ANALYSIS GROUP
ECONOMIC, FINANCIAL and STRATEGY CONSULTANTS

The U.S. Coal Industry: Challenging Transitions in the 21st Century

Susan F. Tierney, Ph.D.
Analysis Group, Inc.

September 26, 2016

Executive Summary

Fundamental market forces have shaped the U.S. coal industry for decades, and continue to do so today. Until around 2000, the industry appeared to be doing reasonably well. Coal production had been rising almost every year over the course of four decades. Coal-mining productivity was improving dramatically, especially in the West, where surface-mining techniques required fewer employees per ton of coal produced. Coal prices remained relatively low, helping to sustain coal's position as the electric utilities' preferred fuel for power production and giving coal a 50-percent share of the nation's power supply.

This productivity, however, did not come without consequences. in the form of reduced jobs, lives lost, and environmental impacts. Between 1975 and 2000, total employment in the U.S. coal industry dropped by more than a half (from nearly 225,000 to under 110,000).[1] In the last 15 years of the 20th Century, coal-*mining* jobs dropped by 53 percent.[2] All of this happened at precisely the time that coal sales were reaching record high levels. Meanwhile, over 2,100 mine workers lost their lives due to mining-related injuries between 1975 and 2000.[3] Coal-fired power generation contributed significantly to rising carbon emissions and unhealthy levels of local air pollution.

The seemingly strong footing that the coal industry stood on at the end of the 1990s actually rested on a number of risky foundations: A positive outlook for the U.S. coal industry into the future depended upon its continued dominance in one single market – U.S. electric power generation, where 90 percent of coal output was sold and used. This dominance, in turn, depended upon the continued price advantage of coal over other fuels for power production. That continued economic advantage depended upon continuing productivity improvements in the mining industry. And positive economic conditions in coal-mining states depended upon rising coal production.

None of those assumed conditions have come to pass, and market forces have shaped new economic conditions in the coal industry since then. Varied market trends – declining coal-mining productivity, declining global demand for U.S. coal exports, increased competition from natural gas as a result of the shale-gas revolution, the ever-increasing efficiency with which consumers use electricity, the overall flat demand in the power sector, the recent cost reductions in renewable energy technology, environmental regulations addressing

unhealthy levels of air pollution from coal combustion, and poor investment decisions by a number of large coal companies – have contributed to the coal industry's troubles since 2000.

Thus, in this 21st Century, the coal industry is troubled. Productivity has eroded as it has become harder to access coal at low cost. Coal has lost its price advantage for power production now that natural gas prices are so low, and coal's share of the power mix has dropped to one-third (the same as natural gas's).

Coal production and the total number of coal-mining jobs in America are now at their lowest in at least three decades. The media's attention to recent declines in coal-mining jobs and to recent bankruptcy filings of major coal companies (such as Peabody Energy, Arch Coal, Alpha Resources) are acutely visible symbols of these changes. But these outcomes have been in the works for many years, starting well before the turn of the century.

These underlying trends and outcomes are summarized in Figures ES-1a and ES-1b:

Trends and Outcomes in the U.S. Coal Industry: Pre-2000 and Post-2000

Figure ES-1a: Coal Production Levels (1985-2015)

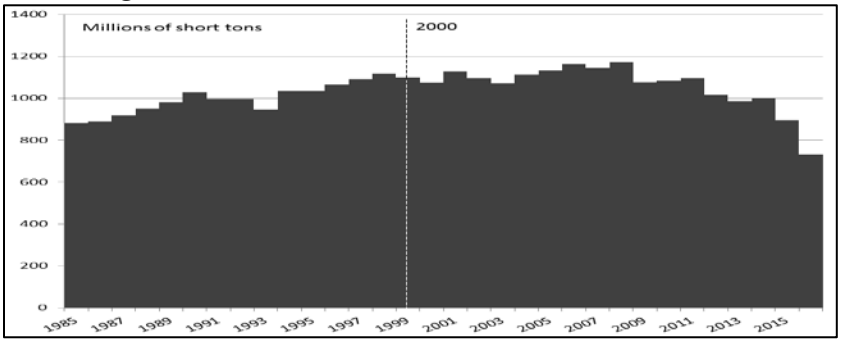
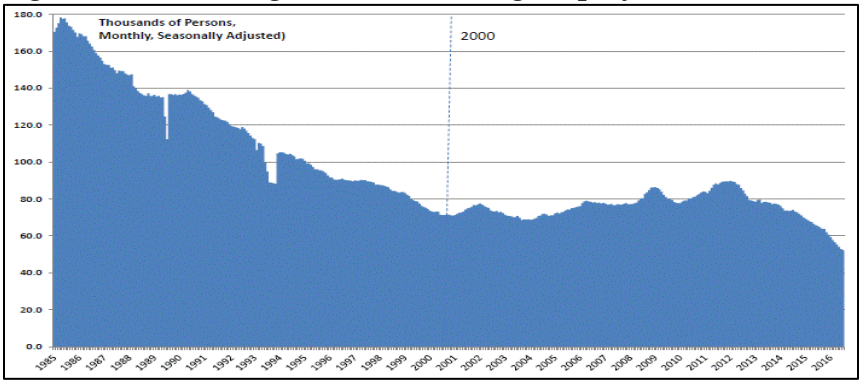


Figure ES-1b: Changes in Coal-Mining Employment (1985-2015)



Source: U.S. Energy Information Administration ("EIA") coal database

TRENDS AND OUTCOMES LEADING UP TO THE YEAR 2000

- The U.S. had **robust coal production and an outlook for steady growth.**
- **Low-cost coal production and low coal prices** were enabled by dramatic **productivity improvements in coal mining**, with those improvements occurring especially in the Western U.S. where surface mining prevailed.
- **Power-sector demand for coal was relatively positive:** U.S. demand for coal was rising. By 2000, over 90% of domestic coal supply was used for U.S. power generation. From 1950 to 1990, more coal-fired generating capacity entered the market than any other technology, leading to an increasing share of power generated by coal. 53% of all electricity was from coal-fired generating stations in 2000.
- **Conditions favored a robust outlook for coal,** based on a number of metrics: production trends, productivity gains, sales into export markets, a highly available fuel for low-cost power generation, and a sizable proven coal resource base.
- **But those conditions came at some real costs**: Coal-mining jobs dropped by half from 1975-2000, with jobs in Appalachia dropping 60% from1985 to 2000 alone.
- Many parts of the U.S. had **unhealthy levels of harmful air pollution** resulting from coal combustion at power plants.
- A **sustained strong outlook for the coal market beyond ~2000 would depend on several "risky" assumptions: e.g.,** the continued favorable price advantage of coal relative to other fuels (especially natural gas); further productivity improvements; continued strong demand for coal in a growing power market – none of which ended up being right.
- Even with decreasing injury rates, **over 2,100 mine workers lost their lives** due to mining-related injuries from 1975 to 2000.

TRENDS AFTER 2000, WITH OUTCOMES AS OF ~2016

- **The "shale gas revolution" has reshaped U.S. energy market conditions.** Gas production grew by one-third since 2008 and prices dropped 70%.
- **Increasing amounts of new gas-fired generating capacity entered the market,** enabling these plants to increase their output significantly once gas prices ended up dropping since 2008.
- By contrast, only a small amount of new coal-fired capacity was added after 1990. This led to an **aging fleet of coal plants** with many small, inefficient generating units lacking modern pollution controls.
- **Demand for electricity has been flat**, due to significant gains in both the efficiency of electricity use and generation.
- **The costs of renewable energy have dropped dramatically,** with a growing share of wind and solar generating capacity.
- **Productivity gains experienced by the U.S. coal industry prior to 2000 reversed after roughly 2005**: Productivity and production levels in Western states decreased as rapidly in the past decade. U.S. coal production costs increased as producers rushed to increase output at "almost at any cost" and added mining jobs from around 2000 to around 2010.
- **Coal lost its comparative advantages after 2000.** Prices of metallurgical coal (used in global industries) rose in the 2000-2010 period, leading to a rush for production of such coal. But prices for metallurgical coal have collapsed, in part with a weakening of industrial demand for coal (including in China).
- **U.S. coal production has steeply dropped in the past five years**. It peaked in 2011 and then has now dropped to its 1980 level, leading to continued decreases in coal-mining employment.
- **The coal industry's dependency on power-sector demand exposed it to transitions that have been occurring over several decades and led to a lower market share of coal for power generation**. These conditions included: flat demand; strong competition from gas-fired power plants that previously had low levels of utilization and which could increase output as natural gas prices dropped relative to coal's; growing installations of wind and solar project capacity; retirements of older and less-efficient coal-plant capacity leading up to 2015 when new regulations controlling mercury and toxic air pollution went into effect.
- **These trends have reduced air pollution from the power sector.** The shift away from coal-fired generation toward gas-fired and renewable power production has contributed to lower emissions of air pollutants that contribute to Acid Rain, smog, regional haze, respiratory diseases and other public health problems, and climate change.
- **Carbon-dioxide ("CO_2") emissions from the power sector continued to increase until 2007,** when they began to drop**.** To address climate change, the U.S. entered into international commitments to reduce CO_2 emissions. In 2015, the Environmental Protection Agency finalized Clean Power Plan regulations to reduce carbon emissions from existing power plants.
- **Major coal companies grew through mergers and acquisitions** during the ~2000-~2010 period, betting on continued growth in U.S. and global markets and a sustained market tolerance for high prices.
- **Major U.S. coal companies are under financial stress,** resulting in part from corporate growth strategies, and in part from the many market forces affecting supply and demand for coal. Coal companies' costs are high, demand for their product is low, financial returns have been trimmed, market value has dramatically dropped in recent years. Over the past five years, 13 U.S. coal producers lost more than 92% of their market value. Several major U.S. coal companies filed for bankruptcy.

In effect, these various conditions have taken the coal industry back to the position it was in several decades ago. And its market share is likely to continue to decline gradually over the next decade as the trends already underway in the electric industry further erode the role of coal. In spite of these challenges, however, the coal industry will still have many more years in which it supplies fuel to companies in U.S. markets. For example, most of the recently published estimates of the impact of the upcoming federal Clean Power Plan (scheduled to go into effect starting in 2022) indicate a continuing important role for coal even as market forces and states' policies and plans are leading to greater utilization of natural gas and renewable energy.

Regardless of the relatively small incremental effect of the Clean Power Plan on outcomes for the U.S. coal industry, its long-run ability to prosper will depend on how it succeeds in innovating, making productivity improvements and regaining cost advantages, on how well coal companies are able to restructure their balance sheets and control costs, and on how the industry (and others) can get behind support for breakthroughs in science and technology that will enable energy industries to burn coal while also substantially controlling and managing its carbon emissions.

Purpose and Focus of the Report

This independent report, commissioned by Environmental Defense Fund but solely authored by Susan Tierney[4] of the Analysis Group, provides a descriptive overview of recent market trends in the U.S. coal industry with attention to both market force and regulatory drivers of change affecting the supply and demand for coal produced in the United States. The report also discusses various impacts and outcomes of these trends, not only for the coal industry but also for the financial status of various coal companies, for coal-mining jobs and workers, for coal production trends in various regions of the U.S., for generation mixes in the power market, and for emissions from the power sector.

Table of Contents

Introduction

Fundamental market forces have shaped the U.S. coal industry for decades, and continue to do so today.

In the last quarter of the 20th Century, the U.S. economy grew and Americans' standard of living rose as the nation electrified its energy system. This economic growth tapped into the vast domestic resources of cheap coal and the coal companies and miners that produced ever-increasing quantities of supply. By many measures – productivity improvements, coal-mining output, and growing share of power production – the U.S. coal industry looked to be reasonably strong as of the year 2000.

This productivity, however, did not come without consequences. Between 1985 and 2000, the number of U.S. coal-mining jobs dropped by more than a half.[5] Over 2,100 mine workers lost their lives due to mining-related injuries between 1997-2000 alone.[6] Coal-fired power generation contributed significantly to rising carbon emissions and unhealthy levels of local air pollution.

The seemingly strong footing that the overall coal industry stood on at the end of the 1990s actually rested on a number of risky foundations: A positive outlook depended heavily on the continued dominance of coal in one single market – U.S. electric power generation – which was on the verge of a massive market-driven transformation. This market dominance also depended upon a continued price advantage of coal versus other fuels for power production. That continued economic advantage depended upon continuing productivity improvements in the mining industry. And the economic conditions in coal-mining states depended upon rising coal production.

Since 2000, these market trends – declining coal-mining productivity, shifts in global demand for coal, the shale-gas revolution which eroded coal's price advantage, the ever-increasing efficiency with which consumers use electricity, the overall flat demand in the power sector, recent cost reductions in renewable energy technology, poor investments by a number of large coal companies – have caused the coal industry's fortunes to decline, as described further in this report. In addition to those market-driven impacts, new but long-anticipated regulations to address the unhealthy levels of air pollution added pressure on the least-performing coal-fired

power plants. But even so, the forces that have reshaped the coal industry have been underway for decades.

Coal production and the total number of coal-mining jobs in America have returned to levels last seen in the 1980s (although most of the decline took place before 2000). The media attention to continuing declines in miners' employment levels (especially in Appalachia) and recent bankruptcy filings of several major coal companies (such as Peabody Energy, Arch Coal, Alpha Resources) are acutely visible symbols of these changes, but these outcomes have been in the works for many years starting well before the turn of the century.

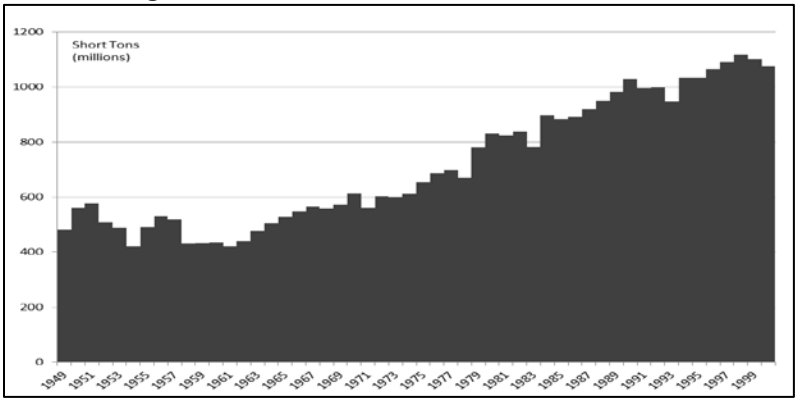
This report summarizes the fundamental changes that have shaped the course of the coal industry over a number of decades, starting with a thumbnail sketch of conditions prior to start of the 21st Century, and then providing a more in-depth review of the forces that have been transforming the American coal industry.

The U.S. Coal Industry: Trends and Outcomes as of Around 2000

Trends Affecting the Market for U.S. Coal

As of the year 2000, coal played a growing and important role in the nation's overall energy supply. The United States' proven coal resource base surpassed that of any other country and accounted for 25 percent of the world's total reserves.[7] Coal production was robust, with steady growth (Figure 1).

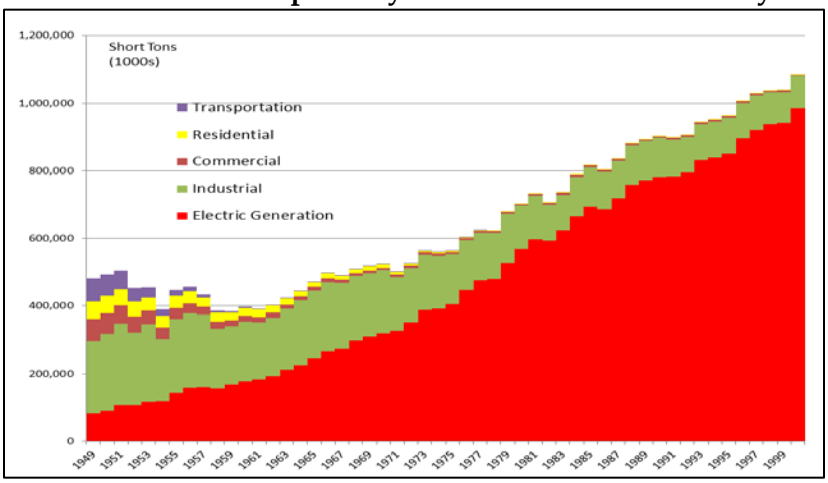
Figure 1: U.S. Coal Production: 1949-2000



Source: EIA coal database.

