Consensus Coal Production Forecast for West Virginia: 2014

FINAL REPORT

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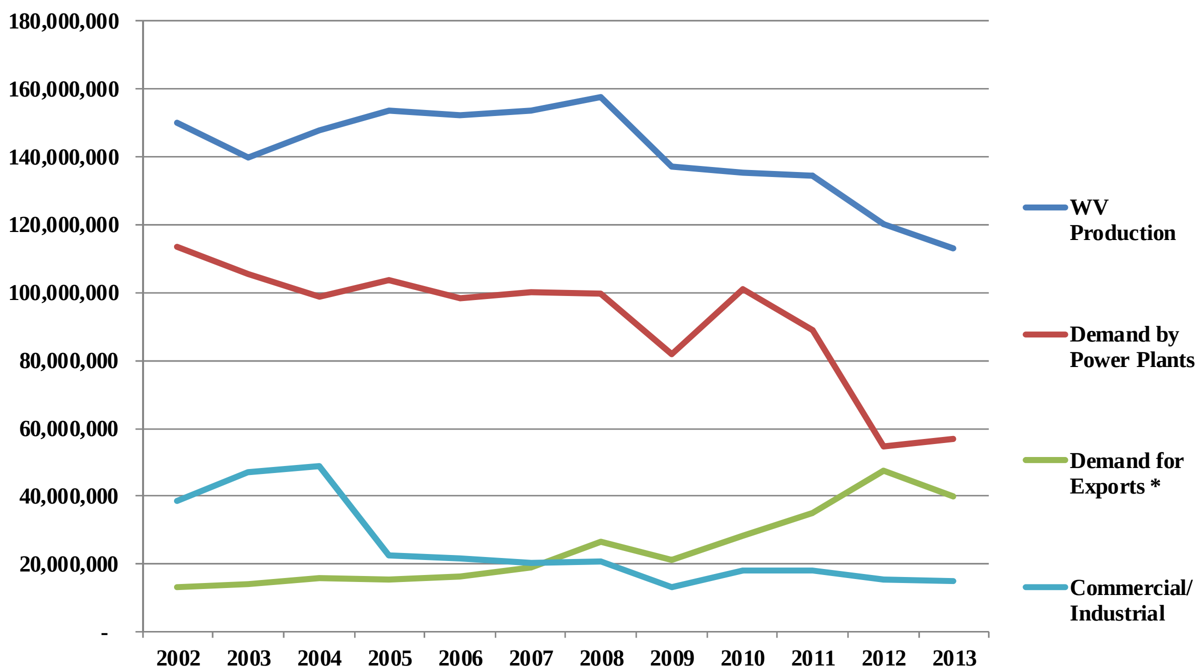
Consensus Coal Production Forecast for West Virginia: 2014

Overview

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 crowds" in producing an expectation for output from the coal industry. The Consensus Forecast is used in planning analysis to provide the best expectation of tax to be collected for mandatory reclamation activities conducted through the Special Reclamation Fund and the Special Reclamation Water Trust Fund.

West Virginia coal production for 2013 was around 113 million tons (Energy Information Administration 2014),[1] a decline of about six percent from the 120 million tons produced in 2012. Further, 2013 values were 28 percent below 2008 production of 158 million tons, peak production during the 2002 to 2013 time period. This decline reflects various trends and events within the coal industry's primary markets: power generation, exports and industrial demand. Recent demand trends with preliminary sector-level data for 2013 are shown below.

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



Source: (EIA 2014). * 2013 volumes estimated by MU CBER. Other 2013 figures are preliminary EIA.

[1] 112.9 million tons is the final 2013 value published by MSHA, the source of EIA's publications, and is clean coal production reported on MSHA Form 7000-2. As EIA will conduct its own internal evaluation of the data prior to publishing its 2013 Annual Coal Report what it reports as final tonnage for 2013 may not match this amount. The West Virginia Office of Miner's Health, Safety and Training reports 2013 production of 119.5 million tons but this is not exclusively "clean" coal, which is the final production volume.

The Electricity Sector

Although demand for West Virginia-produced coal by the electricity sector increased slightly from 2012 to 2013, the significant decline observed since 2010 is expected to continue. Natural gas prices rose in 2013 from the historic lows of 2012, which contributed to the increase. Much of the anticipated short-term decline in demand will be due to closure of many power plants in the eastern U.S. that have been announced for the 2014 to 2016 time period in order to comply with Environmental Protection Agency (EPA) air quality regulations. Power plants must comply with the Mercury & Air Toxics Standard (MATS) rule, which requires fossil-fuel steam electric generators to meet emissions limits based on maximum achievable control technologies (MACT)[2] for emissions of acid gases, toxic metals, and mercury. In 2011, at least 10 percent of the coal-fired generation fleet was expected to be retired by 2022 (Edison Electric Institute 2011).

Based on lists of announcement retirements and review of EIA power plant data by MU CBER, at least 78 plants that were customers of West Virginia coal between 2002 and 2012 have already retired or have announced full retirement. Several plants due to retire have already reduced consumption of WV coal, thus causing the effects of retirement to occur prior to full implementation of MATS. It is likely that the number of established plant customers of WV coal will be reduced to about 65 plants by 2022, compared to 90 plants in 2012. The majority of the closures are smaller plants, and with a few exceptions the larger plants will remain open.

The EPA has also issued draft standards to limit carbon dioxide emissions using authority under the Clean Air Act (CAA) Section 111(d) to set limits for states that would apply to existing generating units, and would have the greatest impact on coal-fired plants. The impact and timing of this future rule is still somewhat uncertain as each state will be instructed to determine its own method of compliance. Full compliance would need to be met in 2030 and is a reduction in carbon emissions of 30 percent from 2005 levels.

