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ENERGY & ENVIRONMENT POLICY

Trends and Market Forces Shaping the Future of U.S. Coal Industry

The coal industry has been on a bumpy ride in recent years. The industry has seen a wave of bankruptcies and mine closures in the face of falling demand and efforts to reduce carbon emissions. Jobs losses in the industry have led to economic devastation in already struggling communities across eastern Kentucky, southern West Virginia, and southwestern Virginia.

Bringing back coal mining jobs and reviving the coal industry is at the top of President Donald Trump's energy agenda. But it is unclear whether the federal government has the power to disrupt a complex set of trends that have to do with market forces and technology, in addition to regulations.

This brief first looks at the current state of the U.S. coal industry. It then discusses a variety of trends that have impacted the coal industry over the past several decades as well as in the last few years. While environmental regulations have certainly played a part, this brief argues that there are other, likely stronger influences at work. The brief closes by discussing the outlook for coal's future.



The State of Coal in the United States

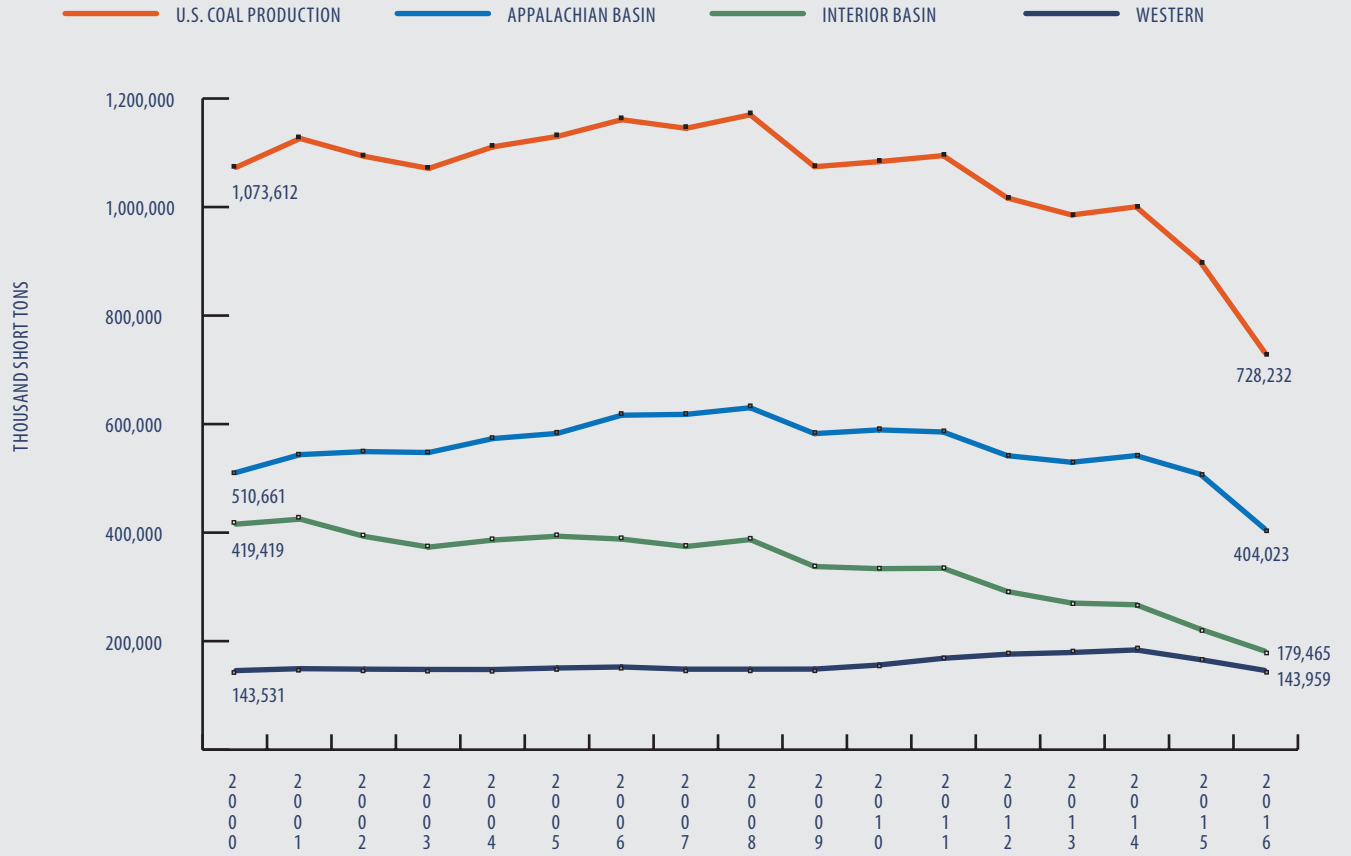
- **Coal production** in the United States totaled 739 million short tons (MMst) in 2016, a 17.5 percent decline from 2015.¹ This is the lowest level of coal production since 1978. This decline in coal production has not occurred uniformly across the major coal producing regions of the country. Production declines in the Appalachia region have been more dramatic, falling by 53 percent since 2008. The Western region, including the Powder River Basin that spans parts of Wyoming and Montana, witnessed a 36 percent decline since 2008. Although over the past 60 years, the output of coal more than doubled, 2011 marked the start of a steep decline in coal production.
- **Coal mining employment** in the United States totaled approximately 50,475 workers in 2016, the lowest level since the U.S. Energy Information Administration began collecting coal mining employment data in 1978.² Loss in coal mining jobs has been happening for decades. Nationwide employment in the coal mining industry peaked in 1920, when it employed roughly 785,000 people. Employment has declined more or less

