Re-envisioning Coal

Coal Use in Non-conventional Markets

Janet Gellici, CEO, National Coal Council

Cosmos Club Science Group

May 6th, 2019 – Washington, DC

Advisors to the U.S. Secretary of Energy

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

Body of Work

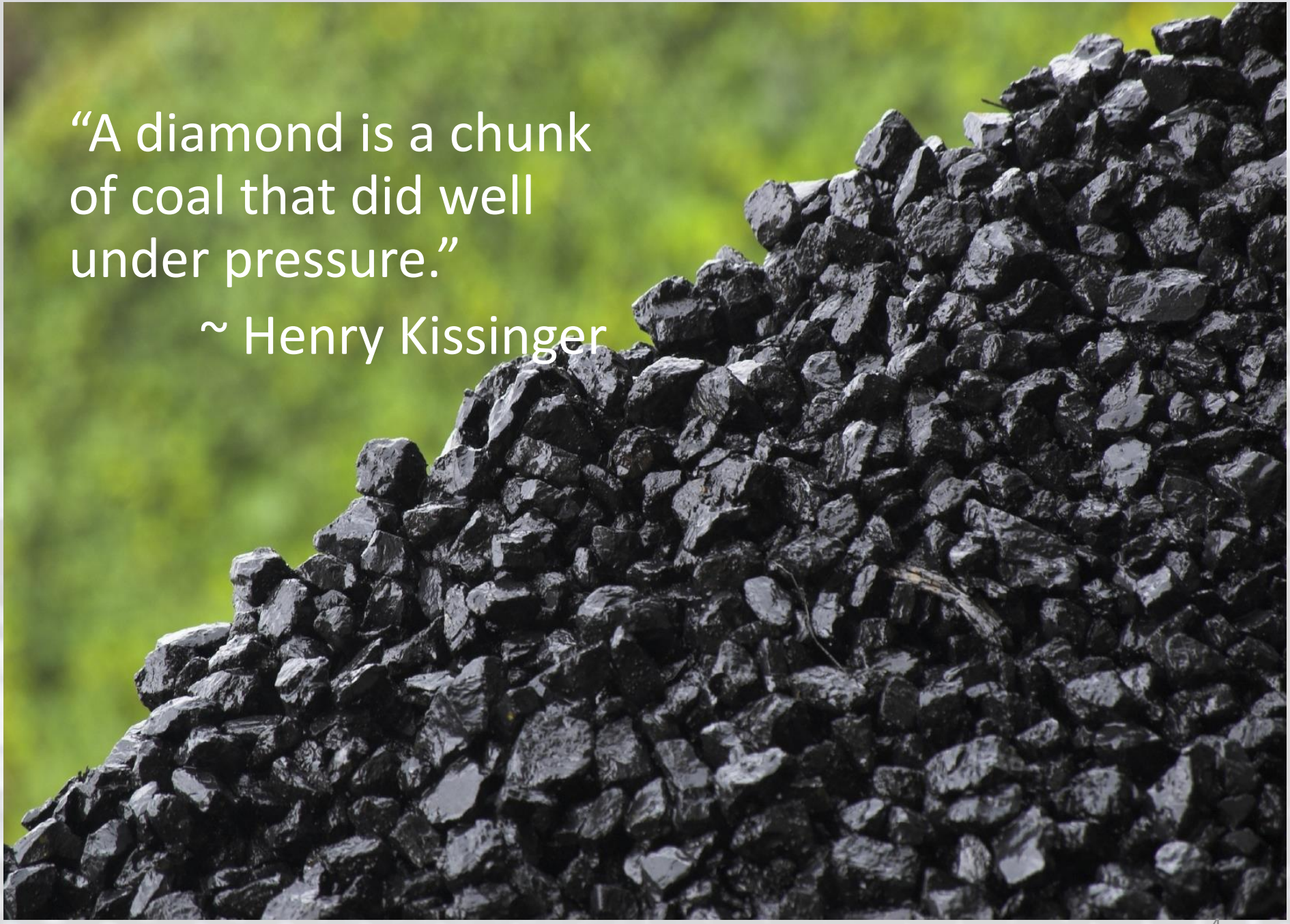
Reports

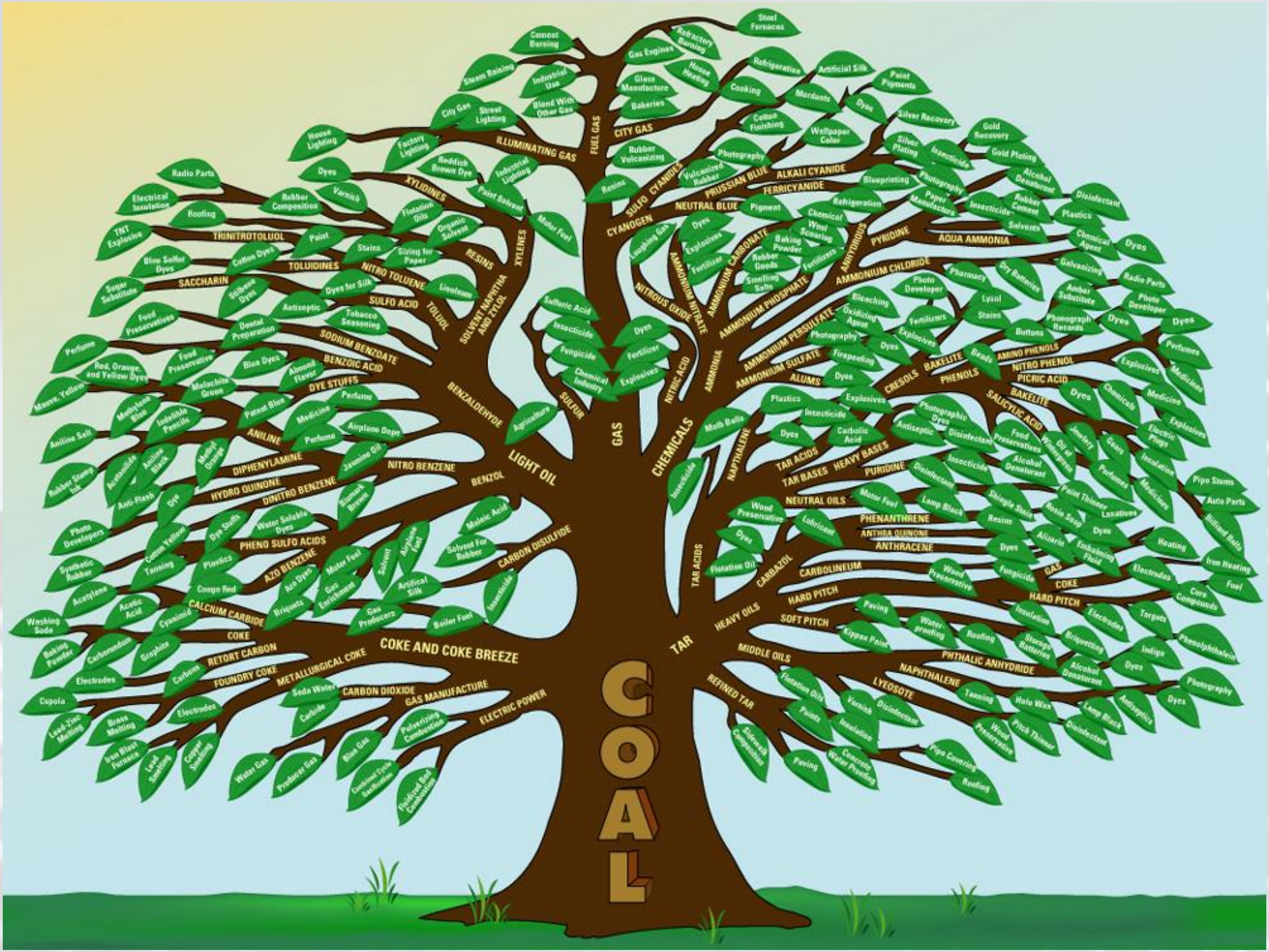
~ 35 reports prepared by NCC members at no cost to DOE

Extensive Range of Report Topics:

- Carbon Management
- Clean Coal Technologies
- Coal & Coal Technology Exports
- Coal Conversion
- Utility Deregulation
- Climate & Clean Air Regulations
- Enhancing Coal's Image
- Building New Coal Plants

- Industrial Coal Use
- CCUS for EOR
- Value of Existing Coal Fleet
- Advancing CCS Technologies
- Policy Parity for CCS
- CO_2 Utilization
- Advancing U.S. Coal Exports
- Power Reset: Existing Coal Fleet


