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Reliable & Resilient
The Value of Our Existing Coal Fleet

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

International Pittsburgh Coal Conference

Pittsburgh, PA

October 7, 2014

National Coal Council

Celebrating 30 years ~ 1984|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.

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NCC is a Federal Advisory Committee organized under FACA legislation.

NCC

Members are appointed to serve by Secretary of Energy

110-125 members

Over 30 studies conducted for the Secretary of Energy

Prepared by NCC members at no cost to DOE

- **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

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

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Study Conducted January-May 2014; Approved by NCC Members ~ May 14, 2014

Study Leadership & Lead Authors

- NCC Chair ~ **John Eaves**, President & CEO, Arch Coal
- Coal Policy Comt. Chair ~ **Fred Palmer**, Sr. VP Peabody Energy
- CPC Vice Chair ~ **Bill Brownell**, Chairman, Hunton & Williams

- Study Chair & NCC Vice Chair ~ **Jeff Wallace**, VP, Southern Co.
- Study Technical Chair ~ **Steve Wilson**, GM R&D, Southern Co.

- Lead Author ~ **Doug Carter**, Independent Energy Consultant
- Author ~ **Ed Cichanowicz**, Independent Engineering Consultant
- Author ~ EPRI Team lead by **Stu Dalton**, Sr. Govt. Rep.

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Advisors & Contributors

- **Coal Generators**

Ameren Energy, American Electric Power, PPL EnergyPlus,

PSEG Fossil, Southern Company, Tri-State G&T

- **Coal Producers**

Arch Coal, Patriot Coal, Peabody Energy

- **Coal Support Service Industries**

ADA-ES, ALSTOM, CH2M Hill, Clean Energy Consulting, CURC, Energy Industries of Ohio, Headwaters,

Hunton & Williams, MISI, MIT, Jupiter Oxygen, Penn State, Shenhua Group

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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

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Study at a Glance

A. Executive Summary

B. The Role/Benefits of Existing Coal Fleet

C. Challenges to Existing Coal Fleet

D. Technology Responses to Maximize Future Benefits from Existing Coal Fleet

+ Bonus Section – The 2014 Polar Vortex

< 90 pages

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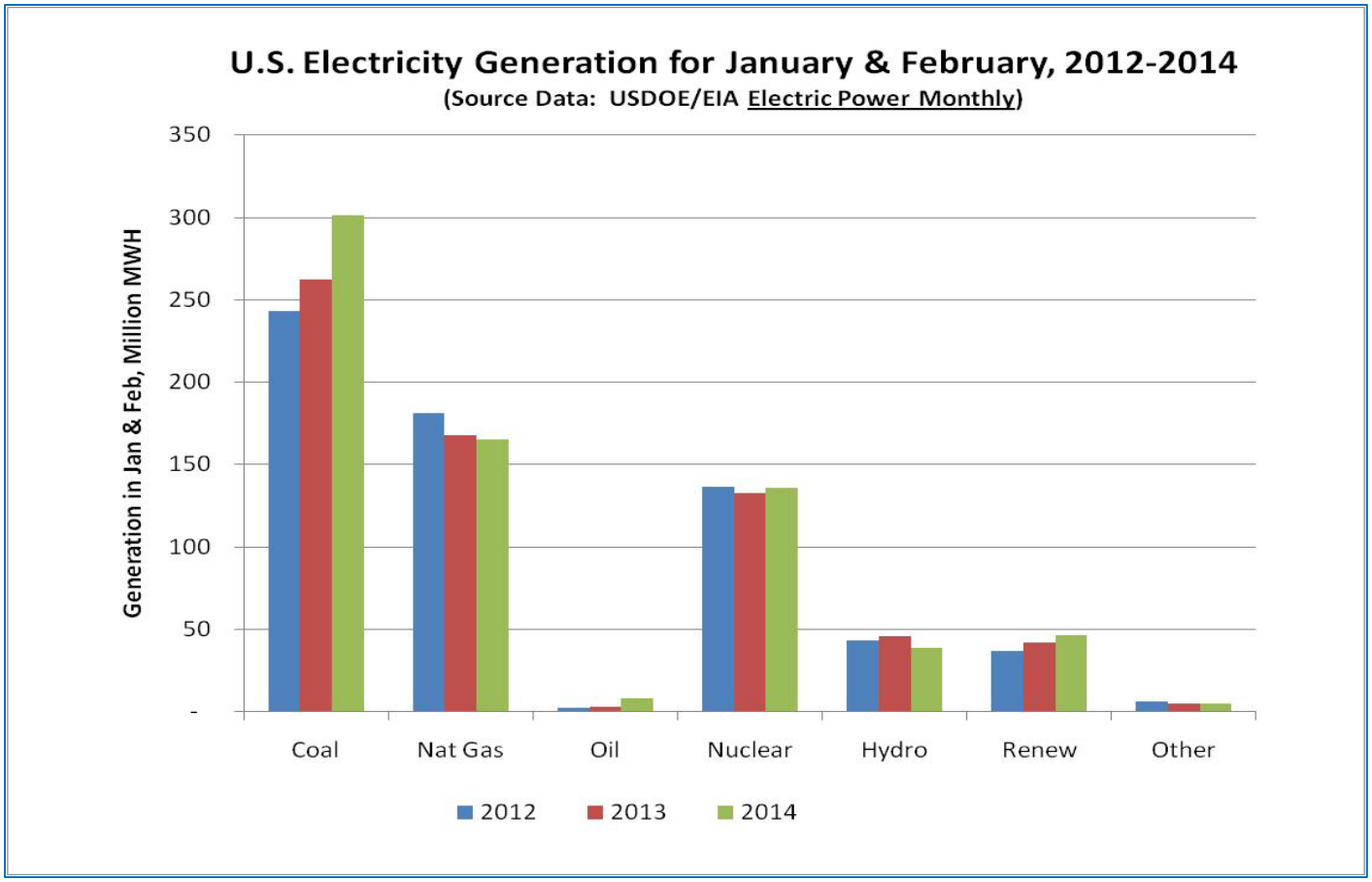
Polar Vortex 2014



"This country did not just dodge a bullet – we dodged a cannonball."
Nick Akins, CEO, American Electric Power

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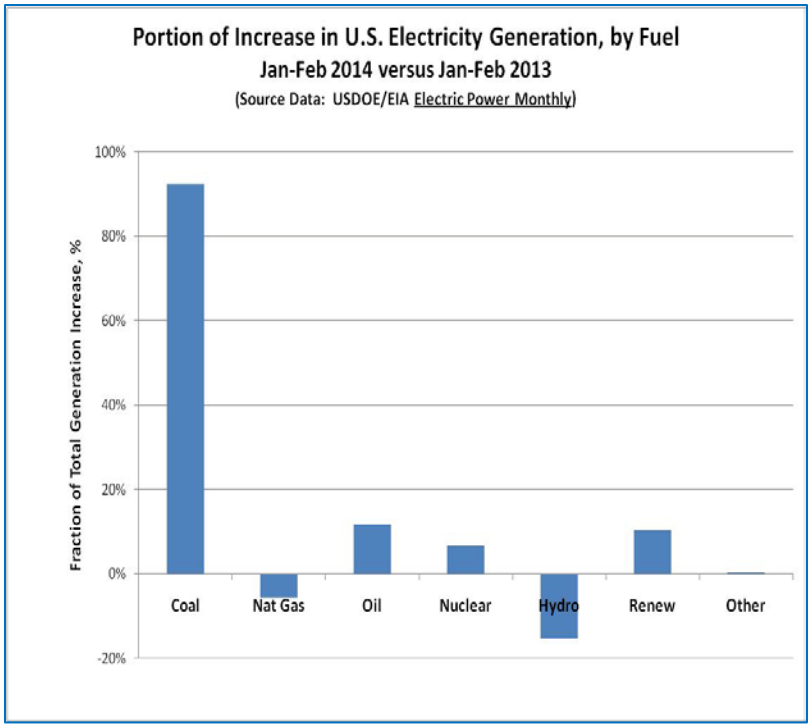
Polar Vortex 2014



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.

