Consensus Coal Production Forecast for West Virginia 2006 Update

Prepared for the
West Virginia Department of Environmental Protection
Office of Special Reclamation

By

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Executive Summary

West Virginia’s coal production rebounded from 139.7 million tons in 2003 to 148.0 million tons in 2004 to 153.6 million tons in 2005, according to data currently published by the Energy Information Administration (EIA). This has been accompanied by sustained high coal prices, which have remained nearly double their 2003 levels (currently near $60 per ton for Central Appalachian coal and $45 per ton for Northern Appalachian coal) since mid-2004. In addition, West Virginia coal mining jobs have increased from about 15,000 in 2000 to 17,300 in 2005.

The updated consensus coal production forecast described in this report calls for state production to continue rising through 2009, hitting 162 million tons in that year. During the 2010-2020 period, state coal production drifts down to the 155 million ton level, as electric power plants respond to tighter emission restrictions (SO2 and NOx restrictions under the Clean Air Interstate Rule (CAIR) and mercury restrictions under the Clean Air Mercury Rule (CAMR)) through massive investment in scrubbing capacity. These investments are expected to increase the demand for higher-sulphur coals produced in the northern part of the state. However, this impact is initially more than offset by declining demand for coals produced in the southern West Virginia coal fields and by the increasingly difficult geologic conditions faced by coal operators in the southern fields. Continued demand for coal for electricity generation eventually stimulates enough new coal mining capacity to return production to the 160 million ton level by 2030.

The updated forecast calls for significantly more coal production in the state than envisioned in the consensus forecast produced in 2004. As noted in that report, the 2004 consensus forecast was constructed using forecasts completed in 2003, well before the durability and production implications of the run-up in coal prices became clear. The updated consensus forecast reflects the improved state coal production observed during the last two years. It also relies on higher coal production forecasts from the WVU BBER (which heavily influences the forecast through 2010) and from Hill & Associates (which heavily influences the evolution of state coal production during the 2011-2021 period). In addition, the updated forecast weights used to combine the individual projections now place more emphasis on higher coal production forecasts, since those projections have performed better recently.

Risks to the updated coal production forecast include risks to U.S. and world economic growth. If economic growth slows significantly, this will reduce demand for energy and thus demand for coal as well. Further, coal faces competition from other fuels, primarily natural gas. If natural gas prices decline relative to coal, then there is the potential for coal production growth to be slower than envisioned under baseline assumptions. Transportation costs for coal have risen significantly during the last two years. If transportation costs/capacity shift in such a way as to favor mid-west and western coals, this has the potential to adversely affect coal production in the state. Coal also faces labor force issues that may restrict production in the future. With a rapidly aging workforce, coal operators will have to work hard, and pay more, to attract a skilled workforce. Finally, environmental issues will remain important considerations for coal producers/consumers. In particular, major efforts to reduce CO2 emissions have the potential to greatly reduce coal demand and thus production nationwide and in West Virginia.

This report proceeds as follows: the Recent Developments section describes in more detail updated trends in coal production, prices, employment, and productivity; the updated consensus coal production forecast for West Virginia is summarized next; followed by an update risks section. Appendix I contains the details of the construction of the consensus forecast and Appendix II summarizes each of the updated component forecasts individually.
Recent Developments
with Scott Murdoch, Graduate Research Assistant

Coal Production
National coal production has remained relatively steady at 1,100 million tons since 1996, as Figure 1 shows. National coal production peaked in 2001 at 1,127 million tons then declined until 2003, attaining the lowest coal production for the nation since 1996 at 1,072 million tons. West Virginia coal production has declined from 170 million tons in 1996 to 140 million tons in 2003, before rebounding to 148 million tons in 2004. During the 2003-2004 period, national and West Virginia coal production increased by 3.8 and 5.9 percent respectively. Finally, West Virginia’s share of U.S. coal production has fallen from 16 percent in 1996 to 13 percent by 2004.

