CONCORD, MA - WASHINGTON, DC

47 Junction Square Drive
Concord, MA 01742

978-369-5533
www.mjbradley.com

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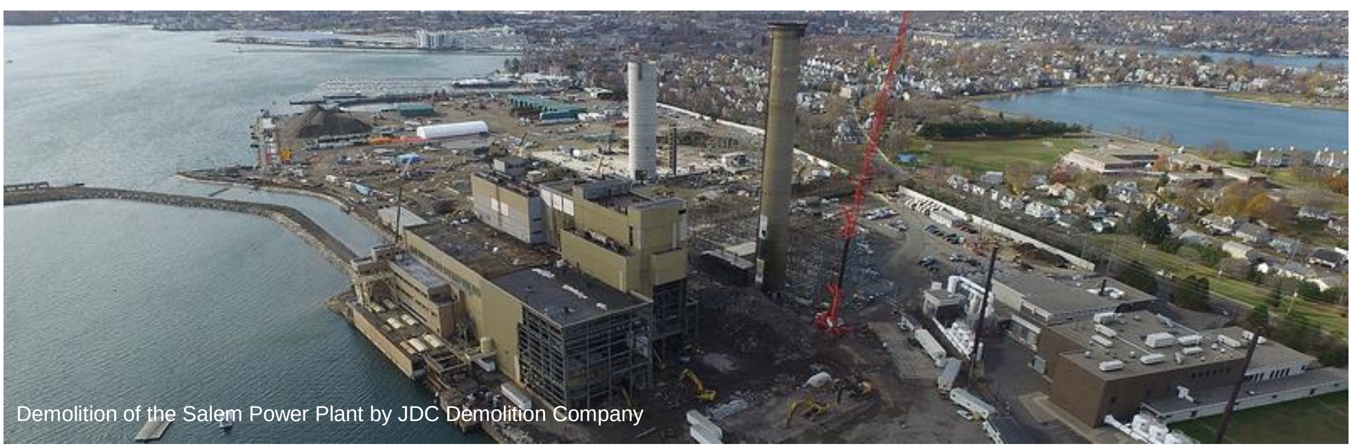
Coal-Fired Electricity Generation in the United States and Future Outlook

Coal-fired power plants, long the mainstay of the electric generating fleet, have been retiring in record numbers over the past several years and more are planning to close in the years ahead. This is a dramatic reversal for what was once the leading source of electricity production in the country. Coal plants are generally large facilities designed to run around-the-clock and throughout the year. Their output of electricity accounted for 51 percent of total U.S. electricity generation on average from 1949 through 2005. However, since that time, coal's share of generation has declined at a steady clip (see Figure 1).[1] In 2016, U.S. coal plants accounted for just 30 percent of total generation output, according to government figures—2016 was a year of record low natural gas prices in the U.S. contributing to the decline in coal generation. For the first time, in 2016, natural gas was the leading source of electricity generation (34 percent of total generation), reflecting an on-going trend that is reshaping the nation's generation mix.

This issue brief details M.J. Bradley's latest tracking of coal plant retirement announcements, including case studies of recent plant closures. The issue brief also discusses the factors that are leading companies to shutter their operations. There is no single factor that explains all the recent closures, rather it has been a combination of factors that is causing plants to close. Other generators, such as natural gas and nuclear, have also been facing similar economic pressures, suggesting that the causes are by no means unique to the coal fleet.

The issue brief also includes a discussion of the current outlook for coal generators. In the past two years (2015 and 2016), the coal sector was particularly hard hit by a combination of warm weather and record low gas prices. There have been some signs of improvement for the industry in the past several months with increased coal deliveries. However, there have also been further retirement announcements. Since January, about 10 large coal


Demolition of the Salem Power Plant by JDC Demolition Company

[1] Electricity generation accounts for more than 90 percent of coal consumption in the United States (U.S. EIA, "Coal Explained". May, 30, 2017. Accessed July 11, 2017. Available at: https://www.eia.gov/energyexplained/index.cfm?page=coal_use).

plants have announced plans to close. The brief concludes with a discussion of the potential reliability implications of coal plant retirements.

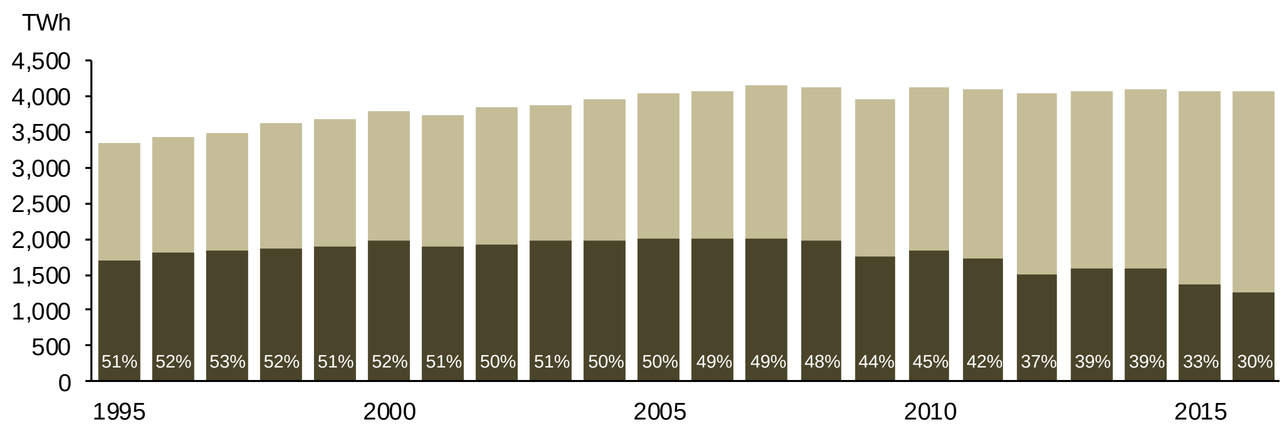
Background

The decline in U.S. coal generation reflects two fundamental trends: (1) a decline in the average utilization rate (or capacity factor) of coal-fired power plants; and (2) a reduction in the total amount of coal capacity due to retirements. Less capacity, running fewer hours, translates to fewer megawatt hours delivered to the grid.

