Consensus Coal Production Forecast for West Virginia: 2017

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Introduction

The West Virginia Consensus Coal Production Forecast is a combined production forecast comprised of four component forecasts. A consensus approach to forecasting seeks the wisdom of the crowd in producing an expectation for output from the coal industry. The Consensus Forecast is used to provide the best expectation of tax revenues to be collected for mandatory reclamation activities conducted through the Special Reclamation Fund and the Special Reclamation Water Trust Fund.

This report describes recent historical coal production trends for the State of West Virginia including the individual industries that comprise the major segments of demand for coal produced in West Virginia. Each of the component forecasts used to form the Consensus Forecast is described, with information about assumptions and resulting projected levels of production for West Virginia. The process used to produce the Consensus is also described, including the weightings applied to each of the component forecasts. The West Virginia Consensus Coal Production Forecast is calculated for the years 2017 through 2040.

Overview

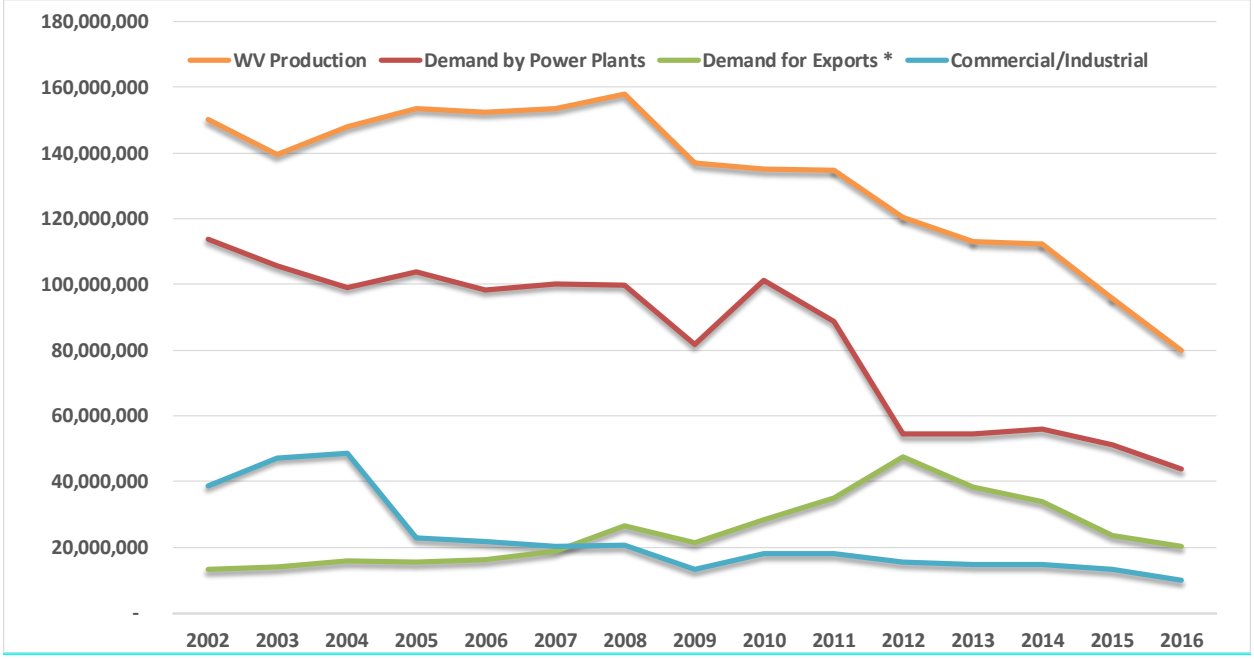
West Virginia coal production for 2016 was 80.1 million tons (EIA 2017),[1] a decline of about 16 percent from the 95.5 million tons produced in 2015. This decline reflects various trends and events within the coal industry's primary markets: power generation, exports and industrial demand as well as expectations regarding environmental policy. Demand for West Virginia coal fell by about 16 percent from 2015 levels, led by a decline in demand from coal-fired power plants.

Future demand for West Virginia coal depends on several variables. These include the capacity of gas-fired electrical generators in the region and the price paid for gas by those generators, the lifespan and generation levels of the coal-fired power plants that will continue to burn coal from the State, exchange rates and the rate of economic growth of countries that import West Virginia coal, and the nature of compliance with environmental regulations.

Recent demand trends with preliminary and estimated sector-level data for 2016 are shown in Figure 1.

[1] 80.1 million tons is the Energy Information Administration's revised 2016 production value based on the final 2016 value published by MSHA (clean coal production reported on MSHA Form 7000-2). The West Virginia Office of Miner's Health, Safety and Training reports 2016 production of 88,424,255 tons, but this is not exclusively clean coal which is the final production volume.

Figure 1: Historical West Virginia Coal Production and Components of Demand



Source: EIA, 2017. Asterisked (*) 2016 volumes estimated by MU CBER. Other 2016 figures are preliminary by EIA.

The Electricity Sector

Preliminary coal distribution data for 2016 published by the U.S. Energy Information Administration (EIA) indicate that demand for West Virginia-produced coal by the electricity sector fell in 2016, to about 43.8 million tons, compared to about 51.1 million tons in 2015 (EIA 2017). This was a decline of 14 percent, between 2015 and 2016, while total electric power industry coal demand fell by about 11 percent during the same time (EIA 2017).