Figure 1
Annual Coal Production
W.Va. and U.S.
(Million Short Tons)

In order to further analyze West Virginia coal production it is beneficial to divide the production into the northern and southern regions, which is illustrated in Figure 2. Approximately 73 percent of West Virginia’s coal production came from the southern region in 1996. Annual average production for the southern region fell from 124.5 million tons in 1996 to 104.8 million tons in 2003, before rebounding to 107.4 million tons in 2004. Annual average production for the northern region fell from 45.9 million tons in 1996 to 34.9 million tons in 2003, before rebounding to 40.6 million tons in 2004. By 2004, the southern region accounted for 72.5 percent of state coal production, down from 1996 levels.

Preliminary data for 2005 suggests that statewide production rose again, to 153.5 million tons, which translates into a growth rate of 3.7 percent over 2004. Both northern and southern regions in the state posted production gains, with southern production estimated at 110.9 million tons and northern production estimated at 42.6 million tons in 2005. Year-over-year production growth was faster for the northern region in 2005, at 4.9 percent, than for the southern region, at 3.3 percent. Nationally, preliminary data suggest that coal production rose by 1.9 percent in 2005.
Coal Prices
The average mine price of West Virginia coal has decreased significantly during the last two decades, but also rebounded strongly since 2000. In 1981 the average mine price was $38.05 per short ton while in 2000 the average mine price was $25.17 per short ton, as illustrated in Figure 3. However this trend has reversed in recent years. The average mine price in 2004 was $35.41 per ton, which is $10 higher than 2000, an annual growth rate of 8.9 percent. According to the EIA the mine price is the price available to the open market, consumers and companies, excluding cost for freight, shipping, and insurance. Also illustrated in Figure 3 is the real or inflation-adjusted price of West Virginia coal. Note that the inflation-adjusted price of coal has risen since 2000, which indicates that the nominal price of coal has risen faster than overall prices.
Figure 4 depicts monthly coal spot prices for the Central and Northern Appalachian regions since March 2003. The spot price for coal in the Central Appalachian region, which includes southern West Virginia, remains nearly double 2003 levels, beginning 2006 around $60 per ton compared to $35 per ton in 2003. Likewise, spot prices for Northern Appalachian coal have risen from just over $25 per ton to the $45 per ton level in early 2006.

**Figure 4**

*Average Weekly Coal Commodity Spot Prices*  
*Business Week Ended March 17, 2006*

EIA continues to attribute the spike in coal prices to a large number of factors, including the influence of regulatory issues (and associated permitting delays) related to mountaintop removal/valley fill techniques, the diminishing of readily mineable reserves, temporary mine closures due to fires, accidents, and safety issues, diminishing rail capacity to handle western coal, higher natural gas prices, rising gasoline prices, and international factors like the falling value of the U.S. dollar (which makes U.S. exports more competitive), and strong international demand (as China devotes its coal resources to internal use).

**Coal Mining Employment**

West Virginia and United States coal mining employment declined significantly through the 1990’s, as demonstrated by Figure 5. The annual average coal mining employment for West Virginia decreased from 26,808 in 1990 to 14,925 in 2000, a loss of 11,883 jobs. West Virginia’s coal mining employment has cycled between 15,000 and 17,000 jobs during the last five years, reaching 17,300 on average in 2005. The overall upward trend in employment since 2003 reflects increasing coal production during the period. As Figure 5 illustrates, coal mining jobs in the United States have followed a similar trend during the last five years.
Coal Productivity

West Virginia and national coal productivity increased steadily throughout the 1990’s, with coal productivity defined by EIA as the number of short tons of coal per miner per hour. West Virginia coal productivity soared from 2.96 tons in 1990 to 4.92 tons in 2000, which is an annual average increase of 5.2 percent. However, since 2000 West Virginia’s coal productivity decreased to 4.03 in 2004. Similarly, national coal productivity increased from 3.83 tons in 1990 to 7.02 tons in 2000. After 2000, coal productivity fluctuated slightly until reaching 6.8 tons in 2004.
Figure 7 shows monthly coal productivity for West Virginia and the U.S. measured in short tons per miner. Figure 7 illustrates for West Virginia and the nation that the average coal productivity during 2005 is a bit lower than the annual average of 2004.

