

Secretary Perry's Request

"... develop a white paper assessing opportunities to enhance the use of U.S. coal beyond power markets ... focus on new markets for 'coal products' including coal conversion ... carbon engineered products ... rare earth elements ... coal combustion products ... biotechnology approaches ... and beneficiated coal ..."

Key Questions Addressed

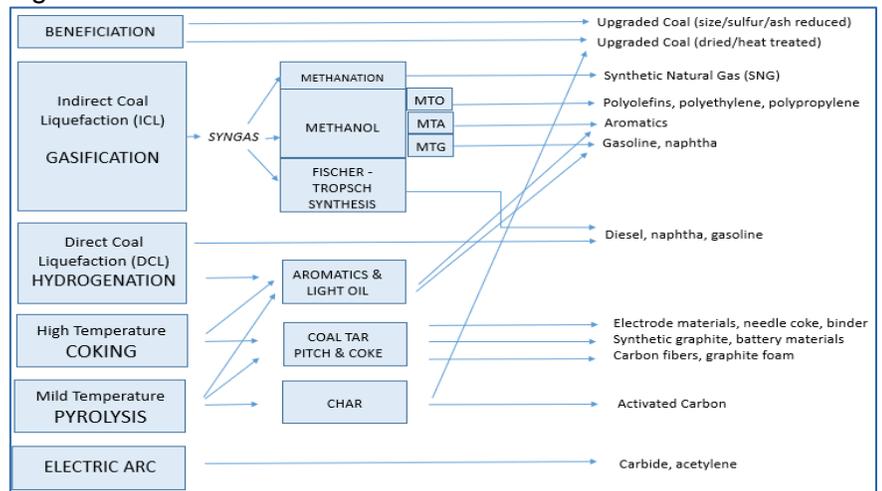
- ~ What significant market-scale opportunities exist for new markets for coal?
- ~ What are the economic, energy security, trade and other issues the U.S. faces now that can be addressed with new markets for coal?

Strategic Objective

The United States is embarking on a "New Age of Carbon" which will usher in significant opportunities for coal beyond conventional markets for power generation and steelmaking. Coal, with its inherent carbon content, is on the crest of powering a wave of innovation in advanced products and manufacturing.

Principal Findings

- The opportunity represented by coal-to-products markets is compelling. The U.S. currently produces about 750 million tons of coal per year, more than 90% of which is used for power generation. The global market for coal-to-products is estimated to consume 300-400 million tons of coal annually. Utilization of domestic U.S. coal for coal-to-products applications has the potential to be on the same order of magnitude as that projected for coal power generation applications.
- Coal-to-products markets create associated and additive economic and social benefits in the form of new mining and manufacturing jobs, especially in regions of the U.S. adversely impacted by the recent downturn in coal production and power generation.
- Coal-to-products markets support and enhance U.S. environmental objectives through their unique performance characteristics. Criteria and CO₂ emissions reductions are achieved by utilizing coal as an alternative to high-emitting processes/products, through use of coal to create durable, light-weight carbon products for aerospace and automotive industries with the potential for corresponding fuel reduction, and by using coal to create sorbents that capture CO₂ from fossil power plants. Coal is also used to create high-strength composite materials and rare earth element components for the wind and solar power industries.