Natural Gas Prices

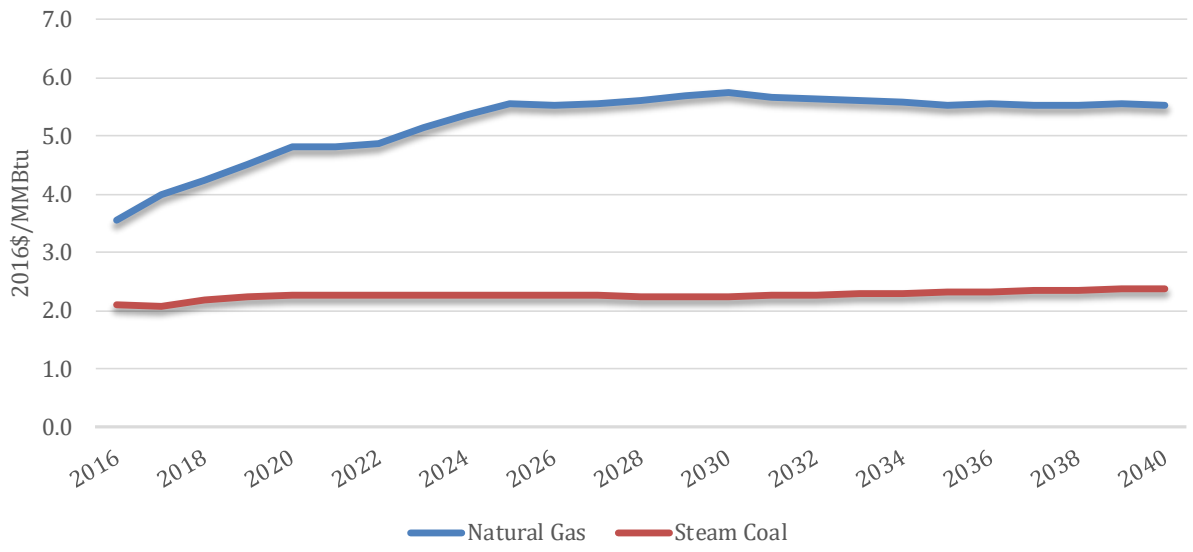
A large contributor to reduced coal demand is the price of natural gas, which fell again in 2016, with the average U.S. price for the electric power sector declining to $2.99/mcf (2016 dollars) from $3.37/mcf in 2015 (EIA 2017). Coal was even more competitive in 2014, when delivered gas prices averaged $5.19/mcf.

Abundant gas production from the Marcellus play continues to result in particularly low gas prices in a primary region in which West Virginia coal competes. In 2016, Marcellus-area prices continued to trade at a discount to the Henry Hub price, the national benchmark for natural gas. To date in 2017, prices at the Zone 4 Marcellus and Dominion South hubs have been in the range of 80% to 90% of the Henry Hub price. This is a

reduction from the 2016 differentials, which were often in the range of 50 to 75% of the Henry Hub price.

In its AEO 2017 Reference Case analysis the EIA continues to project gas prices delivered to the power generation sector to increase at a faster rate than coal prices, which will moderate declining coal demand (EIA 2017). These prices are shown below.

Figure 2: Forecasted Natural Gas & Coal Prices to Electricity Sector



Coal-Fired Power Plant Retirements

Since 2015 no additional units at coal-fired power plants in West Virginia have closed. However, several other plants that have utilized West Virginia coal retired in 2016. These include the Colbert plant in Alabama and the Cedar Bay and Lansing Smith plants in Florida (EIA 2017).

Environmental Regulation

Several changes to regulations that would have impacted the cost of mining coal or generating electricity fueled by coal have occurred in the past few months. These changes will most likely increase the amount of coal produced in West Virginia and the nation.

The Stream Protection Rule, issued by the U.S. Interior Department in 2016, was nullified in February 2017 (Office of Surface Mining Reclamation and Enforcement 2017). This rule would have increased the cost of mining coal by limiting the distance from a stream that coal mining can occur. The U.S. Environmental Protection Agency (EPA) and the Department of the Army also announced an intention to review and rescind or revise the Waters of the United States (WOTUS) rule (Federal Register 2017). The review may seek to change the definition of ‘‘navigable waters’’ as defined in the Clean Water Act in a manner that may loosen restrictions on mining operations by excluding "occasional,"

"intermittent," or "ephemeral" flows from the definition of WOTUS (Chicago-Kent College of Law at Illinois Tech n.d.).

The stay of the Clean Power Plan (CPP) in 2016 is still in effect. EPA Administrator Pruitt sent a letter to governors informing them "that EPA does not expect the states to dedicate resources to complying with a rule that has been stayed by the Supreme Court of the United States (U.S. Environmental Protection Agency 2017)." Despite the stay, the potential impact of the EPA's Clean Power Plan (CPP) rule is still included in the EIA's Reference Case forecast. None of the other three of the four forecasts simulate the impact of the rule.

The Industrial Sector

As shown previously in Figure 1 demand for West Virginia coal by the industrial sector (coke plants and self-generating manufacturers, including coal-fired combined heat and power plants) continues a slow and steady decline driven by a decline in demand for metallurgical coal. EIA's national-level projections forecast a decline in demand for coking coal at an annualized rate of 2.8 percent through 2050, as well as a decline in other industrial demand at a rate of 0.3 percent per year.

U.S. imports of steel products have increased in recent months in 2017 after declining in the second half of 2016. In May 2017, the steel trade deficit narrowed to -2.2 million metric tons from -2.3 million metric tons in April 2017, a 1.3% decrease while imports increased 3.5% by volume to 3.1 million metric tons. May 2017 imports were up 20.5% from one year ago, and down 14% from three years ago (International Trade Administration 2017). This trend may correlate with reduced domestic demand for coking coal from West Virginia but the net effect is uncertain due to recent upticks in exports of coking coal.