Even though domestic industrial demand was declining, overall U.S. demand for coal was rising, with a growing share of coal consumed for power generation (Figure 2). More than 90 percent of American coal supply was used to produce electricity in the U.S. in 2000.

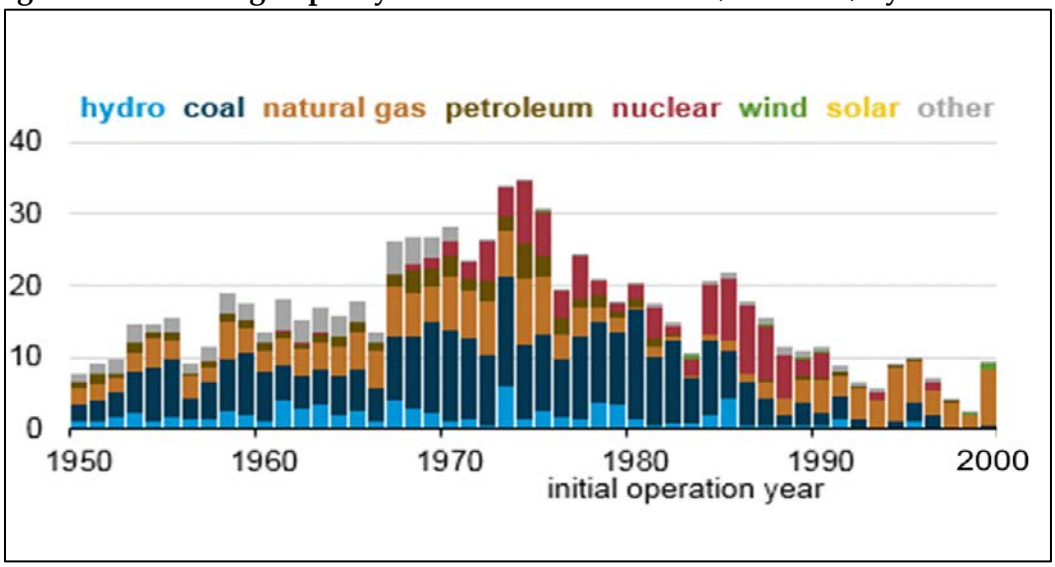
Figure 2: U.S. Coal Consumption by Sector of the U.S. Economy: 1949-2000



Source: EIA coal database

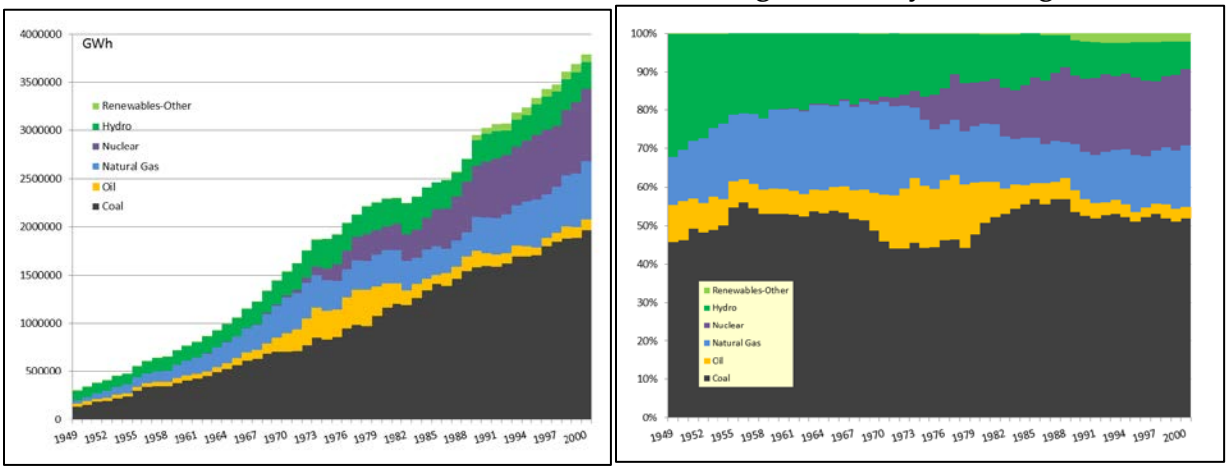
In the forty years between 1950 and around 1990, more coal-fired generating capacity entered the market than any other generating technology (Figure 3). 53 percent of all U.S. electricity generation occurred at coal-fired generating units in 2000 (Figure 4). Even so, the coal fleet was aging, with a significant amount of plant capacity built decades before the turn of the century. As of 2000, only a quarter of the nation's coal-fired generating capacity was younger than 25 years old, and a sixth was already over 40 years in age. The older plants were relatively small and less efficient, and tended to lack modern pollution control equipment.[8]

Figure 3: Generating Capacity Additions in Each Year (1950-2000) by Fuel Source



Source: Excerpted from EIA, "Demand trends, prices, and policies drive recent electric generation capacity additions," March 18, 2016.

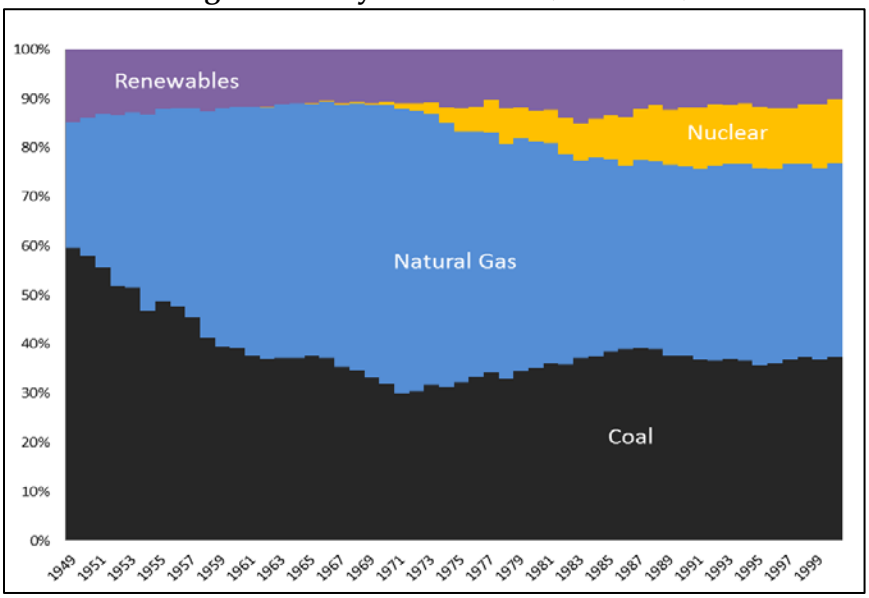
Figure 4: U.S. Electric Generation by Fuel: 1949-2000
Absolute Year-to-Year Growth (Left) and Percentage Shares by Fuel (Right))



Source: EIA electricity database

Among uses of energy outside of the transportation sector (which was almost entirely based on oil as of 2000), coal held steady as a critical source of energy to the U.S. economy (Figure 5). For decades, coal had accounted for approximately 40 percent of non-transportation uses of energy in the United States.

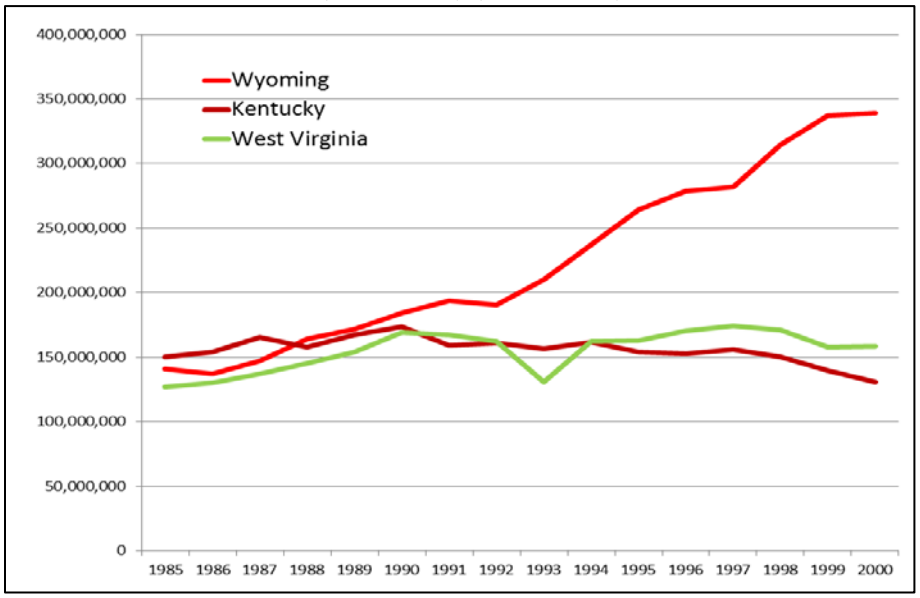
Figure 5: Energy Consumed for Non-Transportation Uses – Percentage Shares by Fuel Source (1949-2000)



Source: EIA energy database

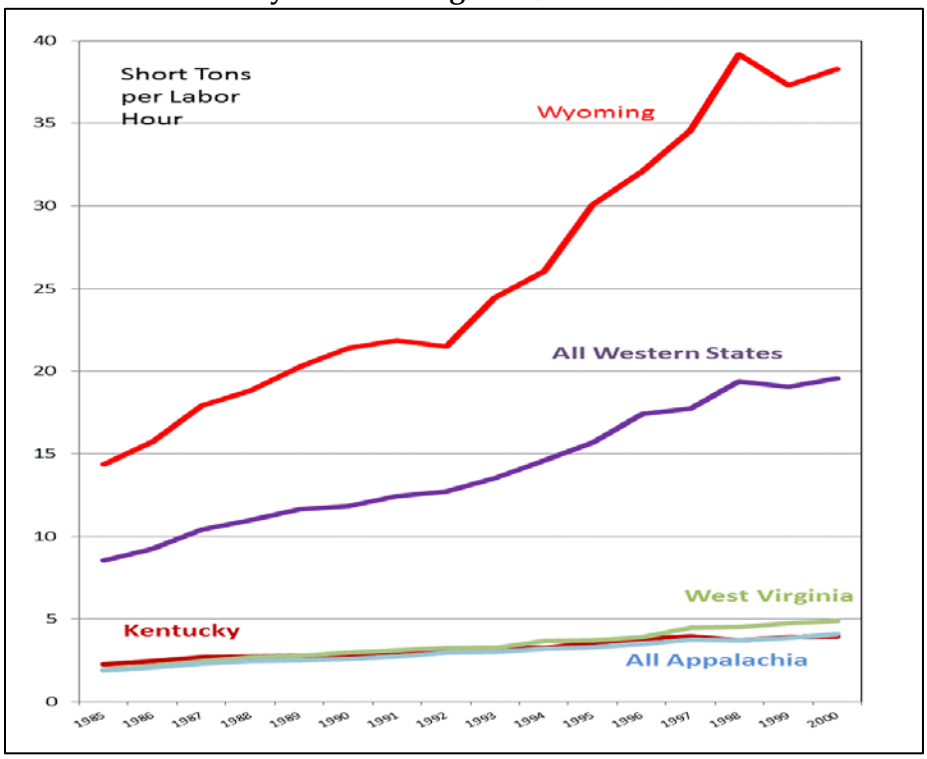
Low-cost coal was enabled by dramatic productivity improvements. As of 2000, the most productive region, Wyoming, required less than 14 percent of the labor per ton of coal mined than the Appalachian region. Western coal gradually increased its previously insignificant share of total U.S. coal production, and accounted for over half of the nation's output as of 2000. Coal produced in Wyoming alone exceeded the output of West Virginia and Kentucky combined (the states with the next-largest production levels as of 2000). (Figure 6.) Productivity improvements were particularly strong in the Western half of the United States (west of the Mississippi River), with that region's coal-mining operations relying primarily on surface-mining methods. (Figure 7.) Western coal, with its low-sulfur content, was also particularly valuable in the years following the enactment of more-protective air pollution control requirements in the 1990 Amendments to the Clean Air Act.[9] Even so, the overall growth in U.S. demand for coal allowed the Appalachian region to maintain its production, even as more market share shifted to the West.

Figure 6: Coal Production: Wyoming, Kentucky, West Virginia (1985-2000) (short tons)



Source: EIA, Annual Coal Reports (1994-2015)

Figure 7: Coal-Production Productivity Improvements by Selected Regions (1949-2000)



Source: EIA, Annual Coal Reports (1994-2015)

As of 2000, the U.S. coal industry had for several decades been the world's second-largest exporter of coal, helping to fuel the increasing global appetite for metallurgical coal and thermal coal (used for industrial purposes and power generation, respectively), especially in Asian markets.[10] This global, high-value market appeared poised for significant growth and coal companies began making big bets based on that assumption.

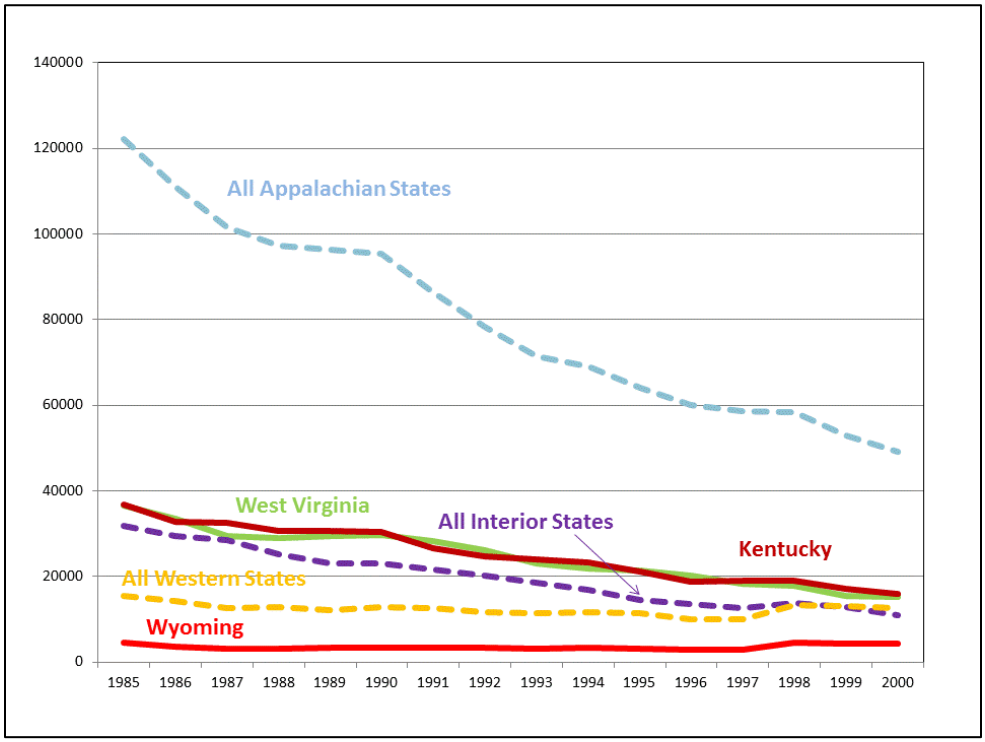
Outcomes in the Coal Industry as of ~2000

Thus, from the perspective of the end of the 20th Century, the conditions in the U.S. coal industry seemed relatively robust based on a number of historical trends in coal production, productivity gains, sales into export markets, a highly available fuel for low-cost power generation, and the world's largest proven coal resource base.

A sustained strong outlook into the 21st Century, however, would depend on the continuation of several factors: the continued favorable price and cost advantages relative to other forms of electric generation (including natural gas and renewables); further productivity improvements in getting coal out of the ground and delivering it efficiently to buyers; and sustained delays in addressing air pollution issues (and other environmental considerations) associated with high reliance on coal for power generation.

