United States Energy Association

Coal-to-Products (C2P): Expanding the U.S. Coal Value Chain Beyond Combustion

OVERVIEW

Coal remains a foundational component of the United States' energy and industrial system, with significant production concentrated in the Powder River Basin, Appalachian Basin, and Illinois Basin. Abundant domestic coal resources continue to support reliable energy supply, industrial activity, and regional economic development, while also offering strategic advantages in an increasingly competitive global resource environment. The Coal-to-products (C2P) expands the potential for coal utilization positioning it as a carbon-based feedstock for high-value materials, chemicals, and advanced manufacturing. In the current 2025-2026 policy environment, focused on energy security, domestic production, and resilient supply chains, C2P pathways provide a mechanism to strengthen the economic and strategic value of U.S. coal resources while supporting critical industries. This article examines the emerging coal-to-products landscape in the United States, including key technology pathways, commercial applications, regional opportunities, and the policy and market drivers shaping deployment.

WHAT IS COAL-TO-PRODUCTS (C2P)?

Coal-to-products (C2P) refers to the use of coal not merely as a fuel, but as a carbon-rich industrial input for the production of higher-value materials and advanced industrial products. In the U.S., the Department of Energy (DOE) and the National Energy Technology Laboratory (NETL) frame this as expanding coal beyond power and steel into products such as carbon fiber, graphite, battery materials, graphene and other materials. C2P is really several different pathways, not one technology. Some pathways convert coal into solid carbon materials. Others use coal or coal waste as a source of minerals and rare earth elements. Others use coal-derived intermediates such as pitch or char to make engineered materials. In practical terms, the field sits at the intersection of materials science, chemical processing, critical minerals strategy, advanced manufacturing, and regional economic development.

KEY PRODUCT CATEGORIES INCLUDE:

Category	Products	Primary Applications / Markets
Carbon-Based Materials	Carbon fiber; graphite and graphene; activated carbon; carbon foams	Aerospace and defense; electric vehicles; energy storage systems; filtration
Chemicals and Industrial Inputs	Methanol and ammonia; synthetic hydrocarbons; fertilizers and solvents	Petrochemicals; fuel production; agricultural inputs; industrial manufacturing
Construction and Infrastructure Materials	Carbon composites; asphalt additives; cement and concrete enhancements	Building materials; transportation infrastructure; durability and performance improvements in construction
Energy and Advanced Applications	Battery materials; hydrogen production (via coal gasification with carbon capture); electrodes for energy storage systems	Grid-scale energy storage; hydrogen; advanced manufacturing; electrification and digital infrastructure
Rare Earth Elements and Critical Minerals	Rare earth oxides (e.g., neodymium, dysprosium); critical minerals (e.g., gallium, germanium, lithium from coal-associated resources); scandium and yttrium	Permanent magnets (wind turbines, EV motors, defense systems); semiconductors and electronics; advanced batteries; aerospace and defense supply chains; clean energy technologies

ADVANCED CARBON MATERIALS FROM COAL

DOE and NETL have identified coal as a precursor for high-performance carbon materials, particularly carbon fiber and graphite, which are critical for aerospace, defense, and energy storage applications (DOE NETL Carbon Products Initiative, 2025). Coal gasification converts coal into syngas (CO + H_2), which can be used to produce: hydrogen, ammonia, methanol and synthetic fuels. The United States currently operates a limited number of coal gasification facilities, with deployment remaining modest relative to global markets (EIA, 2025). DOE's National Laboratories (particularly NETL) have advanced multiple coal-to-products and coal-to-minerals technologies that are now positioned for potential industry partnership and commercialization.

