



**The National Coal Council**  
*Power for America from America*

## Reliable & Resilient

### The Value of Our Existing Coal Fleet

#### **An Assessment of Measures to Improve Reliability & Efficiency While Reducing Emissions**

[www.nationalcoalcoalcouncil.org/NEWS/NCCValueExistingCoalFleet.pdf](http://www.nationalcoalcoalcouncil.org/NEWS/NCCValueExistingCoalFleet.pdf)

*During the winter of 2013-2014, the National Coal Council (NCC) conducted a study for the U.S. Secretary of Energy assessing the value of the existing U.S. coal fleet and opportunities to enhance its capacity, efficiency, flexibility and emissions profile.*

The value of the existing coal fleet is not an abstract concept. At a time of great stress on power demand in January-February 2014, coal produced 92% of the increase in U.S. electricity generation relative to January-February 2013.

*The severe cold weather events experienced while the study was underway, reinforced the importance of retaining and maintaining coal generation assets in order to reliably and affordably meet the electricity needs of U.S. residents and businesses. The major lesson learned from the Polar Vortex experience is that the availability and operation of coal units now scheduled for retirement over the next two years enabled the power sector to meet demand during periods of harsh weather.*



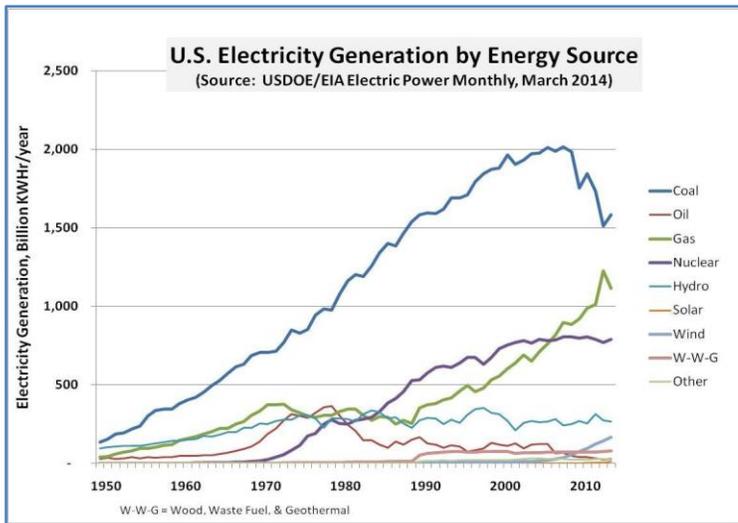
NCC's assessment of the existing U.S. coal fleet supports the findings that:

- The current 310 GW fleet of coal-fired power plants underpins economic prosperity in the U.S., providing direct economic and macroeconomic benefits; energy supply and price stability; environmental benefits through continuous technology advancements; and job-creating opportunities.
- Coal plant closures and increasing reliance on natural gas for power generation will adversely impact price stability and resource 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 and reliability, to increase its efficiency and to reduce its emissions profile.

The need for RD&D is vital to support marketplace shifts and public policy objectives:

- > Increasing deployment of intermittent renewable energy technologies, competition from other fossil fuels, use of non-design coals and continued use of older coal generation technologies will lead to increased operation of base load units in a cycling mode for which they were not designed.
- > Modest improvements in efficiency are possible with existing technologies to improve heat transfer, reduce heat losses and make better use of low quality heat. More advanced improvements, if technically and commercially viable, could significantly enhance efficiency.
- > 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; the ability to retrofit these plants for CCS is problematic. More research is needed to commercialize CCS retrofit potential; improved efficiencies provide an interim path in the meantime.

## The Role & Benefits of the Existing Coal Fleet

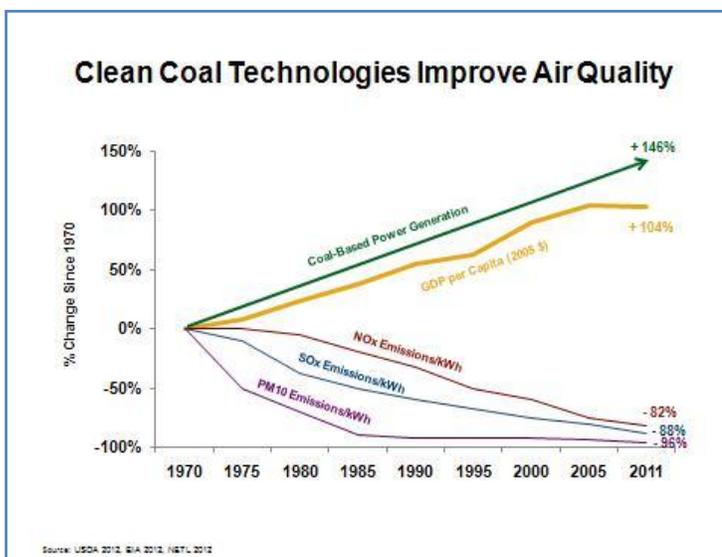
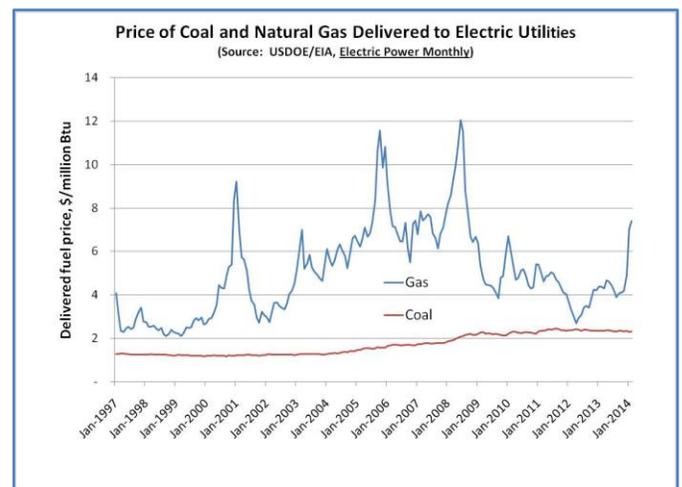


Coal has dominated electricity generation in the U.S. from 1950-2013. This dominance is a result of coal's domestic abundance, reliability, accessibility and low cost. Among the benefits offered by the current coal fleet (310 GW of generating capacity):

- Direct and macroeconomic benefits of low-cost electricity.
- The portfolio value of having a robust and reliable alternative for power generation.
- The energy security value of a generation fleet not confined to real-time fuel delivery-transport, and relatively immune to purposeful attack (terrorism).

