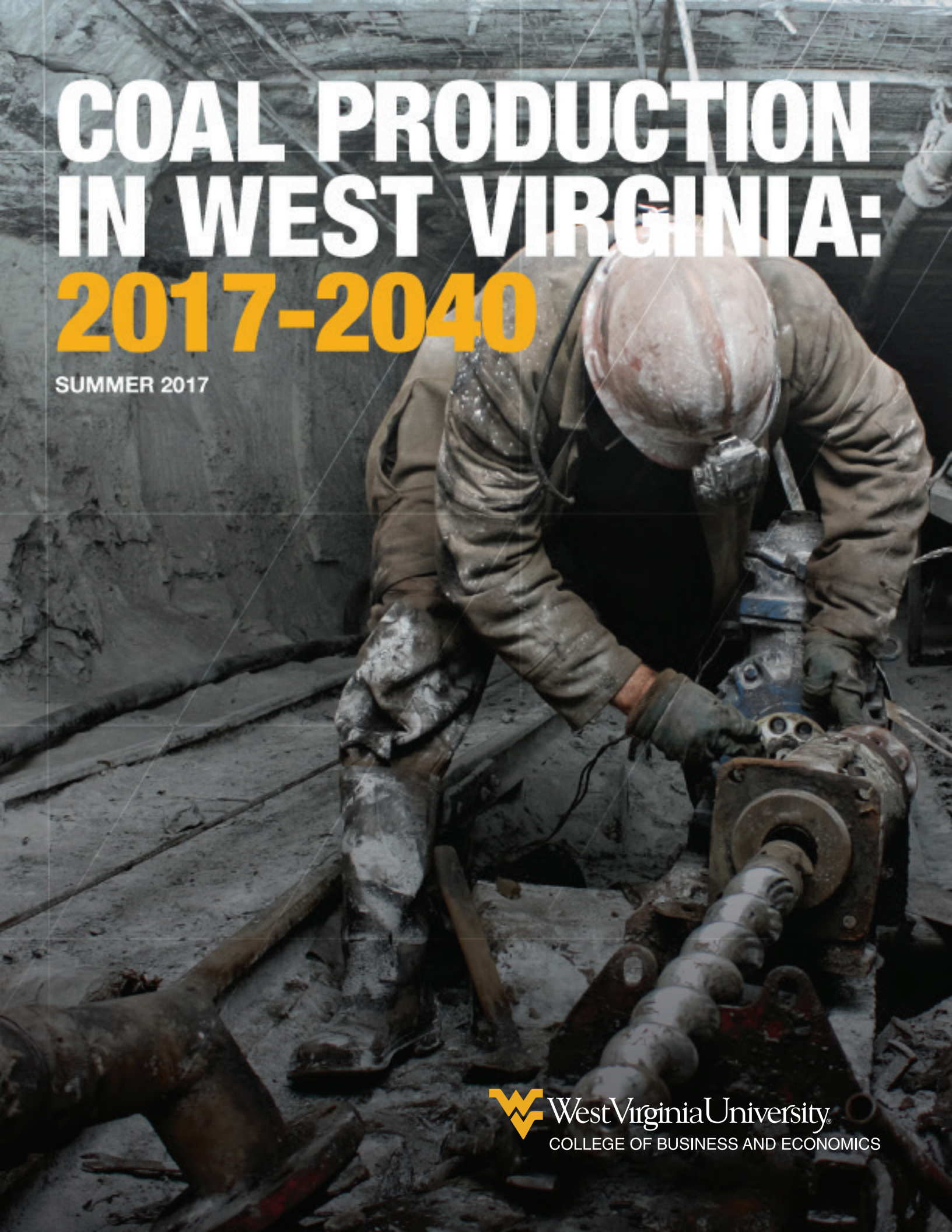

COAL PRODUCTION IN WEST VIRGINIA: 2017-2040

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Executive Summary

Overview: West Virginia's coal industry has experienced substantial declines in production for much of the past decade. After reaching nearly 158 million short tons in 2008, statewide coal mine output plummeted by nearly half to an annual total of 80 million short tons in 2016. Declining use of coal by domestic power plants—linked to the coincident timing of low natural gas prices and stricter emissions standards—weak export demand and the backdrop of declining productivity from Southern West Virginia coal seams have been the primary factors weighing on coal production. Coal output has rebounded over the past few quarters, reflecting an upturn in metallurgical coal markets and increased coal-fired electricity generation, but production remains below levels observed during the first half of 2015.

West Virginia Regional Variation: Although coal production fell in each of the state's producing regions during 2016, these areas have seen output trend in different directions in recent years. Southern West Virginia mines accounted for more than two-thirds of state coal production in 2011, but that share fell to 46 percent in 2016 as the region's coal output plunged 61 percent. Even after recording a decline in production during 2016, Northern West Virginia coal output remained 8 percent above 2008 levels.

Short-Term Forecast: The baseline forecast calls for statewide coal production to approach 89 million short tons in 2017, but fall slightly to 87 million short tons during 2018 as exports dip with Australian coal shipments returning to normal levels. Improved conditions for global metallurgical coal markets will provide a lift to Southern West Virginia production while thermal coal output from highly productive mining operations in Northern West Virginia should hold steady. Domestic use of coal in industrial applications is expected to pick up through the end of 2018, due in large part to an uptick in steel production.

Long-Term Forecast: Coal production in West Virginia is expected to remain relatively stable through the early 2020s. Additional retirements or lower utilization rates for coal-fired generators will likely affect both regions, but met coal demand will be strong enough to keep Southern West Virginia production stable. Northern West Virginia coal tonnage should hold in a relatively small range over the longer term as retirements of the coal fleet subside. By comparison, output from Southern West Virginia will fall as shrinking reserves raise production costs and make the region's coal even less competitive for most domestic uses. These cost issues will weigh on Southern West Virginia coal on global markets, but lower coal use by the electric power sector in the EU and other nations will also hurt. Statewide coal production is expected to fall below 80 million tons by 2030 and decline further over the rest of the outlook period.

Alternative Forecast Scenario – Natural Gas Prices: The forecast report analyzed the impacts of different trajectories for natural gas prices on coal production. If natural gas prices average 24 percent less than assumed under the baseline forecast, state coal output would slip below 80 million short tons within a few years and fall below 70 million short tons by the mid-2030s. At the same time, should natural gas prices rise at an average annual rate of more than 6 percent from 2016, coal production would finish nearly 6 million short tons higher versus the baseline forecast—though this differential would be greater earlier in the outlook period. Each scenario affects the state's producing regions differently, but Northern West Virginia output exhibits the largest sensitivity to natural gas prices.

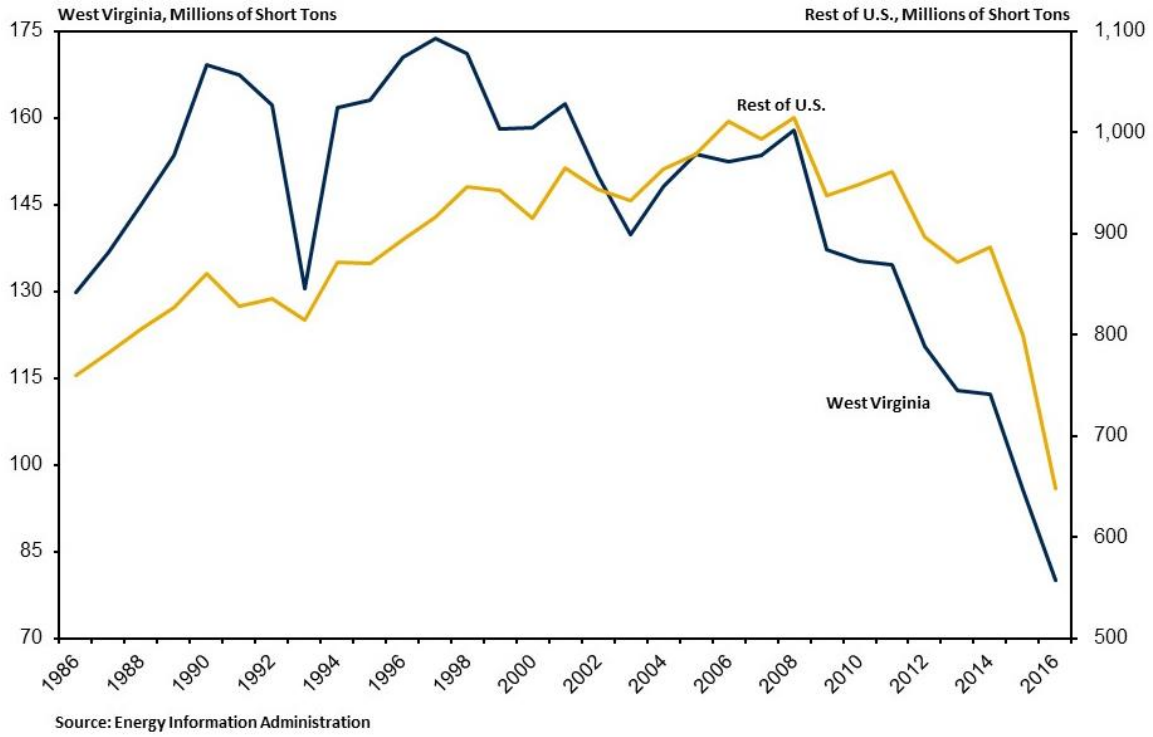
Alternative Forecast Scenarios – Coal Export Demand: The impacts of assumptions for stronger and weaker export demand on statewide coal production were assessed. For example, stronger-than-expected global demand for coal would cause West Virginia mine output to exceed baseline forecast levels by more than 10 percent. By contrast, should global demand fail to rebound much, whether due to weaker-than-expected global economic growth or more aggressive reductions in coal use, production would decline throughout the forecast horizon down to a level of just above 70 million short tons.

1 Recent Trends in Coal Production

WEST VIRGINIA OVERVIEW: West Virginia's coal industry has seen output track sharply lower over the past decade or so, but the past two years represent one of the most difficult episodes in several decades. Indeed, since 2008 the state's overall coal mine output plunged by almost half from over 157 million to 80 million short tons in 2016[1]. The production figure for 2016 marked the state's lowest physical output of coal since the 1920s and absent the rebound that occurred during the second half of the year, production could have registered its lowest calendar year total in more than a century. Statewide coal production has picked up in each of the last three quarters, increasing 15 million short tons on a seasonally adjusted annual rate basis, though overall activity still lags 2015 levels.

NATIONAL OVERVIEW: West Virginia had generally experienced steeper declines in coal production compared to most of the major coal-producing states, but only a few states managed to avoid a double-digit rate of drop in coal output during 2016. Excluding West Virginia, US coal production totaled less than 650 million tons for the calendar year as a whole—the lowest reading since the late 1970s. Just as production activity has improved in West Virginia, coal tonnage has increased in most other coal-producing states in recent quarters. Through the first five months of 2017, non-West Virginia coal mine output has jumped 18 percent versus the same time period in 2016.

