Coal in a New Carbon Age

Powering a Wave of Innovation in Advanced Products & Manufacturing

Coal Market Strategies 2019
American Coal Council
August 13th, 2019 – Park City, Utah
Janet Gellici, CEO, National Coal Council
NCC is a Federal Advisory Committee
Organized under Federal Advisory Committee Act (FACA)

The National Coal Council
provides advice and recommendations
to the Secretary of Energy
on general policy matters
relating to coal and the coal industry.

Celebrating 35 years – 1984|2019

Members
Appointed by Secretary of Energy
Limited to 125-150 members representing a broad spectrum of coal interests
Reports

~ 40 reports prepared by NCC members at no cost to DOE
Extensive Range of Report Topics

Carbon Management
Clean Coal Technologies
Coal & Coal Technology Exports
Coal Conversion
Utility Deregulation
Climate & Clean Air Regulations
Building New Coal Plants
Industrial Coal Use

CCUS for EOR
Value of Existing Coal Fleet
Fossil Forward: CCS Technologies
Policy Parity for CCS
CO₂ Utilization
Advancing U.S. Coal Exports
Power Reset: Existing Coal Fleet
Coal in a New Carbon Age
Output has fallen sharply in all three major coal mining regions. From their peak years to 2020, production is expected to fall by more than 40 percent in the West and the Interior, and 66 percent in Appalachia.

Appalachia, 1990 peak: 489 million tons
Interior, 1990 peak: 206 million tons
Western, 2008 peak: 634 million tons

Source: Energy Information Administration; 2019-2020 estimates from May 2019 Short-Term Energy Outlook
“A diamond is a chunk of coal that did well under pressure.”

~ Henry Kissinger
Coal in a New Carbon Age

The Secretary of Energy
Washington, DC 20585

August 31, 2018

Mr. Derek Stone
Chairman, The National Coal Council
1000 Independence Avenue SW, Room 4G-006
Washington, DC 20585

Dear Chairman Stone:

I am writing today to request the National Coal Council (NCC) develop a white paper assessing opportunities to enhance the use of U.S. coal beyond power markets.

The white paper should focus on new markets for “coal-to-products” including coal conversion (coal to liquids, coal to gas, coal to chemicals), carbon engineered products (carbon-added non-fuels products), rare earth elements, coal combustion products, methanol, biotechnology approaches (agriculture, liquid fuels), and interfacial coal for non-power uses, among others.

The key questions to be addressed include:

- 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 new that can be addressed with new markets for coal?
- Considering the current use for coal (synthetic fuels, bioenergy, transportation fuels, etc.), where and how are these markets growing today and what is the outlook for these markets going forward?
- What has been the domestic history of coal utilization and what can be learned from past successes/failures in coal utilization?
- How can domestic markets for utilization (other than for CO2s) be developed similar to those underway in other countries?

The white paper should be managed under the auspices of the Executive Advisory Board within the NCC. I ask that the white paper be completed no later than April 12, 2019.

Upon receipt of this request and establishing your internal working group, please advise me of your schedule for completing the white paper. The Department looks forward to working with you in this effort.

Sincerely,

Rick Perry

Rick Perry
Coal in a New Carbon Age

• The Value of Advancing New Markets for Coal
• International Activity
• U.S. Historical Efforts
• Trends & Outlook for Coal-Derived Products in the U.S.
• Recommendations
• + Technology Compendium Appendix
Coal Beneficiation

Physical coal preparation technologies

- Dense media wet separation:
  - dominant prep technology
  - need to improve recovery of fines + reduce wastes

- Dry separation:
  - sorts coarse and small coal
  - increasing use in drought regions
  - attracting solutions such as x-ray sorting
Coal to Liquids Fuels & Chemicals

Gasification-Based Coal to Chemicals Process
Coal to Liquids
Fuels & Chemicals

Typical Direct Coal Liquefaction Process
Coal to Liquids
Coking & Pyrolysis
Coal to Products

- Graphite
- Carbon Fibers
- Activated Carbon
- Graphene
- Carbon Nanotubes
- Carbon Foam
- Carbon Black

- Electrodes
- Seals & bearings
- Fishing rods
- Golf clubs
- Automotive materials
- Airplane fuselages
- Building materials
- Water purification
Carbon Fiber
Graphene Application Field by Product

- Transistor
- Sensor
- Display
- Solar cell
- Touch Panel
- Flexible Display
- TCO
- Composite
- Energy
- Ink
- Conductive Ink
- EMI Screen Ink
- Bio, 3D Printing
- Super Capacitor
- Battery
- Thermal
- Materials
- Paste, Paint
- Film
- Automobile
- Air Plane
- Components
Building Materials

- Aggregate 0.8%
- Flowable Fill 0.3%
- Agriculture 0.3%
- Mineral Filler in Asphalt 0.1%
- Geosynthetic/Geotextiles 0.0%
- Waste Stabilization/Solidification 0.0%
- Other 3.1%
- Miscellaneous 2.0%
- Road Base/Subbase/Pavement 1.2%
- Mining Applications 0.0%
- Concrete/Concrete Products/Greut 46.4%
- Cement/Raw Feed for Clinker 12.6%
- Structural Fill/Embankments 22.1%
Carbon Foam
Carbon Black
Rare Earth Elements

The Rare Earth Value Chain

**Raw Materials**
- Bastnäsite
- Monazite
- Ionic Clays
- Other

**Basic Rare Earth Materials**
- Separated Rare Earth Oxides, Carbonates, Oxylates, Chlorides, & Nitrates
- Rare Earth Mixed Oxides
- Rare Earth Metals
- Other

**Engineered Rare Earth Materials**
- Rare Earth Alloys
- Magnets & Magnetic Powders
- Catalysts
- Metallurgical Additives
- Polishing Powders
- Phosphors
- Glass Additives
- Ceramics
- Water Purification Chemicals
- Other

**Component & Systems**
- Batteries
- Controls
- Drives
- Fabricated Metal Products
- Lasers
- Motors & Generators
- Sensors
- Transducers
- Other Systems & Components

**End Market Products & Technologies**
- Health Care Technologies
- Hybrid, Electric & PHEVs & Other Vehicles
- HVAC and Home Appliance Systems
- Consumer Electronics
- Energy Efficient Lighting
- Communications & Electronics
- Audio Equipment
- Defense Technologies
- Other Electronics
- Advanced Optics & Other Glass Products
- Oil Refining
- Electric Power
- Other
Soil Amendments – Humic Acid/Humate
Value of Coal-to-Products
Market Potential
• Establish a focused R&D program on coal-to-products.
  – Employ screening tools to focus R&D investments in technologies most likely to achieve commercial status.
  – End historical cyclical support for coal conversion technologies ~ commit and stay the course.
  – Assemble a formal intergovernmental team to align resources.
Strategic Recommendations

• Accelerate research-to-commercial deployment in coal-to-products market sectors.
  – Establish an Office of Carbon Products within DOE.
  – Pursue development of Carbon Advanced Material, Manufacturing and Production (CAMP) centers.
  – Support multiple first-of-a-kind projects.
  – Expand and streamline DOE Loan Guarantee Program.
Strategic Recommendations

• Incentivize private sector investment in coal-to-products production and manufacturing sectors.
  – Employ public-private partnerships
  – Provide tax and investment incentives
  – Validate revenue/business models and management strategies – in addition to technology performance/cost
  – Expedite permitting
  – Ensure adequate infrastructure