- "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

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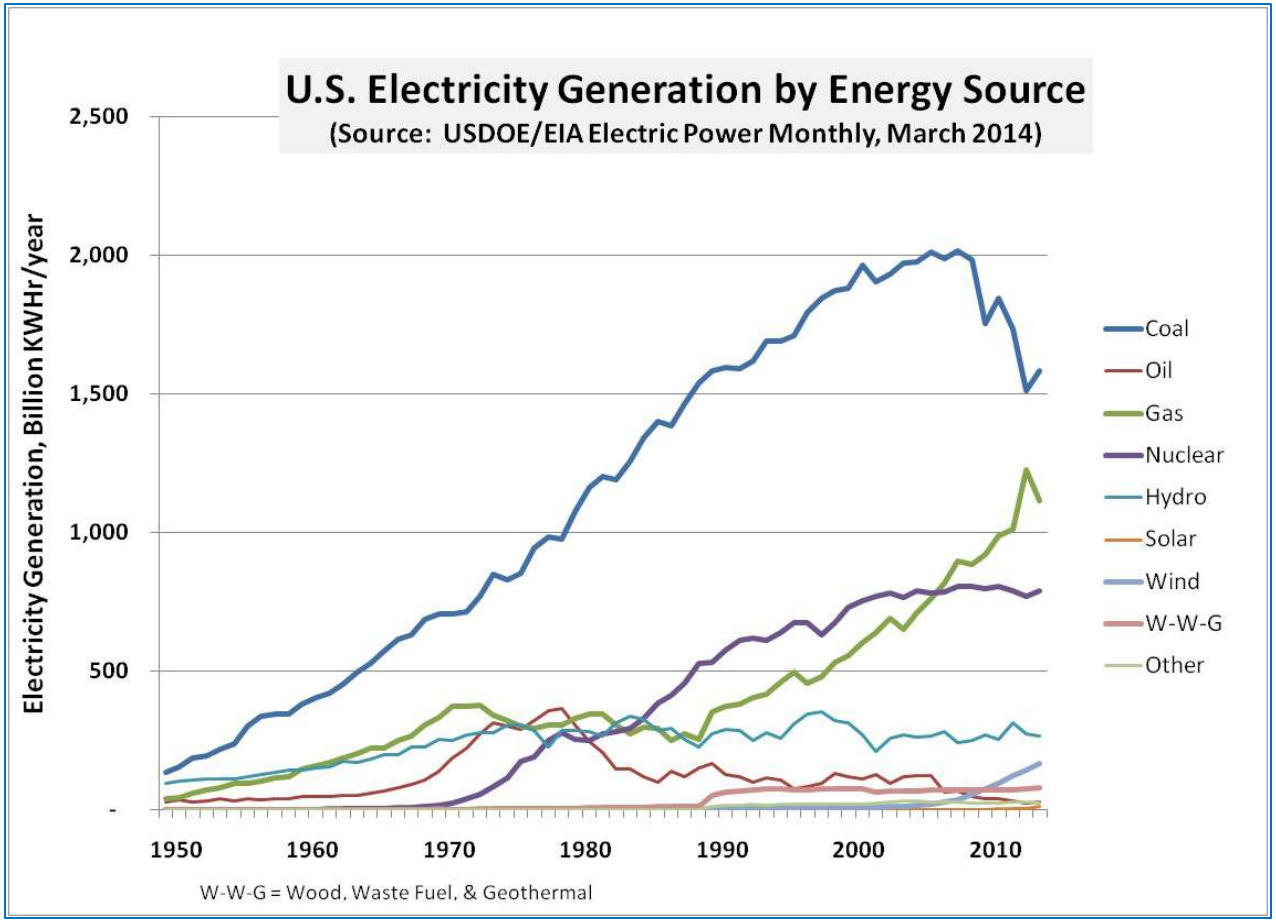
Profile of Existing Coal Fleet



Profile of the Existing Fleet – 310 GW

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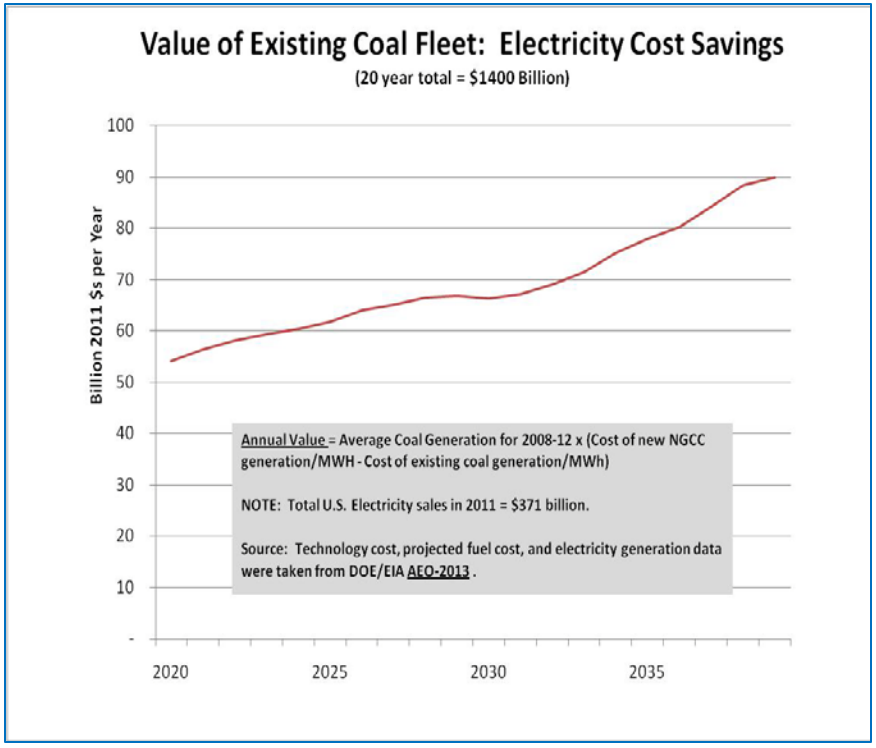
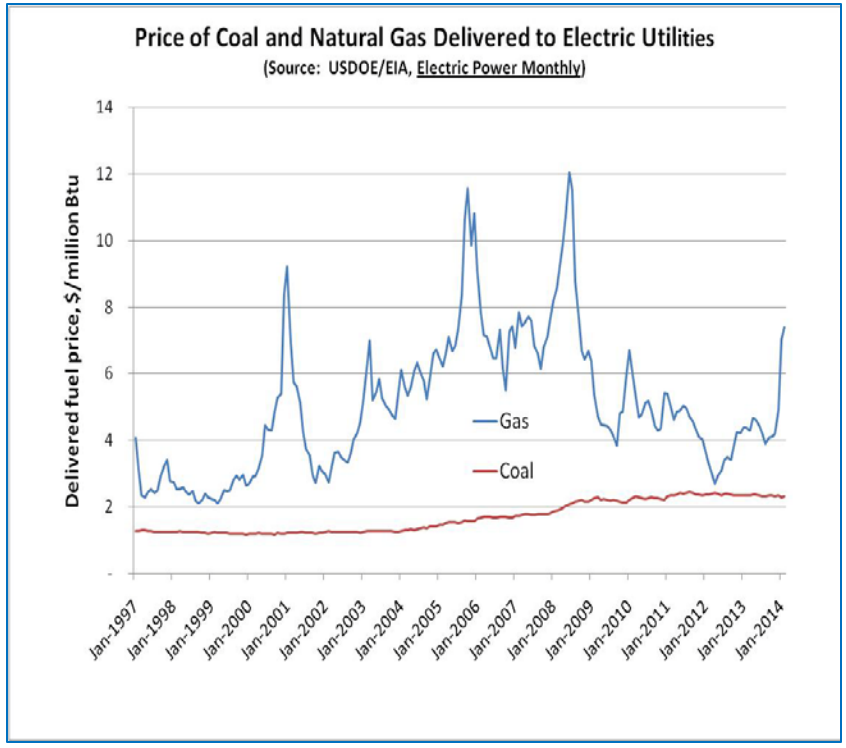
Benefits of Coal Fleet