The average capacity factor of coal generators in the U.S. has dropped from 73 percent in 2008 to 53 percent in 2016.[2] In the PJM power market, the numbers were even more stark. Natural gas combined cycle facilities had a 62 percent average capacity factor in 2016, while coal steam units operated at an average 33 percent capacity factor in the region.[3] In terms of retirements, since 2010, more than 420 coal units have shuttered their operations.[4] Combined, these facilities have a capacity of more than 60 gigawatts (GW), enough to power 40 million homes. In their place, the electric industry has added a mix of natural gas, renewables, and some new nuclear capacity. In some cases, the system has simply absorbed the closures with transmission system upgrades or offsetting production from the remaining generating fleet. Demand for electricity has remained basically flat or declining on average across the U.S. since 2010, contributing to the economic challenges faced by the nation's coal fleet.

Figure 1 shows both total electricity generation in the U.S. from 1995-2016 as well as total coal generation. Total generation is basically flat from 2010 onward. For a significant period of time, coal accounted for more than 50 percent of electricity generation.[5] However, in 2016, U.S. coal plants accounted for just 30 percent of total generation output. Coal-fired power generation in the United States peaked in the years prior to the Great Recession (2009), and then gradually declined. In 2016, coal generation dropped to its lowest levels since the early 1980s due to a combination of warm weather and record low natural gas prices.

Figure 1. Coal Generation (■) in the U.S. as a Share of Total Generation (■) from 1995-2016



[2] U.S. EIA. Table 6.7.A. Capacity Factors for Utility Scale Generators Primarily Using Fossil Fuels, January 2013-April 2017. Available at: https://www.eia.gov/electricity/monthly/epm_table_grapher.php?t=epmt_6_07_a

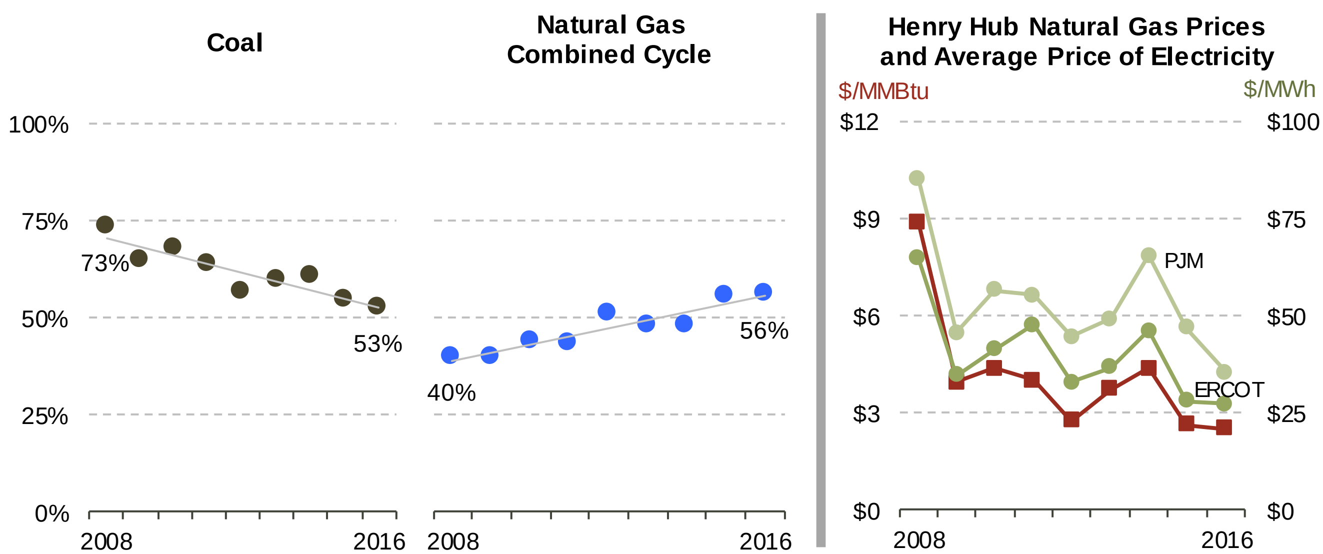
[3] Bowring, Joe, Monitoring Analytics. 2016 State of the Market Report for PJM. March 23, 2017.

[4] MJB&A Coal Retirement Database

[5] U.S. EIA. EIA-923 State-Level Generation and Fuel Consumption Data. Accessed July 10, 2017. Available at: https://www.eia.gov/electricity/data.php

Figure 2 shows the changes in the average capacity factors of coal-fired power plants and natural gas combined cycle facilities.[6] Since 2008, the utilization of the coal fleet has declined by almost 30 percent to an average capacity factor of 53 percent. By contrast, natural gas combined cycle plants operated at an average capacity factor of 56 percent in 2016. This trend is consistent with the decline in natural gas prices since 2008 and the resulting decline in wholesale power prices in many market regions. This decline in the utilization of the existing coal fleet has been far more significant in terms of reducing overall coal generation, than the closure of mostly older, low capacity factor units. Coal plant retirements that occurred between 2010 and 2016 are estimated to account for less than 20 percent of the decline in coal generation over this period and likely far less. By contrast, the reduced utilization of the remaining coal fleet (shown in figure 2) is estimated to account for more than 80 percent of the decline in coal generation.[7]

Figure 2. Changes in Average Capacity Factors by Fuel Type and Price Trends for Natural Gas and Wholesale Electricity Prices in Key Markets from 2008-2016



By the Numbers: Coal Retirements in the U.S.