The Industrial Sector

As shown in Figure 1 demand for coal by the industrial sector - i.e. coke plants and self-generating manufacturers - has not declined as dramatically as demand in the electricity sector. In 2013, industrial demand for West Virginia coal continued a slow and steady decline similar to what has been observed since 2005.

The industrial sector is subject to new emissions regulation requiring industrial boilers and process heaters to conduct periodic tune-ups or meet emissions limits on hazardous air pollutants (HAPs) to comply with MACT criteria. Regulations were finalized in December of 2012 (Energy Information Administration 2014). Several large industrial facilities that currently self-generate

[2] MATS-compliant units are installed with flue gas desulfurization (FGD) scrubbers or dry sorbent injection (DSI) systems and possibly activated carbon injection to control mercury emissions.

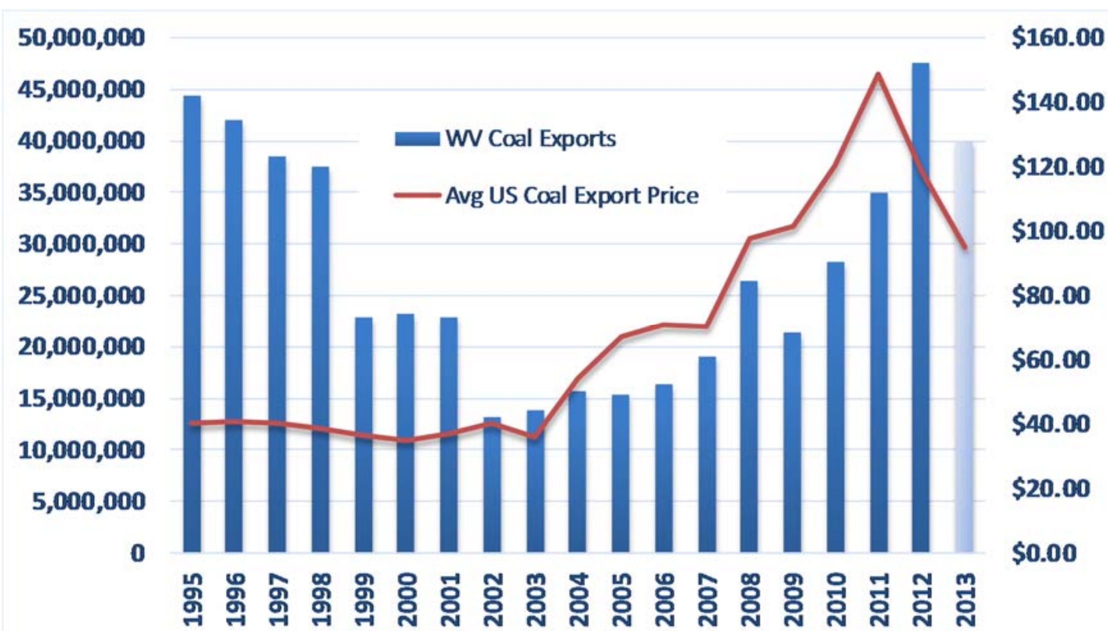
electricity using West Virginia-sourced coal have announced conversion to natural gas as a primary fuel source including RED-Rochester in New York (Recycled Energy Development 2013), and the Fernandina Beach Mill in Florida (Business Wire 2012). EIA's national-level projections forecast nearly no change in industrial demand for coal. Growth in industrial production from other macroeconomic factors is expected to offset the impact of additional capital costs incurred due to compliance; however, events such as these conversions suggest that industrial demand for West Virginia coal may decline more quickly.

Exports

West Virginia's and the nation's coal exports more than tripled between 2002 and 2012, but fell in 2013[3]. US coal exports totaled 117.7 million short tons in 2013 down from approximately 125.7 million short tons in 2012. Some of the decline may be due to slightly increased exchange rates for Euros to Dollars seen since 2008.

West Virginia has consistent exports to more than 30 countries throughout the world, with some of the greatest demand from European countries including the Netherlands, Italy, France, Germany and the U.K. The EIA projects total US coal exports to grow by 25% between 2013 and 2035.

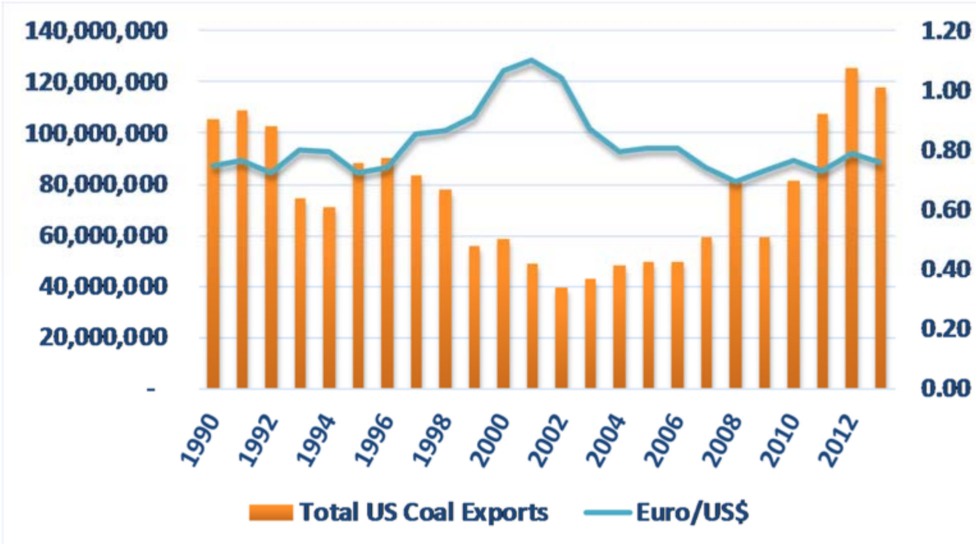
Figure 2: West Virginia Coal Exports (Tons) and Average US Coal Export Price



Source: EIA 2014. *2013 export tonnage estimated by CBER.

