An Assessment of Measures to Improve Reliability and Efficiency While Reducing Emissions

American Coal Council
Coal Q&A Webcast
June 19, 2014
The National Coal Council provides advice and recommendations to the Secretary of Energy on general policy matters relating to coal and the coal industry.

NCC is a Federal Advisory Committee organized under FACA legislation.
NCC Membership

Members are federally appointed; approved to serve by the Secretary of Energy

110-125 members

- **Industry** – coal suppliers, utility & industrial consumers & coal transportation
- **Support Services** – engineering firms, vendors, consultants & attorneys
- **Academics**
- **NGOs** – environmental & trade association reps
- **Government** – PUC & state energy officials

Celebrating 30 years ~ 1984|2014
NCC Studies

• Over 30 studies conducted for Secretary 1984|2014

• Extensive Range of Topics
  • Carbon Management
  • Clean Coal Technologies
  • Coal & Coal Technology Exports
  • Coal Conversion
  • Coal’s Image
  • Utility Deregulation
  • Climate & Clean Air Regulations
  • Building New Coal Power Plants
  • Industrial Coal Use
  • Externalities
  • Interstate Transmission
  • CCUS for EOR

Studies prepared by NCC members, at no cost to DOE.
Reliable & Resilient
The Value of Our Existing Coal Fleet

Study Conducted January-May 2014; Approved by NCC Members ~ May 14, 2014
Secretary Moniz’s Request

“What can industry and the Department of Energy, separately and jointly, do to facilitate enhancing the capacity, efficiency and emissions profiles of the existing coal generation fleet in the United States through application of new and advanced technology? Such a study would also address the jobs implications of modification and addition of equipment at existing coal fired power plants.”

January 31st, 2014
Study at a Glance

A. Executive Summary
B. The Role/Benefits of the Existing Coal Fleet
C. Changes that Could Impact Future Benefits from the Existing Coal Fleet
D. Technology Responses to Maximize Future Benefits to Society
   • Reliability & Flexibility
   • Efficiency
   • Emissions Reductions

+ Bonus Section – The 2014 Polar Vortex

< 90 pages
Polar Vortex 2014

“This country did not just dodge a bullet – we dodged a cannonball.”
Nick Akins, CEO, American Electric Power
Polar Vortex 2014

“89% of our coal capacity slated for retirement in mid-2015 is called upon and running. Natural gas delivery is challenged.”

Nick Akins, CEO, AEP

At least 75% of Southern Company’s coal power plants scheduled to soon close was need to meet consumer demand.

At one point about 75% of New England’s gas generating capacity was not operating due to lack of supply or high prices.

The TVA set new records for electricity demand at the same time that many of its coal-fired units are scheduled for closure.

“We really counted on a combination of coal and gas and nuclear and pump storage and hydro, we needed every bit of it.”

Lynn Good, CEO, Duke Energy

The value of the existing coal fleet is not an abstract concept.

At a time of great stress on power demand in Jan/Feb 2014, coal produced 92% of the increase in U.S. electricity generation, relative to Jan/Feb 2013.
Profile of Existing Coal Fleet

Profile of the Existing Fleet – 310 GW
Role/Benefits of Coal Fleet

What is the value of the coal fleet?

- Energy Security
  - Coal units are immune to weather
  - Coal units are less interesting “targets”

- Portfolio Value
  - Diversity of generation
  - Fundamental element of risk management

- Direct & Macro-economic Benefits
- Supply & Price Stability Benefits
- Environmental Benefits
- Jobs Benefits
Role/Benefits of Coal Fleet

Value of Existing Coal Fleet: Electricity Cost Savings
(20 year total = $1400 Billion)

Annual Value = Average Coal Generation for 2008-12 x (Cost of new NGCC generation/MWh - Cost of existing coal generation/MWh)

NOTE: Total U.S. Electricity sales in 2011 = $371 billion.

