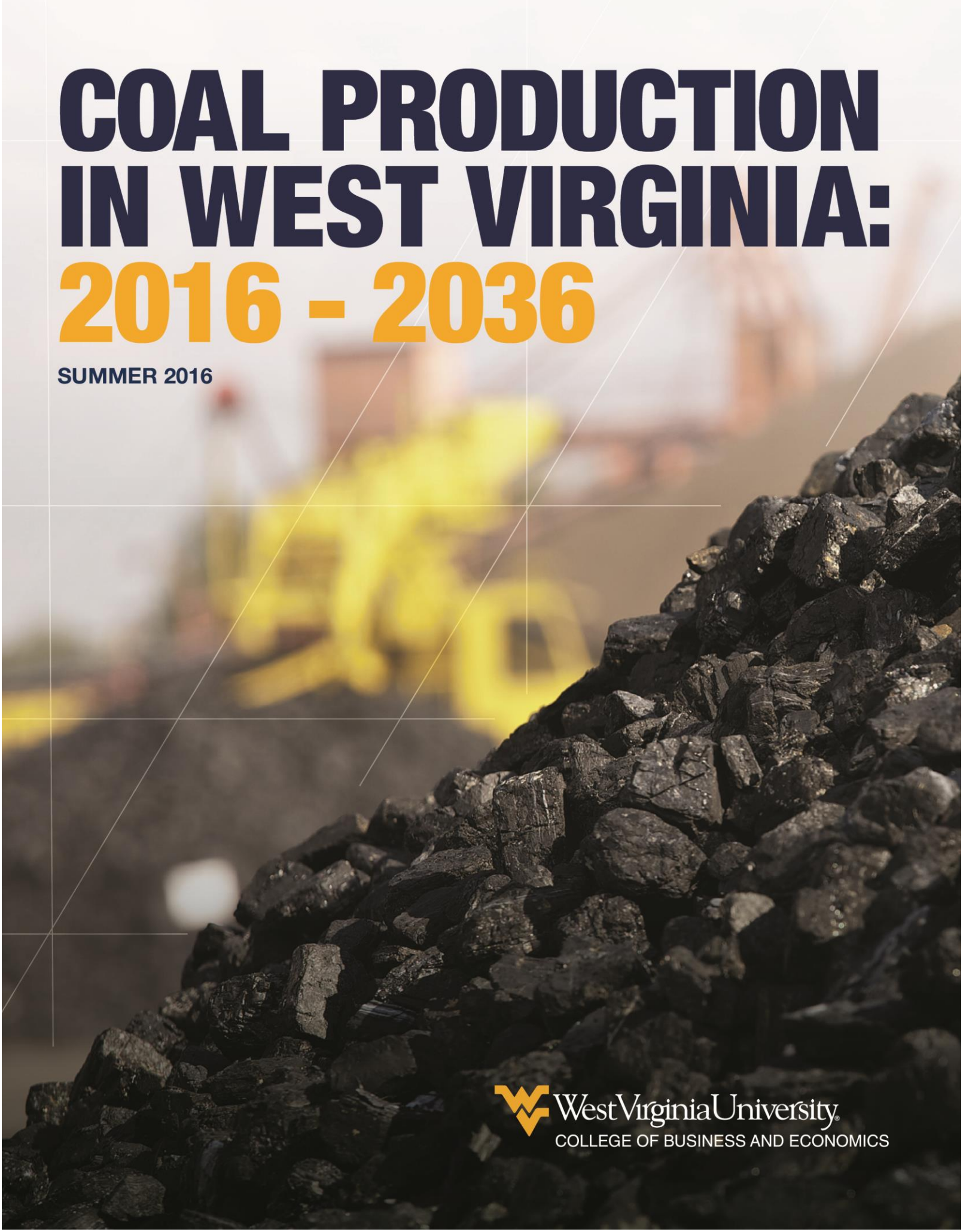
COAL PRODUCTION IN WEST VIRGINIA: 2016 - 2036

SUMMER 2016



West Virginia University
COLLEGE OF BUSINESS AND ECONOMICS

COAL PRODUCTION IN WEST VIRGINIA: 2016 - 2036

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Executive Summary

Overview: West Virginia's coal industry has seen production decline significantly over the past several years. After reaching nearly 158 million short tons in 2008, the state's coal mine output has plummeted to an annual total of 95 million short tons in 2015. The drop in statewide coal production accelerated in recent quarters, falling to an annualized pace of less than 73 million short tons during the first half of 2016. Declining use of coal by domestic power plants, which is driven by the coincident timing of stricter emissions standards and low natural gas prices, weak export demand and challenging geologic conditions in Southern West Virginia are the primary factors weighing on coal production.

West Virginia Regional Variation: Trends for West Virginia's two producing regions have diverged significantly over time. As recently as 2011, Southern West Virginia mines accounted for more than two-thirds of state coal production, but that share fell to roughly half by 2015 as Southern West Virginia mines produced 59 percent less coal tonnage since 2008. Northern West Virginia coal production increased 16 percent between 2008 and 2015, but mine output has fallen appreciably over the past few quarters.

Short-Term Forecast: The baseline forecast, which assumes the status quo regulatory environment remains in place, calls for coal production in West Virginia to total less than 68 million short tons in 2016 before seeing a slight increase during 2017 up to nearly 70 million short tons. Both of the state's coal-producing regions will see weak domestic and global market conditions weigh on mine output through late 2017. Combined with the large stockpiles of thermal coal being held at both mines and power plants, the precipitous drop in domestic coal use by utilities will weigh heavily on thermal coal production in the state. Domestic industrial use and export demand for met and thermal coal will remain weak over the near term.

Long-Term Forecast: Coal production in West Virginia is expected to see a temperate rebound between 2018 and 2020, eventually climbing to an annual total of 75 million tons in 2020. Retirements of coal-fired generation will taper off and an expected increase in natural gas prices should allow coal to regain some share of electricity generation, while global market conditions for thermal and met coal should also stabilize. For the remainder of the outlook period, statewide coal production is expected to fall, contracting to less than 67 million short tons in 2036. The state's southern coalfields will account for all of the downward trend in production as Northern West Virginia production should remain relatively stable level over the remaining portion of the baseline forecast horizon.

Alternative Forecast Scenario – Clean Power Plan: We analyzed the effects of implementation of the EPA's Clean Power Plan (CPP) and New Source Performance Standards on statewide coal production. The results indicate total West Virginia coal output would fall measurably during the outlook period down to less than 57 million short tons by 2036, or approximately 10 million short tons below baseline levels. However, the relative impacts of these rules would be borne by mines operating in the state's northern coalfields as the region's coal is sourced mostly to domestic electric utilities. Mandated limits on CO_2 emissions would cause Northern West Virginia coal production to fall to below 31 million short tons in 2036—22 percent weaker in comparison to the baseline forecast.

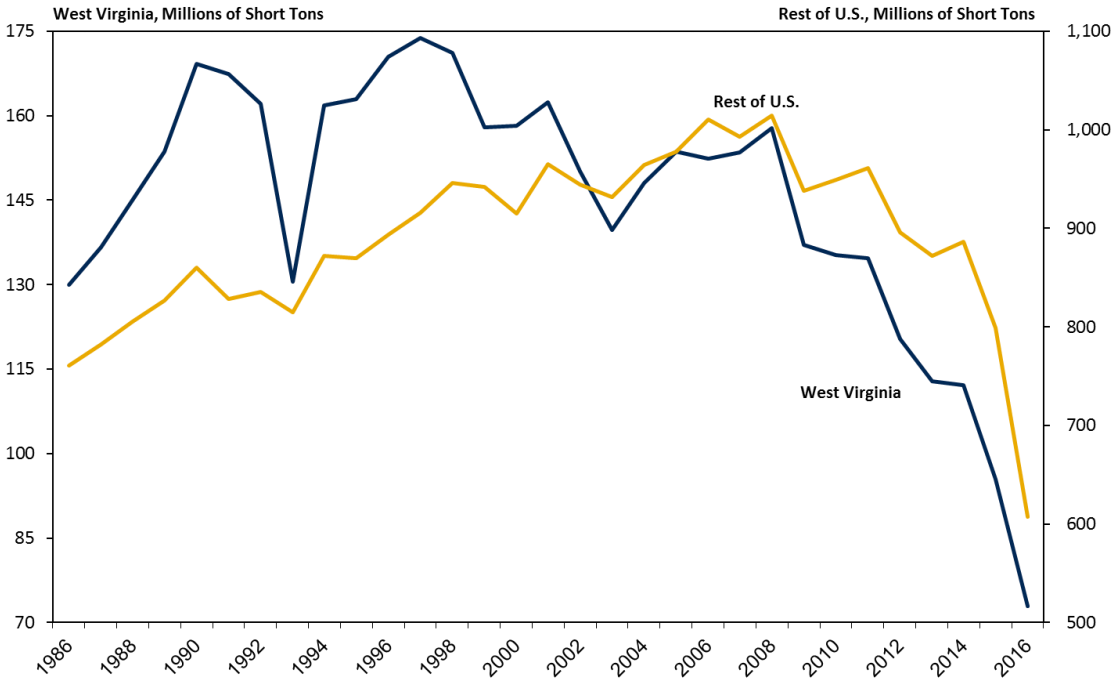
Alternative Forecast Scenarios – Exports and Natural Gas Prices: Two alternative scenarios addressed the impacts of stronger export demand and higher natural gas prices on the state's coal production. Based upon a series of assumptions, stronger-than-expected export demand for coal would cause West Virginia mine output to exceed baseline forecast levels by more than 15 percent. By contrast, natural gas prices that are materially higher than those assumed in the baseline forecast would cause statewide coal production to total 76 million short tons in 2036, surpassing baseline levels from the end of the outlook period by nearly 9 million short tons.

1 Recent Trends in Coal Production

WEST VIRGINIA OVERVIEW: West Virginia's coal industry has experienced precipitous declines in output in the span of less than a decade. After totaling approximately 158 million short tons in 2008, the state's overall coal mine output has plunged sharply in each succeeding year down to fewer than 96 million short tons in 2015[1]--a net decline of more than 39 percent. Unfortunately, the rate of decline has accelerated during the first half of 2016 as preliminary data indicate statewide coal production dropped by roughly one third compared to the first half of 2015. In addition, should the seasonally-adjusted annualized pace of production (~73 million short tons) observed during the first 6 months of the year persist through the second half, it would mark the state's lowest annual coal output total in a century.

NATIONAL OVERVIEW: Although coal production has fallen more rapidly in West Virginia, mine output for most of the nation's other major coal-producing regions has declined over the past few years and at an accelerating pace since the beginning of 2015. Total US coal production (excluding West Virginia) fell an estimated 10 percent during calendar year 2015, or 21 percent short of the level registered in 2008. Through the first 6 months of 2016, non-West Virginia coal mine output declined more than 29 percent versus the same period in 2015 and will likely equal its lowest annual total since at least the early 1980s.

Figure 1: Historical Coal Production Levels



Source: Energy Information Administration
*Note: 2016 figure represents seasonally adjusted annualized rate for first two quarters.