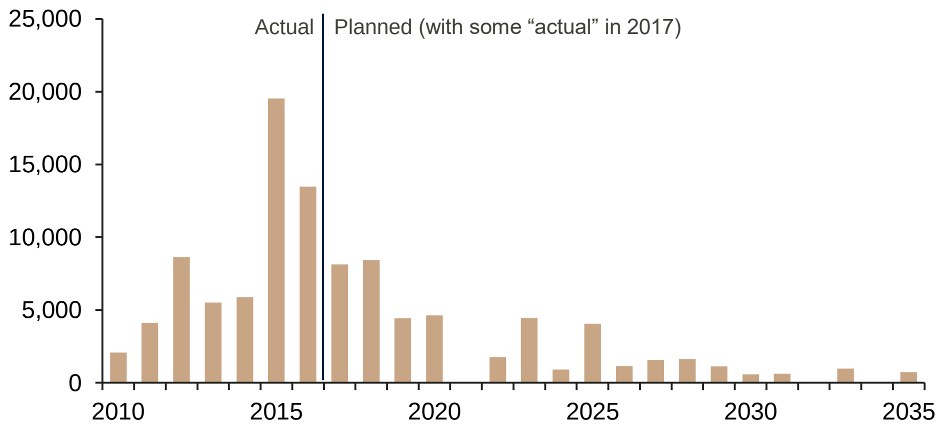
Based on MJB&A's Coal Retirement Tracking Database, since 2010, more than 100 GW of coal capacity has announced plans to retire in the U.S. This represents almost one-third of all U.S. coal capacity, and most of these announced closures have already taken place. As of June 2017, nearly 63 GW of coal capacity has retired from the U.S. generating fleet. The peak retirement years occurred in 2015 and 2016, when 19.5 GW and 13.5 GW retired, respectively (see Figure 3). A good number of closures (21.1 GW) are planned between now and 2020

[6] U.S. EIA. Electric Power Monthly, Tables 6.7A and 6.7B. June 2017. Accessed July 11, 2017. Available at: https://www.eia.gov/electricity/monthly/pdf/epm.pdf

[7] The share of reductions in coal generation due to retirements versus reduced utilization was calculated based on EIA's reported coal generation and capacity in 2010 and 2016. EIA reports that coal units retiring in 2015 had an average capacity factor of 36 percent. For the purposes of this analysis, we assumed an average capacity factor of 40 percent for units that retired between 2010 and 2016—this is a conservative assumption; lowering the assumed capacity factor would increase the share of reductions attributable to the reduced utilization of the existing fleet. The remaining decline in generation (i.e., after deducting the MWh assigned to retired units) was attributed to reduced utilization. No adjustments were made for the small amount of new coal capacity added during this time period.

and more than 19.3 GW have announced plans to close after 2020. Additionally, a number of power companies are working to finalize their 2017 integrated resource plans (IRPs), which outline company planning for the next 20 years. In several cases, preferred pathways in 2017 IRPs move coal retirement dates forward and list end-of-life retirements. Because these plans are subject to both regulatory approval and change, not all of these retirements have been added to MJB&A's "announced" retirement database.

Figure 3. Planned Coal Retirements (MW) by Announced Retirement Date

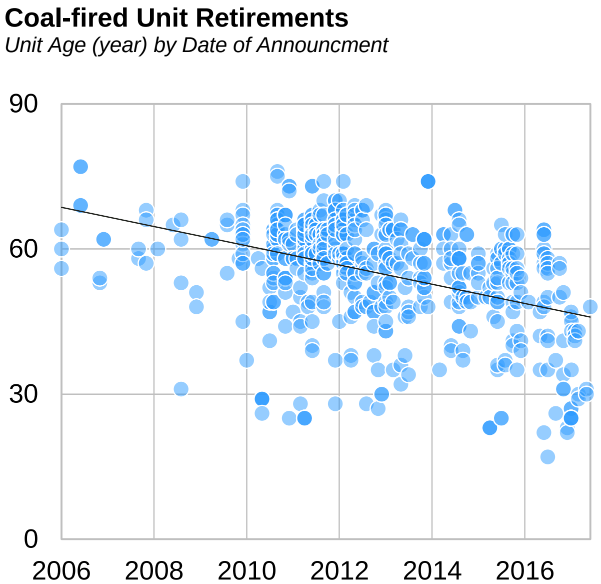


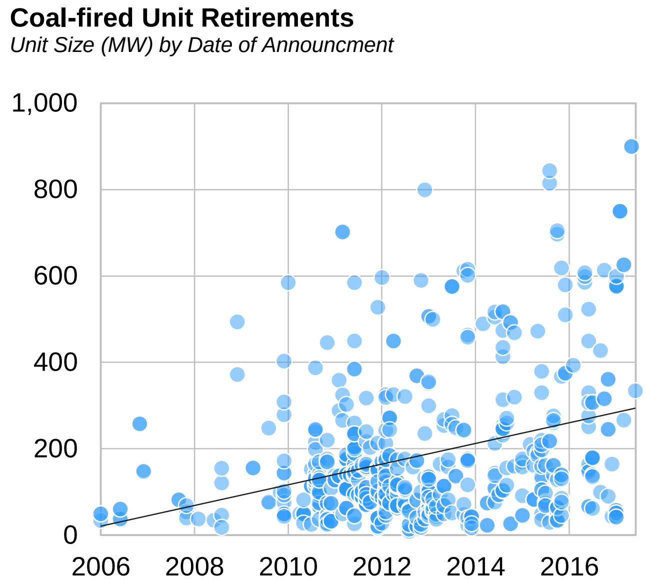
Most coal-fired capacity (88%) was built between 1950 and 1990, and the capacity-weighted average age of operating coal facilities in the U.S. is 39 years.[8] By contrast, the overall age of the North American generating fleet is almost 10 years younger than the age of the average coal plant.[9] In general, the plants that have closed have tended to be smaller and older units. These units are often less efficient, more expensive to operate, and lack modern environmental controls. However, in recent years, several large coal plants have announced plans to retire, including some relatively young facilities. On average, units that announced plans to retire between 2010 and 2015 were 57 years old and only 166 MW. By contrast, units that have announced plans to retire since 2016 are only 42 years old and 336 MW on average. Figure 4 shows the trends in the age and size of coal-fired units that have announced plans to retire.