"A diamond is a chunk of coal that did well under pressure."
~ Henry Kissinger


COAL
GAS
FUEL GAS
CITY GAS
ILLUMINATING GAS
Steel Furnaces
Cement Burning
Refractory Burning
Gas Engines
Stain Raising
Industrial Use
Glass Manufacture
House Heating
Refrigeration
Artificial Silk
Paint Pigments
Blend With Other Gas
Bakeries
Cooking
Mordants
Dyes
Silver Recovery
City Gas
Street Lighting
Cotton Finishing
Wallpaper Color
Gold Recovery
House Lighting
Factory Lighting
Rubber Vulcanizing
Photography
Silver Plating
Insecticide
Gold Plating
Radio Parts
Dyes
Reddish Brown Dye
Industrial Lighting
Resins
Vulcanized Rubber
PRUSSIAN BLUE
ALKALI CYANIDE
Alcohol Denaturant
Electrical Insulation
Varnish
Paint Solvent
SULFO CYANIDES
Sleepproofing
Photography
Disinfectant
Roofing
Rubber Composition
XYLIDINES
FERRICYANIDE
Paper Manufacture
Insecticide
Rubber Cement
Plastics
TNT Explosive
Flotation Oils
Motor Fuel
NEUTRAL BLUE
Refrigeration
Solvents
THINITROTOLUOL
Organic Solvent
CYANOGEN
Pigment
Chemical
Chemical Agent
Paint
Stains
Sizing for Paper
RESINS
XYLENES
Dyes
Wood Scouring
Dyes
Blue Sulfur Dyes
Cotton Dyes
TOLUIDINES
NITRO TOLUENE
Leaching Gas
Baking Powder
PYRIDINE
AQUA AMMONIA
Explosives
Rubber Goods
Fertilizers
Galvanizing
Sugar Substitute
SACCHARIN
Sulfone Dyes
Linoleum
Dyes for Silk
AMMONIUM CARBONATE
AMMONIUM NITRATE
AMMONIUM PHOSPHATE
AMMONIUM CHLORIDE
Fertilizer
Smelting Salts
Pharmacy
Dry Batteries
Radio Parts
Food Preservatives
Antiseptic
SULFO ACID
TOLUOL
SOLVENT NAPHTHA AND XYLOL
Sulfuric Acid
NITROUS OXIDE
Photo Developer
Amber Substitute
Tobacco Seasoning
Bleaching
Lysol
Photo Developer
Dental Preparation
Insecticide
Oxidizing Agent
Stains
Perfume
SODIUM BENZOATE
Fungicide
Dyes
Fertilizer
Fertilizers
Phonograph Records
Dyes
Food Preservative
Photography
Dyes
Explosives
Buttons
Dyes
Red, Orange, and Yellow Dyes
Blue Dyes
BENZOIC ACID
Almond Flavor
Chemical Industry
Explosives
NITRIC ACID
AMMONIA
AMMONIUM PERSULFATE
Firepowder
Beads
AMINO PHENOLS
Perfumes
Mauve, Yellow
Malachite Green
DYE STUFFS
Perfume
BENZALDEHYDE
SULFUR
AMMONIUM SULFATE
BAKELITE
NITRO PHENOL
Explosives
Medicines
Methylene Blue
Indelible Pencils
Patent Blue
Medicine
Agriculture
ALUMS
Dyes
CRESOLS
PHENOLS
PICRIC ACID
Medicine
Aniline Salt
ANILINE
Perfume
Airplane Dope
Plastics
Insecticide
Explosives
BAKELITE
SALICYLIC ACID
Dyes
Chemicals
Rubber Stamp Ink
Aniline Black
Alcohol Orange
Jasmine Oil
DIPHENYLAMINE
NITRO BENZENE
LIGHT OIL
BENZOL
CHEMICALS
Moth Balls
Dyes
Carbolic Acid
Antiseptic
Photographic Dyes
Disinfectant
Food Preservatives
Oil of Wintergreen
Jewelry
Gears
Electric Plugs
Explosives
Anti-Flash
Dye
HYDRO QUINONE
DINITRO BENZENE
Blackish Brown
NAPHTHALENE
TAR ACIDS
HEAVY BASES
Insecticide
Insulation
Pipe Stems
Auto Parts
Photo Developers
Dye Stuffs
Water Soluble Dyes
Maleic Acid
Insecticide
TAR BASES
PURIDINE
Disinfectant
Insecticide
Alcohol Denaturant
Perfumes
Medicines
Cotton Yellow
PHENO SULFO ACIDS
Solvent For Rubber
CARBON DISULFIDE
Wood Preservative
Motor Fuel
Lamp Black
Shingle Stain
Paint Thinner
Rosin Soap
Laxatives
Billiard Balls
Synthetic Rubber
Tanning
Plastics
AZO BENZENE
Motor Fuel
Solvent
Airplane Fuel
NEUTRAL OILS
Lubricant
Resins
PHENANTHRENE
ANTHRA QUINONE
Dyes
Alizarin
Dyes
Embalming Fluid
Heating
Acetylene
Congo Red
Azo Dyes
Gas Enrichment
Artificial Silk
TAR ACIDS
Flotation Oil
ANTHRACENE
Dyes
Electrodes
Iron Heating
Washing Soda
Acetic Acid
Cyanamid
CALCIUM CARBIDE
Briquets
Gas Producers
Insecticide
CARBAZOL
CARBOLINEUM
Wood Preservative
Fungicide
GAS
COKE
Fuel
Baking Powder
Carborundum
Graphite
COKE
Boiler Fuel
HEAVY OILS
HARD PITCH
Paving
Insulation
HARD PITCH
Electrodes
Targets
Cera Compounds
Electrodes
Carbons
RETORT CARBON
COKE AND COKE BREEZE
TAR
SOFT PITCH
Kippse Point
Water-proofing
Roofing
Storage Batteries
Briquettes
Indigo
Phenolphthalein
Cupola
FOUNDRY COKE
METALLURGICAL COKE
MIDDLE OILS
PHTHALIC ANHYDRIDE
Alcohol Denaturant
Dyes
Lead-Zinc Melting
Brass Melting
Electrodes
Soda Water
CARBON DIOXIDE
GAS MANUFACTURE
REFINED TAR
NAPHTHALENE
LYEOSOTE
Flotation Oils
Tanning
Halo Wax
Photography
Iron Blast Furnace
Lead Smelting
Copper Smelting
Carbide
ELECTRIC POWER
Pulverizing Combustion
Paints
Varnish
Insulation
Disinfectant
Wood Preservative
Pitch Thinner
Lamp Black
Antiseptics
Dyes
Disinfectant
Water Gas
Producer Gas
Blue Gas
Continuous Cycle Distillation
Fluidized Bed Combustion
Sidewalk Compositions
Paving
Concrete Water Proofing
Pipe Covering
Roofing

Coal in a New Carbon Age

The Secretary of Energy
Washington, DC 20585

August 31, 2018

Mr. Deck Slone
Chairman, The National Coal Council
1000 Independence Avenue SW, Room 4G-036
Washington, DC 20585

Dear Chairman Slone:

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 (value-added non-Btu products); rare earth elements; coal combustion products, methanol; biotechnology approaches (agriculture, liquid fuels); and beneficiated 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 now that can be addressed with new markets for coal?
- Considering the current uses for coal overseas (syngas, chemicals, synthetic oil, transportation fuels, etc.), where and how are these markets operating 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 CO_2) be developed similar to those underway in other countries?

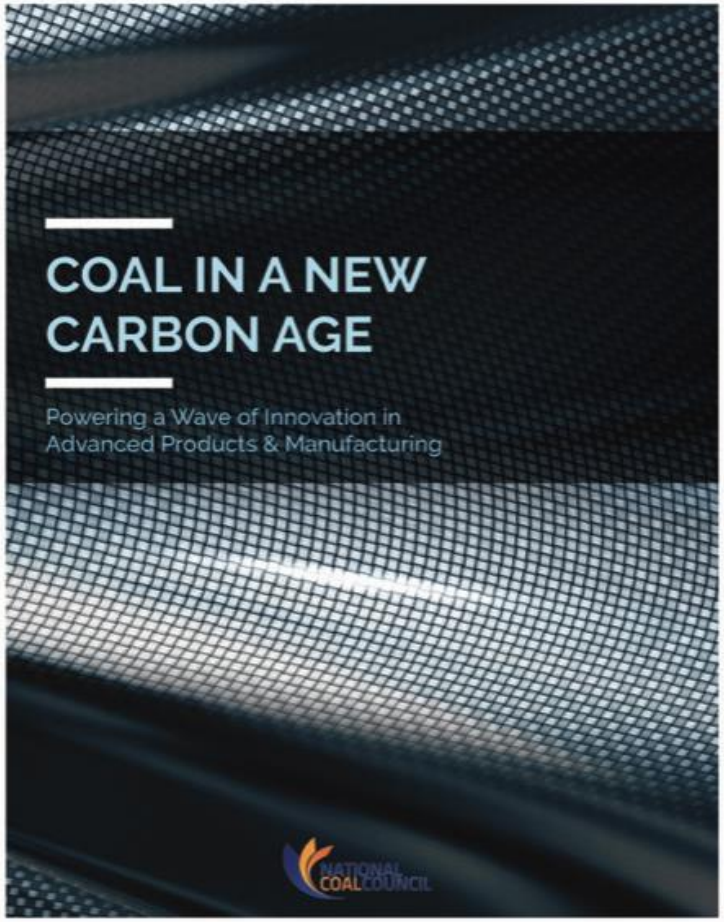
The white paper should be managed under the auspices of the Executive Advisory Board within the NCC. I ask that the white paper be completed no later than April 12, 2019.