A positive outlook was also premised on mitigating risks associated with the coal market's dominance of the power sector coupled with sustained increases in electricity demand, as well as growing demand in global markets for coal, and cost-competitiveness of U.S. coal delivered into those distant markets.

Figure 8: Total Coal-Mining Employment Levels in Selected States and Regions: 1985-2000



Source: EIA, Annual Coal Reports, 1994-2015

The end of the 20th Century thus displayed a mixed set of conditions for the coal industry, with both positive and negative outcomes resulting from complex market forces. Although coal companies were prosperous, there were economic hardships in the local economies that depend upon coal-mining employment.

States, like many in Appalachia such as West Virginia and Kentucky, that had depended upon coal-mining employment for decades, were feeling the pain of workforce contractions even as production was up. Coal-mining employment in Appalachian states dropped 60 percent from 1985 to 2000, and Appalachian coal decreased as a share of total U.S. coal production.

The effects were different in Western coal-dependent states. Even though there were many fewer miners involved in the surface-mining coal-production activities in Western states, such as Wyoming, these states' economies experienced a growing dependency on coal production and the royalties it provided to the state's treasuries.

This tied these Western states' economies to output (and royalty payments) from coal mines (rather than from the number of jobs in the coal industry itself). This contrasts with conditions in Appalachian coal-mining states where the economies were tied to coal jobs – which were also decreasing year by year.

The U.S. Coal Industry: Major Changes Since 2000

Introduction

The first 15 years of the 21st Century has seen an erosion in the role of the U.S. coal industry largely as a result of corporate decisions of coal companies as well as changing market fundamentals that have not favored coal.

By 2016, it is now clear that the comparative advantages of coal have diminished. In recent years, production levels have dropped substantially. Coal companies' costs have increased, and prior productivity gains in coal production have eroded. Coal's market share for electricity production is down, from approximately 50 percent (as recently as 2005) to 33 percent in 2015. Consistent with long-standing norms associated with economic dispatch of generating units, power companies switched the dispatch order of their power plants, running lower-cost natural gas plants more often and decreasing output from coal-fired units. In the past year, several major coal companies (including three of the nation's largest coal-energy companies: Peabody Energy, Arch Coal and Alpha Resources) have filed for bankruptcy.[11] Although coal mining is still occurring at many of the mines owned by those companies, the total number of coal-mining jobs in America is at its lowest level it has been in at least three decades.

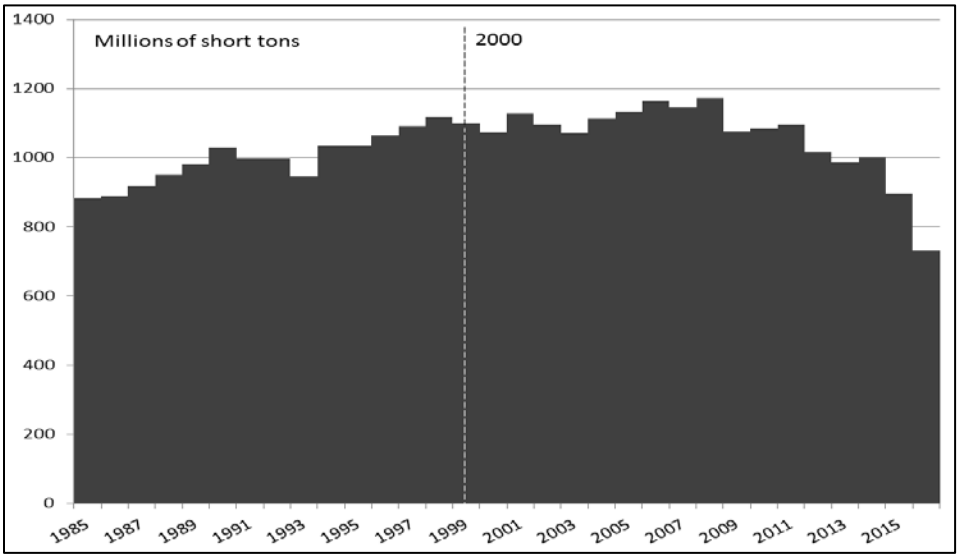
What do the updated metrics show with the post-2000 conditions of the coal industry in the U.S.?

Coal production and coal-mining employment are in decline

U.S. coal production is steeply down in the past five years. After a few years of continued growth in coal output after 2000, annual coal production peaked in 2011 and has since then dropped to the level it was around 1980 (Figure 1 and Figure 9.). Coal-mining employment is lower than it has been in several decades, having dropped from roughly 180,000 in 1985 to 73,700 in 2000 (a 53-percent decrease), and is now down to about 52,900 in mid-2016.[12] (Figure 10.) (Notably, bigger reductions in

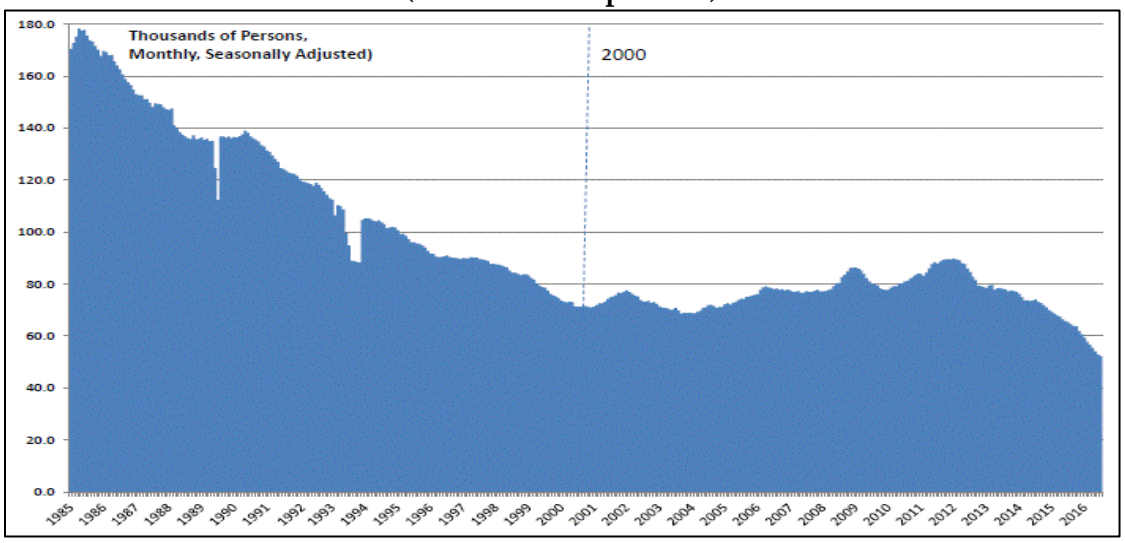
the coal-mining workforce occurred in the last quarter of the 20th Century than in more-recent years.)

Figure 9: U.S. Coal Production: (1985-2016 (est.))
(Millions of short tons)



Source: EIA, Coal database.

Figure 10: Coal Mining Employment: Q1 1985 to Q2 2016
(Thousands of persons)



Source: Federal Reserve Bank of St. Louis, Economic Research Division, Economic Data

Productivity challenges and prices during the past 15 years

The market for U.S. coal has been on a roller coaster in recent years. For a variety of reasons (such as erosion of economies of scale in certain mining techniques, "deeper, harder to mine geology"[13]), the productivity gains experienced the U.S. coal industry over the last decades of the 20th Century reversed in the past ten years.[14] (See text box, and Figure 11.) Productivity and production levels in Wyoming and other Western states, in particular, decreased as rapidly in the past decade (especially in the post-2008 period) as they increased prior to 2000. (Figure 12.)

"US coal industry challenged by over a decade of declining productivity," March 6, 2014.

Following a rise in productivity from technological and other mining improvements, the amount of coal produced per employee hour appears to have peaked around 2000 in most major U.S. coal-producing regions and then notably declined over the past decade…… The most obvious factor playing into coal miner productivity is the method of coal mining, such as underground versus surface, but there are also major regional and geological variables…. **Causes of productivity decline are difficult to pinpoint. …**

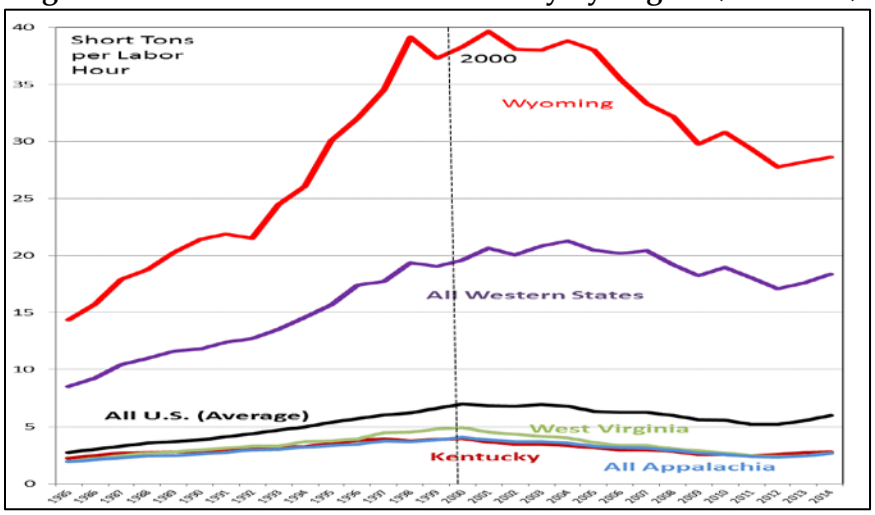
"The Appalachia problem: Coal has been mined intensely in the Central Appalachian Basin for decades, compared to relatively new mining activity in the PRB. As more coal is mined in the region, it becomes increasingly difficult to find the thick and shallow coal seams that kicked off what remains one of the largest industries in the region. "Now the underground mines are coming into deeper, harder to mine geology, which will impact productivity and has impacted productivity, especially east of the Mississippi River," Paduano said….In the face of increasing costs, many larger companies are decreasing their exposure to Central Appalachian thermal coal. Coal that is sold at higher margins, such as metallurgical-grade coal, can continue production in the face of rising costs, and many companies in the basin are increasing their focus on metallurgical coal markets…. Kentucky Coal Association President Bill Bissett also pointed out that long-term contracts with utilities were more commonplace during the last surge in productivity. Short-term contracts now limit companies' ability to sustain consistently high production levels.

Different story in Wyoming….: Coal miners in Wyoming's PRB are facing relatively fewer challenges to productivity as the basin still offers plenty of thick, shallow coal seams accessible by large-scale surface mining. Though producers in the PRB generally have productivity values that are multiples higher than eastern producers, the basin has seen a fairly steady decline over the past decade following a boom in activity and rise in productivity that peaked in 2000…."Mostly, the surface mines in Wyoming were capturing 40% of the US market with coal selling at $6/ton," Carroll said. "So between 2000 and 2008 Wyoming surface mines were producing the most coal that anyone had ever seen before at very high productivity rates." Ultimately, PRB producers could run into the same problem as Central Appalachian producers as they work through the easiest-to-mine seams of coal….

Taylor Kuykendall and Rizwan Qureshi, "US coal industry challenged by over a decade of declining productivity," SNL Financial, March 6, 2014.

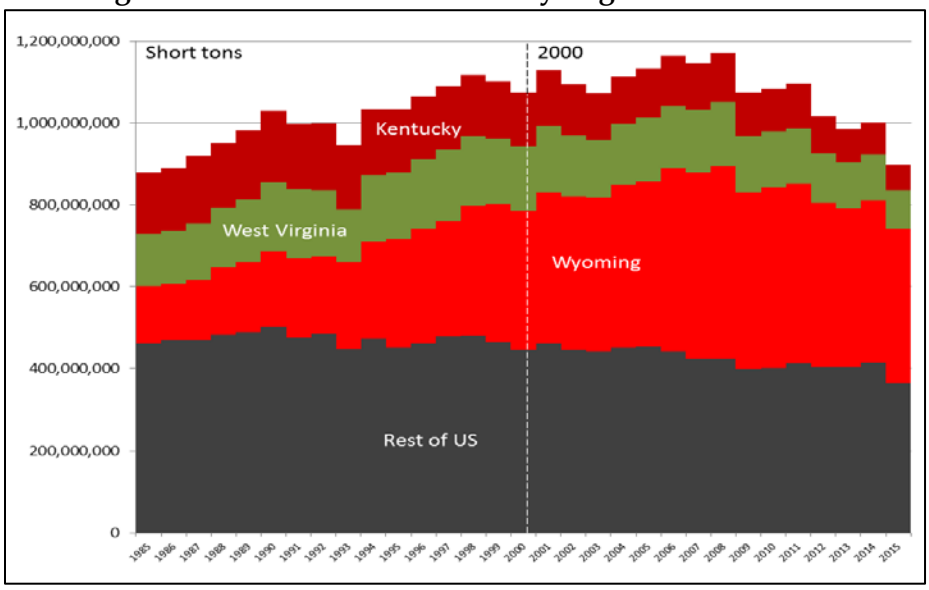
These trends resulted, in part, from a price-and-demand-driven push for high levels of production up to 2008, with output favored over cost and productivity considerations. As described further below, price signals in international coal markets (especially for higher-valued metallurgical coal) and domestic natural gas markets up through 2008 fueled a rush for increased coal production in the United States and other countries.

Figure 11: Coal-Production Productivity by Region (1985-2015)



Source: EIA, Annual Coal Reports, 1994-2015

Figure 12: U.S. Coal Production by Region: 1985-2015

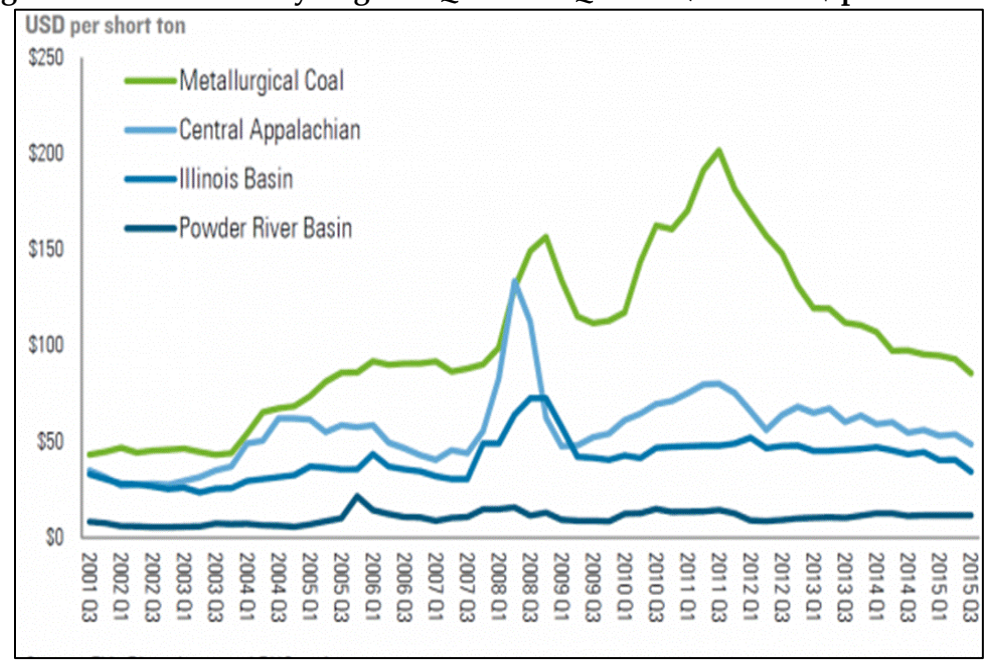


Source: EIA, Annual Coal Reports, 1994-2015

The prices for coal produced in different parts of the United States since 2000 have presented mixed challenges. On the one hand, prices of metallurgical coal (used in the global industrial sector), rose dramatically in the first decade of the 21st Century, leading to a rush for production of that type of coal, for both domestic and export markets.[15] (Figure 13, showing prices of coal produced in various regions of the U.S.

since 2001.) Prices for metallurgical coal softened as of around 2011, however, in part with a weakening of industrial demand for coal (including from China).[16]

Figure 13: Coal Prices by Region: Q3 2001 – Q3 2015 (Nominal $ per short ton)



Source: Trevor Houser and Peter Marsters, "The Hidden Cause of America's Coal Collapse," Rhodium Group, February 22, 2016

Coal production costs increased in the U.S. industry as coal producers rushed to increase production "almost at any cost"[17] and added coal-mining jobs during the first ten years of the century. (Figure 10.) Coal companies also grew through mergers and acquisitions, and added significant debt to their balance sheets.[18]

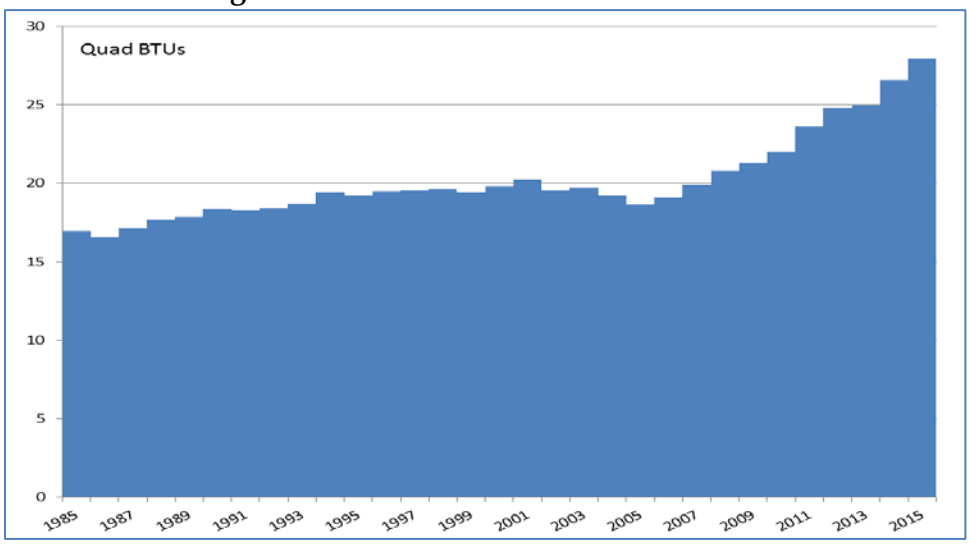
Within the domestic market for U.S. coal (where most of domestic coal is consumed for power generation), coal was still cost-competitive up to 2008 because these prices were still lower than the price of natural gas. (See discussion below.)