[8] U.S. EIA, "Most coal plants in the United States were built before 1990". April 17, 2017. Accessed July 11, 2017. Available at: https://www.eia.gov/todayinenergy/detail.php?id=30812

[9] NERC. State of Reliability 2016. May 2016.

Figure 4. Trends in Coal Unit Retirements: Age and Unit Size





Note: Each blue dot represents one coal unit, plotted by the date the retirement announcement was made.

Why Coal Plants Retire

There has been a long running debate about the causes of the numerous coal plant retirements in the electric power sector. Is it competition from natural gas and changing market conditions that is primarily to blame? Or is it public policy decisions that have caused plants to close, like the U.S. Environmental Protection Agency's limits on mercury air emissions? Are there other factors that may be contributing to the decline in coal capacity? For example, in press reports, there are examples of coal plants rendered uneconomic by equipment failures, flood damage, and basic maintenance costs for safety and reliability. As discussed above, many of the coal plants that have announced plans to retire are well in excess of 40 years old, making them vulnerable to rising maintenance costs and competition from more efficient, modern generating technologies.

In general, coal plants retire when the expected revenues associated with electricity sales, capacity payments, and ancillary services are no longer sufficient to cover the operating costs of the facility. What this means is that multiple market and non-market factors will influence a retirement decision. Falling electricity prices and rising coal prices, for example, will both tend to squeeze profit margins, hurting the economics of a coal-fired power plant and increasing the likelihood of a plant closure. The following table details some of the key factors impacting coal plant economics on both the revenue side of the ledger as well as the cost side. Most retiring plants will face a combination of factors that ultimately forces a retirement decision.

Revenues	Costs
Low **natural gas prices** have a strong moderating effect on electricity prices—reducing the revenues earned by coal generators.	Equipment **maintenance costs** may increase with age, raising operating costs.
Low **demand for electricity** also tends to moderate electricity prices—low demand may be due to economic factors, changes within the economy, weather, or energy efficiency investments.	**Fuel costs**, including production and delivery, are a major factor in the operating costs of a coal plant (50%-60% of total operating cost).[10]
New **capacity additions**, with low operating costs, can also moderate electricity prices and capacity payments (in some markets).	**State and federal environmental regulations** for air and water protection may increase capital and operating costs.

A review of the literature offers insight into the dynamics that are causing coal plants to retire. The Center on Global Energy Policy, based at Columbia University, recently published a report evaluating the U.S. coal sector and the factors that have led to reduced coal production and consumption in the U.S.[11] The paper suggests three main factors that have reduced coal production and consumption:

- "U.S. electricity demand contracted in the wake of the Great Recession, and has yet to recover due to energy efficiency improvements in buildings, lighting and appliances."
- "A surge in U.S. natural gas production due to the shale revolution has driven down prices and made coal increasingly uncompetitive in U.S. electricity markets."
- "Coal has also faced growing competition from renewable energy, with solar costs falling 85 percent between 2008 and 2016 and wind costs falling 36 percent."

These three market factors are estimated to be responsible for more than 90 percent of the decline in domestic coal consumption based on a comparison of actual coal generation in 2016 and government forecasts of U.S. coal generation (when gas prices and demand growth were expected to be higher). As coal generation has declined, natural gas and renewable generation have increased, reducing coal's market share. Electricity demand has also been lower than earlier projections. By parsing these factors, the report attempts to isolate the factors contributing to the decline in coal generation. According to the analysis, the price of natural gas has had the biggest impact on coal consumption: "[i]ncreased competition from cheap natural gas is responsible for 49 percent of the decline in domestic U.S. coal consumption". Reduced demand for electricity and the growth of renewables are estimated to account for 26 percent and 18 percent of the reduction in coal consumption, respectively.

The report also evaluated coal plants that closed between 2012 and 2015, concluding that coal plant retirements had a relatively modest impact on total U.S. coal generation, consistent with our analysis above. As indicated above, the plants that have retired tend to be low capacity factor units. The report estimates that retirements

[10] IEA Clean Coal Centre. Operating Ratio and Cost of Coal Power Generation. December 2016.
[11] Houser, T., Bordoff, J., and Marsters, P. "Can Coal Make a Comeback?" Columbia University School of International and Public Affairs Center on Global Energy Policy. April 2017. Accessed July 11, 2017. Available at: http://energypolicy.columbia.edu/sites/default/files/energy/Center%20on%20Global%20Energy%20Policy%20Can%20Coal%20Make%20a%20Comeback%20April%202017.pdf

accounted for a 5 percent decline in coal generation; reduced utilization of the existing fleet has been a bigger factor in reducing coal consumption.

A recent report[12] from the Analysis Group arrives at a very similar conclusion, pointing to three fundamental changes in the market for electricity that have rendered coal plants uneconomic: "(1) a fundamental shift in fuel prices due to the shale gas revolution, reversing – particularly for older, less efficient coal units – the price advantage coal previously had over natural gas as a fuel for electricity generation - by far the most significant impact; (2) the addition of a large amount of new, lower variable cost generating capacity (mostly natural gas-fired, but also renewable capacity); and (3) the economic downturn and an associated decline in the demand for electricity." Using an "illustrative" analysis, the report demonstrates that natural gas prices have the largest influence on the economics of a coal-fired generating unit. The report indicates that recent environmental regulations and the growth in renewable generation have also played a role in recent retirement decisions, but it goes on to say: "these factors have been viewed as a distant second to the primary economic and fuel price drivers."