Lower cost electricity acts as a stimulus to the economy, providing more disposable income to consumers and creating a competitive edge for U.S. manufacturers supplying global markets. Coal provides economic stability and has been a crucial buffer to spiking natural gas prices. Natural gas prices continue to be volatile, reinforcing an historical trend. The winter of 2013-2014 has demonstrated that large price spikes remain a characteristic of natural gas:

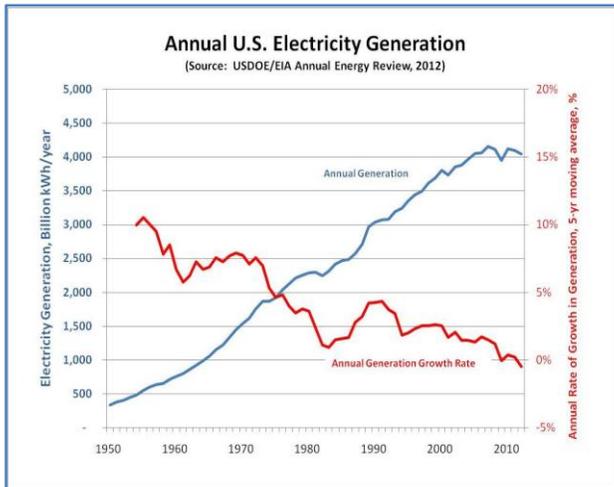
- In New England, natural gas prices reached \$77/mcf or \$435 per barrel in oil equivalent terms, causing switching from gas to oil power generation.
- In the Northwest, spot natural gas at Malin Hub in Oregon quadrupled from \$7.70 to almost \$30/mcf.



The historical deployment of advanced coal technologies demonstrates that coal generation can be increased while simultaneously reducing emissions. Since 1970, coal used for electricity increased substantially alongside a tripling of GDP as key emissions decreased almost 90%. Supercritical and ultra-supercritical plants are the technological pathway to even lower emissions and the necessary precursor to carbon capture and storage (CCS). Retrofitting advanced environmental technologies and enhancing efficiency at existing coal plants could result in the annual creation of 44,000-110,000 jobs, depending on the degree of efficiency improvement achieved.

## Changes that Could Impact Benefits from the Existing Coal Fleet

Recent demand for electricity has declined from 6-11%/year increases of the 1950s and 1960s.

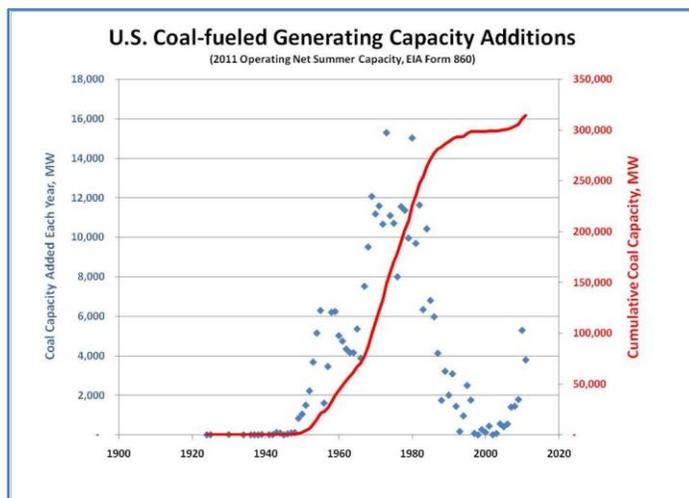
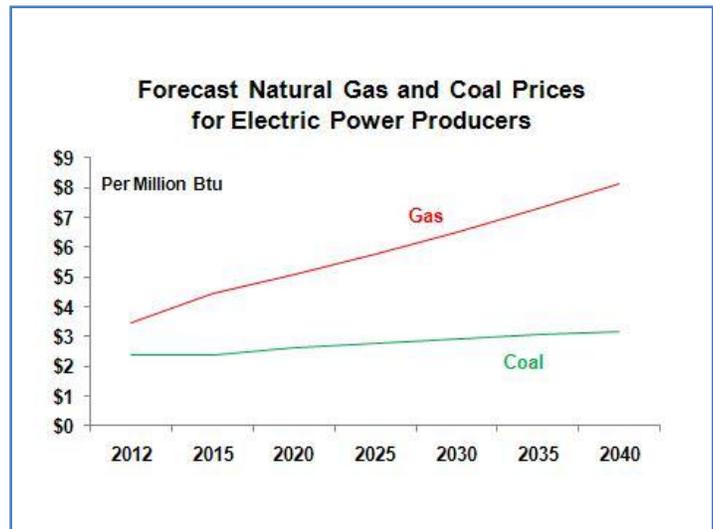


Today's more modest growth rates reflect economic conditions, effects of demand-side energy efficiency measures, a continuing shift from manufacturing to services and a transition to less energy-intensive industrial applications.

This relatively low rate of growth in electric power demand emphasizes the importance of advancing policies and technologies that preserve the existing coal fleet's benefits and portfolio value.