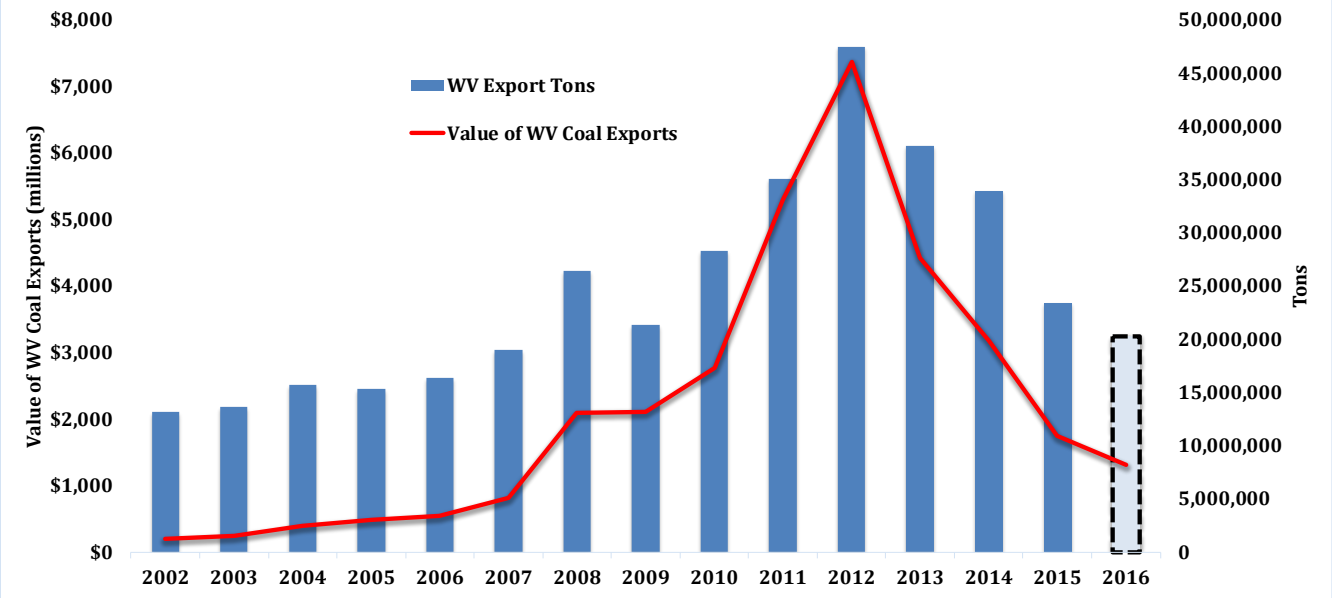
Exports

The nation's coal exports fell again in 2016, to 60 million short tons, down from about 74 million short tons in 2015.[2] The EIA AEO 2017 Reference Case projects total U.S. coal exports to rise after 2017.

The value of coal exports from West Virginia fell to $1.3 billion in 2016, from $1.7 billion in 2015. Despite another year of declining coal exports, both in value and tonnage, the state maintained exports to many countries in North America, Europe, South America, Africa and Asia. The top five importing countries by value were India, Canada, Brazil, the Netherlands and Ukraine (ITA 2017). The following figure shows the value of West Virginia-based coal exports and associated tonnage from 2002 to 2016.

[2] 2016 data for coal export tonnage by U.S. state of origin has not yet been released. CBER estimates West Virginia's exports based on historical shares of total exports and the value of coal exports from the state.

Figure 3: Value and Tonnage of West Virginia Coal Exports, 2002 to 2016



Source: (EIA 2017) (ITA 2017); 2016 Export tonnage estimated by CBER.

Component Forecasts

Energy Information Administration (EIA)

Publication: Annual Energy Outlook 2017

Date: January 2017

Forecast Horizon: 2017-2050

Region(s): Northern Appalachia, Central Appalachia

The EIA provides a forecast of coal production by region in its 2017 Annual Energy Outlook, projecting through 2050 (EIA 2017). This projection is generated using the National Energy Modeling System (NEMS). NEMS uses a market-based approach that balances energy supply and demand while considering regulations and industry standards.

The EIA's forecasts for Northern and Central Appalachia are used to forecast West Virginia coal production. The Northern Appalachia region includes Pennsylvania, Maryland, Ohio, and Northern West Virginia while Central Appalachia includes Virginia, Eastern Kentucky, Northern Tennessee, and Southern West Virginia. To forecast West Virginia coal production through 2040, the annual growth rate for Northern Appalachia is applied to historical production figures for Northern West Virginia and the annual growth rate for Central Appalachia is applied to Southern West Virginia figures.[3] Only the EIA Reference Case figures are used, which assumes a continuation of current technological and demographic trends.[4]

Key Assumptions:

Macroeconomic Issues: Real GDP growth averages 2.2% per year from 2016 to 2040.

Coal Prices: EIA expects Northern Appalachian coal prices to be relatively flat through 2025 and to increase thereafter, from $56.91 in 2016 to $65.76 by 2040. Central Appalachian prices are projected to decline and return to current levels by 2026 and then to both increase and decrease slightly through 2040, from $66.48 in 2016 to $67.46 in 2040.

[3] For more information on the adaptation of the EIA's forecasts, see Appendix A.

[4] The EIA's 2017 Annual Energy Outlook includes several cases: Reference Case, No Clean Power Plan Case, High and Low Economic Growth Cases, High and Low World Oil Price Cases, and High and Low Oil and Gas Resource and Technology Cases.