RARE EARTH ELEMENTS (REES)

In parallel, coal-to-minerals pathways (particularly the recovery of rare earth elements (REEs) from coal ash and other coal-related waste streams) represent a complementary opportunity to extract additional value from coal resources. The United States produced approximately 63.6 million tons of coal combustion products in 2024, providing a substantial domestic resource base for potential critical mineral recovery (American Coal Ash Association, 2024). These materials are managed through a combination of beneficial use, landfills, surface impoundments, and legacy disposal sites. Technologies developed by the NETL and other U.S. Department of Energy laboratories are advancing toward pilot and early commercial-scale deployment, supporting broader U.S. supply chain resilience and critical minerals strategies.

COAL PYROLYSIS AND CARBONIZATION

Coal pyrolysis and carbonization are thermochemical processes in which coal is heated in the absence of oxygen, producing solid carbon materials (such as char and coke), liquid hydrocarbons, and gaseous fuels. These processes are increasingly being developed to produce engineered carbon products, positioning pyrolysis as a key conversion pathway in the emerging coal-to-products value chains.

STRATEGIC DRIVERS AND COMMERCIALIZATION PATHWAYS FOR COAL-TO-PRODUCTS

The emergence of a federal commercialization pipeline is reshaping the outlook for C2P and coal-to-minerals pathways, accelerating their transition from research and development to early-stage deployment. These efforts reflect a shift toward developing technologies, building infrastructure, and integrating coal-derived products into commercial markets. Key priority areas include:

- **Acceleration of market readiness:** Movement from laboratory innovation to pilot and commercial demonstration projects.
- **Expansion of coal value chains:** Integration of coal-derived materials into advanced manufacturing, chemicals, and industrial supply chains.
- **Regional economic development:** Establishment of new industrial hubs and value-added industries in coal-producing regions.
- **Alignment with national policy priorities:** Direct support from federal initiatives focused on energy security, domestic manufacturing, and supply chain resilience.

This broader shift in coal's role in the U.S. economy emphasizes its position as a multi-dimensional strategic resource that supports energy systems, critical materials supply, and advanced manufacturing. These priorities are underpinned by several key strategic drivers shaping the deployment and commercialization of coal-to-products pathways in the United States today:

1. DOMESTIC SUPPLY CHAIN SECURITY

The United States remains heavily reliant on imports for many advanced materials, with 100% import reliance for at least 12 critical minerals and a net import reliance of over 50% for an additional 28 in 2025 (USGS Mineral Commodity Summaries, 2025). At the same time, global supply chains for key materials such as graphite and battery inputs are highly concentrated (particularly in China), reinforcing ongoing supply chain vulnerabilities (IEA, Critical Minerals Market Review 2024). C2P pathways provide a domestic alternative, enabling the United States to produce synthetic graphite for batteries, carbon fiber for defense and aerospace applications, and chemical intermediates for industrial manufacturing. This capability aligns directly with federal priorities to reduce reliance on foreign processing and manufacturing capacity while strengthening domestic supply chains.

2. ALIGNMENT WITH FEDERAL ENERGY AND INDUSTRIAL POLICY (2025-2026)

On April 8th, 2025, President Trump signed Executive Order 14261, *"Reinvigorating America's Beautiful Clean Coal Industry and Amending Executive Order 14241,"* which established a policy framework to expand coal production, utilization, and export capacity, emphasizing energy security, economic competitiveness, and the role of coal in meeting rising electricity demand. The order directs federal agencies to prioritize coal, streamline permitting, and support coal-related technologies and infrastructure (White House, 2025). While the Executive Order focuses broadly on coal production and utilization, it provides a policy foundation that supports the development of C2Ps and coal-to-materials pathways, particularly through expanded federal support for coal-related technologies and industrial applications. This direction builds on existing federal incentives such as the Section 45Q carbon sequestration tax credit, which supports carbon capture and utilization and may complement certain coal-based product pathways where carbon capture and utilization are integrated (U.S. Treasury/IRS).