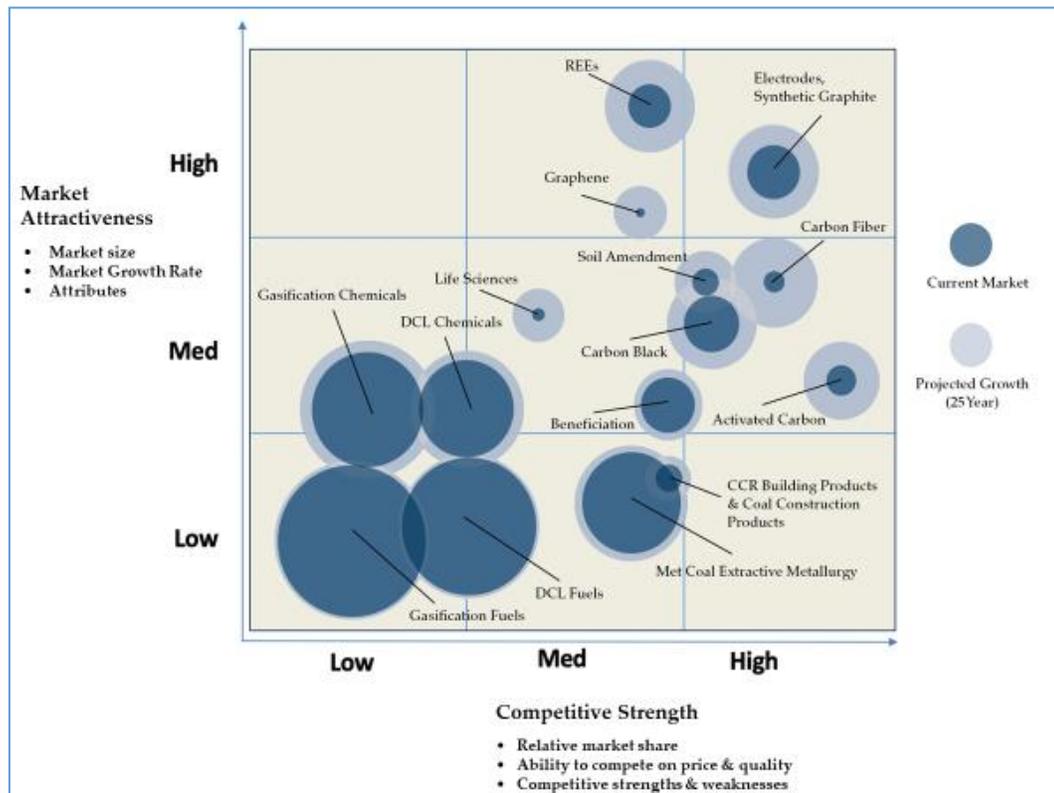


Market Assessment

The NCC's report assesses market-scale opportunities to enhance the use of U.S. coal in various coal-to-products markets. The technologies and market sectors addressed in the report include coal beneficiation; coal to liquid fuels, natural gas and chemicals; coal to carbon products, such as activated carbon, carbon fibers, graphite, graphene, carbon foam and carbon black; rare earth elements; and life science/medical, bio-tech and agricultural uses.

An assessment prioritizing opportunities for development and commercialization of these markets was conducted using a nine-block analysis gauging market attractiveness and competitive strength. The resultant outlook details pathways in three primary categories:

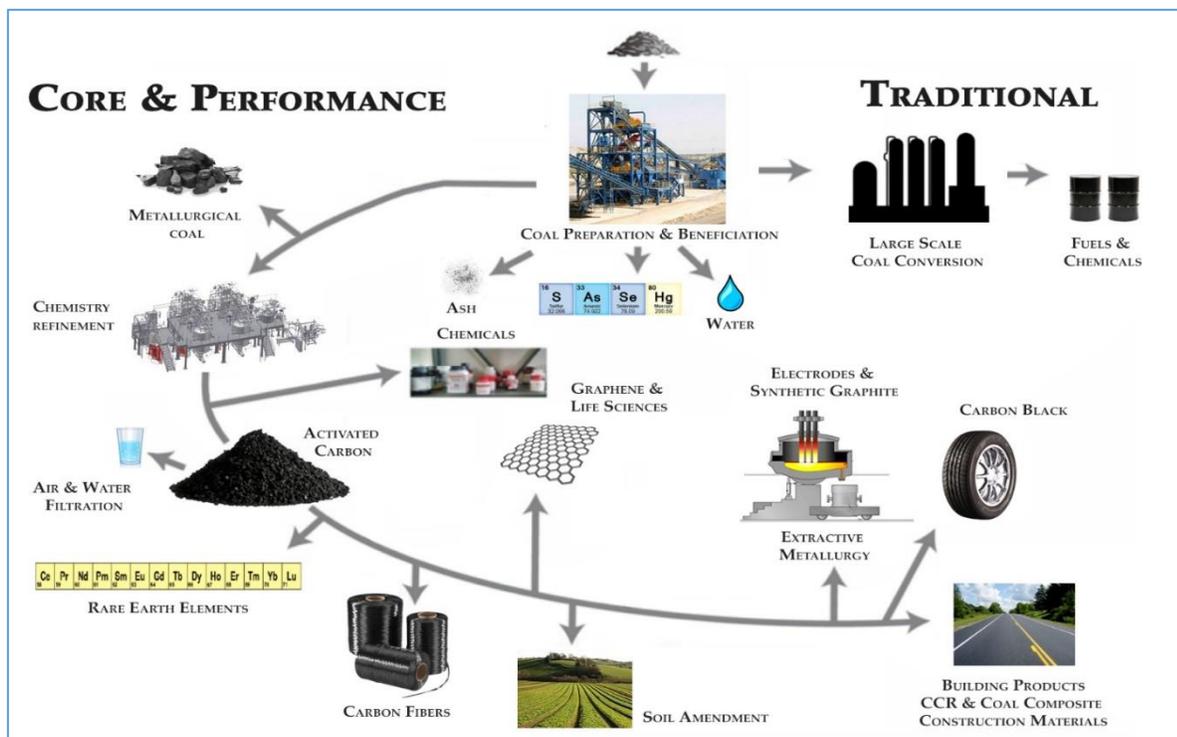
- **TRADITIONAL** – Low Market Attractiveness-Low Competitive Strength
This sector is characterized by high commodity volumes, technically and technologically proven, requiring high capital expenditures and providing marginal economic opportunity in the U.S. due to competition from other resources. Products in this category include bulk chemicals and fuels.
- **CORE** – Medium Market Attractiveness-High Competitive Strength
This sector is characterized by moderate industrial-scale volumes, technically proven, requiring moderate capital expenditures and providing a sizeable opportunity in the U.S. Specialized products in this category include extractive metallurgy, coal beneficiation, activated carbon, carbon black and coal-derived building products.
- **PERFORMANCE** – High Market Attractiveness-High Competitive Strength
This sector is characterized by specialty volumes of high-performance materials utilizing coal's inherent and unique chemistry advantages, optimistically poised for rapid commercialization from small-scale modular to larger industrial scale. Products in this category include rare earth elements, carbon fiber, synthetic graphite and electrodes, graphene, soil amendments and life-science biosensors.