Figure 7

Monthly Productivity
W.Va. and U.S.
(Coal Production Annualized in Thousand Short Tons per Miner)

Source: Energy Information Administration
Bureau of Labor Statistics
Consensus Coal Production Forecast for West Virginia

The updated consensus coal production forecast for the state was constructed by computing a weighted average of seven forecasts of coal production growth rates from five forecast providers. The weights used to compute the weighted average were derived from an updated analysis of relative forecast accuracy during the last five years. See Appendix I for a detailed explanation of the forecast evaluation procedure and the weights used to combine the forecasts.

The forecasts used to compute the consensus outlook come from the Energy Information Administration, Global Insight, Inc., Hill & Associates, the Center for Business and Economic Research at Marshall University, and the Bureau of Business and Economic Research at West Virginia University. See Appendix II for summaries of each individual forecast.

Forecasts were chosen to include a wide variety of modeling strategies and forecasts. These forecasts vary from a short-run forecast (five years ahead) designed to capture business cycle influences on state coal production to long-run forecasts derived from firm-level modeling exercises. All but one of the forecasts (the Marshall University forecast was produced in 2001) were generated during 2005.

The updated forecast, summarized in Figure 8 and Table 1, calls for West Virginia coal production to rise from the 150 million tons per year range of 2004-2005 to the 160 million tons per year during 2008-2010. With the increased emission restrictions imposed by CAIR and CAMR, and the associated increased in scrubbing capacity at U.S. power plants, state coal production drops to the 155 million tons per year level during the 2011-2021 period. The increased scrubbing capacity increases the demand for higher-sulphur coals produced in the northern part of the state. However, this impact is initially more than offset by declining demand for coals produced in the southern West Virginia coal fields and by the increasingly difficult geologic conditions faced by coal operators in the southern fields. Continued demand for coal eventually stimulates enough new coal mining capacity to return production to the 160 million ton level by 2030.

Figure 8
W.Va. Consensus Forecast
Coal Production

![Figure 8](image-url)
The updated forecast calls for significantly more coal production in the state than envisioned in the consensus forecast constructed in 2004. As noted in that report, the 2004 consensus forecast was constructed using forecasts completed in 2003, well before the durability and production implications of the run-up in coal prices became clear.

The updated consensus forecast reflects the improved state coal production observed during the last two years. It also relies on higher coal production forecasts from the WVU BBER (which heavily influences the forecast through 2010) and from Hill & Associates (which heavily influences the evolution of state coal production during the 2011-2021 period). In addition, the updated forecast weights used to combine the individual projections now place more emphasis on higher coal production forecasts, since those projections have performed better recently.

Table 1
W.Va. Coal Production
Consensus Forecast (Millions of Tons)

<table>
<thead>
<tr>
<th>Year</th>
<th>Forecast</th>
<th>Actual</th>
</tr>
</thead>
<tbody>
<tr>
<td>W.Va. Coal Production</td>
<td>158.3</td>
<td>162.4</td>
</tr>
<tr>
<td>W.Va. Coal Production</td>
<td>157.5</td>
<td>159.5</td>
</tr>
<tr>
<td>W.Va. Coal Production</td>
<td>156.9</td>
<td>155.5</td>
</tr>
<tr>
<td>W.Va. Coal Production</td>
<td>152.0</td>
<td>153.9</td>
</tr>
<tr>
<td></td>
<td>2024</td>
<td>2025</td>
</tr>
<tr>
<td>W.Va. Coal Production</td>
<td>158.3</td>
<td>159.1</td>
</tr>
<tr>
<td></td>
<td>2030</td>
<td></td>
</tr>
<tr>
<td>W.Va. Coal Production</td>
<td>164.0</td>
<td></td>
</tr>
</tbody>
</table>
Risks to the Forecast

Most forecasts differ from actual events (once they finally transpire). An important part of using and understanding forecasts is to consider a few likely ways in which they may turn out to be incorrect.

