FOSSIL FUEL OPPORTUNITIES FOR WEST VIRGINIA: 2017 UPDATE

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Executive Summary

In the five years since the West Virginia Energy Plan was published in 2012, West Virginia has undergone significant changes in its energy economy. The state's coal sector has fallen into a deep recession as coal production fell by more than 40 percent between 2011 and 2016. The large majority of the losses have been felt in the state's southern coalfields where several counties are now experiencing rates of job loss not seen since the Great Depression. The decline in the coal sector has coincided with a period of rapid growth in production of natural gas from shale formations underlying West Virginia. The trends in coal and natural gas have been shaped in large degree by changes in demand from the electric power sector. In 2016, natural gas constituted the largest source of power generation in the United States, accounting for about 34 percent of total generation for the year, while generation from coal fell to less than 30 percent nationally, down from more than 50 percent in 2001. In this report, we examine these three interlocking sectors of West Virginia's energy economy. The highlights of this research are as follows:

COAL: The market for West Virginia coal has undergone a sea change in the last few years, with large-scale declines in production, and subsequent layoffs for workers employed in the mining industry.

- From 2001 to 2016, **coal production in West Virginia fell by more than half**, declining from nearly 162 million short tons to 76 million tons.
- Coal production in the **southern coalfields** declined from a total of 125 million tons in 2001 to 36 million tons in 2016, a **decline of more than 70 percent**.
- **Worker productivity in the southern mines fell by half between 2001 and 2016** from 4.4 tons per worker hour to 2.2 tons per worker hour. Productivity in the US and northern West Virginia dipped during the recession but then recovered, and now stand at 6.5 tons per worker hour and 4.7 tons per worker hour respectively.
- Exports from West Virginia to international markets surged between 2001 and 2012, rising from about $400 million in export value to more than $7 billion. However, **export value has since declined, falling by 82 percent between 2012 and 2016**.
- **Coal employment has fallen by about 13 thousand jobs between 2011 and 2016**—a decline of more than 52 percent—with the bulk of those job losses coming in southern West Virginia.

NATURAL GAS: While West Virginia has historically been a significant producer of natural gas, new horizontal drilling techniques and hydraulic fracturing of shale formations has allowed the state to unlock large reserves of natural gas in recent years.

- **Natural gas production in West Virginia more than quadrupled between 2010 and 2016**, rising from 265 billion cubic feet to nearly 1.4 trillion cubic feet.
- **West Virginia's gas boom has been felt primarily in the state's Northern Panhandle and North-Central regions**.
- **West Virginia added more than 1,100 billion cubic feet per day of outgoing pipeline capacity between 2011 and 2015, a rise of about 15 percent**. Additional major pipeline projects that originate or pass through West Virginia are expected to add 18,650 Bcf per day in the region over the next two years, almost doubling the current capacity of 10,369 Bcf per day.

ELECTRIC POWER: West Virginia's electric power industry has had significant decrease in capacity and employment in the last few years. To a large degree, the decline of the state's coal-fired power generation fleet is due to national trends that have affected coal-fired power throughout the United States.

- **Coal-fired generation has fallen as a share of power generation nationally from above 50 percent as recently as 2008 to about 30 percent of the total in 2016**. Coinciding with this decline, natural gas-fired generation rose to 34 percent of total generation from below 20 percent in 2001. Renewables accounted for almost 10 percent of generation nationally.
- **Coal-fired power plants accounted for about 94 percent of total electric power generation in West Virginia in 2016**. Renewable generation made up about 1.9 percent of West Virginia's power generation mix, and natural gas accounted for 1.6 percent.
- Approximately 2.4 gigawatts of coal-fired capacity were retired in West Virginia between 2012 and 2015, **a drop of about 14 percent of the state's capacity**. The retirements were part of nearly 40 gigawatts of coal capacity retired nationwide during that period.
- A rapid rise in West Virginia's electricity prices has the potential to hamper the state's economic development efforts. **Industrial rates rose 61 percent between 2008 and 2017 to 6.76 cents per kilowatt-hour. Average rates for all end-users grew about 6 percent per year during the same period, the fastest growth rate in the nation.**

1 Introduction and Overview

In the five years since the West Virginia Energy Plan was published in 2012, West Virginia has undergone significant changes in its energy economy. The state's coal sector has fallen into a deep recession as coal production has fallen to approximately 80 million tons in 2016, a drop of more than 50 percent since 2001. The large majority of the losses have been felt in the state's southern coalfields where several counties are now experiencing rates of job loss not seen since the Great Depression. Coal production in the northern part of the state has remained fairly stable, but employment has shown signs of decline in recent quarters as demand for thermal coal has declined in the power sector.

The decline in the coal sector has coincided with a period of rapid growth in production of natural gas from shale formations underlying West Virginia. The introduction of technological advances in hydraulic fracturing and horizontal drilling has made the natural gas deposits in the Marcellus, Utica, and Upper Devonian shales accessible to mining. Natural gas production rose to nearly 1.4 trillion cubic feet in 2016, a gain of more than 400 percent over 2010's production of 265 billion cubic feet. This growth has resulted in the oil and gas sector reaching near parity with coal as the largest industries in the state in terms of GDP.

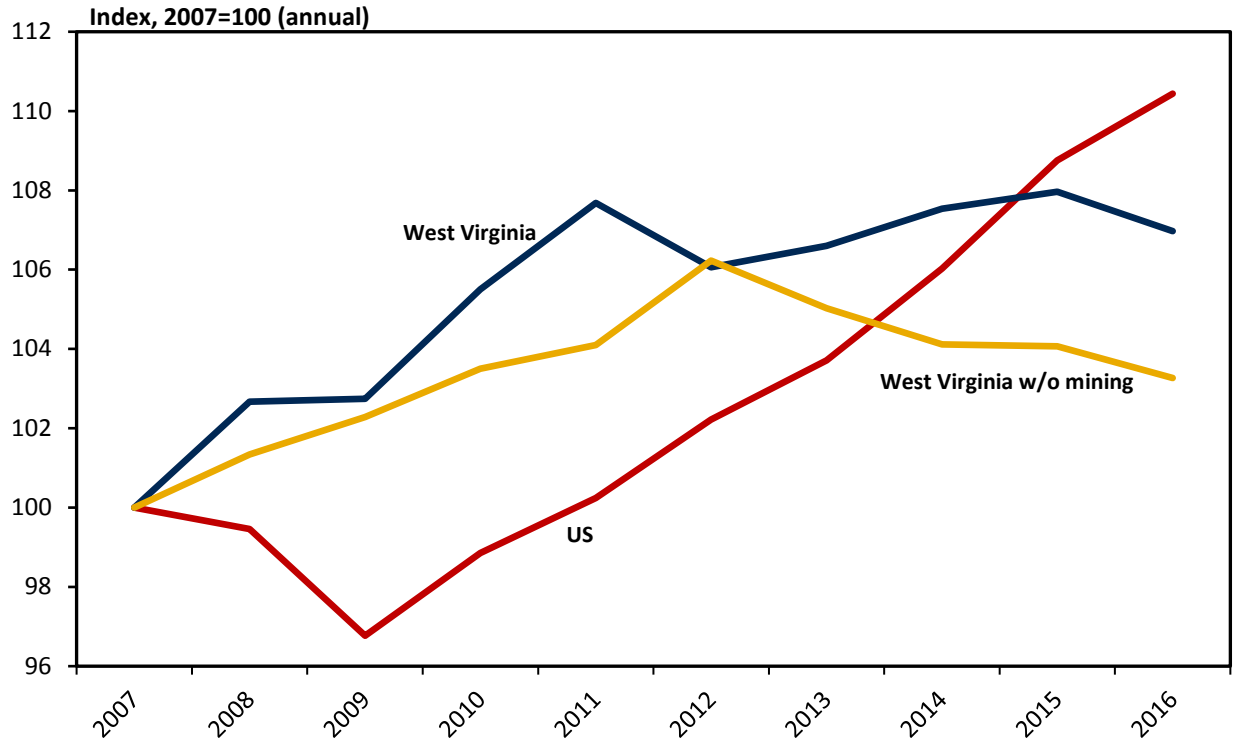
The trends in coal and natural gas have been shaped in large degree by changes in demand from the electric power sector. In 2016, natural gas constituted the largest source of power generation in the United States, averaging about 34 percent of total generation for the year. Power generation from coal fell to less than 30 percent nationally after producing more than half the nation's electricity in 2008. The drop in demand for coal-fired power, along with the rise of renewable power generation and the impact of environmental regulations aimed at reducing air pollution and other emissions, have caused several coal-fired power plants in West Virginia to be retired since 2012. In all, 2.4 gigawatts of capacity has been retired in the state, constituting 14 percent of the state's total capacity.

This report, along with a parallel report on energy efficiency and renewable energy produced by the Center for Business and Economic Research (CBER) at Marshall University, sets forth a five-year plan for the state's energy policies and provides a direction for the private sector. This research was commissioned by the West Virginia Division of Energy. In this report, we will examine three interlocking sectors of West Virginia's energy economy. Beginning in Section 2, we briefly discuss the recent performance of the West Virginia economy. In Section 3, we conduct an in-depth examination of West Virginia's coal sector. In Section 4, we examine the effect that the natural gas boom has had on West Virginia's economy. In Section 5, we discuss the evolution of the electric power sector and its implications for West Virginia's future. Lastly, in Section 6, we report our forecast of the state's energy sectors.

2 Statewide Economic Trends

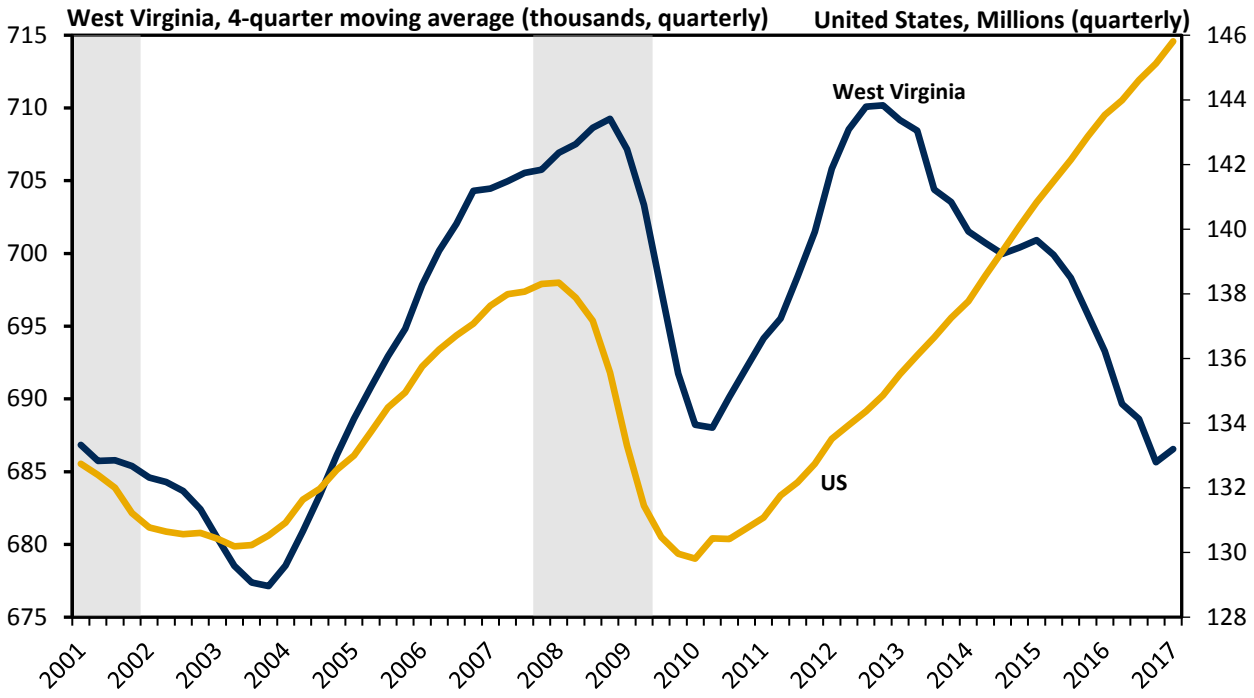
The changes in West Virginia's energy sectors have caused ripple effects across the rest of the state's economy. In Figure 1, we report GDP growth rates for West Virginia and the United States indexed to 2007 prior to the Great Recession. While West Virginia weathered the recession better than the nation as a whole, the state's GDP growth has lagged behind the US for the last four years. In addition, outside of GDP growth in the energy sector, which came largely from the natural gas industry, West Virginia's economy would have been significantly worse off.

Figure 1: GDP Growth



West Virginia's overall employment also fared better during the recession than the US as a whole, as shown in Figure 2. However, since 2012, the state has lost about 22 thousand private sector jobs and employment levels are now below where they were during the recession years. The job losses have been led by declines in the coal industry, but employment in the natural gas industry also weakened in 2015 and early 2016. We expect job growth in West Virginia to be approximately 0.6 percent annually over the next five years, which is about two-thirds of the national figure.

Figure 2: Total Employment



Source: US Bureau of Labor Statistics

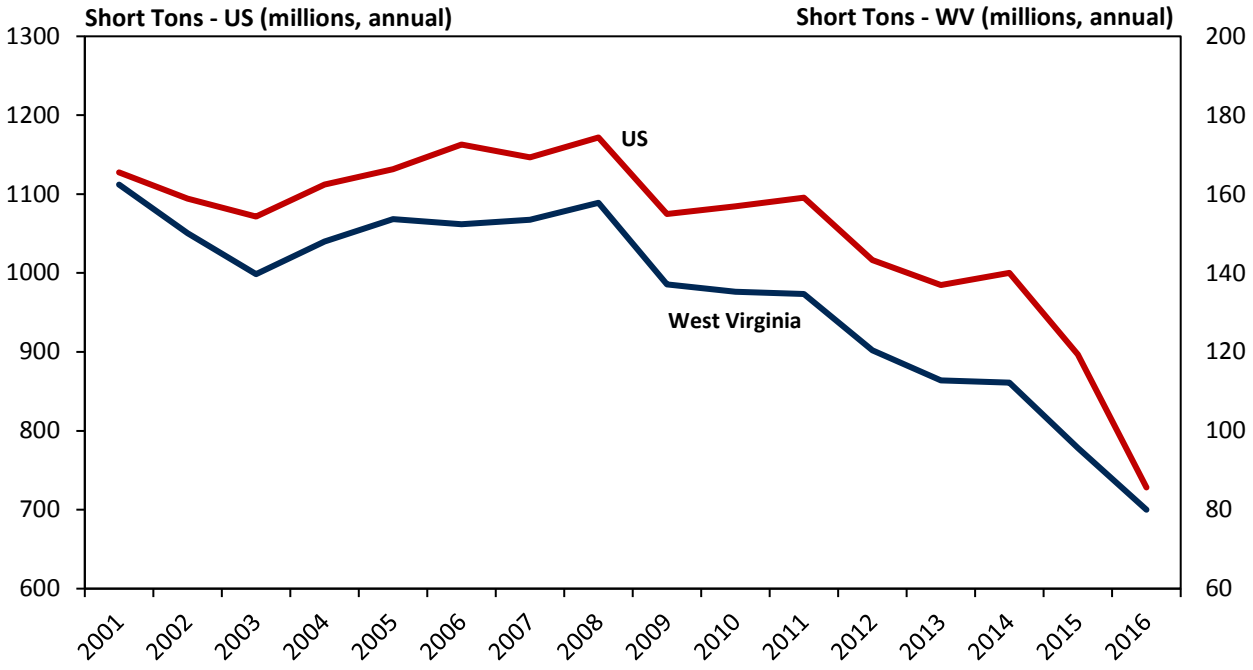
3 Coal

The market for West Virginia coal has undergone a sea change in the last few years, with large-scale declines in production, and subsequent layoffs for workers employed in the mining industry. In this section, we examine these changes and identify some of the contributing factors to this decline.

3.1 Production

As shown in Figure 3, coal production in the US and West Virginia have both declined considerably in the last several years. From 2001 to 2016, coal production in West Virginia fell by half, declining from nearly 162 million short tons to 80 million tons. During the same period, US coal production followed a similar trend, falling from 1.2 billion tons to 728 million, a decline of more than 35 percent. The bulk of the decline—41 percent—has occurred since 2011, when coal production in West Virginia was 135 million tons.