Figure 1: Historical Coal Production Levels

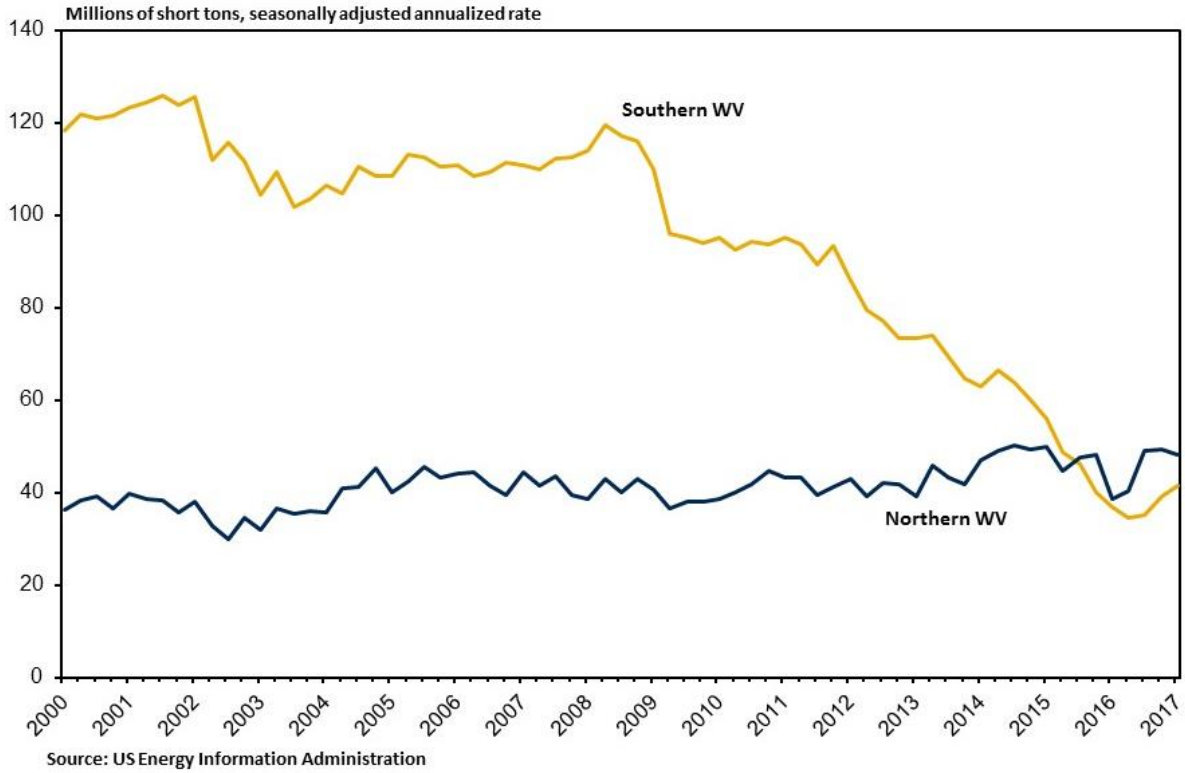


[1] The production figure for 2016 is an estimate and will not be considered final until the US Energy Information Administration publishes the *Annual Coal Report 2016* later this year.

WEST VIRGINIA'S SHARE OF NATIONAL COAL OUTPUT: Although coal output has been falling both nationally and for West Virginia for most of the last decade, the state has accounted for a shrinking share of national production for many years as mining operators have focused on more productive assets in other coal basins. For example, West Virginia's share of total US coal production fell from 13.5 percent in 2008 down to less than 11 percent in 2016. Over that same time period output from mines in the Illinois Basin, which includes Illinois, Western Indiana, and part of Western Kentucky, saw its share of domestic coal production climb more than 4 percentage points to 13.5 percent. Even with the large declines it registered over the past two years, the Illinois Basin still has output on par with 2008 levels. Ultimately, however, any discussion of US coal production trends must focus mostly on the Powder River Basin (Northeastern Wyoming and portions of Eastern Montana). This coal basin alone accounted for 43 percent of national output in 2016 despite experiencing a 182 million short ton (or 37 percent) reduction in output between 2008 and 2016.

NORTHERN AND SOUTHERN WEST VIRGINIA COAL OUTPUT: While coal production has shifted westward geographically in the US in relative terms, production within West Virginia has become increasingly concentrated in mines located in Northern West Virginia. As recently as 2011, Southern West Virginia mines accounted for well over two thirds of coal produced within the state. By mid-2015, however, both regions were producing roughly equivalent levels of coal tonnage and during each of the last 7 quarters Northern West Virginia has accounted for most of the state's overall production.

Figure 2: Historical Coal Production by Region in West Virginia

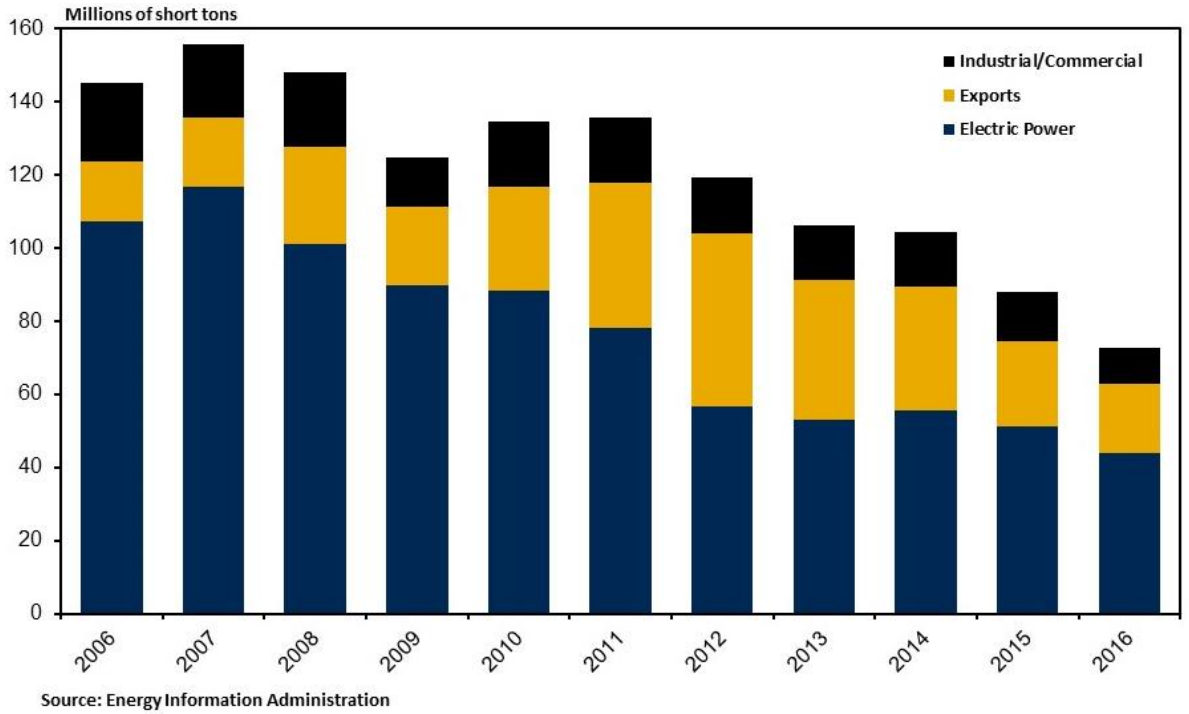


As mentioned above, coal production activity has improved over the past few quarters and the gains have occurred in both coal-producing regions. Based upon preliminary data, output from the state's northern coalfields has averaged more than 49 million short tons on a seasonally adjusted annualized basis through the first five months of 2017, marking a 27 percent jump compared to the same period in 2016. The rate of improvement has not been quite as large and the overall level of production remains weak compared to recent historical norms, but Southern West Virginia has enjoyed successive increases in coal output over the last three quarters. Overall, the region has seen a nearly 10 percent jump in production (on a seasonally adjusted basis) year-to-date in 2017 over levels seen for the same time frame in 2016.

2 Electric Power Sector Coal Demand

Coal demand is affected by a blend of domestic and international market and regulatory forces, and each of these has played a significant role in shaping not only the trend in statewide coal production, but also the different paths for the state's northern and southern coal-producing regions. Even as coal accounts for a dwindling share of electricity generation in the US, domestic power plants still represent the top destination market for West Virginia coal by a wide margin. Of the 54 million short tons distributed to domestic coal buyers in 2016, just over 81 percent (44 million tons) was shipped to the electric power sector in 19 states. Shipments of coal from West Virginia mines to domestic utilities have fallen in 8 of the last 9 years and are approximately 43 percent lower than the amount delivered to power plants in 2011.

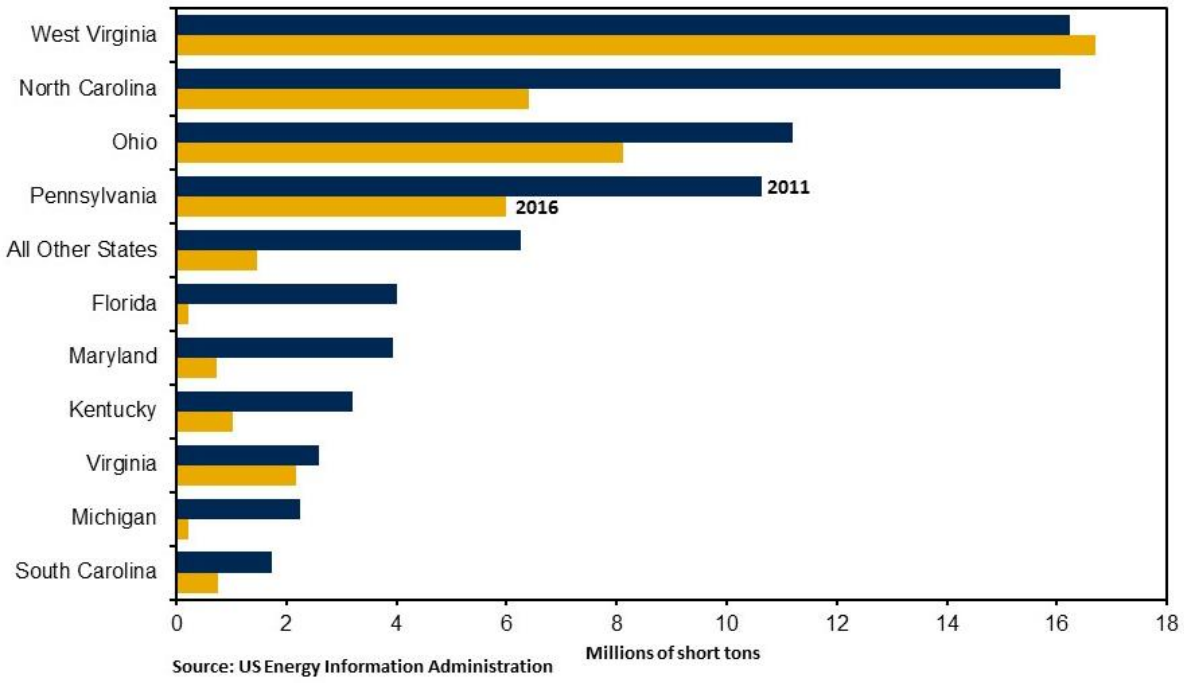
Figure 3: Distribution of West Virginia Coal by Type of Consumer



Source: Energy Information Administration

As coal use by the electric power sector has plunged nationwide over the past several years, and the fact that so much of the state's coal is used by domestic power plants, the trend has clearly had a significant effect on West Virginia's coal mining industry. Indeed, while coal shipments from in-state mines to West Virginia power plants increased slightly between 2011 and 2016, every other state that received thermal coal shipments from West Virginia mines in 2011 purchased fewer tons in 2016, by significant amounts in several instances. West Virginia does remain the leading destination state for coal shipments, but the 2015 retirements of the Kammer, Kanawha River and Philip Sporn power plants in West Virginia did contribute to a drop of more than 2 million short tons of in-state shipments between 2014 and 2016.

Figure 4: Destination States for WV Coal Shipments to Electric Utilities, 2011 vs 2016



However, the largest impacts have come from a combination of reduced coal consumption and sourcing shifts by power plants in several states that have been leading destination markets in the past. For example, North Carolina, Pennsylvania, Ohio and Florida have each seen the amount of coal tonnage burned by electric power plants (via retirement or reduced utilization rates) cut by nearly one-fourth to 40 percent over the last five years. In some cases, however, utilities operating in these key states have lowered the coal they source from West Virginia mines in an even more disproportionate manner due to relative prices for coal from other basins and/or satisfying compliance standards for certain environmental regulations. For instance, electric utilities in North Carolina reduced coal consumption by 10 million short tons (40 percent overall) between 2011 and 2016, but coal shipments sourced from West Virginia mining operations dropped by nearly the same tonnage over that same five-year period.