What is the value of the coal fleet?

Direct & Macro-economic



Supply & Price Stability



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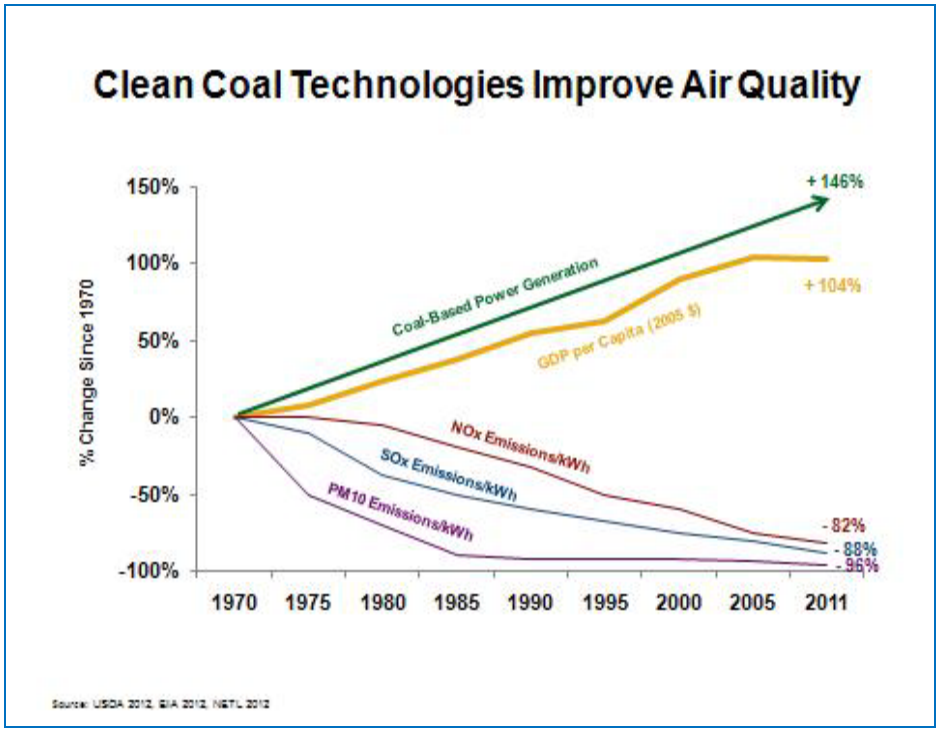
Benefits of Coal Fleet

What is the value of the coal fleet?

Environmental



Jobs

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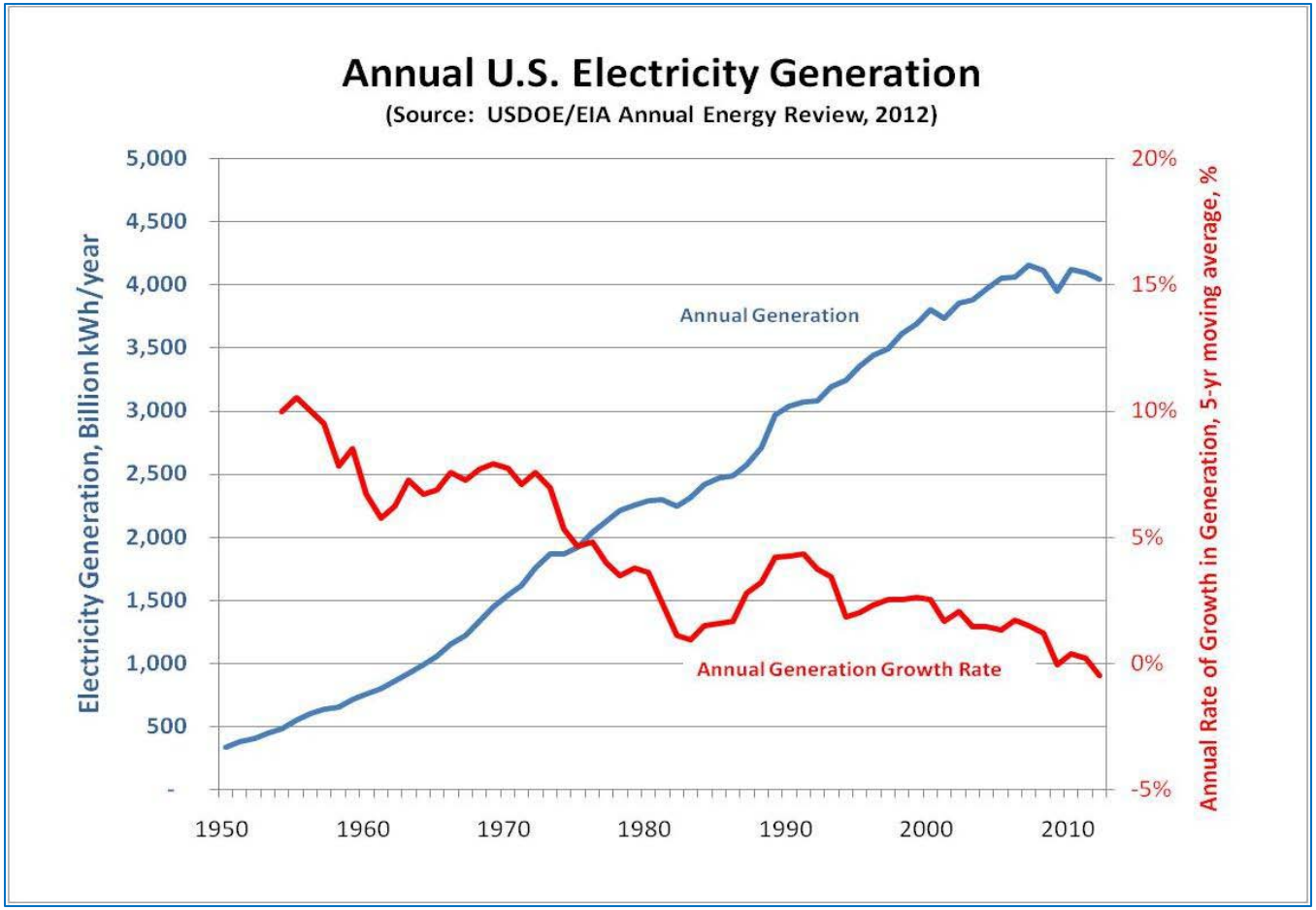
Changes Impacting the Fleet