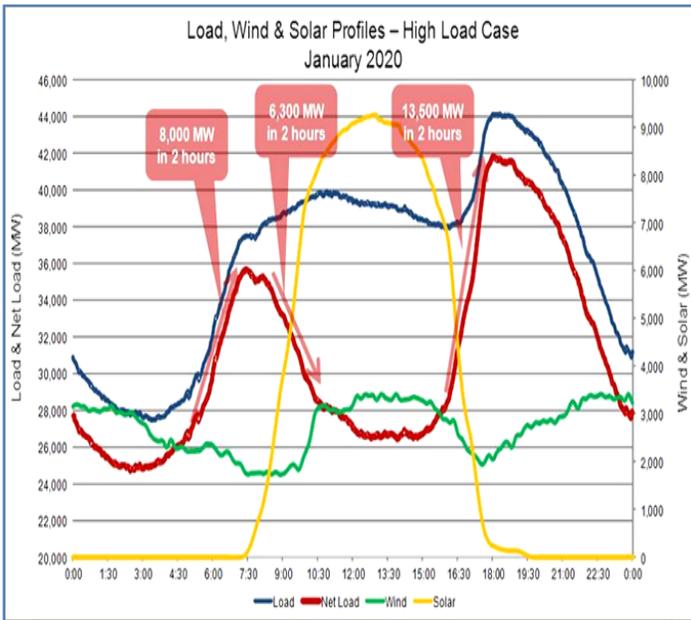
To advance its economic interests, the U.S. will need to start producing more and exporting more. Our nation will require significantly more reliable, reasonably priced electricity in the coming years – electricity not subject to cut-offs and price spikes.

Recent use of the existing coal fleet has been impacted by a dramatic decrease in the price of natural gas. However, EIA's most recent projections for the price of delivered gas to electric utilities indicate an expected real (constant dollar) increase of 3.1%/yr for 2012-2040, versus 1%/yr for coal. Projections of future natural gas prices are relevant to the existing coal fleet because retirement decisions for existing coal capacity will rely in part on projected costs for coal and natural gas.



The intricacies of New Source Review (NSR) regulation are important to understand because they impact the development and potential use of technologies that could be used to improve plant efficiency, reduce emissions and enhance capacity. The uncertainties created by NSR rules, their enforcement by EPA and certain environmental groups against efficiency and capacity enhancing technologies, and the very substantial – even prohibitive – cost of NSR create strong disincentives to the widespread deployment of those measures.

## Technology Responses to Maximize Future Benefits to Society

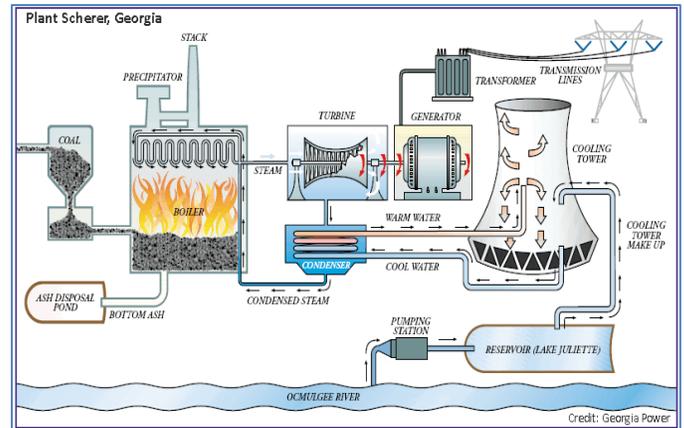


### Improving Flexibility & Maintaining Reliability

Most large existing coal power plants were originally designed to run in base load mode. Changing market conditions and public policies suggest that many of base load units will, in the future, be used in a cycling mode resulting in significant operational and maintenance challenges. Various technologies may be able to address these issues, including improved materials, better sensors and monitors and treated coals to reduce moisture or trace element content. A greater understanding of failure mechanisms leading to tube leaks, component failures and other malfunctions resulting in forced outages and reduced equipment life are necessary to maintain system reliability.

### Increasing Existing Coal Fleet Efficiency

Improving the efficiency of today's power plants is critical to maintaining the value of the existing coal fleet. While many of the needed technologies already exist and are operating on some units, they are not a one-size-fits-all package of solutions that can be readily applied across the board. The degree of efficiency improvement possible at a given unit is highly site-specific. Some technologies could potentially achieve significant efficiency improvements – such as adding “topping” or “bottoming” cycles to existing units – but will require extensive RD&D efforts.



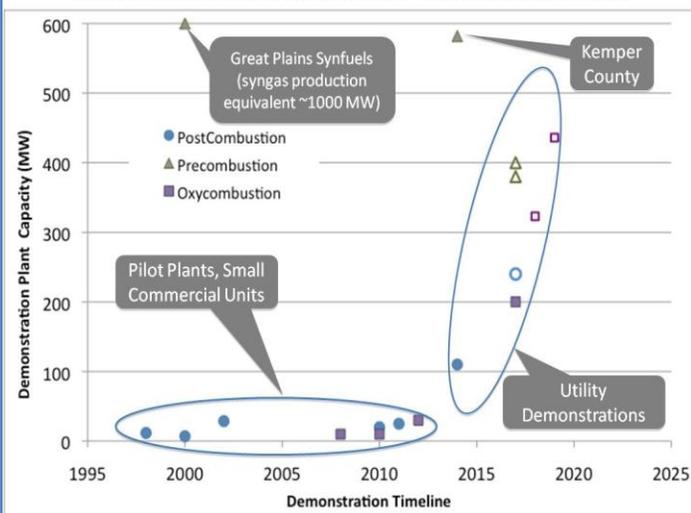
### Reducing Emissions at the Existing Fleet

The existing fleet is generally well equipped with systems designed to control emissions of PM, NOx and SO2. Recently proposed or adopted regulations, however, will lead to more stringent reduction requirements and often reduction of emissions in one media (e.g., air) will result in new pollution control issues in another media (e.g., wastewater). Additionally, regulatory efforts to reduce GHG emissions enhance the urgency of accelerating carbon capture and storage (CCS) solutions that will have applications for both coal and natural gas-fired power plants. More emphasis must be placed on commercial scale demonstration of CCS systems and more work is needed on issues related to cost reduction, systems integration and legal frameworks.