But in the past five-plus years, global demand for coal – including U.S. coal – has weakened, with changes in the Chinese economy, global over-supply of coal, and the relatively high cost of coal exported from the U.S. coal fields (as compared to, for example, delivered prices of coal exported from Australia into those markets).[19] In turn, these have contributed to price and production declines even in major coal-producing regions in the West.

U.S. shale gas revolution

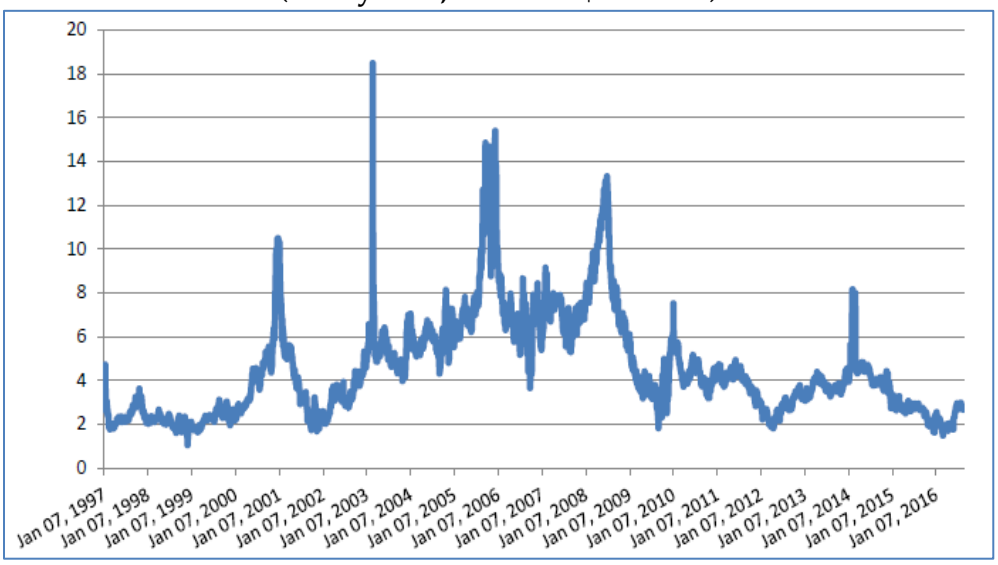
The now-famous changes that have reshaped the domestic natural gas market have greatly impacted the market for coal.[20] Since 2008, U.S. production of natural gas has grown by one-third (Figure 14) and average annual natural prices have dropped by 70 percent (Figure 15).

Figure 14: U.S. Gas Production: 1985-2015



Source: EIA, Natural Gas database

Figure 15: Natural Gas Prices: January 1997 – January 2016
(Henry Hub, Nominal $ MMBtu)



Source: EIA, Natural Gas database

These conditions are the reverse of what happened to production and prices of coal since 2008. While coal production tended to surpass natural gas production for decades, these trends changed after 2008, with coal production declining while natural gas production was increasing. (Figure 16a, showing absolute quantities of U.S. coal versus natural gas production; Figure 16b, showing change in production relative to 2008.) The relative change in price of natural gas to coal is also significant, as shown in Figure 17. Since their peak just before the global economic collapse in 2008, natural gas prices have remained below their early 2008 levels. Coal prices have consistently been above their 2008 levels, while the opposite is true for natural gas. This has eroded the market share of coal used for power generation.

Figure 16a
Coal versus Natural Gas Production: U.S., 1985-2015 (Quad Btus)

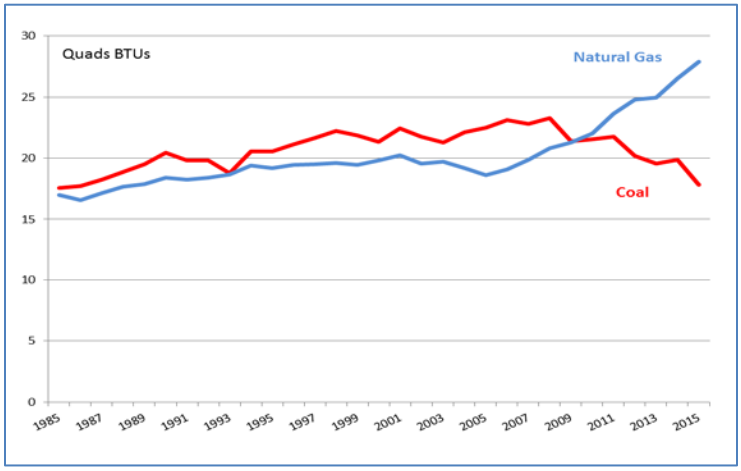
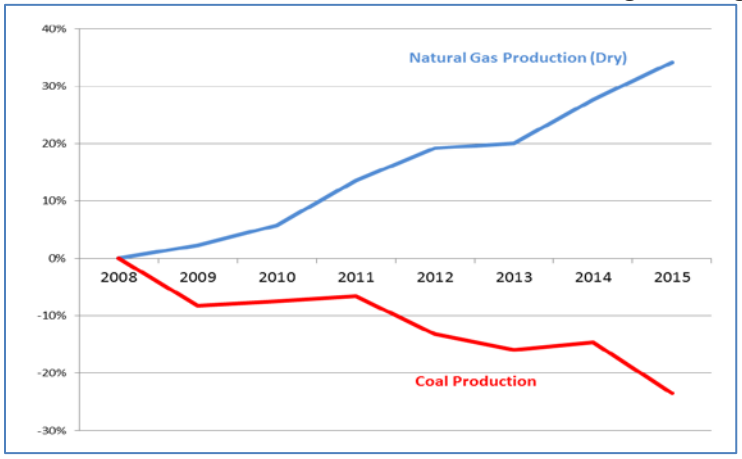
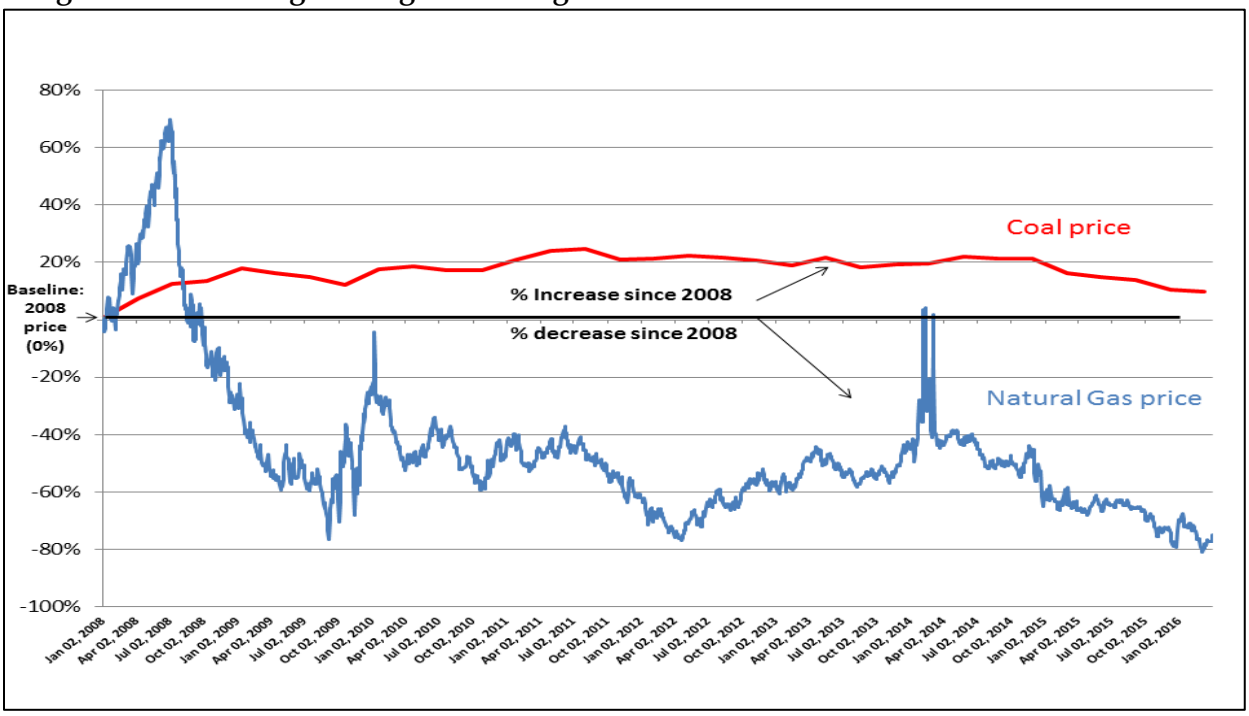


Figure 16b
Change in Production: Coal v. Natural Gas: U.S., Percentage Change from 2008



Source: EIA energy price data

Figure 17: Percentage Change in Average Prices for Natural Gas and Coal Since 2008



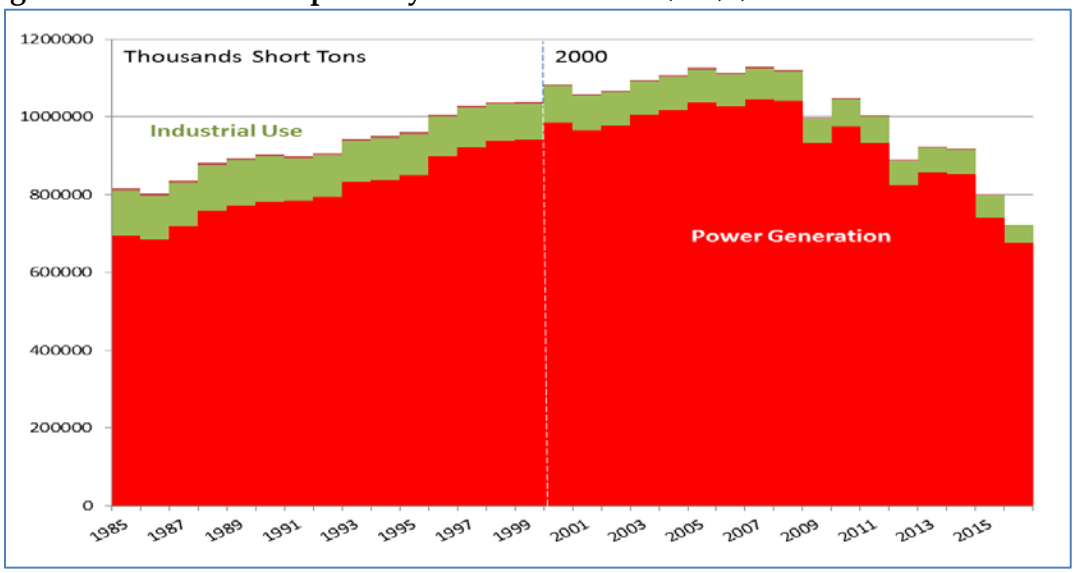
Source: EIA energy price data

Sales of U.S. coal are linked to conditions in the U.S. power-sector

Given its dependency on electric-sector demand (which accounted for over 90 percent of U.S. coal consumption in 2008), the coal industry has been vulnerable to a number of transitions that occurred over the past two decades and which have materially reduced demand for coal. Figure 18 shows total consumption of coal in the United States, with a significant decline in the past decade in both power-sector and industrial use of coal.

The changing conditions in the power-sector's demand for coal have resulted from a combination of inter-related factors – with few working to the advantage of coal (especially compared to the years leading up to 2000).

Figure 18: Coal Consumption by Sector: 1985-2016 (est.) (Thousands of Short Tons)



EIA, Coal database

Flat electricity demand

Overall demand for electricity has remained flat over the past decade; total power produced in the U.S. in 2015 is only 1 percent higher than it was in 2005, with several periods of decreases within the decade.[21] As described by Bloomberg New Energy Finance, "Energy productivity – the ratio of US GDP to energy consumed – continues to grow, improving by 2.3% from 2014 to 2015 following a 1.1% increase the previous year. The US economy has now grown by 10% since 2007, while primary energy consumption has fallen by 2.4%."[22]

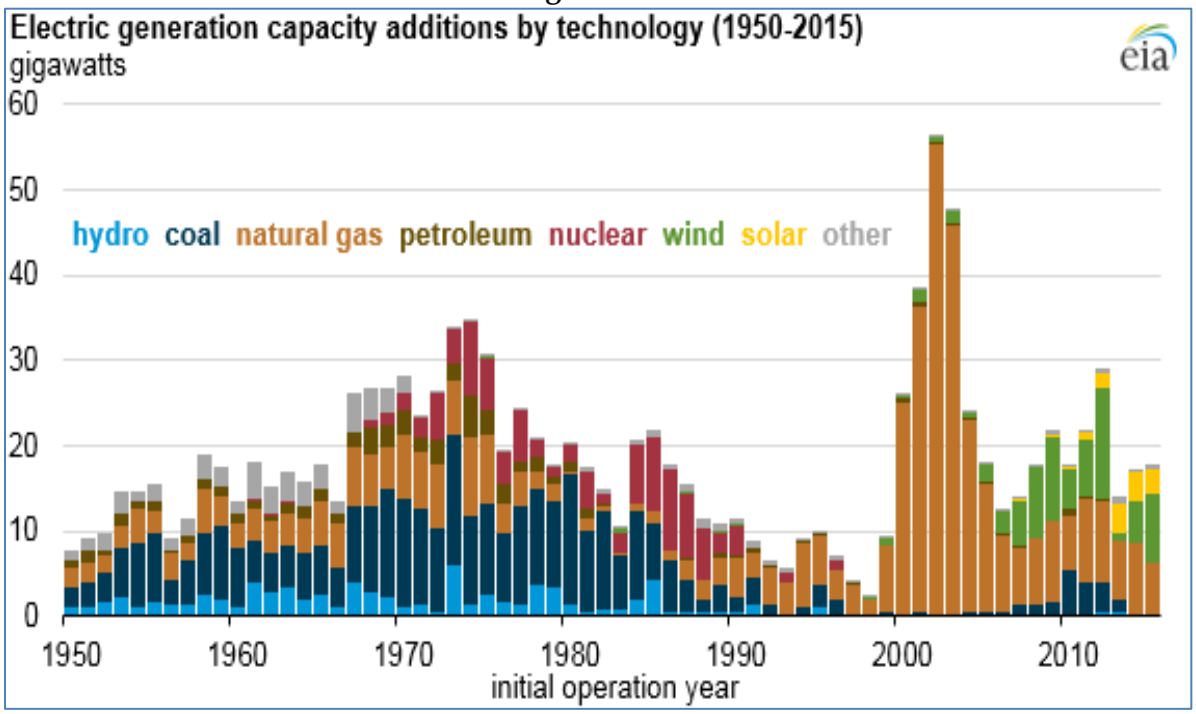
This resulted from several factors: economic conditions following the 2007-2008 collapse of global financial markets; aggressive investment in energy efficiency measures in buildings; and the impact of more and stronger federal appliance efficiency standards as stipulated in Congressional legislation; and the increasing popularity of small-scale solar panels on customers' premises. All of these have mitigated overall growth in demand for electricity – and in turn, have kept the total market size of the power sector relatively flat (in terms of output and demand for power from different generating technologies and fuels).