Reduced Rate of Demand for Electricity

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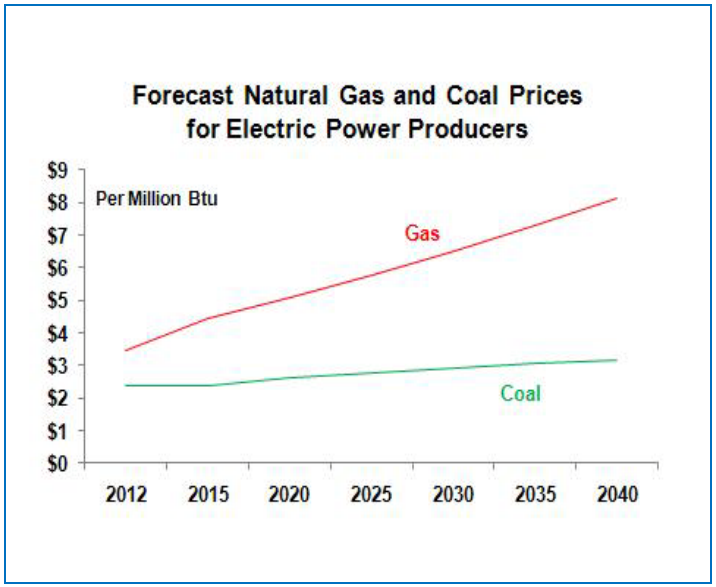
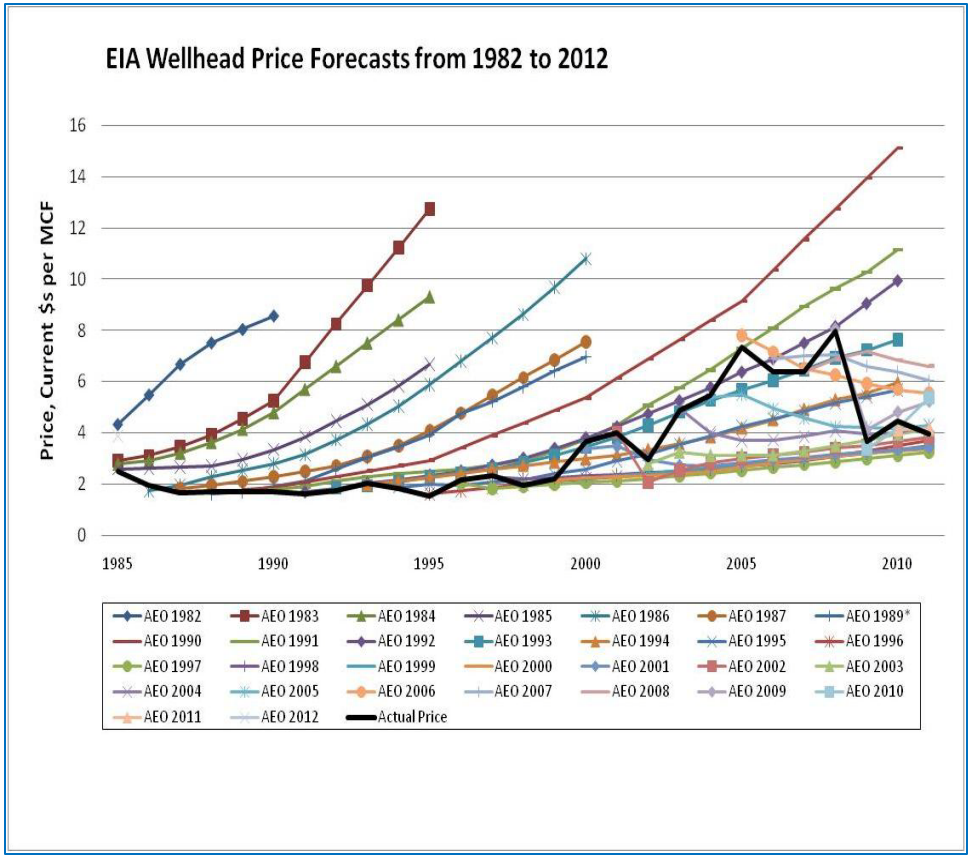
Changes Impacting the Fleet





More Advantageous Natural Gas Prices

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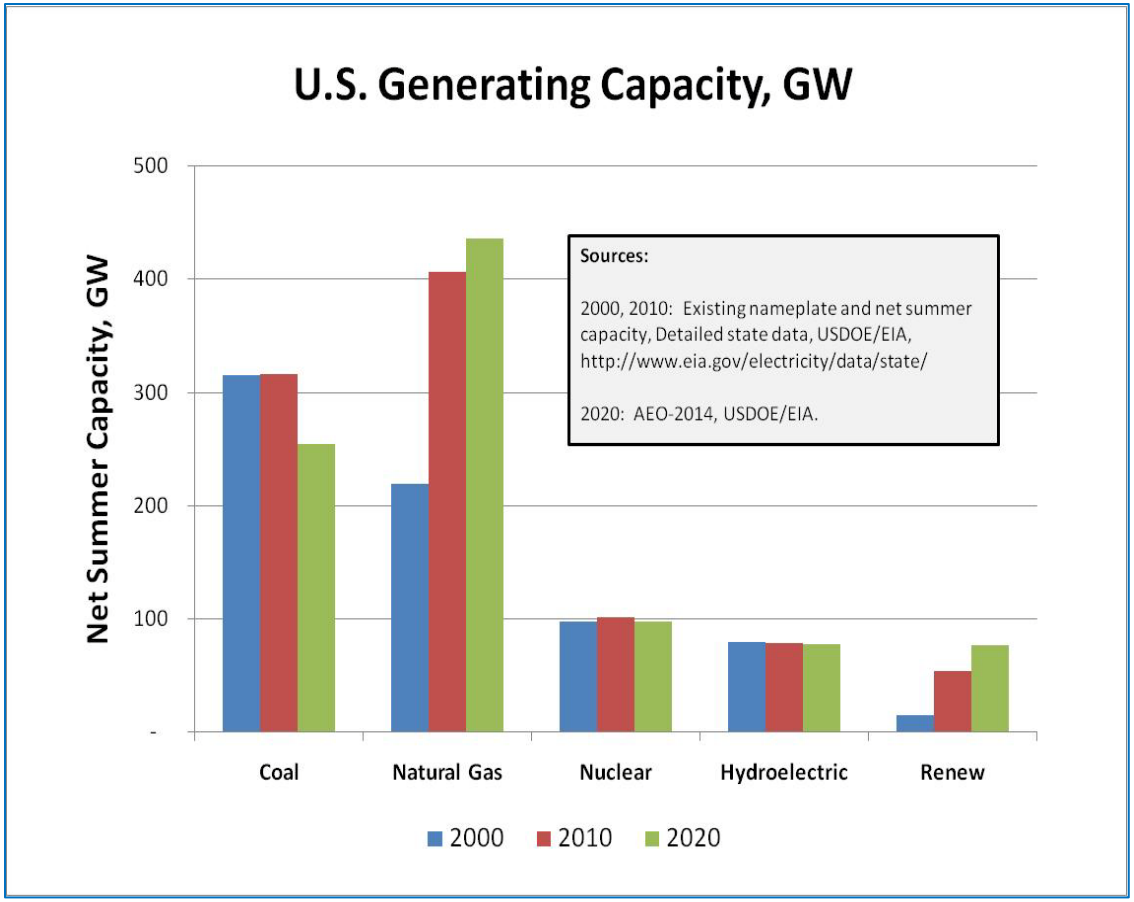
Changes Impacting the Fleet