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### CCS Pilot and Demonstration Plant Timeline

Operating/Construction: Solid Symbols Planned: Open Symbols





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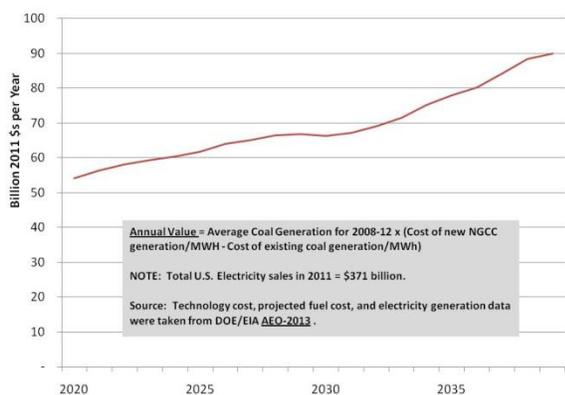
### The Value of Our Existing Coal Fleet

#### The Role & Benefits of the Existing Coal Fleet

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

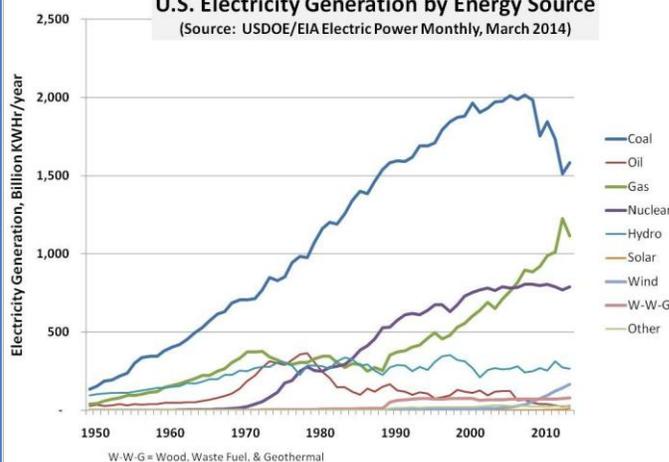


Low-cost power from the nation's existing coal fleet keeps U.S. electricity prices below those of other free market nations. If the existing coal fleet were replaced with the next cheapest alternative generating source – natural gas combined cycle power plants – a conservative estimate of the impact on the U.S. economy would be a 1.5% drop in GDP and a loss of 2 million jobs by 2040.

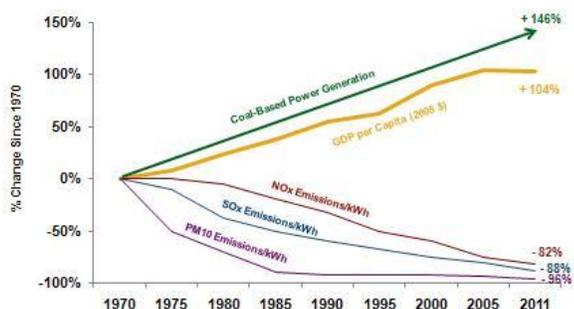
### Profile of the Existing Coal Fleet

Since 1950, coal has dominated electricity generation due to its domestic abundance, accessibility, reliability, and low-cost compared to other generation alternatives. In 2013, coal continued to lead U.S. generation, producing 39% of electricity nationwide with approximately 310 GW of generating capacity.

**U.S. Electricity Generation by Energy Source**  
(Source: USDOE/EIA Electric Power Monthly, March 2014)



### Clean Coal Technologies Improve Air Quality



Continuous technology improvements have greatly reduced emissions from the coal fleet. Since 1970, coal-based power generation has increased nearly 150% while key emissions have decreased almost 90%. State-of-the-art technologies have reduced emissions of SO<sub>2</sub> 88%, NO<sub>x</sub> 82% and particulates 96%.

## Benefits Provided by the Existing Coal Fleet

The U.S. benefits from having a diverse mix of fuels and technologies for power generation.

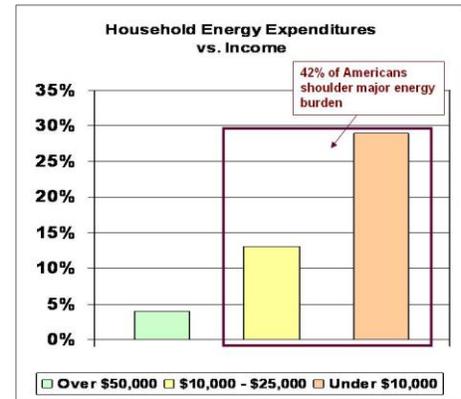
### COAL FLEET BENEFITS

- Energy Security
- Fuel Mix Diversity
- Direct & Macroeconomic
- Supply & Price Stability
- Environmental
- Job Creation

Coal's low-cost and abundance (U.S. has 27% of the world's proven coal reserves) provides economic stability. In addition to serving as a crucial buffer to spiking natural gas prices, coal offers the energy security value of a power generation option that is not dependent upon real-time fuel delivery/transport and is relatively immune to terrorism.

### Affordable Energy for All in a Growing Nation

The energy burdens of low-income households are much greater than those of higher income families. Families earning more than \$50,000/year spent only 4% of their income to pay energy expenses; those earning between \$10,000-25,000/year (29% of U.S. population) spent 13% on energy and those earning less than \$10,000/year (13% of population) spent 29% on energy costs.



Source: American Association of Blacks in Energy

Consumer class	Electricity Price in 2013, Cents/kWh						
	U.S.	Denmark	France	Germany	Italy	Spain	UK
Residential	12	42	20	41	32	31	24
Industrial	7	15	13	20	23	17	16

### Global Competitiveness

Lower cost electricity acts as a stimulus to the economy, providing more disposable income to consumers and creating a competitive edge for U.S. manufacturers supplying global markets. European power costs are two to three times those in the U.S.