steadily since then. In 1980, the industry employed approximately 229,000 people. By 2000, 15 years before the Environmental Protection Agency first proposed the Clean Power Plan and released new pollution guidelines to cut toxic emissions from power plants, industry employment had dropped to 72,000. By 2016, coal mining had shed 78 percent of its workforce, compared to 1980. The job loss has been especially precipitous in the Appalachian region, encompassing communities in Kentucky and West Virginia.

In short, the above trends point to a simple pair of facts. Coal production in the country has declined recently after experiencing decades of growth. Job loss in the coal industry is almost a century long story.

With those two trends in mind, it is worth taking a closer look at the various forces that have been impacting the U.S. coal industry over the years. While some of those forces, such as automation in coal mining, have been decades in the making, the U.S. coal industry is also facing headwinds from a variety of market forces that have emerged in the past decade.

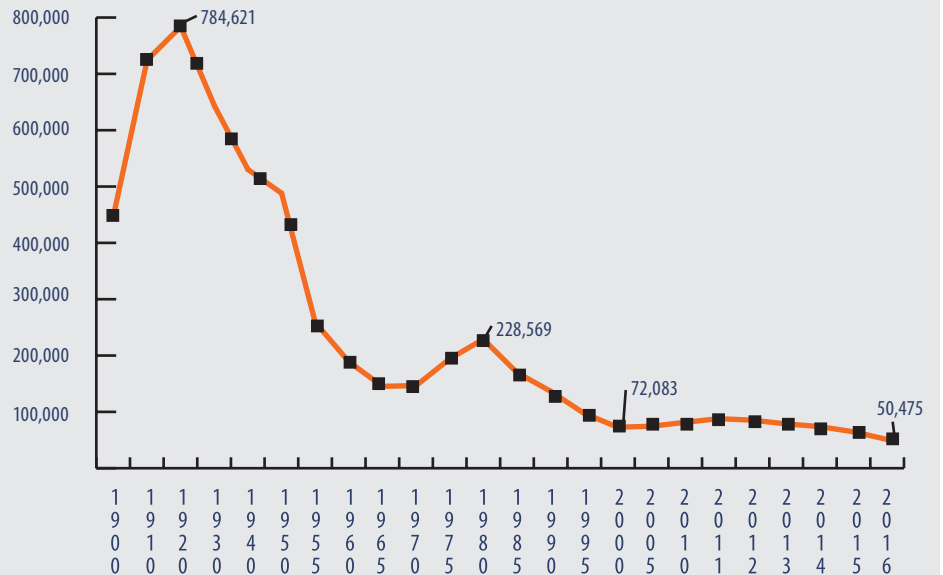
After Years of Continued Growth, U.S. Coal Production Has Witnessed a Steep Decline Since 2011



Source: U.S. Energy Information Administration

Employment in U.S. Coal Mining Peaked in 1920 and Has Been on a Steady Decline Since Then

Total U.S. Coal Miner Employment, 1900-2016



Source: U.S. Bureau of Labor Statistics

Major Forces Affecting the Market for U.S. Coal

The fate of the U.S. coal industry depends heavily on its continued dominance in one single market: U.S. electric power generation. About 93 percent of coal consumed in the United States is for power generation. Given coal's dependency on U.S. power sector demand, the industry has been particularly vulnerable to four significant changes in the domestic power sector that have reduced demand for coal. In addition to the trends shaping the U.S. power sector, two other—namely a decline in global demand for coal and increasing automation—have put great pressure on the industry.