Environmental Regulation

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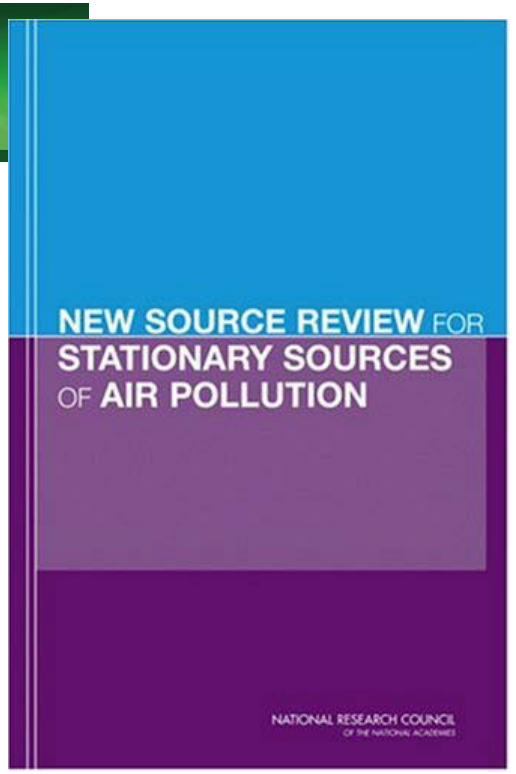
Changes Impacting the Fleet

United States Environmental Protection Agency

"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

New Source Review

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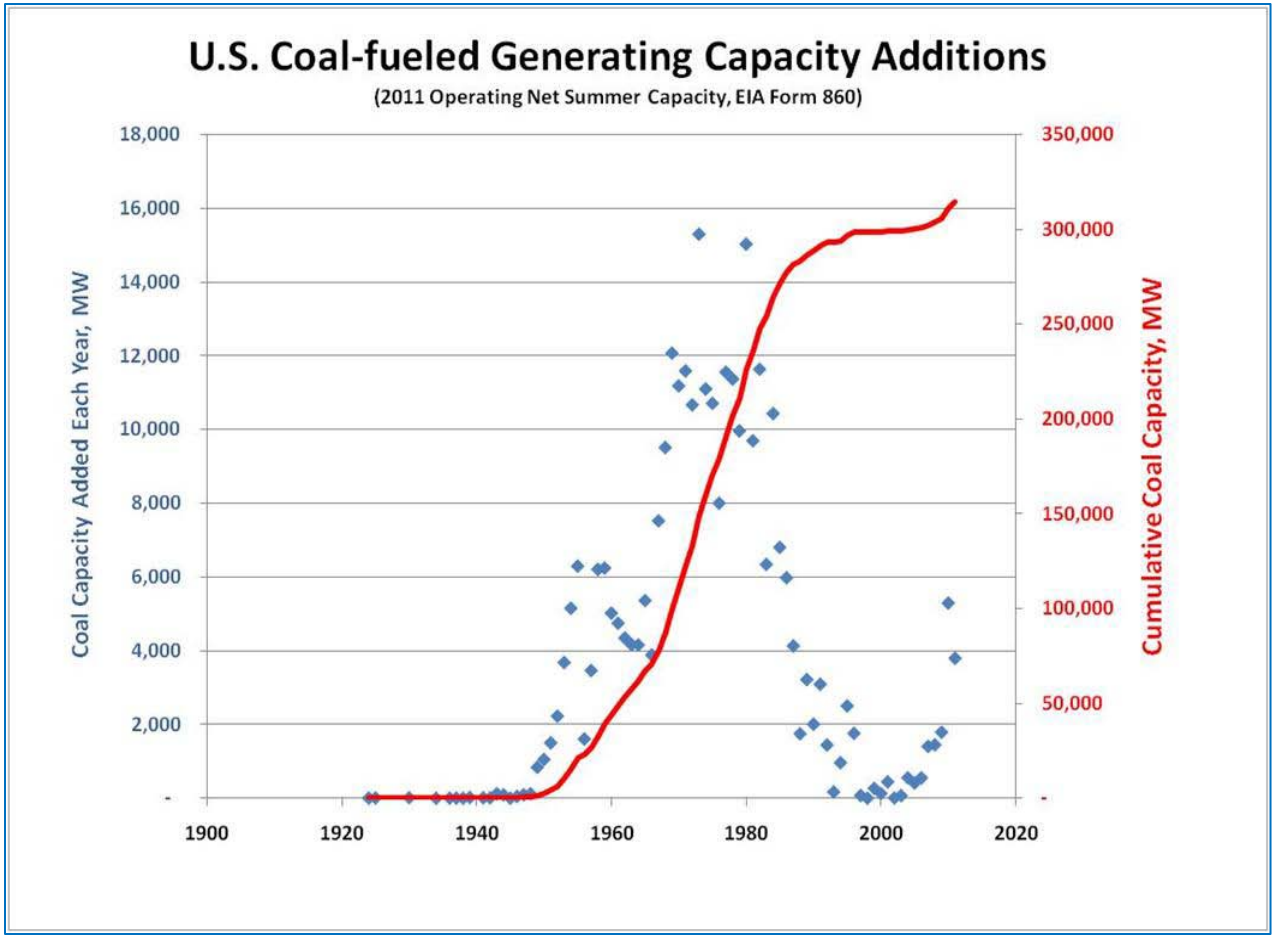
Changes Impacting the Fleet