All of the forecasts used in this study rely on a forecast of U.S. economic growth, typically summarized by expected real GDP growth. As noted below, Hill & Associates now rely on EIA assumptions about overall economic growth and electricity demand. EIA in turn uses economic forecasts produced by Global Insight to generate its projections. Further, the West Virginia University Bureau of Business and Economic Research forecast also uses the Global Insight macroeconomic outlook as an input into its coal production forecast.

Overall real GDP growth forecasts range from 2.2 percent (for the Marshall University forecast, based on EIA assumptions in 2001) to 3.0 percent per year for the more recent longer-term outlooks. However, if real GDP growth turns out to be stronger (weaker) than expected, then we should expect the coal production forecasts to fall short (above) of actual estimates.

In addition, it is important to remember that West Virginia coals will increasingly compete in a global marketplace, with some coal produced in the state exported to countries around the world and with foreign-produced coals imported into the U.S. This implies that future coal production will depend not only on U.S. economic growth but also in part on worldwide economic growth. This has recently been highlighted by developments in the market for metallurgical coal, where surging demand has spurred price increases, and it implies that stronger than expected worldwide economic growth has the potential to generate stronger coal production in the state. Keep in mind that the opposite is also true, in that slower than expected worldwide growth may generate slower growth in state coal production.

None of the forecast providers compute simulations for West Virginia (or Northern and Central Appalachia, for that matter) coal production based on alternative economic growth scenarios. EIA comes the closest by publishing simulations of total Appalachian coal production based on two alternative economic growth scenarios: high growth and low growth.

In the high-growth scenario, EIA assumes an average annual real GDP growth rate of 3.5 percent per year during the forecast period (compared to 3.0 percent in their reference case). Faster economic growth generates stronger sales of electricity and its growth rate rises from 1.6 percent per year under the reference case to 1.9 percent per year in the high-growth scenario. This translates into faster growth for Appalachian production as well, with production rising by 0.6 percent per year in the high-growth scenario, compared to 0.1 percent per year in the reference case. EIA does not publish coal production for Appalachian sub-regions under alternative scenarios.

In the EIA low-growth scenario, real GDP growth averages 2.4 percent per year, 1.1 percent per year slower than under high-growth assumptions. This generates significantly slower electricity sales, which grows by just 1.2 percent per year. This translates into significantly slower coal
production growth nationally, at 1.1 percent per year, while Appalachian production falls at an annual rate of -0.5 percent per year.

While none of the forecast providers forecast coal production for West Virginia under alternative economic growth scenarios, it is very likely that state coal production will respond to overall national economic growth. Faster (slower) than expected national growth will tend to generate higher (lower) than expected levels of state coal production.

In electricity generation, coal faces competition from natural gas. EIA generated alternative coal production forecasts based on alternative oil and natural gas price scenarios in its latest outlook. In the high-price scenario, EIA assumes that oil prices reach about $90/bbl in 2030, compared to $50/bbl in the baseline outlook. Natural gas prices (constant 2004 dollars, lower 48 wellhead) are assumed to hit $7.72/mcf in 2030, compared to $5.92/mcf in the reference case. Higher natural gas prices increase the attractiveness of coal for electricity generation, increasing national and Appalachian coal production rates above baseline levels. National coal production growth averages 2.2 percent per year under this scenario, while Appalachian production averages 0.5 percent per year.

In the low-oil-and-gas-price scenario, EIA assumes that oil prices hit $28/bbl in 2030 while natural gas prices fall to $4.96/mcf in 2030. This scenario generates lower rates of coal production growth nationally and in Appalachia, with national growth averaging 0.8 percent per year and Appalachian production averaging -0.4 percent per year.