1. Competition from Cheap Natural Gas Sparks Wave of Coal Plant Retirements

The decline in coal's fortunes is largely a result of competition from cheap and abundant natural gas, which was freed in soaring volumes during the last decade due to technological advancements in horizontal drilling and hydraulic fracturing. Utilities are increasingly choosing natural gas over coal for meeting electricity demand, as cheap gas has kept power prices low, making it uneconomic for generators to upgrade older coal plants to meet increasingly strict federal and state environmental rules. Since 2005, coal's share of the U.S. electricity mix declined from about half to just 30 percent in 2016 while natural gas generation's share grew from 19 percent to 34 percent.

Regionally, coal remains the dominant fuel for electricity generation only in the Midwest, although

even there its share has decreased significantly in the past several years. In the Northeast, natural gas-fired generation has exceeded coal-fired generation since February 2011, while in the South natural gas generation surpassed that of coal in every month since January 2015. Electricity generated by coal and natural gas has remained in close competition in the West.

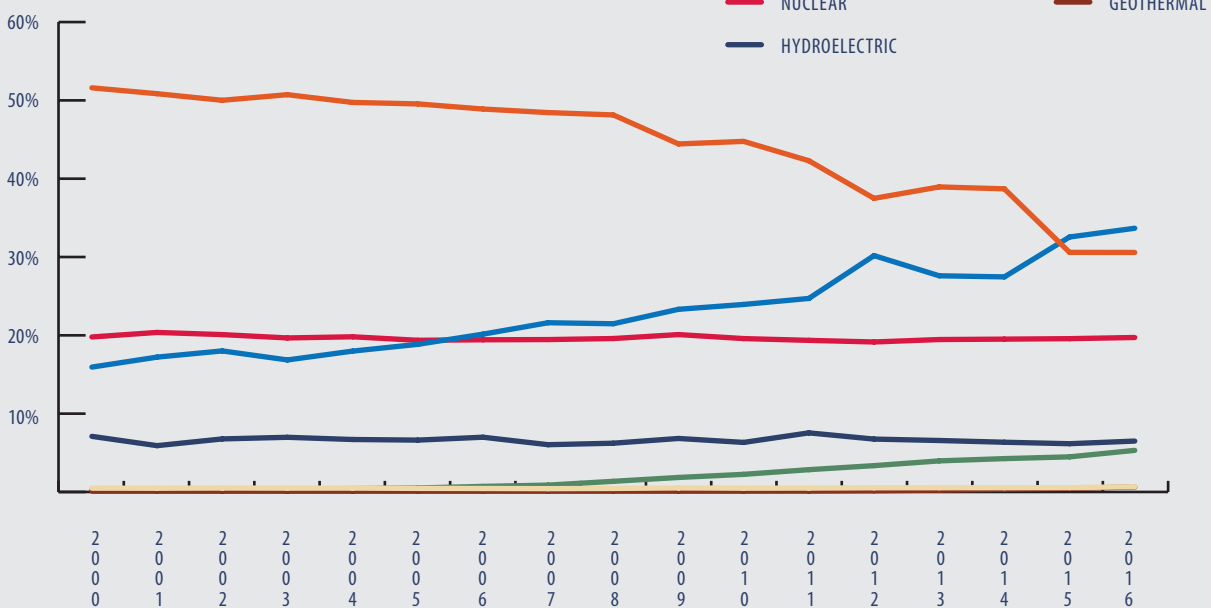
According to the U.S. Energy Information Administration, nearly 228 gigawatts (GW) of capacity fueled by natural gas was added in the country in the past 15 years, far exceeding retirements of 54 GW. In comparison, 20 GW of coal-fired capacity was added, while more than 53 GW was retired.³ These retirements help explain a sharp decline in U.S. coal demand for electricity generation.