Age of Fleet

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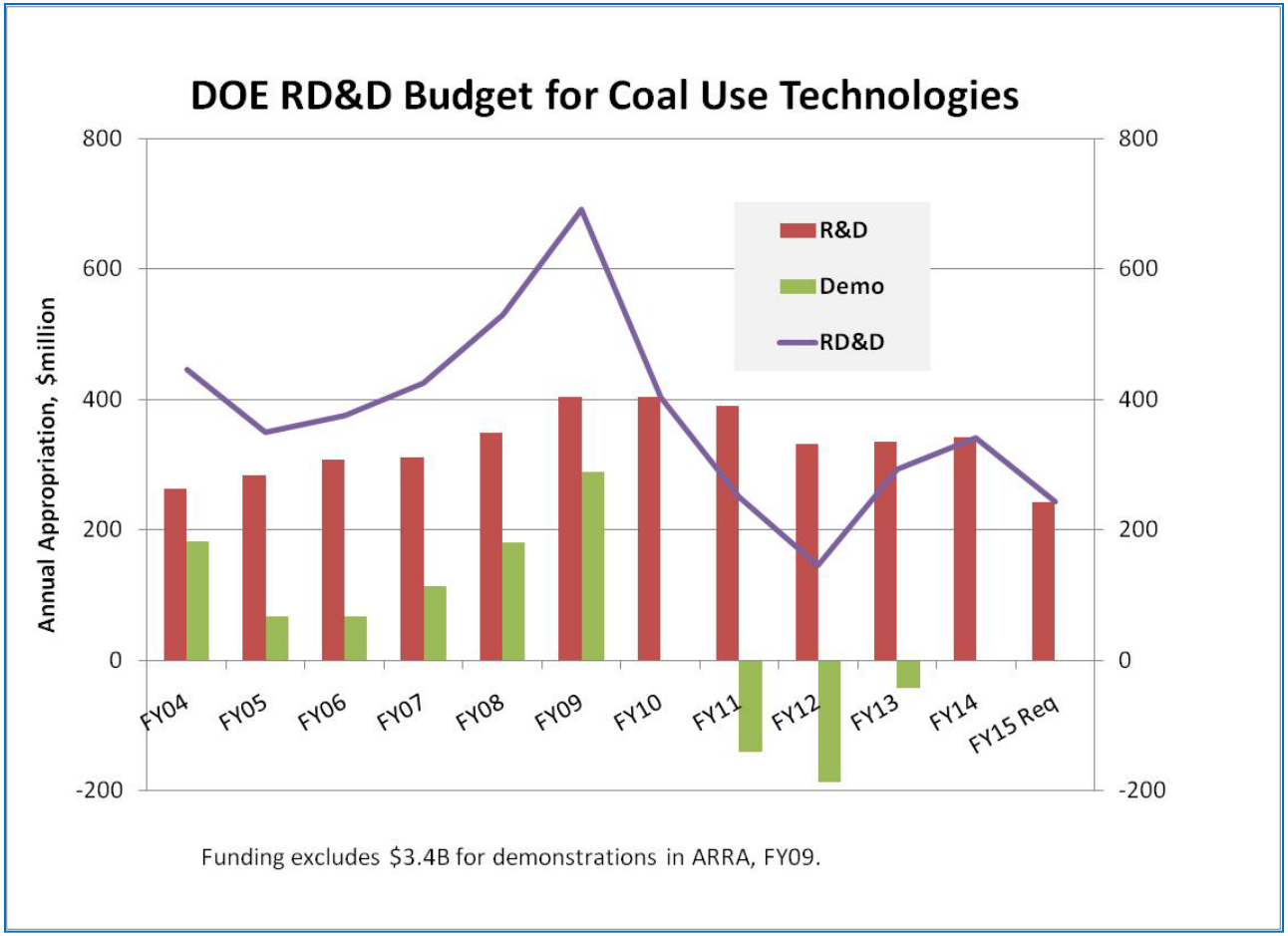
Changes Impacting the Fleet



Reduced RD&D Funding– Industry & Government

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Technology Responses

Technology options to:

- Enhance Reliability & Flexibility
- Improve Efficiency
- Reduce Emissions

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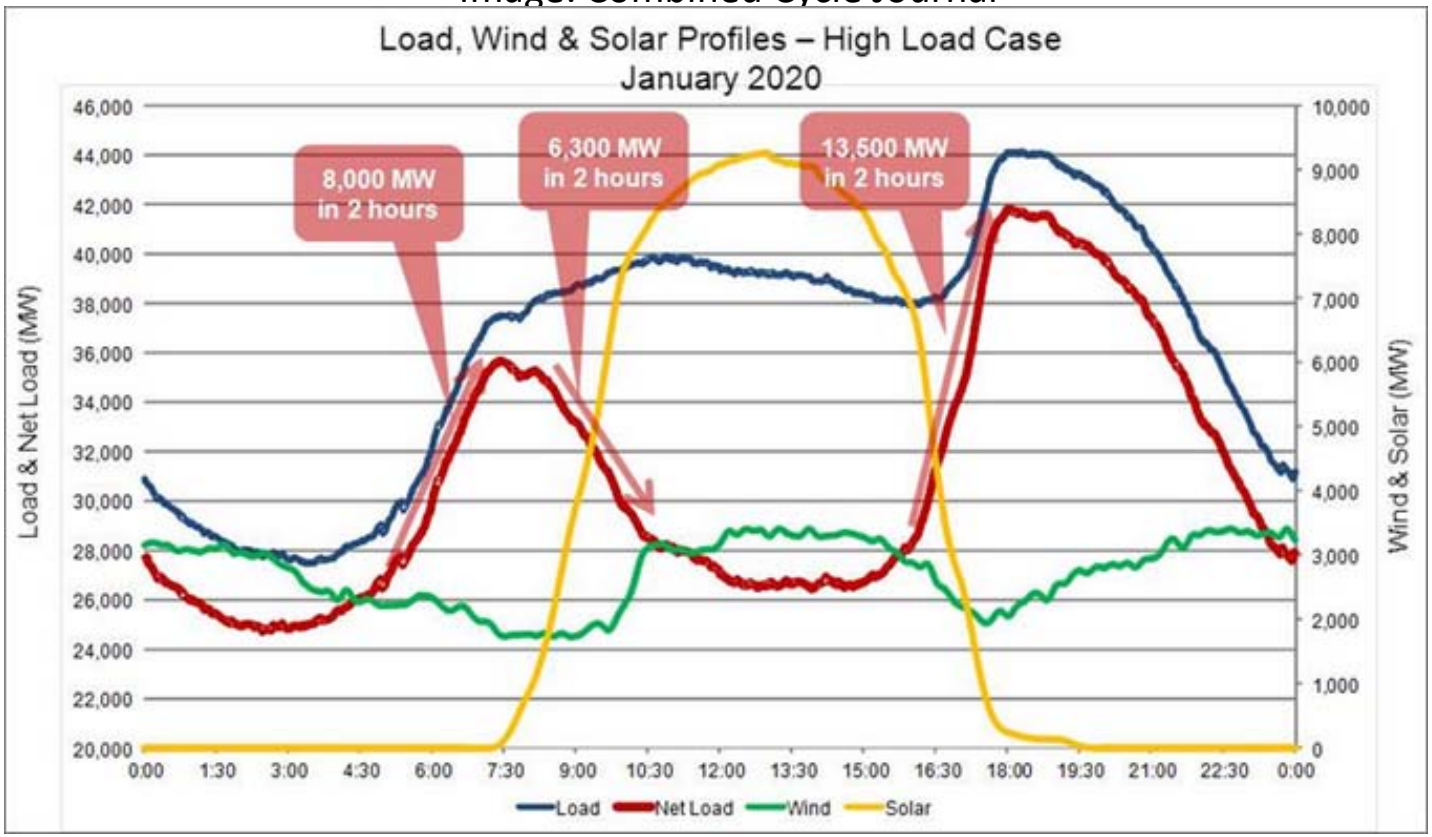
Technology Responses