Coal production forecasts assume that coal operators succeed in attracting the skilled workforce required by the industry. With a rapidly aging workforce, coal operators will have to work hard, and pay more, to attract the workers needed to maintain (or increase) production levels called for in the baseline forecast.

In addition to economic growth (and fuel competition) risks to the forecast, there are also risks related to relative transportation costs and environmental regulation. Hill & Associates provides simulations for West Virginia steam coal production under alternative assumptions about relative transportation costs for Western versus Eastern coals and under the assumption of new limits on CO2 emissions. The results of these alternative assumptions, as well as the baseline forecast, are shown in Figure 9.

Under baseline assumptions, Hill & Associates assumes that overall coal transportation costs remain higher than those prevalent in 2004, but that transportation costs rise uniformly across the country. In the alternative simulation, Alternative Transport Costs, Hill & Associates assumes that Western coal transportation costs rise 2 percent per year faster than do Eastern coal transportation costs. This scenario also assumes that international shipping costs remain near current high levels during the forecast. The results of this simulation suggest higher-than-baseline production levels for West Virginia steam coals, with production peaking at over 160 million tons in 2019, compared to peak production of 149 million tons in 2021 under baseline assumptions.

Hill & Associates also examine one alternative environmental scenario and its impacts on West Virginia steam coal production: limits on CO2 emissions. In particular, they implement a CO2 limit based roughly on the McCain-Lieberman Climate Stewardship Act of 2003, which would set up a system of tradable CO2 allowances. The initial cap would be implemented in 2010 (at year 2000 levels), followed by a lowering of the cap in 2016 to 1990 levels. This scenario projects dramatically reduced steam coal production nationally and in West Virginia, particularly after the more stringent limits imposed after 2015. Indeed, the simulation suggests that state
steam coal production could drop from 145 million ton level in 2022 under baseline assumptions to 81 million tons under the assumption of CO₂ limits. While this is certainly dramatic, Hill & Associates caution that economic pressures of the magnitude would change the way energy is produced and consumed. Structural change of this magnitude suggests caution in interpreting model results.

Figure 9
Hill & Associates
Baseline and Alternate Scenarios
W.Va. Steam Coal Production
Outlook for U.S. Steam Coal
Long-Term Forecast To 2024
Appendix I

Assessment of Forecast Accuracy and Forecast Weights

A forecast is a prediction about the future. In the simplest terms, evaluating a forecast means comparing forecast values to actual realizations. In theory, this is simple; in practice, it gets complicated. The purpose of this appendix is to systematically compare coal production forecasts from EIA, Global Insight, Hill & Associates, Marshall University Center for Business and Economic Research, and West Virginia University Bureau of Business and Economic Research, to actual realizations and summarize the results.

Keep in mind that most forecasts differ from what we eventually observe. It is a fact of life that the future is uncertain and economic models cannot fully surmount that. In addition, the current economic situation is uncertain. Even preliminary production data are released at least one month after the fact and sometimes take years to become "final." Thus, we find ourselves in the position of evaluating what the future may bring, while in possession of only incomplete information about what has just happened. Indeed, this uncertainty contributes to the importance of timely analysis of current trends and forecasting.

Comparing Forecasts to Actual Values

Forecast Horizon

To summarize the forecasting performance of the models, we focus on forecasts that are one, two, three, and four years ahead. Now, what is the meaning of a one-year-ahead forecast? A practical example using an actual forecast from the BBER West Virginia State Econometric Model will be used to illustrate basic concepts. This model is used twice per year to forecast the state economy.

In the spring of 2002, the BBER used its econometric model to generate an annual forecast of West Virginia coal production. In the spring of 2002, we knew that coal production in West Virginia was 160 million tons in 2001 and we had a couple of months of coal production data for 2002. In the spring of 2002, a one-year-ahead forecast of state coal production from the BBER West Virginia Econometric Model was for annual production in 2002 (the model predicted that state coal production would be 154 million tons). Similarly, a two-year-ahead forecast was for 156 million tons for 2003, and so on.