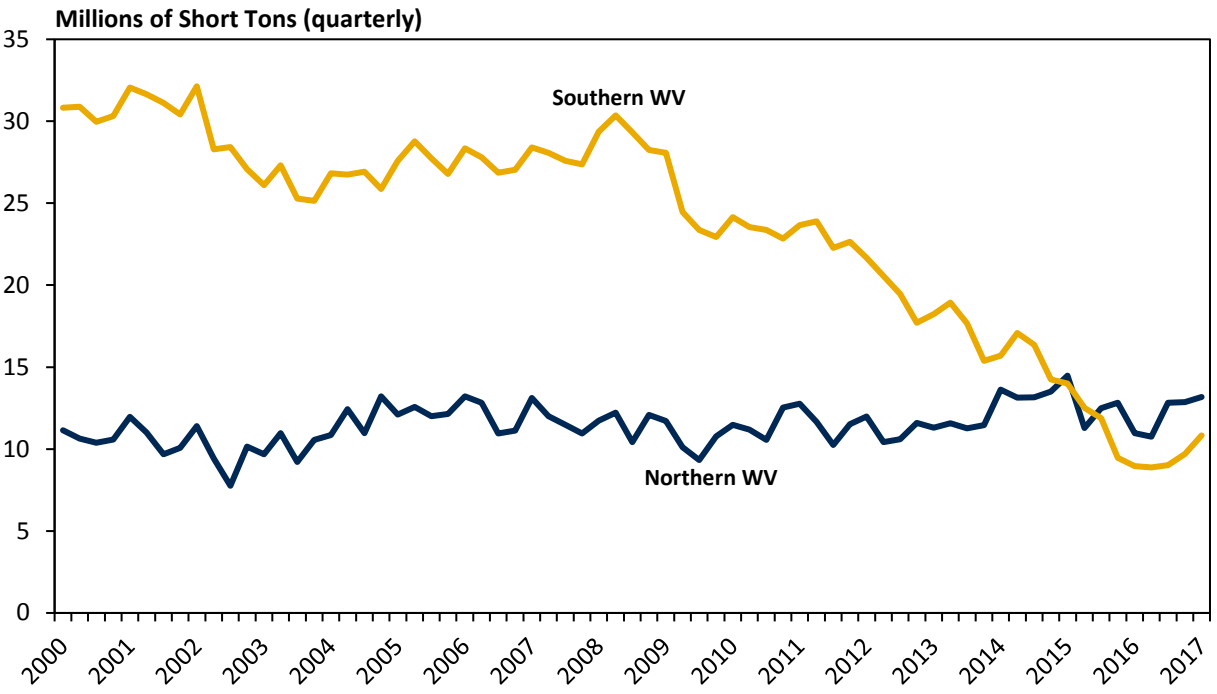
Figure 3: Coal Production



Source: US Energy Information Administration

The impact of the coal decline has been felt particularly in the Central Appalachian coal basin, which covers the southern portion of West Virginia. As shown in Figure 4, coal production in the southern coalfields declined from a total of 125 million tons in 2001 to 36 million tons in 2016, a decline of more than 70 percent. During the same period, production in the northern part of West Virginia was relatively steady, rising from 43 million tons to 47 million tons. As recently as 2008, the state's southern coalfields produced nearly three times as much coal as the northern part of the state, but by 2016, the state's northern counties surpassed the south by nearly 11 million tons.

Figure 4: Coal Production by Region



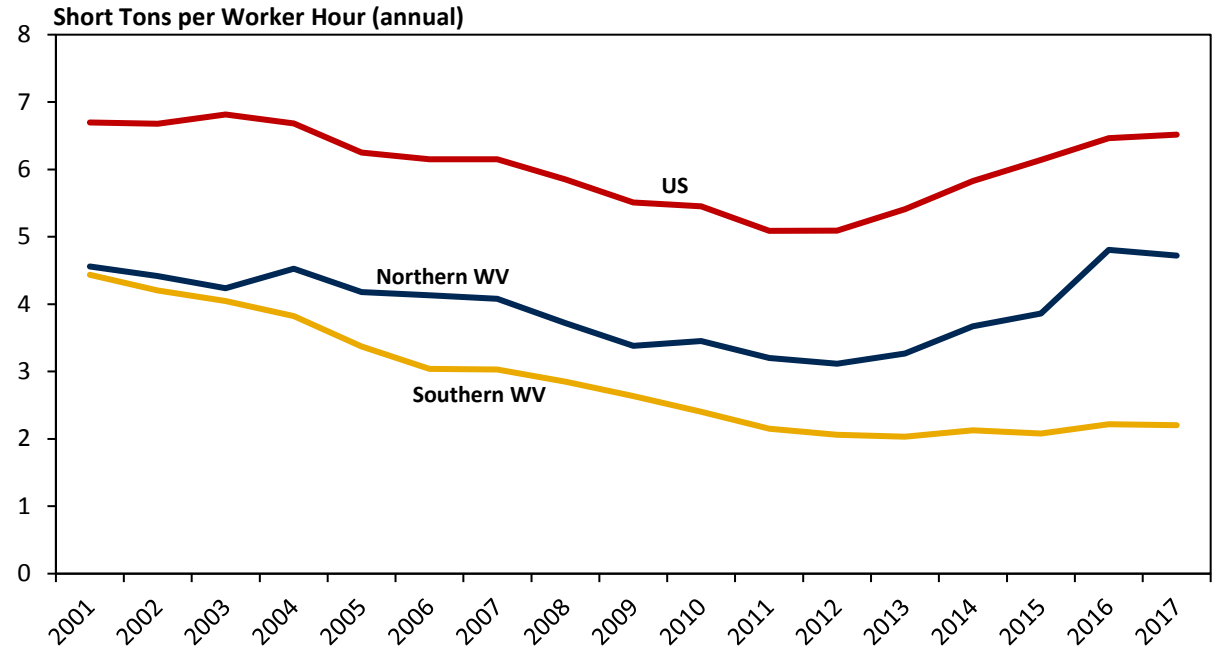
Source: US Mine Safety and Health Administration

3.1.1 Productivity

Much of the decline in the state's southern coal region can be explained by falling productivity at the region's mines, in part due to depletion of the region's coal seams after decades of mining. While southern coal is generally a hotter burning, higher-quality coal, the most easily accessible seams have become depleted, leaving the more difficult-to-reach, thinner seams as the only coal available to be mined. Declining productivity has likely raised the cost of coal in the southern region relative to coal produced in other parts of the country, putting southern West Virginia coal at a price disadvantage during a period of declining national demand.

As depicted in Figure 5, worker productivity, measured as short tons per worker hour, was nearly identical in the northern (4.6) and southern (4.4) regions of West Virginia in 2001. However, by 2016, worker productivity in the southern mines had fallen roughly in half to 2.2 tons per worker hour. Over the same period, worker productivity in the state's northern mines declined through 2012, but rose again to end at approximately the same level in 2016. While higher overall than in West Virginia alone, US productivity mirrored the pattern seen in northern West Virginia during this period, falling through 2012, then rising again into 2016.

Figure 5: Coal Mining Productivity

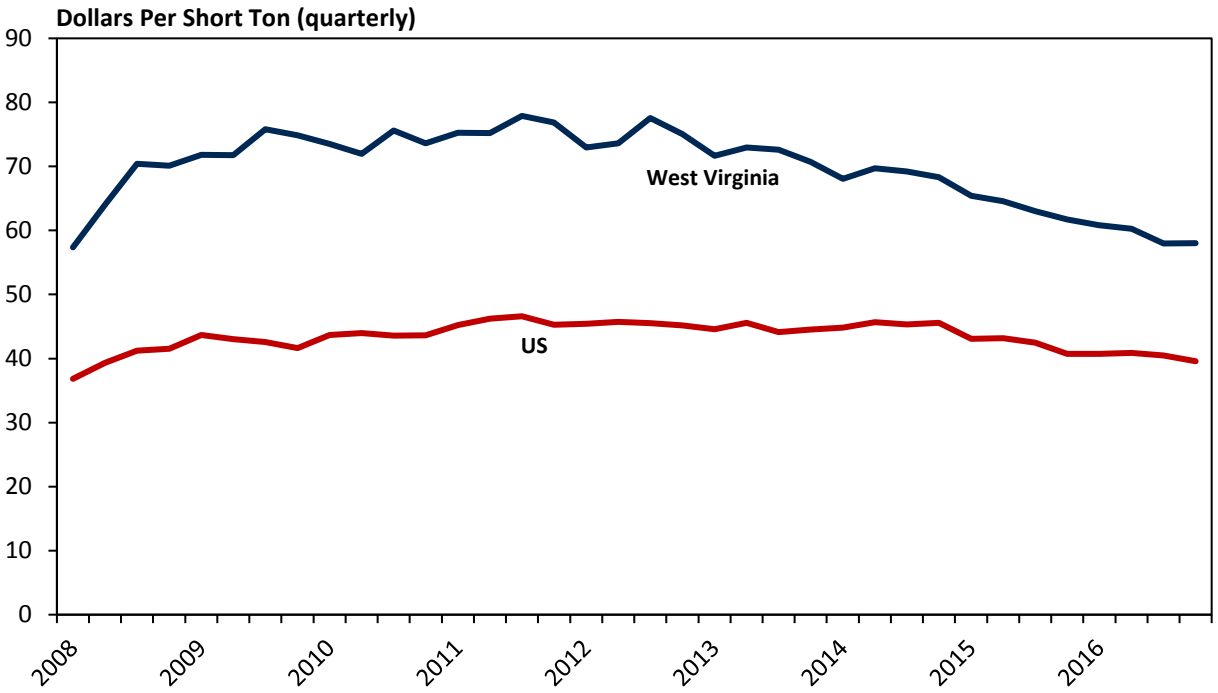


* Data through first quarter 2017
Source: US Mine Safety and Health Administration

3.1.2 Prices

West Virginia has been favored with high quality coal that has demanded a price premium over competing regions for deliveries to the electric power sector. As shown in Figure 6, prices in the US averaged around $40 per short ton throughout the period between 2008 and 2016. Average prices for West Virginia coal peaked in 2011 at approximately $76 per short ton, but fell to an average of $59 per ton in 2016, a decline of 22 percent. This has caused the price differential between West Virginia and the US average to drop from about $30 per ton in the period prior to 2013, to less than $20 per ton in 2016.

Figure 6: Average Price for Coal Shipments to Electric Power Sector

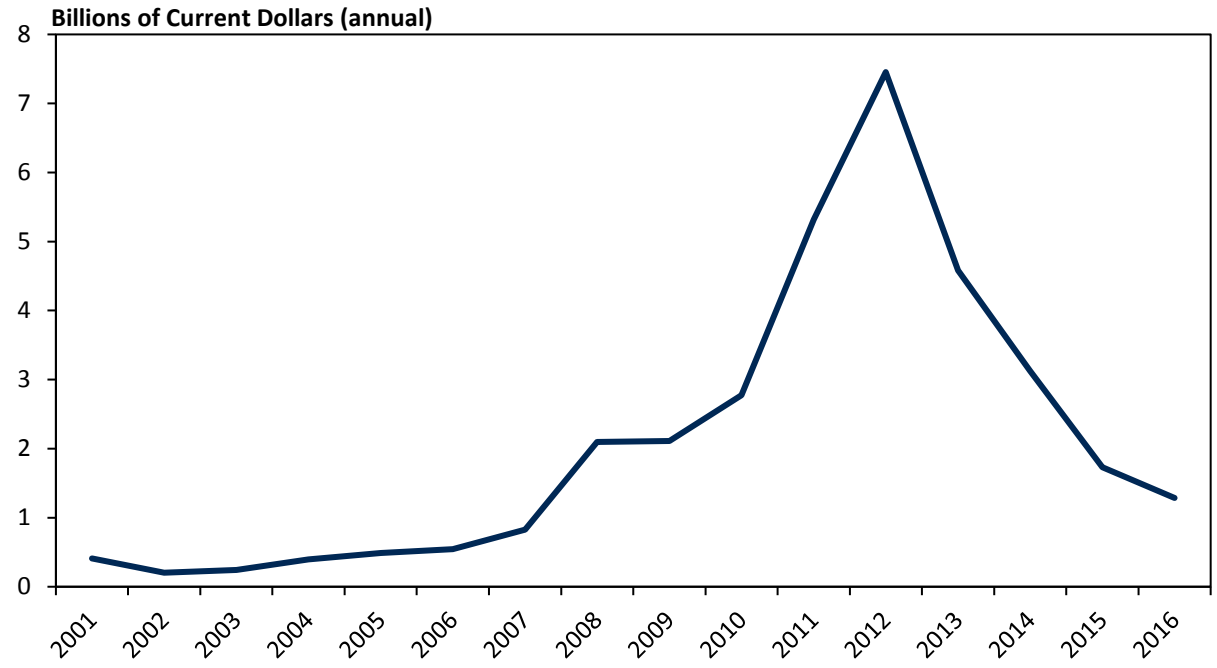


Source: US Energy Information Administration

3.2 Exports

One factor that supported West Virginia's coal industry during and immediately after the Great Recession was export markets for the state's coal. As shown in Figure 7, the value of West Virginia's exports of minerals and ores rose by more than 255 percent between 2008 and its peak in 2012, rising from about $2.1 billion to nearly $7.5 billion. Exports rose due to a combination of favorable conditions in world markets—most importantly supply disruptions in Australia, the traditional supplier of Asian markets—that led to greater demand for West Virginia coal internationally.[1] However, once these factors subsided, international demand for coal fell sharply. Exports fell to a little under $1.3 billion in 2016, well below the level of exports in 2008.

Figure 7: Value of West Virginia Exports of Minerals and Ores



Source: US International Trade Administration TradeStats

[1] For a more detailed explanation of the effect of international demand for West Virginia coal, see Lego, Brian and John Deskins. "Coal Production in West Virginia: 2016-2036." WVU Bureau of Business and Economic Research. http://busecon.wvu.edu/bber/pdfs/BBER-2016-03.pdf

The shift in international markets is evident in the top export destinations at the 2012 peak vs. the most recent values. As shown in Table 1, China and Japan were heavy importers of West Virginia coal during the 2012 peak, but are no longer in the top 10 in 2016. While other markets—such as the Netherlands, India, and Brazil—are still important importers, these countries all reduced their consumption by between 70 and 80 percent.

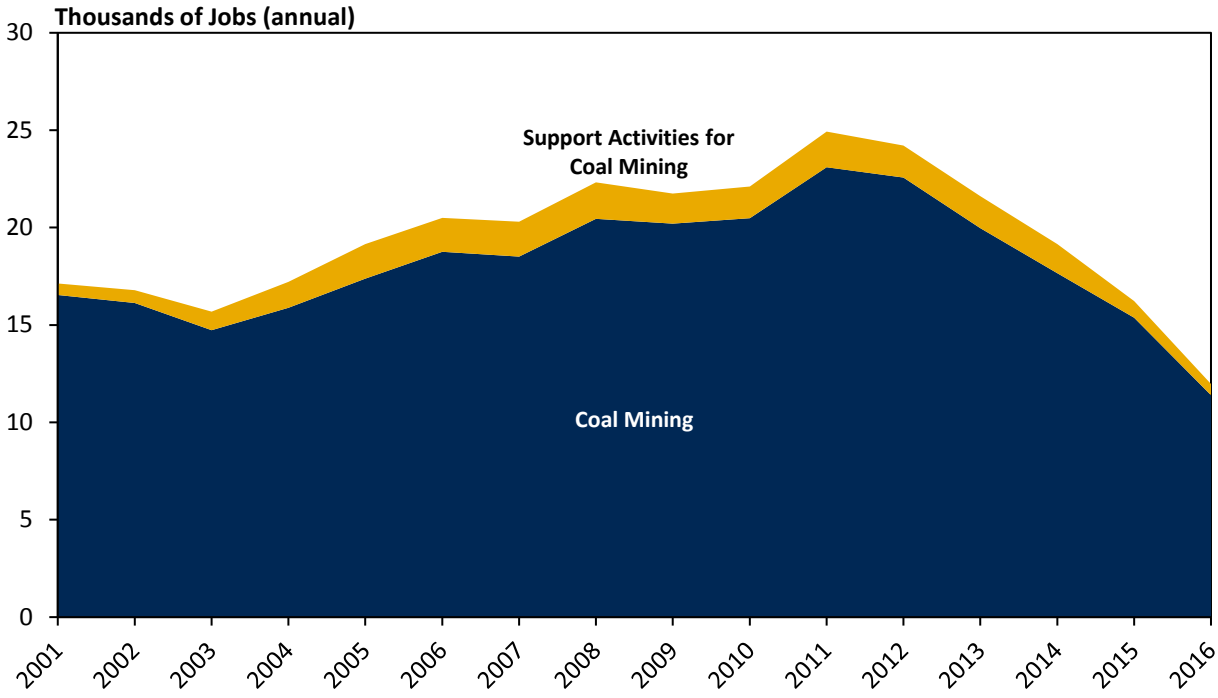
Table 1: Top 10 Export Destinations for West Virginia Minerals and Ores

2012		2016	
Country	**Value ($, Millions)**	**Country**	**Value ($, Millions)**
Netherlands	815.5	**India**	167.7
Italy	697.8	**Brazil**	160.6
India	694.0	**Canada**	145.7
Brazil	556.0	**Netherlands**	126.0
South Korea	520.6	**Ukraine**	119.9
China	491.8	**Italy**	94.3
United Kingdom	474.1	**Turkey**	66.4
Turkey	403.0	**South Korea**	56.5
Japan	395.2	**France**	54.9
France	381.7	**United Kingdom**	48.1

3.3 Employment

While total coal production was largely consistent between 2001 and 2008, employment in the mining sector, which we define as mining and support activities, follows a pattern similar to that of coal exports. As shown in Figure 8, coal mining sector employment increased substantially between 2003 and its recent peak in 2011, rising from just under 16 thousand jobs to nearly 25 thousand jobs, a gain of 59 percent. Since that time, employment has fallen by about 13 thousand jobs—a decline of more than 52 percent—ending nearly 4 thousand jobs below 2003 levels.