2. Renewable Energy Makes Deeper Inroads into U.S. Energy Mix, Further Eroding Coal's Market Share

Renewables are surging in the United States and renewable energy has increased its share of net electricity generation in the past few years. In 2016, of the 4.08 trillion kilowatt-hours (kWh) of electricity generated at utility-scale facilities in the country, about 15 percent was from renewable energy sources: hydro-power (6.5 percent), wind (5.6 percent), biomass (1.5 percent), solar (0.9 percent), and geothermal (0.4 percent). Renewable energy provided 10 percent of electricity in 2010.⁴

According to the U.S. Energy Information Administration, most renewable energy generation comes from Western states, which accounted for 63 percent of all U.S. hydroelectric power and 77 percent of all solar generation in 2016. Nearly 72 percent of wind

Natural Gas is Taking on Coal to Power America's Electrical Plants
Share of U.S. Electricity Generation by Energy Source, 2000-2016



Source: U.S. Energy Information Administration

power came from the Midwest and the South, while 24 percent came from Western states.

The growth in wind and solar generation has been particularly significant. In 2016, 14 states generated more than 10 percent of their total electricity from wind, with Iowa (36.6 percent), South Dakota (30.4 percent) and Kansas (29.6 percent) leading the pack. Only three states had this share of wind generation in 2010. Utility-scale solar installations, including photovoltaic and thermal technologies, grew at an average rate of 72 percent per year between 2010 and 2016, faster than any other generating technologies.⁵ Nearly 10 percent of California's total electricity now comes from solar while for Nevada, Vermont, and Arizona the shares are 6.4 percent, 4.0 percent and 3.5 percent respectively.

Policies at both the state and federal levels, such as renewable portfolio standards and other financial incentives including state net metering policies and federal tax credits, have been an important driver of growth in non-hydro renewable capacity and generation since 2008. In addition, dramatic decline in costs of solar and wind technologies have stimulated significant growth in wind and solar installations in the country. Recent numbers from the investment firm Lazard reveal that the average levelized cost of energy (LCOE) for unsubsidized wind generation is between \$32/MWh and \$62/MWh, lower than the average LCOE for natural gas, which is between \$48/MWh and \$56/MWh, and also cheaper than coal.⁶

As renewable projects come online, providing an increasing share of electricity generation, they are contributing to a reduction in coal-fired generation in many parts of the country. The U.S. Energy Information Administration's most recent long-term

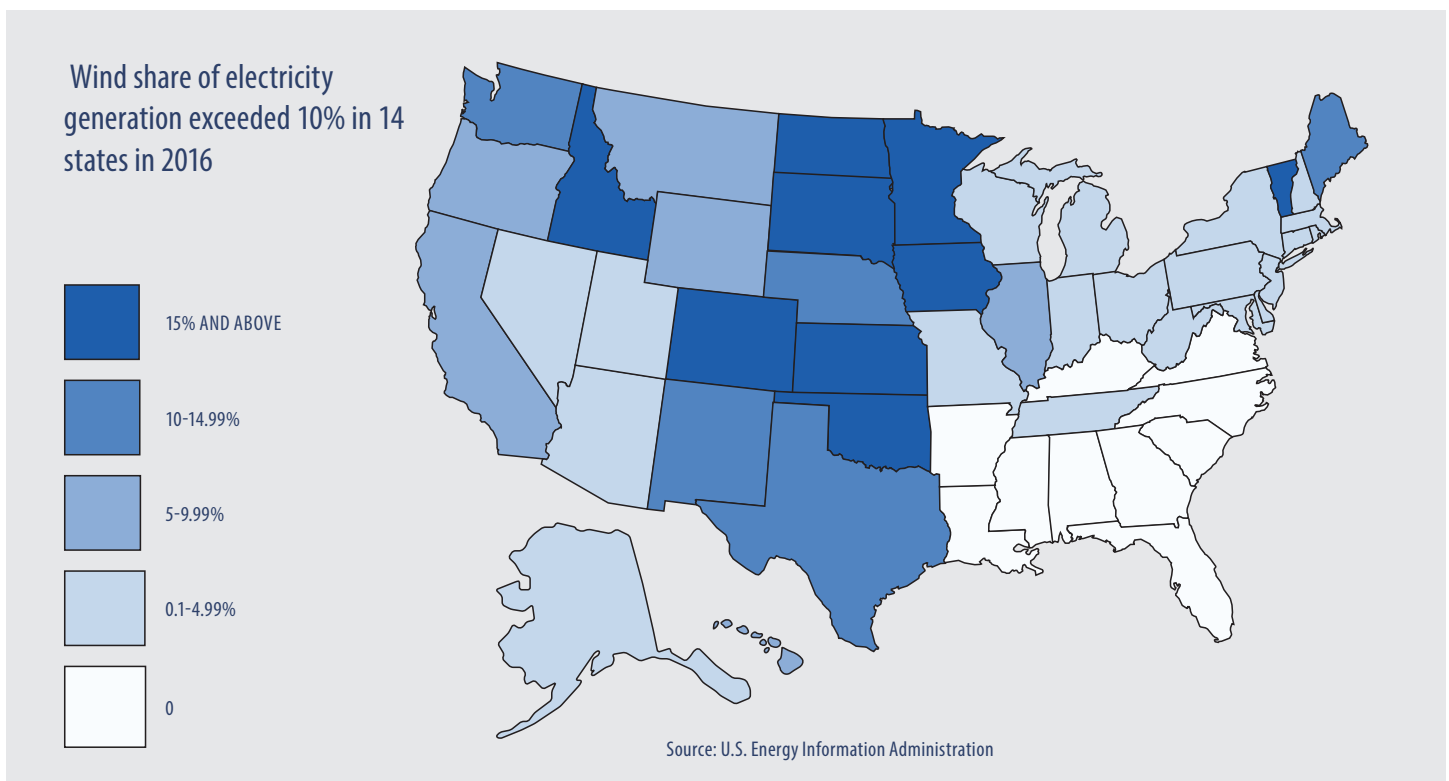
projections estimate that renewable energy and natural gas will continue growing, regardless of what happens with the Clean Power Plan.⁷