In a similar fashion, each forecast from the BBER West Virginia Econometric Model generates forecasts of coal production one, two, three, four, and up to 10 years ahead. Thus, since the BBER model is used to produce two forecasts each year, we will have several forecasts at each forecast horizon (one year ahead, two years ahead, etc.).

Forecast Difference

To measure how a forecast differs from the actual results, at each forecast horizon, I will use the term “forecast difference.” A forecast difference is measured simply as a forecast value minus the actual value. A percentage forecast difference is just the forecast difference divided by the actual value, multiplied by 100, as shown in the equations below,
Forecast Difference\(_t\) = \text{Forecast}_{t} - \text{Actual}_{t}

\[
\text{Percent Forecast Difference}_{t} = \frac{\text{Forecast}_{t} - \text{Actual}_{t}}{\text{Actual}_{t}} \times 100
\]

Thus, a positive forecast difference tells us that the forecast exceeds the current estimate, whereas a negative difference tells that the forecast falls short of the current estimate. Specifically, the one-year-ahead forecast difference for the West Virginia coal production forecast produced in the spring of 2002 was +3 million tons (the actual value for 2002 turned out to be 151 million tons). The one-year-ahead percent forecast difference for this forecast was +2.0 percent.

For each forecast provider, I report the average percentage forecast differences for all available forecasts at the four forecast horizons (a measure of the bias of the forecasts). Since the forecast difference from each release could be positive or negative, an average of forecast differences will allow positive forecast differences to be canceled by negative forecast differences.

However, a forecast accuracy measure based on a simple average of positive and negative forecast differences is not sufficient. In order to see why, suppose we are comparing the one-step-ahead forecast accuracy of two models, each of which has produced two forecasts. Suppose that for model 1, the percent forecast differences are +1 percent and -1 percent. Thus, the average percent forecast difference is 0.0 percent. Suppose that for model 2, the percent forecast differences are +10 percent and -10 percent. The average percent forecast difference for model 2 is 0.0 percent as well. It is obvious, however, that model 1 has produced the superior forecasts, coming closer to actual values each time. (The forecast from model 1 is more efficient in the sense that its variance around the actual value is lower.) We can account for this issue by averaging the absolute percent differences for each model. Thus, for model 1 the average absolute percent difference is 1 percent, while for model 2 the average is 10 percent.

**Evaluating the Internal Accuracy of Coal Production Forecasts**

Table 2 shows the ability of forecast providers to predict the coal production level of their chosen geography (Northern Appalachia, Central Appalachia, or West Virginia) and coal type (steam coal or all coal). The table shows the average percentage forecast differences as well as average absolute percentage forecast differences, by forecast horizon, for each forecast provider. In each case, the target variable corresponds to the variable forecasted. For example, EIA generates coal production forecasts for Northern Appalachia. In order to evaluate the performance of this forecast, we compare forecast coal production for Northern Appalachia to actual coal production for Northern Appalachia. The results of this analysis tell us about the performance of each forecast providers model, relative to the geography/coal-type they are trying to predict.

The table summarizes the type of coal production forecasted, the geography forecasted, as well as the number of one-step-ahead forecasts available from each forecast provider. A larger number of forecasts available for evaluation tends to make the average forecast differences a more robust indicator of overall forecast performance. The number of forecasts available ranges from 13 for West Virginia University to one for Marshall University. All forecasts evaluated were produced during the 1998 to 2004 period.

At the one-year-ahead horizon, average absolute percentage differences range from 0.63 percent to 12.63 percent. At the four-year-ahead horizon, average absolute percentage differences range
from 5.73 percent to 33.65 percent. As the table shows, forecast differences rise with the length of the forecast horizon. This is a standard result in forecast evaluation and arises because of the increasing uncertainty associated with forecasts at longer horizons.