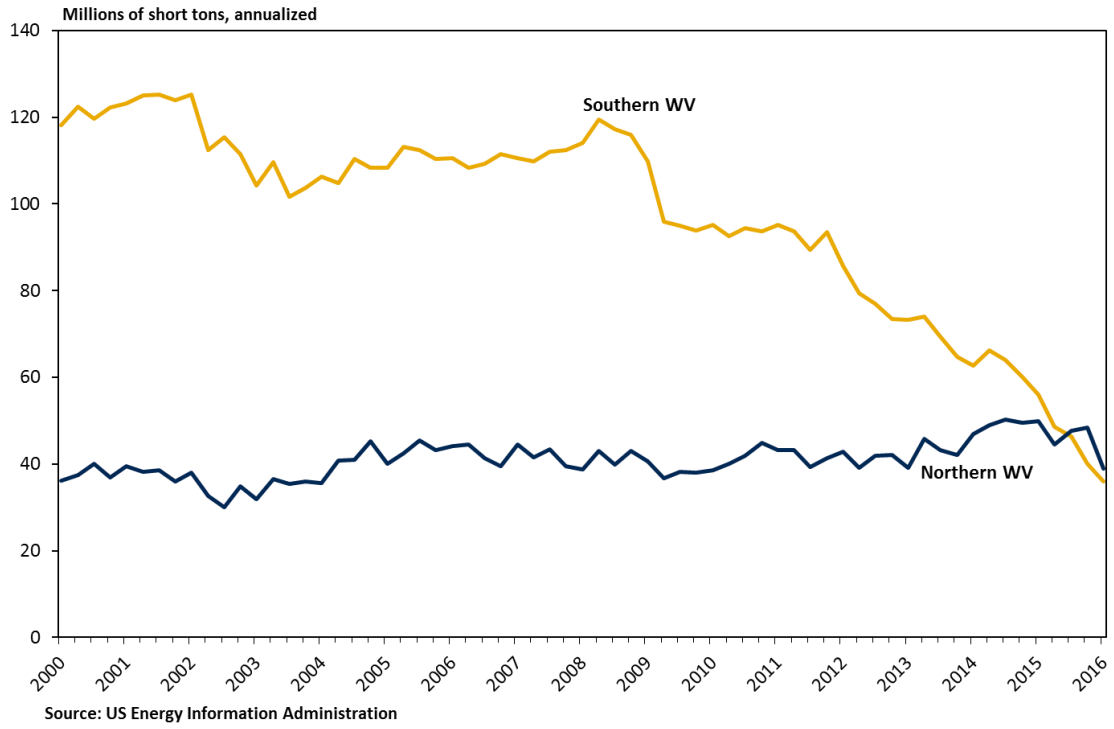
WEST VIRGINIA'S SHARE OF NATIONAL COAL OUTPUT: Given West Virginia's above-average declines in coal production over recent years, overall national coal mine output has increasingly shifted

[1] The production figure for 2015 is an estimate and should not be considered final until the US Energy Information Administration publishes the 2015 Annual Coal Report.

away from West Virginia and toward other US coal-producing regions. For example, West Virginia's share of total US coal production has fallen from 13.5 percent in 2008 down to 10.7 percent in 2015 while over that same time period the Illinois Basin, which includes Illinois, Western Indiana, and part of Western Kentucky, saw its share of domestic coal production climb 4.5 percentage points to nearly 14 percent of overall total tonnage. Even with the region's 9.7 percent drop in coal mine output during 2015, Illinois Basin production has expanded by nearly 25 million short tons since 2008, due in large part to more domestic power plants shifting their coal purchases to the region's lower-cost high sulfur coal reserves. Even with these market share gains, US coal production still remains decidedly concentrated in the West, with the Powder River Basin accounting for 44 percent of national output despite experiencing a 96 million short ton (20 percent) reduction in output between 2008 and 2015.

NORTHERN AND SOUTHERN WEST VIRGINIA COAL OUTPUT: As much as coal production has shifted westward geographically in the US, production within West Virginia has experienced a significantly larger geographic shift from the state's southern-producing counties to mines located in Northern West Virginia. As recently as 2011, Southern West Virginia mines accounted for roughly 69 percent of coal produced in the state. By 2015, however, the southern coalfields produced half of the coal mined within the state's borders as production levels shrank from 93 million to just under 48 million short tons. This downward trend has worsened to an even greater degree recently as Southern West Virginia coal production has accounted for less than 50 percent of statewide coal output in each of the last four quarters. According to preliminary data, production for the state's southern coalfields was estimated at a seasonally-adjusted annualized rate of approximately 33 million tons during the first half of 2016.

Figure 2: Historical Coal Production by Region in West Virginia



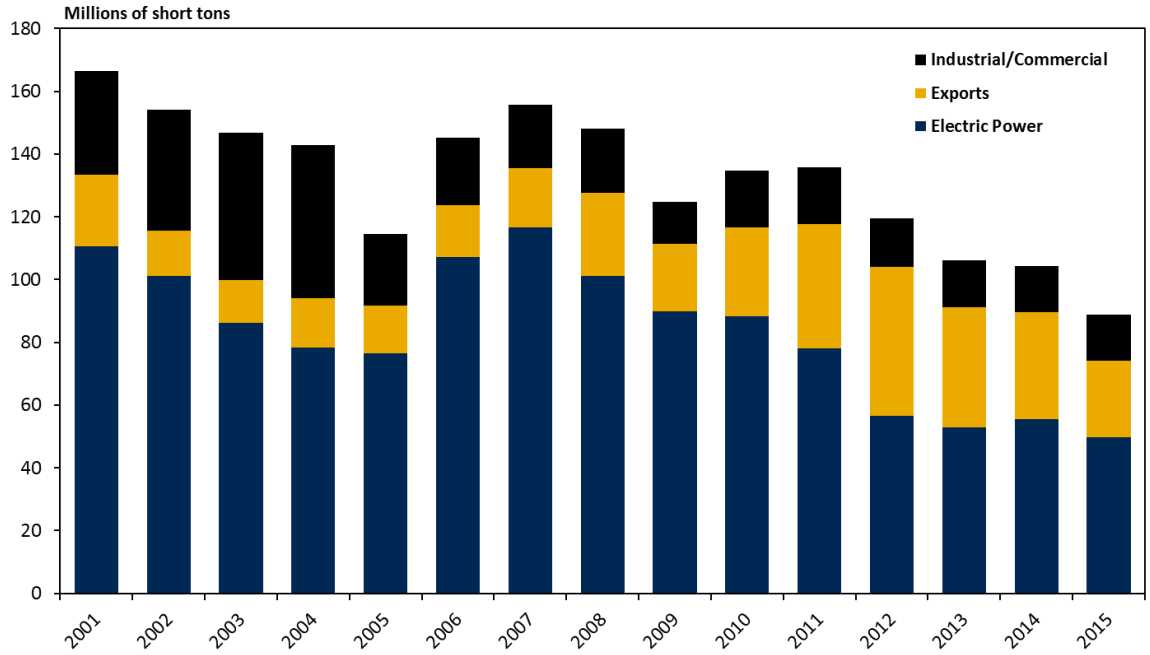
After maintaining several years of stable or expanding production, most counties in the state's northern-producing region have seen coal mine output weaken over the past several quarters. Between 2011 and 2014 Northern West Virginia coal production climbed at an average annual rate of nearly 5 percent. Even

after a 2.5 percent annual decline in production during 2015, regional coal output was still more than 5 million short tons above levels observed during the 2005 to 2007 time period. Although the drop-off in production has been less severe in comparison to Southern West Virginia and most of the nation's other major-producing states, coal production from Northern West Virginia has trended significantly lower since mid-2015. Overall, the seasonally-adjusted annualized pace of mine output from the region during the first two quarters of 2016 is 22 percent below last year as Northern West Virginia mining operations are currently producing, in aggregate, fewer tons of coal than they mined during the Great Recession.

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. Domestic coal-fired power plants still represent the largest end-user for coal mined in West Virginia, but coal utilization for electricity generation has accounted for a declining share of domestic distribution over the past decade or so. Approximately 50 million short tons (preliminary) of coal sourced from West Virginia mines were shipped to electric utilities across 21 states during 2015. This figure represents roughly half the tonnage shipped in 2008 and a reduction of more than 36 percent below shipment levels as recently as 2011.

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



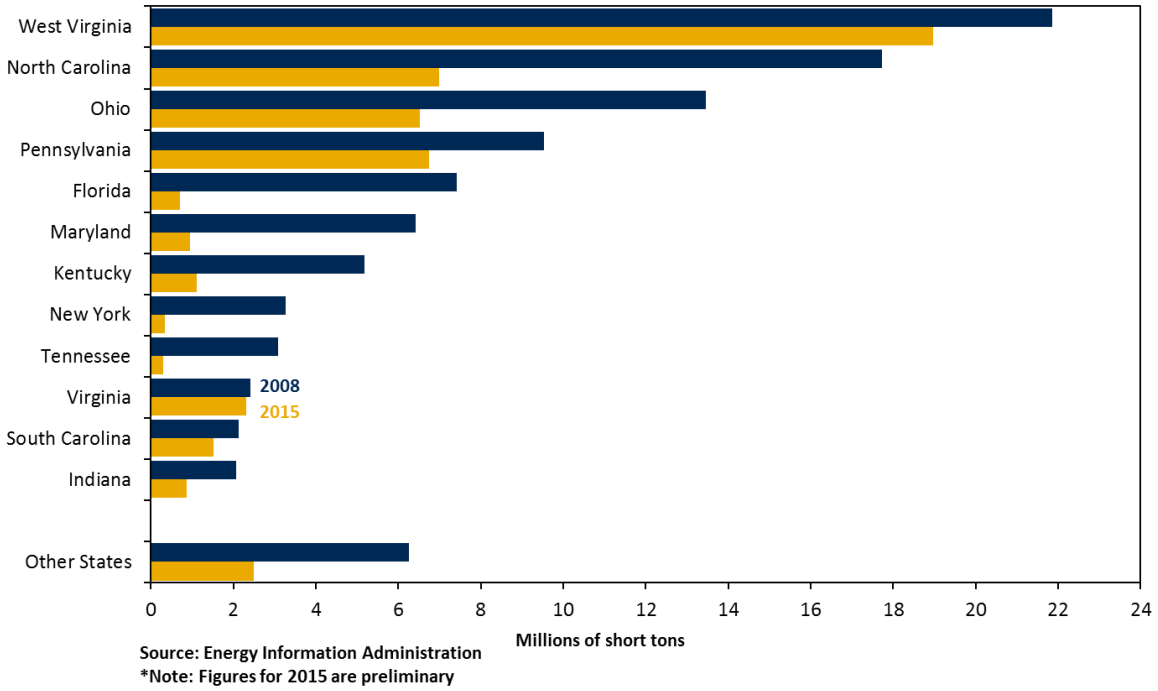
Source: Energy Information Administration
*Note: Figures for 2015 are preliminary

While overall coal use by the electric power sector has fallen considerably for the nation as a whole, the change in shipments to the states that source coal from West Virginia has varied significantly in recent years. Among the states where power plants received at least an annual total of 2 million short tons of coal during 2008, each state saw some degree of decline in coal tonnage shipped to utilities by 2015. Even after a 13 percent decline (3 million short tons) that could be attributed (at least in part) to the 2015

retirements of the Kammer, Kanawha River and Philip Sporn power plants, West Virginia remained the leading destination state for coal produced here as its electricity generation portfolio is comprised almost entirely of coal-fired assets.