3. Electricity Demand has Flatlined, Limiting the Market in Which Coal Plants Can Compete

During the better part of the past century, demand for electricity increased year after year, except during economic downturns. Now that trend has come to a screeching halt. After decades of growth, U.S. electricity demand has essentially flatlined.

The initial drop in electricity use in 2008 and 2009 could be attributed to the Great Recession and the resulting economic hangover. However, the economy has grown since 2010. And yet, electricity use in 2016 was below its 2007 level.

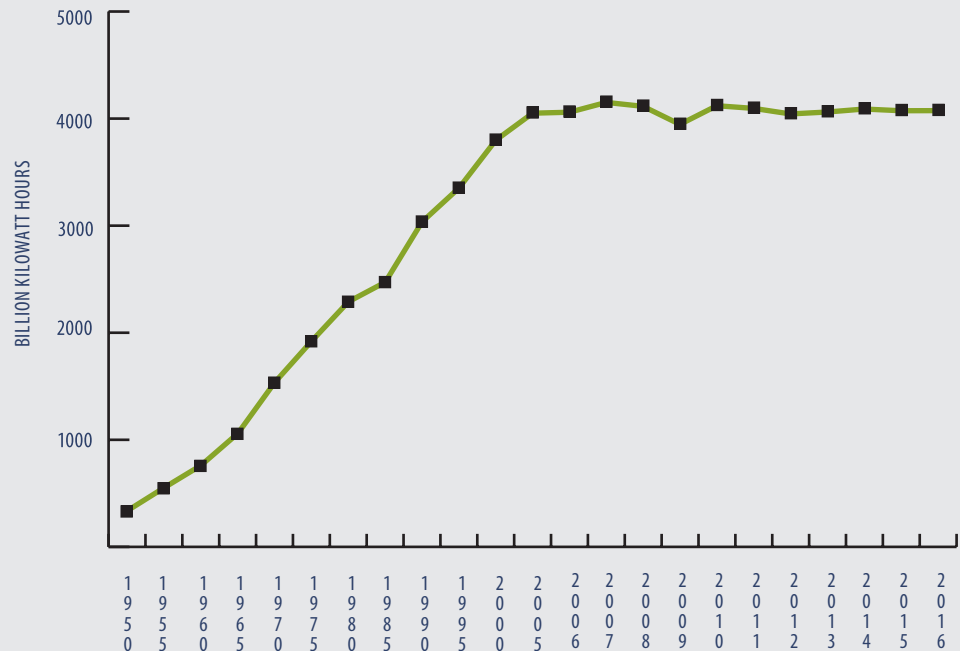
The slowdown in electricity consumption in the United States reflects a combination of factors. Energy efficiency has clearly played a role in moderating growth of electricity consumption. While some improvements in energy efficiency have been market driven, much of it has been driven by federal and state policies. As of July 2017, thirty states and the District of Columbia have adopted energy efficiency policies—either mandated requirements, voluntary goals, or pilot programs—with the goal of lowering the growth of electricity consumption by using electricity more efficiently.⁸ At the same time, America's feeble economic growth has also contributed to flattening of electricity demand. The U.S. Energy Information Administration suggests that a decline in industrial activity has more to do with the nationwide shift than do energy efficiency.⁹