[3] 2013 data for coal export tonnage by U.S. state of origin has not yet been released. CBER estimates export tonnage based on value of coal exports published by the International Trade Administration and average export prices.

Figure 3: Historical US Coal Exports in Tons and Exchange Rate of Euro



[4]

Looking Forward

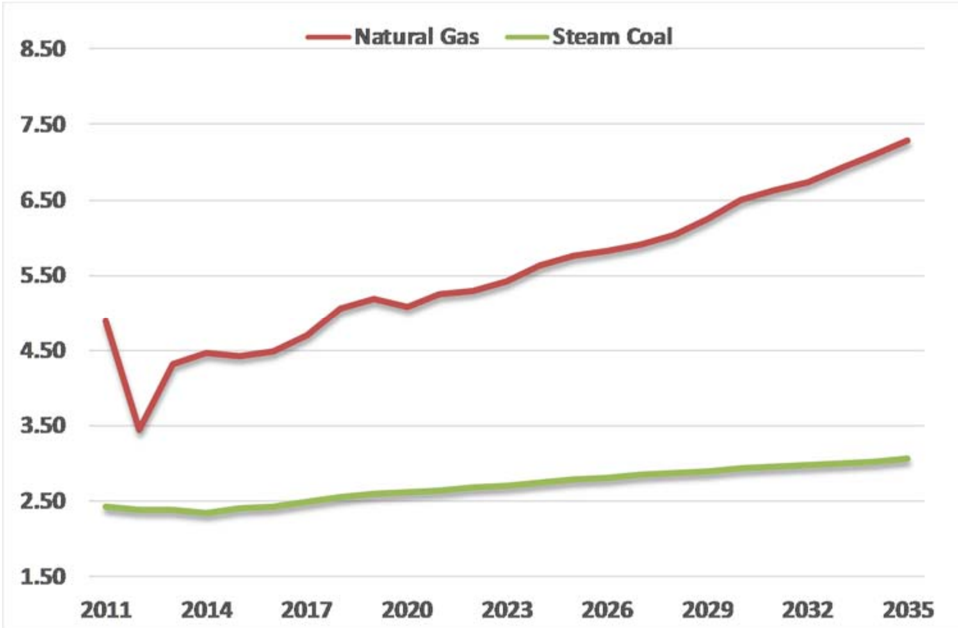
Future demand for West Virginia Coal depends on several variables including the prices of competing fuels, the longevity of the fleet of coal-fired power plants that have historically burned coal from the State, the rate of economic growth of importing countries and the nature of compliance with proposed carbon regulation.

As noted previously, the capacity of power plants available to use West Virginia coal continues to shrink as plants retire. While most retirements to date have been older plants with relatively small capacities, the occasional retirement of larger plants, e.g. Hatfield's Ferry in 2013 (The Herald-Standard 2013) and announcement of the intent to retire others, e.g. Brayton Point in 2017 (The Boston Globe 2014), represent loss of larger supply contracts for WV producers.

The price of natural gas also affects utilization of coal-fired power plants. Supply of natural gas continued to be high in 2013, although higher prices of natural gas than in 2012 made coal-fired generation more competitive. In its Annual Energy Outlook (AEO) 2014 Base Case analysis, the EIA continues to project natural gas prices, including for gas delivered to the power generation sector, to increase at a faster rate than coal prices. Thus, the expectation is that the rise in the relative price of natural gas will potentially moderate declines in coal demand. Included as a component of this analysis is the assumption that the U.S. will become a net exporter of natural gas by 2020.

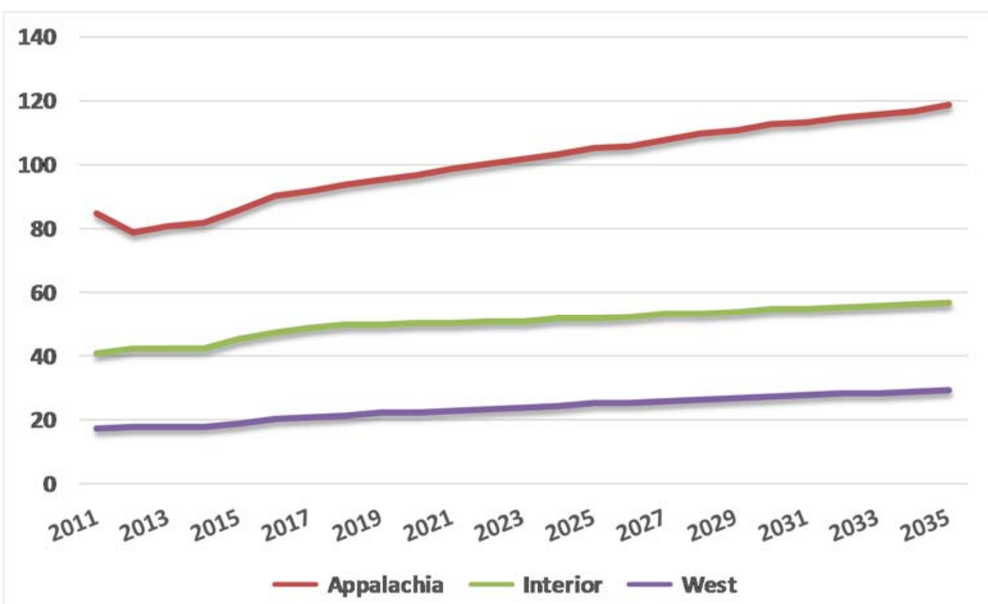
[4] The simple correlation coefficient confirms the negative association between national coal exports and the exchange rate between the Euro and the US Dollar. The correlation is -.54 for concurrent demand and exchange rate. When comparing the exchange rate with a two year lag of exports, the correlation increases in absolute magnitude to -.67 suggesting international markets take time to respond to changes, perhaps reflective of the influence of long-term purchase contracts.

