy.gov>

U.S. Department of the Treasury / Internal Revenue Service (IRS). Section 45Q - Carbon Oxide Sequestration Credit  
<https://www.irs.gov/credits-deductions/businesses/section-45q-credit-for-carbon-oxide-sequestration>

### **Reliability and Grid Institutions**

North American Electric Reliability Corporation (NERC). Long-Term Reliability Assessment  
<https://www.nerc.com/pa/RAPA/Pages/default.aspx>

North American Electric Reliability Corporation (NERC). Reliability Risk Priorities Report  
<https://www.nerc.com/pa/RAPA/rrp/Pages/default.aspx>

### **Federal Energy and Environmental Policy**

The White House. Fact Sheet: Strengthening United States National Defense with America's Clean Coal Power Generation Fleet (February 11, 2026)  
<https://www.whitehouse.gov>

U.S. Environmental Protection Agency (EPA). Mercury and Air Toxics Standards (MATS)  
<https://www.epa.gov/mats>

U.S. Environmental Protection Agency (EPA). Greenhouse Gas Standards and Guidelines for Fossil Fuel-Fired Power Plants  
<https://www.epa.gov/stationary-sources-air-pollution>

U.S. Environmental Protection Agency (EPA). Coal Combustion Residuals (CCR) and Coal Ash Program  
<https://www.epa.gov/coalash>

### **Energy Infrastructure and Power Sector Data**

Federal Energy Regulatory Commission (FERC). Energy Infrastructure Updates and Electricity Market Data  
<https://www.ferc.gov>

U.S. Energy Information Administration (EIA). Electric Generator Inventory (EIA-860)  
<https://www.eia.gov/electricity/data/eia860/>

U.S. Energy Information Administration (EIA). Electric Power Plant Operations (EIA-923)  
<https://www.eia.gov/electricity/data/eia923/>

### **Critical Minerals and Energy Innovation**

U.S. Department of Energy – National Energy Technology Laboratory (NETL). Critical Minerals Recovery from Coal and Coal Byproducts  
<https://netl.doe.gov/coal/crosscutting-research/rare-earth-elements>

National Energy Technology Laboratory (NETL). Rare Earth Elements from Coal and Coal Byproducts Research Program

<https://netl.doe.gov>

National Energy Technology Laboratory (NETL). Carbon Storage Atlas and Carbon Management Research

<https://netl.doe.gov/coal/carbon-storage>

National Energy Technology Laboratory (NETL). Advanced Coal-Based Carbon Products Initiative

<https://netl.doe.gov/coal/carbon-products>

U.S. Department of Energy (DOE). Critical Minerals Strategy and Supply Chain Initiatives

<https://www.energy.gov>

### **Coal Ash and Industrial Data**

American Coal Ash Association (ACAA). Coal Combustion Product (CCP) Production & Use Survey 2024

<https://www.aaa-usa.org>

U.S. Environmental Protection Agency (EPA). Coal Ash (CCR) National Inventory and Program Data

<https://www.epa.gov/coalash>

### **Global Critical Minerals and Energy Demand**

International Energy Agency (IEA). World Energy Outlook 2024

<https://www.iea.org/reports/world-energy-outlook-2024>

International Energy Agency (IEA). Critical Minerals Market Review

<https://www.iea.org/reports/critical-minerals-market-review>

International Energy Agency (IEA). Electricity 2025: Analysis and Forecast to 2027

<https://www.iea.org/reports/electricity-2025>