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



Reliability & Flexibility

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Coal Plant Retirements Impact Flexibility

Source: www.sourcewatch.org

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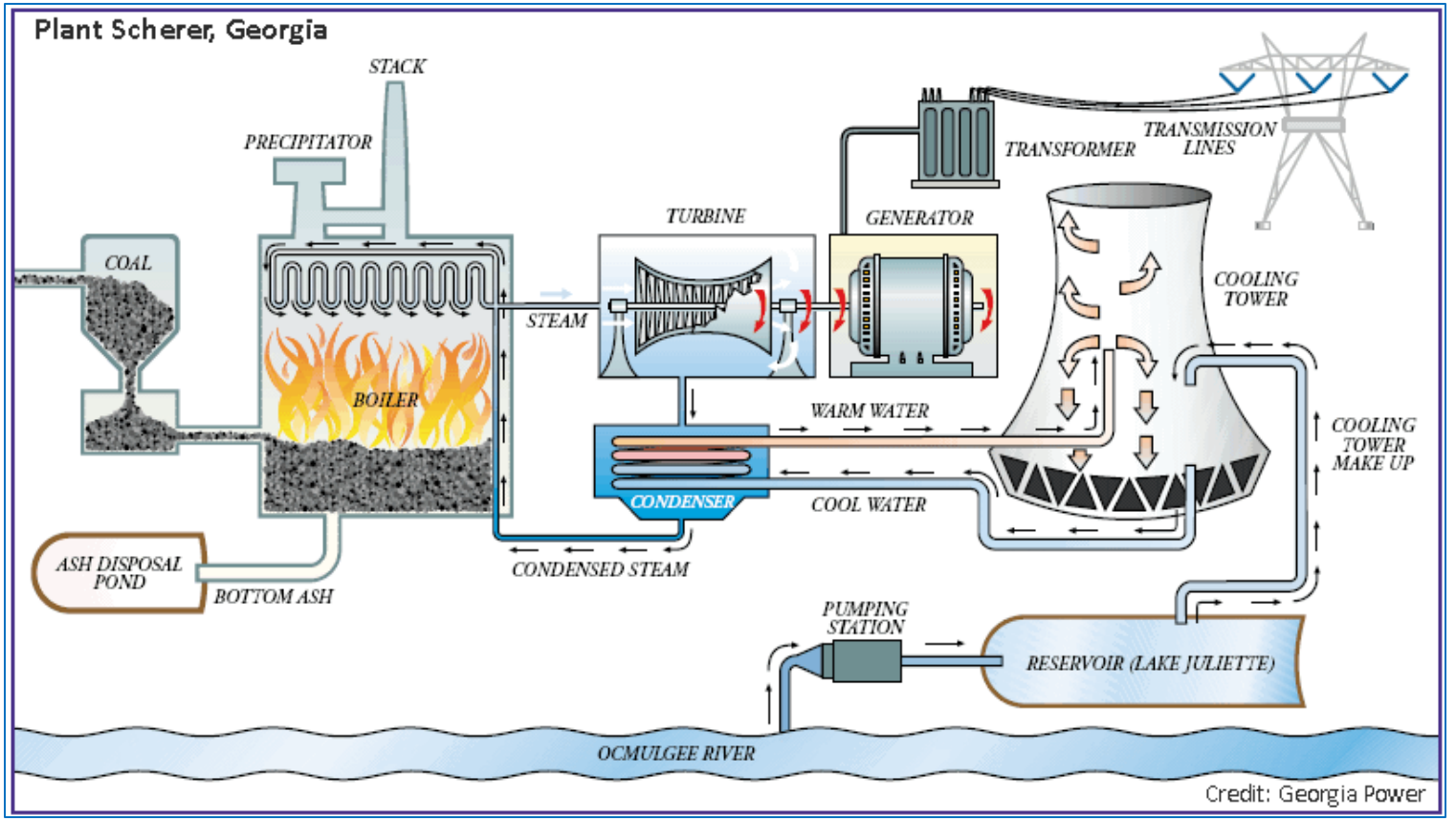
Flexibility & Reliability Technologies

- 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

Technology Responses



Improving Efficiency

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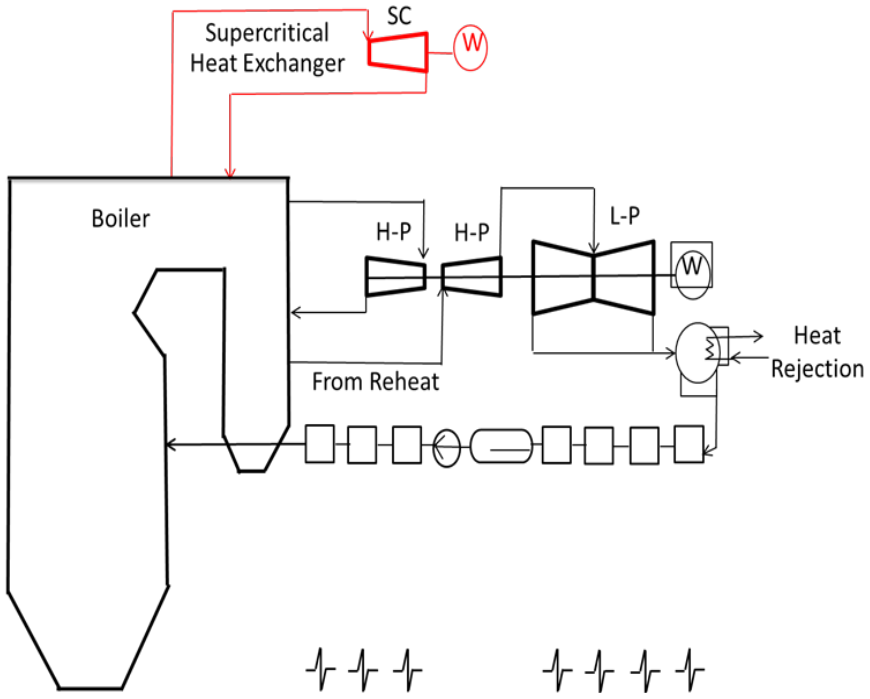
Efficiency Technologies

- 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
  - Bottoming cycle could convert condenser into a mini-generator.