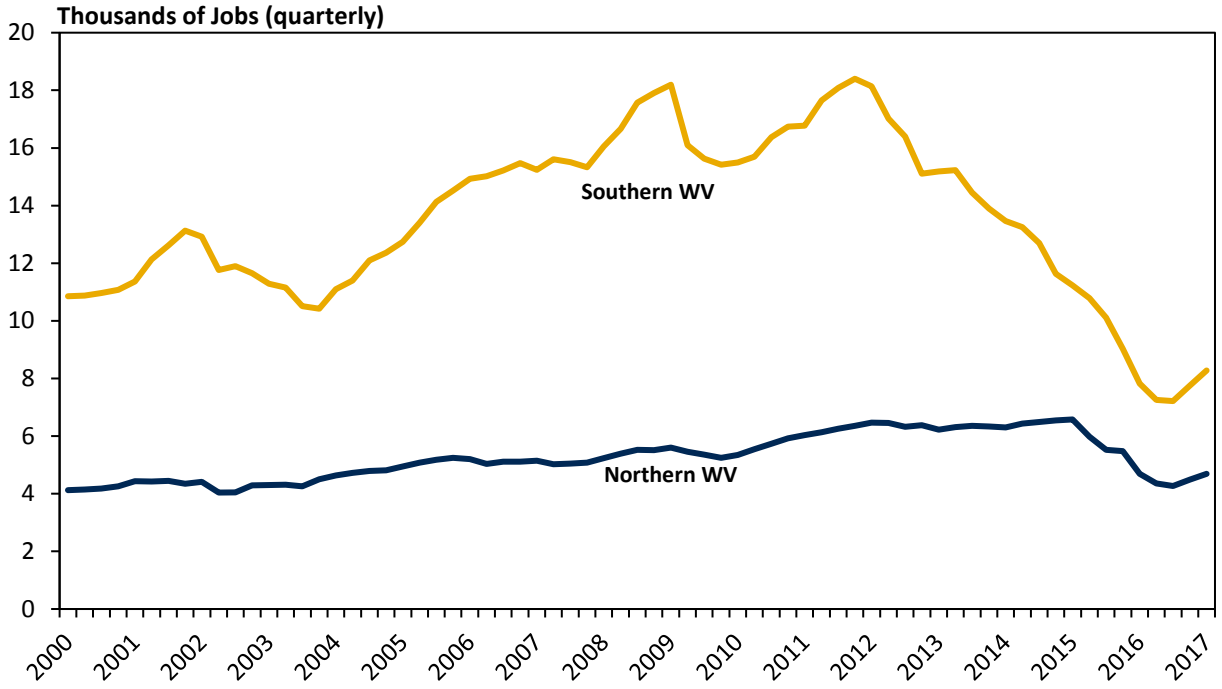
Figure 8: Coal Mining Employment



Source: WorkForce West Virginia

As with coal production, the state's southern coalfields have had the largest employment losses over the last 15 years. As shown in Figure 9,[2] mining employment rose along with export demand between 2001 and 2012 in both northern and southern West Virginia, though the trend is more pronounced in the southern coal basin. Employment fell rapidly in the southern coal counties starting in early 2012, while employment in northern West Virginia has had a more modest decline within the last two years.

Figure 9: Coal Mining Employment by Region

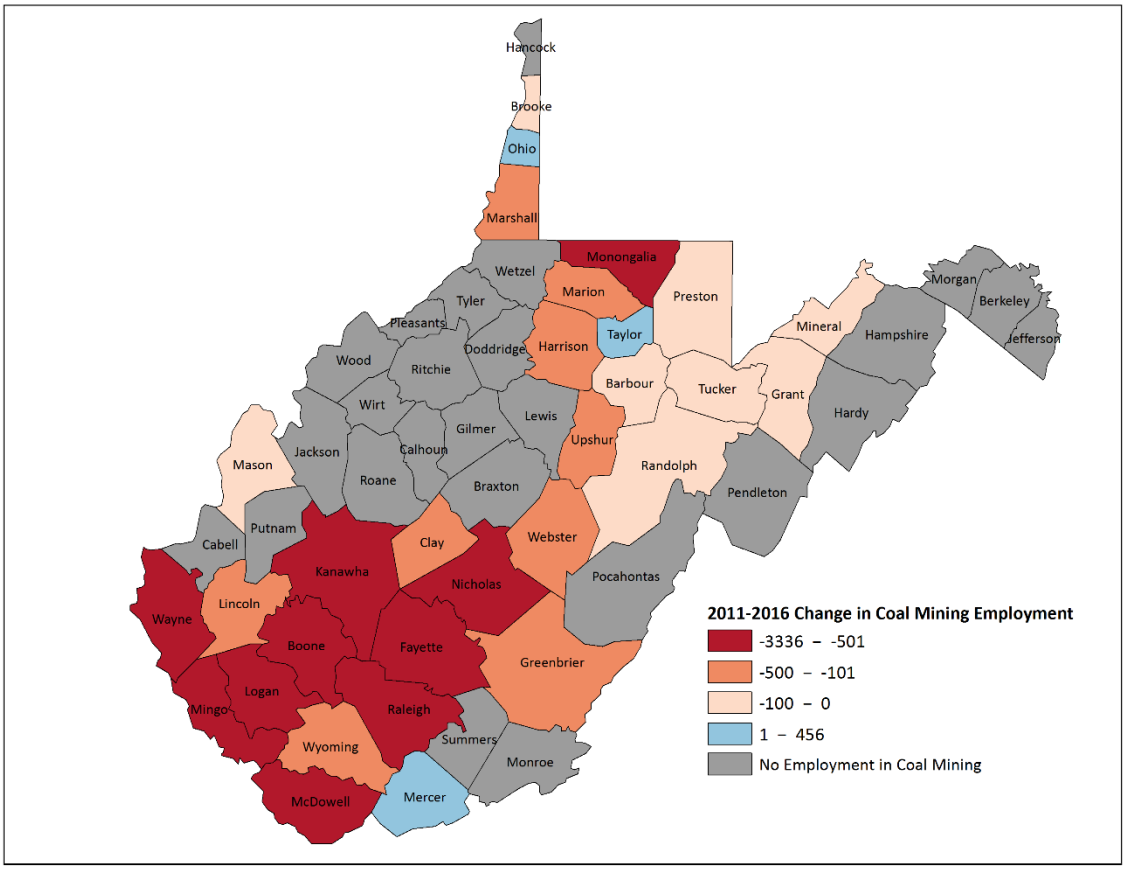


Source: US Mine Safety and Health Administration

[2] Data in Figures 9 and 10 may not match totals in Figure 8, as they are derived from different sources.

As with production, coal sector employment losses have been particularly high in southern West Virginia, as shown in Figure 10. Boone County has had the largest losses, with employment falling by 3,300 jobs, a drop of nearly four in five mining jobs in that county. Mingo and Logan counties each lost more than 900 mining jobs during that same period. Fayette, Wayne, Monongalia, and McDowell counties lost more than 700 mining jobs since 2011, which constituted more than half of the mining jobs in each of those counties.

Figure 10: Coal Employment Change by County, 2011-2016



Source: US Mine Safety and Health Administration

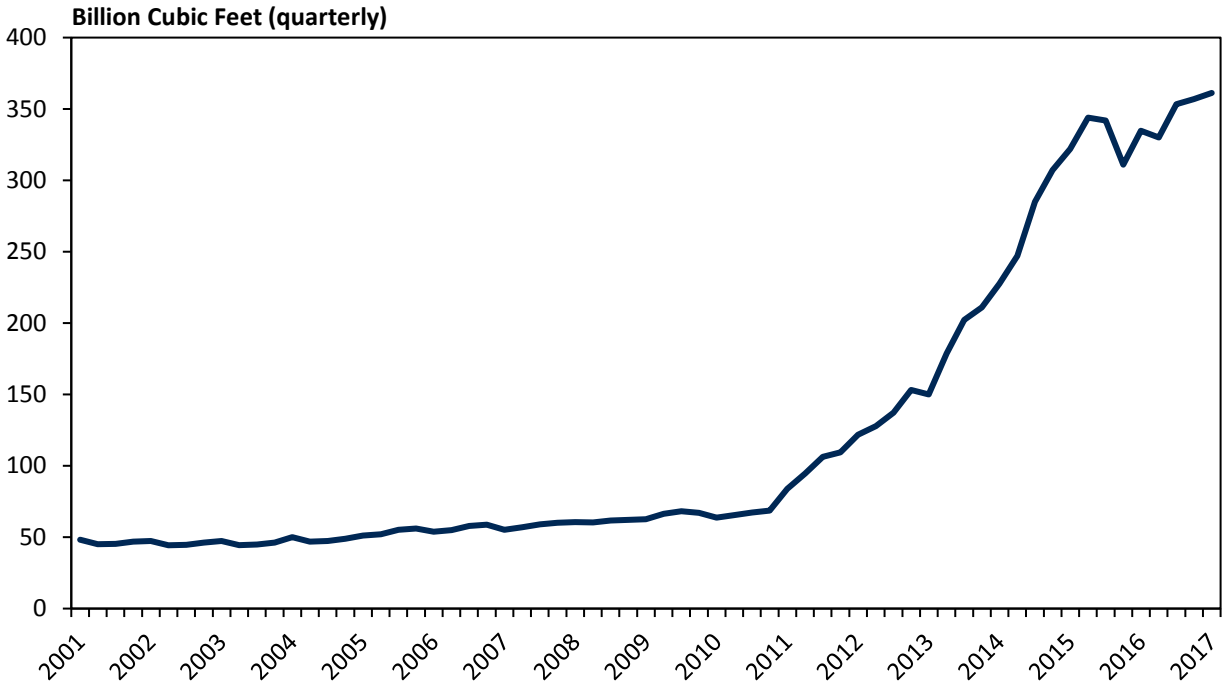
4 Natural Gas and Oil

While West Virginia has historically been a significant producer of natural gas, new horizontal drilling techniques and hydraulic fracturing of shale formations has allowed the state to unlock large reserves of natural gas in recent years. West Virginia—along with parts of Pennsylvania, Ohio, Maryland, and New York—sits atop three different shale formations: Upper Devonian, Marcellus, and Utica. The Marcellus region is the largest of the three in terms of production, totaling approximately 6.6 trillion cubic feet (Tcf) in 2016. However, in the last two years, the Utica shale formation has had the fastest growth rate in the US, from about 993 billion cubic feet (Bcf) in 2015 to more than 1.4 Tcf in 2016, a growth rate of more than 43 percent. As a result of tapping these formations, West Virginia's natural gas industry has become a major player in the US natural gas market. The state has risen to become the eighth-largest producer of natural gas in the country, up from 15th in 2010. In this section, we explore the rise of the West Virginia natural gas industry using a variety of economic indicators—including production, reserves, prices, and pipelines.

4.1 Production

As depicted in Figure 11, natural gas production in West Virginia more than quadrupled between 2010 and 2016, rising from 265 Bcf to nearly 1.4 Tcf. However, production growth in the state has tapered off in the most recent quarters, as total production has been relatively flat since mid-2015. Production declines are likely due to falling natural gas prices (discussed below) making additional drilling less profitable. Gas producers may also be waiting for additional pipeline capacity (see subsection 4.2) to ease constraints on selling gas to markets in the northeast US.

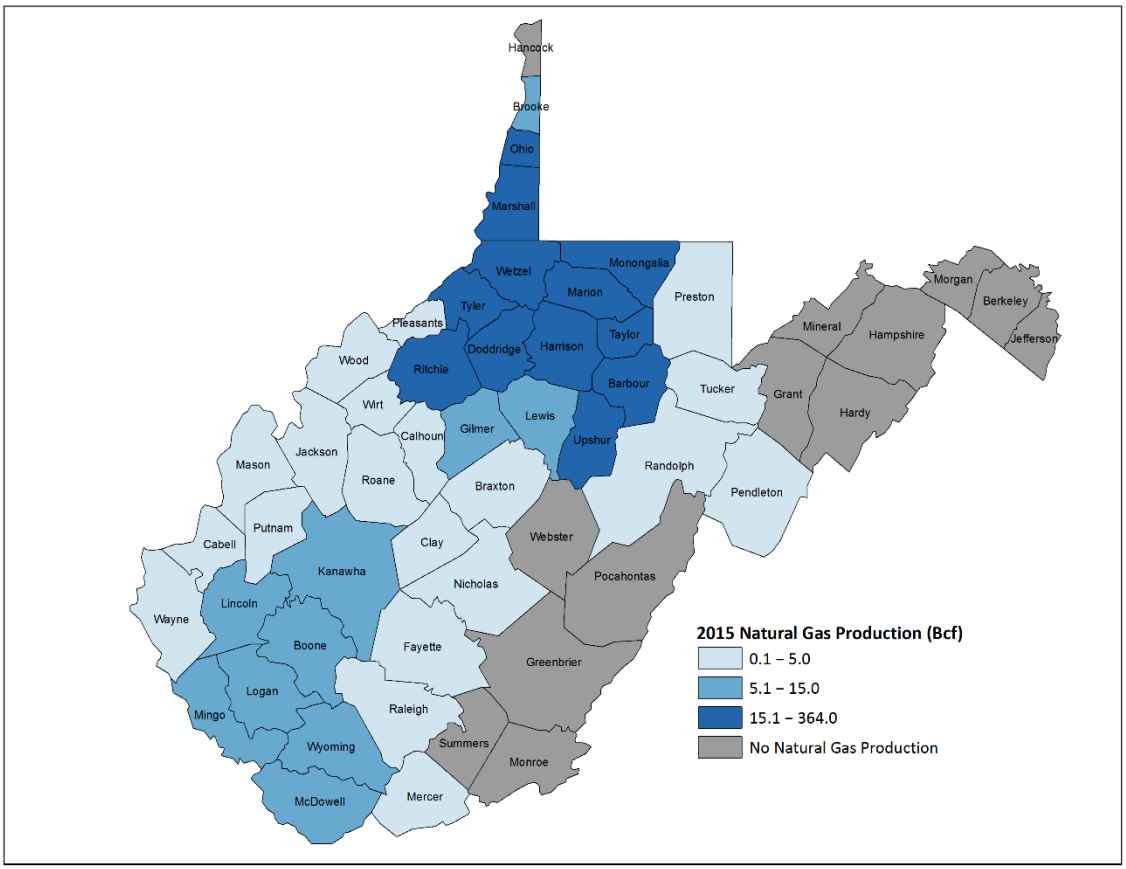
Figure 11: Natural Gas Marketed Production



Source: US Energy Information Administration

West Virginia's gas boom has been felt primarily in the state's Northern Panhandle and North-Central regions, as shown in Figure 12. The state's largest producing counties are Doddridge, Wetzel, Harrison, and Marshall, each of which produced more than 100 billion cubic feet of natural gas in 2015. This is a marked contrast to 10 years ago, when the top four producers—Wyoming, McDowell, Kanawha, and Lewis counties—were primarily in the southern part of the state.

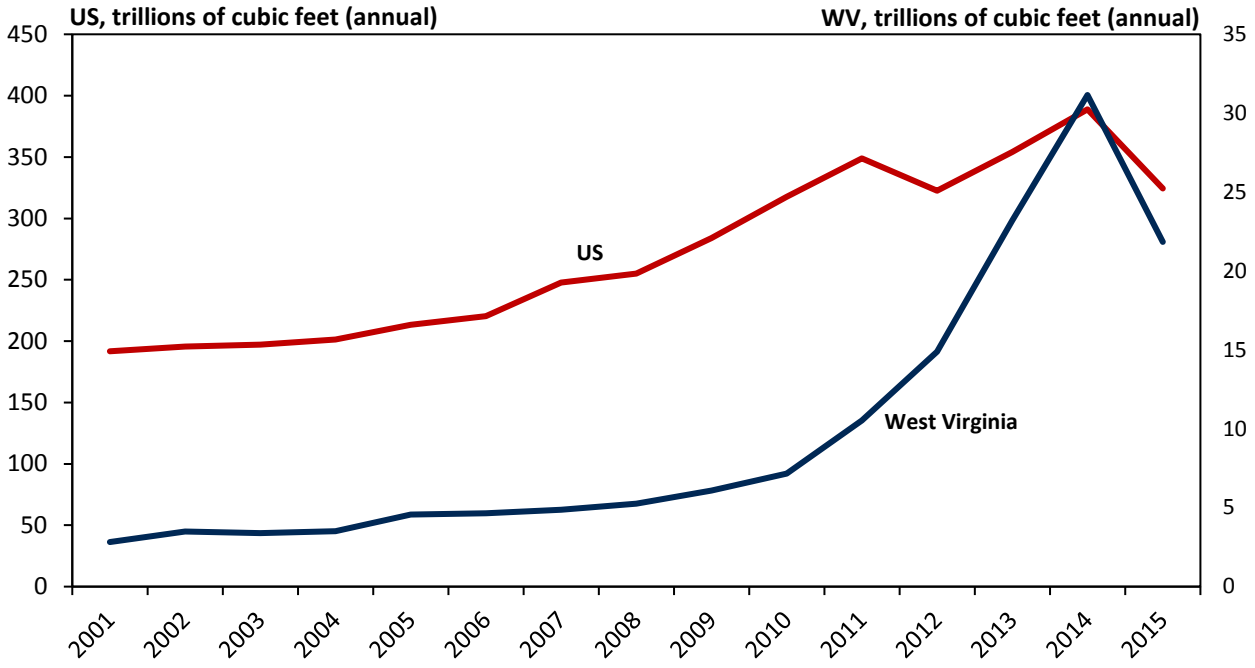
Figure 12: Natural Gas Production by County