The shift in sourcing patterns was even more dramatic for Florida. Coal shipments to electric utilities in the Sunshine State have fallen by just over five million short tons (~22 percent) since 2011. Of the nearly 23 million short tons of coal that was used by coal-fired generators in 2011, roughly 4 million tons were sourced from West Virginia mines. By 2016, of the nearly 18 million short tons of coal consumed for

electricity generation in Florida, just over 200,000 tons originated in West Virginia as that state's remaining coal-fired fleet shifted coal purchases to mines in the Illinois Basin but also imported a larger quantity of coal from Colombia.

Shifts in coal sourcing by power plants has also helped to push the diverging production trends observed for Northern and Southern West Virginia in recent years. During the 2000s, West Virginia's southern coalfields produced on average nearly two-thirds of the state's coal shipments destined for domestic power plants. By 2016, that share fell to 37 percent as much of the state's thermal coal production shifted toward higher-sulfur deposits in Northern West Virginia mines.

TECHNOLOGICAL CHANGE: This pronounced shift away from Southern West Virginia coal for electricity generation stems from the interplay of geological, technological, economic and regulatory factors. For example, costs of flue gas desulfurization (FGD) "scrubbers" or dry sorbent injection (DSI) systems, which help to remove Sulfur Dioxide, Nitrogen Oxides, Hydrogen Chloride gas, Mercury and other particulates from smokestack emissions, have fallen appreciably over the past decade. Therefore, electric utilities can burn lower cost coal (that incidentally contains higher concentrations of these elements and compounds) more commonly found in Northern Appalachia (which includes Northern West Virginia) and the Illinois Basin yet still meet federal regulations governing mercury and other power plant emissions.

REGULATORY POLICY: These technologies have been even more crucial in allowing utilities to achieve compliance with the Mercury and Air Toxics Standard (MATS) rule, which requires fossil-fuel steam electric generators to meet limits for a range of toxic elements and compounds. The required compliance period began in April 2015 and initial one-year extensions were granted to provide an opportunity to retrofit to meet the standard. Further extensions have been granted in cases where plants will be needed to maintain electrical grid operability and reliability standards, but those have been limited to a couple of cases.

Overall, nearly 41 GW of coal-fired capacity has been retired since 2012 (when the MATS rule was finalized). Disentangling whether these retirements can be attributed to the MATS rule itself, other regulatory changes passed in previous years (such as CSAPR, etc), the facility's age or falling prices for other fuel choices is a difficult process that requires detailed data at the power plant level. However, the timing for many of these retirements does provide highly suggestive evidence that the MATS rule was important in causing the recent losses in coal-fired capacity. As for its impact on West Virginia's coal production, beyond the direct impact of retiring generators, the rule has helped to reinforce utilities' shift in coal sourced from mines in Southern West Virginia and other portions of the Central Appalachian Coal Basin to the Illinois and Northern Appalachian basins.

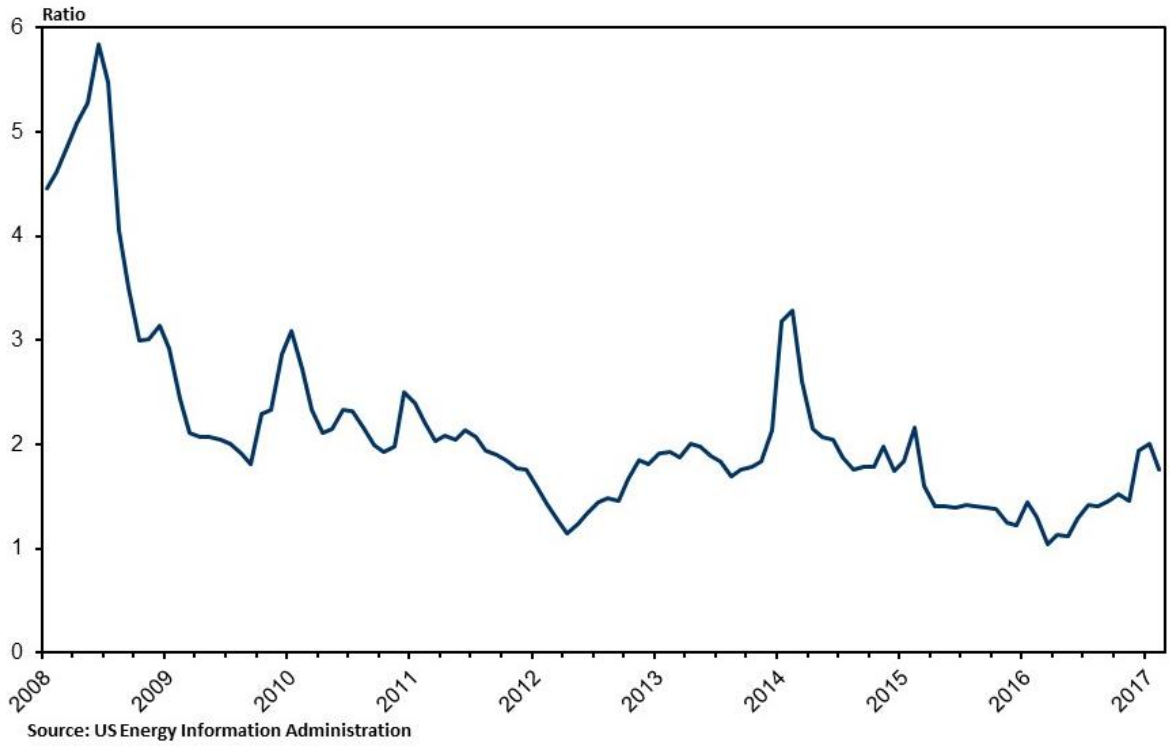
NATURAL GAS USE: While the MATS rule and other regulatory policies, as well as the general shift in utilities sourcing coal from different basins in the US, domestic coal demand in recent years has faced the most pressure from natural gas. Production growth for natural gas skyrocketed over the 2008 to 2014 time period thanks to horizontal fracturing and hydraulic drilling methods opening tight gas deposits once considered economically unfeasible and rapid exploration and development within the Marcellus and Utica Shale plays, both of which West Virginia, Ohio and Pennsylvania.

Although weak market conditions have stunted exploration and development activity since mid-2015, continued increases in natural gas withdrawals combined with some bottlenecks in midstream infrastructure throughout the Mid-Atlantic Region led to a significant drop in natural gas prices over the

course of 2015 and 2016. Furthermore, the precipitous drop in natural gas prices paid by utilities due to this massive supply growth in recent years, when combined with falling construction costs for new advanced combined-cycle plants and their lower costs on a dollar/MWh basis, has enabled natural gas to emerge as the fuel of choice for baseload electricity generation in a growing number of areas in the US, particularly as new pipeline capacity has come on line in the past year.

Prior to the collapse of oil and natural gas prices in late 2008, electric utilities paid as much as almost 6 times more for natural gas relative to coal on a per Btu basis. Since January 2012, the ratio of natural gas and coal prices on a per-Btu basis has been above two during only nine total months and most of those were observed during the 2014 Polar Vortex and Winter Cold Wave. In fact, this ratio has been below 1.5 in 19 out of the last 27 months nationally.

Figure 5: Ratio of Natural Gas and Coal Prices per Btu Paid by Electric Utilities

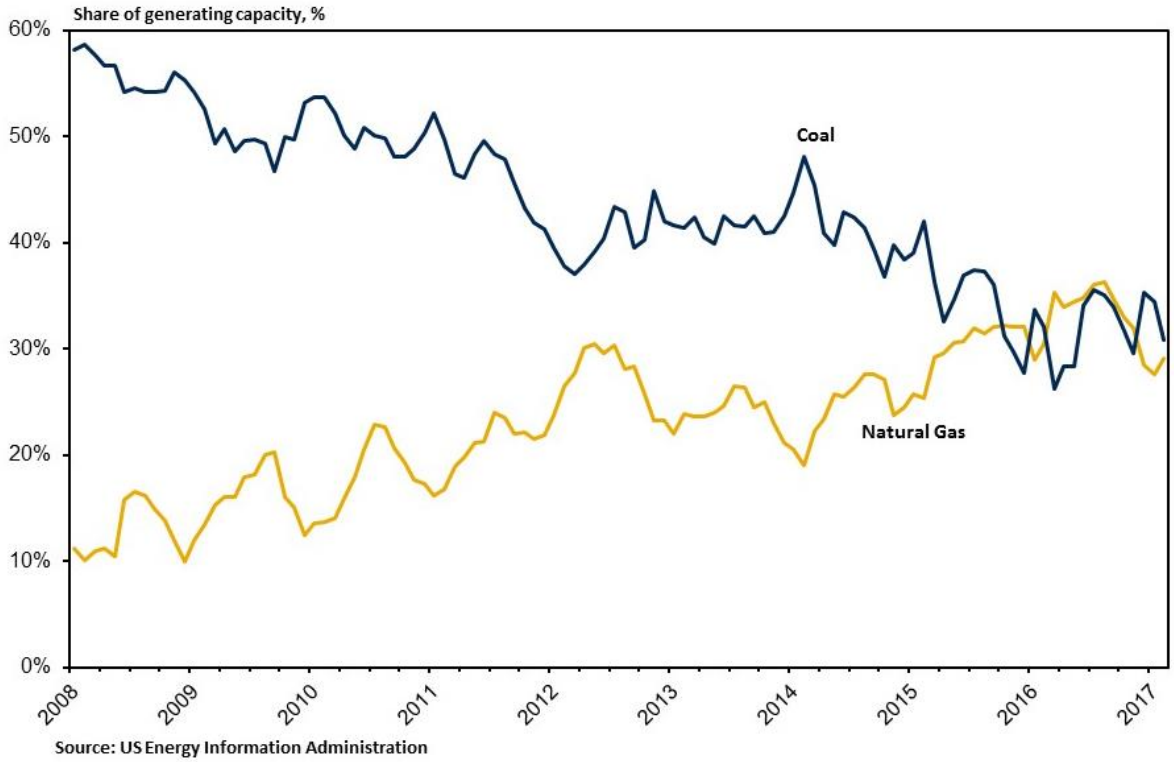


Aside from helping it become the leading fuel source for electricity generation overall, low natural gas prices have also helped to shift the extent coal- and gas-fired plants are dispatched for baseload power demand. In previous years, low prices relative to natural gas allowed coal to remain the feature fuel source for baseload generation in many areas, even though coal plants require more energy than gas to produce a given MWh of electricity. Per the US Energy Information Administration (EIA), capacity factors, which measure the ratio of a plant's actual output to its potential output if the facility were operating at peak levels, capacity factors for natural gas plants averaged 35 percent in 2005 while the corresponding figure for coal plants was 67 percent—with roughly half of these coal-fired assets operating at rates of 70 percent or greater. By 2016, natural gas combined-cycle plants had an average operating rate of 56 percent during 2015 and 2016, while coal plants operated at a capacity factor of just below 54 percent on average over this period. Preliminary data indicate utilization rates for coal-fired power plants have risen

in the first several months of 2017 compared to last year, but are still several percentage points lower than what was observed as recently as 2015.

This shift in fuels to fulfill baseload demand has also helped to exacerbate the divergent patterns of coal output for the northern- and southern coal-producing regions in West Virginia, since Southern West Virginia is more expensive on a per Btu basis. In the late 2000s, coal accounted for more than half of the electricity generation, on average, among states that sourced coal from West Virginia mining operations. Since late-2015/early-2016, these shares have been roughly identical for both fuel sources in these states.