U.S. Electricity Demand Has Plateaued

Annual Net Electricity Generation, 1950-2016

Note* The chart measures electricity generation, not consumption. The numbers are very similar, and the generation data is available for a longer period



Source: U.S. Energy Information Administration

The factors influencing electricity use are complex and difficult to boil down to a few key explanatory factors. However, lower than expected demand for electricity has kept the total market size of the power sector relatively flat in terms of demand for electricity from different generating technologies and fuels, thereby limiting the market in which coal plants can compete.

4. Environmental Regulations Have Kept the Pressure on Coal-Fired Generation

Environmental regulations have also played a role in the switch from coal to natural gas and renewables in the U.S. electricity supply by accelerating coal plant retirements. Over the years, the Environmental Protection Agency has proposed and/or enacted a portfolio of regulations that have significant impacts on coal plants including Mercury and Air Toxics Standards (MATS), National Ambient Air Quality Standards (NAAQS), Cross State Air Pollution Rule (CSAPR), and the Clean Power Plan. Federal regulations and the growing cost of compliance have made many coal plants too expensive to operate, leading to their retirements. About 30 percent of the coal capacity that retired in 2015 was pulled offline in April, when the EPA's MATS rule went into effect.¹⁰

Industry representatives, academics, and market experts agree though that cheaper natural gas from the shale gas revolution is the biggest factor contributing to coal's decline. Environmental regulations have played a minor role and in many ways only served to reinforce the market trends that have been underway in the electric industry. A report from Columbia University's Center on Global Energy Policy analyzed the factors leading to the

coal industry's sharp decline over the past six years and concluded that environmental regulations might account for about 3 to 5 percent of industry's decline over the last several years.¹¹