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

Sincerely,

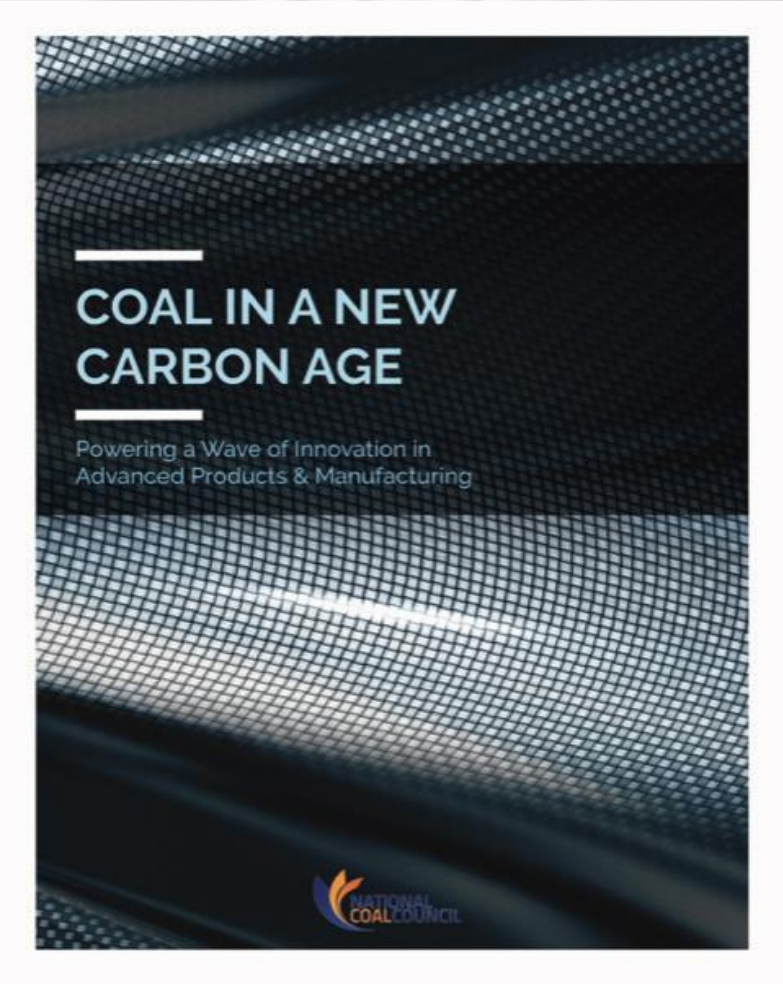
Rick Perry

Rick Perry

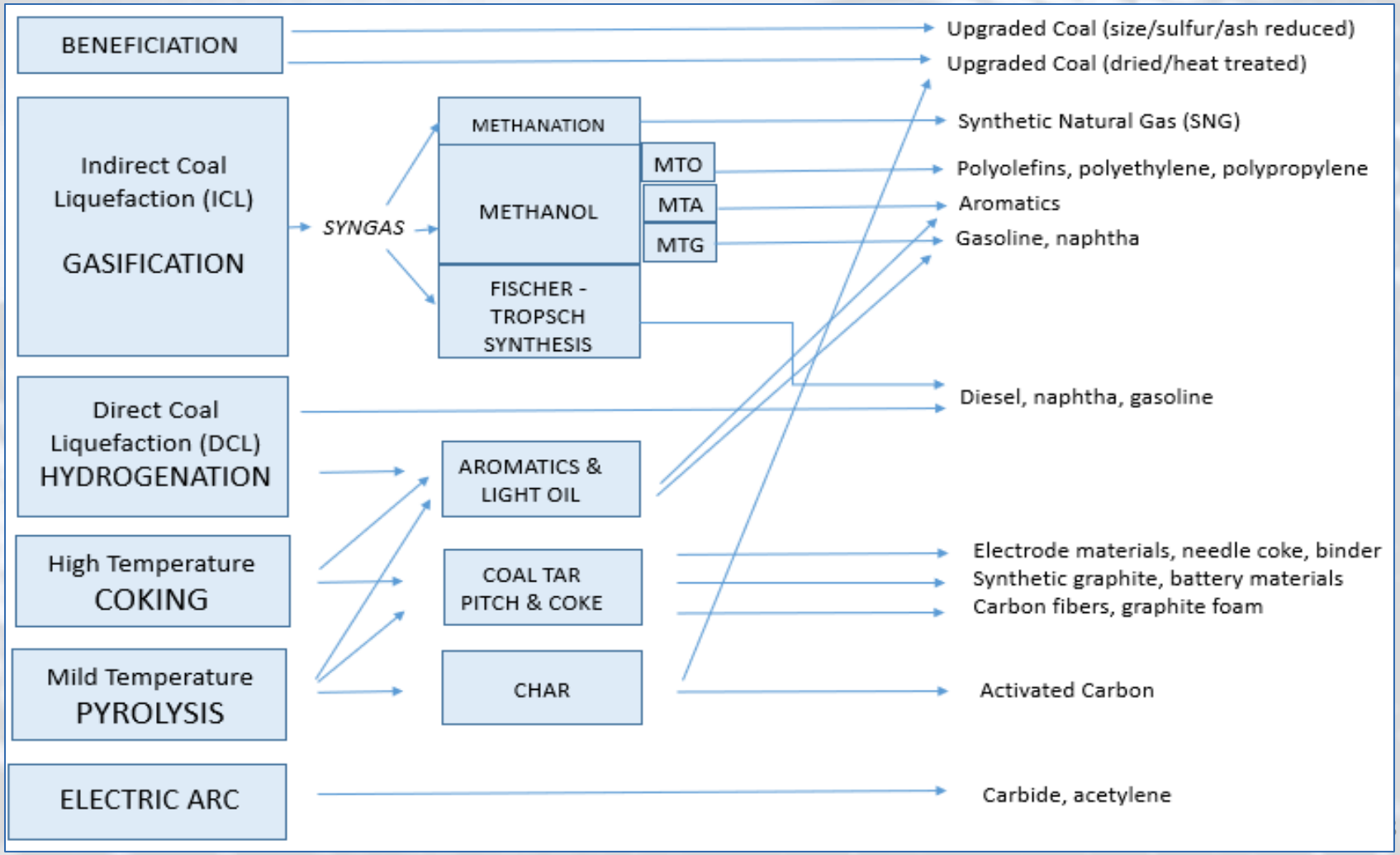


Coal in a New Carbon Age

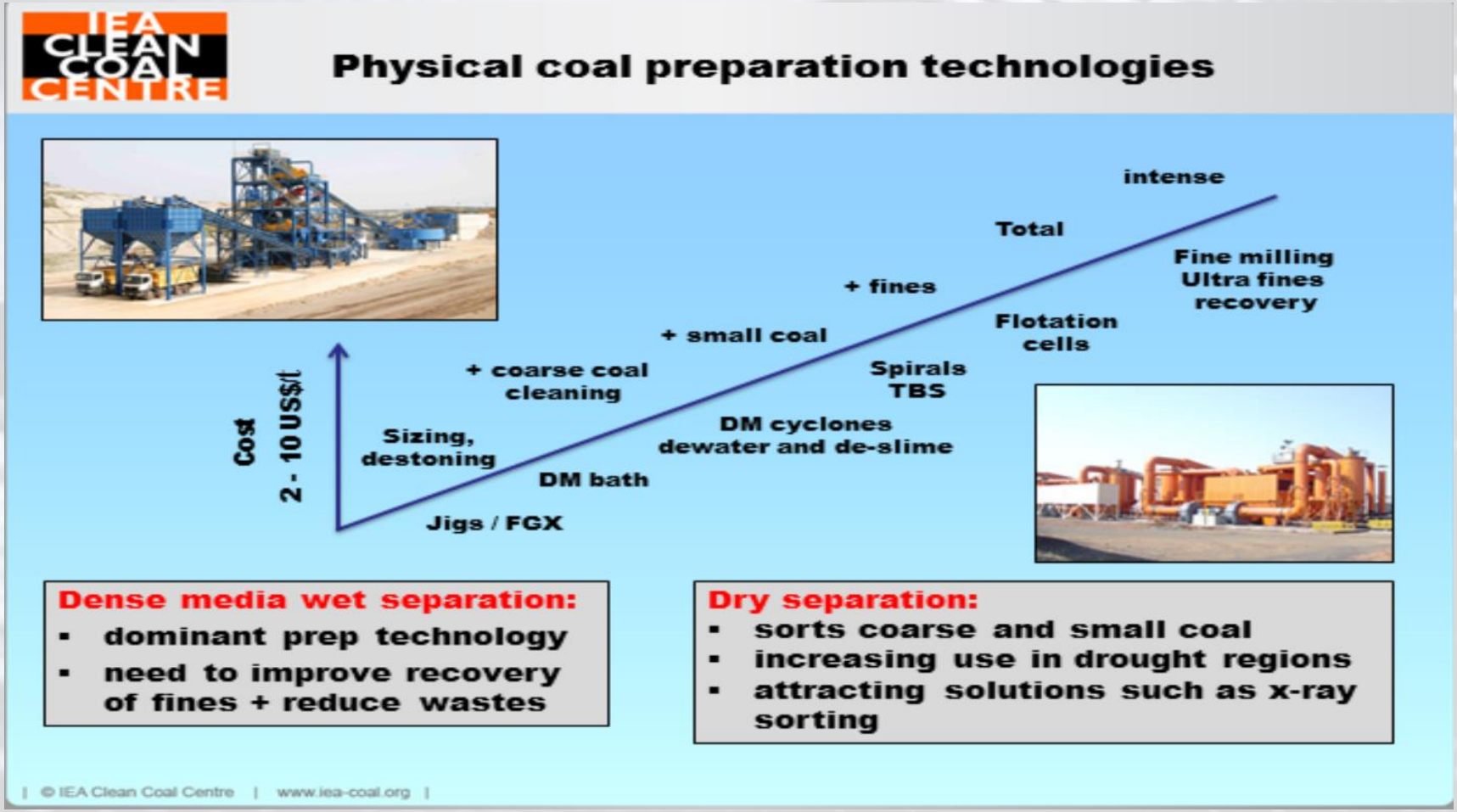
- The Value of Advancing New Markets for Coal
- International Activity
- U.S. Historical Efforts
- Trends & Outlook for Coal-Derived Products in the U.S.
- Recommendations
- + Technology Compendium Appendix