Figure 6: Electricity Generation by Fuel Source – Primary WV Coal Destination States



However, the changing fuel mix and its differential impact on the state's northern and southern mines is more evident when coal generation is weighted by the quantity of coal shipments to each destination state. Based upon this calculation, states that consume Southern West Virginia coal fell from 54 percent down to 47 percent between 2014 and 2016. For states receiving shipments from Northern West Virginia mines, the share of generation coming from coal fell by six percentage points overall in that two-year period. Nonetheless, given that such a large share of coal from the state's northern coalfields ends up being burned by power plants in West Virginia, the tonnage-weighted share of coal-fired generation was still more than 64 percent in 2016.

3 Industrial/Commercial Coal Demand

Aside from electricity generation, industrial and commercial uses constitute the other major domestic source of demand for West Virginia coal. Specific grades of coal mined primarily in the state's southern coalfields are used in the coking process to manufacture steel. However, the secular decline in the US steel industry has reduced domestic demand to a significant degree. Domestic coking coal use has fallen from a national total of nearly 39 million short tons to less than 17 million short tons between 1990 and 2016. For West Virginia, domestic metallurgical coal use has declined by 39 percent since 2011 and totaled just 8.3 million tons in 2016.

In addition to its direct uses in steel production (as well as in the manufacture of cement), coal is also featured as a fuel source for combined heat and power (CHP) generation at various types of manufacturing facilities and some commercial buildings. Consumption of non-coke coal sourced from West Virginia mines for industrial, commercial and institutional uses has also been on a downward trend for many years. In concert with a reduced footprint for the manufacturing sector, increases in heat-rate efficiencies for coal-fired CHP boilers as well as some production facilities switching over to natural gas as the primary fuel source for CHP have driven the domestic use of non-coke industrial coal lower. Also, higher efficiency standards for lighting, electric motors and other types of industrial machinery and equipment have reduced the intensity of electricity consumption by industrial and commercial users lower over time. Since 2011, non-coke industrial and commercial coal distributed from West Virginia coal mines has dropped from 4.5 million down to less than 1.7 million short tons.

4 Coal Export Demand

Given the overall long-term decline in domestic coal use from both the electric power and industrial sectors, export markets have become increasingly important for West Virginia's coal producers—particularly those located in the state's southern coalfields. A majority of coal tonnage exported from West Virginia is used to make steel. Coal exports from the state jumped more than three-fold between 2002 and 2012, climbing from 14.5 million short tons to 47.5 million short tons over these years. This export surge, combined with the effects of falling domestic use, caused global coal shipments to account for 40 percent of the coal distributed from the state's mines.

It appears 2011 and 2012 were likely anomalous years for global coal markets from both a supply and demand perspective that pushed exports from West Virginia to highly atypical levels. For example, Cyclone Yasi shut in 20 percent of Australia's coking coal exports for months on end due to heavy flooding damage to mines in Queensland. With demand from the Asia-Pacific region still running quite strong at that point, the long-lived disruption in Australian supplies caused world coal prices to rise even higher and allow higher-cost Southern West Virginia met coal mines to offset the negative supply shock from Australian producers. Thermal coal was also seeing significantly stronger demand in this period as well due to Japan increasing its coal use in the aftermath of the Fukushima disaster, with a similar push in several European nations due to this catastrophe.

Since 2012, however, coal exports from the state have plunged at an average annual rate of more than 20 percent, falling to an estimated total of less than 19 million short tons for calendar year 2016. Coal shipments to Asian countries have fallen sharply, in particular, contracting 90 percent in the past four years as China and Japan imported essentially no coal from West Virginia during 2016. At the same time, coal demand from most European nations has plunged as well due to the legislated reductions in coal use by power plants via the European Union (EU) Industrial Emissions Directive[2] or by individual countries, such as the Netherlands, which have planned to eliminate coal use altogether. Also, coal-fired power plants across the continent have faced significant financial pressure over the past several years as wholesale electricity prices have collapsed amid sluggish economic growth and rapidly-falling prices for utility-scale wind and solar generation.

[2] For additional information on the EU Industrial Emissions Directive and its various goals and requirements for member nations, see http://ec.europa.eu/environment/industry/stationary/ied/legislation.htm

Table 1: Leading Destination Countries for West Virginia Coal Exports Ranked by 2012 Value

Country	2012	2013	2014	2015	2016	% change (2015-16)
Netherlands	864	560	415	251	126	-50%
Italy	739	459	406	156	94	-40%
India	735	278	138	176	168	-5%
Brazil	589	390	347	208	161	-23%
South Korea	551	119	19	30	56	88%
China	521	180	35	0	0	-8%
United Kingdom	502	417	282	144	48	-67%
Turkey	427	337	190	59	66	12%
Japan	419	46	5	10	2	-79%
France	404	331	148	42	55	30%
Ukraine	380	305	281	223	120	-46%
Canada	306	183	187	148	146	-1%
Morocco	201	245	193	9	43	407%
Germany	176	149	110	33	21	-36%
Spain	161	115	64	33	42	25%
World	7,896	4,774	3,202	1,793	1,284	-27%

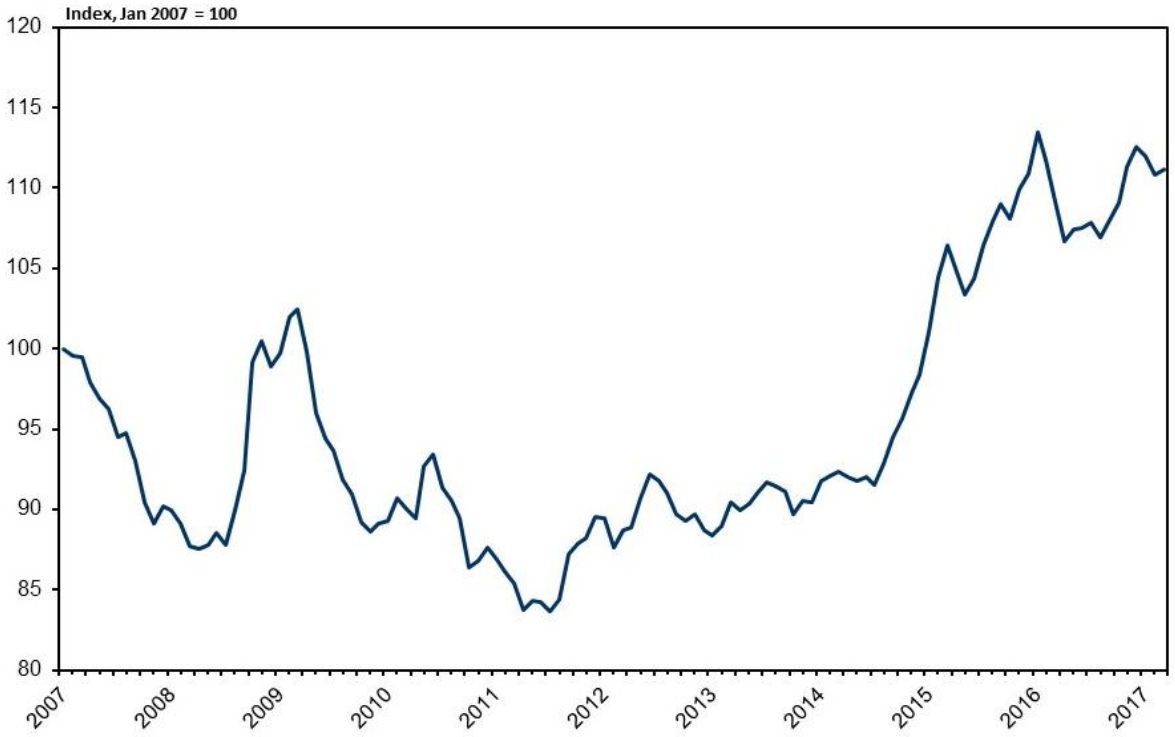
Source: International Trade Administration
Note: Data are in millions 2016 dollars.

On a positive note, export demand for coal from West Virginia mines has picked up in recent quarters. After years of expanding steel production into a global market already dealing with significant excess capacity, China curtailed steel production during a large portion of 2016. With global steel demand now on the rise, these reductions helped to buoy world export coking coal prices in the second half of last year and have helped to bolster production at met coal mines in Southern West Virginia over the last two quarters. In addition, Category 5 Cyclone Debbie made landfall in Queensland in late-March 2017. The tropical storm did not produce the same damage to Australia's mines that occurred after Yasi in 2011, but it did cause extensive damage to railway infrastructure and has effectively marooned a large share of the nation's coal output. Since Australia is the world's largest exporter of coking coal and is also China's primary supplier, the disruption likely produced a sizable boost in coking coal exports from Southern West Virginia during the second quarter of 2017.

THE US DOLLAR AND COAL EXPORTS: While the state of the global economy and several years of excess supply in global coal markets have significantly hurt West Virginia's coal export prospects, unexpectedly persistent strength in the US dollar has also weighed on the commodity's performance. Higher production and inland transportation costs already place coal from Southern West Virginia mines at a competitive disadvantage to other export competitors, and a strong dollar only adds even more of a price premium to coal exports once they enter the global seaborne coal trade.

The real value of the dollar weighted for West Virginia's export destinations soared 23 percent between late-2014 through the beginning of 2016. Although the state's trade-weighted dollar has shown some volatility over the past year or so, reflecting an increase in global political uncertainty due to the outcome of the 2016 US Presidential Election and the United Kingdom's vote to leave the European Union (i.e. Brexit), the dollar remains well within range of its highest value in more than a decade.

Figure 7: Inflation-Adjusted Value of US Dollar Weighted by West Virginia Export Markets



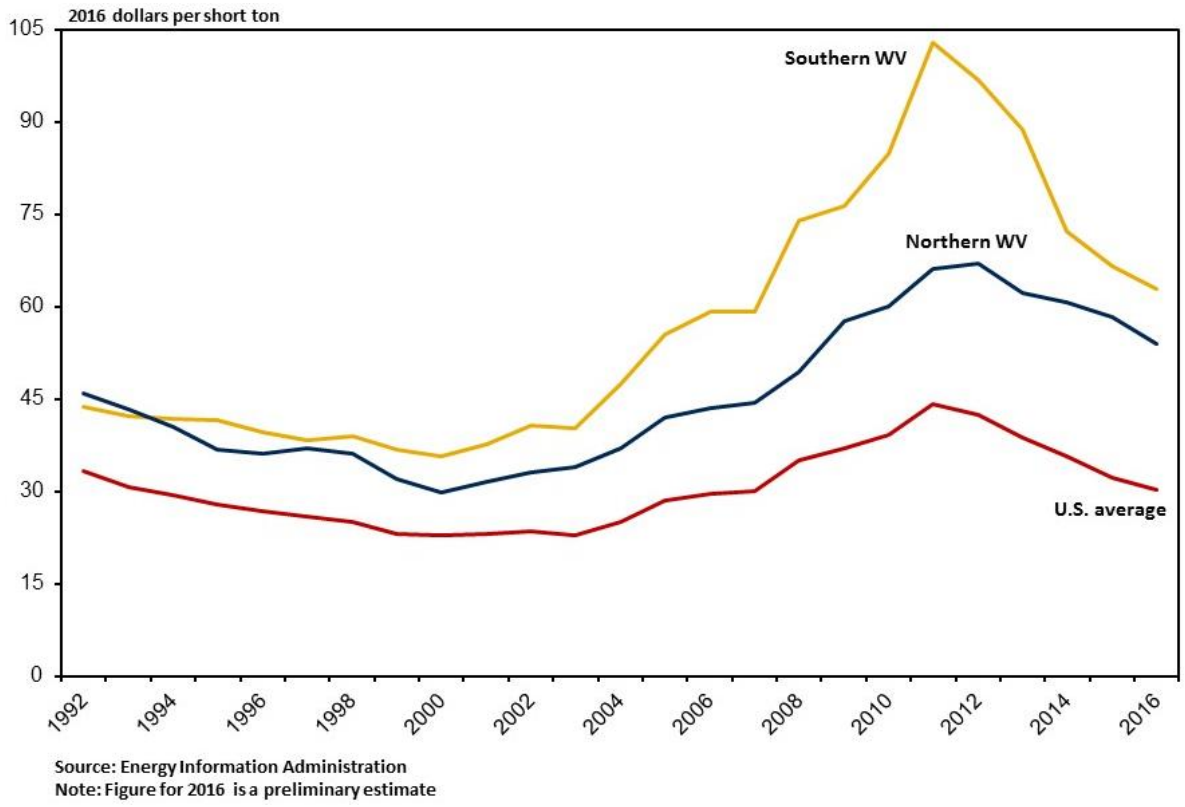
Source: Federal Reserve Bank of Dallas
Note: Index weighted using currencies of countries receiving WV exports.