Competition from natural-gas-fired power plants

Generation of electricity at gas-fired power plants has risen steadily over the past decade, due to the availability of low-cost natural gas and the comparative price

advantage of natural gas to coal (Figure 17). Also, after 2000, the vast major of generating capacity added in the United States has been at gas-fired power plants. (Figure 19 shows updated information previously shown on Figure 3.) By contrast, only a small amount of new coal-fired generating capacity came on line during the post-2000 period. Because comparatively little coal-fired generating capacity was added after 1990 and few coal plants had retired as of 2000, the average age of the coal fleet was continuing to increase during that period. As of 2000, one sixth of all coal-fired generating capacity was 40 years and older (and much of that capacity stayed on line for another decade after that).[23] Newer, more efficient gas-fired generating units began to emerge as competitors to the fleet of coal-fired power plants during the 21st Century.

Figure 19:

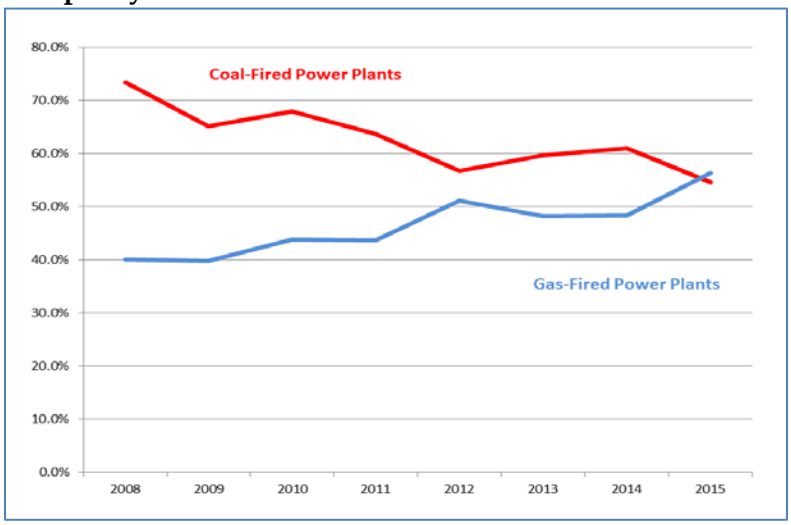


Source: EIA, "Demand trends, prices, and policies drive recent electric generation capacity additions," Today in Energy, March 18, 2016.

Although high natural gas prices during the 2000-2008 period left many of those gas-fired power plants operating at low capacity factors, the existence of so much under-utilized capacity made it possible to increase the dispatch of gas-fired plants when the price of natural gas became attractive relative to coal, as it did starting with the

shale-gas revolution in the mid-2000s. The post-2008 period has seen the overall average capacity factors of gas-fired power plants increase, as output at these plants displaced generation at coal-fired power plants (whose own capacity factors decreased). (Figure 20. See also Figure 23, for information on shares of electricity generation by fuel from 1985 through early 2016.)

Figure 20: Capacity Factors of Gas-Fired Versus Coal-Fired Plants: 2008-2015



Source: EIA, Electric Power Monthly

Renewable project expansion

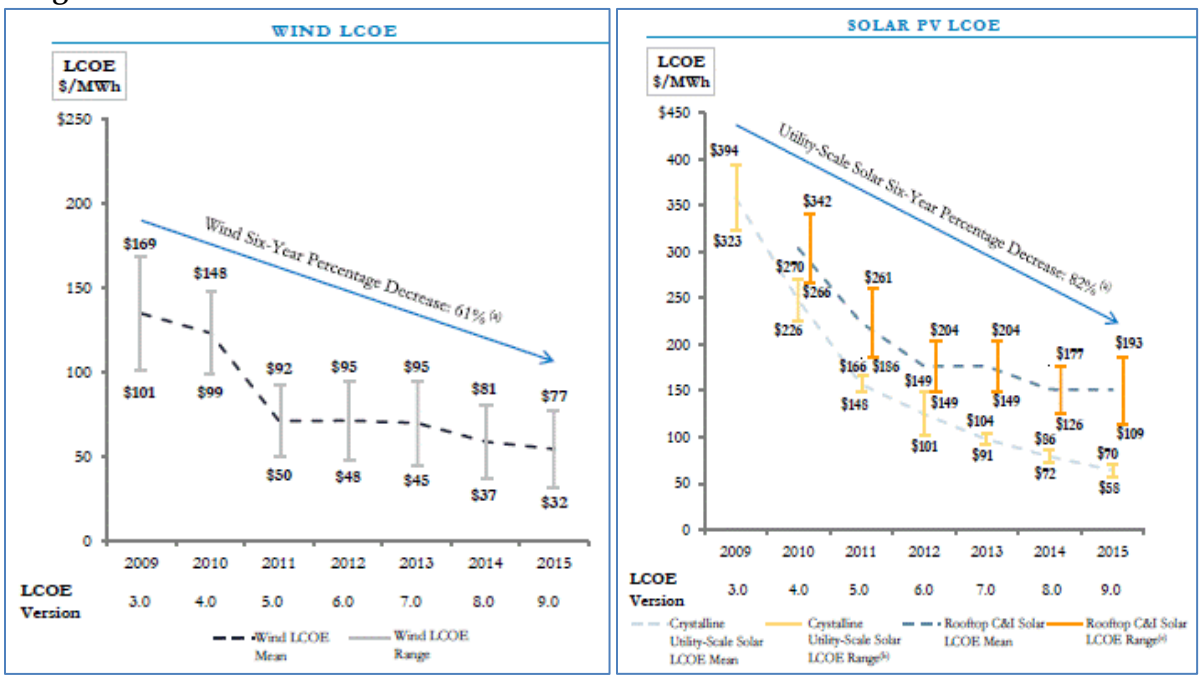
Further, renewable energy has increased its share of total electricity production over the past year. State policies – such as renewable portfolio standards ("RPS") which have been adopted in 29 states and the District of Columbia[24] and other financial incentives (e.g., states' net energy metering policies,[25] federal tax credits[26]) – along with substantially declining costs of solar and wind technologies (Figure 21) have stimulated significant growth in solar and wind installations around the country.[27] Costs of utility-scale solar projects and wind technologies dropped by 61-percent and 82-percent, respectively, in the period from 2009-2015 alone. Rooftop solar photovoltaic ("PV") system costs have similarly dropped dramatically over the past decade.[28]

Since 2008, there has been a 3-fold growth in wind generation and 30-fold growth in solar generation.[29] Since 2010, when there were 151,000 rooftop solar installations providing 2,000 MW of capacity, "[t]oday there are more than 867,000 solar PV

installations in the U.S., with new systems being installed at a rate of roughly one every two minutes."[30] (For context, total U.S. capacity from all generating resources was 1,072,000 MW as of the end of 2015.[31]). Similarly, wind capacity has risen more than tenfold over the past decade (Figure 22).

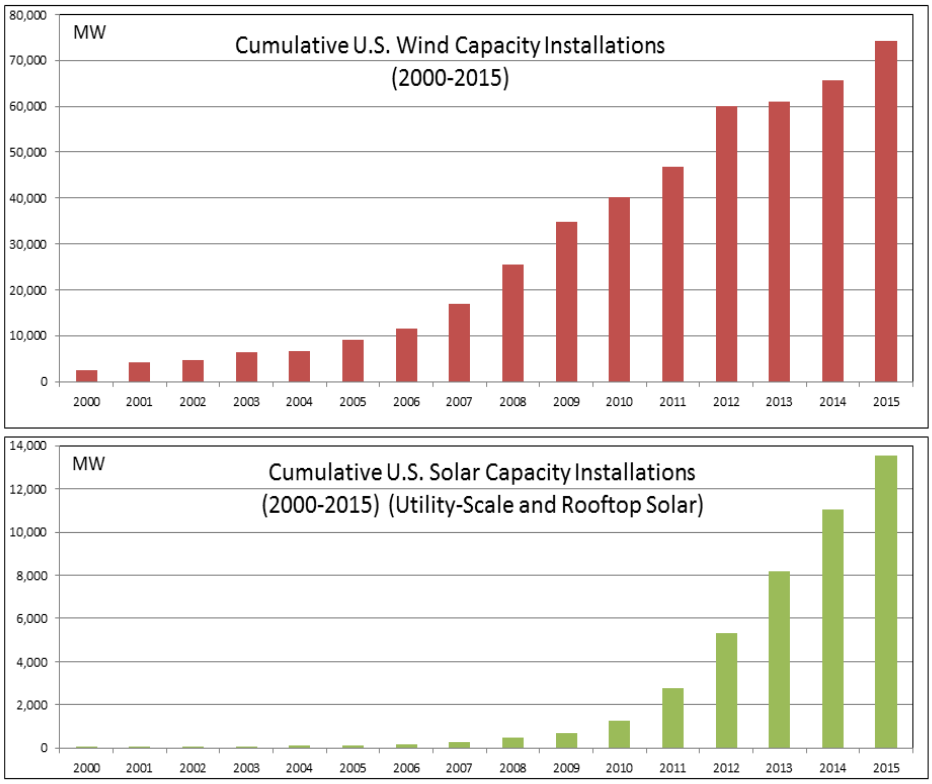
As these renewable projects have entered the market,[32] they generate power whenever the wind and sunshine are available, thus providing an increasing share of generation – and a reduction in coal-fired generation in many parts of the U.S. Many studies, including by the National Renewable Energy Laboratory, the Bipartisan Policy Center, MJ Bradley Associates, the Center for Strategic and International Studies, and the Rhodium Group, anticipate that renewable energy development will continue to grow significantly, even in the event that the Clean Power Plan is not upheld in its current form after review by the federal courts.[33]

Figure 21: Year-to-Year Declines in Levelized Unsubsidized Cost of Wind and Solar[34]



Source: Lazard, "Levelized Cost of Energy," Version 9.0 (2015).

Figure 22: Cumulative Installations of Wind and Solar Capacity (2000-2015)



Source: Greentech Media[35]

Air pollution controls affecting the power sector

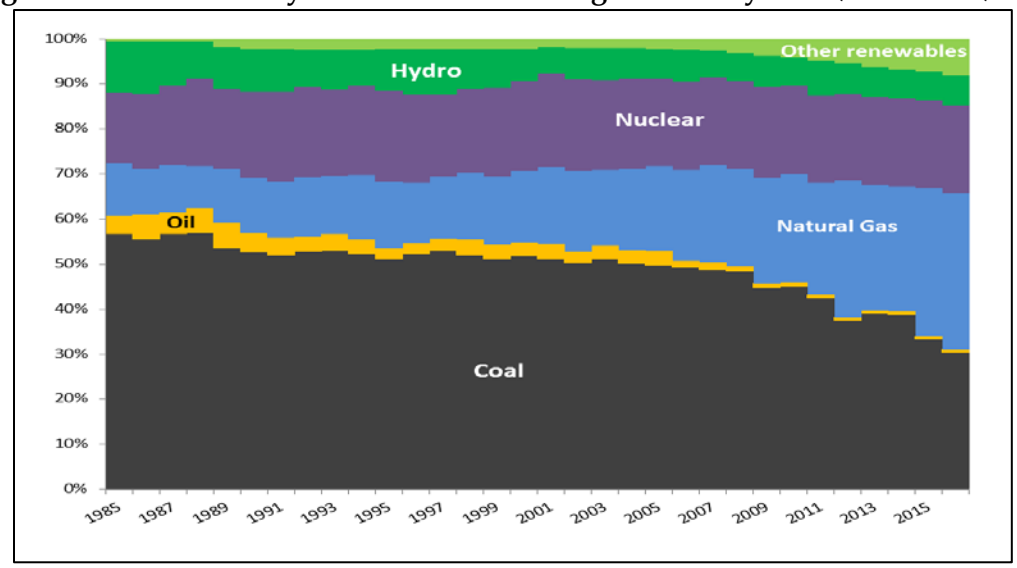
Additionally, many of the nation's coal-fired power plants have had to install equipment and/or modify their operations in order to meet one or another recent regulation to address harmful air pollution from power plants that burn fossil fuel. These regulations have addressed: emissions that contribute to regional haze affecting the nation's 156 national parks and wilderness areas such as the Grand Canyon, Yosemite, the Great Smokies and Shenandoah[36]; the transportation of certain pollutants from one state to another (e.g., the Cross-State Air Pollution Rule, known as CSAPR[37]); mercury and other toxic air pollutants from power plants that burn coal and oil (i.e., the Mercury and Air Toxics Standard known as MATS[38]). Some states – like the nine Northeast/MidAtlantic states participating in the Regional Greenhouse Gas Initiative[39] and California[40] – also adopted policies to control carbon emissions from fossil-fueled power plants. In many respects, these state and federal policies reinforced many of the trends that had already been underway in the electric

industry as a result of competition for coal from power plants operating on natural gas and renewable energy (as described further below).