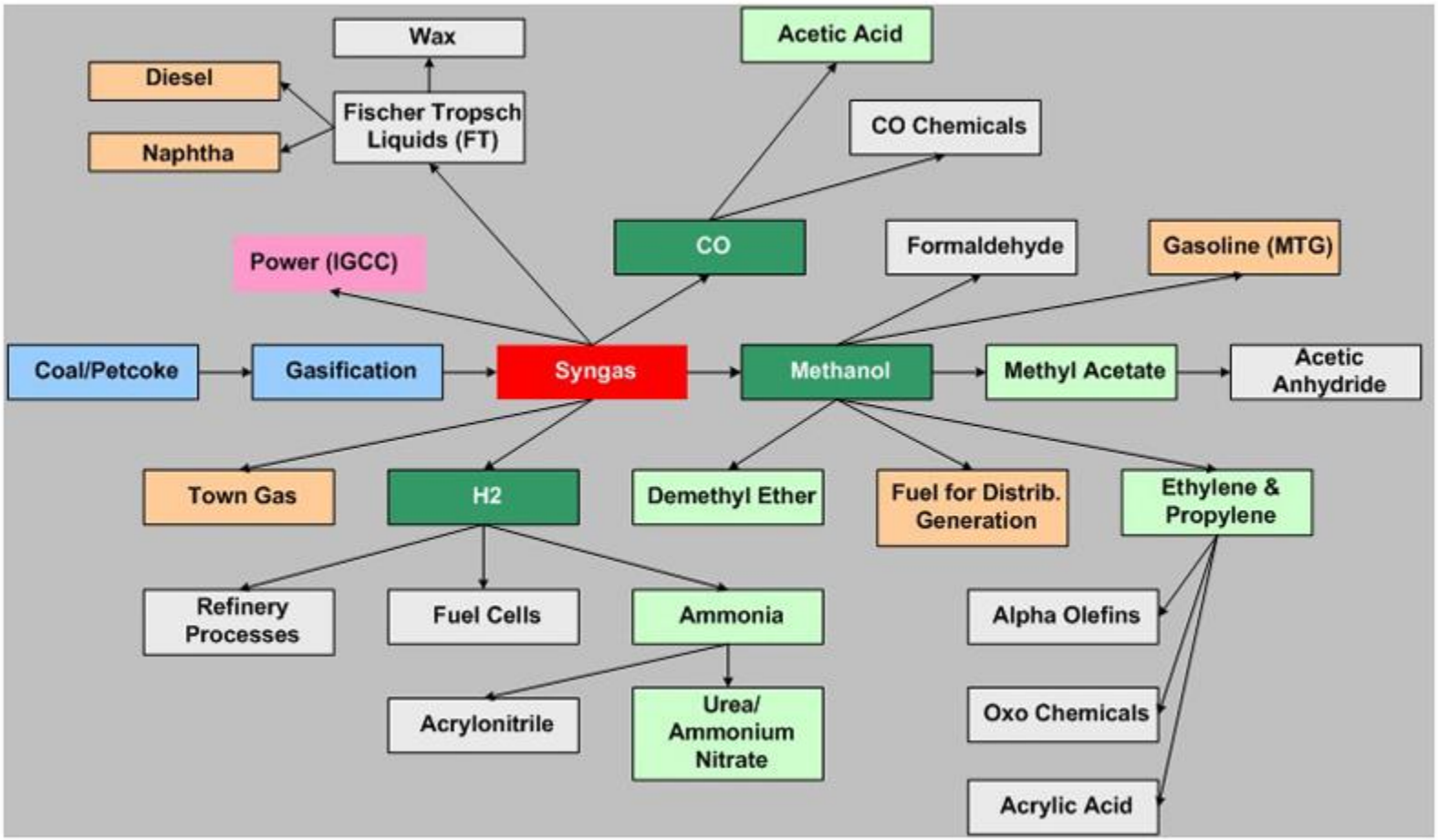
Coal-to-Products



Coal Beneficiation

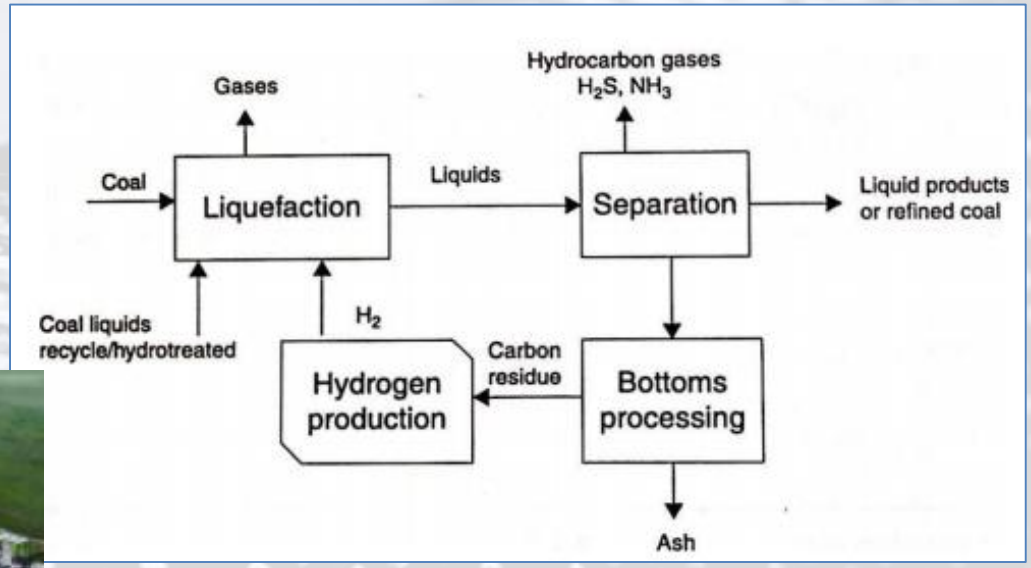


Coal to Liquids
Coal to Chemicals



Gasification-Based Coal to Chemicals Process

Coal to Liquids
Coal to Fuels



Typical Direct Coal Liquefaction Process

Coal to Products

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

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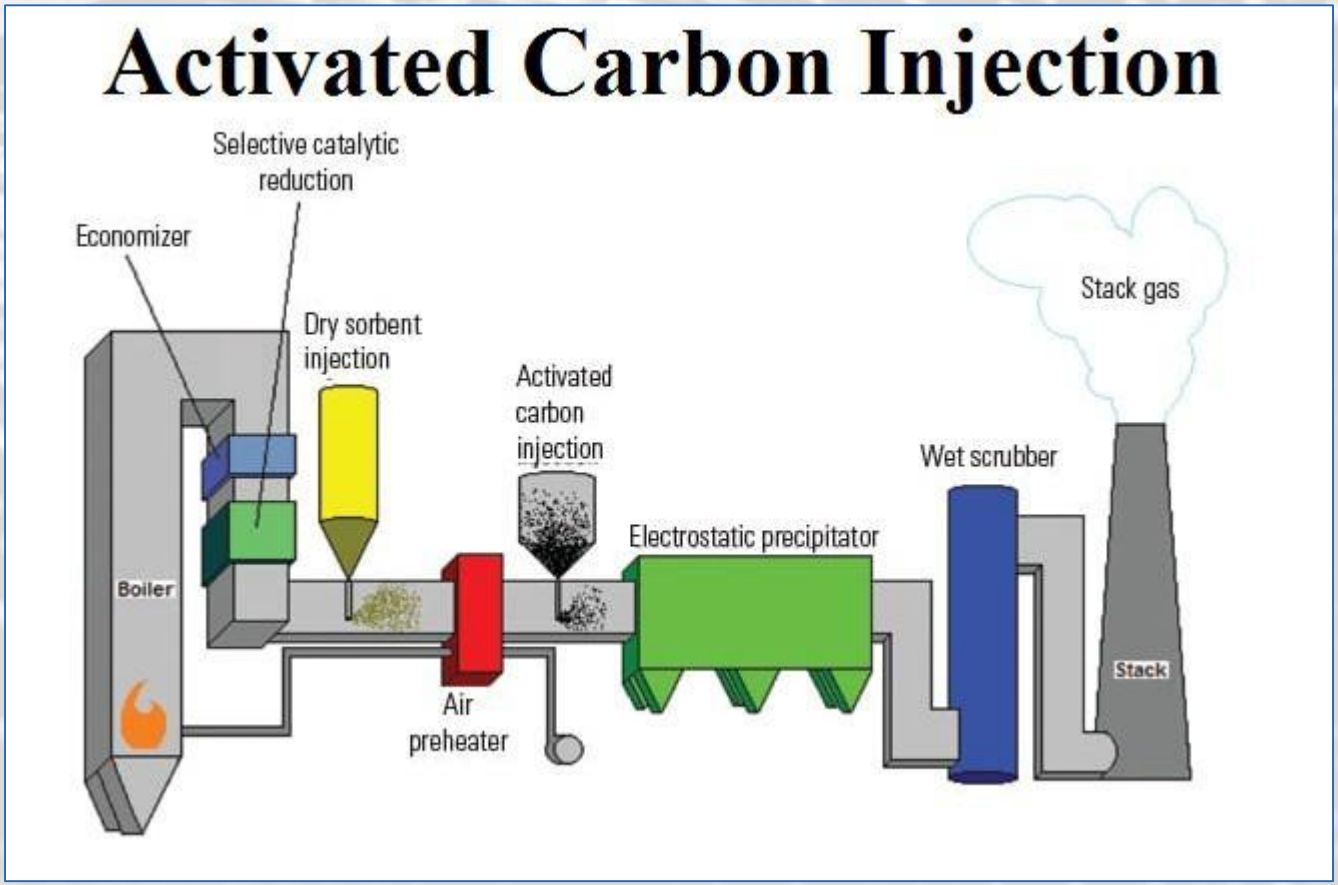
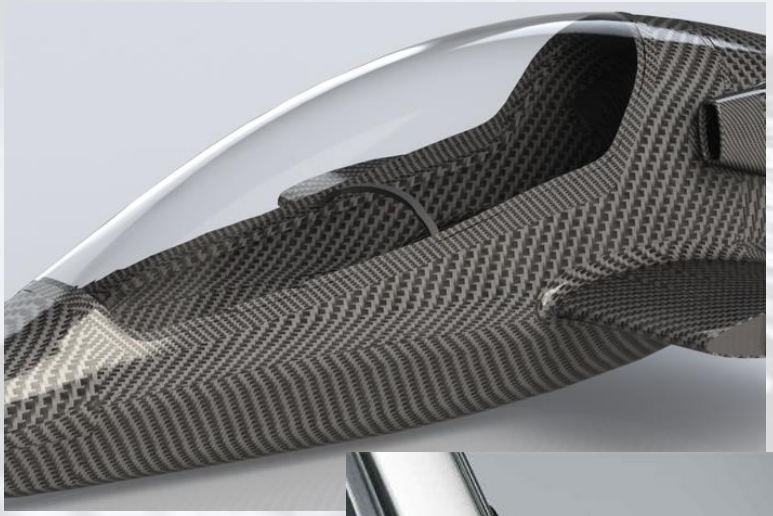
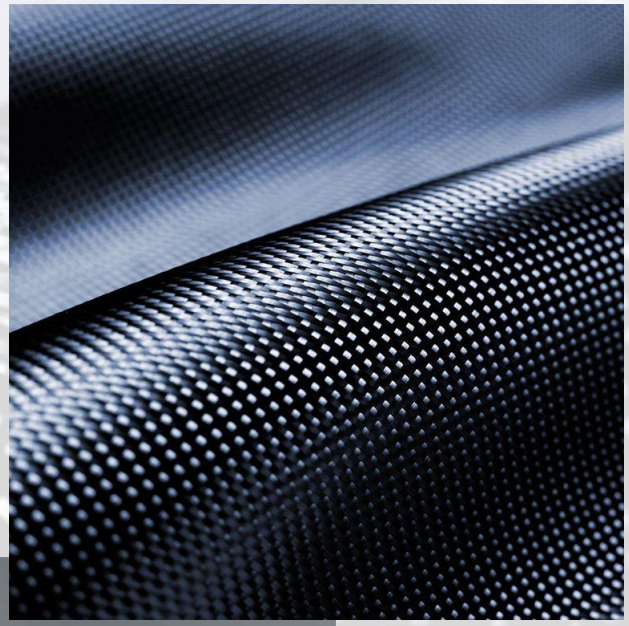
- Electrodes
- Seals & bearings
- Fishing rods
- Golf clubs
- Automotive materials
- Airplane fuselages
- Building materials
- Water purification

