NARUC Winter Policy Summit

Electricity Committee

Subcommittee on Clean Coal and Carbon Management

May 2017: Longview Power Site Visit

- Subcommittee visited Longview Power LLC, a 700 MW coal-fired generating station outside Morgantown, WV
- Newest, cleanest, most efficient coal-fired power plant in the PJM territory with best-in-class heat rate of 8,842 Btu/kWh
- Mine-mouth design brings coal from a 4.5-mile conveyer belt
- $2 billion investment providing over 600 jobs
- Advanced supercritical boiler helps Longview attain the lowest cost of dispatch of any coal-fired power plant in PJM

May 2017: NETL Site Visit

- Subcommittee visited the National Energy Technology Lab in Morgantown, WV
- Commissioners spoke with NETL Director and research portfolio managers from multiple offices
- Topics included rare earth elements, carbon sequestration, carbon capture and reuse, advanced turbines, gasification, supercritical power cycles, economic modeling, and crosscutting R&D programs

September 2017: Petra Nova site visit

- Subcommittee members toured the Petra Nova carbon capture for enhanced oil recovery project at W.A. Parish Plant outside Houston, TX
- Commercial-scale, post-combustion carbon capture technology
- Captures 90% of CO_2 from a 240 MW slipstream of flue gas
- Compressed CO_2 is transported 80 miles via pipeline for enhanced oil recovery at an oilfield, providing financial support

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May 16 – 18, 2018: North Dakota Site Visit

- Commissioners will travel to Bismarck, ND
- Group will tour Coal Creek Station, state's largest lignite-fired power plant
- Members will also see the Great Plains Synfuels Plant, the country's only coal-to-synthetic natural gas facility
- Opportunities to connect with the Lignite Energy Council and the Univ. of North Dakota's Energy & Environmental Research Center, led by former ND commissioner Brian Kalk
- Travel assistance available to commissioners thanks to support from the U.S. Department of Energy (first-come first-serve basis)

Sept. 5 – 7, 2018: Wyoming Site Visit

- Commissioners will tour the state's Integrated Test Center, where Xprize research teams are competing to develop new uses for captured carbon dioxide
- Opportunities to visit some of the largest coal mines in the country
- Travel assistance available thanks to U.S. DOE

Other Activities

- Subcommittee calls, webcasts, and panels at NARUC meetings with experts from the public and private sectors
- Research papers to answer commissioner and commission staff questions about the latest developments in coal-fired generation and carbon capture technology
- Recruiting new members for 2018

Modular Gasification – New Markets for Coal Use

NARUC Winter Policy Summit
Feb. 12, 2018

David Lyons
Technology Manager, Gasification Systems and
Coal & Coal-Biomass to Liquids