Natural Gas Prices: Henry Hub[5] spot prices for natural gas averaged $2.63 per million Btu in 2015 and $2.52 per million Btu in 2016 in real $2016.[6] Prices are expected to be about $3.00 in 2016 and rise thereafter at an annual rate of 2.5 percent, resulting in an average expected price of $5.83 per million Btu in 2040.

Electricity: U.S. use of coal for production of electricity is expected to decline by 1.1% annually from 2016 to 2050. Coal-fired generating capacity is expected to decrease at a rate of 1.5 percent per year through 2050. By comparison, combined-cycle (natural gas) capacity is projected to increase by 1.5 percent per year and renewable capacity by 2.4 percent per year.

Industrial/Commercial: The industrial sector is expected to see gradual declines in coal consumption of 1.1 percent per year through 2050. Metallurgical coal use is projected to decrease faster than other industrial use. The commercial sector is expected to maintain flat coal consumption throughout the forecast period.

Exports: U.S. coal exports are projected to reach a low of 52 million tons in 2017 and then rise throughout the forecast period to 85 million tons in 2050.

Environmental: The AEO2017 Reference case includes the Clean Power Plan (CPP) and assumes that states select the mass-based limits on CO2 emissions. The CPP, which is currently stayed pending judicial review, requires states to develop plans to reduce CO2 emissions from existing generating units that use fossil fuels.

[5] The Henry Hub in Louisiana is the delivery point for the natural gas futures contract on the New York Mercantile Exchange.

[6] Henry Hub spot prices are listed in real dollars in 2016. Nominal prices from previous years are inflation-adjusted to the equivalent dollar value in the year 2016.

Energy Ventures Analysis (EVA)

Publication: EVA Long-Term Forecast

Date: July 2017

Forecast Horizon: 2017-2040

Region(s): West Virginia

EVA utilizes the AURORAxmp 24/7 dispatch model (which EVA licenses) to calculate electricity generation by fuel type. The forecast reflects the least cost dispatch solution consistent with the operating parameters of individual units. Existing generation, planned generation which is deemed to be likely to be constructed, and announced retirements are reflected. In addition, the model adds and retires capacity in an economic manner and as required by law.

Key Assumptions:

Macroeconomic Issues: GDP growth is expected to average 2.1 % per year through 2040.

Coal Prices: Coal prices for both Northern and Central Appalachia are expected to recover from the very low prices in 2015/2016 although the recovery will take some time. By 2040, prices from both regions are expected to be in the $50-57 per ton range in real 2017 dollars and $79-90 per ton range in nominal dollars.

Natural Gas Prices: Gas prices are expected to increase through 2040 resulting in a price of $4.65 per MMBtu (2017$) in 2040.

Electricity: Growth in electricity demand is expected to average 0.5% per year through 2040. Demand for Appalachian coal by the electricity sector is projected to fall 11% between 2016 and 2040. With the retrofit of technologies, coal supply has become fungible meaning demand can switch between coal supply regions (e.g., Northern Appalachia and Illinois Basin) based upon the relative competitiveness of each. Future demand which is based upon an equilibrium analysis may shift between supply regions.

Industrial/Commercial: Non-coke industrial demand for Appalachian coal is projected to fall by about 44% between 2016 and 2040. Demand for metallurgical coal from Northern and Central (primarily) Appalachia during this same period is projected to fall by about 3%.

Exports: The level of exports is affected by the relative strength of the U.S. dollar particularly with respect to the Australian dollar as global coal trade is U.S. dollar denominated and Australia is the largest exporter of bituminous coals. Steam coal exports

from Northern and Central Appalachia which had a recent peak in 2012 (when the U.S. dollar was relatively weak) are projected to decline by about 36% between 2016 and 2040. The decline reflects the relative lack of competitiveness of Central Appalachia steam coals in the global market. Steam coal exports overall could increase if one or more announced export terminals are built in the Pacific Northwest allowing competitive delivery of Powder River Basin coals into the Pacific market. Met coal exports from Northern Appalachia and Central and Southern Appalachia peaked in 2011 and are projected to decline by about 20% between 2016 and 2040. Two market events in the last 12 months caused global prices to increase and spurred significant metallurgical coal mine investment in West Virginia.

Environmental: Phase I of the Cross-State Air Pollution Rule (CSAPR) went into effect January 1, 2015; Phase II went into effect January 1, 2017. The Mercury and Air Toxics Standards (MATS) went into effect April 2015 with a liberal one year extension. Section 316(b) of the Clean Water Act goes into effect with 2019 compliance for minor intake modifications and 2022 compliance for these requiring cooling towers. Coal Combustion Residuals (CCR) goes into effect by 2020. Conversion to dry ash handling is assumed by 2022 and use of lined landfills is assumed for subsequent ash disposal. National Ambient Air Quality Standards (NAAQS) revisions will include fine particulate and ozone standards. SCR's will be required on all units for NOx. Regional haze compliance using Best Available Retrofit Technology will go into effect in 2020 excepting any announced settlements. Greenhouse Gas New Source Performance Standard is assumed to limit ability to add new coal-fired generation absent partial carbon capture and sequestration or co-firing with gas. The modeling does not assume either the Clean Power Plan (CPP) or Effluent Limitation Guidelines (ELGs) going into effect due to actions the new administration in Washington have taken to eliminate/revise these rules. Regional CO2 programs (i.e., RGGI and AB32) are assumed to continue.