### Secure Infrastructure

The U.S. coal generation supply chain is unmatched in the world. Penn State University research estimates the U.S. coal power supply chain provides over \$1 trillion in gross economic output, 7% of U.S. GDP, 6.8 million jobs (5% of the U.S. workforce) and \$362 billion in annual household income.

- 1,200+ active coal mines
- 95,000 miles of Class 1 railroads
- 12,000 miles of commercially navigable waterways
- 90,000 miners

### Job Creation

Retrofitting advanced environmental technologies and enhancing efficiency at existing coal plants could result in the annual creation of 44,000-111,000 jobs, depending on the degree of efficiency improvement achieved.

### NCC Recommendation

DOE should ensure that basic federal energy policy assessments, such as the Quadrennial Energy Review (QER) and the President's Advance Manufacturing Initiatives consider the impact of generation diversity and lower priced electricity facilitated by coal-fired power plants, and assess how pending coal plant retirements are likely to impact power prices, availability and reliability.



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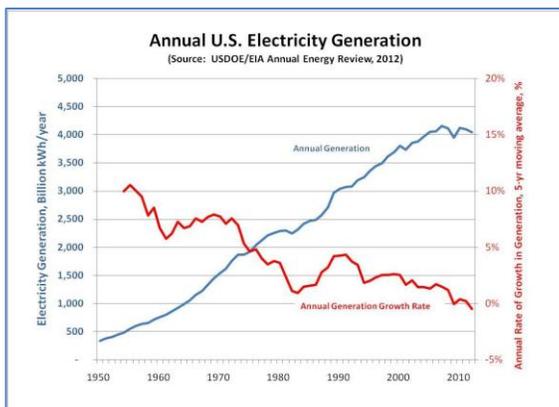
### The Value of Our Existing Coal Fleet

#### Challenges to the Existing Coal Fleet

[www.nationalcoalcoal.org/NEWS/NCCValueExistingCoalFleet.pdf](http://www.nationalcoalcoal.org/NEWS/NCCValueExistingCoalFleet.pdf)



Current challenges to maximizing available future benefits from the existing coal fleet are:

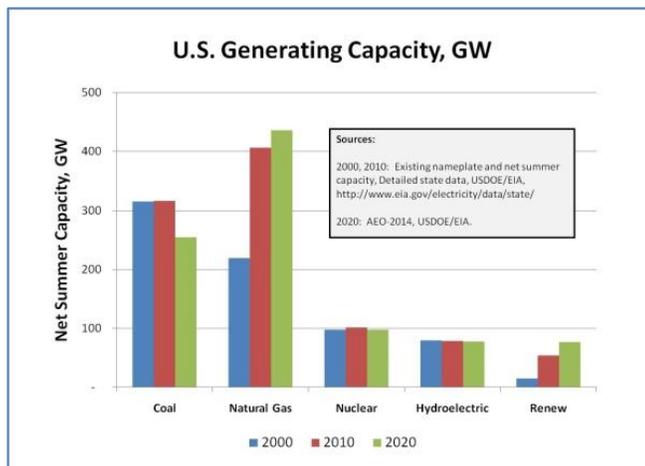
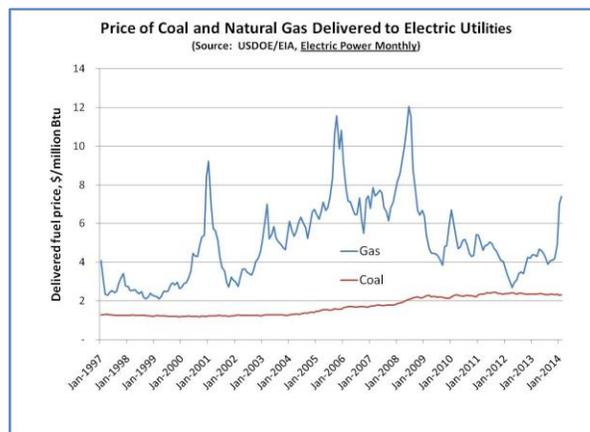


#### Reduced Rate of Demand for Electricity

Electricity demand has declined due to a combination of a slower growing economy, greater deployment of demand-side energy efficiency measures and a continuing shift from manufacturing to less energy intensive services. This relatively low rate of growth emphasizes the importance of policies and technologies that preserve the benefits offered by the existing fleet.

#### More Advantageous Natural Gas Prices [at present]

Natural gas prices of late have significantly decreased, causing greater use of that fuel. However, natural gas prices have a long history of price volatility. EIA projects gas prices will increase over 3%/year (2012-2040) vs. a 1%/year increase for coal.



#### Environmental Regulation

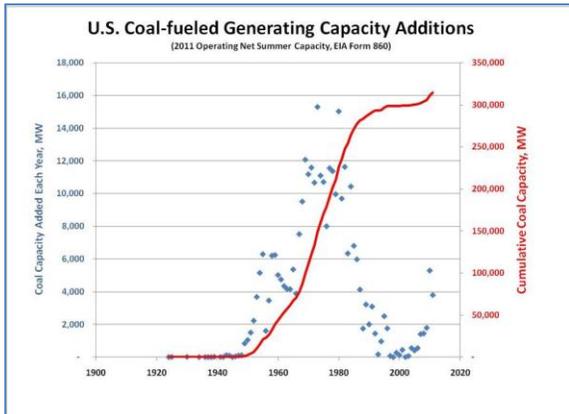
Several new and prospective environmental regulations applicable to the existing fleet will reduce operating flexibility and require implementation of very costly compliance strategies.