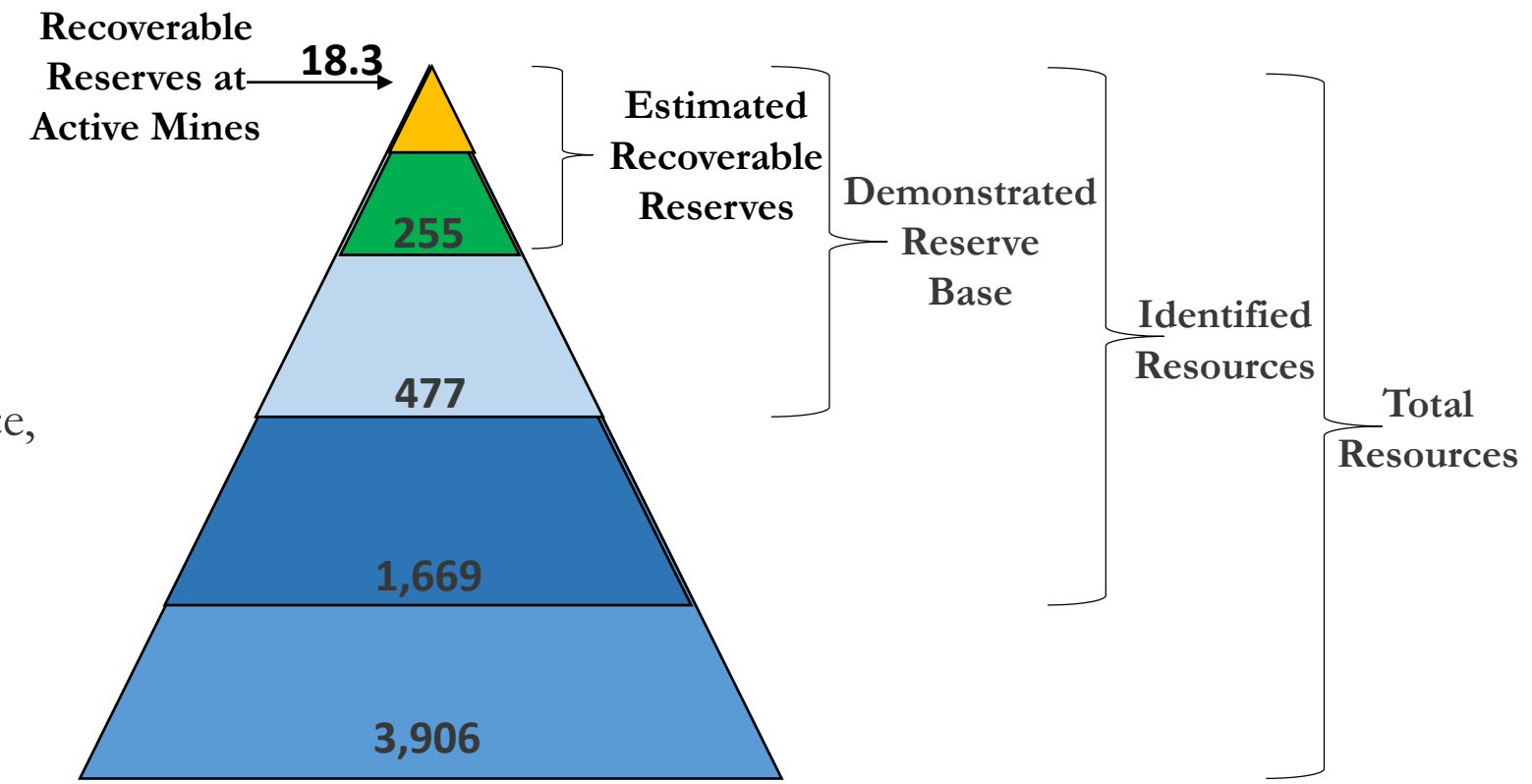
Why the Interest in Coal Gasification?

U.S. Has A Lot of Coal!

Energy Diversity and Security

Gasification can:

- ✓ Convert coal to power
- ✓ Convert coal to valuable products (chemicals/fuels)
- ✓ Superior environmental performance, including GHG
- ✓ Feasible for carbon capture