Marshall University Center for Business and Economic Research (CBER)

Publication: CBER West Virginia Coal Production Forecast 2017

Date: July 2017

Forecast Horizon: 2016-2040

Region(s): West Virginia

The CBER forecast of West Virginia total coal production is an econometric model based on quarterly coal production from 1984 through 2016. The CBER forecast uses an averaging approach based on two separate long-term forecasts (through 2040). Both models incorporate a mid/short-term forecast (through 2027) based largely on the market for thermal coal produced in the State. One short-term model treats 2009 as a structural break in the market[7] while the other uses the differential between natural gas and coal prices delivered to the power generation sector to explain changes in production[8]. To create the initial short-term forecasts, quarterly changes in total coal production were modeled with a vector autoregression (VAR) approach based on historical demand for West Virginia-sourced coal in regional power generation. For years beyond 2027, the forecast utilizes an autoregressive approach, which estimates future changes in total coal production based on historical patterns.

Key Assumptions:

Macroeconomic Issues: Although not explicitly modeled, moderate average annual GDP growth rates of about 2 to 2.5% per year are expected, consistent with other macroeconomic forecasts.

Natural Gas Prices: CBER uses the EIA's price forecasts to represent future expectations of the coal-gas price differential for this model. This differential has been very small, or even negative, in recent years but is expected to widen through 2040.

Electricity: Demand for West Virginia coal by the electricity sector is not forecasted explicitly in this model, although demand is expected to be steady for the next few years.

Exports: Exports are also not explicitly modeled in either forecast. However, in the mid to long-term moderate recovery in export markets for West Virginia coal is expected to mitigate some of the decline in demand from the regional power generation sector.

[7] Dummy variables were included in the model to identify 2009 and later years as being fundamentally different than prior years in terms of underlying factors affecting coal production in West Virginia.
[8] Dummy variables were assigned to quarters where natural gas prices were relatively low compared to coal prices.

Environmental: Expectations regarding the Clean Power Plan and other environmental legislation affect the demand for West Virginia coal. While environmental policy is not an explicit factor in the CBER forecast, changes in behavior due to the actual and expected impacts of legislation are present in the historical production data utilized in the model.

West Virginia University Bureau for Business and Economic Research (BBER)

Publication: WVU BBER Coal Production Forecast 2017

Date: June 2017

Forecast Horizon: 2017-2040

Region: Northern West Virginia 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. (West Virginia University 2017)

Key Assumptions:

Macroeconomic Issues: Expected annual real GDP growth is 2.0% 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: National real natural gas prices (2016 dollars) paid by utilities are expected to increase at an average annual rate of 1.2% 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: 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.

Exports: 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 most the State's 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.

Consensus Forecast

The four long-term forecasts produced by EIA, EVA, CBER, and WVU are combined to create the Consensus Forecast for West Virginia Coal Production. A weighted average is used to combine the four projections as follows:

$$WV\ Coal\ Production_t = w_{EIA} * EIA\ Production_t + w_{EVA} * EVA\ Production_t + w_{CBER} * CBER\ Production_t + w_{WVU} * WVU\ Production_t$$

For the 2017 forecast, equal weights (w_i) of .25 are assigned to each forecast. This weight was selected due to variation in the timing of forecasts produced by each of the forecasting groups. Some forecasts are produced in the beginning of the year while others are produced mid-year, which can affect the accuracy of a forecast.

The Consensus Forecast for West Virginia Coal Production shows production levels increasing in 2017, followed by several years of moderate rises and falls in production. Production is expected to return to 2016 levels around 2026 and then decline slowly thereafter. Between 2030 and 2040, production is expected to be stable, at around 76 million tons. The results are shown below in table and figure format.

Figure 4: Consensus and Component Forecasts 2017 (million tons)