Impacts on coal's market share for electricity generation

These trends have meant that coal has been providing a decreasing share of total electric generation, especially in the last decade. (Figure 23.) As of 2016, coal still accounts for one-third of power produced in the U.S., which is on a par with gas-fired generation for the first time in U.S. history.[41]

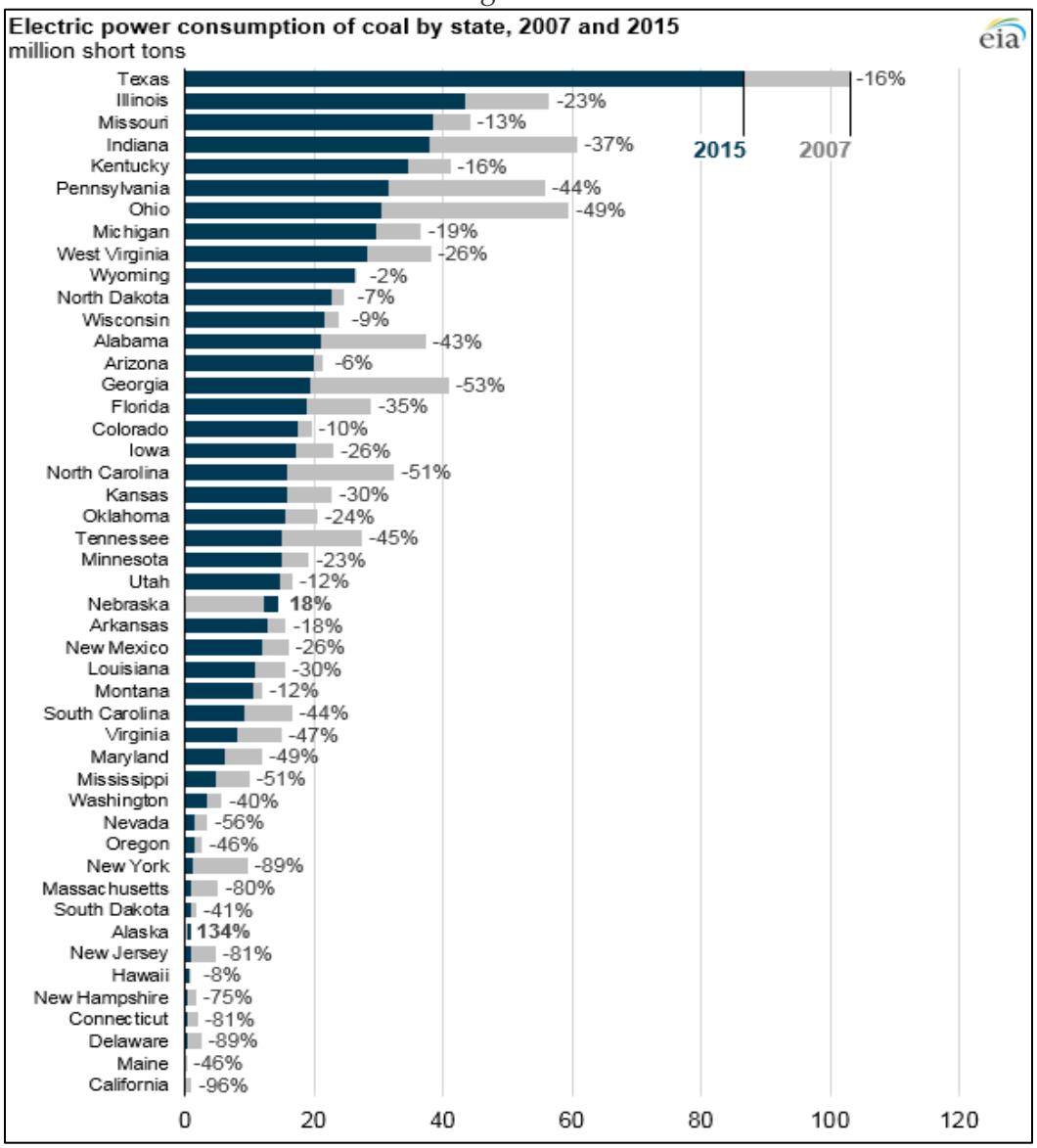
Figure 23: US Electricity Generation: Percentage Shares by Fuel (1985-2016 (est.))



Source: EIA, Electricity generation database

EIA reported in April 2016 that "power sector coal demand has fallen in nearly every state since 2007,"[42] as shown in Figure 24. The reductions have occurred not only in coal-producing states (e.g., West Virginia, Wyoming, Kentucky, Ohio, Illinois, Pennsylvania, Tennessee), but also in regions with substantial generating capacity that relies on natural gas and renewables (e.g., Texas, Iowa).

Figure 24:

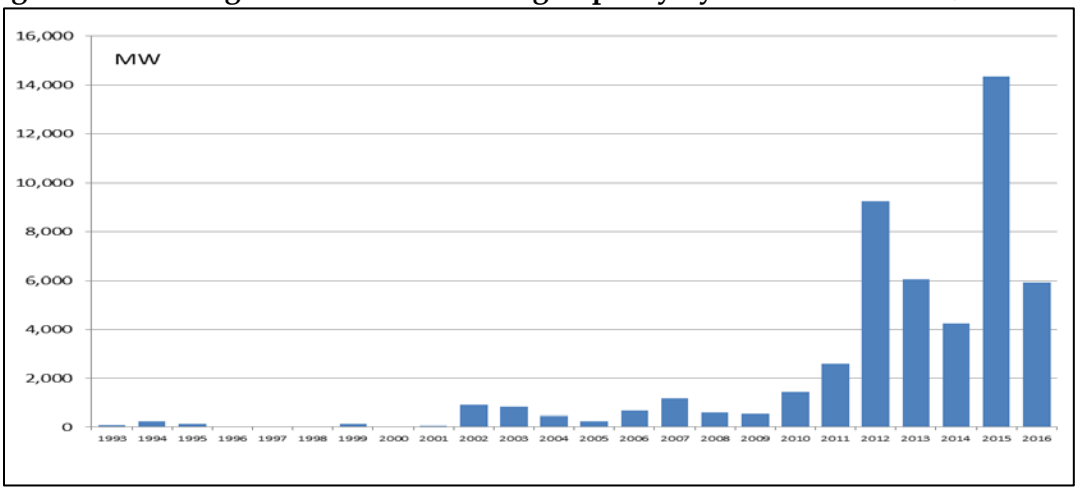


Source: EIA, https://www.eia.gov/todayinenergy/detail.cfm?id=26012#

Recently, the declining capacity factors of coal-fired power plants rendered many of the older and less efficient coal-fired generating units no longer economic to operate. This, combined with the impact of low natural gas prices on reduced revenues in wholesale electricity markets prices and the 2015 requirements that coal-fired power plants comply with new regulations to control harmful emissions of mercury and other toxic air pollutants from coal-fired plants, contributed to many retirements of

especially older, smaller, inefficient and previously uncontrolled coal-fired generating units.[43] (Figure 24.)

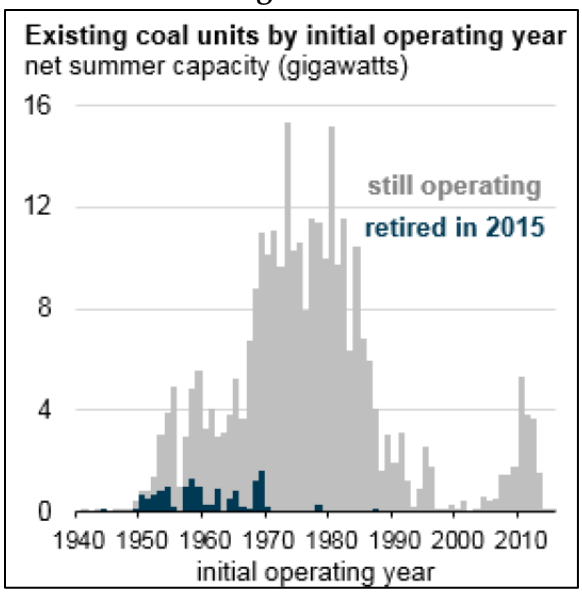
Figure 24: Retiring Coal-Fired Generating Capacity by Retirement Year (1993-2016)



Source: EIA, Electric Generating Capacity database

EIA has explained that the "coal units that were retired in 2015 were mainly built between 1950 and 1970, and the average age of those retired units was 54 years. The rest of the coal fleet that continues to operate is relatively younger, with an average age of 38 years. The coal units retired in 2015 also tended to be smaller than the rest of the coal fleet. The net summer capacity of the average retired coal unit was 133 megawatts (MW), compared with 278 MW for the rest of the coal units still operating."[44] (Figure 26.) These plants had relatively low capacity factors making it hard to justify making the investments that would have been required to keep the plants in operation.

Figure 25

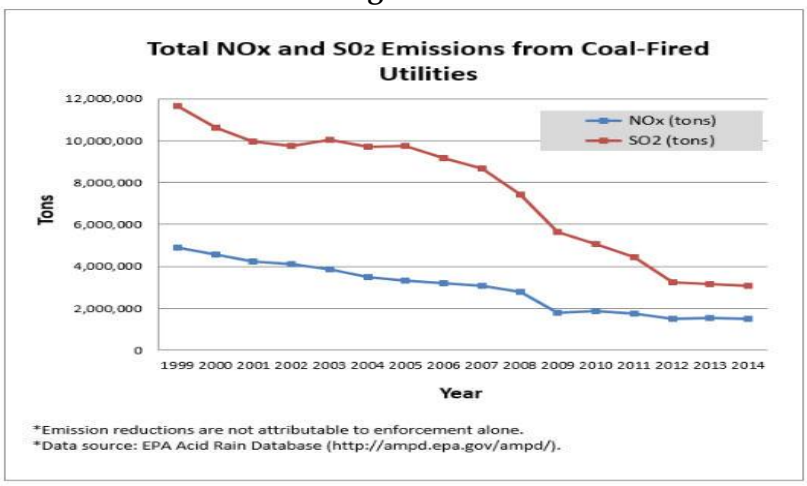


Source: EIA, http://www.eia.gov/todayinenergy/detail.cfm?id=25272.

Implications for emissions of air pollution from the power sector

The shift away from coal-fired generation toward gas-fired and renewable power production has contributed to lower emissions of air pollutants (like sulfur dioxide ("SO_2") and nitrogen oxides ("NOx")) which contribute to Acid Rain, smog, and respiratory diseases and other public health problems. Figure 26 shows the reductions in SO_2 and NOx emissions from coal-fired power plants from 1999-2014.

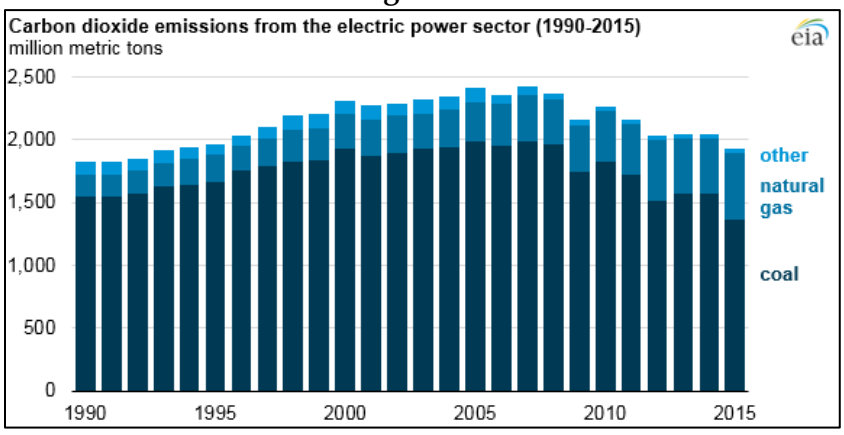
Figure 26:



Source: Environmental Protection Agency[45]

Similarly, the U.S. power sector's emissions of carbon dioxide (CO_2) have also declined in the past decade and are "the lowest since 1993 and 21 percent below their 2005 level."[46] (Figure 27.)

Figure 27:



Source: EIA, Today in Energy, May 13, 2016.

Major U.S. coal companies under financial stress

These many conditions that result from market fundamentals – decreasing comparative advantages of coal for power generation, declining demand for U.S. coal in domestic and global markets, challenging productivity metrics for the coal industry, coal companies' financial burdens from the prior period of expansion at the start of the 2000s, and so forth – have led to financial distress for many of the major U.S. coal companies. In their disclosures to the U.S. Securities and Exchange Commission, many of the nation's largest coal companies point to the impacts of these market conditions.[47] Their costs are high, demand for their product is low, financial returns have been small to non-existent, and market value has dramatically dropped in recent years.

As one article recently described the situation, however, some of the worst-off coal companies' problems were "self-inflicted."[48] Many of the companies made strategic decisions to acquire companies and assets based on expectations about sustained growth in the market for coal – which have not proven out. And those business decisions led to burdened balance sheets and costs that were difficult to manage in a declining market for coal.[49] This is a key, and often overlooked reason, why the value of coal companies has declined at a dramatically greater rate than overall sales.

> "Despite media headlines and coal industry hand-wringing, reports of coal's death have been greatly exaggerated, to adapt Mark Twain's famous (but misquoted) comment. What's more, some of the coal sector's current suffering is the consequence of self-inflicted wounds….."
>
> - Lee Buchsbaum, "The Shifting Fates of Coal Markets, Coal Mining, and Coal Power," Coal Zoom, October 1, 2015.

In March 2016, SNL reported that the "combined market value of major publicly traded U.S. coal producers continues to erode, now standing at approximately $4.59 billion…according to an S&P Global Market Intelligence analysis. Since April 2011, the group of 13 U.S. coal producers has lost more than 92% of its value, with the companies' combined market capitalization falling from $62.5 billion to $4.59 billion amid historically weak coal market conditions."[50] As of the time of that analysis, several major coal companies – including Arch Coal and Alpha Natural Resources – had filed for bankruptcy protection. Since then, Peabody Energy filed in April 2016. In April 2011, Peabody's market cap was $19,680.96 million; as of September 5, 2016, it is $23.5 million.[51]

The stock prices of Peabody and Arch display the market's loss of confidence in these firms' financial conditions in recent years (Figures 28a (Peabody Energy) and 28b (Arch Coal)). These investors' negative signals are especially notable in light of the more optimistic outlooks represented by the stock market as a whole (as shown in Figure 29).

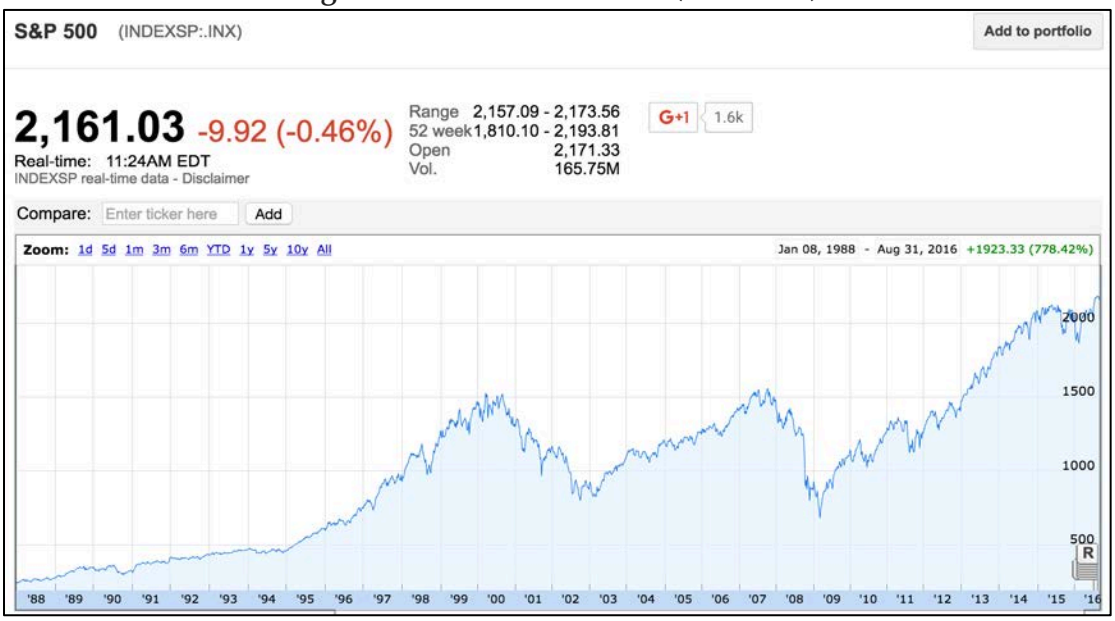
Figure 28a[52]
Peabody Energy (2010-2015)
Current Stock Price (9-5-2016) = 2.07

Source: YCharts

Figure 28b
Arch Coal (1990-2015)
Current Stock Price (9-5-2016) = 0.314

Source: Yahoo Finance

Figure 29: S&P Stock Index (1988-2016)



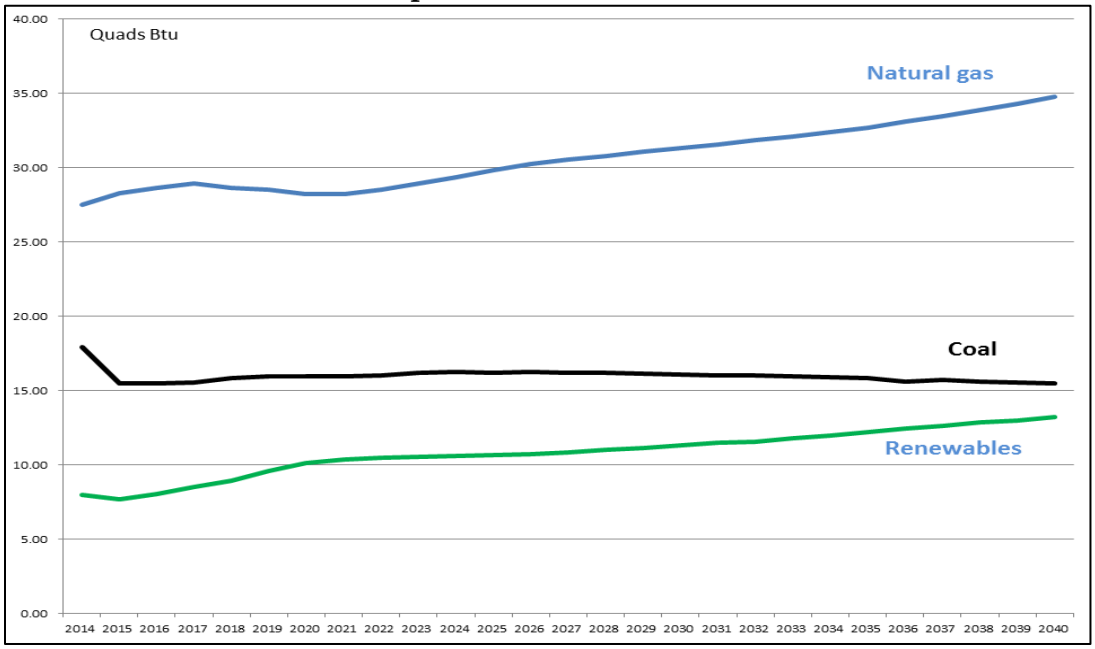
Source: Yahoo Finance

Outlook for the future of coal

In spite of its challenges in recent years, the coal industry will likely have many more years in which it provides substantial quantities of fuel for the U.S. economy.