In December 2025, DOE announced *"Energy Department Announces $134 Million in Funding to Strengthen Rare Earth Element Supply Chains, Advancing American Energy Independence,"* supporting recovery of rare earth elements (REEs) from coal ash, mine waste, and other unconventional feedstocks (DOE, December 1, 2025). These efforts are complemented by broader DOE initiatives to strengthen domestic critical mineral processing, materials development, and manufacturing capacity. On February 11, 2026, the White House issued a Fact Sheet on *"Strengthening United States National Defense with America's Beautiful Clean Coal Power Generation Fleet,"* which underscored coal's role in maintaining a fuel-secure electricity system and reinforcing domestic energy and industrial supply chains (White House, February 11, 2026). Most recently, on March 13, 2026, DOE issued *"Energy Department Announces $500 Million to Strengthen Domestic Critical Materials Processing and Manufacturing,"* a Notice of Funding Opportunity (NOFO) to expand domestic critical mineral processing, battery materials manufacturing, and recycling capacity, investments that, while not limited to coal, directly support the infrastructure necessary to develop coal-to-products technologies (DOE, March 13, 2026).

COORDINATED FEDERAL STRATEGY

Collectively, these actions reflect a coordinated federal strategy to move beyond research and pilot programs toward commercialization, positioning coal for advanced materials, critical minerals, and industrial manufacturing.

3. INDUSTRIAL COMPETITIVENESS AND ADVANCED MANUFACTURING

Coal-derived carbon materials are becoming increasingly important in high-value industrial sectors. Demand for carbon fiber is expected to grow across aerospace, automotive, and wind turbine applications (DOE, 2025), while graphite demand is rising alongside battery manufacturing and grid-scale energy storage expansion (IEA, 2024). DOE research shows that coal-derived carbon fiber could potentially be produced at lower cost than traditional petroleum-based materials, improving the competitiveness of domestic manufacturing and strengthening supply chains (NETL, 2025). However, the economic viability of C2P pathways remains a key challenge, as many technologies are not yet cost-competitive with established petroleum-based or international supply chains. Commercial deployment will depend on continued technology development, targeted policy support, and scaling of processing and manufacturing infrastructure.

4. RESOURCE UTILIZATION AND WASTE REDUCTION

The United States produces substantial volumes of coal-related byproducts, including approximately 63.6 million tons of coal combustion products in 2024 (American Coal Ash Association, 2024). These materials are managed through a combination of beneficial use, landfills, surface impoundments (ash ponds), and legacy disposal sites (U.S. Environmental Protection Agency). C2P technologies offer a pathway to convert these materials into construction products, carbon-based materials, and a range of industrial inputs, supporting both resource utilization and waste reduction.

REGIONAL OPPORTUNITIES FOR COAL-TO-PRODUCTS DEVELOPMENT

Regional variation in coal quality, resource characteristics, and industrial infrastructure shapes the development and deployment potential of C2P pathways across the United States. These regions are well-positioned to host co-located processing, manufacturing, and logistics hubs, supporting broader economic development:

Region	Key States	Coal-to-Products Characteristics	Strategic Significance
Appalachian Basin	PA, WV, KY	High volumes of coal refuse, metallurgical coal, and legacy waste streams suitable for carbon products (carbon fiber, activated carbon) and specialty chemicals (DOE/NETL, 2025)	One of the most advanced near-term opportunity areas due to existing infrastructure, workforce, and proximity to manufacturing and defense supply chains
Illinois Basin	IL, IN, KY	Large-scale coal production and combustion byproducts suitable for gasification, hydrogen, ammonia, and synthetic fuels (EIA, 2025; DOE)	Strong potential for industrial-scale deployment and co-location with petrochemical, fertilizer, and manufacturing facilities
Powder River Basin	WY, MT	Produces approximately 40% of U.S. coal output (EIA, 2025); low-cost, low-sulfur coal suitable for large-scale use in gasification and carbon material production	Resource base supports long-term development for products (hydrogen, synthetic fuels, carbon materials)
Western Coal Regions	UT, CO	Bituminous coal resources with favorable properties for advanced carbon materials, including graphite and carbon fiber precursors (DOE/NETL)	Opportunity to integrate with emerging energy, and advanced manufacturing corridors in the Western U.S.