Figure 4: EIA Forecasted Natural Prices & Coal to Electricity Sector (2012 $/MMBtu)



The relative price of West Virginia coal and Western and Illinois-basin coal is another factor influencing demand. WV producers have lost market share in the power generation sector to coal produced in Ohio, Illinois, Wyoming and other states. The EIA projects Appalachian coal prices to increase at a faster rate than both Interior and Western coals, due in part to more rapid declines in productivity resulting from operating in more marginal reserve areas, regulatory restrictions on surface mines and fragmentation of underground reserves that limit economies of scale (US Energy Information Administration 2014).

Figure 5: EIA Forecasted Minemouth Coal Prices, by Region (2012 $/ton)



Component Forecasts

Energy Information Administration (EIA)

Publication: Annual Energy Outlook 2014

Date: April 2014

Forecast Horizon: 2013-2040

Region(s): Northern Appalachia, Central Appalachia

The EIA provides a forecast of coal production by region in its Annual Energy Outlook, projecting through 2040 (Energy Information Administration 2014). 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 regional forecasts are adjusted to adapt these figures 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 2035, 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.[5] Only the EIA Reference Case figures are used.[6]

Key Assumptions:

Macroeconomic Issues: The long-term macroeconomic projection from IHS Global Insight, Inc. is used in the EIA forecast. Real GDP growth averages 2.4% per year from 2012 to 2040.

Coal Prices: U.S. real minemouth prices are expected to increase from $39.94 per ton to $59.16 per ton in $2012 by 2040, reflecting the assumption that coal mining productivity will continue to decline. EIA expects Appalachian coal prices to also increase due to a continued shift toward more higher-value coking coal exports, although price projections are lower than in the AEO2013, which forecast U.S. minemouth prices to increase to $61.28 by 2040.

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

[6] The EIA presents five primary situations in the Annual Energy Outlook 2014: a Reference Case, a High Economic Growth Case, a Low Economic Growth Case, a High Oil Price Case, and a Low Oil Price Case. The Reference Case was selected for the Consensus Forecast as a continuation of current trends, assuming known technology and technological/demographic trends.

Natural Gas Prices: Real $2012 Henry Hub [7] spot prices for natural gas are expected to increase by an average of 3.7% per year, rising to $7.65 per million Btu in 2040.

Electricity: Overall electricity supply is projected to increase by 25% from 2012 to 2040. Total electricity generated by coal is projected to increase by 11 percent from 2012 to 2040.

Industrial/Commercial: The industrial sector is expected to maintain fairly constant coal consumption through 2025 compared to 2012 levels, after which usage is projected to decline. After 2025, a decline in metallurgical coal use of about 15 percent by 2035 is projected, relative to 2012 levels. Other industrial use is projected to remain fairly constant at around one quadrillion Btu. The commercial sector is expected to maintain flat coal consumption throughout the forecast period of 0.04 quadrillion Btu.

Exports: National coal exports are expected to increase by 27% by 2035 compared to 2012 exports of 126 million tons. Forecasts for individual coal-producing regions are not published.

Environmental: Current legislation and environmental regulations for which implementing regulations were available in 2013 are considered in the forecast. Thus, the AEO2014 Base Case forecast does not include any assumptions for regulating carbon emissions, except to simulate market reaction to potential future regulation, a small increase in the cost of capital modeled for new coal-fired power plants without carbon capture and sequestration (Energy Information Administration 2014), although this assumption has only a small effect on production. The EIA does model three different greenhouse gas cases with varying economy-wide CO_2 emissions prices under which coal production is significantly lower than its Base Case.

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

Results:

Table 1: EIA Annual Energy Outlook 2014 Adapted to WV Production

West Virginia Coal Production (million tons)				
Historical	**Preliminary**	**Forecast**		
2012	**2013**	**2013**	**2014**	**2015**
120.4	112.9	116.8	114.8	104.2
Forecast				
2016	**2017**	**2018**	**2019**	**2020**
96.2	100.9	103.9	102.8	102.0
Forecast				
2021	**2022**	**2023**	**2024**	**2025**
101.3	101.0	100.4	100.3	100.2
Forecast				
2026	**2027**	**2028**	**2029**	**2030**
98.5	98.8	97.1	97.6	97.4
Forecast				
2031	**2032**	**2033**	**2034**	**2035**
98.4	96.9	96.9	98.0	96.8

Energy Ventures Analysis (EVA)

Publication: EVA Long-Term Forecast

Date: May 2013

Forecast Horizon: 2013-2040

Region(s): Northern Appalachia, Central Appalachia, West Virginia

EVA utilizes the Aurora XP Dispatch Model that calculates electricity generation by fuel type by developing the least cost generation situation that will meet power demand. All existing and planned generation capacity is included and the model can add or retire capacity as needed (Energy Ventures Analysis 2013).

Key Assumptions:

Macroeconomic Issues: GDP growth is expected to average 2.3% per year through 2040.

Coal Prices: Coal prices for both Northern and Central Appalachia are expected to increase. Northern Appalachia will reach of price of almost $70 per ton ($2013) and Central Appalachia will see a price over $90 per ton by 2040, averaged for both metallurgical and steam coals.

Natural Gas Prices: A competitive gas supply is a key assumption of the model. Gas prices are expected to steadily increase through 2040 resulting in a price over $7 per MMBtu.