Source: WV Department of Environmental Protection

New drilling techniques described above have caused experts to increase the estimates for West Virginia's recoverable natural gas reserves. Proved reserves are those deposits geological experts expect to be able to be recovered given the current technology and economic value. As shown in Figure 13, proved reserves in West Virginia rose from just under three Tcf in 2001 to more than 31 Tcf in 2014, before falling again to about 22 Tcf in 2015. US reserves also rose during this period, rising from about 192 Tcf in 2001 to 324 Tcf in 2015. The decline in US and West Virginia reserves in 2015 was due largely to a decline in natural gas prices, which made some reserves uneconomic to produce.[3]

Figure 13: Natural Gas Proved Reserves



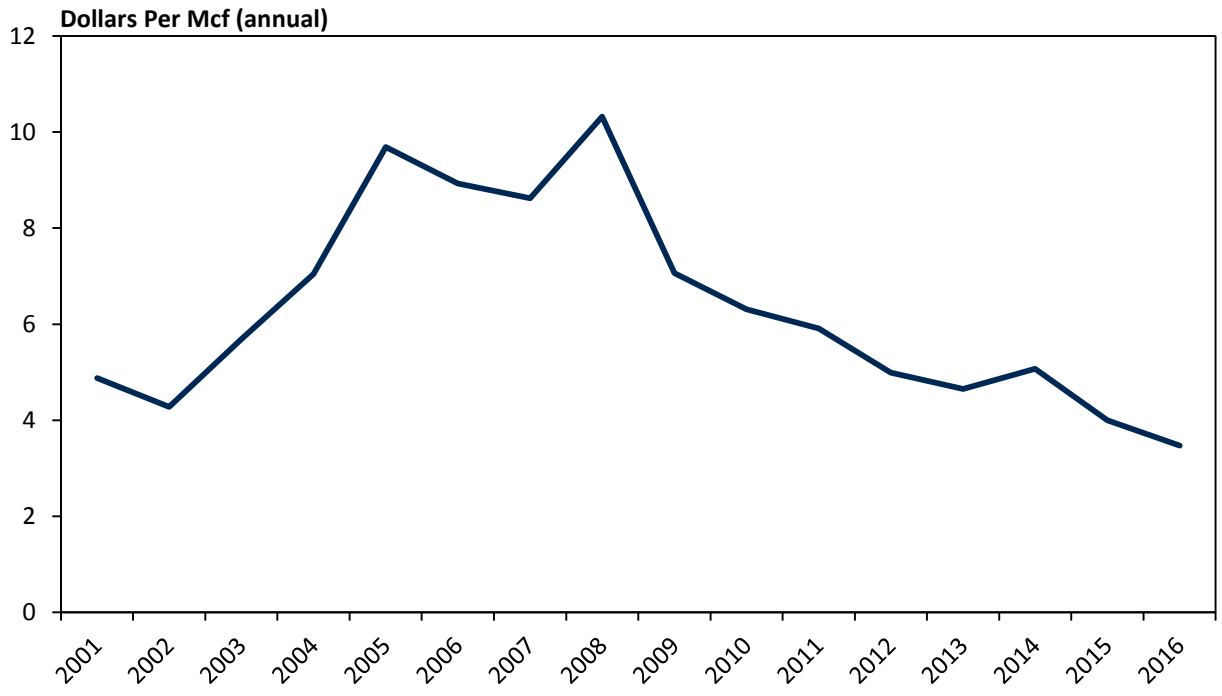
Source: US Energy Information Administration

[3] For more information, see "U.S. oil and natural gas proved reserves declined in 2015 because of lower prices." US Energy Information Administration Today in Energy. https://www.eia.gov/todayinenergy/detail.php?id=29172

Natural gas prices are set in a national market with a benchmark price set at the Henry Hub in Louisiana. However, there are considerable regional differences in prices paid to producers in the local region. For example, as of mid-2017, local producers were paid approximately $1 to $1.25 less than Henry Hub prices for natural gas entering the Tennessee Zone 5 pipeline, which serves the Marcellus region.

In Figure 14, we show the citygate price of natural gas in West Virginia between 2001 and 2016. The citygate price measures the price distributers pay to pipeline companies when purchasing gas for resale, and as such reflects transportation costs, as well as regional price differences in natural gas prices. Overall, prices for natural gas have been extremely volatile over the last 15 years. The average monthly price rose from just under $5 per thousand cubic feet (Mcf) in 2001, to over $10 per Mcf in 2008, just prior to the recession. The price then fell significantly between the middle of 2008 and May 2009, and have been on a slow downward trend since that time. The average citygate price in 2016 was about $3.50 per Mcf.

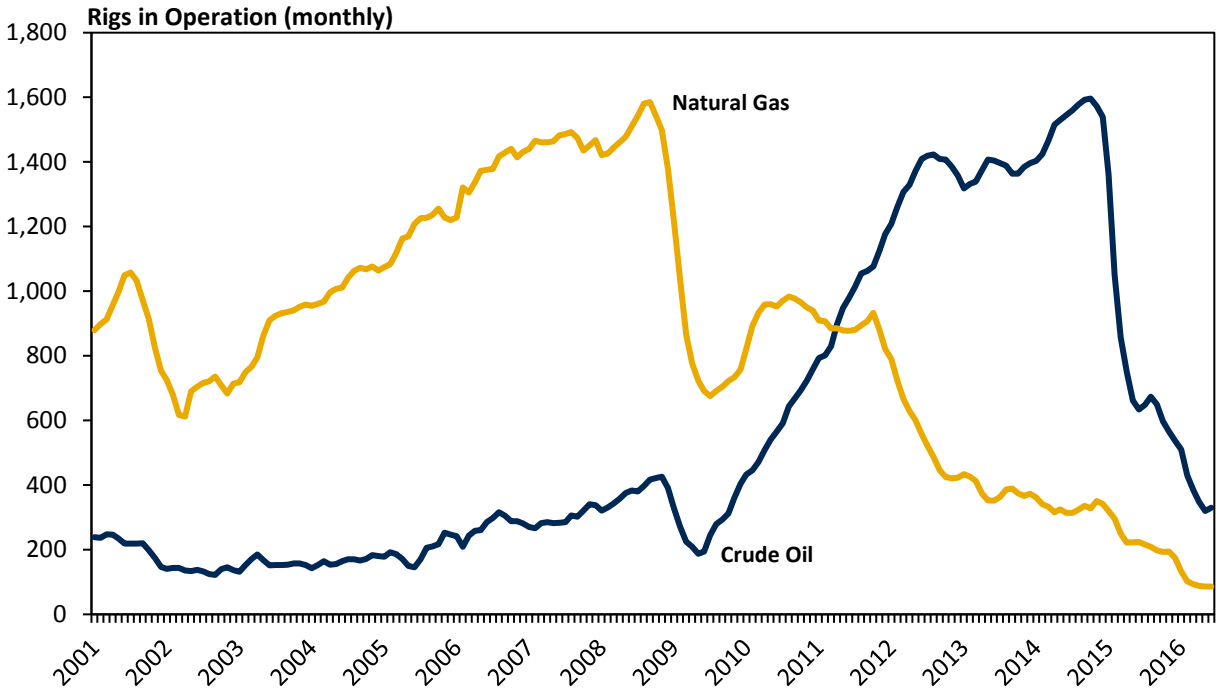
Figure 14: Citygate Natural Gas Price



Source: US Energy Information Administration

In Figure 15, we report the number of natural gas and oil drilling rigs in operation nationwide between 2001 and 2016. We can see in the data the rise in natural gas drilling activity during the period before the Great Recession when prices increased significantly. As natural gas prices fell, drilling activity followed, and currently natural gas drilling is largely at a standstill, with under 100 drilling rigs in operation in 2016.

Figure 15: Oil & Gas Drilling Rigs in Operation, US

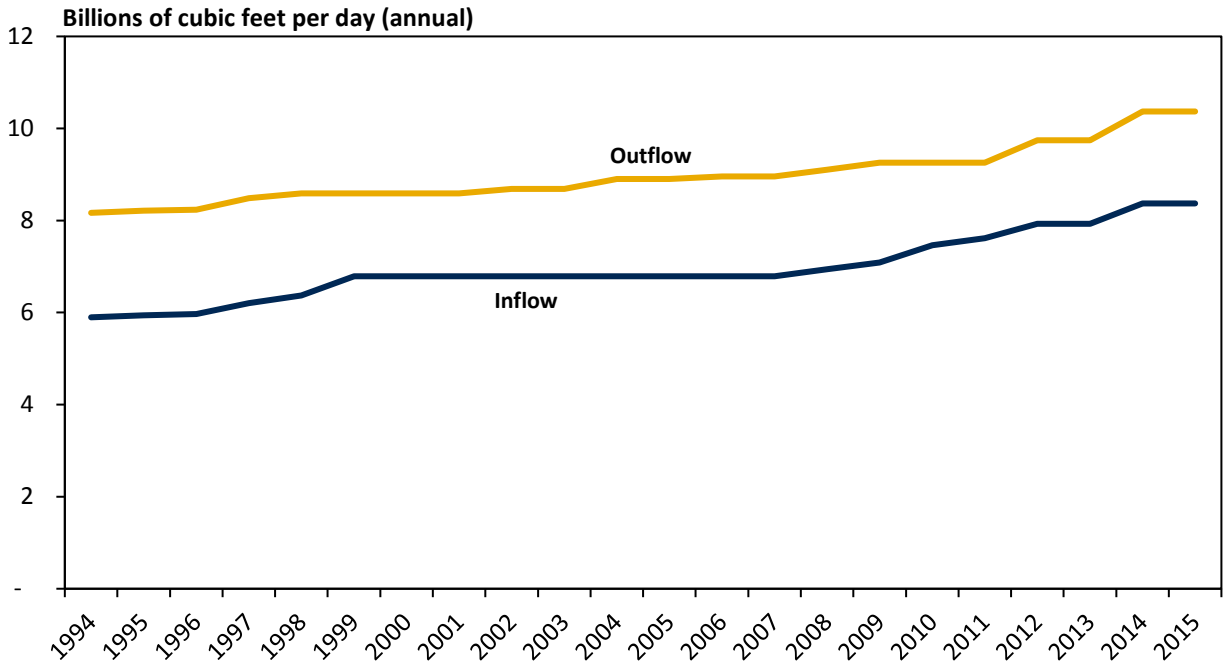


Source: US Energy Information Administration

4.2 Natural Gas Pipelines

One important factor in the growth of the West Virginia natural gas industry will be the ability to get gas to market outside the region through gas pipelines. As shown in Figure 16, West Virginia added more than 1,100 Bcf per day of outgoing pipeline capacity between 2011 and 2015, a gain of 12 percent. Additional major pipeline projects that originate or pass through West Virginia—such as the Atlantic Coast Pipeline and the Mountaineer XPress—are expected to add an additional 18,650 Bcf per day capacity in the region over the next two years, more than doubling total capacity. The additional pipeline capacity may help local producers narrow the spread between the Henry Hub natural gas price and prices paid at regional trading hubs, as examined above.

Figure 16: Natural Gas State-to-State Pipeline Transmission Capacity



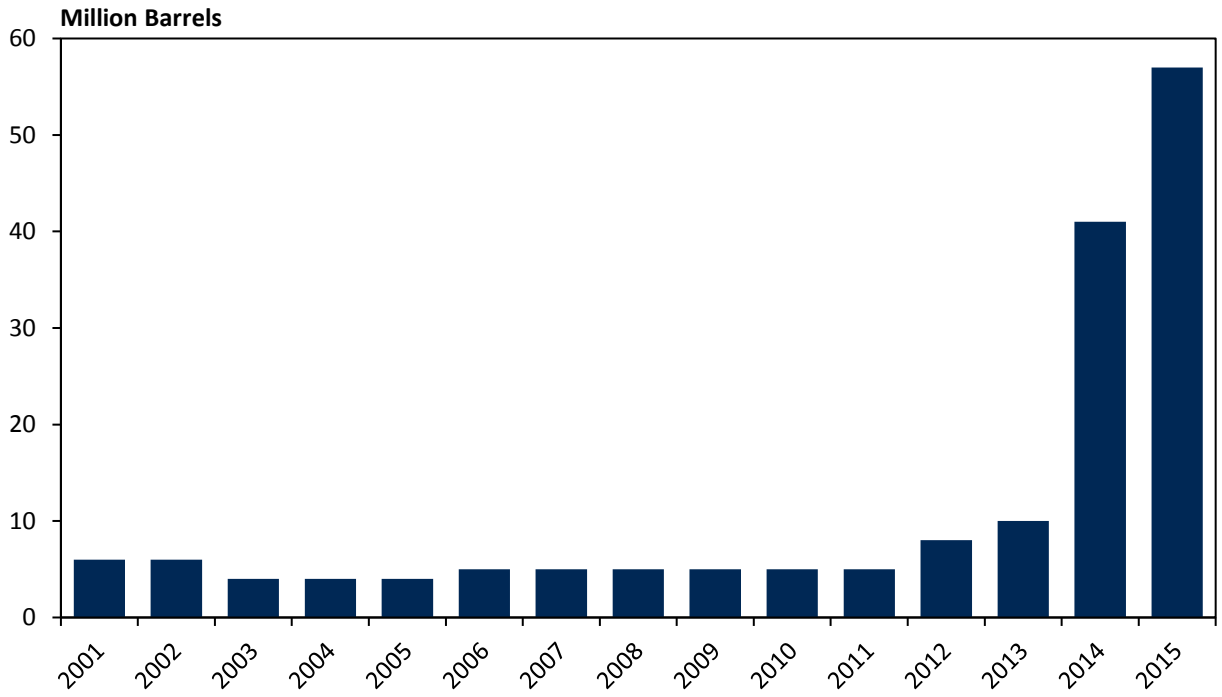
Source: US Energy Information Administration

4.3 Petroleum Liquids and Oil

Alongside the growth in natural gas production, West Virginia has also experienced a rise in production of natural gas liquids (NGLs). NGLs are petroleum products—such as ethane, butane, or propane—that are produced as byproducts of the drilling process for natural gas. Though NGLs are not generally the primary product for the oil and gas industry, selling natural gas liquids can provide additional income in addition to sales of dry gas. West Virginia has also traditionally had a small role in the petroleum sector, which has had a resurgence in recent years along with the natural gas sector. In this section, we report on both of these industries.

As shown in Figure 17, West Virginia NGL production was relatively small in 2000 at 6 million barrels, but began to rise in 2012, reaching 57 million barrels in 2015, a gain of 850 percent. West Virginia's production of NGLs constituted about 4 percent of total US production in 2015, making the state the ninth-largest producer of NGLs. However, NGL production is still a very small fraction of crude oil production, which totaled more than 3.4 billion barrels in the US in 2015, and about 8 million barrels in West Virginia (see Figure 18).

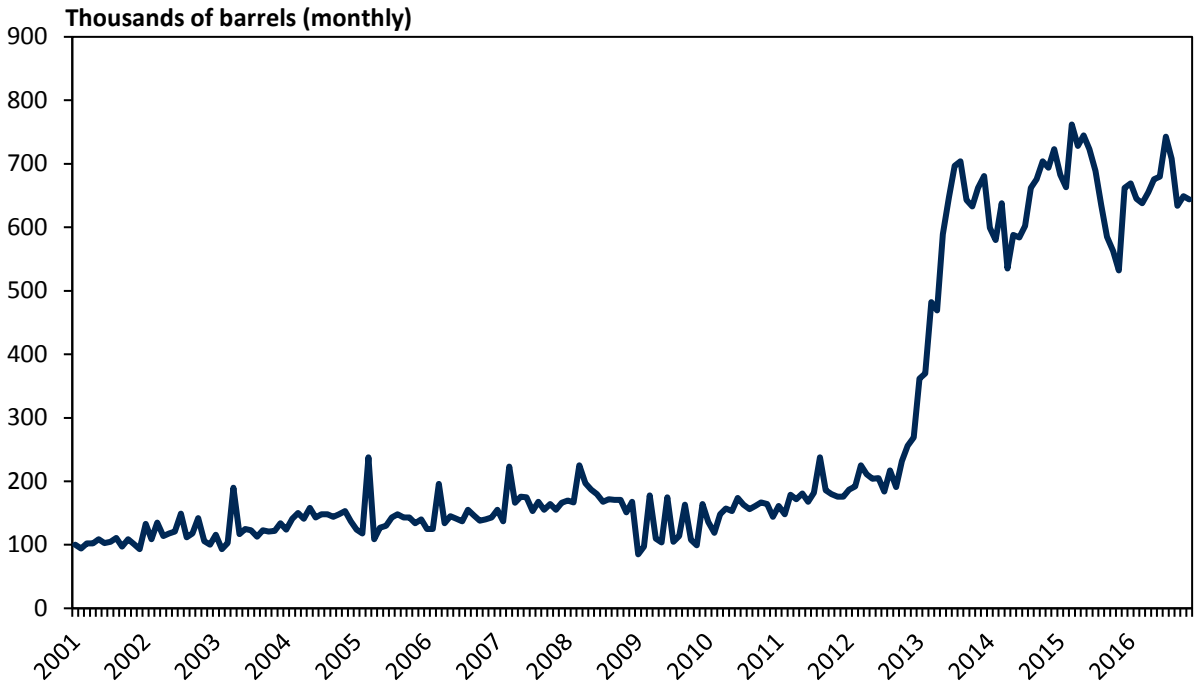
Figure 17: Production of Natural Gas Liquids