KEY CHALLENGES

However, several structural and market barriers continue to constrain the large-scale commercialization of coal-to-products (C2P) and coal-derived materials in the United States. **High capital costs** remain a primary obstacle, as many C2P pathways (particularly those involving gasification, carbon conversion, and advanced material processing) require substantial upfront investment, multi-year development timelines, and further technology maturation before wide commercial deployment. This challenge is compounded by limited supporting infrastructure, including processing capacity, carbon transport and storage systems where relevant, and broader supply-chain networks needed to move coal-derived intermediate and finished products to market.

At the same time, **market development** for coal-derived products is still evolving. Many end-use applications, including advanced carbon materials and specialty industrial products, must still demonstrate cost competitiveness, meet performance and qualification requirements, and secure reliable demand within established supply chains. Policy and permitting uncertainty can add further risk for developers and investors, particularly where projects depend on associated carbon management infrastructure.

Finally, C2P technologies must contend with intense **competition from established global supply chains**, particularly in regions with more mature industrial ecosystems and integrated production networks. Countries with dominant positions in chemicals, advanced materials, and critical minerals processing, most notably China, benefit from economies of scale, vertically integrated supply chains, and sustained policy support across the value chain. As a result, U.S.-based coal-derived products must overcome both cost and market entry barriers to achieve commercial viability, even where they offer strategic advantages in terms of domestic supply security and reduced import dependence.

CONCLUSION

Coal-to-products (C2P) provides a strategic pathway to expanding coal's role within the U.S. economy, positioning it not only as an energy resource but as a critical domestic feedstock for advanced materials, chemicals, and industrial manufacturing. In a global environment defined by concentrated supply chains and increasing competition for critical resources, C2P provides an opportunity to strengthen U.S. energy security, reduce dependence on foreign processing, and reinforce domestic industrial capacity. As federal policy prioritizes domestic production, resilient supply chains, and advanced manufacturing, coal is uniquely positioned to support these objectives through value-added applications that extend beyond power generation. While challenges related to cost, infrastructure, and market development remain, continued investment and commercialization efforts can unlock a new generation of coal-based industries anchored in U.S. resources. With the right policy support and market development, coal-to-products pathways have the potential to enhance American industrial competitiveness, support high-value manufacturing, and secure critical material supply chains, ensuring that coal remains a strategic asset in advancing U.S. economic strength, national security, and global leadership.

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SOURCE LIST

United States Government and National Institutions

Coal Production, Generation & Market Trends

U.S. Energy Information Administration (EIA)
Annual Coal Report 2024
U.S. Department of Energy
https://www.eia.gov/coal/annual/

U.S. Energy Information Administration (EIA)
Electric Power Monthly (2025 data / latest available)
U.S. Department of Energy
https://www.eia.gov/electricity/monthly/

U.S. Energy Information Administration (EIA)
Coal Data Browser – Production by Basin (Powder River Basin Share)
U.S. Department of Energy
https://www.eia.gov/coal/data/browser/

U.S. Energy Information Administration (EIA)
Short-Term Energy Outlook (Electricity Demand & Generation Trends)
U.S. Department of Energy
https://www.eia.gov/outlooks/steo/

Coal Conversion, Gasification & Industrial Applications

U.S. Department of Energy (DOE)
Coal-to-Products and Carbon Materials Initiatives
https://www.energy.gov/

National Energy Technology Laboratory (NETL)
Coal-Derived Products and Advanced Carbon Materials Research
U.S. Department of Energy
https://netl.doe.gov/research/coal

National Energy Technology Laboratory (NETL)
Coal Gasification Systems and Syngas Applications
U.S. Department of Energy
https://netl.doe.gov/coal/gasification

Advanced Carbon Materials & Manufacturing

National Energy Technology Laboratory (NETL)
Carbon Fiber and Advanced Carbon Products from Coal
U.S. Department of Energy
https://netl.doe.gov/coal/carbon-products