Electricity: Growth in electricity demand is expected to average 1.3% per year through 2040. Demand for Appalachian coal by the electricity sector will fall by 50% between 2012 and 2040.

Industrial/Commercial: Non-coke industrial demand for Appalachian coal will fall by about 40% by 2040. Demand for metallurgical coal from Northern and Central (primarily) Appalachia will rise by about 20% by 2040.

Exports: Steam coal exports from Northern and Central (primarily) Appalachia will peak in 2013 and decline by about 45% by 2040. Met coal exports from Northern and Central (primarily) Appalachia will peak in 2012 and decline by about 40% by 2040. An export terminal will be constructed in the Pacific Northwest to deliver coal from the Powder River Basin (PRB) and the Rockies to Asia. Compared to 2011 volume, total Appalachian coal exports decline by 35% by 2040.

Environmental: The Clean Air Interstate Rule (CAIR) is assumed to continue with impacted emitters exceeding compliance. The Cross-State Air Pollution Rule (CSAPR) has been overturned and will not be replaced. The Mercury and Air Toxics Standards (MATS) will continue through April 2015 plus a one year extension. Section 316(b) of the Clean Water Act, which covers cooling water intake structures, requires compliance by 2018 and the Coal Combustion Residuals (CCR) requires compliance by 2020. National Ambient Air Quality Standards (NAAQS) revisions will become affective after 2018. Greenhouse Gas New Source Performance Standard is assumed to see significant revisions to the draft proposal, and CO2 policies are not considered at the national level.

Results:

Table 2: EVA Long-Term WV Coal Production Forecast 2014

West Virginia Coal Production (million tons)				
Historical	**Preliminary**	**Forecast**		
2012	**2013**	**2013**	**2014**	**2015**
120.4	112.9	117.1	115.3	110.2
Forecast				
2016	**2017**	**2018**	**2019**	**2020**
102.8	105.0	104.4	103.3	101.0
Forecast				
2021	**2022**	**2023**	**2024**	**2025**
101.7	102.8	101.6	102.1	100.3
Forecast				
2026	**2027**	**2028**	**2029**	**2030**
99.5	99.2	98.9	98.4	97.1
Forecast				
2031	**2032**	**2033**	**2034**	**2035**
95.3	93.8	91.1	87.9	82.8

Marshall University Center for Business and Economic Research (CBER)

Publication: CBER West Virginia Coal Production Forecast 2014

Date: June 2014

Forecast Horizon: 2013-2035

Region(s): West Virginia

The CBER forecast of West Virginia Total Coal production is an econometric model based on quarterly changes in total production from 1984 through 2012. The forecast model treats 2012 as a structural change in the coal market.[8] Data for the model are from EIA's monthly coal fuel receipts contained in Schedule 2 of Form EIA-923.[9] To create the initial short-term forecast, quarterly changes in total coal production were modeled with a vector autoregression (VAR) approach that explicitly accounted for forecasted demand for West Virginia-sourced coal in regional power generation.[10] For years beyond 2022, the CBER forecast utilizes an autoregressive approach, which estimates future changes in total coal production based on historical patterns. Key assumptions underlying the model include:

Macroeconomic Issues: Moderate average annual GDP growth rates of about 2 to 3% per year, consistent with other macroeconomic forecasts.

Coal Prices: In the short-term, coal prices are expected to follow trends of the last decade, with increases exceeding that of general inflation. In the long-term prices increases are expected to be more modest and do not exceed general inflation. The relative prices of coal to natural gas observed in 2012 are perceived as an anomaly, and are not expected to be repeated in the forecast horizon.

Natural Gas Prices: Stable gas prices in the near term, with modest growth in real natural gas prices of 3 to 4% annually through 2022. The planned addition of new gas capacity will also impact regional competitiveness in the near-term.

Electricity: Growth in electricity demand in the Eastern region of 2.5% over the short term forecast horizon. Demand for West Virginia coal by the electricity sector in the Eastern region expected to decline by approximately 6.5% annually between 2013 and 2022.[11]

Industrial/Commercial: The conversion of former coal-fired self-generators to natural gas is expected to reduce industrial demand for West Virginia coal.

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[8] Dummy variables were included in the model to identify 2012 which moderated the decline in forecasted values that otherwise result when weighting 2012 equally to the preceding years. See Hansen (2001) for a discussion of structural change as relating to U.S. Labor market trends. http://www.ssc.wisc.edu/~bhansen/papers/jep_01.pdf

[9] Form EIA-923 is available at http://www.eia.gov/electricity/data/eia923/.

[10] For more detail on the power generation demand model, see Appendix B.

[11] 6.5% is a compound annual rate.

Exports: Moderate growth in export markets for West Virginia coal is expected to mitigate some of the decline in demand from the regional power generation sector.

Environmental: Power plant closures due to non-compliance with MATS are expected to continue at a steady pace through 2016. West Virginia has already lost market share at plants that are soon to retire, causing some of these effects to occur prior to closure.

Results:

Table 3: CBER Long-term WV Coal Production Forecast 2014

West Virginia Coal Production (million tons)				
Historical	**Preliminary**	**Forecast**		
2012	**2013**	**2013**	**2014**	**2015**
120.4	112.9	111.4	109.6	108.1
Forecast				
2016	**2017**	**2018**	**2019**	**2020**
106.8	105.4	104.0	102.7	101.3
Forecast				
2021	**2022**	**2023**	**2024**	**2025**
99.9	98.5	98.0	97.6	97.1
Forecast				
2026	**2027**	**2028**	**2029**	**2030**
96.6	96.2	95.7	95.3	94.8
Forecast				
2031	**2032**	**2033**	**2034**	**2035**
94.4	93.9	93.5	93.0	92.5

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

Publication: WVU BBER West Virginia Coal Production Forecast 2014

Date: May 2014

Forecast Horizon: 2014-2019

Region: West Virginia

The West Virginia State Econometric Model utilizes over 50 equations to predict economic behavior in West Virginia. The model identifies the sectors that depend on local, regional, national, or international conditions and treats them accordingly. The WVU BBER provides a short-term forecast that is included in the Consensus Coal Forecast.