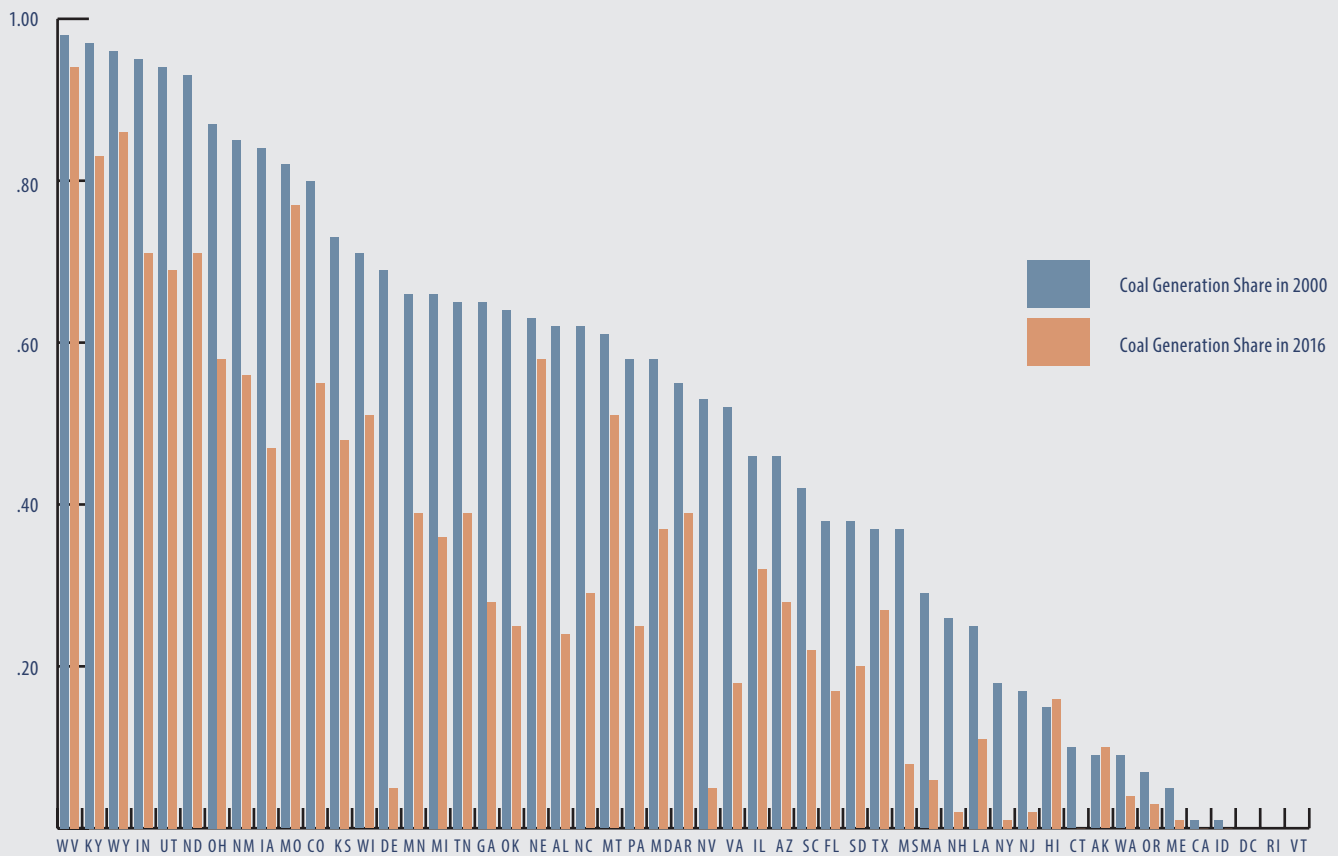
The four trends discussed above have led to rapid decline in use of coal for power generation in the United States. This shift has been remarkably fast, at least by energy industry standards. In 2000, coal accounted for more than half of all U.S. power generation. In 2016, that share dropped to 30 percent, with a significant portion of the difference made up by natural gas, a shift which the U.S. Energy Information Administration described as "mainly a market-driven response to lower natural gas prices."¹²

Additionally, two other forces are worth mentioning: decrease in global demand for coal and increasing automation.

5. Coal Exports Continue to Fall, Standing in the Way of a U.S. Coal Recovery

In the past, the U.S. coal industry has weathered the storm by exporting more coal abroad. But the future of coal exports is also under question. According to the U.S. Energy Information Administration, even though the United States remained a net exporter of coal in 2016, coal exports fell for the fourth consecutive year by 18.5 percent to 60.3 million short tons.¹³ The drop in exports was driven by slow growth in global coal demand and a higher supplier competition. On the demand side, 10 countries accounted for nearly 80 percent of U.S. coal exports in 2016 and exports declined in nine of them. On the supply side, lower mining costs, cheaper transportation costs, and favorable exchange rates continued to provide

Share of Electricity Generated from Coal Has Fallen in Nearly Every State Since 2000



Source: U.S. Energy Information Administration

a market advantage to other major coal-exporting countries such as Australia, Indonesia, Colombia, Russia, and South Africa.

Coal exports from January through May 2017 totaled 36.79 million tons, up 60 percent from 22.94 million tons in the same period in 2016. While reflecting a bounce from 2016, these numbers remained well below export volumes recorded in equivalent periods the previous five years.

Recent shifts in global coal markets do not suggest that coal's strength lies outside of U.S. borders. In 2016, global demand for coal fell for the second consecutive year by 1.7 percent, marking a striking reversal of fortune for coal, which was the largest source of energy demand growth until four years ago.¹⁴ Coal consumption has been declining for three years in China, as its economic boom and output has tailed off in energy-intensive sectors such as iron, steel, and cement. Together with its enormous investment in renewables, China's coal consumption is expected to decline as a portion of the energy mix over the longer term—limiting the market opportunities for U.S. exports. Coal demand in India is likely