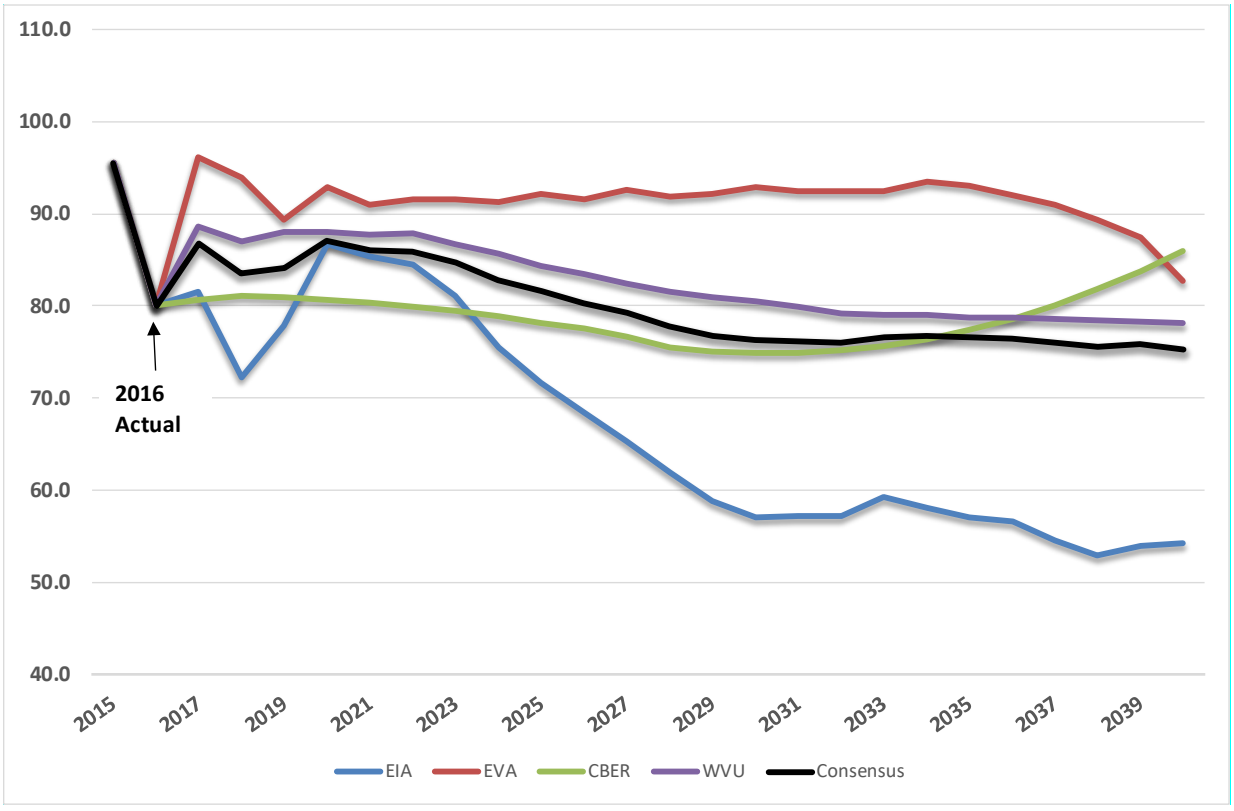


Table 1: Consensus Forecast for West Virginia Coal Production 2017

Year	Historical	2017 Forecasting Group				2017 Consensus	2016 Consensus	2015 Consensus	2014 Consensus	2013 Consensus	2012 Consensus
		EIA	EVA	CBER	WVU						
2011	134.7										
2012	120.1										130.5
2013	112.8									117.4	123.1
2014	111.9								112.4	117.8	118.1
2015	95.5							107.2	106.9	113.9	113.1
2016	80.1						79.5	103.4	101.4	112.2	110.1
2017		81.6	96.1	80.7	88.6	86.8	76.9	101.7	103.0	113.5	105.8
2018		72.3	93.9	81.1	87.0	83.6	74.7	102.7	103.3	108.7	102.6
2019		77.9	89.4	81.0	88.0	84.1	76.7	104.8	102.4	105.6	100.4
2020		86.7	92.9	80.7	88.0	87.1	80.1	104.9	101.5	105.4	96
2021		85.3	91.0	80.3	87.7	86.1	78.6	104.4	100.9	104.8	96.73
2022		84.5	91.6	79.9	87.8	85.9	75.7	103.4	100.7	106.6	96.9
2023		81.0	91.5	79.4	86.7	84.7	73.1	102.8	100.0	107.6	95.1
2024		75.4	91.2	78.8	85.7	82.8	70.3	102.8	99.9	107.2	95
2025		71.6	92.1	78.2	84.3	81.5	69.1	102.4	99.2	106.3	94.9
2026		68.5	91.6	77.5	83.4	80.2	67.9	102.2	98.2	106.3	95.6
2027		65.3	92.7	76.7	82.5	79.3	66.2	101.7	98.1	106.1	98.1
2028		61.9	91.9	75.5	81.6	77.7	64.5	101.2	97.1	105.4	97
2029		58.8	92.2	75.1	81.0	76.8	63.0	100.9	97.1	105.0	97.3
2030		57.0	92.9	74.8	80.5	76.3	61.7	100.9	96.5	104.4	99.2
2031		57.3	92.5	74.9	79.9	76.1	62.1	100.5	96.3	103.5	
2032		57.2	92.4	75.2	79.2	76.0	62.9	100.9	95.1	101.9	
2033		59.3	92.5	75.7	79.1	76.6	63.3	99.8	94.2	99.6	
2034		58.1	93.5	76.4	79.0	76.7	63.1	98.3	93.7	99.0	
2035		57.1	93.0	77.4	78.7	76.6	62.5	97.3	91.6	97.3	
2036		56.6	92.0	78.7	78.8	76.5	62.3				
2037		54.6	91.0	80.1	78.6	76.1	60.4				
2038		52.9	89.3	81.8	78.4	75.6	59.7				
2039		53.9	87.4	83.8	78.3	75.8	58.6				
2040		54.2	82.8	86.0	78.1	75.3	57.1				

Summary

The 2017 West Virginia Consensus Coal Forecast figures are higher than the 2016 Consensus. The four component models incorporate a range of possible levels of West Virginia coal production over the next 24 years, with varying forecasts that illustrate the impact of various supply and demand variables and uncertainty over the continuation of recent trends. The consensus reduces uncertainty by combining the forecasts into one aggregate projection where West Virginia coal production increases to 87 million tons in 2017, remains above 2016 levels through 2025, and then declines slowly through 2040.

Of the four projections, the EIA's is the only one that is lower than the 2016 forecast. The other three models project higher production of West Virginia coal compared to the 2016 forecasts. The primary reason for the higher projections is likely the assumed suspension of implementation of the Clean Power Plan (except by EIA) rule for regulating carbon dioxide emissions from power plants and recent upticks in output.

The EIA projects total coal consumption in the U.S. electric power sector to be lower than in its AEO2016 analysis due to the impact of the Clean Power Plan and to projected natural gas prices that are slightly lower than its AEO 2016 assumptions, particularly during the 2020s. EIA projects a decline in consumption of coal for power generation at a rate of 1.0 percent per year through 2050. Coal production is projected to decline faster in Central Appalachia than in Northern and Southern Appalachia, at a rate of 1.8 percent per year through 2040. Northern production is projected to decline by 1.5 percent per year.

The EVA model projects a return to 2015 production levels in 2017 due to short-term variables that are favorable to West Virginia production. These include higher demand and higher prices for met coal in the global market and rising domestic natural gas prices. Production is projected to fall after 2017 but to remain about 2016 levels through 2040.

WVU's short-term forecast projects improved global conditions for metallurgical coal will boost Southern West Virginia production while demand for thermal coal from Northern West Virginia will be stable. Domestic industrial use of coal is expected to increase through 2018, due in large part to an uptick in steel production. WVU's long-term forecast projects total coal production to be stable through the early 2020s and then fall through 2040.