An earlier Analysis Group report offers additional reasons for the decline in coal demand, including natural gas capacity additions and an aging coal fleet.[13] Low gas prices in the 1990s and early 2000s led to major natural gas capacity additions, but a subsequent increase in prices initially kept capacity factors of these gas plants low. Gas prices then dipped during the shale revolution and consequently led to increased capacity factors of natural gas plants while reducing those of coal plants. Although the recent spike in coal retirements has primarily affected older and smaller coal units, coal plants are becoming an increasingly aged fleet because most fossil capacity additions in the past two decades have been natural gas. With the escalating operating costs of these aging plants, coal capacity factors will likely continue to fall.

A study by the Brattle Group describes several power industry trends that are impacting the economics of generators, such as coal and nuclear. The key factors affecting the economics of those generators include: "low natural gas prices, changes in electricity consumption, declining costs of renewables, capital expenditures to comply with environmental regulations and maintain aging plants, partial internalization of GHG emissions in some parts of the U.S., and the growing customer preferences for clean-energy and distributed resources."[14] The Brattle Study explains that companies like Apple, Amazon, Google, and Microsoft have made public commitments to purchasing renewable energy resources, which is driving demand for renewable energy.

A recent report by the Institute for Energy Economics and Financial Analysis (IEEFA) expects short-term gains in the coal industry, but not longer-term growth.[15] Despite market outlooks and expectations that coal demand will

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[12] Hibbard, Paul, Tierney, Susan, and Katherine Franklin. "Electricity Markets, Reliability and the Evolving U.S. Power System." Analysis Group, Inc. June 2017.

[13] Tierney, Susan. "The U.S. Coal Industry: Challenging Transitions in the 21st Century." Analysis Group, Inc. September 26, 2016. Accessed July 11, 2017. Available at http://www.analysisgroup.com/uploadedfiles/content/insights/publishing/tierney%20-%20coal%20industry%20-%2021st%20century%20challenges%209-26-2016.pdf.

[14] The Brattle Group. "Advancing Past "Baseload" to a Flexible Grid How Grid Planners and Power Markets Are Better Defining System Needs to Achieve a Cost-Effective and Reliable Supply Mix". June 26, 2017.

[15] Sanzillo, T. and Schlissel, D. "IEEFA 2017 U.S. Coal Outlook." IEEFA. January 19, 2017. Accessed July 11, 2017. Available at http://ieefa.org/wp-content/uploads/2017/01/IEEFA-2017-US-Coal-Outlook-ShortTerm-Gains-Will-Be-Muted-by-Prevailing-Weaknesses-in-Fundamentals_JAN-2017.pdf.

not increase, IEEFA contends that the slight increase in coal prices at the end of 2016 may convince coal companies to increase production. However, the pressure coal companies now face to maintain cost discipline – coupled with no major change in coal consumption – will prevent potentially improved profit margins from being sufficient to stimulate new investments or benefit shareholders. In addition, any regulatory relief provided by the current federal administration will likely not result in an increase in applications for coal leases; state public service commissions and public utilities will continue to plan new generation around natural gas, wind, solar, and energy efficiency.

Company statements also offer insight into the factors causing coal plant retirements. For example, after closing three coal units and plans to retire another eight by 2030, DTE Energy's CEO Gerry Anderson recently described the situation facing its coal fleet.[16] Anderson said existing environmental regulations were making coal plants less economically appealing, but he went on to say that the company's coal units are aging, which makes maintenance more costly. He said all of their planned retirements are going to happen regardless of what happens with the Clean Power Plan—the Obama Administration's plan to regulate carbon pollution from the power sector. Anderson expects to phase out coal completely over time. In surveys sent to customers, Anderson said more than 80 percent would like to see renewables added if it could be done at a reasonable cost. "On pure economics you would build natural gas today," Anderson said, but added that "beyond economics there were environmental signals that natural gas and renewables were the way to go."

Several companies point specifically to consumer preferences and demand as a key driver for their move away from coal to alternative energy resources. For example, MidAmerican Energy has a goal of transitioning to 100 percent renewable energy for its customers in Iowa. According to Bill Fehrman, CEO and President of MidAmerican Energy: "[w]e have a bold vision for our energy future…Our customers want more renewable energy, and we couldn't agree more."[17] American Electric Power is seeking to attract new businesses to Virginia and West Virginia by increasing its reliance on renewable energy sources. "Specific customers are looking specifically for renewables and to what degree you are moving toward a new clean energy economy,' said Nicholas K. Akins, AEP's chief executive.[18]

Retirement Case Studies

Several recent case studies highlight the economic pressures facing coal-fired generators throughout the U.S. In many cases, these units had installed pollution control equipment, but still determined that it was not cost-effective to continue operating the facilities. In most cases, companies cite the low price of natural gas as the primary factor in their decision to retire.

- Florida is the third leading consumer of electricity in the U.S., after Texas and California. Over the past two years, Florida Power & Light Company (FPL) has announced plans to shut down three coal-fired plants with a combined capacity of over 1,800 MW. FPL has cited economics and customer savings as the primary reasons for the closures. Two of the plants, **Cedar Bay and Indiantown**, were owned by separate companies that sold electricity to FPL through long-term contracts. FPL determined that it would be less expensive to

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[16] Lawler, Emily. "Michigan's biggest electric provider phasing out coal, despite Trump's stance". MLive. November 28, 2016. Accessed July 11, 2017. Available at: http://www.mlive.com/news/index.ssf/2016/11/michigans_biggest_electric_pro.html

[17] MidAmerican Energy. "MidAmerican Energy announces $3.6 billion investment in renewable energy". April 14, 2016.

[18] The New York Times. "Coal Country's Power Plants are Turning Away from Coal". May 26, 2017.

purchase the plants and retire them rather than continue buying their electrical output under contract. While the contracted electricity prices were competitive at the time they were signed, FPL is now able to purchase or generate electricity from other sources at lower prices. Between the two plants, the buyouts and retirements are expected to save FPL customers an estimated $199 million. According to Eric Silagy, FPL President and CEO, purchasing and retiring the plants is part of a "forward-looking strategy of smart investments that improve the efficiency of our system, reduce our fuel consumption, prevent emissions and cut costs for our customers."[19] Cedar Bay was retired at year-end 2016, while Indiantown is scheduled to shut down in 2018 or 2019.