Cumulatively, meeting these goals will be extremely difficult and costly in the absence of CCS technology (cost to meet goals approaching 138% greater without CCS), as stated by the Intergovernmental Panel on Climate Change (IPCC). These regulations also exert operating challenges on coal plants, such as cycling, minimum load and other factors, thus causing the units themselves to operate less efficiently/economically. As a result, U.S. coal-based electric generation may decrease between 35%-98% by 2040, as compared to 2010.

## New Source Review – Major Modifications

As it is presently employed, NSR is a powerful disincentive for power plant owners to add efficiency improvements to their plants and has resulted in some efficiency improvement project cancellations, the antithesis of EPA’s goal of greater pollution control. EPA has confirmed this problem exists. Current NSR rules result in higher national emissions and continued degradation of efficiency within the existing fleet.

“...EPA concludes that the NSR program has impeded or resulted in the cancellation of projects which [sic] would maintain and improve reliability, efficiency, and safety of existing generating capacity ... [resulting in] lost capacity [and] lost opportunities to improve energy efficiencies and reduce pollution.”

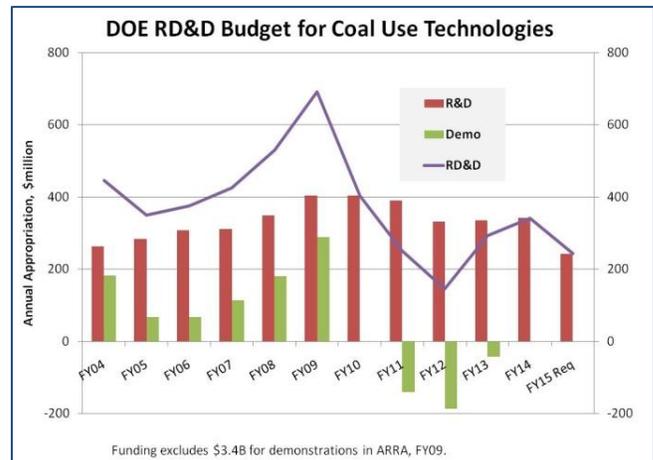


## Age of the Fleet

The majority of coal generation plants are 30+ years old. While there is no fixed endpoint for the useful life of a coal power plant, large capital investments generally are not economically viable on significantly older units, particularly for “parasitic” technologies such as CCS that do not contribute to unit efficiency and economy.

## Reduced Funds for Research & Development [Industry & Government]

In the face of all this, however, federal funding for coal RD&D has significantly decreased in recent years. The Administration’s FY2015 Research & Development (R&D) funding request represents a decrease of approximately 64% compared to average appropriations for the past 11 years. No demonstration project funding has been appropriated since 2009.



## NCC Recommendations

- DOE should work with EPA to eliminate NSR-related barriers that disincentivize generators to pursue efficiency improvements that would otherwise reduce emissions, increase capacity and enhance plant operations.
- DOE should seek input from industry associations, such as the Electric Power Research Institute (EPRI) and the Coal Utilization Research Council (CURC), regarding priority research needs and the appropriate balance between research, development and demonstration (RD&D) of technologies relevant to the existing coal fleet.



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### The Value of Our Existing Coal Fleet

#### Improving Flexibility & Reliability of the Existing Coal Fleet

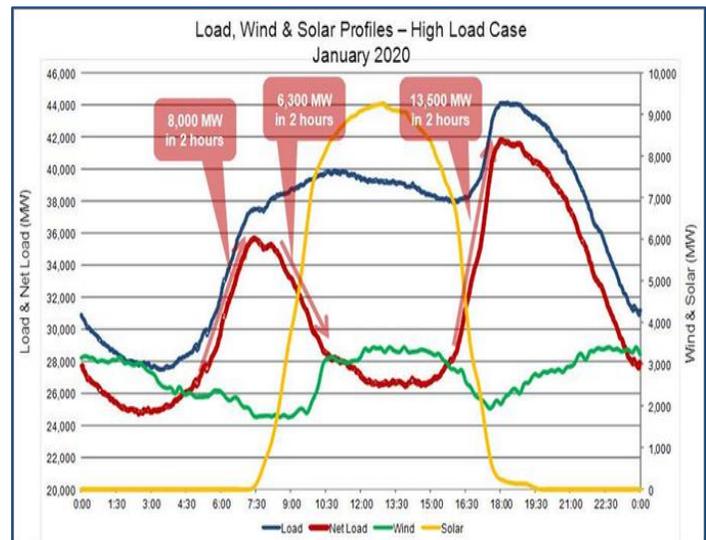
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Coal-fired generating units large and small are being operated in ways not accommodated by their original design. DOE should lead public-private collaborative programs to ensure that these units can provide the operating flexibility vital to the reliability and health of the electricity grid.

### ISSUES

- Market and regulatory factors have caused coal units to be dispatched in alarmingly different ways. Originally designed to run base-load (24/7/365 at or near their maximum output, except for planned and unplanned outages), many of these units now “ramp” often (cycle up and down in output) and start and stop frequently, sometimes daily. Must-run wind facilities and combined cycles burning historically low priced natural gas are dispatched ahead of coal.
- At the same time, when market conditions revert suddenly, such as during this past winter when gas prices escalate or gas supply is not assured, or when renewable resources are unavailable, coal units have to quickly adapt to higher run times and capacity factors.
- Frequent starts and stops and ramping impose stresses on the units, increasing O&M costs. Units suffer from thermal degradation, corrosion and fatigue of thick-walled metal components; lower efficiency, and elevated emissions levels. A full complement of environmental control systems (scrubbers, SCR, etc.) protect against higher emissions but reduce unit flexibility. Dispatch and cycling stresses increase the likelihood of critical component failures and forced outages.
- Older, smaller coal units which traditionally handled the load swings are being permanently retired, forcing larger and larger coal units into flexible but highly stressful operation. Given that it is next to impossible to permit and develop new, more flexible coal units in the near term, loss of flexibility in the existing coal units becomes a critical factor in the security and stability of the grid.
- Managing all the inputs into, and outputs from, a coal unit – water, coal deliveries, scrubber sorbent, catalyst, ash, emissions – gets progressively more difficult under such transient conditions.