Results:

Table 4: WBU BBER West Virginia Coal Production Forecast 2014

West Virginia Coal Production (million tons)				
Historical	**Preliminary**	**Forecast**		
2012	**2013**	**2014**	**2015**	**2016**
120.4	112.9	109.8	106.2	101.4
Forecast				
2017	**2018**	**2019**		
101.6	101.1	101.0		

Consensus Forecast

The three long-term forecasts produced by EIA, EVA, and CBER along with the short-term forecast produced by WVU BBER are combined to create the Consensus Forecast for West Virginia Coal Production.[12] A weighted average is used to combine the four projections as follows (Armstrong 2001):

$$\begin{aligned} WV\ Coal\ Production_t &= w_{EIA} * EIA\ Production_t + w_{EVA} * EVA\ Production_t + w_{CBER} \\ &\quad * CBER\ Production_t + w_{WVU} * WVU\ Production_t \end{aligned}$$

The weight (w_i) assigned to each forecast is based on the accuracy of past forecasts by that organization. All available forecasts for 2011 through 2013 were evaluated for accuracy. For example, EIA's 2012 Annual Energy Outlook was assessed by considering the accuracy of its 2011, 2012, and 2013 projections.

Only recent years were evaluated due to the tumultuous macroeconomic conditions that appeared in late 2007 and 2008. Predictions for the first years of the time horizon were considered because accuracy is typically highest at the beginning of the forecast. Long-term accuracy was not considered in this weighting method due to the large potential for unpredictable macroeconomic conditions to affect annual error.

The error (e_i) of a forecast was determined using the following formula.

$$e_{i,t} = \frac{Forecast\ Production_{i,t} - Actual\ Production_t}{Actual\ Production_t}$$

The absolute value of the errors was averaged for each forecasting organization to remove the effects of under-estimation and over-estimation canceling each other. Since a new methodology was used by CBER, average error was calculated by creating an in-sample forecast and comparing these results to the actual values for 2011 through 2013.

Table 5: Average Absolute Errors

Forecast	Average Error
EIA	5.94%
EVA	8.84%
CBER	7.50%
WVU	7.28%

[12] For more information on the creation of consensus forecasts, see http://www.forecastingprinciples.com/paperpdf/Combining.pdf.

The weight given to each organization in the consensus was calculated as follows (Armstrong 2001):

$$w_i = \frac{\frac{1}{e_i}}{\sum_i \frac{1}{e_i}}$$

One set of weights is used in the 2013-2019 time period when all four organizations created forecasts. Weights are adjusted for the exclusion of the WVU BBER forecast for the period 2020-2035.

Table 6: Consensus Weights

	Short-Term Weight	Long-Term Weight
EIA	0.30	0.41
EVA	0.21	0.27
CBER	0.24	0.32
WVU	0.25	N/A

Using the above weights, the Consensus Forecast is calculated. The results are shown below in table and figure format. The Consensus Forecast for West Virginia Coal Production shows production levels decreasing by about 10 million tons by 2016/2017 and then remaining fairly steady though 2020. After 2020, production levels show a steady decreasing trend falling to 92 million tons of coal produced in 2035.

Table 7: Consensus Forecast for West Virginia Coal Production 2014 (million tons)

Historical	Preliminary	Forecast		
2012	2013	2013*	2014	2015
120.4	112.9	112.9	112.4	106.9
Forecast				
2016	2017	2018	2019	2020
101.4	103.0	103.3	102.4	101.5
Forecast				
2021	2022	2023	2024	2025
100.9	100.7	100.0	99.9	99.2
Forecast				
2026	2027	2028	2029	2030
98.2	98.1	97.1	97.1	96.5
Forecast				
2031	2032	2033	2034	2035
96.3	95.1	94.2	93.7	91.6