Source: US Energy Information Administration

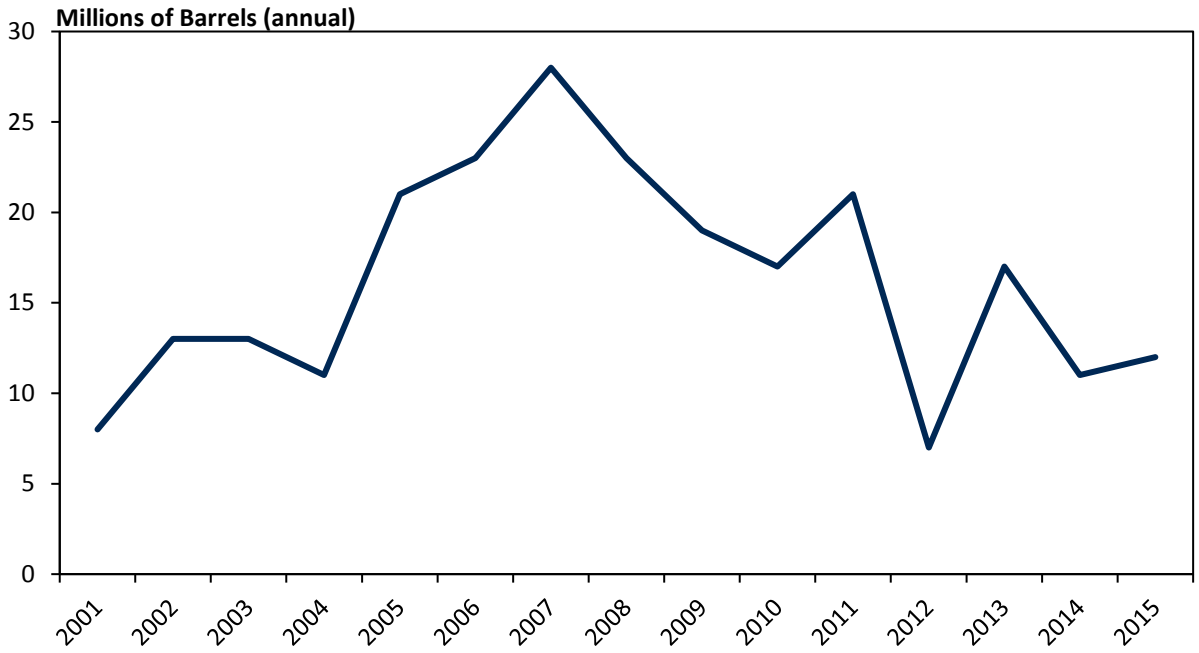
In Figures 18 and 19, we report the production and proved reserves for West Virginia crude oil. As mentioned above, the state's oil production is small relative to the rest of the country, but production has risen in recent years alongside the natural gas boom. Total 2016 crude oil production was about 8 million barrels, up from 2.5 million barrels in 2012, a gain of about 220 percent. Crude oil reserves remain low, however, totaling about 12 million barrels in 2015.

Figure 18: Field Production of Crude Oil



Source: US Energy Information Administration

Figure 19: Oil Proved Reserves



Source: US Energy Information Administration

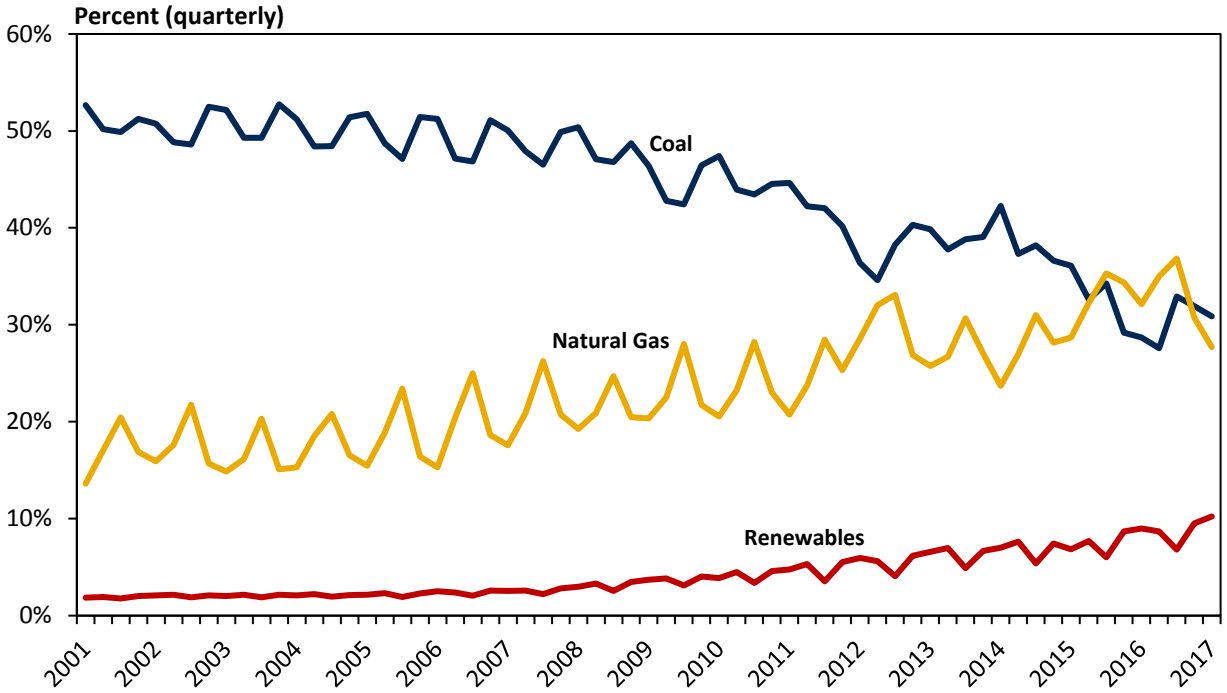
5 Electric Power

West Virginia's electric power industry has had significant decrease in capacity and employment over the last few years. To a large degree, the decline of the state's coal-fired power generation fleet is due to national trends that have affected coal-fired power throughout the United States. The primary factor in coal's decline has been the availability of cheap natural gas brought on by the boom in production of shale gas, a competing fuel to coal in power generation. In this section, we discuss the national generation trends, followed by an examination of their effect on West Virginia's coal-fired power generation market. We also discuss the state's rapidly rising electricity prices, which have the potential to harm the state's economic growth. Finally, we discuss the implications for the state's utility sector of national environmental policy.

5.1 US Electric Power Industry Trends

For decades, coal has been the largely unrivaled fuel used for electricity production in the United States. As recently as 2008, coal provided nearly half of all power generation in the country, with natural gas providing less than 20 percent of generation on average (see Figure 20). Since that time, however, coal-fired generation has fallen as a share of power generation to about 30 percent of the total in 2016. At 34 percent, natural gas-fired generation constituted the largest share of the US power market in 2016, the first time that has been the case for the entire year.

Figure 20: Share of US Electric Power Generation by Fuel Type[4]

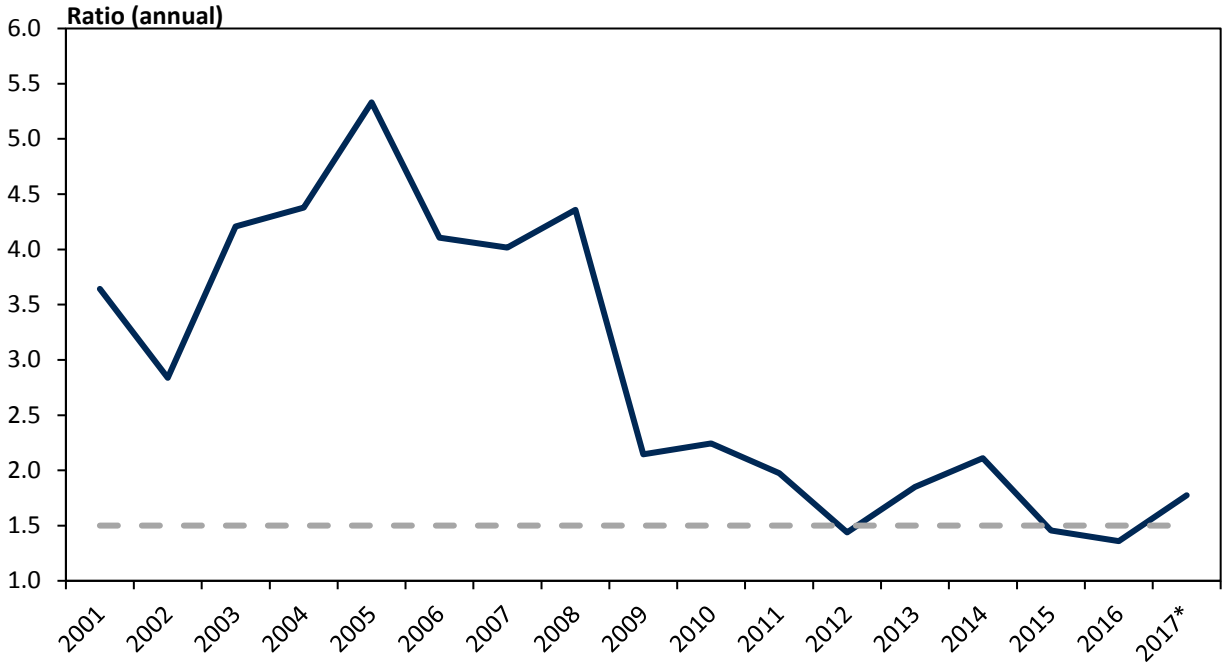


Source: US Energy Information Administration

[4] Other sources not shown include nuclear, hydroelectric, fuel oil, and other fossil fuels.

The rise of natural gas as a fuel for power generation has been largely due to a significant decline in natural gas prices over the last decade. With the advent of horizontal drilling and hydraulic fracturing techniques, the supply of natural gas has risen, causing prices to fall. As shown in Figure 21, natural gas prices have fallen significantly relative to coal prices for the same level of heat output, measured in British thermal units (Btu). As recently as 2005, natural gas was more than five times as expensive as coal on a Btu basis. That ratio had fallen below 1.5 by 2016.[5]

Figure 21: Ratio of Fuel Cost for Natural Gas to Coal in Electricity Generation

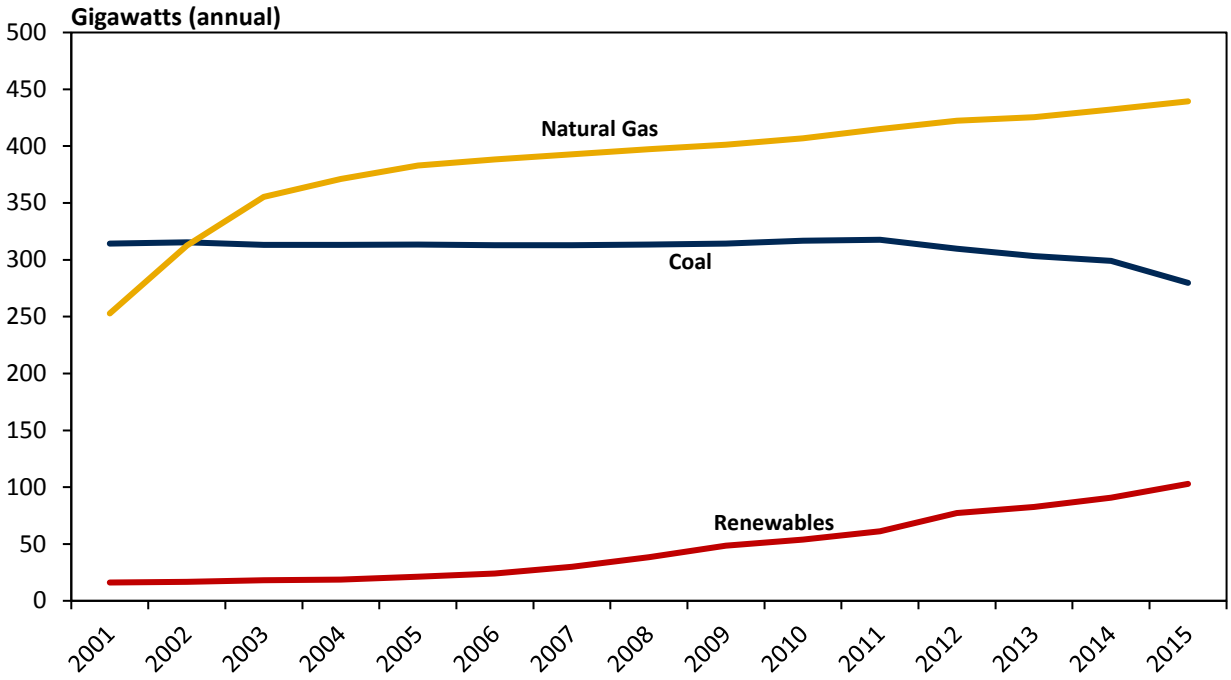


Source: US Energy Information Administration
*2017 ratio based on first quarter data

[5] The ratio of 1.5 in natural gas to coal price has been identified as a significant threshold for fuel switching. For more information, see Lego, Brian and John Deskins. "Coal Production in West Virginia: 2016-2036." WVU Bureau of Business and Economic Research. http://busecon.wvu.edu/bber/pdfs/BBER-2016-03.pdf

Coal's decline in generation has also taken a toll on coal-fired electric generating capacity. As shown in Figure 22, coal nameplate capacity nationally has fallen in the last 15 years from 315 gigawatts in 2001, to 279 gigawatts in 2015, a drop of about 11 percent. During the same period, natural gas generating capacity steadily increased, from 253 gigawatts in 2001 to 439 gigawatts in 2015, a gain of 74 percent. Meanwhile renewable capacity—defined as wind, solar, geothermal, and biomass—has more than quintupled, from about 16 gigawatts in 2001 to more than 102 gigawatts in 2015.

Figure 22: US Nameplate Electric Power Capacity by Fuel Type[6]

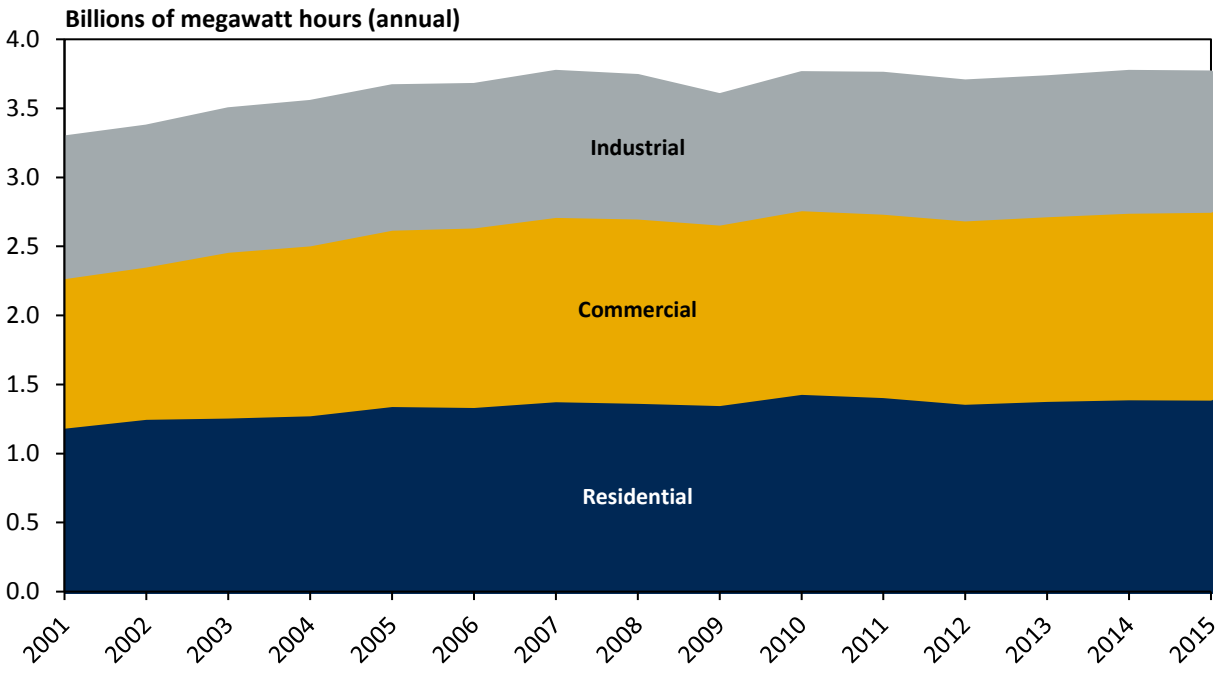


Source: US Energy Information Administration

[6] Other sources not shown include nuclear, hydroelectric, fuel oil, and other fossil fuels.

Overall growth in US energy demand has slowed during the last 15 years and has been largely flat for the last decade, as shown in Figure 23. Since 2007, total US electricity sales have been about 3.8 billion megawatt-hours (MWh). Residential electricity demand has been largely unchanged since that year, rising about 12 million MWh to 1.4 billion MWh. Commercial use has risen by about 24 million MWh from 1.33 billion MWh to 1.36 billion MWh. Industrial electricity use fell significantly during the recent recession and has not recovered fully. Industrial electricity consumption is down from 1.03 billion MWh in 2007 to 987 million MWh in 2016, a drop of 41 million MWh.