### NCC Recommendation

DOE should lead collaborative efforts to develop better assessment tools for cyclic stresses and impacts, best practice guidelines for cyclic operations, R&D investigations into cycling of emissions control systems, advanced materials that better withstand stresses, coal treatment options, and advanced control and automation systems which help manage units under aggressive cycling and dispatch conditions.



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#### Enhancing Efficiency of Power Generation from the Existing Coal Fleet

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Improving thermal efficiency can reduce fuel consumption, lowers operating costs and reduce emissions, including CO<sub>2</sub>.

The operating paradigm of coal-fired plants has changed. Today base load units routinely operate in cycle mode; boiler and emissions control systems operate in highly variable modes; maintenance intervals have been extended to 3 years or longer. These trends compromise plant generating efficiency.

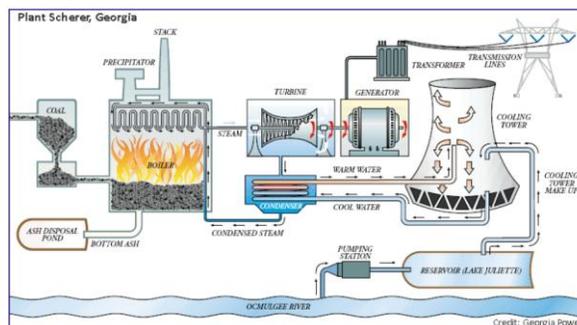
#### Numerous Opportunities Exist to Improve Power Plant Efficiency Today

In 2012, the average coal-fired power plant efficiency in the U.S. was 33%. State of the art plants around the world today can exceed efficiencies of 45%. While a number of efficiency measures are commercially available today, the benefits and cost are highly variable and site specific; many measures have already been deployed. Modest efficiency improvements are achievable today using existing technologies to improve heat transfer, reduce heat losses and make better use of low quality heat.

#### Additional RD&D Can Achieve Even Greater Efficiency Improvements

Numerous opportunities exist to achieve greater levels of efficiency improvements. Many would have a significant cost, would impose major changes to the power plant and/or would require incremental RD&D.

Achieving the most significant improvements in efficiency may be deterred by concerns that the required improvements will be characterized as a “major modification” under New Source Review regulations, resulting in additional environmental requirements that would increase costs and reduce intended efficiency gains.



#### Potential Efficiency Improvements

- Moisture Reduction in Low-Rank Coals Using Waste Heat
- Boiler & Steam Conditions
- Steam Turbine & Condenser Upgrades
- Employment of Advanced Materials
- Process Instrumentation & Controls
- Enhanced Boil Tube Coatings
- Low Temperature Heat Recovery
- Auxiliary Power Consumption
- Cooling System Design Improvements
- Changing Plant Thermodynamics
- Topping & Bottoming Cycles
- Alkali Injection to Reduce Fouling

#### NCC Recommendations

**The private sector should undertake efforts to develop and demonstrate the effectiveness and reliability of efficiency-enhancing technologies for commercial plants.**

**DOE should lead collaborative efforts with industry to design next-generation efficiency-enhancing technologies.**

**DOE should work with EPA to find a way to deploy changes at existing coal-fired power plants that would result in higher fleet efficiency without imposing new emission reduction requirements.**

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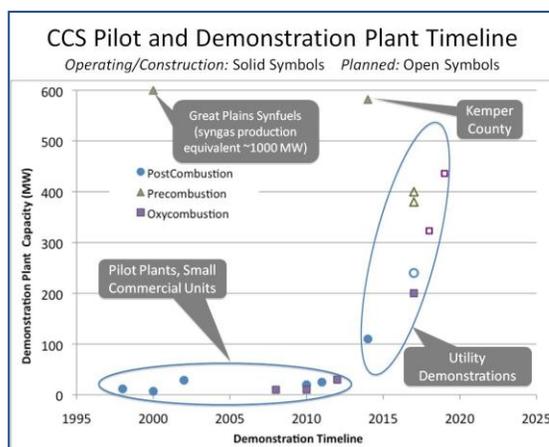
#### Reducing Conventional & CO<sub>2</sub> Emissions from the Existing Coal Fleet

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The existing coal fleet is generally well equipped with systems designed to control emissions of PM, NO<sub>x</sub> and SO<sub>2</sub>. Recently proposed or adopted regulations will lead to more stringent emission requirements aimed at reducing hazardous air pollutants (HAPs), enhancing wastewater emissions, managing solid waste management and reducing greenhouse gas (GHG) emissions. DOE should lead public-private collaborative programs to ensure compliance with environmental mandates.

#### ISSUES

- Some of the new proposed environmental regulations require compliance in a very short time frame. There is insufficient time to launch an R&D program to address these compliance issues.
- At the same time, some of the challenges posed by emerging regulations for conventional pollutants are the result of other emission control systems. New emission streams are being generated by systems employed to capture traditional HAPs.
- Proposed standards for wastewater effluents from existing coal units are not achievable under all operating conditions using existing technologies.
- Trace contaminants in solid waste streams can interfere with the ability to recycle collected materials for beneficial use.
- Commercial scale carbon capture and storage (CCS) has yet to be demonstrated due to a number of significant technical, financial, legal and regulatory challenges. The timeline for commercial-scale projects could be at least a decade from project concept to assessment of operational data.
- Retrofitting CCS to existing power plants creates challenges far beyond those that apply to greenfield CCS applications.
- DOE's RD&D program has no financial resources to move viable CCS concepts through commercial scale demonstration.
- Approximately 12 large-scale CCS demonstration projects are needed to adequately demonstrate CCS is technically feasible and commercially viable.