5 Prices and Mine Productivity

Coal prices increased rapidly over the course of the 2000s. Between 2000 and 2011, the inflation-adjusted sales price of coal rose at an average annual rate of 9.2 percent per year for the state. Real sales prices increased nationally during this timeframe as well, but at a slower pace of 6.5 percent annually.

As has been the case with trends in production, there were notable differences in both the level and rate of growth in prices between the state's northern and southern coalfields. Real average prices increased at an average annual rate of 10.1 percent per year, reaching $103 per short ton (in 2016 dollars) by 2011 in Southern West Virginia due to sustained (or rising) levels of production activity at high-cost mine operations and an increased share of output was premium-grade metallurgical coal bound for overseas export markets. By comparison, inflation-adjusted sales prices for Northern West Virginia's (primarily high-sulfur thermal) coal increased just over percent annually to a peak of $67 per short ton in 2012.

Figure 8: Average Coal Sales Price by Region



Source: Energy Information Administration
Note: Figure for 2016 is a preliminary estimate

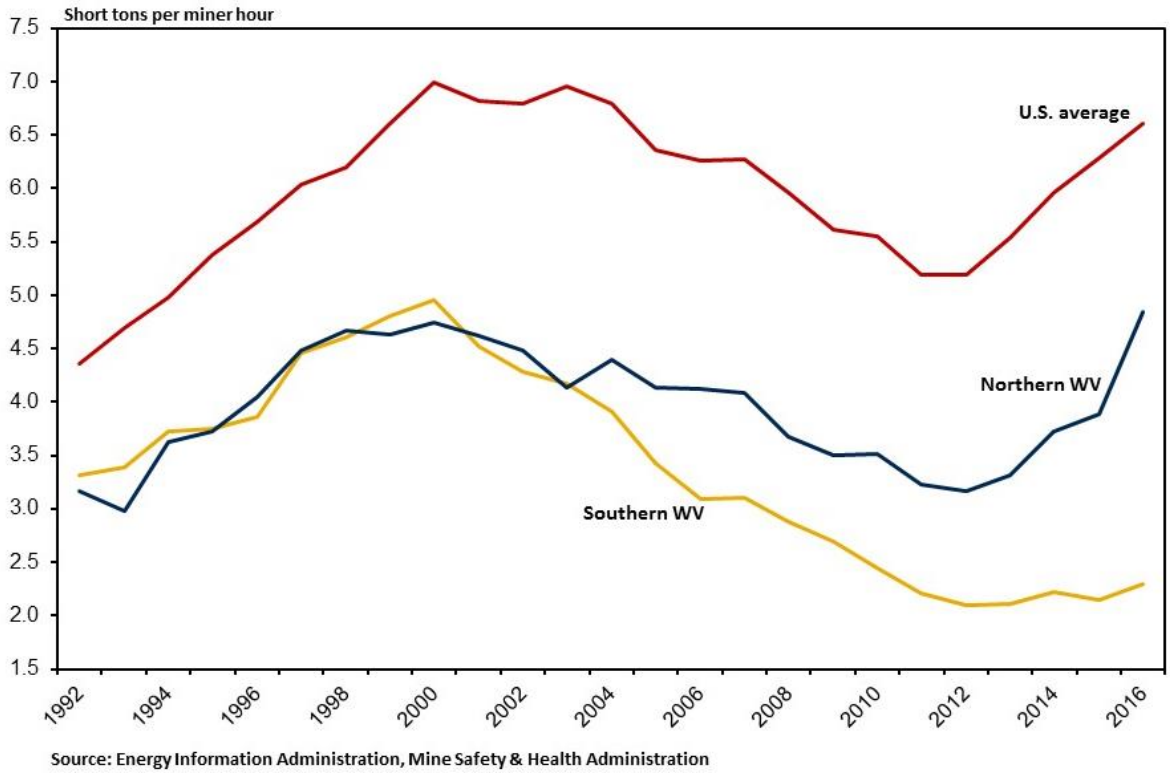
Coal prices likely reached their cyclical low point in early- to mid-2016 and the firming in global coal markets over the latter half of last year has provided a moderate boost to prices. Central Appalachian spot coal prices, which serve as a benchmark indicator for coal mined in Southern West Virginia, increased 39 percent between October 2016 and June 2017. In addition, export prices for metallurgical coal from the US jumped to an average of $118 per short ton during the fourth quarter of 2016 and given the supply disruption caused by Cyclone Debbie, export prices should remain elevated as met coal

producers must offset the temporary loss of Australian shipments into a market already seeing increased global demand.

COAL MINE PRODUCTIVITY: In addition to being affected by broader shifts in global coal demand, prices are also directly affected by supply-side issues that are determined by a combination of regulatory burden, capital/labor utilization, fuel prices and geological constraints. In the short run, labor use tends to have the greatest direct influence on the relative cost of extracting coal from a given seam and thus changes in productivity, as is usually measured in short tons per labor hour, explains a sizable portion of the movement in coal prices over time. Prior to the early 2000s, West Virginia's northern and southern coalfields possessed practically identical rates of mine productivity. Moreover, while well below those observed in the much more productive open-pit operations of the Powder River Basin, both of West Virginia's producing regions also realized gains in productivity throughout the 1990s.

Though mine productivity has declined by varying degrees across all of the major US coal basins compared to 2000, Southern West Virginia (and Central Appalachia in general) has experienced the largest percentage drop-off in productivity during the past 15 years. Overall, mine productivity in Southern West Virginia has averaged roughly 2.2 short tons per miner hour over the past few years, reflecting the fact that many of the region's highest-cost, low-productivity operations have been forced to closed.

Figure 9: Average Mine Productivity by Region



Source: Energy Information Administration, Mine Safety & Health Administration

The large losses in mining productivity for the state's southern coalfields have been particularly noteworthy given that essentially half of the region's operations are surface mines. Both underground and surface mining operations in Southern West Virginia have experienced substantial declines in productivity, with mines having to allocate more labor resources to extract coal from thinner and/or fragmented coal seams. Average productivity levels for both types of mines in Southern West Virginia have fallen by more than half since 2000, from 4.2 to 1.8 short tons per miner hour at underground operations and from 6.4 down to 3.1 short tons per miner at surface mines.

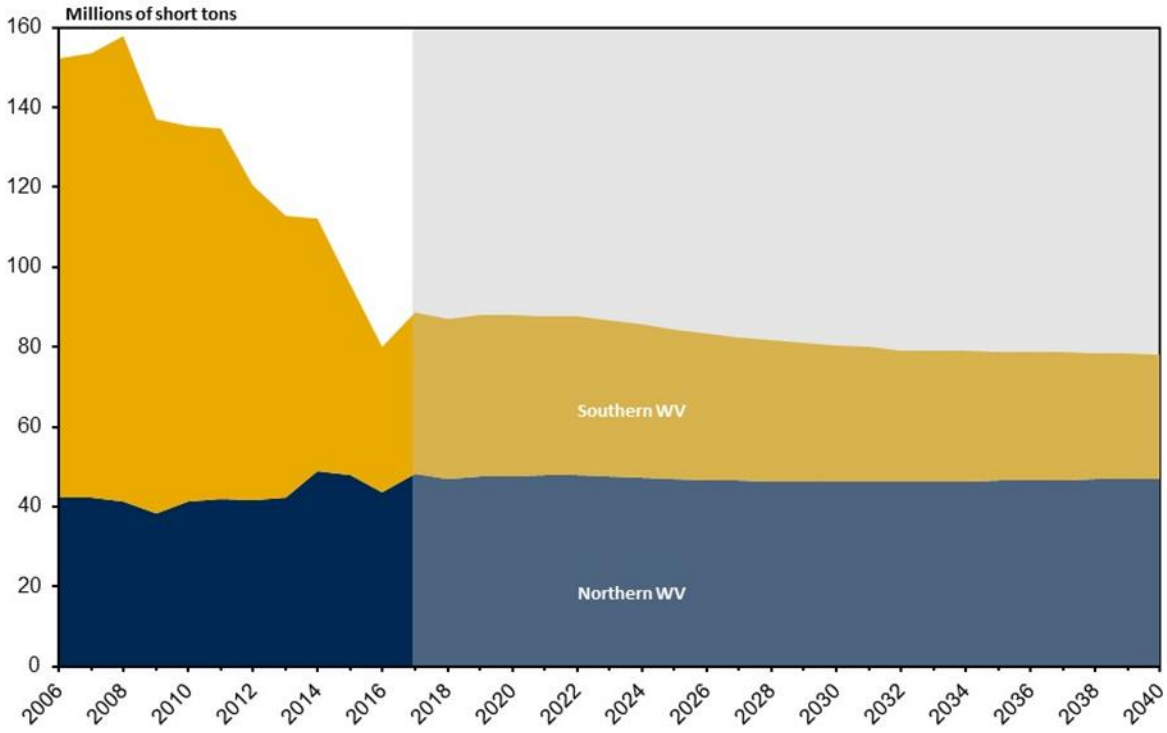
After falling throughout the 2000s, average mine productivity in Northern West Virginia has risen sharply over the past few years. Between 2012 and 2016, average productivity rose by nearly 53 percent, outpacing the overall mine productivity gains observed for the nation during this four-year period. These productivity improvements stem from the fact that several new or recently expanded highly-productive mining operations in Marshall, Ohio, Marion and Taylor counties account for a large share of the region's output.

6 West Virginia Coal Production and Price Outlook

6.1 Short-Term Outlook

The WVU Bureau of Business and Economic Research Coal Production Forecast utilizes an econometric model to forecast coal production for the state's northern and southern coalfields through 2040 based upon a series of variables that influence the demand and supply for each region's coal reserves.[3] Overall, the baseline forecast calls for state coal production to increase to an annual total of more than 88 million short tons during calendar year 2017, which would represent an improvement of nearly 11 percent over 2016.

Figure 10: Coal Production Forecast by Region



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

Growth will likely be strongest for the first few quarters of this year due in large part to the temporary boost in met coal export shipments from Southern West Virginia caused by the supply disruptions linked to Cyclone Debbie in Australia. Production is expected to dip to just over 87 million tons in 2018 as met coal exports cool off and some anticipated retirements of coal-fired generators dampen thermal coal shipments from Southern and Northern West Virginia mines. After sustaining years of declines, shipments of coal from West Virginia to industrial users (both coke and non-coke applications) are expected to improve moderately in 2017 and 2018 as a rebound in the oil and gas capital spending bolsters steel

[3] For a description of the model and summary of the underlying forecast assumptions, see the Appendix.

demand and expectations for higher infrastructure investment buoy cement production and further enhances the need for various types of steel.