Figure 23: US Electricity Sales by End-User Type



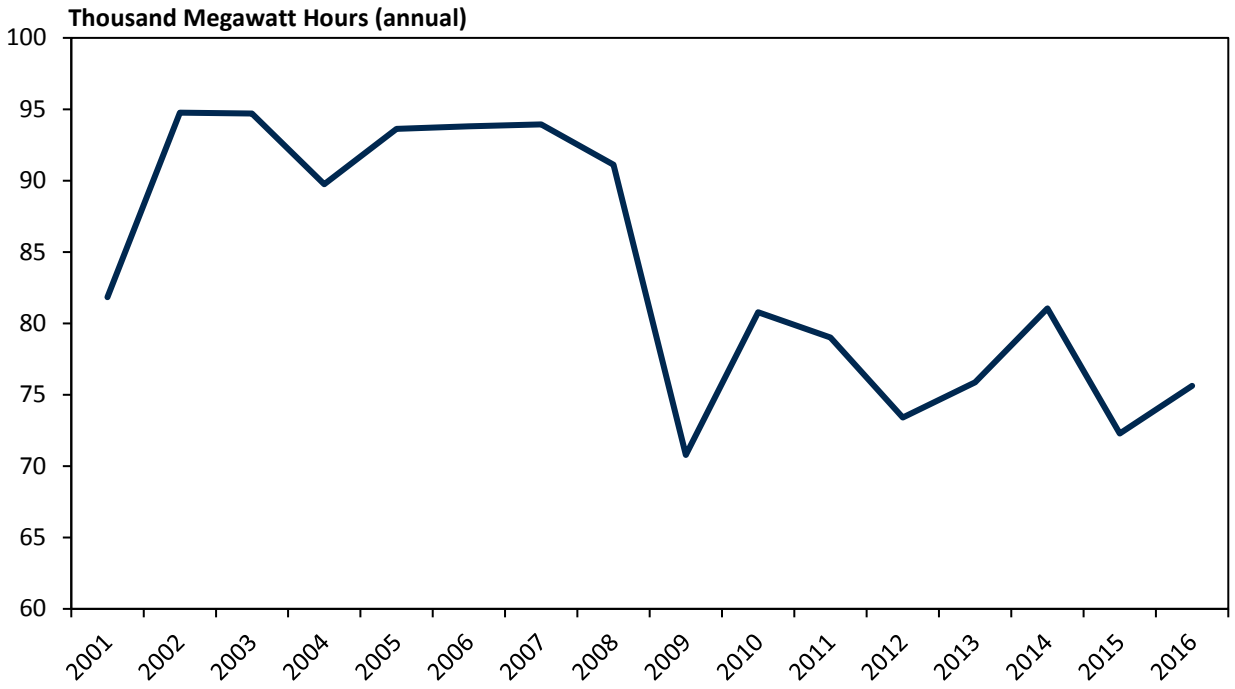
Source: US Energy Information Administration

5.2 Trends in Electric Power Generation in West Virginia

We now turn to trends specific to the West Virginia electric power generation sector. Because the state's power sector is largely based on coal-fired generation, we start with an examination of coal plants. We then examine the potential for natural gas-fired generation capacity additions in the state.

Total electric power generation in West Virginia fell significantly during the Great Recession of 2008-2009 and has not fully recovered. This drop also coincides with the period where natural gas prices fell sharply relative to coal prices, as discussed above. In Figure 24, we report total net generation for all of West Virginia's power plants. In 2016 net generation was approximately 76 thousand MWh, compared with nearly 95 thousand MWh in 2002 (we ignore the decline due to the recession in 2001), a drop of 20 percent.

Figure 24: WV Electric Power Generation

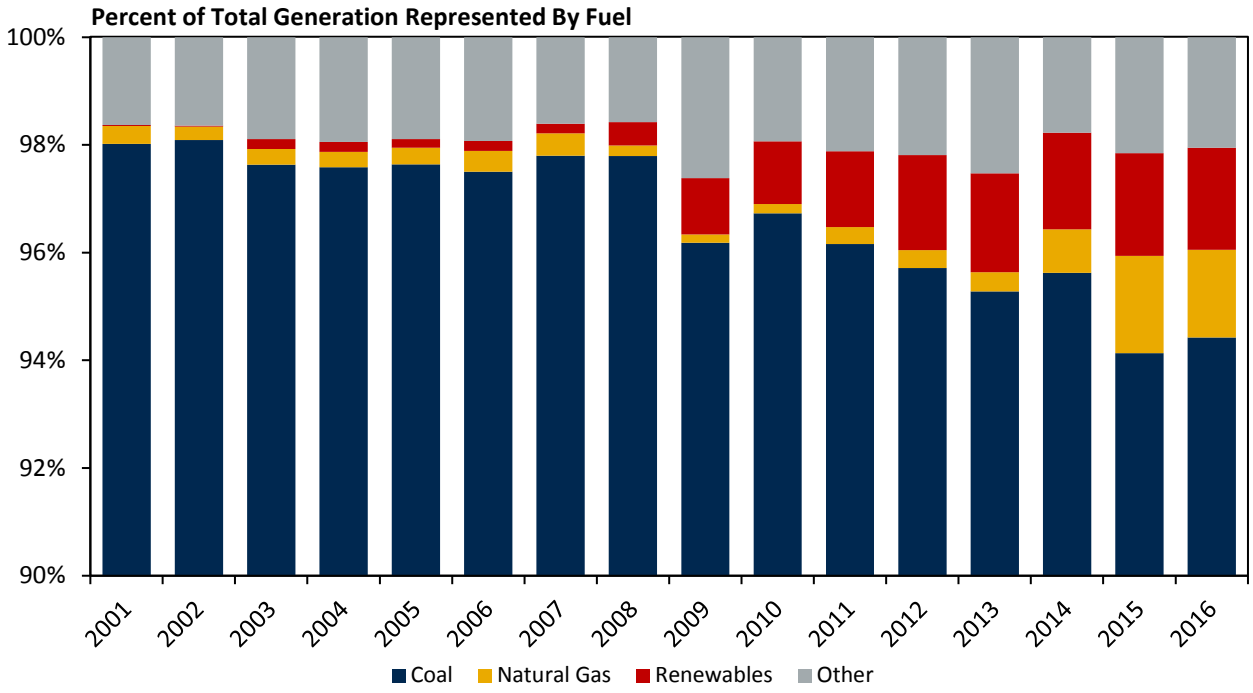


Source: US Energy Information Administration

5.2.1 Coal-Fired Generation

Coal-fired power plants accounted for about 94 percent of total electric power generation in West Virginia in 2016, as shown in Figure 25. However, the share of non-coal fuels has been rising in recent years. Renewable generation now constitutes about 1.9 percent of West Virginia's power generation mix, up from a negligible amount in 2001. Natural gas rose from less than half a percent in 2001 to about 1.6 percent of West Virginia's generation in 2016.

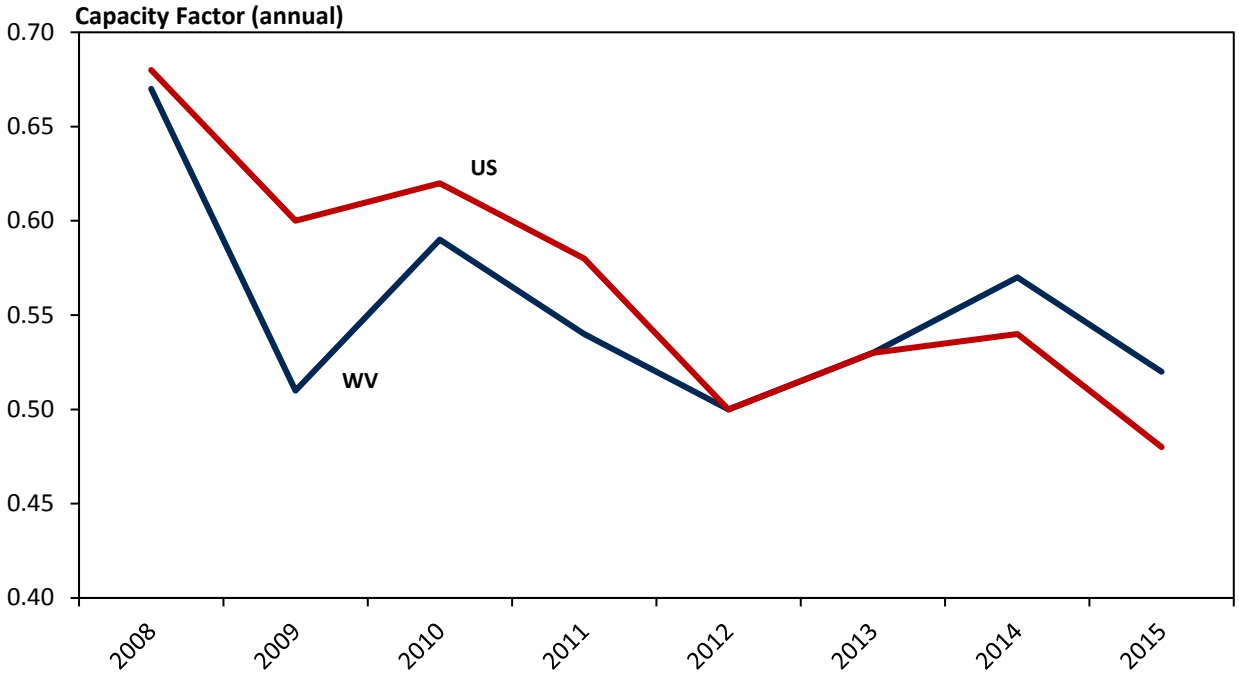
Figure 25: Share of WV Electric Power Generation from Non-Coal Fuels Rising



Source: US Energy Information Administration

The decline in demand for coal-fired generation has led to reduced utilization of the nation's coal plants. In Figure 26, we report average capacity factors—a measure of the percentage of total potential generation at a plant that is actually generated in a year—for both US and West Virginia coal-fired power plants. The average capacity factor for US coal plants was 0.68 in 2008, meaning that coal plants operated at 68 percent of their capacity in that year. By 2016, the average capacity factor was 0.48, indicating plants are operating at less than half capacity. The average capacity factor for West Virginia coal plants was 0.67 in 2008, but fell to 0.52 in 2015, a decline of 15 percentage points.

Figure 26: Average Capacity Factor at Coal-Fired Power Plants



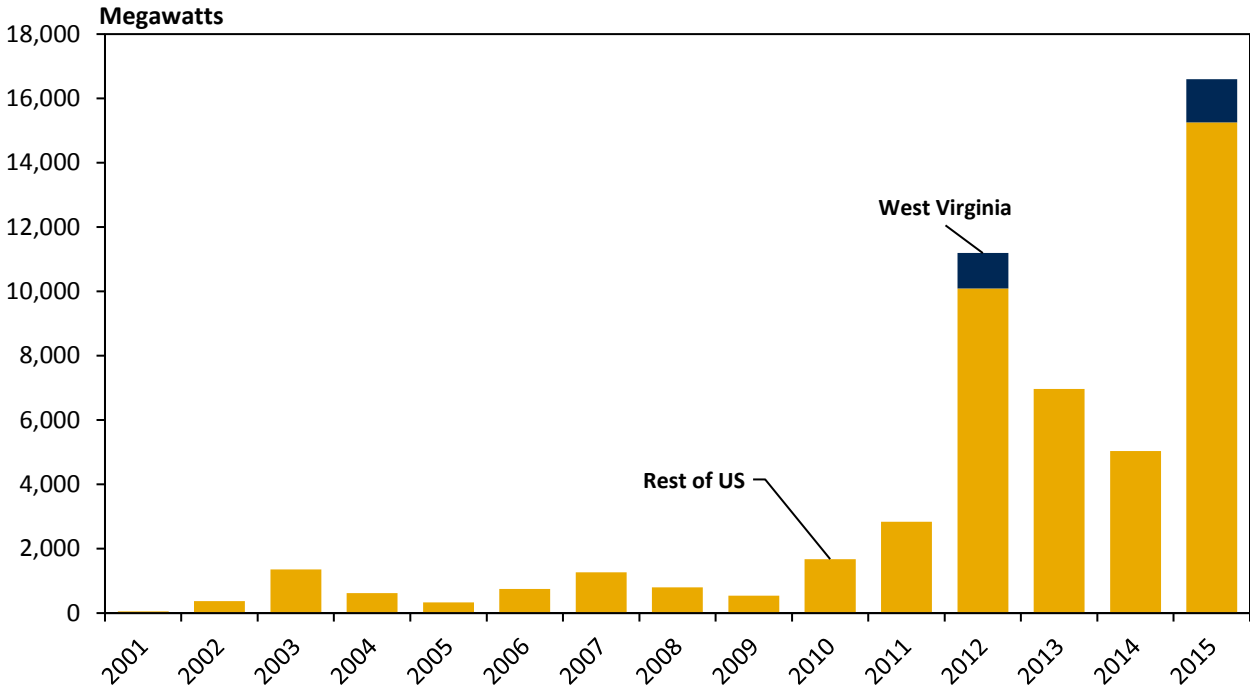
Source: US Energy Information Administration, Author Calculations

Declining generation and capacity factors, combined with regulatory changes described below, have led many utilities to conclude that operating coal plants is not profitable enough to maintain the plant. For example, in 2015 American Electric Power shut down three West Virginia power plants—Kammer in Moundsville, Kanawha River[7] in Glasgow, and Philip Sporn in New Haven. These three plants totaled more than 1,800 megawatts of capacity, which constituted about 10 percent of the state's capacity at the time.

[7] Kanawha River is scheduled for official retirement in December 2017.

In Figure 27, we report total coal-fired capacity retirements in the US and West Virginia. Retirements began to increase in 2010 as natural gas prices and capacity factors began to decrease. Retirements moved into high gear in 2012, with approximately 37 gigawatts retired between 2012 and 2015. Approximately 2.4 gigawatts of coal-fired capacity were retired in West Virginia during that period, which constituted about 14 percent of the state's capacity. The spike in retirements in 2015 was in part due to new regulatory requirements to limit mercury emissions that went into full effect that year. For a discussion of this rule, see our discussion of the Mercury and Air Toxics Standards in subsection 5.4.1 below.

Figure 27: Coal-Fired Power Plant Nameplate Capacity Retirements



Source: US Energy Information Administration

5.2.2 Natural Gas Generation

Following West Virginia's natural gas production gains in recent years, a number of new natural gas-fired power plants have been announced in the state, as shown in Table 2. Quantum Utility Generation, operating under the name Moundsville Power, plans to open a new natural gas combined cycle plant in Moundsville with a net summer capacity of 580 MW. The plant opening is currently planned for 2019. Energy Solutions Consortium has also begun permitting for two other natural gas plants. A Harrison County plant slated to open in 2020 is expected to have a net summer capacity of 525 MW, and another plant in Brooke County with a net summer capacity of 766 MW is expected to open in 2021. If these natural gas plants move forward as expected, they would replace more than three-quarters of the coal-fired capacity retired since 2012.

Table 2: Proposed Natural Gas Electric Plants in West Virginia

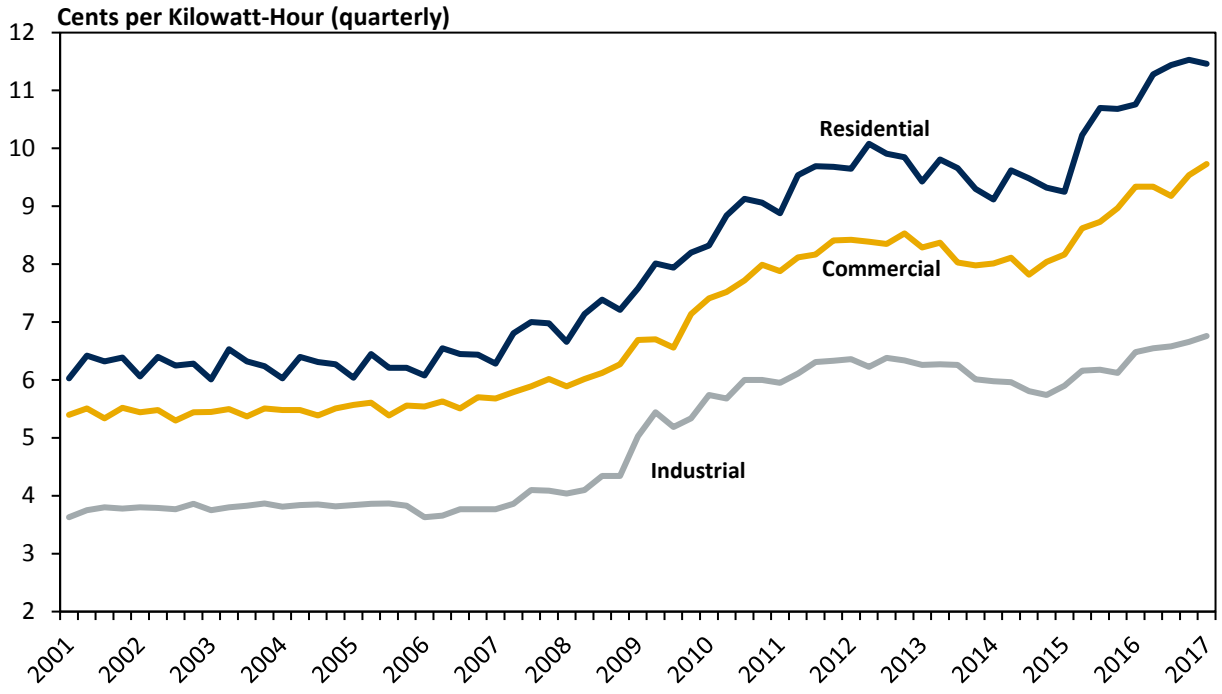
Plant Name	Net Summer Capacity	County	Planned Operation Year
Moundsville Power	580	Marshall	2019
ESC Harrison County Power	525	Harrison	2020
ESC Brooke County Power I	766	Brooke	2021
Total	**1,870**		

Source: US Energy Information Administration

5.3 Electricity Prices

West Virginia has experienced a rapid rise in electricity prices over the past decade, which could affect the state's economic development efforts. As recently as 2008, West Virginia was favored to have low electricity prices relative to the national average, but that price gap has narrowed considerably. As shown in Figure 28, average retail prices for residential, commercial, and industrial consumers were stable between 2001 and 2008. However, prices rose more than 6 percent per year on average in all categories between 2008 and 2017. This constituted the fastest growth rate in electricity prices in the nation over this period.