As indicated in the recently published EIA Annual Energy Outlook for 2016 (which is based on current policies in place today), demand for coal may decline gradually over time (from 2014 through 2040), rather than experiencing an immediate collapse of market share, even in EIA's scenario that assumes that the new Clean Power Plan does not go into effect in 2022. (Figure 30.) (Note that EIA's reference case assumes that the Clean Power Plan is upheld by the courts and goes into effect.) The cumulative effects of the market factors described previously – flat demand in the power sector, competitive prices for natural gas relative to coal, competition from gas-fired power plants and from renewable energy projects – mean that coal is unlikely to rebound to its pre-2000 position, even without the Clean Power Plan. This is because the trends already underway in the industry are pointing to lower overall demand for coal in the future.

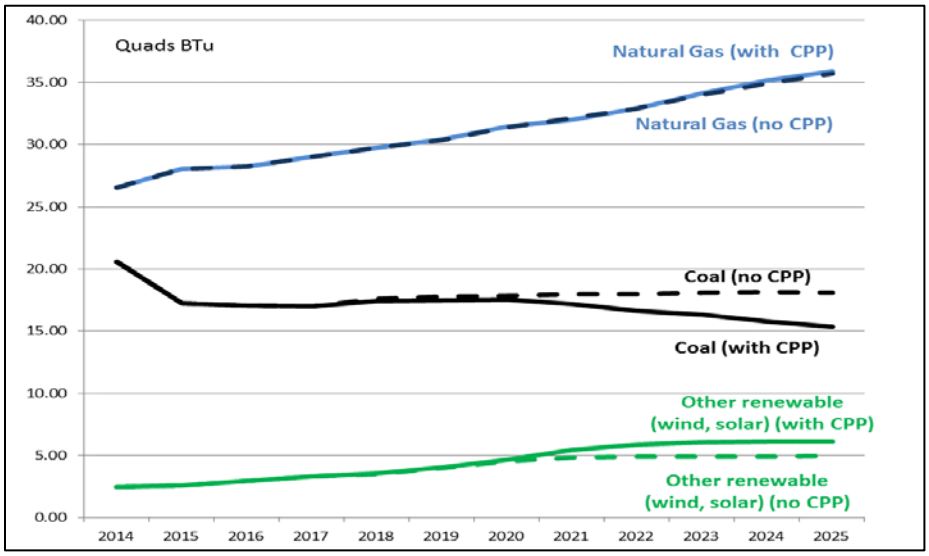
Figure 30: EIA Estimate of Trends in Consumption of Natural Gas, Coal and Renewables, Without the Implementation of the Clean Power Plan: 2014-2040



Source: EIA, Annual Energy Outlook 2016, Reference Case (Scenario without the Clean Power Plan)

EIA's forecast shows that even with the implementation of the Clean Power Plan, starting in 2022, there is a relatively minor incremental impact on total coal-fired generation, because of these market fundamentals. In its new projection that reflects the outlook assuming the implementation of the Clean Power Plan, EIA estimates that by 2025, coal production would still be 15.4 percent of total energy production in the U.S., down from approximately 19.8 percent in 2015 (and down from the 18.0-percent share in 2025 as estimated in the "without CPP" case).[53] (Figure 31.) Notably, the trade-off in the nation's generation mix in the "with Clean Power Plan" versus "without Clean Power Plan" is between different domestically produced energy resources: relatively more natural gas and renewables with the CPP, and relatively more coal without the Clean Power Plan. (Figure 31.) In terms of energy use, EIA's "with CPP" case estimates that coal would constitute 13 percent of total primary energy consumption in 2025, as compared to 16 percent in the "without CPP case".

Figure 31: EIA Estimates of Production of Coal, Natural Gas and Other Renewables in the "With Clean Power Plan" versus "Without Clean Power Plan" Cases: 2014-2025



Source: EIA, AEO 2016, Table 1. Note: "Other Renewables" includes renewables other than conventional hydroelectric and biomass. EIA estimates no difference for nuclear, hydro, biomass, and oil between the two cases (with CPP v. no CPP).

Conclusion

The decline of the U.S. coal industry, manifest in falling production and employment and high-profile bankruptcies, reflects a structural adjustment to new long-term market drivers including low-cost natural gas, falling productivity, flat power sector demand, as well as requirements for cleaning up those coal plants that have previously had harmful level of air emissions. The timing and magnitude of these various trends is not consistent with a regulatory "war on coal" explanation for the state of the industry.

The conditions that contributed to coal's ascendance from 1970s through 2000 were ultimately unsustainable, transient. Looking ahead, most analysts expect that the role of coal will continue to gradually diminish, but this does not mean the coal industry will disappear. Rather, it will no longer be the dominant fuel in the nation's energy mix.

In the long run, the industry's ability to prosper will depend on how it succeeds in innovating, making productivity improvements and regaining cost advantages, how well coal companies are able to restructure their balance sheets and control costs, and how the industry (and others) can get behind support for breakthroughs in science and technology that will enable energy industries to burn coal with much-lower carbon emissions released to the atmosphere.

ENDNOTES

[1] Total coal-industry employment (including office workers) was 224,412 in 1975; it was 108,734 in 2000. U.S. Department of Labor, Mine Safety and Health Administration ("MSHA"), Coal Fatalities for 1900 through 2015. http://arlweb.msha.gov/stats/centurystats/coalstats.asp. It is difficult to track precisely changes in coal-*mining* employment between 1900 and 2016 because in 1973, time-series data were adjusted to include office workers in total coal-mining employment.

[2] In 1985, mining employment totaled 170,500. It was down to 73,700 at the start of 2000. Data from the Federal Reserve Bank of St. Louis: coal-mining employment. https://fred.stlouisfed.org/series/CES1021210001.

[3] In 2010, the MSHA reported on conditions as of 2007: "Coal mining is a relatively dangerous industry. Employees in coal mining are more likely to be killed or to incur a non-fatal injury or illness, and their injuries are more likely to be severe than workers in private industry as a whole, according to the Bureau of Labor Statistics.…Bituminous coal underground mining employs slightly more than half of all coal mining industry workers, but experiences a higher share of occupational injuries, illnesses, and fatalities." http://www.bls.gov/iif/oshwc/osh/os/osar0012.htm

[4] Susan Tierney is a senior advisor at Analysis Group, and formerly Assistant Secretary for Policy at the U.S. Department of Energy, Massachusetts' Secretary of Environmental Affairs and a commissioner at the Massachusetts Department of Public Utilities. As a consultant, she has previously testified before utility regulatory agencies in many states, the Federal Energy Regulatory Commission, the U.S. Congress, state legislatures, and as an expert witness in proceedings before federal and state courts. She chairs the Electricity Advisory Council of the U.S. Department of Energy, previously served on the Secretary of Energy's Advisory Board, and serves on the boards of various non-governmental organizations.

[5] MSHA, http://arlweb.msha.gov/stats/centurystats/coalstats.asp.

[6] MHSA, http://www.bls.gov/iif/oshwc/osh/os/osar0012.htm.

[7] EIA International Energy Outlook 2000, page 68: "Total recoverable reserves of coal around the world are estimated at 1,088 billion tons—enough to last approximately 200 years at current production levels…Although coal deposits are widely distributed, 60 percent of the world's recoverable reserves are located in three regions: the United States (25 percent); FSU (23 percent); and China (12 percent)." Notably, this 2000 report stated on page 74 that "With its substantial supplies of coal reserves, the United States has come to rely heavily on coal for electricity generation and continues to do so over the forecast. Coal provided 53 percent of total U.S. electricity generation in 1997 and is projected to provide 49 percent in 2020…. To a large extent, EIA's projections of declines in both minemouth coal prices and coal transportation rates are the basis for the expectation that coal will continue to compete as a fuel for U.S. power generation."

[8] www.eia.gov/todayinenergy/detail.cfm?id=1830 . Also, see: Susan Tierney, "Why Coal Plants Retire: Power Market Fundamentals as of 2012," February 16, 2012.

[9] The 1990s and early 2000s "'were the go-go years for the Wyoming/Montana Powder River Basin coal,' said Chris Carroll, a coal geologist with the Wyoming State Geological Survey. 'Due to amendments of the Clean Air Act, western U.S. coal with its very low sulfur became the fuel of choice: no washing, very thick seams, very shallow seams, all surface mineable. With the large equipment invented for such operations the economics became very favorable to the large surface mine operator in the PRB.' By 2000, U.S. power producers had scrambled for the cheaper coal from the West." Taylor Kuykendall and Rizwan Qureshi, "US coal industry challenged by over a decade of declining productivity," SNL Financial, March 6, 2014. http://www.wvpolicy.org/wp-content/uploads/2014/10/snlpdf_448ee5a0-d91f-447d-aa69-32d27d883b59.pdf.

[10] EIA, International Energy Outlook, 2000, pages 77-78. http://www.eia.gov/forecasts/archive/ieo00/pdf/0484(2000).pdf.

[11] "The largest pillar of the coal industry has now fallen. In filing for bankruptcy last week, Peabody Energy joined Arch Coal, Patriot Coal, Walter Energy and Alpha Natural Resources among the largest coal mining companies recently facing this fate." Daniel Cohan, "When coal companies go bankrupt, the mining doesn't always stop," The Hill, April 18, 2016. http://thehill.com/blogs/pundits-blog/energy-environment/276628-when-coal-companies-go-bankrupt-the-mining-doesnt. Also: John W. Miller and Peg Brickley, "Arch coal files for bankruptcy," *Wall Street Journal*, 11 Jan. 2016.

[12] Data from the Federal Reserve Bank of St. Louis: coal-mining employment. https://fred.stlouisfed.org/series/CES1021210001.

[13] A 2014 analysis by SNL Financial found the following factors affecting coal-mining productivity declines in the U.S.

> Following a rise in productivity from technological and other mining improvements, the amount of coal produced per employee hour appears to have peaked around 2000 in most major U.S. coal-producing regions and then notably declined over the past decade…… The most obvious factor playing into coal miner productivity is the method of coal mining, such as underground versus surface, but there are also major regional and geological variables. An SNL Energy analysis of U.S. Mine Safety and Health Administration data on coal mines from 1994 to 2013 shows varying levels of productivity decline over the past several years. While most basins saw a slight uptick in productivity rates in 2013, this could be due to factors such as idling of the most inefficient mines instead of improvement in mining techniques or processes, though operators have been increasingly focused on various cost-cutting measures, including worker productivity.
>
> **Causes of productivity decline are difficult to pinpoint.** Nicholas Paduano, a coal data expert with the U.S. EIA has noted that improvements in technology initially allowed underground and surface mines to mine more coal with fewer employees. Now, he says, the trend is reversing, and the average number of employees at coal mines has increased almost 11 percent since 2007, according to EIA data, despite a decline in production. "Production is down probably due to many reasons, a big one being drop in demand, but why would companies spend money to hire more employees if they know they are not producing as

> much? I would guess they need more employees just to mine the same amount, or less, than before because the coal being mined is harder to get out," Paduano said. Michael Mellish, an industry economist with the EIA, said…"While we think that basic geology is a likely candidate, we also feel that there are other factors at play as well," Mellish said. "In the past, technology improvements in coal mining seemed to outpace the impacts of reserve depletion, leading to strong improvements in coal mining productivity between 1980 and 2000."…. He said some of the key factors include increasing stripping ratios, increased regulatory scrutiny, permitting challenges, skilled labor shortages, demographic shifts, longwall saturation and decreasing coal seam thickness….
>
> Hans Daniels, the executive vice president of Doyle Trading Consultants, said the abrupt decline in productivity that began around 2000 resulted largely from reaching the limits of economies of scale and peak efficiency improvements. While throughout the 1990s, positive productivity gains from technology improvements and economies of scale outstripped productivity losses caused by stricter regulations and thinner and deeper coal seams, by 2000 the industry had basically maximized the gains to be had from improvements such as doubling the size of haul trucks or doubling the width of longwalls….

Taylor Kuykendall and Rizwan Qureshi, "US coal industry challenged by over a decade of declining productivity," SNL Financial, March 6, 2014. http://www.wvpolicy.org/wp-content/uploads/2014/10/snlpdf_448ee5a0-d91f-447d-aa69-32d27d883b59.pdf.

[14] Taylor Kuykendall and Rizwan Qureshi, "US coal industry challenged by over a decade of declining productivity," SNL Financial, March 6, 2014.

[15] Trevor Houser and Peter Marsters, "The Hidden Cause of America's Coal Collapse," Rhodium Group, February 22, 2016. http://rhg.com/notes/the-hidden-cause-of-americas-coal-collapse. See also: International Energy Agency report on mid-term global energy outlook (https://www.iea.org/newsroomandevents/pressreleases/2015/december/global-coal-demand-stalls-after-more-than-a-decade-of-relentless-growth.html); EY report on productivity in mining (http://www.ey.com/Publication/vwLUAssets/EY-Productivity-in-mining/$FILE/EY-Productivity-in-mining.pdf); and McKinsey report on mining operations and productivity (http://www.mckinsey.com/industries/metals-and-mining/our-insights/productivity-in-mining-operations-reversing-the-downward-trend).

[16] "The price of metallurgical coal has tumbled about 75 percent since its 2011 peak. That's been particularly painful for Peabody, which spent $4 billion in 2011 to acquire Australia's MacArthur Coal Ltd. to expand its sales of the steelmaking component. Australian operations, which are among the leading producers of seaborne metallurgical coal, continue as usual and aren't part of the bankruptcy, according to court papers." Tiffany Kary, Tim Loh, and Jim Polson, "Coal Slump Sends Mining Gian Peabody Energy Into Bankruptcy," Bloomberg, April 13, 2016. http://www.bloomberg.com/news/articles/2016-04-13/peabody-majority-of-its-u-s-entities-file-for-chapter-11. Also: "In response to weak metallurgical coal markets the Company idled a higher-cost mining complex in the third quarter of 2014 in order to concentrate on metallurgical coal production from its lowest-cost and highest-margin operations. … Global Coal Supply and Demand. The supply and demand fundamentals in global coal markets remained challenged in

2014. Although coal was cost-competitive with natural gas in 2014, Europe's weak economic growth resulted in only modest changes in import coal demand. Additionally, economic uncertainty lowered demand for imported finished goods, which led to reduced steel consumption and therefore lower demand for metallurgical coal. In China, a slowing economy along with abundant hydropower generation has resulted in a modest decline in coal imports in 2014 according to preliminary reports. China continues to add coal-based power generation capacity, but slower economic growth and new regulations on emissions around large urban centers could lead to more moderate rates of growth in the future, albeit on a large base." Arch Coal Company, 2014 10-K filing at the Securities and Exchange Commission. Also, "Record fall in global coal consumption driven by low oil price," The Telegraph, June 8, 2016. http://www.telegraph.co.uk/business/2016/06/08/record-fall-in-global-coal-consumption-driven-by-low-oil-price/; David Roberts, "Goldman Sachs says coal-export terminals are a bad investment," Grist, July 29, 2013. http://grist.org/climate-energy/goldman-sachs-says-coal-export-terminals-are-a-bad-investment/.