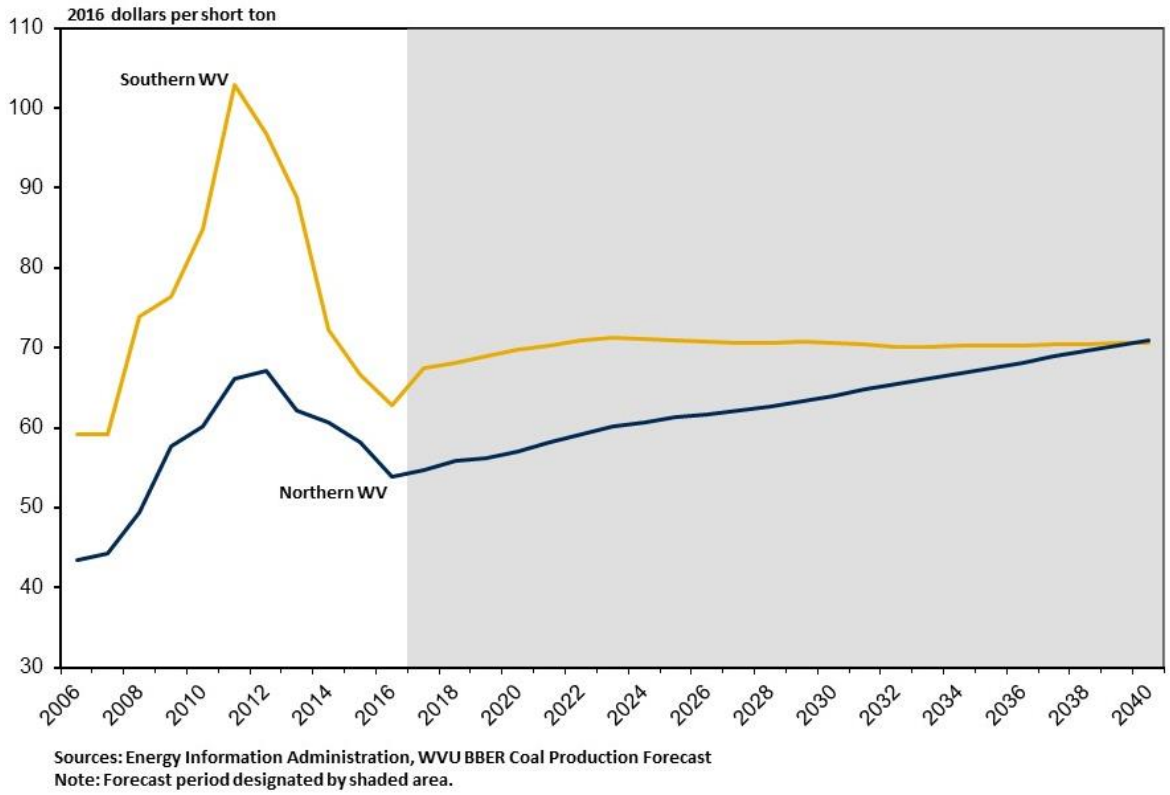
While coal production levels for the state likely remain below levels seen as recently as early-2015, the backdrop for coal production activity over the next year or so has improved from last year's forecast. With the balance tipped slightly toward demand in global steel markets, export demand should stay at healthier levels (compared to 2016) even after Australian supplies re-enter the seaborne coal trade. In addition, most coal companies that declared bankruptcy or undertook significant financial re-organization plans during the industry's collapse now have much healthier balance sheets and have restarted some productive mines or even open new ones, primarily in Southern West Virginia.

Of course, downside risks do remain for the near-term forecast. Regulatory uncertainty does remain a significant issue, as the Trump Administration reviews MATS, the Clean Power Plan and several other environmental rules that were implemented or finalized over the course of the Obama Administration. In addition, legal challenges by supporters or opponents based upon the administration's decisions on each rule are highly likely. Consequently, this only adds uncertainty to the planning process for utilities as they implement long-term decisions that could affect fuel choices and the overall makeup of their generation portfolios, particularly if national elections over the next several years (2018 or 2020) produce results that lead to yet another shift in US environmental policies.

Natural gas prices also have the potential to affect coal production over the next several quarters. As evidenced by recent years, falling construction costs for new plants, abundant supplies and what appear to be structurally-lower prices have enabled natural gas to move beyond serving as a backup fuel for peak demand periods to where it now serves as a baseload generation option in some markets. Should natural gas prices come in lower-than-expected, this could produce a repeat of the last two years where utilization rates of coal plants plunged and led to a several-million-ton drop in thermal coal production.

PRICE OUTLOOK: Healthier demand for higher-priced met coal exports and moderately higher prices for thermal coal will push inflation-adjusted average sales prices higher through the end of 2018. The forecast calls for prices for Southern West Virginia coal to average approximately $67-$68 per short ton (in 2016 dollars) over the next two years and roughly $56 per short ton for Northern West Virginia mining operations.

Figure 11: Average Coal Price Forecast by Region



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

6.2 Long-Term Outlook

As mentioned above, MATS, the Clean Power Plan (CPP) and revisions to New Source Performance Standards (NSPS) for power plants, haze and smog air quality rules and a host of other implemented or finalized regulatory policies from the Obama Administration that affect the coal industry (either directly or indirectly) are being subjected to legal challenges and/or critical review by the Trump Administration. Some of these rules will likely be revised from their original forms (or re-written altogether) and some or all might face legal challenges depending upon the administration's decisions on these changes. The final language or outcome for each of these rules is currently unclear and will thus be difficult to assess. Therefore, the baseline forecast follows a "business-as-usual" approach where currently-enforced rules that are in place and affect the demand or supply for coal are considered, including MATS, coal ash and others.

Coal production in West Virginia is expected to hold in a relatively steady range between 2019 and 2022, averaging roughly 87-88 million tons each year. For the remainder of the outlook period, however, the state's total coal output will trend steadily lower, falling from the mid-80 million-ton range in 2025 down to roughly 78 million tons in 2040.

In terms of the domestic thermal coal market, output from both producing regions in the state will decline from 2019 to 2022, though this anticipated rate of decline will be significantly smaller versus what prevailed in the coal industry between 2012 and 2016. While the forecast calls for higher natural gas prices to lead to a higher share of generation to come from the remaining coal-fired fleet, this will be offset

by mines in both Northern and Southern West Virginia losing sales as more coal-fired generators in Ohio, North Carolina, Maryland, Kentucky and other states have been scheduled to retire within the next several years.

Absent any additional regulations governing CO_2 or other emissions, the pace of capacity retirements or fuel conversions for the coal-fired fleet will likely shrink by the mid-2020s. By this point, the share of electricity generation in states that use coal from either Northern or Southern West Virginia mining operations should remain stable around 61 and 42 percent, respectively, when weighted by the quantity of coal shipments to power plants. Over the last half of the outlook period, however, coal-fired generation will see its electric power market share decline further as the likelihood of lower utilization rates force the least-efficient assets in the coal fleet into retirement. Meanwhile, the costs associated with maintaining, replacing and/or retrofitting (if new standards arise) equipment at aging plants will make these facilities increasingly less competitive over the long term against natural gas, and even utility-scale renewable generation in some markets.

Projected economic growth in China, India and other countries is expected to bode well for coal exports from West Virginia over the long term, but chiefly for premium-grade met coal. Nonetheless, gains in coking coal demand will not be strong enough to lift coal exports from the state much beyond the mid- to upper-20 million short ton range in most years, especially since rising costs make met coal from Southern West Virginia increasingly less competitive against Australia, Indonesia and other key exporters.

For thermal coal, exports from West Virginia will grow thanks to the continued reliance of coal to generate electricity in China, India and parts of Eastern Europe, but the ceiling on thermal coal demand abroad has fallen in recent years. The Trump Administration's decision to reconsider US participation in the Paris Climate Accord could increase the chances of other countries to withdraw from the agreement, but since many countries, particularly those in the European Union, have already implemented plans of their own to reduce coal use in the electric power sector and have been able to do so thanks to rapid growth in renewable capacity over the past several years.

Domestic industrial and commercial demand is expected to hold steady during the early 2020s, but declining non-coke coal use by manufacturers and commercial buildings will eventually begin to offset any demand growth created by coking coal and cement kilns. Moreover, previously-established emissions rules on boilers and process heaters that restrict Maximum Achievable Control Technology (MACT) emissions as well as industry-created efficiency standards for premium motors and other industrial machinery will erode underlying coal demand as well.

From a regional perspective, the long-term declines in coal production expected during the baseline forecast will largely be driven by shrinking output from Southern West Virginia coal mines. As mentioned above, export demand for Southern West Virginia metallurgical and thermal coal reserves will tend to buoy the region's production during the outlook period. However, even that component of demand will weaken as the forecast progresses due to the availability of lower-cost coal reserves from other countries and many importing nations reducing coal use in an effort to lower power plant emissions and mitigate climate change. Also, use of Southern West Virginia coal by domestic power plants will fall further as utilities retire older plants (or operate them at lower rates), shift coal purchases to other basins and/or switch to more natural gas, wind or solar generation capacity. Overall, Southern West Virginia production is expected to fall from 40 million tons in the early 2020s down to 31 million tons in the late 2030s.

After some anticipated retirements of coal-fired capacity or conversion to natural gas-fired generators erode demand for Northern West Virginia's high-sulfur coal reserves, production levels should begin to stabilize in the mid-2020s around 46 million short tons and hold steady at that level for the remainder of the forecast. Combined with this relatively steady level of production and the expected downward trend in coal output from Southern West Virginia mines, Northern West Virginia will account for well over half of the state's coal production during the outlook period.

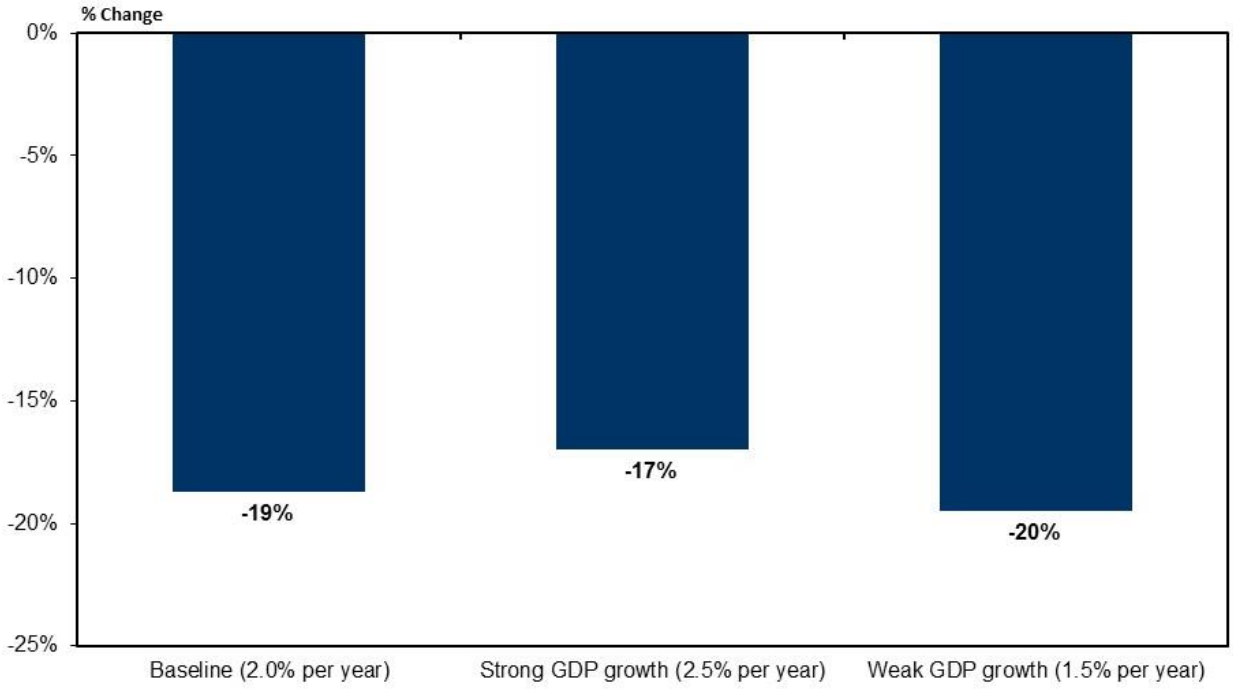
7 Alternative Scenarios for Coal Production

The baseline forecast is built upon a series of assumptions that can have significant impacts on the state's coal production outlook. These assumptions include expectations for domestic and global economic growth, the competitive and regulatory environments and how each interact with costs to the mining industry and the specific fuel choices made by the electric power and industrial sectors. The impact of these assumptions on the forecast can be substantial and, by consequence, creates uncertainty for future coal production in West Virginia, which can ultimately cause growth to deviate from the baseline forecast by an unknown extent. Each of the following scenarios assume changes in policy or underlying economic conditions in isolation of one another, with all other exogenous variables held constant.