Schematic of Topping Cycle for Conventional Rankine Power Station

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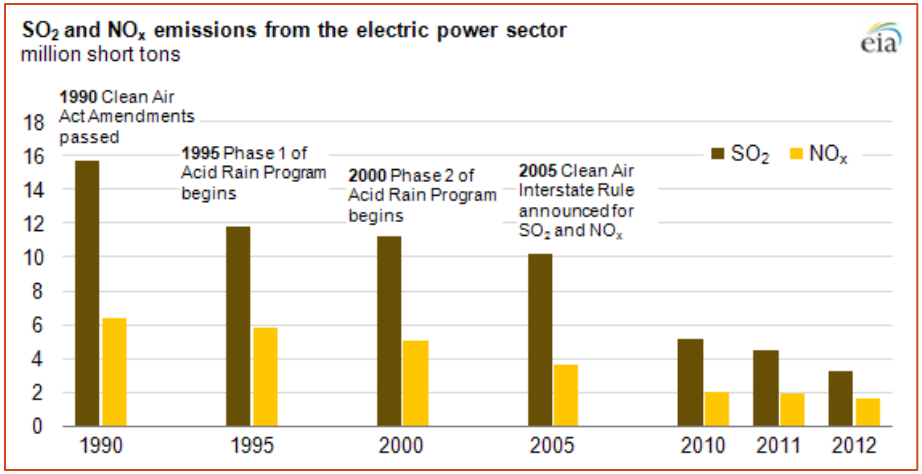
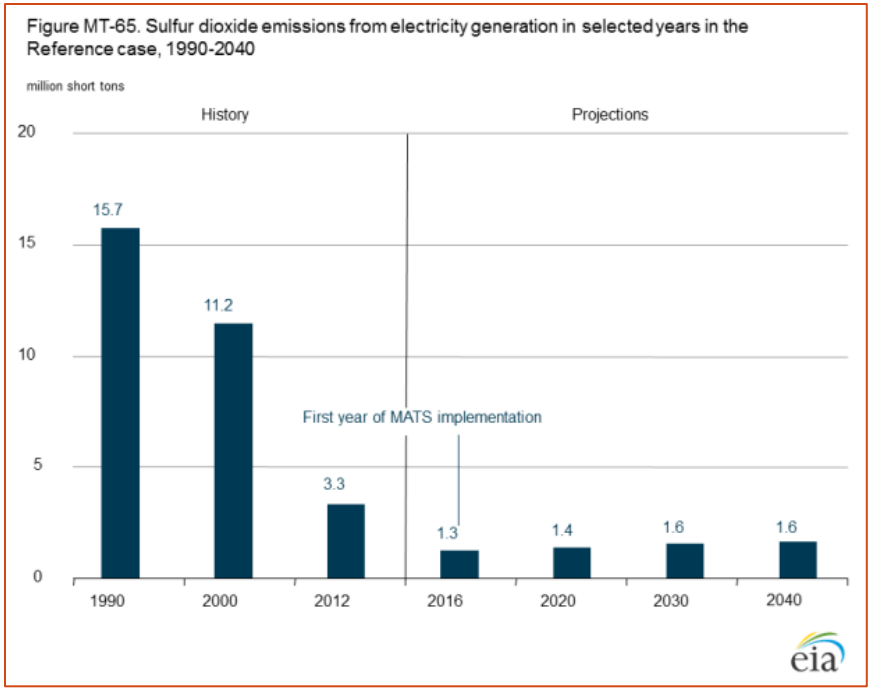
Technology Responses





Emissions Reductions

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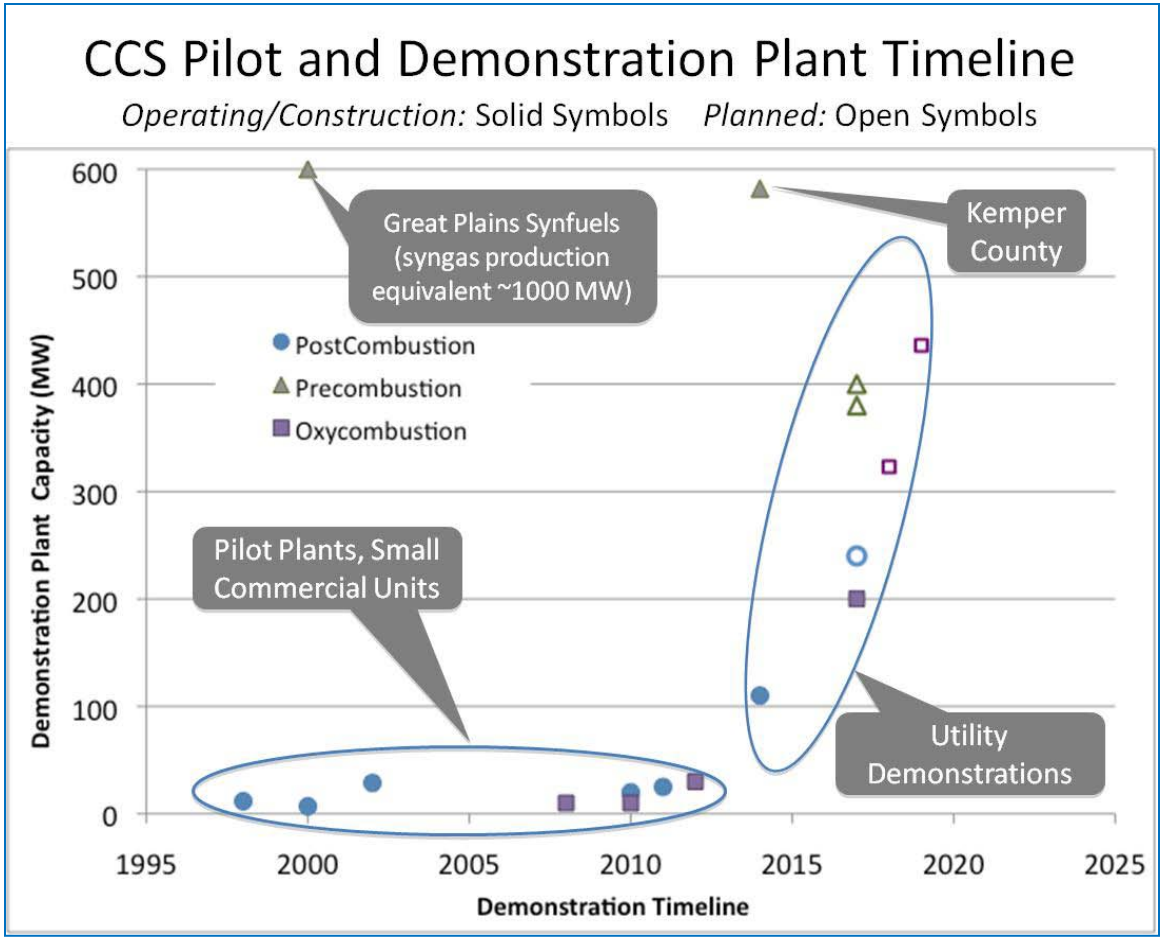
Technology Responses



Emissions Reductions

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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 issues for existing units
- CCS Priority
  - Much less costly CCS technologies needed much sooner than the current RD&D program provides

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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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