Activated Carbon

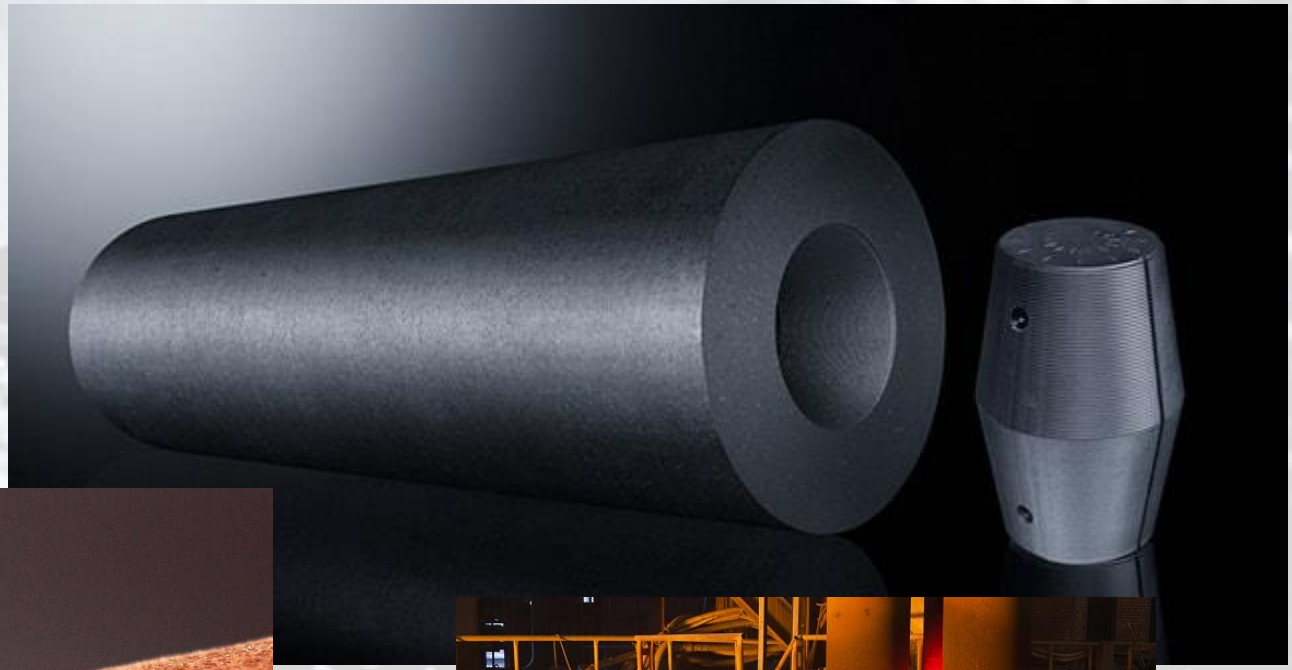


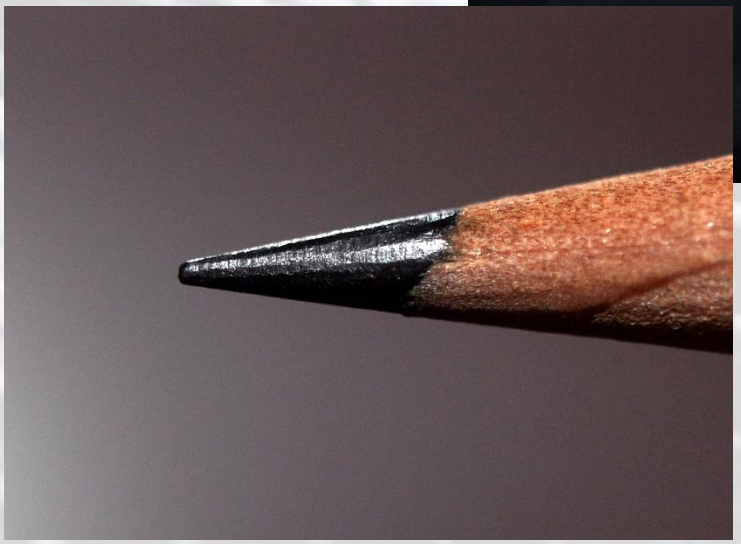
Carbon Fiber



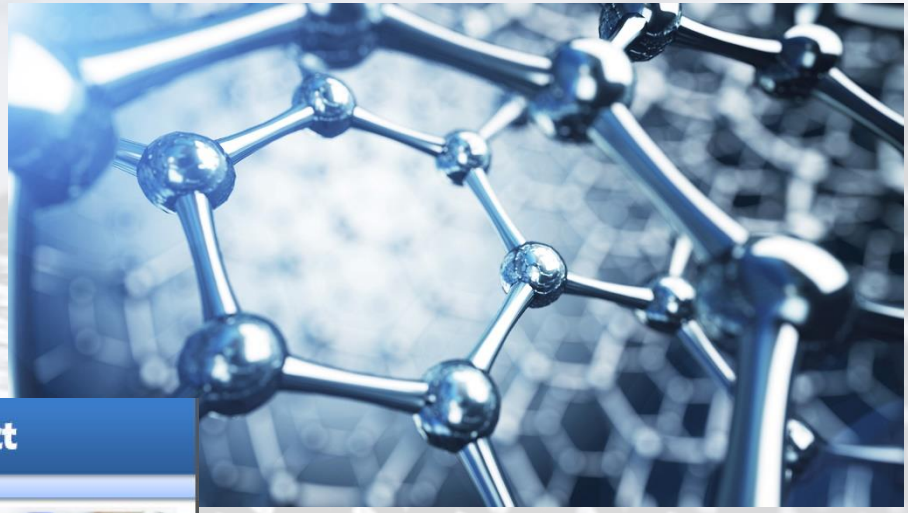


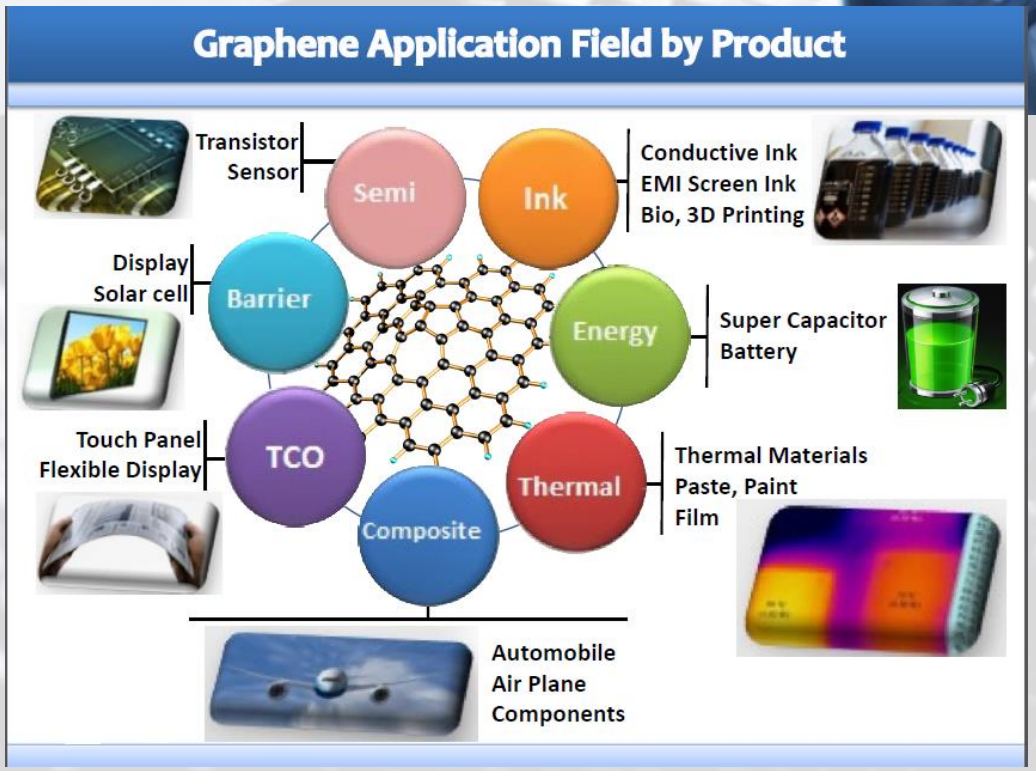
Carbon to Graphite & Electrodes



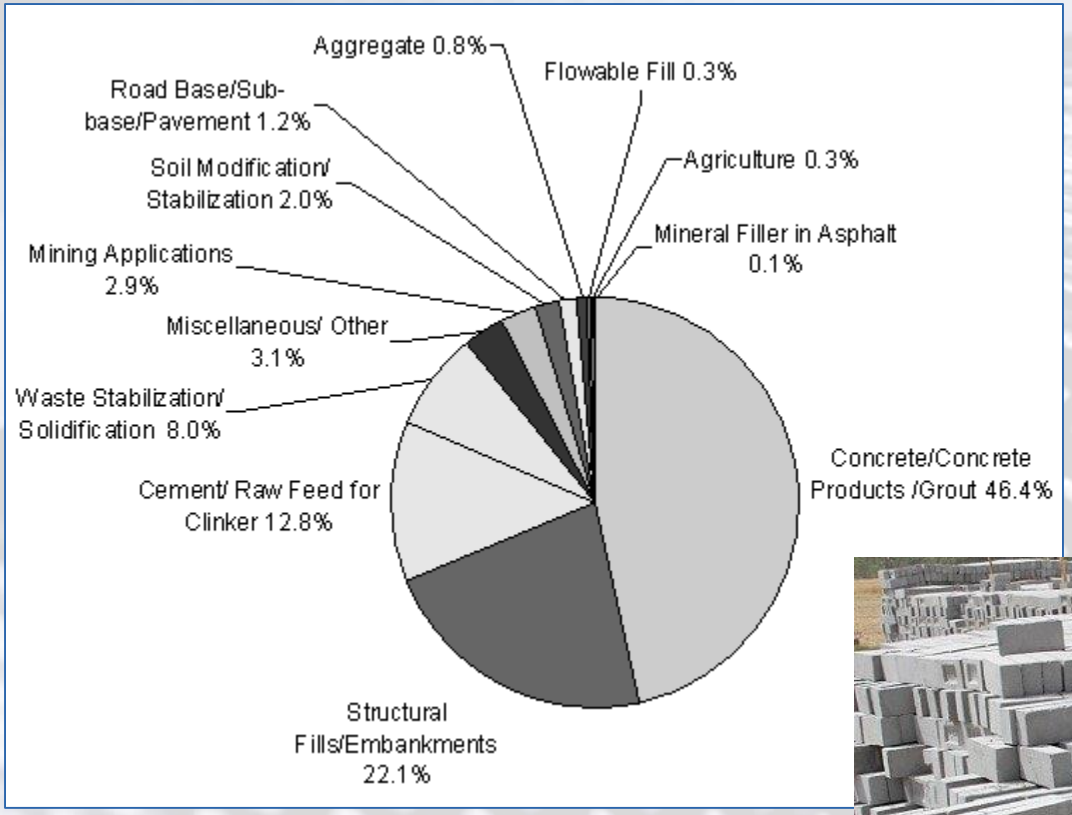


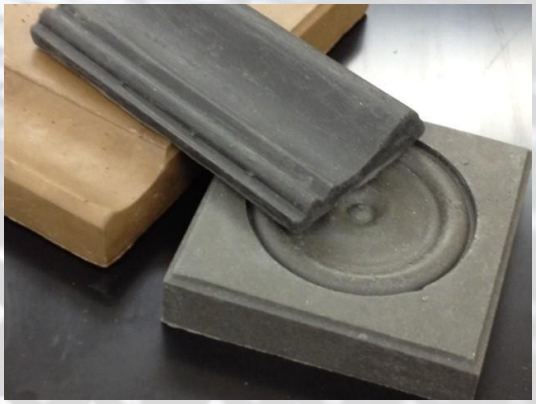
Graphene