Source: Technology cost, projected fuel cost, and electricity generation data were taken from DOE/EIA AEO-2013.
Role/Benefits of Coal Fleet

Supply & Price Stability Benefits
Role/Benefits of Coal Fleet

Clean Coal Technologies Improve Air Quality

- NOx Emissions/kWh
- SOx Emissions/kWh
- PM10 Emissions/kWh
- GDP per Capita (2006 $)
- Coal-Based Power Generation

% Change Since 1970

Source: USDA 2012, EIA 2012, NETL 2012

Environmental Benefits
Changes Impacting the Fleet

Annual U.S. Electricity Generation
(Source: USDOE/EIA Annual Energy Review, 2012)

Reduced Rate of Demand for Electricity
Changes Impacting the Fleet

More Advantageous Natural Gas Prices
Environmental Regulation

Changes Impacting the Fleet

U.S. Generating Capacity, GW

Sources:
2020: AEO-2014, USDOE/EIA.
Changes Impacting the Fleet

“As applied to existing power plants and refineries, EPA concludes that the NSR program has impeded or resulted in the cancellation of projects which would maintain and improve reliability, efficiency and safety of existing energy capacity. Such discouragement results in lost capacity, as well as lost opportunities to improve energy efficiency and reduce air pollution.” ~ EPA

“NSR’s treatment of modifications has been particularly controversial.” National Research Council
Changes Impacting the Fleet

U.S. Coal-fueled Generating Capacity Additions
(2011 Operating Net Summer Capacity, EIA Form 860)

Coal Capacity Added Each Year, MW

Cumulative Coal Capacity, MW

1900 1920 1940 1960 1980 2000 2020

The National Coal Council
Power for America from America
Changes Impacting the Fleet

Reduced RD&D Funding – Industry & Government
Technology Responses

Technology options to:

• Enhance Reliability & Flexibility
• Improve Efficiency
• Reduce Emissions
Technology Responses

CAISO Load Profile Demonstrates Need for Pulsed Loads
Image: Combined Cycle Journal

Reliability & Flexibility
Technology Responses

Improving Efficiency

Plant Scherer, Georgia

Credit: Georgia Power
Technology Responses

CCS Pilot and Demonstration Plant Timeline

Operating/Construction: Solid Symbols  Planned: Open Symbols

- Great Plains Synfuels (syngas production equivalent ~1000 MW)
- Kemper County
- Pilot Plants, Small Commercial Units
- Utility Demonstrations

Emissions Reductions
Reliable & Resilient
The Value of Our Existing Coal Fleet

FINDINGS & RECOMMENDATIONS
FINDINGS – Existing Fleet is Vital

- The 310 GW fleet of coal-fired power plants underpins economic prosperity, providing direct socio-economic benefits; energy supply and price stability; environmental progress through continuous technology advancements; and creating jobs.

- Coal plant closures and increasing reliance on gas for generation are adversely impacting reliability, affordability and supply.

- New Source Review (NSR) regulations adversely impact generators’ decisions and ability to enhance plant efficiency, reduce emissions and improve overall operations and capacity.

- Collaborative RD&D efforts (DOE and industry) can enhance the ability of the coal fleet to improve its flexibility, reliability and efficiency as well as to reduce its emissions profile. These efforts can eventually lead to near zero emissions though carbon capture and storage (CCS).
FINDINGS – Need for RD&D is Vital

- Past R&D to improve fleet performance and reduce emissions has yielded $13 of benefits for every $1 of federal investment.

- Marketplace shifts, changing regulations and time will lead to increased operation of base load units in a cycling mode for which they were not designed. R&D is needed to maintain system reliability.

- Modest improvements in efficiency are possible with existing technologies. More advanced improvements could significantly enhance efficiency, but needed R&D will require time and resources.

- Challenges arise in complying with emerging regulations for control of traditional pollutants when new control regimes create secondary, follow-on emissions issues.