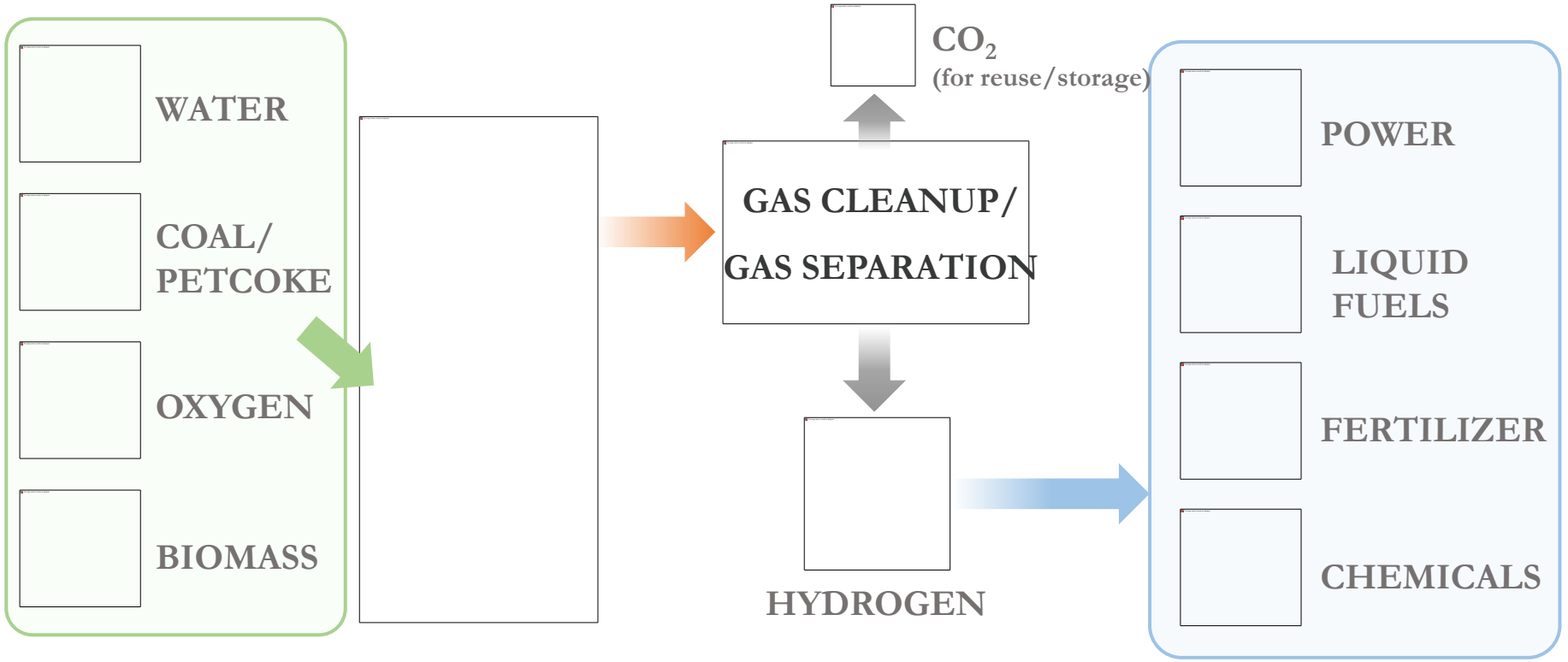
U.S. Coal Resources
billion short tons

https://www.eia.gov/energyexplained/index.cfm?page=coal_reserves

Benefits and Products of Gasification

Gasification can be

- Used to make: hydrogen, fertilizer, chemicals (methanol, plastics, etc.) and transportation fuels
- Lowest cost option to make power with almost total carbon dioxide (CO_2) capture and storage



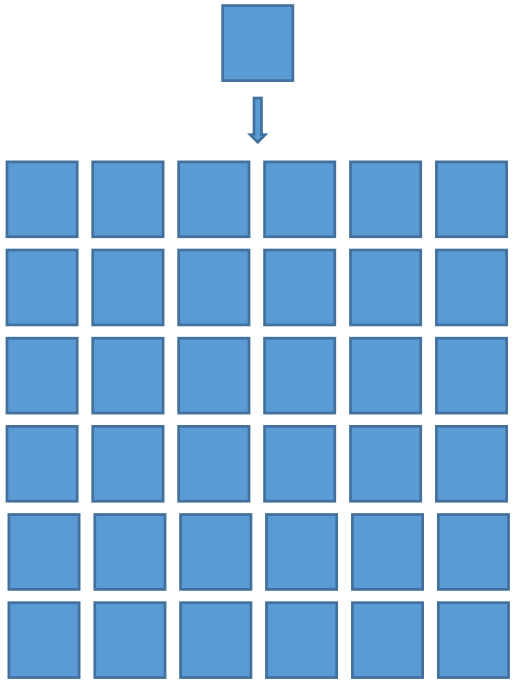
Gasification can play in the global market, including developing countries

Modular/Small Scale Approach

- Identify emerging markets for coal via modular/small scale technology implementation
- Perform cold flow tests & perform system analyses
- Determine what manufacturing & balance-of-plant R&D can reduce capital costs

NETL-Internal Research Strategy: develop a software toolbox for unit operation & plant optimization, component characterization, advanced manufacturing, solid/liquid carbon capture & re-use, and performance modeling via systems analysis. The toolbox will lower the risk and cost of implementation.

Modular Approach
Revolutionary Engineering



Potential Economic Benefits of Modular/Small Scale

Results of early screening study

Location	Available Fuels	Primary Need	Possible Markets
Rural Alaska	• Subbituminous coal • Woody biomass (southern region) • Peat (northern region) • MSW?	• COE reduction • Transport/heating fuel cost • Job creation • GHG reduction	• Diesel – make use currently available infrastructure • Power
Rural Appalachia	• Bituminous coal • Woody biomass • Natural gas • MSW or prep plant coal fines	• Job creation • Increased coal sales • GHG reduction	• Chemicals • Tar • Power Plants
Rural Southwest U.S.	Solar + • Subbituminous coal • Bituminous coal	• Lower-cost power w/o transmission line expense	• Power • DC Micro-grid
U.S. Military Installations	• Biomass • Fossil Fuels • MSW	• Meet lifecycle GHG requirements of EISA 2007 §526 • Supply fuel/power w/o power lines	• Jet fuel • Power (both for bases and humanitarian aid needs)

Questions?