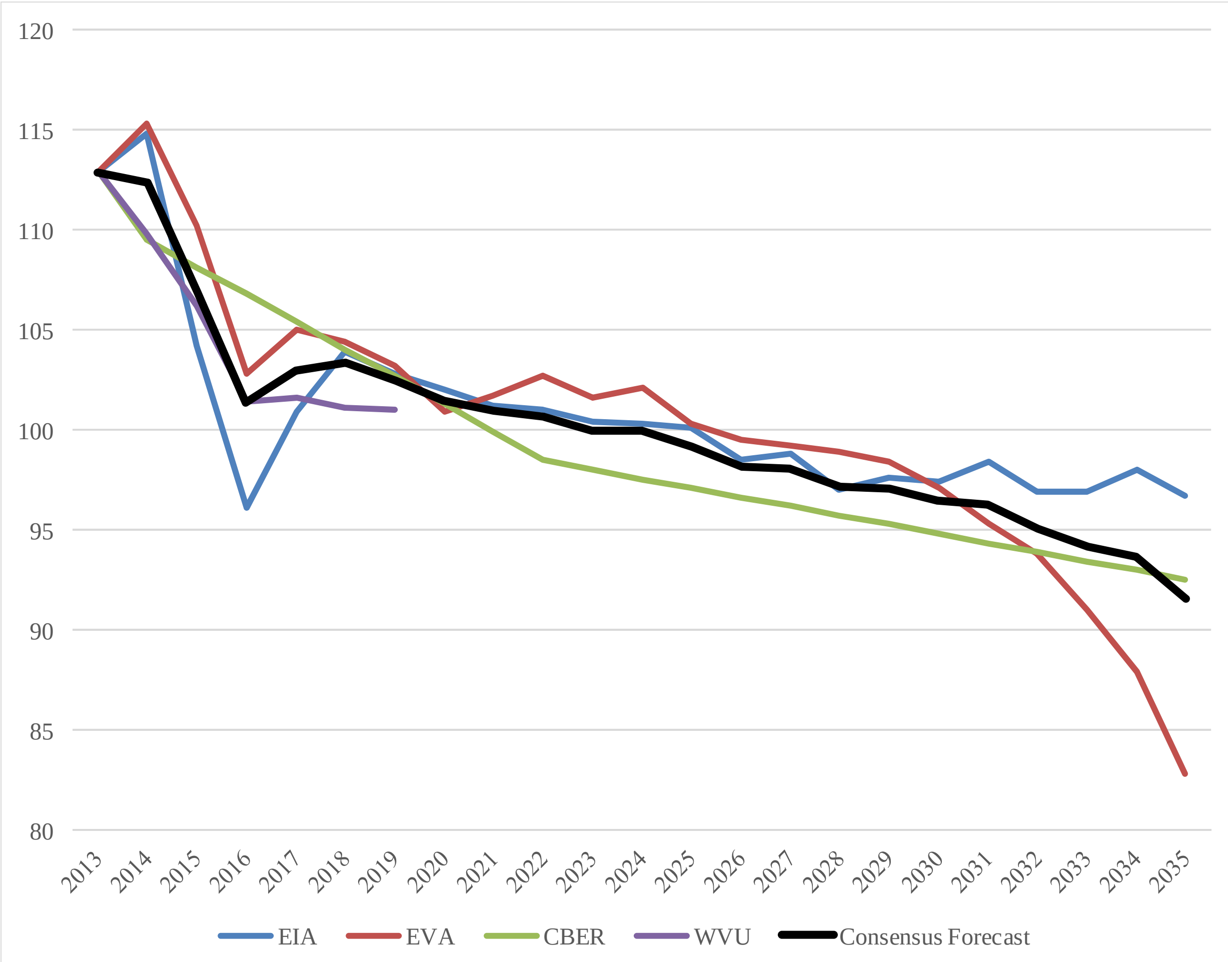
*Preliminary total production estimate from EIA

Table 8: Comparison of Component Forecasts and 2013/2014 Consensus Forecasts

West Virginia Coal Production (million tons)						
Year	**Forecasting Group**				**2014 Consensus**	**2013 Consensus**
	CBER	**EIA**	**EVA**	**WVU**		
2013	111.4	116.8	117.1		112.9*	117.4
2014	109.6	114.8	115.3	109.8	112.4	117.8
2015	108.1	104.2	110.2	106.2	106.9	113.9
2016	106.8	96.2	102.8	101.4	101.4	112.2
2017	105.4	100.9	105.0	101.6	103.0	113.5
2018	104.0	103.9	104.4	101.1	103.3	108.7
2019	102.7	102.8	103.3	101.0	102.4	105.6
2020	101.3	102.0	101.0		101.5	105.4
2021	99.9	101.3	101.7		100.9	104.8
2022	98.5	101.0	102.8		100.7	106.6
2023	98.0	100.4	101.6		100.0	107.6
2024	97.6	100.3	102.1		99.9	107.2
2025	97.1	100.2	100.3		99.2	106.3
2026	96.6	98.5	99.5		98.2	106.3
2027	96.2	98.8	99.2		98.1	106.1
2028	95.7	97.1	98.9		97.1	105.4
2029	95.3	97.6	98.4		97.1	105.0
2030	94.8	97.4	97.1		96.5	104.4
2031	94.4	98.4	95.3		96.3	103.5
2032	93.9	96.9	93.8		95.1	101.9
2033	93.5	96.9	91.1		94.2	99.6
2034	93.0	98.0	87.9		93.7	99.0
2035	92.5	96.8	82.8		91.6	97.3

*Preliminary total production estimate from EIA

Figure 6: Component and Consensus Forecasts 2014 (million tons)



***** With 2013 preliminary production as published by EIA, based on mine-level data reported to MSHA.

Summary

The 2014 West Virginia Consensus Coal Forecast figures are lower than the 2013 Consensus. A primary reason for this is inclusion of final 2012 supply and demand data in forecasting models, which shifted projections of future production downward. In addition, expectations of more rapidly declining productivity in Appalachia, particularly in Central Appalachia, caused EIA to lower projections for both Northern and Central Appalachian coal production and to raise projections for Interior coal production. The AEO2014 also projects lower prices for Appalachian coal compared to AEO2013 due to lower capacity utilization at existing mines. As the EIA forecast has the largest assigned weight of all the forecasts used to construct the Consensus, its assumptions significantly influence forecast production levels.

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Appendix A: EIA Forecasts for Northern and Southern WV

The EIA forecasts coal production by region in its Annual Energy Outlook. Appalachia is split into three regions: Northern, Central, and Southern. For the purposes of this study, only the Northern and Central Appalachian regions are applicable. 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. Forecasts for these regions are adapted to Northern and Southern West Virginia production. EIA's forecasted annual growth rates for Northern and Central Appalachia are shown first.