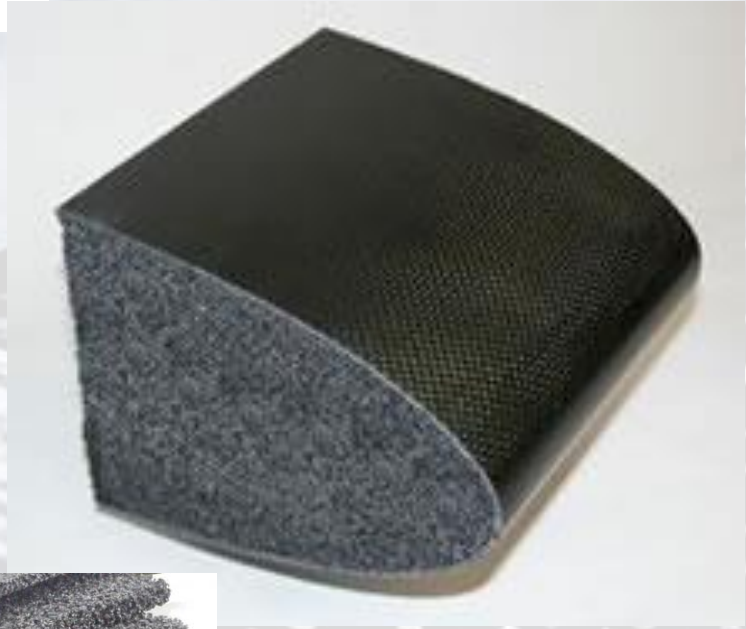

Graphene Application Field by Product
Semi
Transistor
Sensor
Ink
Conductive Ink
EMI Screen Ink
Bio, 3D Printing
Barrier
Display
Solar cell
Energy
Super Capacitor
Battery
TCO
Touch Panel
Flexible Display
Thermal
Thermal Materials
Paste, Paint
Film
Composite
Automobile
Air Plane
Components