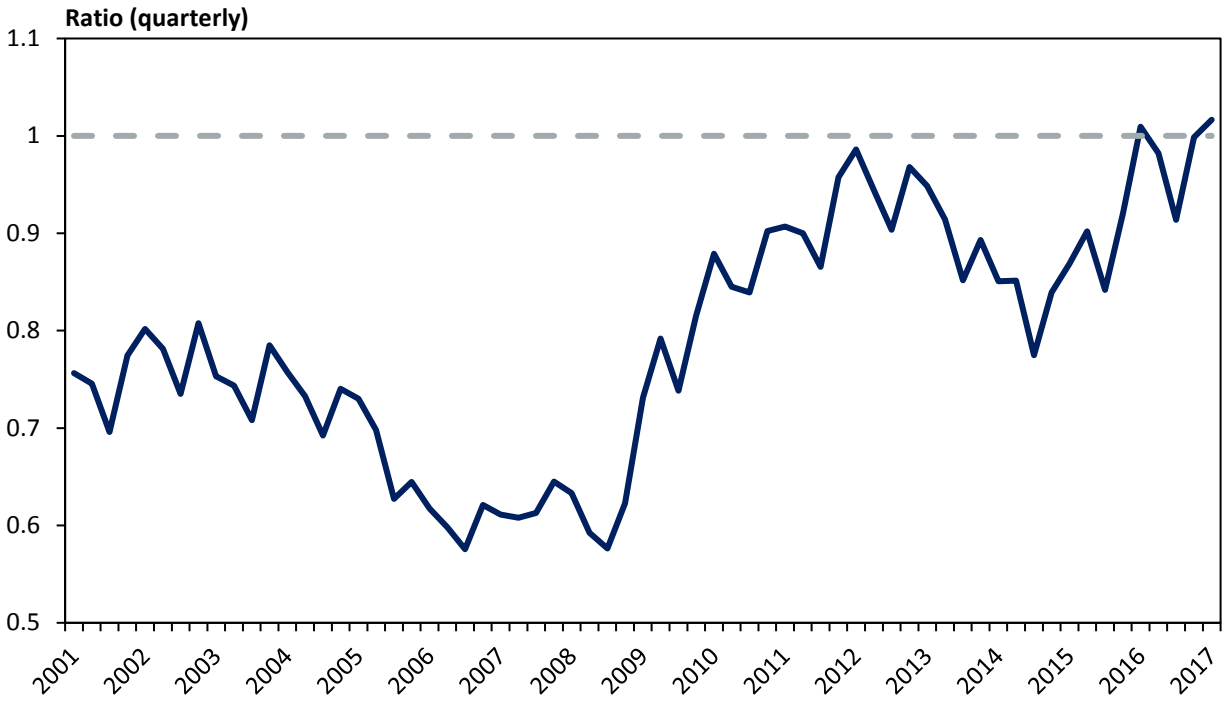
Figure 28: Average Electricity Price by Consumer Category



Source: US Energy Information Administration

The price increases have been particularly acute in the industrial sector. Industrial users are generally the largest purchaser of electricity and thus most sensitive to price changes. In Figure 29, we report the average retail price for industrial consumers relative to the US average. West Virginia has had a significant increase in industrial electricity prices starting in 2009, as prices rose from an average of 4.21 cents per kilowatt-hour (kWh) in 2008 to 6.76 cents in the first quarter of 2017, an increase of 61 percent. This rise has meant that average prices are now at or above the national average.

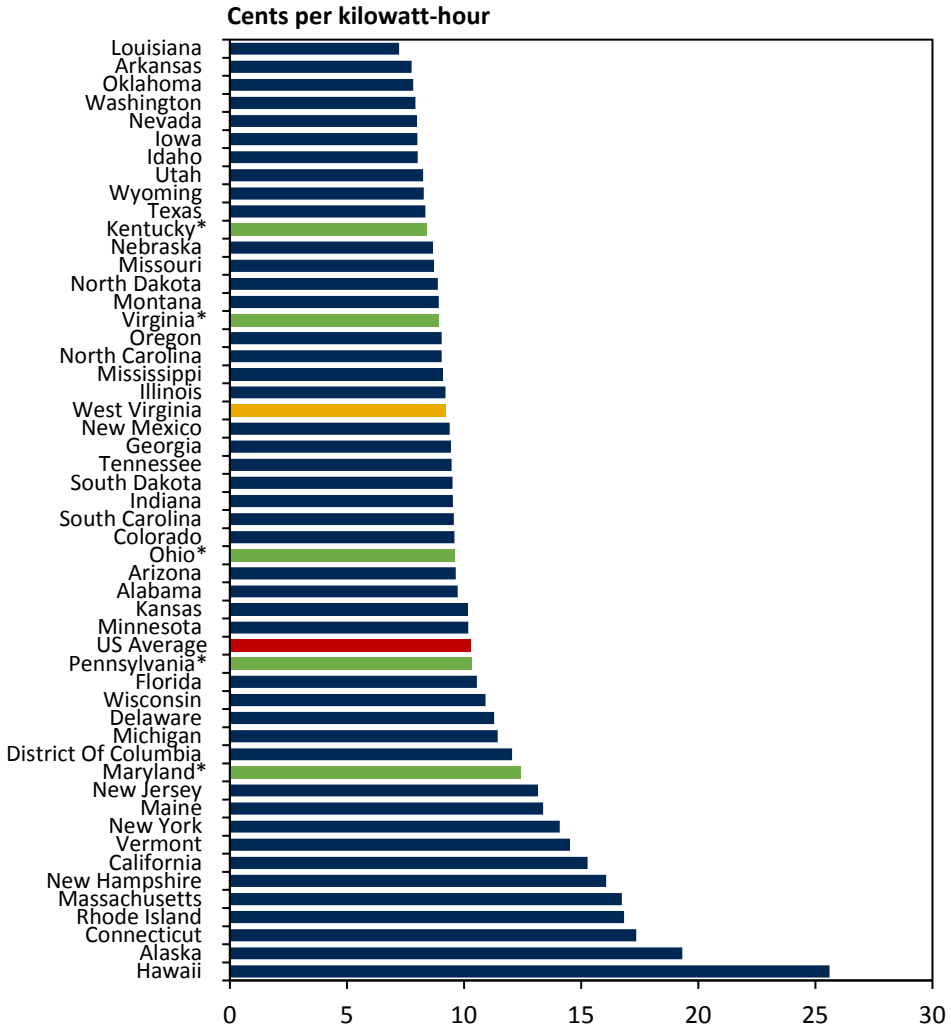
Figure 29: Ratio of West Virginia to US Retail Electricity Price for Industrial Consumers



Source: US Energy Information Administration

The recent electricity price increases have pushed West Virginia's prices above several other neighboring states. In 2008, before the increases began, West Virginia's average electricity rates were ranked third-lowest in the country. By the first quarter of 2017, the state had moved to 21st in the country (see Figure 30).

Figure 30: Average Electricity Rates for All End Users by State (2017 Q1)



Source: US Energy Information Administration

* States bordering West Virginia in green

West Virginia's regulated electricity market allows utilities a local monopoly on retail service territories in exchange for oversight by the West Virginia Public Service Commission (PSC). In general terms, regulated utilities can expect a minimum return on investment by building cost increases into their rate base. However, any rate increases must be approved by the PSC in a rate case proceeding. Over the last decade, the PSC has allowed electric companies to pass through a number of increased costs to end users. There are at least three primary potential reasons for the increase in the state's electricity prices over this period:

- Prices for coal delivered from West Virginia mines to utilities rose significantly between 2008 and 2010 from an average of $65 per ton to $74 per ton, a rise of more than 13 percent. In rate cases filed by utilities over this period, the PSC allowed utilities to recover these increased costs through higher prices for the state's electricity consumers. As coal prices fell following the recession, state electricity prices began to be reduced. However, they did not return to their pre-recession levels.
- Utilities also incurred significant capital costs to pay for emission control technologies in order to comply with environmental regulations.
- Low natural gas prices pushed down capacity factors at the state's coal-fired power plants, resulting in lower revenue from the state's coal fleet. Because utilities invest in capital over very long time horizons, these plants can become "stranded" when a technological change, such as hydraulic fracturing, changes the expectation of future profits that drove the original investment decision. Thus falling capacity factors may have caused utilities to attempt to recover lost revenue from these stranded assets.

It is clear that rising electricity rates are a critical issue for West Virginia. Increased rates have the potential to limit economic growth as industrial firms look for lower prices in other states. Consumers also are paying more for electricity in their homes, and will likely have corresponding decreases in disposable income spent in other areas.

More research is needed to determine how the above factors have influenced electricity prices in West Virginia and potential public policies to address the issue. Some potential areas for future study include:

- What are the root causes of the electricity rate increases experienced over the last decade?
- Why have West Virginia's rates risen faster than neighboring states, such as Kentucky, which has a similar coal-fired power plant fleet?
- How have policies implemented by the PSC contributed to rate increases, if at all?
- What is the appropriate level of compensation, if any, for power plant assets stranded by technological advancement?
- Would some form of utility restructuring result in lower rates, and what form would that take?

5.4 Implications of Environmental Policy on West Virginia Utilities

During the Obama administration, the US Environmental Protection Agency (EPA) issued a number of environmental rules that had significant implications for utilities in West Virginia. Many of the rules were challenged in the courts, and the Trump administration has said it plans to eliminate some of the existing rules that were issued during the previous administration. In this section, we discuss two of the rules that have had, or have the potential to have, the greatest impact on the sector: The Mercury and Air Toxics Standards (MATS) and the Clean Power Plan.

5.4.1 Mercury and Air Toxics Standards

In 2011, The US EPA finalized its Mercury and Air Toxics Standards (MATS). This rule was designed to limit emissions of mercury from all of the nation's power plants, but the rule primarily affected coal-fired power plants, as coal is the primary fuel with mercury content. The original compliance deadline for MATS was April 2015 with the potential for extension into 2016. However, the rule was challenged in the courts and the Supreme Court ruled that the EPA failed to properly consider the economic cost of plant closures, as required by the Clean Air Act. The Court allowed implementation of the rule to move

forward, and in March 2016, the Supreme Court again ruled that the EPA could continue implementation despite ongoing court challenges. In April 2017, the Trump administration asked that the rule be suspended pending review, and the Washington DC Court of Appeals agreed.

Since the MATS rule has already been implemented, however, many power plants have shut down or built the necessary scrubbers to reduce mercury. The scrubbing technology required significant capital investment, particularly for older plants. It is unclear whether any of these plants would reopen should the Trump administration eliminate the rule. As of June 2017, no further plant retirements are planned by utilities in West Virginia.

5.4.2 Clean Power Plan

The EPA finalized two rules in August of 2015 as part of the Obama Administration's Clean Power Plan, with the goal of reducing carbon in order to limit the effects of climate change. The Clean Power Plan sets limits on carbon emissions from the nation's existing power plants, requiring a 32 percent reduction in carbon emissions by 2030. Because coal produces about 68 percent of the carbon emissions in the power generation sector,[8] this rule will have a larger impact on coal-fired power plants than those using other fuel sources. Each state has its own emissions requirement, with West Virginia required to reduce carbon intensity of its power plants by between 29 and 36 percent, depending on the compliance strategy the state chooses.

In the same year, the EPA also released a final rule to regulate carbon emissions in new power plants. This rule was first proposed in 2012, but was substantially revised after the rule's comment period and was released at the same time as the Clean Power Plan rules. The new source carbon rules apply only to newly constructed power plants, and limit carbon emissions at the nation's coal plants to 1,400 pounds of CO_2 per megawatt hour of generation. For coal-fired power plants, this emissions level would be difficult to achieve except with carbon capture and storage technologies, thus making it unlikely that new coal-fired generating plants will be built in the near term. However, the EPA's economic impact study of the new source rule indicates that it is unlikely to have a significant impact in the short-term as the large majority of new proposed power generation plants in the country use natural gas as a fuel instead of coal.

In February 2016, the US Supreme Court issued a stay on implementation of the EPA Clean Power Plan (CPP) regulations, which remains in effect as of June 2017. West Virginia, along with several other states, has also sued to stop implementation of the EPA New Source Performance Standards. The Trump administration has announced plans to review the Clean Power Plan regulations with the intention of repealing some or all of the limits on carbon emissions.

[8] Natural gas contributes about 30 percent of carbon emissions, with small amounts from petroleum and fossil-based waste fuels.

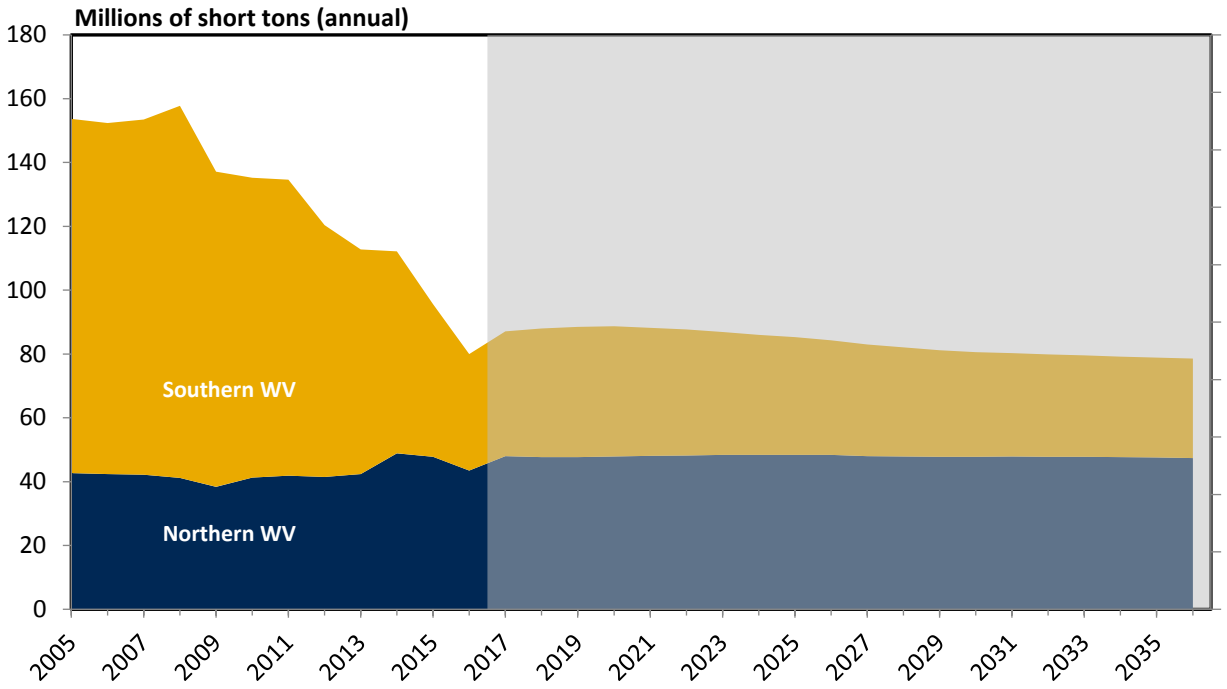
6 Energy Sector Economic Outlook

West Virginia's energy sector is heavily tied to the economic outlook in the state. In this section, we forecast economic outcomes for employment and production for the three primary energy industries in West Virginia.[9] Then we examine the impact of the energy sector on the state's overall economy.

6.1 Coal Industry Forecast

While coal production in West Virginia has declined sharply in the last 10 years, production has rebounded somewhat so far in 2017. As shown in Figure 31, we forecast that West Virginia mines will continue to produce at the recent lower level for the foreseeable future. We forecast that production will rise to about 87 million tons in 2017, then decline slowly for the next two decades, ending at about 78.5 million tons in 2036.