Not all of the coal sourced by utilities comes from within the state's borders, due in major part to several plants receiving some (or all) of their coal shipments from mines located just across state boundaries, often from affiliated companies. Regardless, nearly 64 percent of coal received by West Virginia power plants originated from mines in the northern or southern part of the state, representing a six percentage-point increase over 2008.

Figure 4: Destination States for WV Coal Shipments to Electric Utilities, 2008 vs 2015



All states that were major purchasers of coal from West Virginia mines in 2008 have reduced their coal consumption for electricity generation, with states such as North Carolina, Ohio, Pennsylvania and Florida reducing their overall coal use by between a third to as much as a half by 2015. However, utilities operating in these states have also altered the proportion of coal they have sourced from mines in West Virginia and other origin states due to relative fuel prices, which includes the price of coal from other basins, as well as meeting compliance standards for various environmental regulations. For example, while power plants in Ohio reduced consumption of coal from West Virginia overall by nearly 52 percent between 2008 and 2015, utilities lowered the share of electricity generated from their remaining coal-fired fleet driven by West Virginia coal only slightly.

By comparison, the electric utility sector in North Carolina reduced coal tonnage purchased by 49 percent overall, but significantly shifted the purchasing source of coal to mines in the Northern Appalachia and Illinois basins. Indeed, North Carolina power plants cut purchases of coal produced in West Virginia (primarily in the state's southern counties) by 61 percent from 2008 to 2015. Consumption of coal by utilities in Florida declined by a much smaller 33 percent over the same time period, but coal-fired generators operating in that state have shifted the primary source of coal purchases to an even greater extent in recent years. During 2008, power plants in Florida received more than 7.2 million short tons from West Virginia mines, but that total diminished to just over 700,000 short tons in 2015 as Florida's remaining coal-fired fleet sourced the majority of its coal from the Illinois Basin and imports.

Declining domestic coal use has certainly had a significant impact on West Virginia's coal industry, but the shifts in coal sources by power plants has also helped to further the diverging production trends observed for Northern and Southern West Virginia. During the 2000s, West Virginia's southern coalfields produced on average nearly two-thirds of coal produced within the state that was utilized by electric power plants. That share gradually began to decline in 2011, and by 2015 Southern West Virginia accounted for only 39 percent of the coal from the state that was distributed to domestic power plants.

TECHNOLOGICAL CHANGE: This 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 (SO_2), Nitrogen Oxides, Hydrogen Chloride gas, Mercury and other particulates from smokestack emissions, have fallen appreciably over the past decade. As a result, has allowed electric utilities to burn higher sulfur coal more commonly found in Northern Appalachia (which includes Northern West Virginia), the Illinois Basin and other regions, where production costs are lower, yet still meet the full suite of existing federal regulations governing 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 in order to meet the standard. Further extensions have been granted in cases where plants will be needed to maintain electrical grid operability and reliability standards. Even though the standard was remanded by the US Supreme Court to a lower court in June of 2015, the DC Court of Appeals issued a subsequent ruling enabling the EPA to enforce the rule as the agency addressed the deficiencies identified in the Supreme Court's decision.

Given the necessary lead time, most utilities had already made the decision between retiring non-compliant generators, retrofitting with the scrubber technology or alternatively shifting to another primary fuel source. Thus, the Supreme Court's decision had little to no effect on the rule's ultimate impact on coal use. Overall, 13.6 Gigawatts (GW) of coal-fired net generating capacity was retired during 2015 and an additional 5.3 GW is slated for retirement or conversion over the course of this year. The total amount of coal power plant retirements from these two years will amount to over 6 percent of the nation's coal-fired fleet, with much of it in the Midwest and Mid-Atlantic regions, and exceeds average annual capacity retirements from 2004 to 2014 by a factor of four.

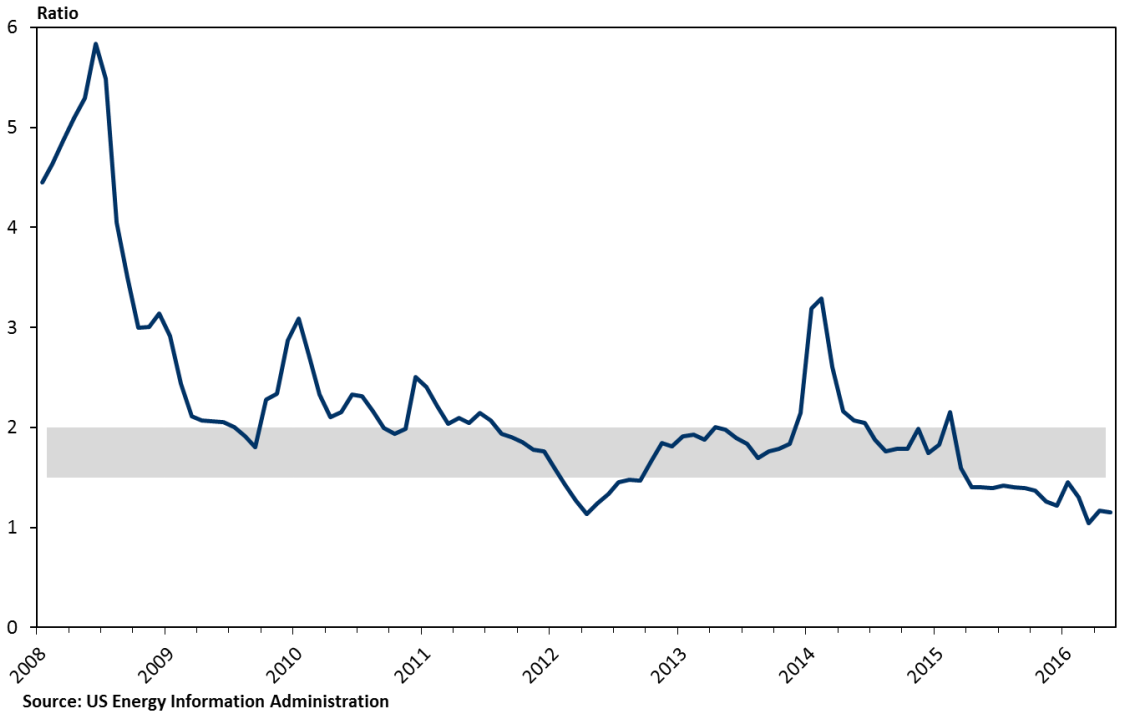
While attributing all of these retirements solely to MATS is difficult, the rule heavily influenced utilities' decisions since most of the retired (or to-be retired) capacity could not be profitably retro-fitted with the equipment that became essentially a de-facto requirement under MATS due to the facilities' age and/or lower capacity factors. Ultimately, where the MATS-affected coal-fired capacity was located has helped to

drive the shifts in coal sourcing discussed above, as many retired generators purchased low- to medium-sulfur coal that originated in Southern West Virginia mines (as well as other parts of Central Appalachia).

NATURAL GAS USE: In addition to the availability of lower-cost coal from other US basins, demand for West Virginia coal has also been directly affected by the emergence of natural gas as a highly competitive alternative for baseload generation. Although production growth has slowed dramatically since early 2015, as low market prices have stunted exploration and development activity for both crude oil and natural gas, the supply response created by the abundance of natural gas deposits in the Marcellus and Utica Shale plays has made natural gas a strong option for electricity generation, particularly in the Mid- and South-Atlantic states where pipeline infrastructure is more readily available. This shift toward natural gas for a larger share of electricity generation is only augmented further by the fall in construction and operating costs for combined-cycle natural gas generators in recent years as well as the coincident timing of regulatory requirements (MATS, etc) that tend to weigh more heavily on coal and oil-fired generation.

Prior to the collapse of oil and natural gas prices in late 2008, electric utilities paid as much as 6 times more for natural gas relative to coal on a per Btu basis. Since 2012, however, aside from several months that largely fell during colder-than-normal months in early 2014, the ratio of natural gas and coal prices on a per-Btu basis has been at 2 or lower, actually remaining below 1.5 since mid-2015. This has helped to shift the calculus of switching toward natural gas even more significantly. Indeed, natural gas supplanted coal as the leading fuel source for electric utilities in each of the past two quarters, accounting for roughly 32 percent of generation versus just below 30 percent for coal. For calendar year 2016 as a whole, natural gas will fuel around one-third of overall electricity generation—marking the first time on record it has supplanted coal as the leading fuel source for an entire year.

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. According to the EIA, capacity factors, which measure the ratio of actual plant output to potential output if the facility were operating at peak capacity, for natural gas combined-cycle plants rose to 56.3 percent during 2015, surpassing the average utilization rate for coal-fired generators (54.6 percent) for the first time ever. By contrast, in 2005, capacity factors for natural gas plants averaged 35 percent while the corresponding figure for coal plants was 67 percent, and half ran at capacity factors at 70 percent or greater.

In previous years, low prices relative to natural gas allowed coal to remain the feature fuel source for baseload generation in many areas during periods of peak demand, despite the fact that coal plants require more energy than gas to produce a given MWh of electricity. Sharply lower natural gas prices have clearly affected this calculus for baseload generation and the differential that existed in 2015 has only widened through the first four months of 2016. Capacity factors for combined-cycle gas plants have averaged 52 percent compared to 44 percent for coal steam generators.

This shift in fuels to fulfill baseload generation requirements has also helped to exacerbate the divergent patterns of coal output for the northern- and southern coal-producing regions in West Virginia. In 2007, coal accounted for a weighted average of more than half of the total electricity generated in states sourcing coal from mines in either Southern or Northern West Virginia. By 2015, however, the share of coal generation in states that received Southern West Virginia coal fell to less than 31 percent. The corresponding figure for those states utilizing coal shipments from Northern West Virginia mines fell five percentage points to 46 percent.

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 U.S. steel industry has reduced domestic demand to a significant degree. Domestic metallurgical coal use has fallen from a national total of nearly 39 million short tons to less than 19 million short tons between 1990 and 2015. For West Virginia, domestic metallurgical coal use has declined by 30 percent since 2008 and totaled less than 11 million tons in 2015.

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 2001, non-coke industrial and commercial coal distributed from West Virginia coal mines has dropped from 17.5 million short tons down to just above 3 million short tons.

4 Coal Export Demand

Given the overall decline in domestic coal use from both the industrial and electric power markets, export markets have grown in relevance for West Virginia's coal producers—particularly those located in the state's southern coalfields. 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 the course of that time period. Moreover, this export surge 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, a major flood event for the Australian state of Queensland during 2010-11 shut in a large percentage of the nation's thermal and coking coal production for many months. Demand from the Asia-Pacific region that would have traditionally been met by Australia—along with a few other major producing-countries in Asia—was temporarily replaced in part by output from Central Appalachian mines (which includes Southern West Virginia).