Principal Recommendations

The NCC recommends three primary strategic objectives be pursued by the U.S. Department of Energy to ramp up U.S. manufacturing of coal-derived solid carbon products, chemicals, fuels and rare earth elements.

- **Establish a focused R&D program on coal-to-products.**
Additional research and development (R&D) is needed to achieve commercially viable technical performance-to-cost ratios for the manufacture of coal-derived solid carbon products, chemicals, fuels, and REEs in the U.S.
- **Accelerate research-to-commercial deployment in coal-to-products markets.**
Competing successfully in a global economy requires that the U.S. bring new technologies and related manufacturing to market much faster via replicable modular systems. To avoid being out-paced by other countries, gaps in funding and delays in progression from research to commercial deployment, including new-skills workforce development, must be eliminated.
- **Incentivize private sector investment in coal-to-products production and manufacturing sectors.**
Efficient use of public and private sector financial capital requires alignment of private sector interests and investment readiness with government public sector R&D and economic development investment plans, as well as with defense procurement schedules. Steps must be taken to establish a stronger private sector investment appetite for first-of-a-kind (FOAK) and subsequent single-digit coal conversion plants and end-product factories, in order to quickly move DOE supported coal-to-products technologies into commercial operation, to create jobs and to improve U.S. balance of trade.



Coal in a New Carbon Age Report

<https://www.nationalcoalcoal.org/page-NCC-Studies.html>

Actions to Advance U.S. Coal-to-Products Markets & Technologies

Strategic Objective:

Establish a focused R&D program on coal-to-products.

- Establish a national R&D program for advanced carbon products and manufacturing within the U.S. Department of Energy.
- Sustain a multi-decade base level of Federal commitment and support.
- Implement a broad-based interagency coordinated program to accelerate coal to fuels and products development.
- Elevate the priority of and increase R&D funding for coal-to-products technologies.

Strategic Objective:

Accelerate research-to-commercial deployment in coal-to-products markets.

- An Office of Carbon Products within the U.S. Department of Energy would establish the required national commitment and empower DOE program managers to pursue the strategic objectives and achieve the desired economic growth, job creation and national security benefits. An Office of Carbon Products would be tasked with building one or more Carbon Advanced Material, Manufacturing and Production (CAMP) centers at coal mining sites in key coal states to accelerate the pace of research-to-commercial deployment of coal-to-products and to develop repeatable modular plant designs.
- Support multiple first-of-a-kind projects throughout the U.S.
- Expand DOE Loan Guarantee Program.
- Dramatically reduce DOE Loan Guarantee Program costs, red tape and processing time.
- Apply U.S. Department of Defense Manufacturing Readiness Levels to DOE programs.
- Target defense applications and national critical materials to avoid “Valley of Death” stall-out.
- Target dual-use applications to quickly grow markets and demand for coal.
- Ensure U.S. developed technologies are deployed in the U.S.
- Address U.S. Export Administration Regulations (EAR) and International Traffic in Arms Regulations (ITAR).

Strategic Objective:

Incentivize private sector investment in coal-to-products production and manufacturing sectors.

- Establish public-private partnerships.
- Provide tax and other investment incentives and subsidies to facilitate the rapid development and commercialization of coal-to-carbon products.
- Validate revenue and business models and management strategies in addition to technology performance and cost.
- Expedite environmental and permit approvals.
- Analyze the condition and suitability of existing infrastructure assets.
- Use shuttered and producing mines, coal power plants and coal communities as economic revitalization zones for new coal to fuels and products production and manufacturing centers.
- Update regulations, legislation and permitting.
- Provide DOE financial support for pre-FEED and FEED projects.

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