Figure 31: Coal Production Forecast

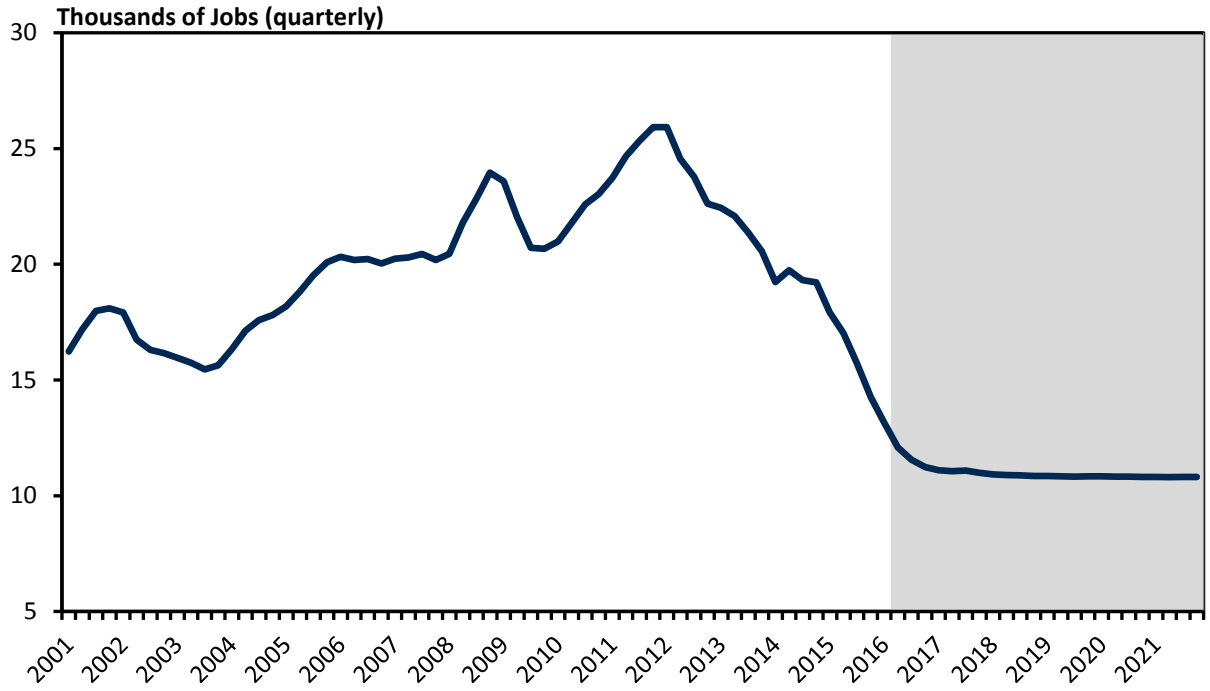


Note: Forecast period designated by shaded area
Source: US Energy Information Administration, WVU BBER Coal Production Forecast

[9] Economic forecasts in this section are derived from Lego, Brian and John Deskins. "Coal Production in West Virginia: 2016-2036." WVU Bureau of Business and Economic Research. http://busecon.wvu.edu/bber/pdfs/BBER-2016-03.pdf; and Deskins, John et al. "West Virginia Economic Outlook: 2017-2021." WVU Bureau of Business and Economic Research. http://busecon.wvu.edu/bber/pdfs/WV-economic-outlook-2017.pdf

In Figure 32, we forecast coal-mining employment over the next five years. As with production, employment is expected to remain relatively steady for the next few years. We forecast that employment will remain at about 11 thousand jobs through 2021.

Figure 32: Coal Employment Forecast

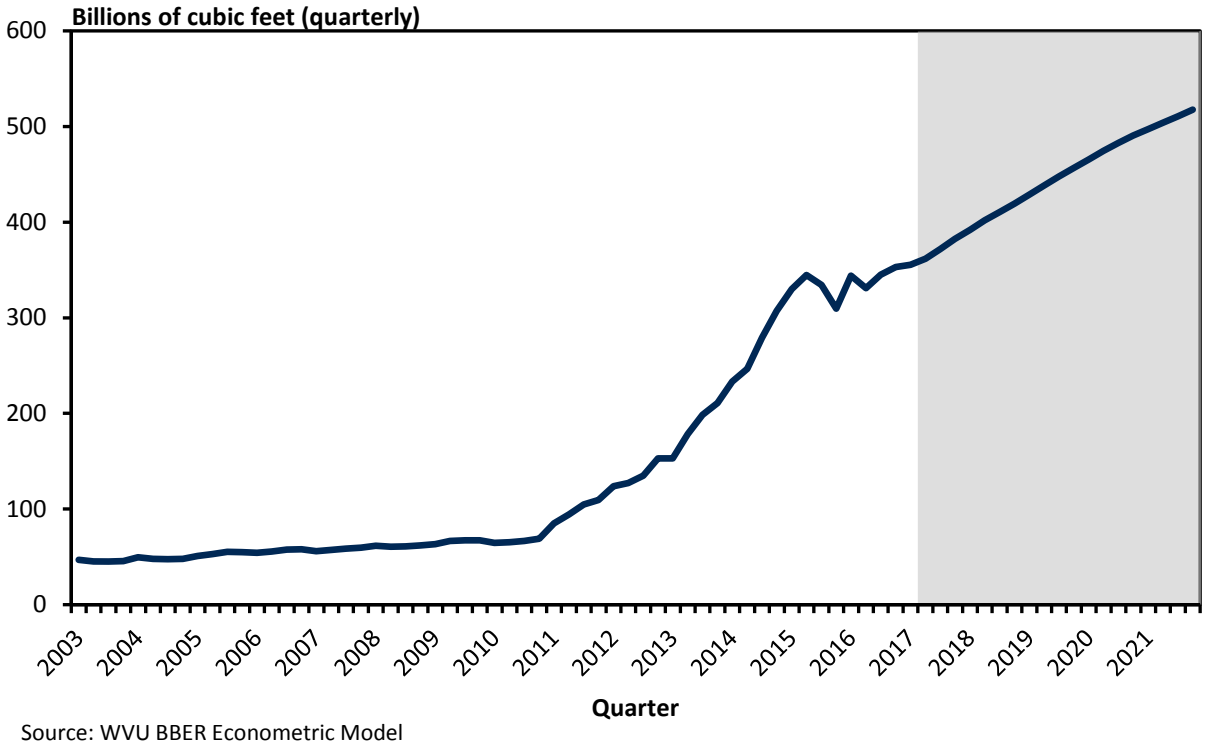


Source: US Bureau of Labor Statistics; WVU BBER Econometric Model

6.2 Natural Gas Industry Forecast

West Virginia's natural gas industry has been on a rapid growth trajectory since about 2010. However, production growth in the industry stalled starting in 2015, and has been flat for the last two years. As shown in Figure 33, we forecast that growth will resume in 2017 and continue an upward trajectory through 2021. We predict that natural gas production will rise from about 343 Bcf per quarter on average (1.4 Tcf annually) in 2016 to more than 507 Bcf per quarter (2 Tcf annually) in 2021, a gain of about 8 percent per year on average.

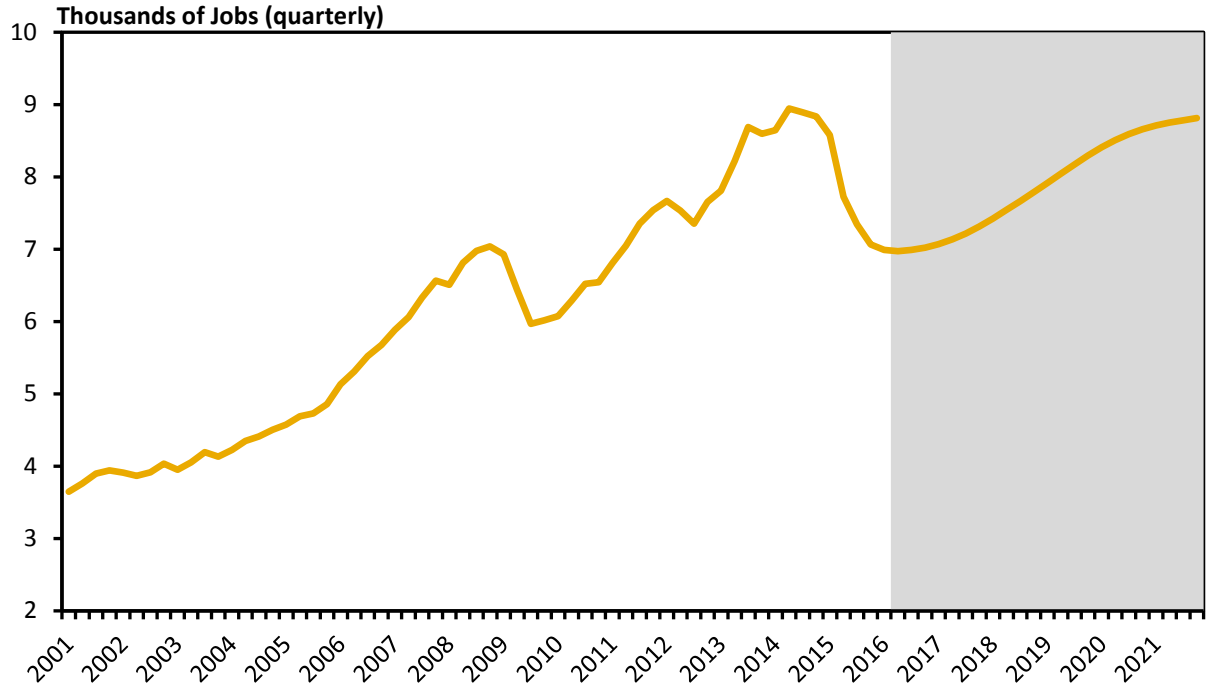
Figure 33: Natural Gas Production Forecast



Source: WVU BBER Econometric Model

Natural gas employment is expected to follow a similar trend as production. As shown in Figure 34, natural gas employment has fallen off in the last two years as drilling activity has declined in the state's shale region. However, we forecast that employment in the industry will start to turn around in 2017, then increase at a healthy pace over the next five years. By 2021, we forecast that natural gas industry employment will total about 8,800 workers, up from about 7,000 workers in 2016, a rise of about 4.6 percent per year on average.

Figure 34: Natural Gas Employment Forecast

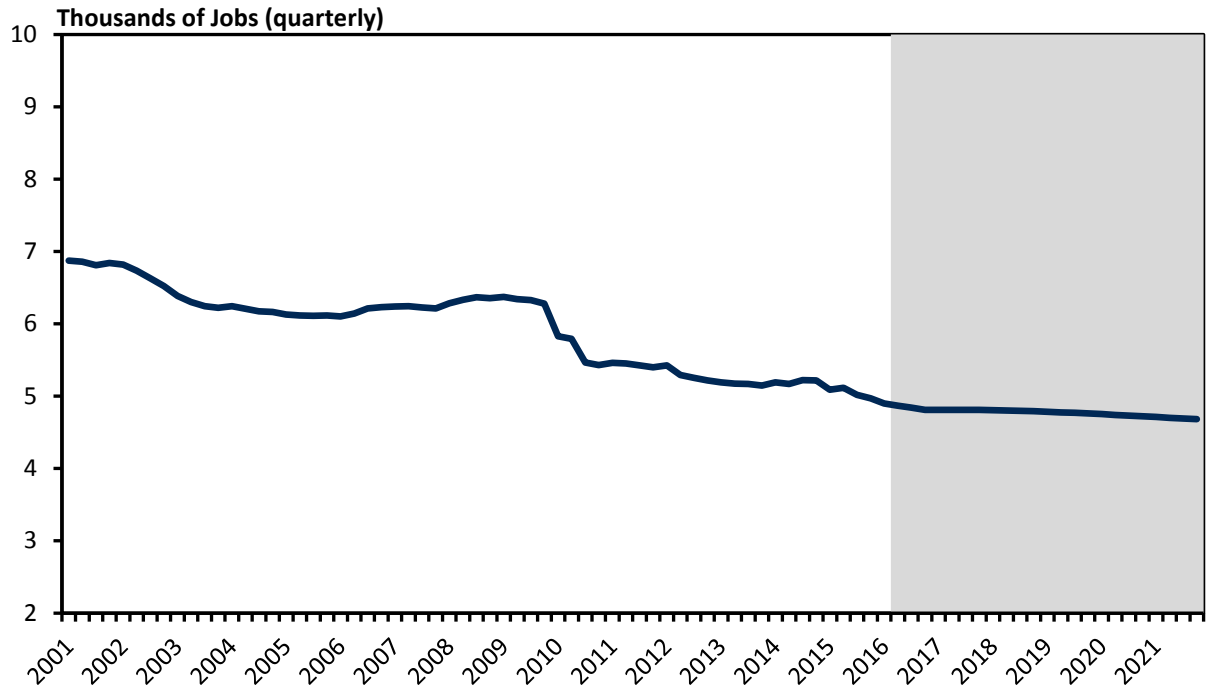


Source: US Bureau of Labor Statistics; WVU BBER Econometric Model

6.3 Utilities Industry Forecast

As coal-fired power plant capacity has been retired in recent years, utility employment has followed suit. In Figure 35, we report historical as well as forecast employment in the utilities industry. Between 2001 and 2016, employment in the utilities industry fell from about 6,800 employees to about 4,800 employees, a drop of about 2.6 percent per year on average. We forecast that utilities employment will continue to decline over the next five years, though at a slower rate of 0.7 percent per year, for a total of about 200 jobs.

Figure 35: Utilities Employment, History and Forecast



Source: US Bureau of Labor Statistics; WVU BBER Econometric Model

7 Policy Options

Many of the energy trends in West Virginia detailed above stem from national and international energy market forces that have significant effects on the state's economy. While state policy makers have little control over many of these changes in the energy marketplace, or national energy and environmental policy, West Virginia can consider a number of state-level policies that could influence energy markets in the state. In this section, we provide a brief outline of policy options the state may want to consider to respond to changing energy market conditions. However, as a non-partisan research organization, we do not recommend any particular policy.

WORKER RETRAINING PROGRAMS: As coal industry employment has contracted in the last five years, many of the state's mining workers have faced the prospect of long-term unemployment. One policy that could potentially help these workers find new employment is increased funding for job training programs. Research has shown mixed effects of job training programs on the incomes of displaced workers.[10] While some workers are able to gain new skills and find jobs in other industries, in many cases these industries are lower paying than the manufacturing or mining jobs they lost. Also, studies show that workers who pursue higher education, at community college for example, are likely to have higher incomes than those who pursue skill-based training.

SEVERANCE TAX MODIFICATIONS: West Virginia's severance tax on minerals and natural resources represented approximately 8 percent of the state tax revenue in fiscal year 2017, bringing in about $321 million. In recent years, policy makers have proposed a variety of changes to the state's severance tax. For example, in 2016, the state legislature eliminated a severance tax surcharge that was earmarked for retiring the state's worker compensation debt. In the 2017 legislative session, Gov. Justice proposed a tiered severance tax rate that would raise taxes as coal prices increased. These changes have the potential to increase coal demand by reducing the price of coal produced in the state. However, previous research by the BBER indicates that severance tax reductions are likely to have limited impact on in-state coal sales.[11]

RESEARCH ELECTRICITY RATE INCREASES: As mentioned above, rising electricity rates are of critical importance for the state. More information is needed on the causes of these rate increases, as well as an explanation of why West Virginia's rates have risen so quickly relative to neighboring states. Also, further research is needed to ascertain potential policies to combat higher electricity rates. These policies may include new PSC regulations, or potential restructuring of the state's electricity markets.

[10] For a useful summary, see Jacobson, Louis, Robert J. LaLonde, and Daniel G. Sullivan. "Is Retraining Displaced Workers a Good Investment?" https://www.chicagofed.org/publications/economic-perspectives/2005/2q-jacobson-lalonde-sullivan.

[11] See for example Bowen, Eric, Christiadi, and John Deskins. "Government Incentives to Promote Demand for West Virginia Coal." (January 2015). http://busecon.wvu.edu/bber/pdfs/BBER-2015-01.pdf.

UTILITY RESTRUCTURING: Since the passage of the federal Public Utility Regulatory Policy Act in 1978, many states have moved to restructure or deregulate their electric utility sectors. Most of the states in the northeast United States, including many bordering West Virginia, have implemented retail deregulation. While power generators in West Virginia sell excess power in the PJM wholesale utility market, West Virginia continues to regulate retail electricity sales for in-state consumers. Research on retail deregulation[12] indicates that well-designed policies have the potential to enhance competition among retail providers and decrease overall prices for consumers. However, further research is needed to determine if restructuring would benefit utilities and consumers in West Virginia.

REDEVELOPMENT INCENTIVES FOR RETIRED COAL-FIRED POWER PLANTS: The retirement of several West Virginia coal-fired power plants leaves open the possibility for redevelopment of these sites for other uses. State policy makers could offer incentives for making use of these sites for natural gas-fired power generation, or for brownfield redevelopment into other non-utility businesses that could utilize existing infrastructure.

[12] See Joskow, Paul L. "Markets for Power in the United States: An Interim Assessment." *The Energy Journal* 27, no. 1 (2006): 1-36. http://www.jstor.org/stable/23296974.

Appendix A: Terms and Abbreviations

Term	Definition
Mcf	**Thousand cubic feet.** Natural gas is generally measured by volume in Mcf. The prefixes MM, B, and T stand for million, billion, and trillion cubic feet respectively.
bbl	**Barrel**. A barrel is a standard measure of crude oil volume. A barrel is 42 gallons.
Short ton	**2,000 pounds**. Differentiated from a long ton, which weighs 2,240 pounds, and a metric ton, which is 1,000 kilograms (approximately 1.1 short tons). Generally used to measure coal by weight.
Btu	**British thermal unit**. Btu is a measure of heat output required to raise the temperature of 1 pound of liquid water by 1 degree Fahrenheit. It is used to measure the heat produced when fossil fuels are burned for power generation.
MW	**Megawatts.** A measure of electric generating capacity. Equal to 1 million watts, or 1,000 kilowatts.
MWh	**Megawatt-hour.** A measure of electricity production or consumption. Equal to one megawatt operating for one hour.

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