Of course, Asian coal demand during this time period was also very strong thanks to booming growth in China and the fallout from the Fukushima nuclear reactor disaster in Japan. Indeed, coal exports from West Virginia mines to several countries in Asia skyrocketed by more than five-fold between 2010 and 2012. European demand for low- and medium-sulfur thermal coal from West Virginia also surged during 2011 and 2012, nearly quadrupling over that two-year period.

Since 2012, however, coal exports from the state have plunged at an average annual rate of more than 18 percent, falling to an estimated total of 24 million short tons during calendar year 2015. Coal shipments to Asian countries in particular have fallen sharply, contracting 90 percent in the past three years as China and Japan imported essentially no West Virginia coal in 2015. Factors from both the demand and supply side have driven this sharp downturn in West Virginia coal exports, and the global coal trade in general.

First, Chinese economic growth has decelerated significantly over the past few years and the resultant weakening in metallurgical coal demand has pushed global prices down to levels that are unprofitable for most producers. In addition to the issues in China, the broader global economy remains quite sluggish as many of the world's largest economies in both Europe and Asia are coping with below-trend growth. From the supply side of the equation, traditional global coal export flows have normalized since 2012 as Australia's supply constraints created by the Queensland flooding have disappeared and other major global coal exporters such as Indonesia, Colombia and South Africa produce at lower cost relative to Southern West Virginia coal mines.

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

Country	2010	2011	2012	2013	2014	2015
Netherlands	203	527	815	538	405	247
Italy	224	581	698	440	396	154
India	303	603	694	267	135	174
Brazil	280	547	556	374	339	206
South Korea	10	267	521	115	19	30
China	33	94	492	173	34	0
United Kingdom	221	288	474	400	275	142
Turkey	155	276	403	323	186	58
Japan	31	29	395	44	4	10
France	151	249	382	328	145	42
Ukraine	245	499	358	293	274	218
Canada	104	217	289	175	183	146
Morocco	0	73	190	235	189	8
Germany	34	136	167	143	107	33
Spain	112	52	152	110	63	33
World	2,772	5,319	7,454	4,591	3,134	1,726

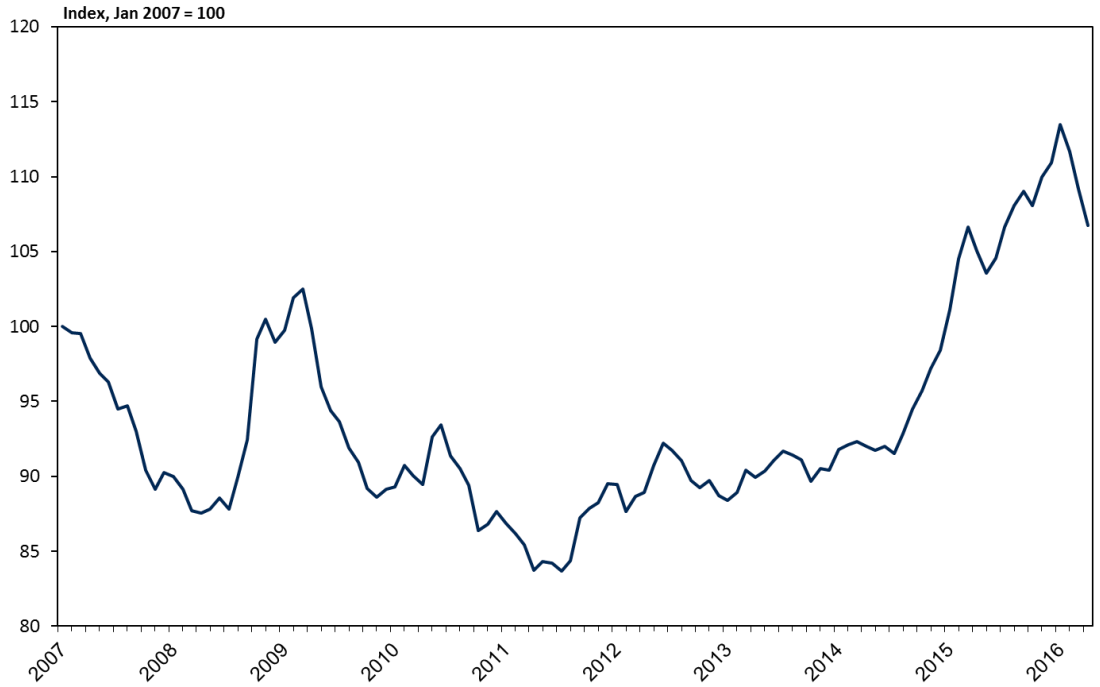
Source: International Trade Administration
Note: Data are in millions of nominal dollars.

While continued weak economic growth across much of Europe has weighed on steam coal demand, the reduction has not been as large in comparison to Asia. For example, even though the EU's Industrial Emissions Directive[2] will spur retirement of some older coal-fired generators and replace them with renewable sources in coming years, coal has actually expanded its share of generation within several countries. Germany, Turkey and the Netherlands have expanded coal-fired capacity (each for different reasons) in recent years and will likely add more generation from coal plants going forward. In addition, the Ukraine has become a major consumer of coal from West Virginia (and other regions) after losing its key producing areas in the Crimea and having its supplies that were previously provided by Russia cut off.

[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

THE US DOLLAR AND COAL EXPORTS: Aside from sluggish global economic growth and an oversupplied global coal market, coal exports from West Virginia have been impacted further by a persistently strong US dollar. Since West Virginia coal tends to face higher production and inland transportation costs than other export competitors, the strong dollar places coal exports from the state at an even greater disadvantage when they enter the global seaborne coal trade. After remaining in a relatively narrow range between 2012 and mid-2014, the state's real trade-weighted dollar soared 23 percent from late-2014 through the beginning of this year. The relative value of the dollar adjusted for the currencies of the state's major export destinations has weakened over the first several months of 2016, but at its current level the dollar continues to add a price premium on West Virginia coal shipments when they enter international coal trading markets. Moreover, the Brexit vote results for the UK to sever economic and political ties with the European Union will likely cause the dollar to strengthen for at least the next several months due to heightened uncertainty in currency markets over the vote's ultimate impacts on global trade and economic cooperation.

Figure 6: Inflation-Adjusted Value of US Dollar Weighted by West Virginia Export Markets



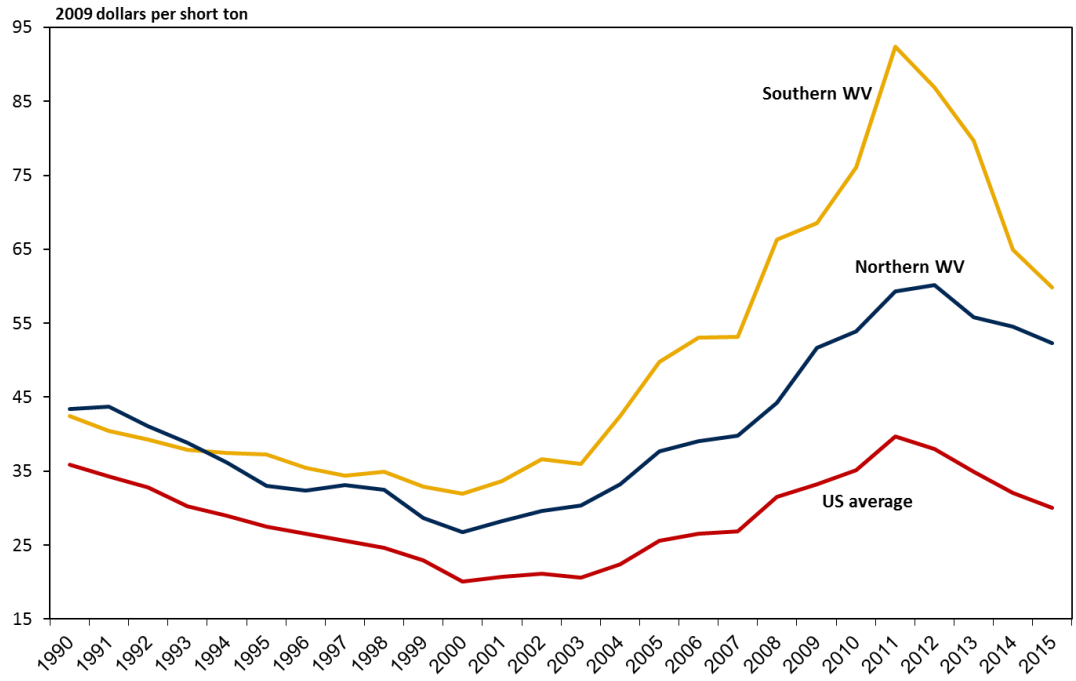
Source: Federal Reserve Bank of Dallas
Note: Index weighted using currencies of countries receiving WV exports.

5 Prices and Mine Productivity

Coal prices increased rapidly over the course of the 2000s. Between 2000 and 2011, the inflation-adjusted minemouth price of coal rose at an average annual rate of 9.2 percent per year for the state as a whole. Real minemouth prices increased nationally during this time period 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 minemouth prices increased at an average annual rate of 10.1 percent per year, reaching $92 per short ton (in 2009 dollars) by 2011 in Southern West Virginia due to sustained (or rising) levels of production activity at mines with higher production costs. By comparison, inflation-adjusted sales prices for Northern West Virginia coal increased just over 7 percent annually to a peak of $60 per short ton in 2012. Since achieving their peaks in 2011 or 2012, average minemouth prices have declined in both regions but the rate of decline has been measurably larger for Southern West Virginia (10.2 percent) as the drop-off in global coal demand has prompted many of the region's higher-cost underground and surface operations to close.