The third power plant, **St. Johns River Power Park** (SJRPP), is scheduled to retire in 2018, a move that will save FPL customers an estimated $183 million. Mr. Silagy called the proposal "another step forward in our ongoing strategy of making smart investments in affordable clean energy to better serve our customers now and in the future."[20] All three plants had installed pollution control equipment for NOx, SO_2, and PM control. All three retiring plants are also relatively young, with the oldest unit, SJRPP 1, 30 years old this year. The other SJRPP unit is a year younger, while the Cedar Bay and Indiantown units are 23 and 22 years old, respectively.

- New Jersey had five coal-fired power plants at the start of 2017. Two retired in June and one may convert to natural gas or retire in 2019. One of the plants that closed this year is the **Hudson Generating Station,** a 620 MW coal-fired facility owned by PSEG in Jersey City, New Jersey. In late 2010, the unit installed a full suite of environmental controls, including a dry scrubber, selective catalytic reduction (SCR), a baghouse, and activated carbon injection. PSEG announced the plant's retirement in October 2016, and the actual shutdown occurred in June 2017. The plant's capacity factor had decreased dramatically in recent years, dropping from 62 percent in 2005 to 42 percent in 2010, before falling to 8 percent in 2015. According to the PSEG President and Chief Operating Officer Bill Levis, "the sustained low prices of natural gas have put economic pressure on these plants for some time", and PSEG "could not justify the significant investment required to upgrade these plants to meet the new reliability standards."[21] Further, Hudson failed to clear the past two capacity auctions, which were critical to its economic viability. According to PSEG Senior Director of Operations Bill Thompson, the company is retiring coal-fired plants for economic reasons, not because of pressure from environmental regulations: "They're not getting shut down for equipment conditions. It's just economics."[22]

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[19] Florida Power & Light. "FPL announces plans to buy and phase out another coal-fired power plant, saving customers millions of dollars and preventing millions of tons of carbon emissions". June 20, 2016. Accessed July 11, 2017. Available at: http://newsroom.fpl.com/2016-06-20-FPL-announces-plans-to-buy-and-phase-out-another-coal-fired-power-plant-saving-customers-millions-of-dollars-and-preventing-millions-of-tons-of-carbon-emissions

[20] Florida Power & Light. "FPL files plans to shutter third coal-fired power plant and continue modernizing its generation fleet, cutting emissions and generating millions in customer savings". May 22, 2017. Accessed July 11, 2017. Available at: http://newsroom.fpl.com/2017-05-22-FPL-files-plans-to-shutter-third-coal-fired-power-plant-and-continue-modernizing-its-generation-fleet-cutting-emissions-and-generating-millions-in-customer-savings

[21] Pyper, Julia. "Three Coal Plants Close the Same Day Trump Said to Exit the Paris Climate Agreement". Greentech Media. May 31, 2017. Accessed July 11, 2017. Available at: https://www.greentechmedia.com/articles/read/three-coal-plants-close-as-trump-rumored-to-exit-the-paris-climate-deal

[22] Associated Press. "PSEG Closing Its 2 Final New Jersey Coal-Fired Power Plants". U.S. News. May 30, 2017. Accessed July 11, 2017. Available at: https://www.usnews.com/news/best-states/new-jersey/articles/2017-05-30/pseg-closing-its-2-final-new-jersey-coal-fired-power-plants

- The **Intermountain Power Project** (IPP) is a two-unit, 1,800 MW coal-fired facility located in western Utah. In May 2017, the plant announced that it had finalized plans to shut down in 2025, less than 40 years after it opened. Initial proposals to retire the plant were announced in 2013, driven by concerns over the environmental impact of coal-fired generation. Despite being located in Utah, the majority of IPP's electricity is purchased by public utilities in southern California. In 2006, California passed Senate Bill 1368, which required the state to establish a CO_2 emission standard for baseload generation owned by or under long-term contract to California utilities. The final emission rate was set at 1,100 lb CO_2/MWh, significantly lower than IPP's 2015 CO_2 rate of 2,007 lb/MWh. As part of its efforts to comply with these rules, the Los Angeles Department of Water and Power (LADWP) announced that it would not renew its power purchase agreement with the coal plant when it expires. IPP will not be economical to operate after losing its California customers and so will retire. A new natural gas-fired power plant, which will be more economical and not exceed California's emissions standards, will be built on the site of the IPP facility and be operational when the coal plant retires in 2025.
- The **Najavo Generating Station**, in Page, Arizona, has been facing similar economic pressures due to the low price of natural gas. The Najavo plant, which came on-line between 1974 and 1976, is the largest remaining coal plant in the Western U.S. with a capacity of 2,250 MW. According to a press release from the majority owner and plant operator, "[Salt River Project] has an obligation to provide low-cost service to our more than 1 million customers and the higher cost of operating [Navajo Generating Station] would be borne by our customers".[23] The release goes on to say: "[e]lectricity produced at [Navajo Generating Station] is currently more expensive than electricity purchased on the wholesale spot market," and "price trends examined suggest a turnaround might be years away, especially if natural gas prices remain low."[24] The owners of the facility recently signed a new lease agreement that would allow the plant to operate through 2019, then begin the process of decommissioning the facility unless a new owner can be found.
- Ohio is at the epicenter of the shale gas revolution with large shale basins in the region and ten large natural gas combined cycle facilities (having a cumulative capacity of 9,800 MW) under construction or in the permitting stage within the state.[25,26] To put this in context, there is currently about 16,000 MW of coal-fired generating capacity in Ohio today. Competition from natural gas is putting significant financial pressure on the state's coal generators, and 6.3 GW of coal capacity retired between 2010 and 2015. An additional 3.7 GW has announced plans to retire by the end of 2020. Ohio lawmakers recently rejected proposed legislation to subsidize the operating costs of two coal-fired power plants in the state: **Kyger Creek and Clifty Creek**. The units at these plants, which have a cumulative capacity of nearly 2.4 GW, have modern wet scrubbers that were installed between 2011 and 2013, as well as SCR and electrostatic precipitators. Developers of gas-fired generators warn that the subsidies could discourage investment in new gas facilities and hurt the state's