7.1 Sensitivity Analysis: Differences in Economic Growth

Economic growth influences electricity demand and steel production, which are easily the pre-dominant uses of coal. The baseline forecast assumes real GDP will grow at an average annual rate of 2.0 percent between 2015 and 2040—a rate that is well short of growth observed during the post-WWII era. Using this assumption, statewide coal production is expected to decline 19 percent from 2015 levels, as discussed above. However, raising expectations for national economic growth to 2.5 percent per year would narrow the rate of decline by a couple of percentage points down to 17 percent. Weaker growth of 1.5 percent annually would cause production to fall by 20 percent from 2015 levels. The relatively limited impacts on future coal demand under these assumptions highlight the fact that the outlook for domestic coal use remains weak, regardless of any potential long-term shifts in economic growth.

Figure 12: Change in West Virginia Coal Production by GDP Growth Scenario (2015-2040)



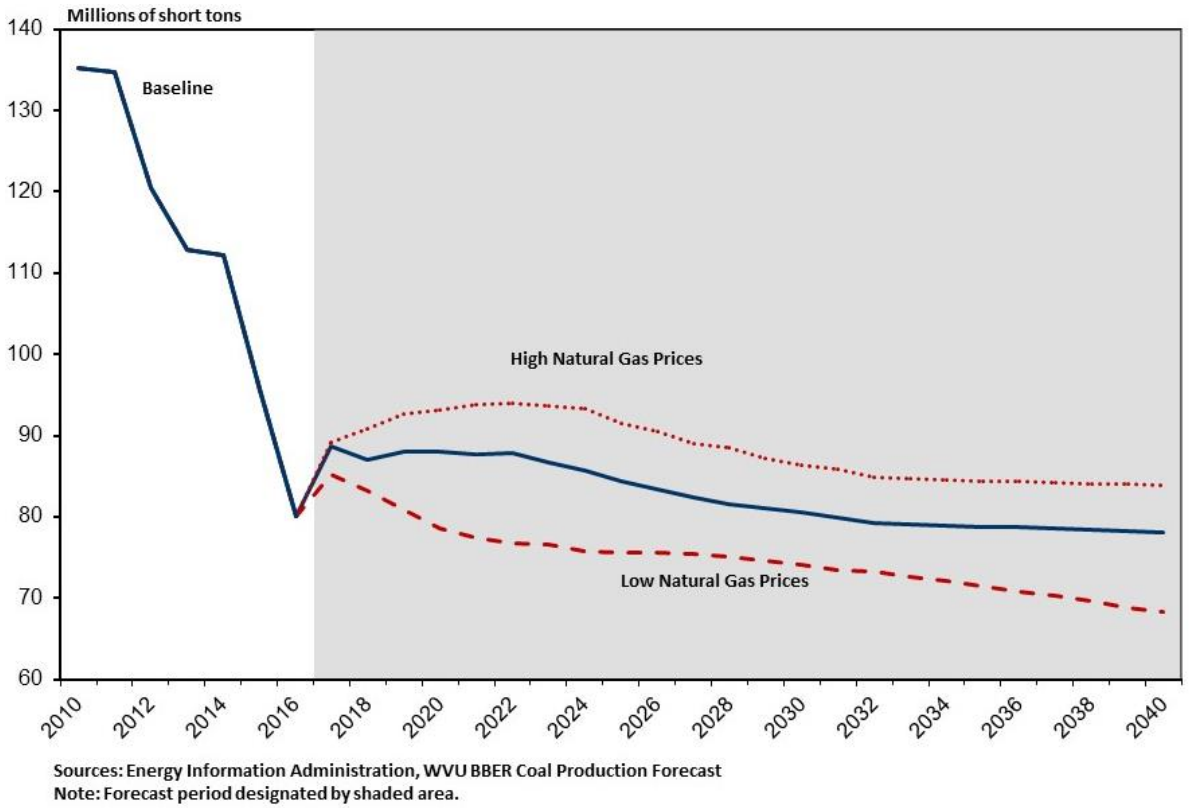
Source: Bureau of Economic Analysis; IHS Economics; WVU BBER Coal Production Forecast

7.2 Sensitivity Analysis: Natural Gas Prices

The first scenarios under consideration in this report examine differing trajectories in the prices electric utilities pay for natural gas. The baseline forecast assumes that natural gas prices will rise throughout much of the outlook period, with supply growth from the Marcellus, Utica, Permian and other shale plays largely offsetting the fuel's expanded demands for domestic electricity generation, new downstream processing facilities in the Mid-Atlantic and Gulf Coast regions as well as rising international consumption of US shale gas via LNG exports. Ultimately, inflation-adjusted prices paid by utilities for natural gas are expected to average $4.30 per Btu by the mid-2020s (expressed in 2016 dollars) and slowly rise to $4.70 per Btu by the latter portion of the outlook period.

HIGH NATURAL GAS PRICE SCENARIO: An alternative scenario was developed, under which natural gas prices are expected to rise in a more aggressive fashion, surpassing $5 per Btu in 2016 dollars by 2020 and rising beyond $8 per Btu in inflation-adjusted terms by the late 2030s. The mechanism for these higher prices could come from a host of sources, ranging from regulatory constraints on natural gas drilling (fracking bans or tighter rules on methane emissions from wells) or weaker-than-expected productivity levels from US shale gas formations. Assuming no establishment of a rule like the CPP, or perhaps even the introduction of an explicit tax on carbon, higher prices for natural gas would likely enable coal to account for a larger share of electricity generation when compared to the baseline and bolster statewide coal production during the outlook period, exceeding the baseline forecast for 2040 by more than 5 million short tons.

Figure 13: Coal Production Forecast – Baseline vs Natural Gas Price Scenarios



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

As Figure 13 shows, however, the differential between the higher gas price and baseline scenarios shrink in size deeper into the outlook period. First, while natural gas prices at these levels would likely encourage some generators to purchase coal from mines in Southern West Virginia, this would only raise fuel costs over the long-term since ramped up production would deplete the region's limited (economically recoverable) reserves at a faster rate and ultimately lead to utilities purchasing more coal from other basins. Thus, while coal production in Northern West Virginia would rise 6 percent over 2015 levels under this scenario for natural gas prices, Southern West Virginia output can still be expected to see a 31 percent drop between 2015 and 2040.

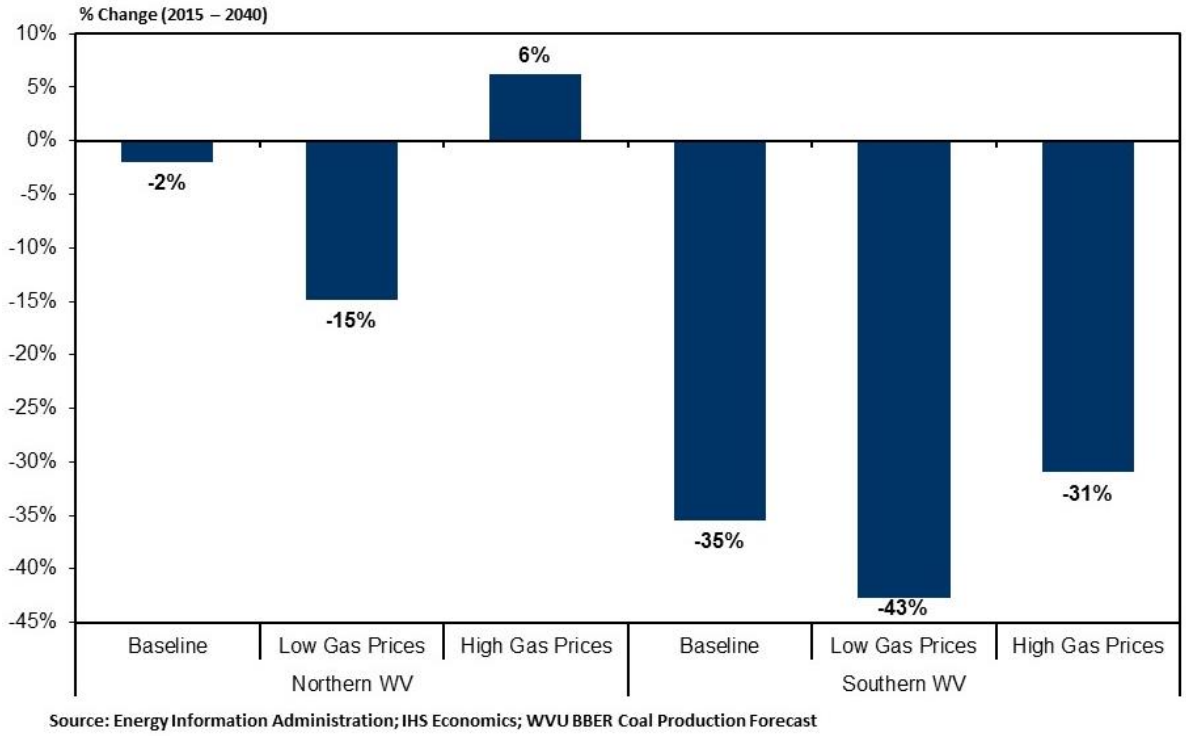
Second, with an average age of roughly 40 years for those still in operation and few new ones having been built in the past decade, a sizable proportion of the remaining coal-fired fleet will likely be up for retirement over the next 10 to 20 years. Keeping some of these facilities in operation beyond typical service lives would likely raise operational costs over the long term since utilities would need to replace aging equipment to maintain efficiency levels or to comply with air quality standards. Even though coal-fired capacity would remain higher compared to its baseline estimate, building new coal-fired capacity, even highly-efficient ultra-supercritical (USC) plants, will remain incredibly difficult due to high construction costs, very long timelines to receive permitting and approval as well as the high likelihood of protracted legal challenges for any proposed plant. Instead, new generation under a scenario of higher gas prices would have to come mostly from new wind and solar capacity in areas where these sources are economically or technically feasible.

LOW NATURAL GAS PRICE SCENARIO: This report also assessed a scenario in which the inflation-adjusted prices utilities pay for natural gas only rise at an average annual rate of 0.7 percent between 2016 and 2040. Growth at this level would cause prices to climb to levels only slightly above those that prevailed in 2015, when natural gas prices were already low compared to historical averages. Several factors could cause natural gas prices to remain depressed over the long term relative to the baseline forecast. For example, productivity enhancements within the drilling industry have been one cause behind the sharp decline in withdrawal costs at the wellhead in recent years, as companies have managed to expand production by re-fracking existing wells that previously would have been considered depleted. Should drilling and exploration companies manage to push costs at the wellhead even lower going forward, it could keep a lid on prices further along the entire gas supply chain. In addition to productivity gains, the overall level of natural gas production could surpass the baseline forecast by simply adding to their base of reserves, either through upward revisions in existing reserves across current shale gas plays or vis-à-vis the discovery of new reserves in other shale formations.