Figure 7: Average Minemouth Coal Price by Region



Source: Energy Information Administration
Note: Figure for 2015 is a preliminary estimate

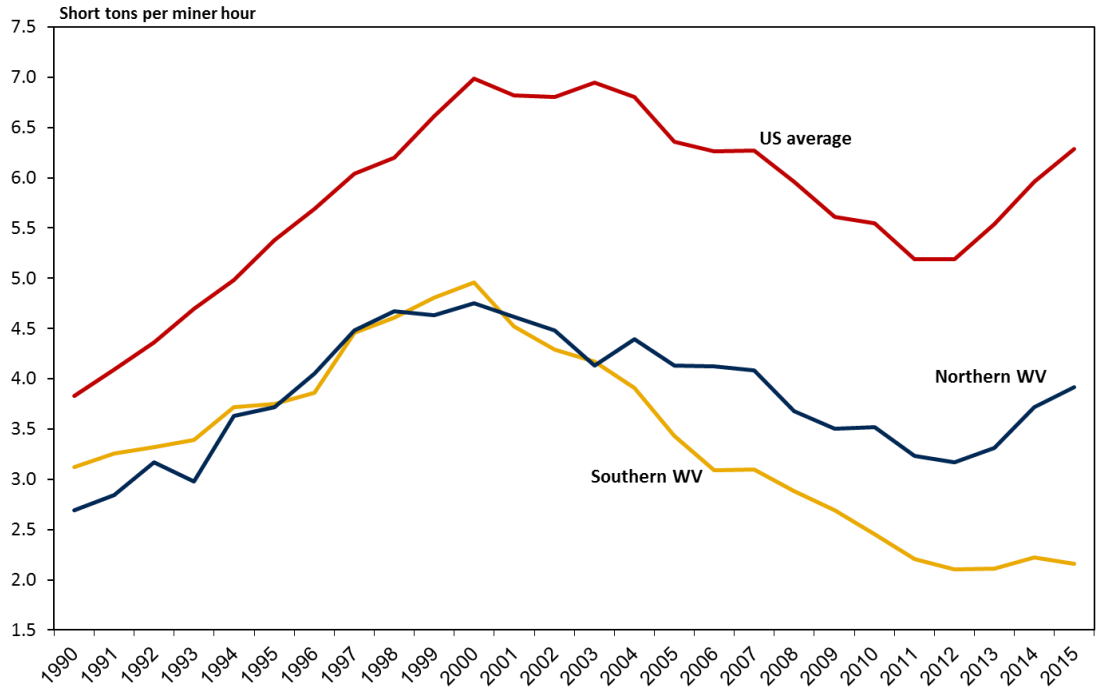
The types of coal produced in Northern and Southern West Virginia helps to explain a portion of the sales price differential as well as the relative growth in prices observed between the two producing regions. In particular, metallurgical coal is mined in significantly larger tonnages in Southern West Virginia, and given this type of coal is a premium grade and fetches higher prices both domestically and internationally, the higher observed price is not entirely surprising. Although the prices mines in West Virginia receive for thermal coal do shift based upon global supply/demand conditions to some extent, price volatility tends to be much more pronounced for met coal since its use is determined by the performance of a highly cyclical steel industry as well as based upon the growth expectations for China and India. Indeed, after reaching

an average of nearly $202 per short ton (nominal dollars) during the third quarter of 2011, world met coal prices have since plunged by nearly two thirds as Chinese steel demand has declined markedly in recent years.

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 U.S. 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 8: 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 over the past 15 years, with mines allocating more and more labor resources to extract coal from thinner and/or fragmented coal seams. Average productivity for underground mines in Southern West Virginia has declined from 4.2 to 1.8 short tons per miner hour between 2000 and 2015 while surface operations in the region have fallen from 6.4 down to 3.1 short tons per miner hour over that time period.

After falling throughout the 2000s, average mine productivity in Northern West Virginia has rebounded in recent years. Between 2012 and 2015, the region's coal operators have seen average productivity rise by nearly one-fourth, outpacing the overall mine productivity gains observed for the nation as a whole during this time period, largely a result of previous capacity expansion and capital improvement projects at several of the region's most productive mines in Marshall, Ohio, Marion and Taylor counties.

6 West Virginia Coal Production and Price Outlook

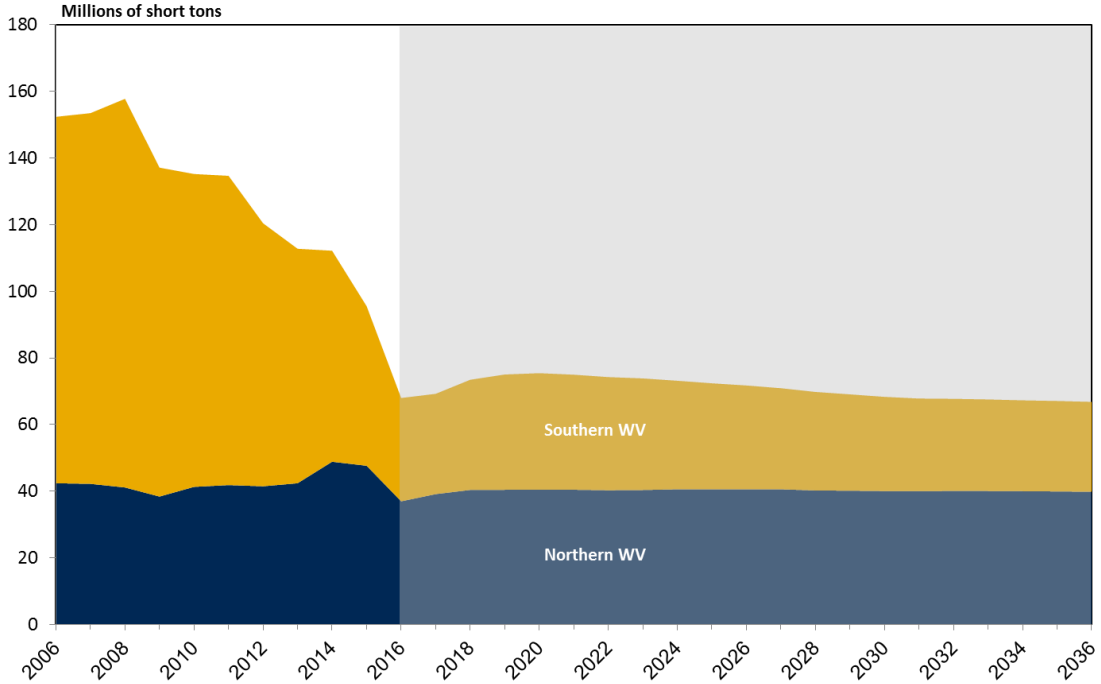
6.1 Short-Term Outlook

The WVU Bureau of Business and Economic Research Coal Production Forecast utilizes an econometric model to predict coal production for the state's northern and southern coalfields through 2036 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 decline to an annual total of 68 million short tons during calendar year 2016, which will represent a decline of 28 percent from the previous year and a cumulative decline of 57 percent versus 2008. Output is expected to stabilize slowly and rebound slightly over the course of 2017, rising to nearly 70 million short tons for the year as a whole.

Numerous factors are expected to weigh on West Virginia coal production over the next year or so for both of the state's coal-producing regions. First, electric utilities are expected to steadily work through their current relatively high stockpiles of coal going forward. Coal's diminished use as a fuel for domestic electricity generation, which was driven in part by the MATS rule forcing a surge in coal-fired generator retirements, combined with relative fuel prices favoring natural gas even more baseload power generation point to thermal coal shipments from West Virginia coal mines will remain very weak for the next several quarters.

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

Figure 9: Coal Production Forecast by Region



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

Domestic use of coal in the industrial sector is also expected to remain weak during the next two years. Sluggishness in the steel industry, fostered to a great extent by global excess capacity linked to sharply slower Chinese economic growth, will hurt demand for metallurgical coal. At the same time, CHP industrial generators are likely to utilize more natural gas going forward while those that do decide to stick with coal will consume less overall due to higher efficiency standards for boiler and plant industrial machinery.

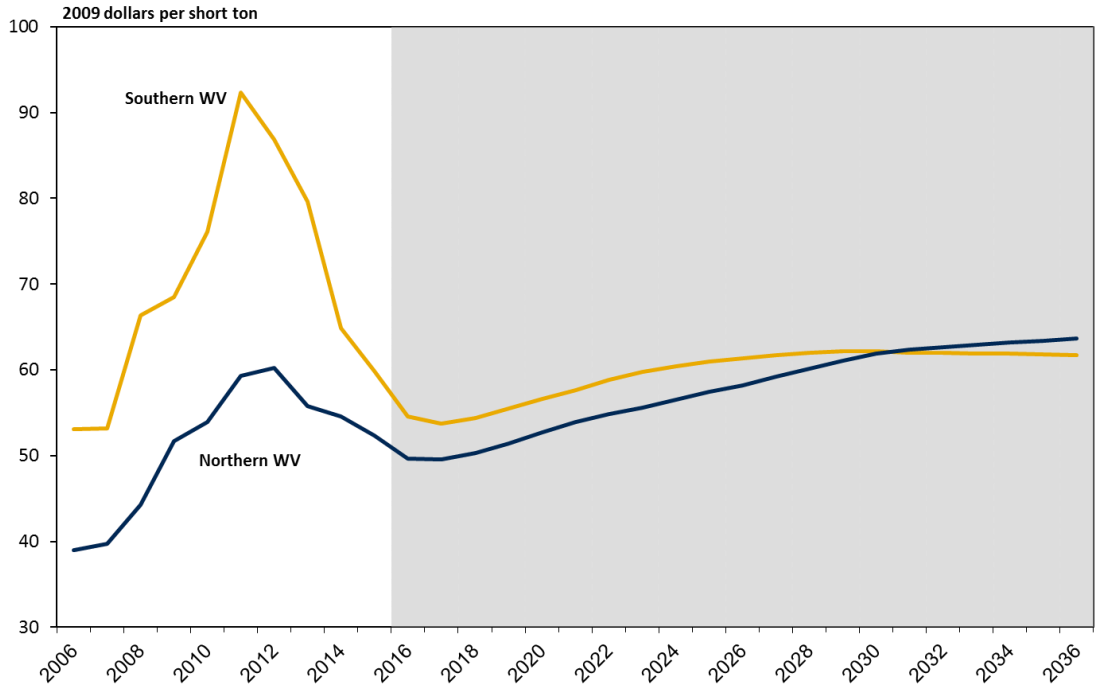
Export demand for coal from West Virginia mines is expected to remain under pressure at least for the next year. Weak end-use demand, extremely low world prices for both met and thermal coal as well as a strong dollar will combine with relatively high production costs for most of the state's mining operations will keep coal tonnage exported from West Virginia at very low levels. Overall, total exports of met and thermal coal will likely bottom out by mid- to late-2017.

While the forecast contains fewer near-term downside risks, merely due to the fact that production has fallen at such a steep rate over the past two years, the majority of underlying supply and demand factors affecting coal are weak (at best). The primary risk over the near term stems from the tenuous financial conditions of coal mining companies, especially those holding mining assets in West Virginia. Most of the state's largest mining operators have entered bankruptcy proceedings, with one having had its assets liquidated and sold off to other buyers. If market conditions deteriorate further or persist for longer than what is currently expected, it could disrupt the unwinding process for companies already undergoing reorganization, possibly forcing operators to liquidate assets and leave mines at risk to major cutbacks or outright closure. Moreover, given the high debt loads within the industry, a weaker-than-expected

performance for coal markets could push other mining companies into financial turmoil, leaving open the possibility of additional mines being idled or completely shut down.