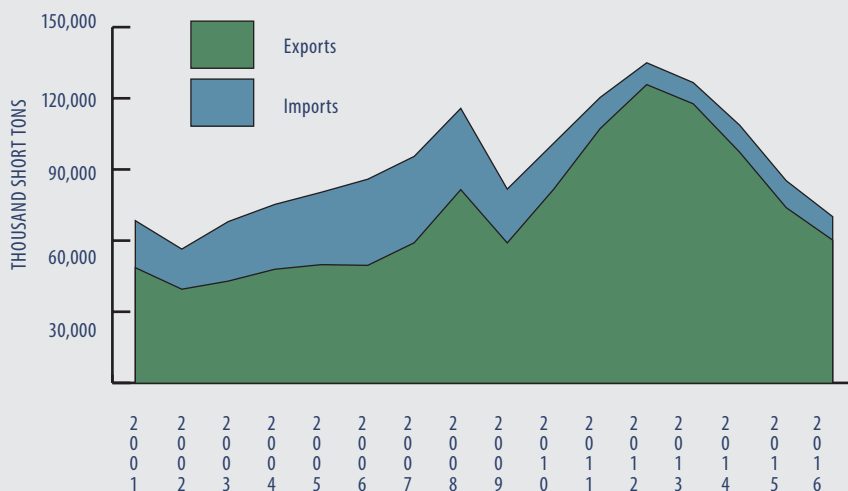
to grow in the years ahead as the country continues to push to provide electricity to more of its poor, but they may not be enough to make up for the slowdown in China.¹⁵ The same is true for other emerging economies, many of whom have been negatively impacted by slowdown in Chinese commodities demand themselves.

6. Increased Automation Indicates a Less Than Positive Outlook for Coal Jobs

Jobs in the coal industry have declined due to the same productivity gains that have led to fewer manufacturing jobs across the country. With workers producing more output per hour, the industry can see an increase in coal production and still see a decrease in coal jobs. Coal automation has been ongoing for decades and is poised to accelerate.

After World War II, the adoption of 'continuous miner' machine, which uses a large rotating drum and teeth to scrape coal from underground seams much faster than humans, transformed coal mining into more of a factory job. Similarly, 'long-wall

U.S. Has Experienced Sharp Decline in Coal Exports in Recent Years



Source: U.S. Energy Information Administration

mining’ technology—heavily automated devices that can shear off thousands of tons per shift and drop the coal onto long conveyor belts—led to rising productivity and declining jobs. More recently, since the 1990s, surface mining, which is more mechanized and less labor-intensive, has outpaced underground mining. With the rise of surface mining, the focal point of production has moved west from Appalachia to the Powder River and Illinois basins. Correspondingly, through the 1990s and 2000s, coal production increased even as coal mining employment declined.¹⁶

The mining industry in general is poised for automation in the coming years, given that it is highly capital intensive, pays relatively well, and buys expensive equipment.¹⁷ The industry has already adopted various automated technologies such as autonomous haul trucks and loaders; autonomous long-distance haul trains; semi-autonomous crushers, rock breakers, and shovel swings; automated drilling and tunnel-boring systems; automated long-wall plough and shearers; autonomous equipment monitoring; and GIS and GPS technologies. The deployment of these technologies is likely to be accelerated in the coming decades. 40 to 80 percent of today’s mining jobs are at risk of being replaced by robots and self-driving trucks.¹⁸

Outlook for Coal’s Future

Despite the challenges facing the U.S. coal industry, the fuel will remain a viable option for years to come. The U.S. Energy Information Administration’s latest annual report indicates that coal-fired power will regain its place at the top of the U.S. generation mix in 2019 and hold its position into the 2030s if the Clean Power Plan is repealed.¹⁹ This forecast is contingent upon expected price trends for other technologies, especially natural gas. The U.S. Energy Information Administration recently projected a

slight increase in domestic coal production through 2018 as a result of projected increase in natural gas prices. However, that increased production would occur in Western coal mining regions, not the Appalachian Basin.²⁰

Having said that, coal is also unlikely to rebound to its pre-2000 position, even without the Clean Power Plan. The various market forces—competition from gas-fired plants and renewable energy projects, flat demand in the power sector, declining global demand for coal—all point to lower overall demand for coal in the future. A new survey of utility executives found that just 4 percent think coal use will increase moderately or significantly in their utility’s power mix over the next decade. 27 percent said coal use would decrease moderately and 52 percent said it would decrease significantly.²¹

Over the long run, the future of U.S. coal industry will depend on its ability to innovate. Breakthroughs and cost reductions with advanced coal technology, including carbon capture, utilization and storage, could upend the negative perceptions about coal’s environmental impacts and enable it to regain cost advantages.



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