The net effect of lower-than-expected natural gas prices would be a larger decline in West Virginia coal production relative to the baseline forecast. Natural gas has managed to capture a growing share of electricity generation thanks to low prices and the large-scale retirement of the coal-fired fleet in recent years. Extending a low trajectory for natural gas prices to the entire outlook period would only allow the fuel to increase its share of electricity generation relative to coal in most markets. Utilities are already expected to retire additional coal-fired generators during the outlook period, but lower prices for natural gas would lead to an even larger increase in retirements or fuel conversions relative to the baseline since more coal plants would end up with unprofitably low capacity factors, especially those operating in deregulated power markets.

POTENTIAL IMPACTS BY COAL REGION: While statewide coal production is projected to fall to less than 80 million short tons by 2020 and eventually slip below 70 million tons in the latter years of the forecast under a low gas price scenario, the impacts would be felt differently across West Virginia's coal-producing regions. For the baseline, Southern West Virginia is expected to see coal production finish the outlook period 35 percent below 2015 levels, but a sizable share of those anticipated output declines is already being driven by domestic power plants using less use of the region's coal due to generator retirements, shifting purchases to other basins or fuel conversions. Since the domestic market for thermal coal from Southern West Virginia has eroded to such a degree over the past decade, lower-than-expected natural gas prices would likely not create a large change in trajectory for the region's coal production. Overall, coal output from the southern coalfields would fall 43 percent from 2015 levels if natural gas prices paid by utilities were to rise only marginally during the forecast.

Figure 14: Regional Coal Production – Baseline vs Natural Gas Price Scenarios



Source: Energy Information Administration; IHS Economics; WVU BBER Coal Production Forecast

For Northern West Virginia, the vast majority of coal produced by the region's mines is sold to domestic power plants. Since large quantities of coal shipments from Northern West Virginia end up in states where persistently low natural gas prices would accelerate coal plant retirements or capacity conversions under this scenario, regional coal output would be much more negatively affected during the outlook period. Coal production in Northern West Virginia is expected to be 2 percent below 2015 levels by the end of baseline forecast, but changing assumptions to a generally flat level for inflation-adjusted natural gas prices would cause output from the region's mines to fall to 40 million tons by the late 2030s, or 15 percent than 2015 on a cumulative basis. Also, coal production levels for both regions could be even weaker under this scenario, particularly in the state's northern coalfields. As a higher level of coal fleet retirements in the US reduce domestic demand for the region's coal, a portion of these shipments are assumed to end up on global export markets. Should this offset to structurally lower domestic demand not materialize, Northern West Virginia's coal output would be hurt further over the long term.

7.3 Sensitivity Analysis: Changes in Export Demand

Since exports account for approximately one-third of the coal distributed from West Virginia mines in most years, potential shifts in the global coal trade could affect the overall trajectory of statewide coal production, particularly given the drop in domestic coal use that is expected going forward. Thus, stronger- or weaker-than-expected export coal export demand will have a material impact on the state's coal industry over the long term.

The baseline forecast assumes coal exports from the state will increase by more than 2.5 percent annually through the early 2020s before slowing to a pace of roughly 1.3 percent per year through 2040,

allowing export tonnage to return to 2010 levels in the early 2030s. Under the first alternative scenario, total US coal exports are assumed to increase at roughly twice the average annual rate over the entire forecast horizon versus what was assumed under the baseline. Healthier export growth could be caused by stronger global economic growth, structural shifts in the global coal supply chain or some other factor. Regardless of the underlying cause, healthier global demand for coal would push export tonnage past 2015 totals by the early 2020s and 37 percent above the baseline forecast by the late 2030s.

Most of the jump in global export demand would likely be coking coal for steel production, much of which would be supplied by mines in Southern West Virginia, Pennsylvania, Virginia and Alabama. However, thermal coal is also expected to account for a portion of any enhanced demand as stronger-than-anticipated economic growth in nations such as China and India would also boost electricity demand, a significant portion of which is still provided by coal-fired generators. Therefore, mining operations in Northern West Virginia and Illinois basins should see added production bound for overseas export markets. Powder River Basin coal exports will also improve somewhat, but insufficient rail and export terminal infrastructure in the Pacific Northwest will remain a hindrance due to protracted legal challenges and bans by several jurisdictions across the region.

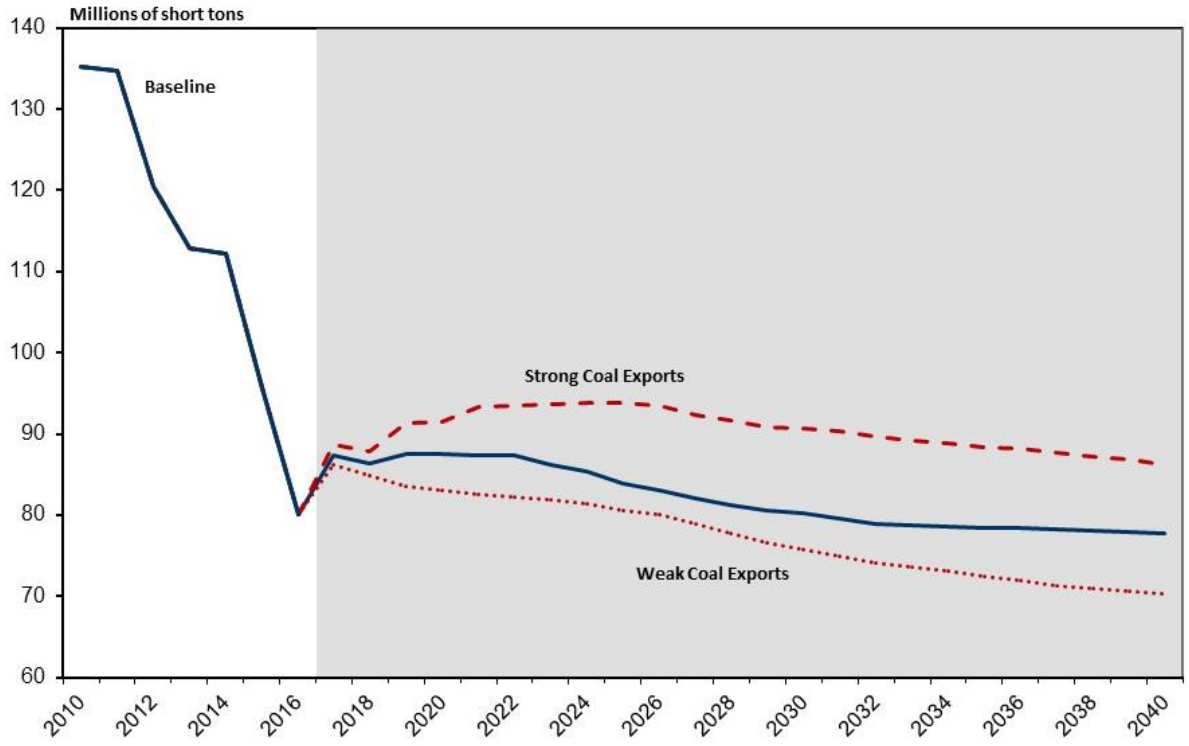
Based upon these assumptions, statewide coal production would bounce back at a much stronger pace during the first half of the outlook period, averaging 93 million tons between 2021 and 2026. Most of the added production activity would come from Southern West Virginia, though the state's northern mines would also contribute as high thermal coal export prices would incentivize producers to raise output for overseas sales. By the late 2020s, coal output will begin to decline steadily as more reserves in Southern West Virginia are increasingly depleted or uncompetitive on global markets due to high production costs. Northern West Virginia will end up accounting for a growing share of the state's overall coal export base, but without adding any new thermal or met coal mines, the region lacks the productive capacity needed to raise export activity in a significant manner over the long term. Production will slip to less than 87 million short tons by the end of the outlook period, which will still represent an 11 percent increase over the baseline forecast.

For a scenario where coal export demand is characterized as "weak," the forecast assumes export activity will grow by just 1.7 percent per year through 2023 and fall slightly over the subsequent decade, leaving US coal exports in 2040 more than 10 percent below levels observed during 2015. The key driving forces behind a weaker outlook for global coal demand would likely come from a faster and larger-scale transition to natural gas, wind or solar for baseload electricity generation, whether driven by single- or multi-nation policy accords to reduce power plant CO_2 emissions and/or continued declines in the cost structure of utility-scale renewable generation and improvements in the commercial scalability of battery storage technology.

Metallurgical coal exports are assumed to be less affected by these policy or technological changes, though certain factors could weigh on this aspect of global coal demand over the long term and push exports even lower than what is expected under this scenario. For example, the wider adoption of recycling old steel products, when commercially practical, would lead to appreciable reductions in coking coal needs. Also, large improvements in the commercial viability of an alternative steel-making method such as electrolysis could lead to significant declines in coal demand since the process uses molten electrolytes and an electrical current to extract iron from its mined ore state rather than burning it in a blast furnace with coking or anthracite coal.

Without any growth in export demand during the outlook period, coal production in West Virginia will fall steadily throughout the outlook period. Overall, statewide coal output is expected to sink back below 80 million tons by the mid-2020s and drop to roughly 70 million tons by the end of the forecast horizon, or nearly 8 million tons less than what is anticipated in the baseline forecast. Though both regions are likely to be affected in this scenario, Southern West Virginia coal output would bear the brunt of any increasingly negative global demand outlook for coal since such a large proportion of the region's thermal and metallurgical coal is exported.

Figure 15: Coal Production Forecast – Baseline vs Export Demand Scenarios



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

Appendix: Model Description and General Forecast Assumptions

Publication: West Virginia University BBER Coal Production Forecast 2017

Date: June 2017

Forecast Horizon: 2017-2040

Regions: Northern and Southern West Virginia

The WVU Bureau of Business and Economic Research Coal Production Forecast is an econometric model based upon changes in factors that affect the demand and price for coal sourced from mines in Northern and Southern West Virginia between 1985 and 2016. Historical data on coal prices, production and other energy-related data are obtained from a variety of Energy Information Administration reports. Forecasts for the model's US-specific explanatory variables were taken from the IHS May 2017 Long-Term Forecast and the 2017 Annual Energy Outlook from the Energy Information Administration. Key assumptions for the model include:

Macroeconomic Growth: Real Gross Domestic Product is expected to increase at an average annual rate of 2.0 percent per year through 2040.

Coal Prices: Inflation-adjusted coal prices are expected to increase in both regions, reaching $71 per short ton (in 2016 dollars) in Northern West Virginia and $70 per short ton in Southern West Virginia—averaged for metallurgical and thermal coal. The US average price is expected to rise to $42 by 2040.

Natural Gas Prices: The national average for real natural gas prices (2016 dollars) paid by utilities are expected to increase at an average annual rate of 1.2 percent per year between 2017 and 2040, reaching an inflation-adjusted amount of just over $4.70/MMBtu by 2040.

Electricity: Total U.S. electricity generation is expected to increase 0.7 percent per year between 2017 and 2040. Coal-fired plants will account for a generally declining share of capacity during the outlook period as no new coal plants are constructed and additional capacity is retired. Coal will account for an average of 27 percent of electricity generated in states that source coal from West Virginia by the late-2030s.

Industrial/commercial use: Total commercial/industrial demand for West Virginia coal is expected to decline 0.9 percent per year over the forecast horizon. Most of this decline will be driven by non-coke coal C&I use due to energy efficiency programs and natural gas conversion.

Export Demand: The baseline forecast assumes 2012 was the all-time peak for West Virginia coal export activity, and both metallurgical and steam coal exports from the state will remain below these levels throughout the outlook period. Total exports are expected to increase 43 percent cumulatively between 2017 and 2040. Southern West Virginia will continue to account for the majority of state coal exports.

Environmental: The baseline forecast incorporates only laws that are in place and not currently subject to legal challenges or under delayed implementation by the Trump Administration. Coal-fired generation that was retired between the 2012-2016 MATS rule implementation and compliance period is expected to remain off line. The Clean Power Plan, Stream Protection Rule, New Source Performance Standards rules and any other finalized rules are not incorporated into the baseline.

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