PRICE OUTLOOK: Given lackluster demand for coal in both domestic and international markets, as well as the idling and closure of numerous higher cost-of-production mining operations, inflation-adjusted prices for coal are expected to fall further through 2017. The forecast calls for prices for Southern West Virginia coal to average approximately $55 per short ton (in 2009 dollars) and approximately $50 per short ton for Northern West Virginia mining operations. For the nation as a whole, minemouth prices are expected to average just below $33 per short ton.[4]

Figure 10: 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

The EPA's MATS, Clean Power Plan (CPP) and revisions to New Source Performance Standards (NSPS) for power plants, plus to a lesser extent, the Office of Surface Mining Reclamation & Enforcement (OSMRE) proposed Stream Protection Rule, are major regulatory changes that have had or could have significant impacts on West Virginia's coal industry (either directly or indirectly). However, legal challenges and possible shifts in the national political landscape create uncertainty as to whether these policies will be implemented or enforced as originally published—or if they will be implemented at all. As a result, our baseline forecast assumes a "business-as-usual" regulatory backdrop where the CPP and NSPS are not implemented and MATS-related retirements remain in place. However, recognizing the potential influence of these regulatory changes on future trends in coal use, we have constructed an

[4] US Energy Information Administration, *2016 Annual Energy Outlook*. https://www.eia.gov/forecasts/aeo/index.cfm

alternative scenario that examines the impact on coal production in West Virginia if the CPP and NSPS are implemented as scheduled.[5]

Coal production in West Virginia is expected to rebound moderately between 2018 and 2020, rising to an annual average of nearly 76 million tons in 2020. Retirements of coal-fired generation will taper off significantly after the remaining compliance extensions for MATS expire. Furthermore, expected increases in natural gas prices will lead to an increase in coal use, primarily from the state's northern mines, as it re-coups a portion of electricity generation share lost in the past few years. After any potential increases in demand, thermal coal shipments from Southern West Virginia mines will continue to remain under pressure over the entire forecast horizon. Market prices for coal need to be much higher for many Southern West Virginia mines to operate profitably and any anticipated price growth will not be enough to bring much idled or closed production back on line. This issue is exacerbated to an even greater degree by the poor financial conditions faced by the region's major coal operators, as prospective buyers will be less likely to buy mining assets with high production costs or legacy reclamation costs.

In addition, utilities in most states have reduced coal use to a significant degree in just the past few years, whether due to retiring MATS non-compliant units and/or converting generators to natural gas. However, several utilities that remain large purchasers of coal from Southern West Virginia mines are expected to shift their generation portfolios even further toward natural gas thanks to improved pipeline infrastructure and due to fact that, barring some unforeseen major supply disruptions, natural gas should remain price competitive relative to other fuels. Duke Energy and several other utilities have already announced the addition of several new natural gas plants plus the conversion of coal-fired capacity to natural gas combined-cycle units during the next several years. Overall, states that receive shipments of coal from Southern West Virginia mining operations are expected to reduce their coal-fired share of electricity generation from 33 percent in 2014 down to 26 percent by 2036.

Firming global demand for metallurgical and thermal coal should allow world prices for both coal types to recover to the extent that some Southern West Virginia mining operations that face lower production costs and fewer geologic constraints, such as exceedingly thin or isolated seams, the opportunity to ramp up output. Domestic industrial and commercial demand should stabilize into the early 2020s, but the long-term downward trend should re-emerge thereafter as expanding industrial output will be more than offset by CHP units and other non-utilities converting to natural gas as well as federal emissions rules on boilers and process heaters that restrict MACT emissions take hold. Higher efficiency standards for integral horsepower motors and a range of other industrial machinery and equipment will also dampen industrial use of coal.

For the remainder of the outlook period, statewide coal production is expected to contract to 66 million short tons by 2036. Continued output declines from mines in many of the state's southern counties will drive this trend, with the region's coal production expected to drop nearly 57 percent from 2014 levels. Export demand for Southern West Virginia metallurgical and thermal coal reserves will buoy the region's production for a time, but yawning production costs that stem from the relatively high rates of labor utilization needed to access increasingly depleted or fragmented reserves as well as thin seams, will remain a dominating factor throughout the forecast horizon.

The forecast calls for domestic use of Northern West Virginia's high-sulfur coal to be diminished in comparison to recent years as utilities add new or convert existing baseload generation to natural gas,

[5] A subsequent section will present the results of several scenarios related to regulatory proposals or economic issues that affect coal production in West Virginia.

leaving production levels in 2036 more than 18 percent below what was observed in 2014. Although total output is expected to be measurably lower when compared to recent years, the region's coal production should generally be stable at around 40 million short tons as relatively low production costs at several major operations keep it competitive on price versus natural gas and other basins, assuming the regulatory structure that is in place currently. Combined with this steady level of production and the anticipated slide in output from Southern West Virginia mines, Northern West Virginia will account for a majority of the state's coal production during the outlook period.

LONG-RUN PRICE OUTLOOK: Inflation-adjusted prices of Southern and Northern West Virginia coal are expected to increase at an average annual rate of 0.5 and 1.2 percent, respectively, between 2020 and 2036. Although improved met coal export demand will spur production of this higher-priced grade of coal from Southern West Virginia during the forecast, domestic demand for coal from the region's mines will be weak, putting little upward pressure on prices. Relatedly, this lackluster demand and pricing situation will keep higher-cost coal supplies from the southern coalfields shut in as many producers in the region will find it difficult to operate profitability since unfavorable geological conditions for remaining reserves will require ever-higher market prices to justify production.

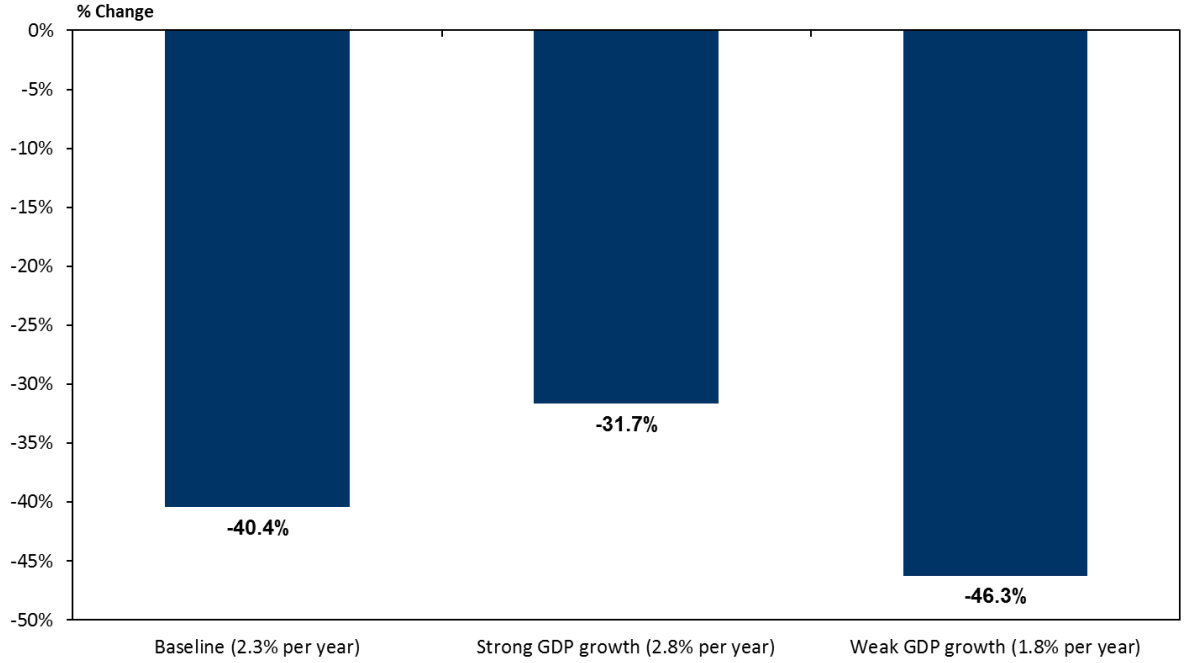
7 Alternative Scenarios for Coal Production

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 four 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 represents a key determinant of electricity demand and steel production, which are the pre-dominant uses of coal. The baseline forecast assumes real GDP will grow at an average annual rate of roughly 2.3 percent between 2016 and 2036—a rate that is well short of growth observed during the post-WWII era. Using this assumption, statewide coal production is expected to decline approximately 40 percent from 2014 levels, as discussed above. However, raising expectations for national economic growth to 2.8 percent per year would narrow the rate of decline to 31.7 percent, while weaker growth equivalent to 1.8 percent annually would cause production to fall by more than 46 percent compared to 2014.

Figure 11: Change in West Virginia Coal Production by GDP Growth Scenario (2014-2036)



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

7.2 Regulatory Policy Changes

In addition to variations in economic growth, we analyze the expected impacts of implementing the EPA's Clean Power Plan (CPP) and New Source Performance Standards (NSPS) for new, modified and reconstructed power plants. The Clean Power Plan sets explicit targets for carbon dioxide emissions from power plants that states must meet by 2030, [6] but also includes three interim period goals for emissions in specific years (2022, 2025 and 2028) preceding the rule's full implementation in 2030. States can opt to use rate-based (pounds of CO_2 per net MWh of electricity) or mass-based (short tons of CO_2) goals in their implementation plans.[7]

Mandates from the CPP would apply to system-wide reductions in carbon dioxide emissions, so efficient coal-fired power plants would not necessarily need to be retired or install carbon capture and sequestration (CCS) technology as long a state meets its specific targets. The addition of NSPS does allow states more leeway for moderately larger amounts of carbon dioxide emissions overall relative to the baseline CPP goals; however, any newly-built generators (either coal or natural gas), or those modified/reconstructed that meet certain conditions found within the Clean Air Act, must meet emission limitations that can be achieved utilizing the "best technology available."

Overall, the likely impact of these tougher emissions standards will be for utilities to retire more coal-fired generation capacity, though some flexibility is allowed should plant retirements affect the reliability of the

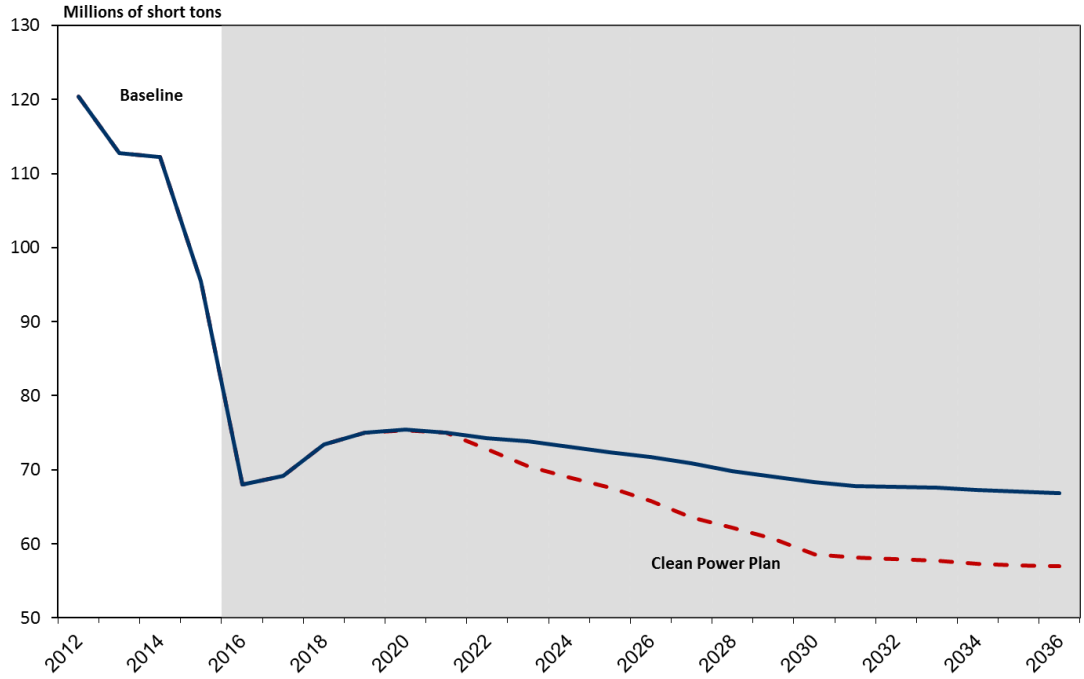
[6] The US Supreme Court's stay of the CPP rule and impending future litigation in the federal courts will likely affect the EPA's published timeline, but for the purposes of this scenario we assume no change in the years listed for the interim or final goals.