Thank You

Additional Slides

Financial Assistance Projects Awarded in FY17

- DOE/NETL selected 9 projects to support the development of advanced technologies that will foster early adoption of small-scale modular coal-gasification.

- Focus on the development of emerging gasification technologies that can be scaled down to modularization to support program goals using the modular/small scale concept.

- Total DOE funding: ~$16M.

Advance Syngas Cleanup for REMS

Research Triangle Institute-FE0031522

Project Strategy

Address knowledge gaps to develop modular sorbent-based warm syngas cleanup to be cost-competitive with state-of-the-art commercial plants.

Objectives

- Expand experimental database for sorbent desulfurization of low-sulfur syngas
- Determine lowest cost design

Scope of Work

- Develop potential desulfurization process designs for coal gasification CHP or polygeneration
- Develop fixed-bed sorbent formulation and fixed-bed process design

Small Scale Engineered High Flexibility Gasifier

Southern Research Institute-FE0031531

Project Strategy

Develop modular pressurized oxygen-blown gasifier that is simple to operate and minimizes tar production.

Objective

Use mathematical model to guide engineering design, construction, and pilot-scale testing.

Scope of Work

Implement experimental test plan to optimize gasifier performance and simulate a 1-5 MW power generation system.

Benefits

- Reduce coal conversion cost via a modular system
- Feed flexibility optimizing syngas make and quality
- Flexibly for site specific-needs

Staged OMB for Modular Gasifier/Burner

University of Kentucky-FE0031506

Project Strategy

Test a staged opposed multi-burner (OMB) gasifier for a modular version of a commercial gasification technology.

Objective

- Test staged-OMB utilizing coal slurry feed for high-temperature gasification.
- Standardize burner design

Benefits

- Loading flexibility
- Improved fuel conversion/gasification efficiency
- Prolonged refractory/burner service life
- Demonstrate potential system gain
- Standardized burner

Radically Engineered Modular Air Separation System using Tailored Oxygen Sorbents

Project Strategy

Development of modular coal gasifiers with reduced capital cost and energy consumption.

Scope of Work

Demonstrate REM-ASU technology at pilot-scale to generate data for commercial implementation.

Benefits

- Advanced O_2 sorbent capacity and high activity
- Oxygen generation without a vacuum desorption step
- Modular ASU that can be readily integrated
- Validate feasibility to enable future commercial sector implementation

Pilot Testing of a Modular Oxygen Production System Using O_2 Binding Adsorbents

Research Triangle Institute-FE0031527

Project Strategy

Design, fabricate, and test a modular O_2 production system.

Objective

O_2-purity >95% at cost equal/less than current commercial system.

Scope of Work

- Optimization/scale-up O_2 binding adsorbent
- Optimize pressure swing adsorption process
- Develop simulation tools
- Determine O_2 production cost

Benefits

- 99% pure O_2 for modular applications
- Reduced air separation cost
- Reduced product cost

Making Coal Relevant for Small Scale Applications: Modular Gasification for Syngas/Engine CHP Applications in Challenging Environments

University of Alaska Fairbanks-FE003146

Project Strategy

Provide analysis to prepare a modular Front-End Engineering and Design (FEED).

Objective

Develop cost estimates to examine potential for modular/small-scale coal gasification units.

Scope of Work

- Design gasifier, cleanup train, and plant modification components/systems
- Perform FEED level cost estimation

Benefits

- Non-baseload applications/distributed generation.
- Reduced manufacturing costs

Gasification CHP from Coal Fines

University of Kentucky-FE0031520

Project Strategy

Complete front-end engineering design (FEED) study for a 5 MWe equivalent polygeneration plant utilizing waste coal fines and biomass.

Objective

Identify appropriate main components (technology selection and operating conditions.

Scope of Work

- Complete design basis, including site visits, feedstock, and slurry characterization
- Complete a preliminary polygeneration process design
- Determine economic viability

Benefits

- Monetize coal impoundment and reduce environmental impact
- Template to spear development in coal community

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