Table 9: Growth Rates for Coal Production in Northern and Central Appalachia (EIA)

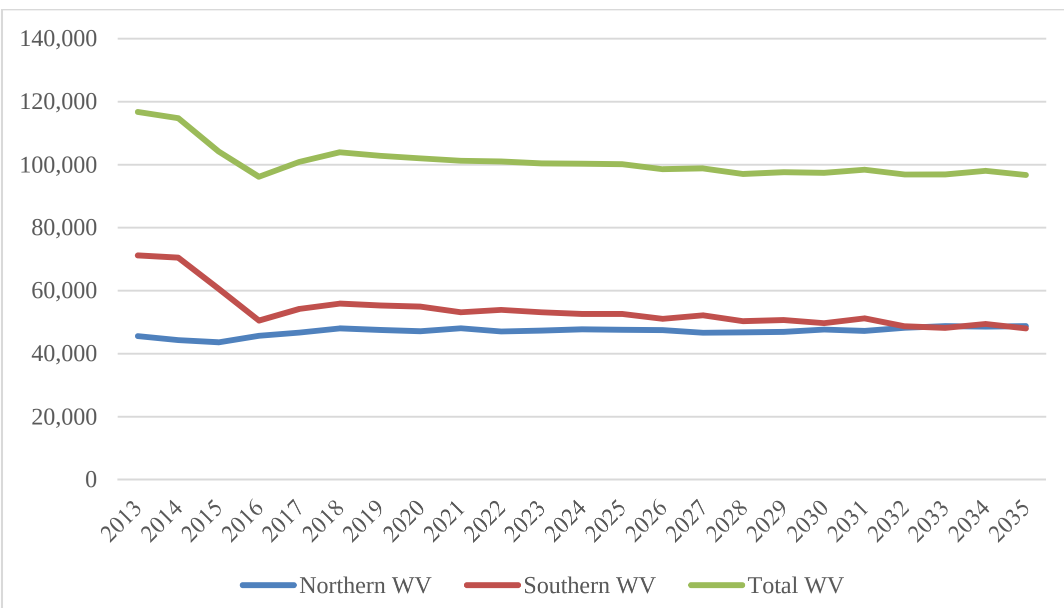
	2013	**2014**	**2015**	**2016**	**2017**
Northern Appalachia	9.9%	-2.8%	-1.6%	4.7%	2.3%
Central Appalachia	-9.8%	-1.0%	-14.0%	-16.7%	7.3%
	2018	**2019**	**2020**	**2021**	**2022**
Northern Appalachia	2.8%	-1.0%	-0.9%	2.1%	-2.2%
Central Appalachia	3.1%	-1.1%	-0.7%	-3.2%	1.5%
	2023	**2024**	**2025**	**2026**	**2027**
Northern Appalachia	0.5%	0.9%	-0.3%	-0.2%	-1.8%
Central Appalachia	-1.5%	-1.0%	0.0%	-2.9%	2.2%
	2028	**2029**	**2030**	**2031**	**2032**
Northern Appalachia	0.3%	0.4%	1.6%	-1.0%	2.2%
Central Appalachia	-3.6%	0.8%	-2.0%	3.0%	-4.9%
	2033	**2034**	**2035**		
Northern Appalachia	1.0%	-0.2%	0.2%		
Central Appalachia	-1.0%	2.6%	-2.9%		

These regional growth rates are applied to historical West Virginia coal production data to achieve the State forecast. 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. The calculated forecasts for Northern and Southern West Virginia are summed to produce the total West Virginia coal production.

Table 10: WV Coal Production by Region (EIA)

	2013	2014	2015	2016	2017
Northern WV	45,587	44,321	43,593	45,661	46,713
Southern WV	71,177	70,463	60,625	50,493	54,198
Total WV	**116,764**	**114,784**	**104,218**	**96,154**	**100,911**
	2018	**2019**	**2020**	**2021**	**2022**
Northern WV	48,035	47,538	47,089	48,095	47,051
Southern WV	55,890	55,296	54,907	53,156	53,932
Total WV	**103,925**	**102,834**	**101,996**	**101,251**	**100,983**
	2023	**2024**	**2025**	**2026**	**2027**
Northern WV	47,289	47,720	47,576	47,477	46,630
Southern WV	53,127	52,576	52,579	51,067	52,165
Total WV	**100,416**	**100,296**	**100,155**	**98,545**	**98,795**
	2028	**2029**	**2030**	**2031**	**2032**
Northern WV	46,757	46,926	47,688	47,201	48,227
Southern WV	50,293	50,683	49,689	51,195	48,662
Total WV	**97,050**	**97,609**	**97,377**	**98,397**	**96,889**
	2033	**2034**	**2035**		
Northern WV	48,711	48,602	48,718		
Southern WV	48,189	49,448	48,033		
Total WV	**96,900**	**98,049**	**96,751**		

Figure 7: WV Coal Production by Region (EIA)



Appendix B: Power Generation Demand Forecast

To better understand the dynamics influencing total coal production for West Virginia, CBER analyzed data on West Virginia Coal consumed by power plants in the eastern region of the United States. The data for the analysis are from EIA's monthly fuel receipts data (Energy Information Administration 2014), which have been aggregated into total quarterly fuel receipts of coal sourced from West Virginia for the period 2002-2012. During the period, about 220 to 290 coal-fired plants operated in the region each quarter. Additional factors considered for the analysis include real natural gas prices and electricity demand (as indicated by average heating and cooling degree days in the region).

To construct the power generation demand forecast, CBER first projected electricity demand in the region, using coal-fired power plant capacity as a proxy. A key assumption is that capacity required to serve estimated electricity demand is irrespective of fuel type, and thus indicative of electricity demand generally. Using a vector autoregression model (VAR), CBER jointly forecasted the quarterly change in total fuel receipts for West Virginia sourced coal and real natural gas prices, conditional on modest growth in electricity demand and treating the substantial decline observed in 2012 as a structural break in the coal market.[13]

[13] Dummy variables were included in the model to identify 2012 which moderated the decline in forecasted values that otherwise result when weighting 2012 equally to the preceding years.