[7] For a more in-depth description of the final Clean Power Plan rule and the published emissions standards guidelines for each state, as well as a summary of the Carbon Pollution Standards for New Modified and Reconstructed Power Plants see https://www.epa.gov/cleanpowerplan and https://www.epa.gov/cleanpowerplan/carbon-pollution-standards-new-modified-and-reconstructed-power-plants.

electrical grid. In order to simulate the effect of these rules, we assume states will utilize mass-based plans and achieve their interim and final emissions goals largely through retirement of coal-fired generating capacity. Including the modification/reconstruction standards for generators under the NSPS rule significantly raises the cost of keeping less efficient power plants in service for utilities operating in states that are well above their emissions targets, especially since CCS has proven costly and has not been adopted commercially on a large-scale basis. This suggests states with stricter targets (i.e. steeper reductions in CO_2) will likely need to retire coal-fired plants in larger numbers to achieve compliance.

Incorporating the specific mass-based plan emissions targets published by the EPA for each state[8], we reduce the quantity of coal shipped to the electric power sector relative to the baseline scenario by the amount needed to bring a state's overall carbon dioxide emissions into compliance for the specified interim years and by 2030. While this is a simplistic approach, barring any stronger-than-expected use of CCS technologies during the outlook period, regardless of whether power plants reduce emissions vis-à-vis gains in generator efficiency rates, lower capacity factors, customer demand management programs, fuel switching or a combination of these or other methods, the outcome will still be diminished coal use. Overall, the results from this scenario indicate statewide coal production would fall to less than 57 million tons by 2036, representing a reduction of more than 9 million tons, or 15 percent, below baseline levels.

Figure 12: Coal Production Forecast – Baseline vs Clean Power Plan Scenario



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

REGULATORY IMPACT BY WEST VIRGINIA REGION: For the destination states where utilities purchased significant quantities of coal from Northern and/or Southern West Virginia mines during the 2012 to 2015 time period, CO_2 emissions from power plants must be cut by an average of 24 percent by 2030 relative to estimated 2015 levels. However, the mandated changes vary significantly on a state-by-

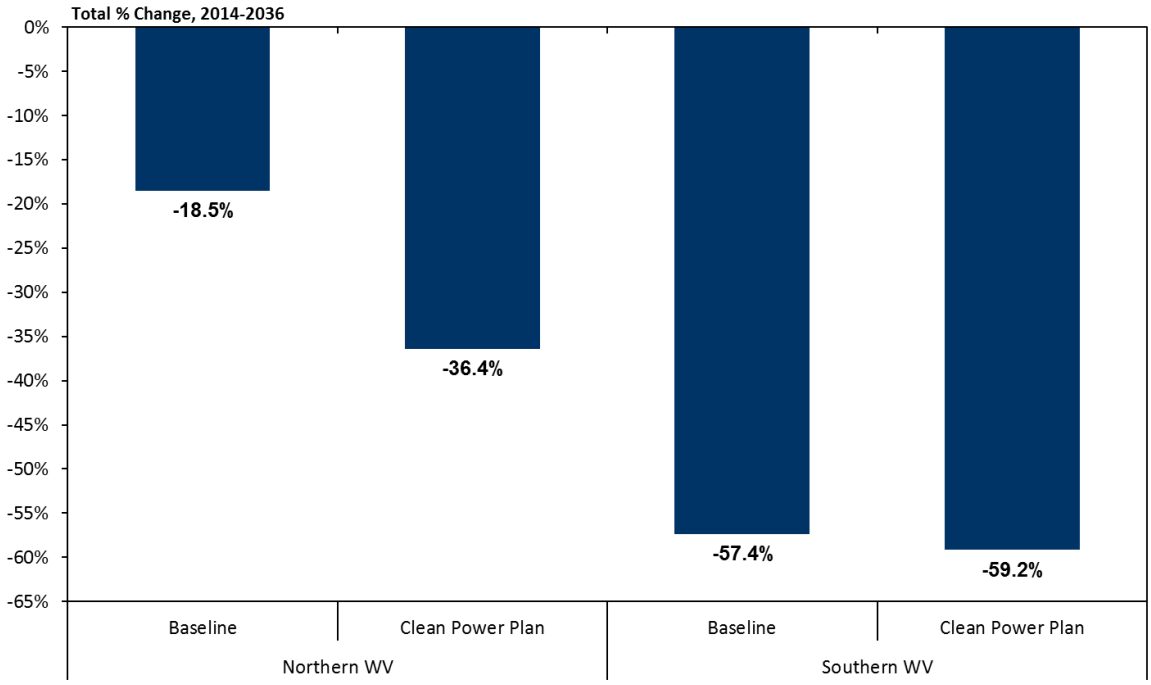
[8] For complete details on each state's published goals, see https://www.epa.gov/cleanpowerplantoolbox/clean-power-plan-state-specific-fact-sheets.

state basis, ranging from only slight reductions in Virginia to cuts of approximately 30 percent relative to 2015 levels for Kentucky and West Virginia.

Changes in coal use for states sourcing coal from Northern and/or Southern West Virginia coal mines will vary widely relative to the baseline, and as a result the impacts felt by each of the state's coal-producing regions as a result of implementing CPP/NSPS will also differ substantially during the outlook period. For example, under the baseline scenario, while it will account for a smaller portion of destination states' generation portfolios versus 2014, coal is still expected to account for a fairly stable share (~40%) of generated electricity from 2020 onward among the states that are traditional buyers of coal from Northern West Virginia mines. Owing to the steep required cuts in emissions for several of these states, coal is expected see its share of electricity generation fall nearly 30 percentage points, on average, in the CPP scenario within these states down to a projected share 23 percent.

This marked deterioration in generation assumed to take place as a result of the CPP policy, combined with the fact that most of the coal produced in Northern West Virginia is consumed by domestic power plants, will weigh heavily on the region's coal output. Indeed, while Northern West Virginia coal production is expected to be 18.5 percent below 2014 levels in the baseline forecast, the results from the scenario indicate that implementing the CPP and NSPS would cause output from mines in the region to plunge to less than 31 million tons by 2036, yielding a 36.4 percent cumulative decline from 2014 and more than 22 percent weaker compared to the baseline.

Figure 13: Regional Coal Production – Baseline and Clean Power Plan Scenario



Source: Energy Information Administration; WVU BBER Coal Production Forecast

By comparison, the CPP produces only marginally weaker production for Southern West Virginia. Many utilities that sourced coal from mines located in the state's southern coalfields in years past have already retired large amounts of coal-fired capacity that burned the region's coal, shifted purchases (partially or entirely) to lower-cost high-sulfur coal from other basins or converted generators to natural gas. Since

more coal-fired capacity that uses Southern West Virginia coal is slated for retirement or conversion to other fuels during the outlook period, stricter emissions limits on carbon dioxide under the CPP will likely lead to just a small drop in coal production relative to the baseline as a vanishing share of the region's coal will be utilized by domestic power plants.

7.3 Sensitivity Analysis: Variation in Export Demand

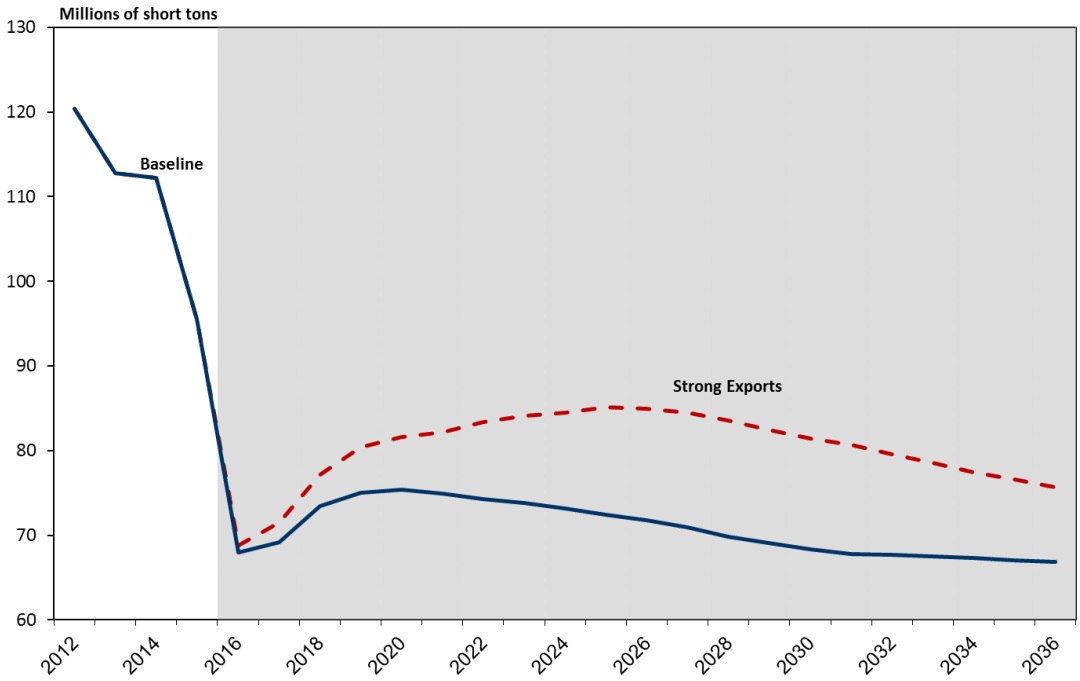
Since exports account for approximately one third of coal distributed from West Virginia mines, potential shifts in the global coal trade could have major impacts on the trajectory of statewide coal production. The baseline forecast assumes coal exports from the state will climb at a fairly steady pace between 2020 and 2036, surpassing 2015 levels by more than 10 percent at the end of the outlook period. Global coal demand is expected to grow as the Chinese and Indian economies expand and mature, and must import greater amounts coal, oil and other fuels to accomplish this. Moreover, most EU member nations plan to increase the share of electricity generated by renewable sources, but coal will remain a key part of the continent's baseload generation portfolio, particularly for countries like the Netherlands, Germany and Turkey. While these factors support a greatly expanded need for coal exports from the state, much of the appetite for Asian coal demand over the long term will be met by Australia, Indonesia and other major producers within or close to the Asia-Pacific region.