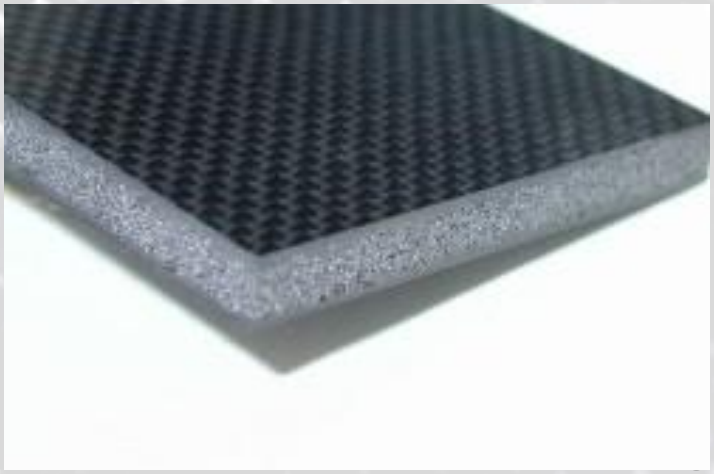
Building Materials



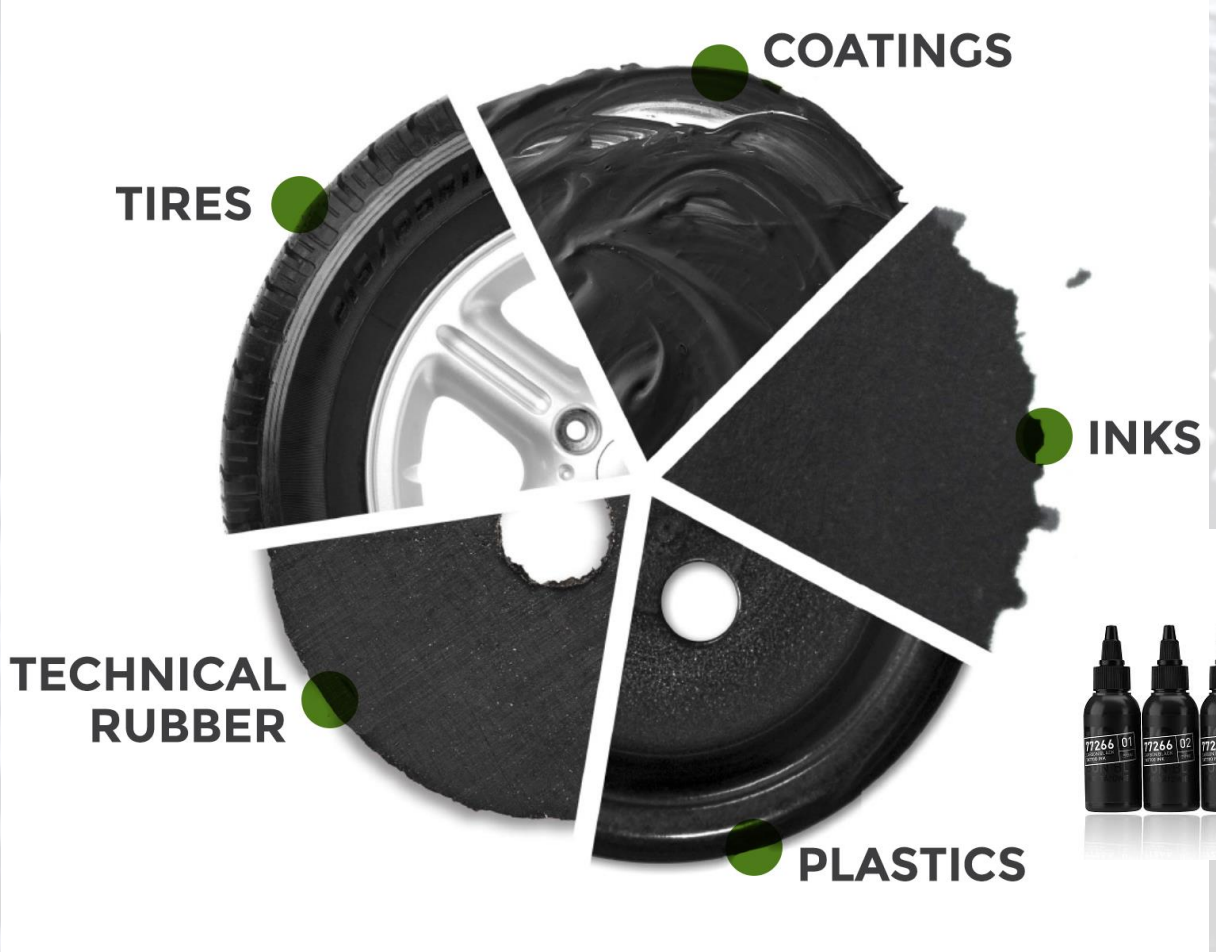


Carbon Foam





Carbon Black



Rare Earth Elements

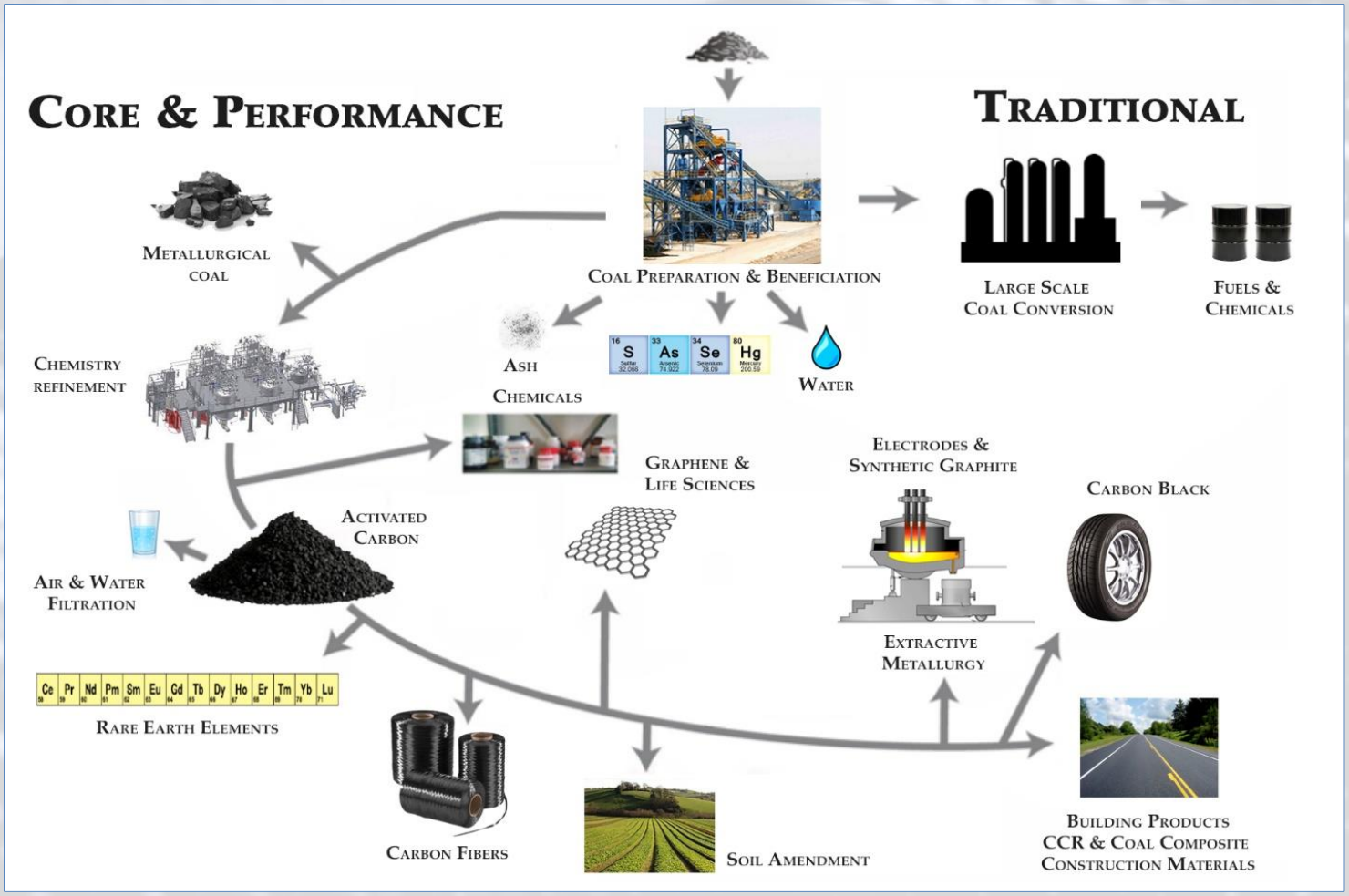
The Rare Earth Value Chain

Raw Materials	Basic Rare Earth Materials	Engineered Rare Earth Materials	Component & Systems	End Market Products & Technologies
Bastnäsite Monazite Ionic Clays Other	Separated Rare Earth Oxides, Carbonates, Oxylates, Chlorides, & Nitrates Rare Earth Mixed Oxides Rare Earth Metals Other	Rare Earth Alloys Magnets & Magnetic Powders Catalysts Metallurgical Additives Polishing Powders Phosphors Glass Additives Ceramics Water Purification Chemicals Other	Batteries Controls Drives Fabricated Metal Products Lasers