The CBER model is influenced by inclusion of 2016 coal production and demand data which added another year of decline to already declining historical trends. However, the trend is tempered by refinement of model specification that accounts for quarterly coal and gas price differentials since 2002 and an expectation of larger differentials throughout the forecast.

Works Cited

Chicago-Kent College of Law at Illinois Tech. n.d. *Rapanos v. United States.* https://www.oyez.org/cases/2005/04-1034 .

EIA. 2017. *Annual Coal Distribution Report.* https://www.eia.gov/coal/distribution/annual/.

—. 2017. "Annual Energy Outlook 2017." January. http://www.eia.gov/forecasts/aeo/.

EIA. 2017. *Archive weekly and monthly coal production.* U.S. Department of Energy. http://www.eia.gov/coal/production/weekly/archive/.

EIA. 2017. *Form 860.* U.S. Department of Energy. http://www.eia.gov/naturalgas/weekly/.

Energy Ventures Analysis. 2017. *West Virginia Coal Production Forecast.*

Federal Register. 2017. "Vol. 82, No. 42." *Proposed Rules* . March 6.

International Trade Administration. 2017. "Steel Industry Executive Summary: July 2017."

ITA. 2017. "State Export Data, Global Patterns of a State's Exports."

Office of Surface Mining Reclamation and Enforcement. 2017. "Stream Protection Rule." https://www.osmre.gov/programs/rcm/streamprotectionrule.shtm.

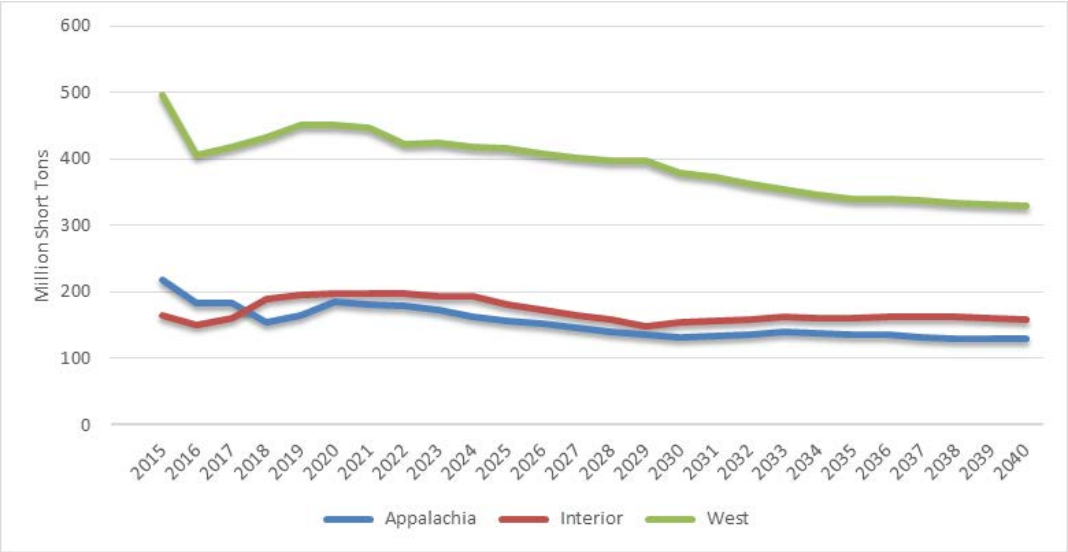
U.S. Environmental Protection Agency. 2017. "Guidance Letter re: Clean Power Plan from EPA Administrator to Governors (March 30, 2017)." https://www.epa.gov/newsroom/guidance-letter-re-clean-power-plan-epa-administrator-governors-march-30-2017.

West Virginia University. 2017. *Coal Production in West Virginia: 2017-2040.* WVU College of Business & Economics. https://www.documentcloud.org/documents/2089129-wvu-bber-coal-forecast-2015.html.

Appendix A: Forecasts for Northern and Southern West Virginia

The EIA's 2017 AEO forecasts Appalachian coal production to decline steadily through 2040, with some stability in the 2017 to 2021 and 2028 to 2032 time periods. As shown below, Interior[9] production is projected to surpass Appalachian production in 2017.

Figure 5: EIA Forecasted Coal Production, by Region



Appalachia is split into Northern, Central, and Southern regions. Northern Appalachia includes Pennsylvania, Maryland, Ohio, and Northern West Virginia. Central Appalachia includes Virginia, Eastern Kentucky, Northern Tennessee, and Southern West Virginia.

Table 2: EIA Growth Rates for Coal Production in Northern and Central Appalachia

	2016	**2017**	**2018**	**2019**	**2020**
Northern Appalachia	0.6%	5.0%	-29.8%	6.1%	16.3%
Central Appalachia	-17.2%	-9.4%	12.1%	9.1%	7.5%
	2021	**2022**	**2023**	**2024**	**2025**
Northern Appalachia	-4.7%	-1.1%	-4.6%	-3.7%	-2.6%
Central Appalachia	1.0%	-0.9%	-3.6%	-9.5%	-7.1%
	2026	**2027**	**2028**	**2029**	**2030**
Northern Appalachia	-2.1%	-3.0%	-3.2%	-3.6%	-2.6%
Central Appalachia	-6.4%	-5.9%	-7.2%	-6.4%	-3.7%
	2031	**2032**	**2033**	**2034**	**2035**
Northern Appalachia	3.0%	2.2%	3.1%	-1.2%	-1.6%
Central Appalachia	-2.1%	-2.4%	4.3%	-3.3%	-1.9%
	2036	**2037**	**2038**	**2039**	**2040**
Northern Appalachia	-1.8%	-1.6%	-1.5%	4.1%	1.4%
Central Appalachia	0.5%	-5.9%	-4.9%	-0.9%	-0.7%

[9] Arkansas, Illinois, Indiana, Iowa, Kansas, W. Kentucky, Louisiana, Mississippi, Missouri, Oklahoma, and Texas.