For the export scenario, we assume global demand for coal rises at roughly twice the rate compared to the baseline, causing US coal exports to surpass 2015 levels by the mid-2020s as the surge in demand raises world prices and producers in the Central Appalachian Basin to re-start idled capacity and re-open some closed mines. Coal export growth will taper off by the late 2020s, but coal export tonnage would be one-third larger than the baseline forecast by the end of the outlook period in 2036.

Although most of the jump in coal export shipments would likely be filled by Southern West Virginia and Eastern Kentucky mines, operations in other basins such as Northern Appalachia and the Eastern Interior would be assumed to expand production for the export trade since stronger-than-expected growth in the Asia-Pacific region would bolster demand for thermal coal and offset its smaller projected footprint in domestic electricity generation. Furthermore, the scenario assumes the transportation bottlenecks that currently strand much of the coal produced in the Powder River Basin will persist as legal challenges by environmental advocacy groups and other groups continue to block the installation of export terminals at West Coast ports and no additional capacity is added to Gulf Coast terminals.

Based upon these assumptions, statewide coal production would bounce back at a much stronger pace through the first half of the outlook period, reaching 85 million tons by the mid-2020s. Much of this increased production activity would at first come from Southern West Virginia, but the state's northern mines should also be expected to bolster production under this scenario as high export prices for thermal coal would incentivize producers to expand output and re-direct it to overseas consumers. By the late 2020s, Southern West Virginia coal output is expected to decline at an appreciable pace as production costs would rise as reserves become too depleted or fragmented to recover. Northern West Virginia will end up accounting for a growing share of the state's overall coal export base, but the region's limited reserves of metallurgical coal and overall capacity will not be enough to offset the fall in output from the state's southern coalfields. As a result, production is expected to fall to just below 76 million tons by 2036, which would still represent a 15 percent improvement over the baseline forecast.

Figure 14: Coal Production Forecast – Baseline vs Strong Export Demand Scenario



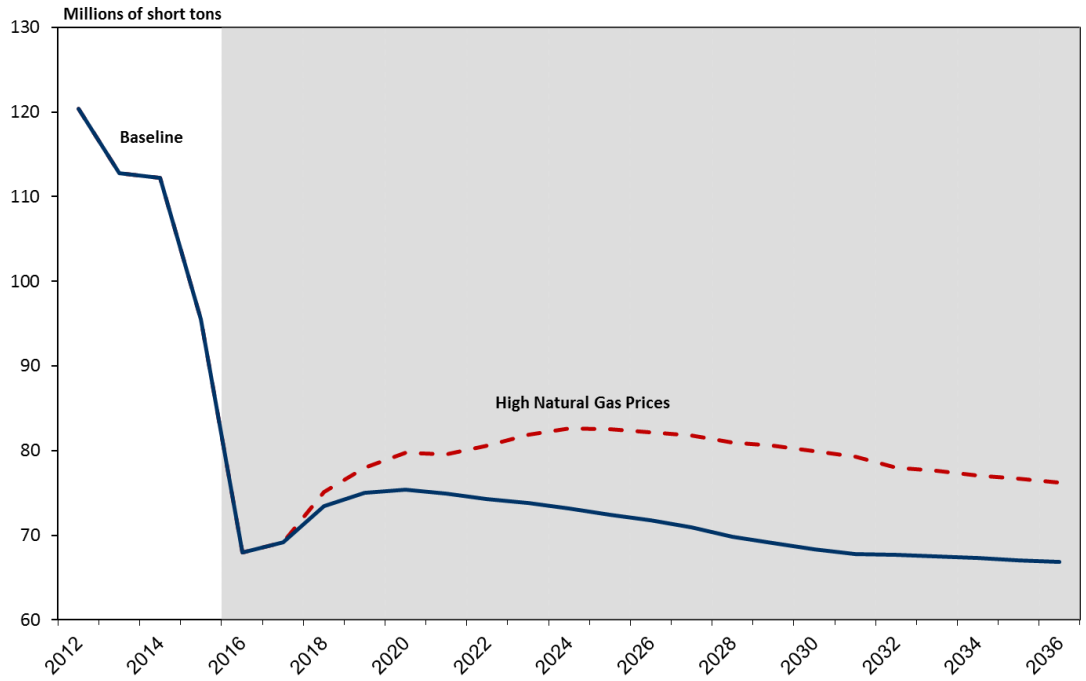
Sources: Energy Information Administration, WVU BBER Coal Production Forecast
Note: Forecast period designated by shaded area.

7.4 Sensitivity Analysis: Fluctuations in Natural Gas Prices

The final scenario under consideration in this report examines the effects of stronger-than-expected growth in prices paid by utilities for natural gas. The baseline forecast assumes that as natural gas edge higher in the next few years, drilling activity within the Marcellus and Utica Shale plays will pick back up and meet the fuel's expanded use in electricity generation. In addition, development of downstream facilities in the Mid-Atlantic as well as the addition of export terminals at Cove Point, Maryland, and other locations along the Eastern Seaboard and Gulf Coast should enhance the industry's supply response. Ultimately, inflation-adjusted prices paid by utilities for natural gas (2009 dollars) are only expected to reach just below $4 per Btu in the mid-2020s and slowly rise to over $4 per Btu at the end of the outlook period.

Under the alternative scenario, however, natural gas prices are expected to rise more aggressively, surpassing $4 per Btu in 2009 dollars before 2020 and exceed the assumed baseline forecast price levels by 25 percent for the balance of the outlook period. Absent the addition of stricter carbon dioxide emissions as outlined in the CPP, or perhaps even the introduction of explicit tax on carbon, higher prices for natural gas would likely enable coal to account for a larger share of baseload generation compared to the baseline. Southern West Virginia coal production would increase, but the pre-existing cost disadvantage the region's coal faces compared to other basins will limit upside potential (as measured by this scenario) to 4 million short tons over projected baseline levels. Growth will largely come from smaller generators in the Mid- and South-Atlantic states that increase purchases of the region's thermal coal as their capacity factors rise as natural gas gets dispatched for back-up generation. Northern West Virginia mine output is expected to climb by 5 million short tons relative to the baseline, and while falling short of the 2014 and 2015 levels, this will represent nearly a 10 percent projected improvement over what is expected in 2016.

Figure 15: Coal Production Forecast – Baseline vs High Natural Gas Prices Scenario



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

Several mechanisms could cause natural gas prices to come in higher than what is expected in the baseline forecast. The low price environment that has persisted for nearly the past two years has idled rigs and prompted companies to dramatically lower exploration and development spending. Since supply growth has slowed significantly while demand has soared amid increased use in electricity generation and growing export activity, prices could spike for an extended period due to a supply disruption or a prolonged heat wave/cold snap in areas such as New England, where pipeline infrastructure is already insufficient. Although these threats are ephemeral in nature, they could lead to natural gas prices carrying a premium to reflect their risks.

However, legal and regulatory concerns pose a larger risk for natural gas over the longer term. For example, the EPA recently announced new rules intended to curb methane emissions from new and modified oil and natural gas wells, compressors, pumps and pipelines. The agency also submitted an information collection request (ICR) for public comment that, if finalized, would seek to require companies to provide information on existing potential sources of methane so as to regulate emissions from existing oil and gas wells. Although the magnitude of their impacts is unclear at this time, the net effect of these rules would be measurably higher costs in extracting natural gas, particularly for wells that have been in operation for prolonged periods of time and are producing lower daily volumes of gas.

Another potential legal/regulatory risk stems from opposition to fossil fuel production in general, and hydraulic fracturing of oil and gas wells in particular. New York has already implemented a statewide ban on fracking and several other states have attempted to pass bans of their own in recent years, while some groups have sought to pass “local control” ordinances that would impose restrictions on or effectively seek to ban fracking activity outright in certain areas. Since “fracking” of shale and tight gas formations has accounted for the wide majority of oil and natural gas supply growth over the past several

years, widespread success of these bans and ordinances in areas containing sizable reserves of oil and gas deposits would certainly dampen production going forward and push prices higher.

Appendix: Model Description and General Forecast Assumptions

Publication: West Virginia University BBER Coal Production Forecast 2016

Date: July 2016

Forecast Horizon: 2016-2036

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 2015. 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 Economics May 2016 forecast and the 2016 Annual Energy Outlook preliminary report from the Energy Information Administration. Region-specific explanatory variables, such as exports, were projected by the BBER based upon historical relationships with their corresponding national data series. Key assumptions for the model include:

Macroeconomic Growth: Real Gross Domestic Product is expected to increase at an average annual rate of 2.3 percent per year through 2036.

Coal Prices: Inflation-adjusted coal prices are expected to increase in both regions, reaching $64 per short ton (in 2009 dollars) in Northern West Virginia and $62 per short ton in Southern West Virginia—averaged for metallurgical and thermal coal. The U.S. average price is expected to rise to $38 by 2036.

Natural Gas Prices: Real natural gas prices (2009 dollars) paid by utilities are expected to increase at an average annual rate of 2.3 percent per year between 2016 and 2036, reaching an inflation-adjusted amount of just over $4 by 2036.

Electricity: Total U.S. electricity generation is expected to increase 0.7 percent per year between 2016 and 2036. Coal and natural gas are expected to account for nearly identical shares (~30 percent) of overall electricity generation. No new coal-fired power plants are expected to be constructed during the outlook period.

Industrial/commercial use: Total commercial/industrial demand for West Virginia coal is expected to decline 1 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 gains and natural gas conversion.

Export Demand: The baseline forecast assumes 2012 was an 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 42 percent cumulatively between 2016 and 2036. Southern West Virginia will continue to account for the majority of state coal exports.

Environmental: The baseline forecast assumes only laws that are in place and not currently subject to legal challenges. Retirements of coal-fired generation not compliant with the MATS rule will continue through 2017. The Clean Power Plan and New Source Performance Standards rules are not considered in the baseline, but given their relevance to future West Virginia coal production, they are addressed in an alternative scenario.

About the Bureau of Business and Economic Research

Since the 1940s, the BBER's mission has been to serve the people of West Virginia by providing the state's business and policymaking communities with reliable data and rigorous applied economic research and analysis that enables the state's leaders to design better business practices and public policies. BBER research is disseminated through policy reports and briefs, through large public forums, and through traditional academic outlets. BBER researchers are widely quoted for their insightful research in state and regional news media. The BBER's research and education/outreach efforts to public- and private-sector leaders are typically sponsored by various government and private-sector organizations.

The BBER has research expertise in the areas of public policy, health economics, energy economics, economic development, economic impact analysis, economic forecasting, tourism and leisure economics, and education policy, among others. The BBER has a full-time staff of four PhD economists and one master's-level economist. This staff is augmented by Ph.D. student research assistants. The BBER also collaborates with affiliated faculty from within the College of Business and Economics as well as from other parts of WVU.

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