Motors & Generators Sensors Transducers Other Systems & Components	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

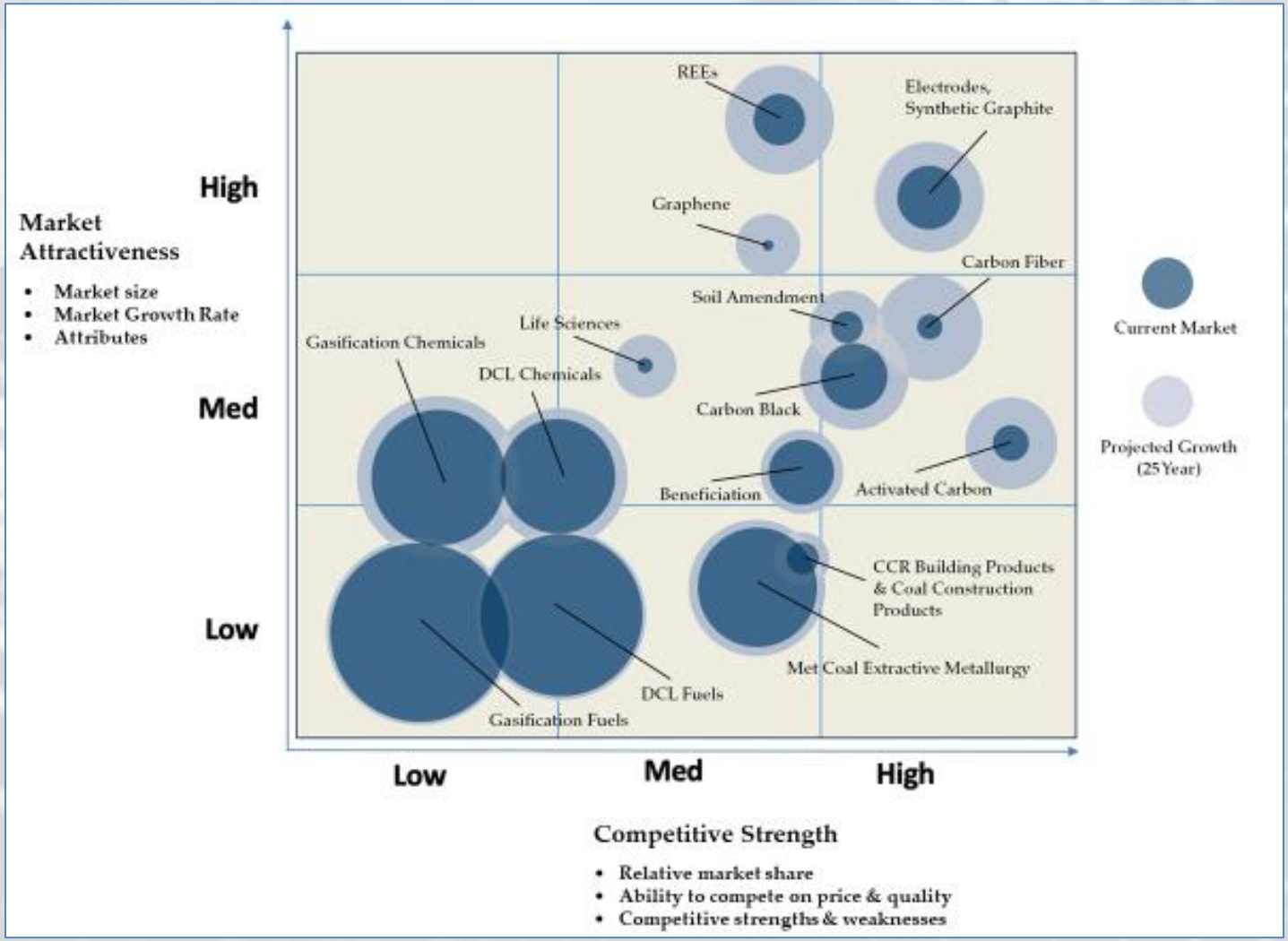
Life Sciences & Medical

Soil Amendments – Humic Acid/Humate

Market Sectors



Nine Block Analysis



NATIONAL COAL COUNCIL

Value of New Markets for Coal

Coal Rocks

Country	Million Tonnes	Share
U.S	258,709	25.0%
Russia	160,364	15.5%
Australia	144,918	14.0%
China	139,919	13.5%
India	97,728	9.4%
Germany	36,100	3.5%
Ukraine	34,375	3.3%
Poland	25,811	2.5%
Kazakhstan	25,605	2.5%
Indonesia	22,598	2.2%
Other	88,885	8.6%
Total	**1,035,012**	**100.0%**

Source: BP Statistical Review of World Energy, June 2017

Global Coal Reserves

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