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[23] Salt River Project. "Owners Vote on Navajo Coal Plant Lease". February 13, 2017. Accessed July 11, 2017. Available at: http://www.srpnet.com/newsroom/releases/021317.aspx
[24] Ibid.
[25] Knox, Tom. "Here are the 10 natural gas plants in development in Ohio". Columbus Business First. Accessed July 11, 2017. Available at: http://www.bizjournals.com/columbus/news/2017/01/09/slideshow-here-are-the-10-natural-gas-plants-in.html
[26] The Energy Information Administration's Electric Power Monthly reports almost 2,500 MW of natural gas combined cycle capacity under construction in Ohio (U.S. EIA. Electric Power Monthly, Table 6.5. June 2017. Accessed July 11, 2017. Available at: https://www.eia.gov/electricity/monthly/xls/table_6_05.xlsx

competitive position.[27] The legislative debate will continue in Ohio and similar debates are playing out in Pennsylvania, as coal plants face economic pressures in the competitive power markets.

- The **Jim Bridger Power Plant** is a large coal-fired facility in southwestern Wyoming co-owned by PacifiCorp and Idaho Power. In its 2017 IRP, Idaho Power's preferred portfolio for the next 20 years calls for retiring Units 1 and 2 at the plant in 2032 and 2028, respectively. According to the IRP, "[t]he decline in baseload energy production is primarily viewed as driven by low natural gas prices and the expansion of renewable generating capacity; because of the low natural gas prices and expanded renewable generating capacity, wholesale electric market prices over recent years have frequently been too low to merit economic dispatch of coal generating capacity."[28] The two units, which have a cumulative capacity of 1,058 MW, have installed wet scrubbers, electrostatic precipitators, and activated carbon injection. The plan to retire the units early avoids the need to install additional pollution control equipment (i.e., selective catalytic reduction controls for NOx), which is required on one unit by the end of 2021 and the other by the end of 2022. While noting that the decision to retire the units early instead of installing controls will require approval from PacifiCorp and regulators, Idaho Power states that "it can be generally asserted" that the units will be retired in the next 15 years.[29]
- In response to the on-going market conditions, We Energies announced earlier this year that it would be idling its **Pleasant Prairie coal plant** in Kenosha County, Wisconsin.[30] This is not a full retirement decision, rather the plan is to shut down the facility during March, April and May as well as September through November. According to a company spokesman, the plant has not been called on much during the spring and fall in recent years because natural gas-fired power plants are cheaper than coal and get called to run more often. In addition, demand for electricity remains below the levels seen before the Great Recession. The facility's SCR and scrubber air pollution control systems went into service in 2006 and 2007.

Outlook

The U.S. Energy Information Administration's (EIA) latest forecast of the nation's domestic energy markets (Annual Energy Outlook 2017) offers two starkly different outlooks for the coal sector. In the Reference Case (which does not include the Clean Power Plan, or CPP), natural gas prices gradually increase, coal generation recovers to roughly 2016 levels by 2020, and then remains basically flat through the balance of the forecast period (i.e., through 2050). However, EIA also ran a sensitivity case that assumes "High Oil and Gas Resources." This scenario translates to lower natural gas prices (less than $4.00/mmBtu) and greater competition with coal.[31] In

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[27] Testimony of William Siderwicz, Founder and President of Clean Energy Future, LLC before the Ohio Senate Public Utilities Committee on June 8, 2017. Accessed July 11, 2017. Available at: http://search-prod.lis.state.oh.us/cm_pub_api/api/unwrap/chamber/132nd_ga/ready_for_publication/committee_docs/cmte_s_pubutil_1/testimony/cmte_s_pubutil_1_2017-06-08-0900_560/cleanenergyfuturesb155.pdf

[28] Idaho Power. "2017 Integrated Resource Plan". June 2017. Accessed July 11, 2017. Available at: http://www.puc.idaho.gov/fileroom/cases/elec/IPC/IPCE1711/20170630INTEGRATED%20RESOURCE%20PLAN.PDF

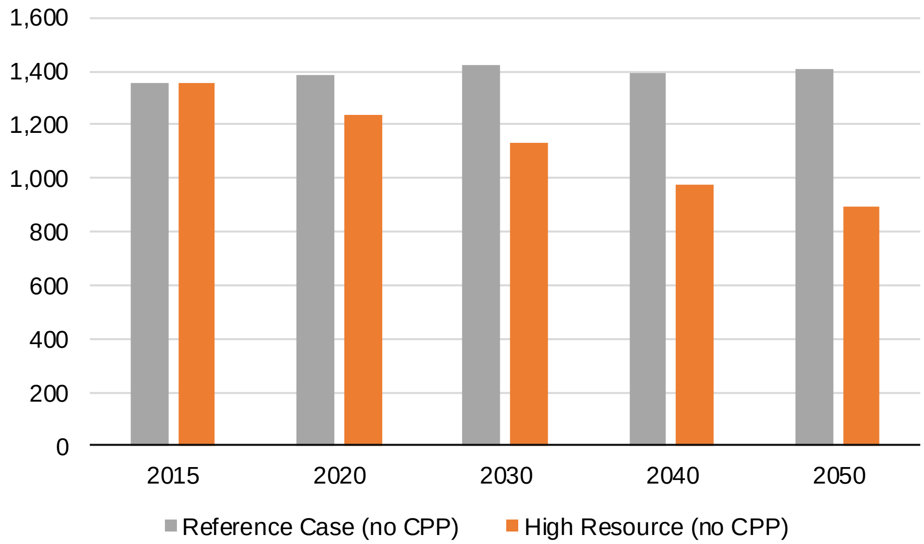
[29] Ibid

[30] Journal Sentinel. "We Energies to idle one of its coal plants for half the year." January 20, 2017.