#### NCC Recommendation

**DOE should lead collaborative efforts with industry to develop technologies to meet additional requirements associated with managing wastewater effluents and secondary emissions from existing coal units. The need for accelerated solutions to managing conventional pollutants requires greater emphasis on hands-on test facilities that emulate the National Carbon Capture Center design concept.**

**DOE should lead collaborative efforts with industry to demonstrate at commercial scale lower cost post-combustion CCS systems with less parasitic power consumption for bituminous and subbituminous coals.**



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#### The 2014 Polar Vortex

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**“This country did not just dodge a bullet – we dodged a cannonball.”**

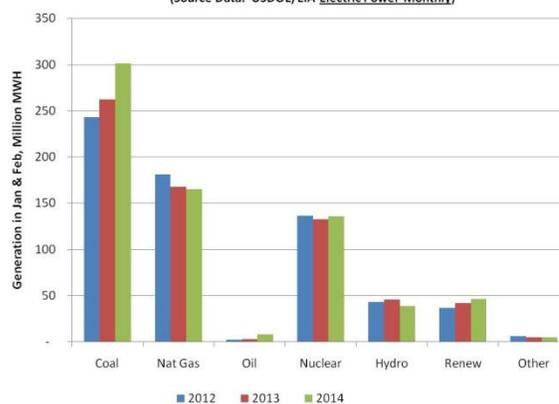
– Nick Akins, CEO  
 American Electric Power  
 Testimony before  
 Senate ENR Committee

The National Coal Council’s Existing Coal Fleet Study was conducted during the winter of 2013-2014. The severe cold weather events experienced throughout the U.S. highlighted the value of our existing coal fleet and reinforced the need to maintain our coal generation option. While electricity supply did meet demand, even under these severe conditions, electricity and gas prices surged and energy supplies were stretched to their limits. Were it not for the utilization of existing coal plants that are slated to go offline in the near future, many regions would not have met the demand for power.

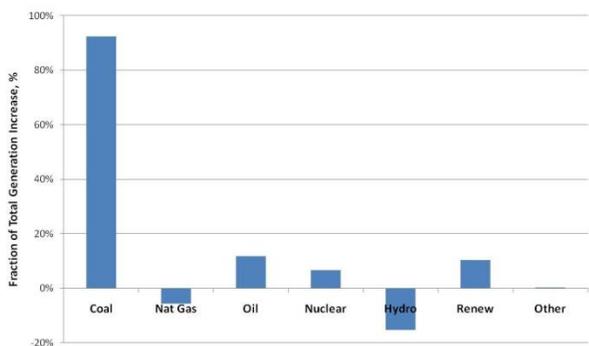
### “Coal to the Rescue”

The Polar Vortex situation is best summed up by the title of an article published on March 10<sup>th</sup>, 2014, the *New York Times* – *Coal to the Rescue, but Maybe Not Next Winter*. For the months of January/February 2014, coal was the leading source of electric power in the U.S. Wind produced just 4.7% of the nation’s power while solar produced less than 0.2%. Nuclear provided only 5% of incremental “year-over-year” generation and hydroelectric output declined 13%.

U.S. Electricity Generation for January & February, 2012-2014  
 (Source Data: USDOE/EIA Electric Power Monthly)



Portion of Increase in U.S. Electricity Generation, by Fuel  
 Jan-Feb 2014 versus Jan-Feb 2013  
 (Source Data: USDOE/EIA Electric Power Monthly)



The value of the existing fleet is not an abstract concept. At this time of great stress on power demand (Jan/Feb 2014), coal produced 92% of the increase in U.S. electricity generation relative to the same period in 2013. During this time, natural gas generation *decreased* because natural gas was diverted to fuel residential heating needs and gas prices soared to over three times that of coal.

As the year progresses, the nation is depending upon “gas to coal switching” to allow for refilling of gas storage which declined to 822 billion cubic feet (bcf) at the end of March 2014, the lowest level in over a decade.

## The Value of Diversity

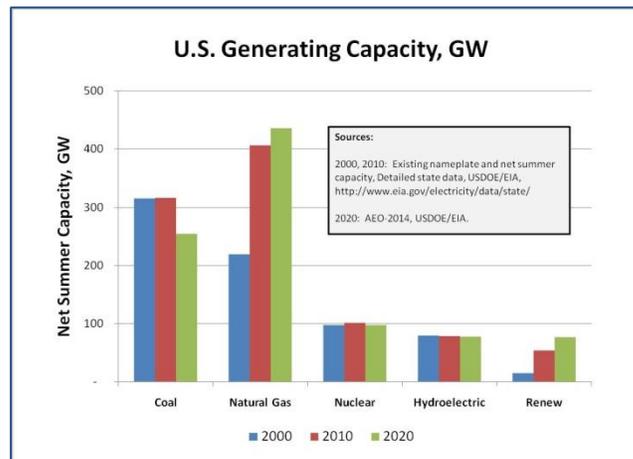
Based on the most recent data from the Energy Information Administration (EIA), if the projected premature closure of 60 GW of existing coal plants proceeds, by 2018 natural gas generating capacity will exceed that of coal, nuclear and hydro combined. This dependence on natural gas for electricity places both reliability and affordability at risk.

- “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 Existing Coal Fleet’s Value Has Never Been More Apparent

EIA indicates that at least 54 GW of coal generation will be forced to close by 2016, more than one-sixth of the entire coal fleet in just two years. Cuts into coal capacity may go much deeper, particularly as new environmental regulations now under development are promulgated.

The major lesson learned from the 2014 Polar Vortex is that the U.S. power grid is less resilient than previously believed. Only the availability and operation of coal units now scheduled for retirement over the next two years enabled the power sector to meet demand during periods of harsh weather.

## NCC Recommendation

**DOE should lead collaborative efforts with industry to assess the impacts of the 2014 Polar Vortex experience on power prices, availability and reliability.**