U.S. Department of Energy (DOE)
Advanced Materials and Manufacturing Office (AMMTO)
https://www.energy.gov/eere/ammto

U.S. Department of Energy (DOE)
Carbon Materials and Energy Storage Research Initiatives
https://www.energy.gov/

Critical Minerals & Rare Earth Elements
U.S. Geological Survey (USGS)
Mineral Commodity Summaries 2025 – Rare Earth Elements
U.S. Department of the Interior
https://www.usgs.gov/centers/nmic/mineral-commodity-summaries

U.S. Geological Survey (USGS)
Rare Earth Elements in Coal and Coal Fly Ash
U.S. Department of the Interior
https://www.usgs.gov/publications/rare-earth-elements-coal-and-coal-fly-ash

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

Coal Ash, Waste Streams & Resource Utilization
American Coal Ash Association (ACAA)
Production and Use Survey Reports (2023–2025)
https://acaa-usa.org

U.S. Environmental Protection Agency (EPA)
Coal Combustion Residuals (CCR) Rule & Disposal/Storage Data
https://www.epa.gov/coalash

U.S. Environmental Protection Agency (EPA)
Coal Ash (CCR) Risk and Legacy Site Data
https://www.epa.gov/coalash/coal-ash-basics

Federal Highway Administration (FHWA)
Fly Ash Use in Concrete and Infrastructure Materials
https://www.fhwa.dot.gov/pavement/sustainability/

Federal Policy, Executive Actions & Funding Programs (2025–2026)
The White House
Executive Order 14261: Reinvigorating America's Beautiful Clean Coal Industry (April 8, 2025)
https://www.whitehouse.gov/presidential-actions/

The White House
Fact Sheet: Strengthening United States National Defense with Coal-Based Power Generation (February 11, 2026)
https://www.whitehouse.gov/fact-sheets/

U.S. Department of Energy (DOE)
Energy Department Announces $134 Million to Strengthen Rare Earth Element Supply Chains (Dec 1, 2025)
https://www.energy.gov/articles/

U.S. Department of Energy (DOE)
Energy Department Announces $500 Million for Domestic Critical Materials Processing and Manufacturing (March 13, 2026)
https://www.energy.gov/articles/

U.S. Department of the Treasury / Internal Revenue Service (IRS)
Section 45Q Carbon Sequestration Tax Credit Guidance
https://www.irs.gov/

International Organizations & Global Market Analysis
Global Energy Markets & Coal-to-Products Development
International Energy Agency (IEA)
Critical Minerals Market Review 2024
https://www.iea.org/reports/critical-minerals-market-review-2024

International Energy Agency (IEA)
Global Energy Outlook and Industrial Materials Demand Trends
https://www.iea.org/

China & Global Supply Chain Dominance
International Energy Agency (IEA)
Global Critical Minerals Supply Chains and Processing Capacity
https://www.iea.org/

U.S. Geological Survey (USGS)
Global Rare Earth Production Statistics (2025)
https://www.usgs.gov/

India Coal Gasification & Industrial Strategy
Government of India
National Coal Gasification Mission & Policy Targets
Ministry of Coal
https://coal.gov.in/

International Energy Agency (IEA)
India Energy Outlook and Industrial Development Trends
https://www.iea.org/

Industrial Demand & Advanced Manufacturing Markets

U.S. Department of Energy (DOE)
Carbon Fiber Market and Demand Projections (Aerospace, Automotive, Wind Energy)
https://www.energy.gov/

International Energy Agency (IEA)
Battery Materials, Graphite, and Energy Storage Demand Outlook
https://www.iea.org/

Regional U.S. Coal & Industrial Development Context

U.S. Energy Information Administration (EIA)
Regional Coal Production Data (Appalachian, Illinois, Powder River Basins)
https://www.eia.gov/coal/

National Energy Technology Laboratory (NETL)
Regional Coal Resource and Utilization Studies
https://netl.doe.gov/