- Existing coal plants were not designed or located with CCS in mind. More research is needed to commercialize CCS retrofit potential; improved efficiencies provide an interim path in the meantime.
RECOMMENDATIONS FOR DOE

• Lead efforts to maintain coal’s cornerstone role in a diverse portfolio, ensuring reliable, affordable power for families, businesses and institutions.

• Ensure that basic federal energy policy assessments consider the impact of lower priced electricity facilitated by coal power plants. Assessments should consider the value of diversity of generation sources and the impact of coal plant retirements.

• Lead collaborative efforts with industry to assess the impacts of the 2014 polar vortex experience on prices, availability, reliability and potential consequences of similar future events.

• Work with EPA to eliminate New Source Review (NSR) barriers that disincentivize efficiency improvements that reduce emissions, increase capacity and enhance plant operations.
RECOMMENDATIONS FOR DOE

- Lead collaborative RD&D efforts with industry to develop advanced materials, assessment tools, improved sensors and controls, non-destructive evaluation, remaining life evaluation and an understanding of damage mechanisms.

- Lead collaborative RD&D efforts with industry to enhance practical knowledge of emissions control systems in a cycling environment.

- Lead collaborative RD&D efforts to develop topping and bottoming cycles that can be retrofit to existing power plants to enhance efficiency.

- Place significantly more emphasis on commercial scale demonstration of CCS.

- Recognize that the need for accelerated solutions points to greater emphasis on hands-on test facilities that emulate the National Carbon Capture Center design concept.
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www.nationalcoalcouncil.org
www.nationalcoalcouncil.org/NEWS/NCCValueExistingCoalFleet.pdf

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Flexibility & Reliability Technologies

- **Improved Materials**
  - Stronger, more corrosion-resistant alloys & metal coatings
  - Stronger materials allow thinner-walled components
  - Thinner walls = less temperature change stress damage

- **Sensors & Controls**
  - Can automate optimization of multiple plant operating parameters under rapidly changing load conditions
  - Can help predict problems b/f a critical component failure
  - Can allow operation closer to design margins with greater reliability by detecting performance/life degradation

- **Coal Beneficiation**
  - Treat coal to reduce moisture and/or trace element content
Efficiency Technologies

- Dry coal using waste heat, enhances boiler efficiency
- Refit steam turbines with modern, more efficient multi-stage rotors
- Reduce corrosion & deposition on major heat transfer components (boiler tubes & condensers), enhances heat transfer efficiency
- Inject alkali materials into flue gases to reduce acidity (↓ corrosion at low temps), allows greater heat recovery
- Improved sensors & controls allowing operation closer to conditions optimal for higher efficiency
- Use variable speed drives to enhance motor efficiency, especially at lower load
Advanced Efficiency Technologies

- Add “topping” or “bottoming” cycles to existing units with conventional Rankine cycles
  - Involves adding one/several new components & integrating them with the existing plant operation
Emissions Reduction Technologies
Controls for Conventional Emissions

• Findings
  • Fleet well equipped now to handle PM, NOx, SO2 ++
  • New regs = more stringent reduction requirements
  • Key issue = continual addition of disparate emission requirements on existing units & subsequent interactions of new controls

• Recommendations
  • Re-establish a program for Innovations for Existing Plants
  • ID specific technologies to be developed via NETL-sponsored workshops to prioritize needs/benefits
  • Ongoing R&D on materials, instrumentation and controls and sensors + water management can benefit management of conventional air emissions.
  • Emulate NCCC for hands-on tests to accelerate technology developments.
Emissions Reduction Technologies

Retrofitting CCS on Existing Plants

• CCS Current Shortcomings
  • Not demonstrated at commercial scale on power plants
  • Limited knowledge of saline storage and EOR
  • Unresolved non-technical barriers – legal & regulatory
  • Costly technologies today
  • Impose significant energy penalties
  • Increased cooling water requirements
  • Integration, space limitation, cost & timing issues for existing units

• CCS Priority
  • Much less costly CCS technologies needed much sooner than the current RD&D program provides