[31] To put these numbers in perspective, average Henry Hub natural gas prices have been less than $3.00 in recent years: $2.66/mmBu in 2015 and $2.50/mmBtu in 2016. Spot prices have risen to around $3.00/mmBtu in 2017.

that scenario, coal generation gradually declines through the entire forecast. This highlights the sensitivity of the coal sector to natural gas prices.

Figure 5. Projected Coal Generation (TWh) from Annual Energy Outlook 2017



As coal plants continue to retire in the face of low natural gas prices, the industry has been evaluating the potential implications for electric system reliability. In April 2017, Secretary of Energy Rick Perry ordered a comprehensive review to assess the reliability of the electric grid. The final Department of Energy (DOE) report was released on August 23, 2017, outlining the dynamic changes occurring within the U.S. electric industry and the efforts underway by grid planners and operators to maintain high levels of grid reliability even as the resource mix continues to evolve.[32] The report concludes that electric reliability remains strong, but notes that reliability- and resilience-enhancing resource attributes (on both the supply and demand side) will continue to be an important area of focus for the industry in the coming years.

Others have also looked at the potential reliability implications of the dynamic changes in the nation's electric system. For example, a recent Brattle Group study, conducted on behalf of the Natural Resources Defense Council, describes the evolving nature of the electric system and how system operators have been developing mechanisms to encourage greater operational flexibility to better integrate renewables, while maintaining cost-effective and reliable electric service.[33] In the face of coal plant retirements and the ongoing changes to the resource mix, the study argues that the term "baseload" has become outdated and the concept is often misused or misunderstood. Baseload, intermediate, and peaking units accurately describe the resource categories that have traditionally served the electric system. However, the products and services that are needed to maintain grid reliability, including resource adequacy and operational reliability services such as frequency and voltage control, can and are provided by a wide range of resources and grid management tools, including: fast ramping generating

[32] U.S. Department of Energy. Staff Report to the Secretary on Electricity Markets and Reliability. August 2017.

[33] The Brattle Group. Advancing Past "Baseload" to a Flexible Grid How Grid Planners and Power Markets Are Better Defining System Needs to Achieve a Cost-Effective and Reliable Supply Mix. June 26, 2017.

facilities and renewables, advances in technologies (e.g., inverters), new market rules for energy, capacity, and ancillary services, improved forecasting tools, and planning guidelines.

A recent Analysis Group report, conducted on behalf of Advanced Energy Economy and the American Wind Energy Association, finds that the changes in the wholesale electric markets are improving or maintaining key reliability metrics, citing a recent reliability review by the North American Electric Reliability Corporation (NERC)—the nation's designated reliability organization.[34,35] The NERC analysis also reports that the bulk power system's resiliency to severe weather conditions continues to improve. The Analysis Group report concludes that:

> "[m]any advanced energy technologies can and do provide reliability benefits by increasing the diversity of the system. The addition of newer, more technologically advanced and more efficient natural gas and renewable technologies is rendering the power systems in this country more, rather than less, diverse. These newer generating resources are also contributing to the varied reliability services—such as frequency and voltage management, ramping and load following capabilities, provision of contingency and replacement reserves, black start capability, and sufficient electricity output to meet demand at all times—that electric grids require to provide electric service to consumers on an around-the-clock basis."

PJM's work on the evolving resource mix within its footprint also includes a discussion of the reliability attributes of different resource types, including conventional resources, renewables, battery storage, and demand response.[36] PJM's reliability attribute matrix highlights how emerging technologies such as demand response and battery storage can provide valuable reliability services, such as regulation and contingency reserves, and how natural gas and renewable resources also contribute to grid reliability. According to PJM, "the expected near-term resource portfolio is among the highest-performing portfolios and is well equipped to provide the generator reliability attributes." In evaluating different potential resource portfolios, PJM found that some reliability attributes will decrease and others will increase with less coal and more wind, solar, and natural gas. The analysis concludes that "PJM could maintain reliability with unprecedented levels of wind and solar resources, assuming a portfolio of other resources that provides a sufficient amount of reliability services."

Finally, MJB&A has also published analysis of the different ways that alternative resources can contribute to specific grid reliability needs and help create a more resilient system by providing capacity, controllable generation, frequency and voltage control, and other flexibility- and reliability-services.[37]

These issues around reliability, resiliency, and long-term planning will be an ongoing topic of analysis and research for electric grid operators as the resource mix continues to evolve.

[34] Analysis Group. Markets, Reliability and the Evolving U.S. Power System. June 2017.
[35] NERC. State of Reliability 2017. June 2017.
[36] PJM Interconnection. PJM's Evolving Resource Mix and System Reliability. March 30, 2017.
[37] M.J. Bradley & Associates. Powering into the Future: Renewable Energy & Grid Reliability. February 2017.

Contacts

For more information on this topic, please contact:

Christopher Van Atten
Senior Vice President
vanatten@mjbradley.com
(978) 369-5533

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MJB&A provides strategic consulting services to address energy and environmental issues for the private, public, and non-profit sectors. MJB&A creates value and addresses risks with a comprehensive approach to strategy and implementation, ensuring clients have timely access to information and the tools to use it to their advantage. Our approach fuses private sector strategy with public policy in air quality, energy, climate change, environmental markets, energy efficiency, renewable energy, transportation, and advanced technologies. Our international client base includes electric and natural gas utilities, major transportation fleet operators, investors, clean technology firms, environmental groups and government agencies. Our seasoned team brings a multi-sector perspective, informed expertise, and creative solutions to each client, capitalizing on extensive experience in energy markets, environmental policy, law, engineering, economics and business. For more information, we encourage you to visit our website: www.mjbradley.com.