[17] EY (Ernst & Young), "Productivity in mining: now comes the hard part. A global survey," 2014: "What has caused the decline in productivity? … The survey participants were asked to describe the key factors that caused the decline in productivity in their organization. The responses covered each of the factors regularly referred to by economists, namely — labor, capital and material (resource). An additional theme that emerged from our interviews is the challenge of operating at scale. 1. Labor: During the boom, a focus on growth at any cost forced many mining companies to accelerate recruitment. Higher salaries enticed workers from other sectors to work in remote locations, but the subsequent war for talent escalated labor costs, and consequently labor productivity fell.….2. Capital: Capital productivity has been impacted by long lead times between investment and production, over-investment in capital,… 3. Material (resource): Depleting reserves and falling grades are also a contributing factor as shown below, with productivity falling per tonne of ore mined….4. Economies of scale: During the boom time, mines expanded as quickly as possible with little consideration around how to manage the additional complexity that this created. Many of the executives observed a decline in productivity levels as their operations expanded, primarily due to the challenge of managing complexity, compounded by the talent challenge, and lack of appropriate skills development. http://www.ey.com/Publication/vwLUAssets/EY-productivity-in-mining-now-comes-the-hard-part/$FILE/EY-productivity-in-mining-now-comes-the-hard-part.pdf.

[18] According to a Bloomberg article written at the timing of Peabody Energy's bankruptcy filing, debt-related issues were significant: "Peabody filed in the U.S. because Chapter 11 allows it to retain control of its businesses, providing protection that isn't available in Australia, said Beth Sutton, a Peabody spokeswoman in St. Louis. Also, the company's debt is primarily at the corporate level, she said. Peabody Chief Financial Officer Amy Schwetz said in court filings that after the MacArthur purchase and other acquisitions the following year, international coal prices began a downward cycle, making the company's debt unsustainable. That's been particularly painful for [Peabody spent $4 billion in 2011 to acquire Australia's MacArthur Coal Ltd. to expand its sales of metallurgical coal.] Powder River Basin coal, produced from one of Peabody's largest mines, traded Tuesday at $9.05 a ton, the lowest price in more than three years and 16 percent

below the five-year average, according to data compiled by Bloomberg…."I very much expect them to go through a restructuring where the vast majority of assets that are producing today will produce for the foreseeable future," Sussman said. "It's much more of a balance sheet restructuring than anything else." ….Peabody said it will use the bankruptcy to cut debt and improve cash flow and remained upbeat about its product. ….Last year Peabody began cutting jobs and looking to sell assets. A planned sale of its New Mexico and Colorado assets was terminated after the buyer was unable to complete the transaction, according to Wednesday's statement." Tiffany Kary, Tim Loh, and Jim Polson, "Coal Slump Sends Mining Gian Peabody Energy Into Bankruptcy," Bloomberg, April 13, 2016. http://www.bloomberg.com/news/articles/2016-04-13/peabody-majority-of-its-u-s-entities-file-for-chapter-11.

Also: "In the end, Alpha's debt-fueled expansions proved to be its undoing. Alpha, of course, was not the only company to rapidly jump into the growing met and exports market. Also in 2011, Arch Coal paid $3.4 billion to acquire the International Coal Group….Fueled by a widely held faith in China's steel mills and appetite for electricity, Alpha, Peabody, Arch, and several other producers also built, bought, or improved their own coastal export coal terminals too—another incentive to push their product overseas. But those moves only flooded the market with cheap coal. Chinese demand eventually sputtered, and the domestic markets withered. "Someday this is going to be a fascinating case study in what happens when an industry invests at the top of the market," said David Gagliano, an analyst who tracks coal companies at BMO Capital, a bank. Collectively, the deals left all three companies saddled with debt. Alpha still owes its creditors almost $3.2 billion—let alone what it owes federal and state regulators for admitted violations of the Clean Water Act and other environmental infractions. With a looming debt payment of $109 million due in August, Alpha chose instead to seek bankruptcy protection. On August 1, 2008, stock in Alpha had reached $104 a share. Seven years later, the company was valued at only 24¢. As of early September, Arch, which is desperately trying to avoid bankruptcy itself, through a series of financial legerdemain, owes its creditors upwards of $4 billion. Those high debt loads have further affected coal producers who might otherwise simply cut back on production to realign supply and demand curves. But with debt payments to make, miners need to produce. For companies in a precarious financial position, running a mine at a loss is preferable to closing it." Lee Buchsbaum, "The Shifting Fates of Coal Markets, Coal Mining, and Coal Power," Coal Zoom, October 1, 2015, http://www.coalzoom.com/article.cfm?articleid=5572.

[19] http://theconversation.com/election-factcheck-qanda-is-global-demand-for-coal-still-going-through-the-roof-60234]

[20] National Petroleum Council, "Prudent Development: Realizing the Potential of North America's Abundant Natural Gas and Oil Resources," 2011; John Deutch, "The Good News About Gas The Natural Gas Revolution and Its Consequences," Foreign Policy, 2011; Stephen Brown and Mine Yucel, "The Shale Gas and Tight Oil Boom: U.S. States' Economic Gains and Vulnerabilities," Council on Foreign Relations Energy Brief, October 2013; Trevor Houser and Shashank Mohan, *Fueling Up: The Economic Implications of America's Oil & Gas Boom*, Petersen Institute for International Economics, January 2014; Nick Cunningham, "The Shale Gas Revolution Is Not

Over, It's Just on Hold," The Fuse, September 24, 2015, http://energyfuse.org/the-shale-gas-revolution-is-not-over-its-just-on-hold/.

[21] EIA electric generation and retail sales databases. Total generation grew only 1 percent from 2005 through 2015; total retail sales grew only 3 percent from 2005 through 2015.

[22] Bloomberg New Energy Finance, "Sustainable Energy in America Factbook, 2016," page 1 of the Executive Summary.

[23] Data from EIA, "Age of electric power generators varies widely," Today in Energy, June 16, 2011. http://www.eia.gov/todayinenergy/detail.cfm?id=1830.

[24] http://ncsolarcen-prod.s3.amazonaws.com/wp-content/uploads/2014/11/Renewable-Portfolio-Standards.pdf.

[25] See DSIRE database: http://ncsolarcen-prod.s3.amazonaws.com/wp-content/uploads/2014/11/NEG-1.20161.pdf.

[26] See Trieu Mai, Wesley Cole, Eric Lantz, Cara Marcy, and Benjamin Sigrin, "Impacts of Federal Tax Credit Extensions on Renewable Deployment and Power Sector Emissions," National Renewable Energy Laboratory, February 2016, http://www.nrel.gov/docs/fy16osti/65571.pdf.

[27] Recent polling data shows growing interest among the public for power produced by renewable energy. LAZARD, Alternative energy poll, 2016, https://www.lazard.com/perspective/alternative-energy-poll-2016/.

[28] Bloomberg New Energy Finance, Sustainable Energy in America Factbook, 2016.

[29] EIA, "Electricity Net Generation: Total (All Sectors) by power production source. https://www.eia.gov/totalenergy/data/monthly/pdf/sec7_5.pdf.

[30] North Carolina Clean Energy Technology Center, "The 50 States of Solar: 2015 Policy Review and Q4 Quarterly Report," February 2016, page 9.

[31] EIA, 2014 summer generating capacity, with net capacity additions in 2015.

[32] EIA, "Scheduled 2015 Capacity Additions Mostly Wind and Natural Gas; Retirements Mostly Coal," Today in Energy, March 10, 2015, http://www.eia.gov/todayinenergy/detail.cfm?id=20292&src=email; EIA, "Monthly U.S. renewable electricity generation in 2016 surpasses previous years," Today in Energy, August 25. 2016. https://www.eia.gov/todayinenergy/detail.cfm?id=27672.

[33] Note the following studies that examine differences between two alternative scenarios for the U.S. electric system: one in which the Clean Power Plan is upheld by the courts and goes into effect; another indicating an outlook without the Clean Power Plan: EIA, Annual Energy Outlook, 2016, "Issues in Focus", page IF-5 (comparing the two scenarios in the reference case of the Annual Energy Outlook); Charles Fiertz and Ashley Lawson, "Insights from a Comparative Analysis of Clean Power Plan Modeling," Center for Climate and Energy Solutions, September, 2016 (comparing modeling results from MJ Bradley Associates, EIA, Bipartisan Policy Center ("BPC"), Center for Strategic and International Studies ("CSIS")/Rhodium Group),

http://www.c2es.org/docUploads/insights-comparative-analysis-clean-power-plan-modeling.pdf; Camilla Stark, Jacquelyn Pless, Jeffrey Logan, Ella Zhou, and Douglas J. Arent. "Renewable Electricity: Insights for the Coming Decade," Joint Institute for Strategic Energy Analysis/National Renewable Energy Laboratory, February 2015, http://www.nrel.gov/docs/fy15osti/63604.pdf.

[34] "Over the last six years, wind and solar PV have become increasingly cost-competitive with conventional generation technologies, on an unsubsidized basis, in light of material declines in the pricing of system components (e.g., panels, inverters, racking, turbines, etc.), and dramatic improvements in efficiency, among other factors." Lazard, "Levelized Cost of Energy," Version 9.0, 2015. The original explanatory notes to the wind and solar tables are as follows: *Source: Lazard estimates.* (a)Represents average percentage decrease of high end and low end of LCOE range. (b)Low end represents crystalline utility-scale solar with single-axis tracking in high insolation jurisdictions (e.g., Southwest U.S.), while high end represents crystalline utility-scale solar with fixed-tilt design. (c)Lazard's LCOE initiated reporting of rooftop C&I solar in 2010.

[35] http://apps2.eere.energy.gov/wind/windexchange/wind_installed_capacity.asp; https://www.greentechmedia.com/articles/read/us-solar-market-sets-new-record-installing-7.3-gw-of-solar-pv-in-2015.

[36] See: https://www.epa.gov/visibility/visibility-regional-haze-program.

[37] See: https://www3.epa.gov/airtransport/CSAPR/.

[38] See: https://www.epa.gov/mats.

[39] See; https://www.rggi.org/.

[40] See https://www.arb.ca.gov/cc/ab32/ab32.htm.

[41] EIA, "Natural gas expected to surpass coal in mix of fuel used for U.S. power generation in 2016," Today in Energy, March 16, 2016, http://www.eia.gov/todayinenergy/detail.cfm?id=25392; EIA, "Average utilization for natural gas combined-cycle plants exceeded coal plants in 2015," April 4, 2016, http://www.eia.gov/todayinenergy/detail.cfm?id=25652EIA; "Natural gas-fired electricity generation expected to reach record level in 2016," Today in Energy, July 14, 2016, http://www.eia.gov/todayinenergy/detail.cfm?id=27072.

[42] EIA, "Power sector coal demand has fallen in nearly every state since 2007," https://www.eia.gov/todayinenergy/detail.cfm?id=26012#.

[43] According to Bloomberg New Energy Finance, "Challenging economics and the shadow of environmental regulations encouraged the accelerated retirement of 14GW of coal-fired power plants, representing 5% of the installed coal capacity in the country. Since 2005, the US has disconnected over 40GW of coal-burning power plants, while adding only 19GW new coal to the grid. Several gigawatts of coal-fired capacity have also converted to natural gas or, in a few cases, biomass. Due to both these retirements and competition from low-priced natural gas, coal provided only 34% of US electricity generation in 2015, down from 39% in 2014 and from 50% at its peak in 2005." BNEF, "Sustainable Energy in America Factbook," 2016, page 8.

[44] EIA, "Coal made up more than 80% of retired electricity generating capacity in 2015," Today in

Energy, March 8, 2016. http://www.eia.gov/todayinenergy/detail.cfm?id=25272.

[45] https://www.epa.gov/enforcement/national-enforcement-initiative-reducing-air-pollution-largest-sources.

[46] EIA, "Carbon dioxide emissions from electricity generation in 2015 were lowest since 1993," Today in Energy, May 13, 2016. https://www.eia.gov/todayinenergy/detail.cfm?id=26232.

[47] See, for example the following SEC filings: Alliance Resource Partners (2015 10-K); Alpha Natural Resources (Q2 2014 10-Q; Q2 2015 10-Q); Arch Coal (2014 10-K); Cloud Peak Energy (2015 10-K); CONSUL Energy (2014 10-K); Foresight Energy (2014 10-K, 2015 10-K); Peabody energy (2014 10-K, 2015 10-K, Q2 2016 10-Q).

[48] Lee Buchsbaum, "The Shifting Fates of Coal Markets, Coal Mining, and Coal Power," Coal Zoom, October 1, 2015, http://www.coalzoom.com/article.cfm?articleid=5572.

[49] See footnote 18, above, for descriptions of the debt challenges of Peabody, Arch and Alpha Coal.

[50] Christopher Coats, "CONSOL bucks trend, but market value keeps eroding for most coal producers," March 22, 2016, https://www.snl.com/InteractiveX/article.aspx?ID=35850599&KPLT=2.

Coal companies market capitalization changes ($M)

	04/01/11		08/03/12		07/02/13		08/13/14		11/24/15		03/18/16	
	($M)	Rank	($M)	Rank	($M)	Rank	($M)	Rank	($M)	Rank	($M)	Rank
CONSOL Energy Inc. (CNX)	12,038.76	2	6,630.83	1	6,205.06	1	9,195.16	1	1,722.48	1	2,689.10	1
Alliance Resource Partners LP (ARLP)	3,004.21	7	2,226.51	4	2,626.59	3	3,546.76	3	1,292.37	2	957.95	2
Foresight Energy LP (FELP)	NA	NA	NA	NA	NA	NA	2,451.09	4	601.27	3	188.71	3
CNX Coal Resources LP (CNXC)*	NA	NA	NA	NA	NA	NA	NA	NA	272.16	4	159.54	4
Hallador Energy Co. (HNRG)	328.91	10	224.02	10	218.54	10	401.07	11	192.66	7	148.89	5
Cloud Peak Energy Inc. (CLD)	1,333.71	8	1,073.73	8	984.93	6	937.09	6	163.33	8	134.39	6
Westmoreland Coal Co. (WLB)	196.80	11	100.57	11	165.86	11	728.39	8	105.50	9	134.38	7
Natural Resource Partners LP (NRP)	3,751.26	6	1,996.50	5	2,248.96	4	1,801.15	5	211.58	6	112.97	8
Peabody Energy Corp. (BTU)	19,680.96	1	5,712.80	2	4,010.71	2	4,324.42	2	220.15	5	46.35	9
Rhino Resource Partners LP (RHNO)	617.92	9	372.40	9	371.03	9	400.99	12	11.14	11	7.92	10
Alpha Natural Resources Inc. (ANRZQ)	7,283.47	4	1,518.24	6	1,177.40	5	857.01	7	4.03	12	5.23	11
Arch Coal Inc. (ACIIQ)	5,787.47	5	1,426.45	7	783.17	7	666.56	9	22.36	10	4.93	12
Walter Energy Inc. (WLTGQ)	8,509.38	3	2,276.14	3	675.15	8	422.62	10	2.98	13	2.75	13

As of March 19, 2016.
* Owned by CNX with a 55.40% stake.
NA = not available
Source: SNL Energy, a part of S&P Global Market Intelligence

[51] New York Times, Business Day Markets: Coal. "Peabody Energy Corp. BTUUQ: NYS, Market cap. 23.5 M," http://markets.on.nytimes.com/research/markets/usmarkets/industry.asp?industry=50111 (accessed September 5, 2016, 11:51 AM).

[52] http://www.moderngraham.com/2014/09/22/peabody-energy-corporation-annual-stock-valuation-2014-btu/; Motley Fool chart: http://www.fool.com/investing/general/2015/04/12/why-peabody-energy-corporations-stock-took-a-33-be.aspx.

[53] EIA, Annual Energy Outlook 2016, Table 1.