EIA's forecasts for these regions are applied to Northern and Southern West Virginia production to obtain EIA's forecast for West Virginia. Growth rates for Northern Appalachia are used to project Northern West Virginia coal production, and rates for Central Appalachia are applied to Southern West Virginia. 2016 figures are actual production.

Table 3: EIA Forecast Applied to West Virginia Coal Production by Region (million short tons)

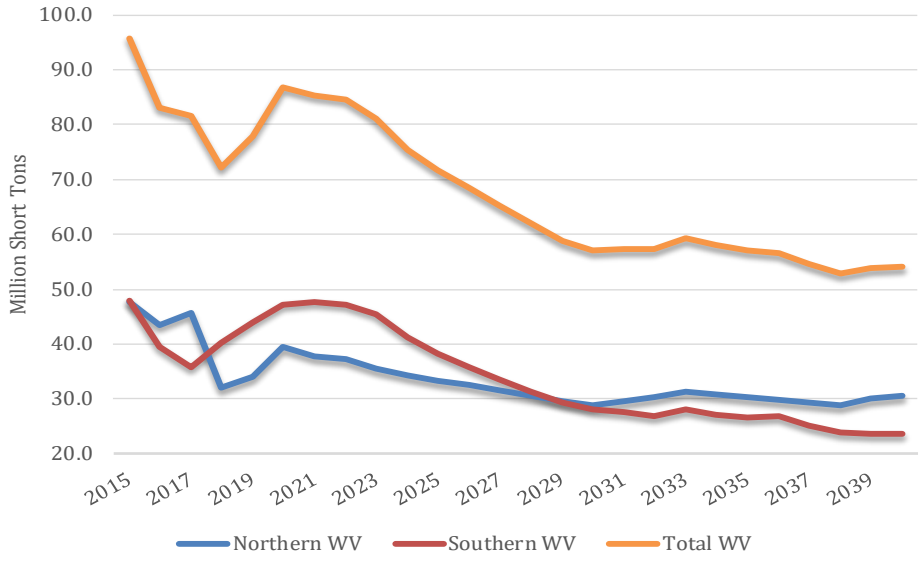
	2016	2017	2018	2019	2020
Northern WV	43.5	45.7	32.0	34.0	39.5
Southern WV	36.6	35.9	40.2	43.9	47.2
Total WV	**80.1**	**81.6**	**72.3**	**77.9**	**86.7**
	2021	**2022**	**2023**	**2024**	**2025**
Northern WV	37.7	37.3	35.6	34.3	33.4
Southern WV	47.6	47.2	45.5	41.2	38.2
Total WV	**85.3**	**84.5**	**81.0**	**75.4**	**71.6**
	2026	**2027**	**2028**	**2029**	**2030**
Northern WV	32.7	31.7	30.7	29.6	28.8
Southern WV	35.8	33.7	31.3	29.3	28.2
Total WV	**68.5**	**65.3**	**61.9**	**58.8**	**57.0**
	2031	**2032**	**2033**	**2034**	**2035**
Northern WV	29.7	30.3	31.2	30.9	30.4
Southern WV	27.6	26.9	28.1	27.2	26.7
Total WV	**57.3**	**57.2**	**59.3**	**58.1**	**57.1**
	2036	**2037**	**2038**	**2039**	**2040**
Northern WV	29.8	29.4	28.9	30.1	30.6
Southern WV	26.8	25.2	24.0	23.8	23.6
Total WV	**56.6**	**54.6**	**52.9**	**53.9**	**54.2**

EIA projects coal mining productivity (short tons per miner hour) to decline for both Northern and Central Appalachian supply through 2040. Central Appalachian productivity is projected to fall from 2.2 tons per miner hour in 2014 to around one ton per miner hour by 2040. Northern Appalachian productivity is projected to fall from around 3.4 tons to 2.6 tons per miner hour during the same period.

Correspondence with EIA indicates a likelihood that its forecast for Northern Appalachian production for the year 2018 will likely be higher in the AEO2018. In the AEO2017, a short-term benchmark window covers the years 2015, 2016, and 2017 but not 2018. In its next forecast, a more immediate recovery in production will be reflected in 2018, whereas the AEO2017 projects in a recovery in 2019-2020 based on an assumption for increases in gas prices in the 2019-2021 period. Inclusion of 2018 in the short-run forecast will cause higher projections that incorporate trends from 2017.[10]

[10] Personal correspondence with the EIA Office of Electricity, Coal, Nuclear, and Renewables Analysis on 8/29/17.

Figure 6: EIA's Appalachian Forecasts Applied to West Virginia Coal Production by Region



WVU's regional forecasts for Northern and Southern West Virginia Coal Production expect Northern output to be quite flat from 2017 through 2040 at around 46 million tons. Southern output is projected to be flat from 2017 through 2022, at around 40 million tons, and then fall to around 32 million tons by 2040 (West Virginia University 2017).

As noted by WVU, Southern West Virginia mines accounted for more than two-thirds of total state coal production in 2011, but that share fell to 46 percent in 2016. By contrast, 2016 output at Northern West Virginia remained 8 percent above 2008 levels even with a decline in production during 2016 (West Virginia University 2017).