Overall, forecast differences tend to be a bit smaller for the EIA, Hill & Associates, and West Virginia University forecasts. This arises in part from the model structures and data used by these agencies. Each of these forecasts relies on published historical data, which are then combined with statistical techniques designed to capitalize on key historical correlations found within the data.

Global Insight and Hill & Associates employ a very different methodology, which focuses on firm-level modeling of the economic decisions made by energy producers and coal producers. Thus, the coal production forecasts from each of these models are dominated by demand for steam coal. Further, these models do not attempt to capture and extrapolate current trends in any way. Thus, they are not tied to published estimates of steam coal production. In the case of the Global Insight forecasts, their estimates of the actual level of steam coal production have changed significantly from their published forecast in 1998 to their latest forecast (published in 2003). Thus, a large share of their forecast difference stems from a change in their estimated level of past steam coal production. Their view of history has settled down during the last two years, which suggests that their latest forecasts should track better in the future.

Table 2
Internal Forecast Performance by Forecast Geography and Coal Type
Average Percentage Differences and Average Absolute Percentage Differences

<table>
<thead>
<tr>
<th>Forecast Provider</th>
<th>Forecast Geography</th>
<th>Coal Type</th>
<th>One Step Forecasts</th>
<th>Average Percentage Differences*</th>
<th>Average Absolute Percentage Differences</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>One</td>
<td>Two</td>
<td>Three</td>
</tr>
<tr>
<td>Energy Information Admin.</td>
<td>Northern Appalachian Region</td>
<td>All</td>
<td>8</td>
<td>0.38</td>
<td>4.91</td>
</tr>
<tr>
<td></td>
<td>Central Appalachian Region</td>
<td>All</td>
<td>8</td>
<td>-1.01</td>
<td>0.14</td>
</tr>
<tr>
<td>Global Insight</td>
<td>Northern Appalachian Region</td>
<td>Steam</td>
<td>6</td>
<td>-6.30</td>
<td>-16.67</td>
</tr>
<tr>
<td></td>
<td>Central Appalachian Region</td>
<td>Steam</td>
<td>6</td>
<td>4.81</td>
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<td>Hill &amp; Associates</td>
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<td>Steam</td>
<td>3</td>
<td>4.20</td>
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<tr>
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<td>Central Appalachian Region</td>
<td>Steam</td>
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<td>-1.70</td>
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<td>West Virginia</td>
<td>Steam</td>
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<td>West Virginia</td>
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<td>All</td>
<td>13</td>
<td>0.09</td>
<td>4.56</td>
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</table>

*Positive (negative) values indicate over (under) prediction on average.
NA is Not Available. The Hill & Associates and Marshall University models have not produced enough West Virginia forecasts to be evaluated four years ahead.

Forecasts Evaluated:
EIA: Annual Energy Outlook 1997-2004
Marshall University: Mountain State Clean Water Trust Fund, 2001

Evaluating the Accuracy of Coal Production Forecasts for West Virginia Coal Production

The analysis so far tells us a great deal about the relative performance of the five forecasts we will combine. However, our ultimate goal is to produce a forecast for West Virginia coal production, by combining forecasts for West Virginia coal production, West Virginia steam coal production, Northern (and Central) Appalachian coal production, and Northern (and Central) Appalachian steam coal production. Since two of the five forecast providers generate forecasts for geographies which extend beyond West Virginia’s borders (EIA, Global Insight) or which forecast only steam coal production (Global Insight, Hill & Associates), we need to evaluate the ability of these forecasts to predict West Virginia total coal production.
To evaluate these forecasts we will compare forecast coal production growth rates from each provider to actual West Virginia coal production growth rates. The forecast growth rates are computed using exactly the same coal production forecasts evaluated above. I follow the same procedure as above, except that I focus on forecast differences only and do not compute percentage forecast differences.

The results of this exercise are presented in Table 3 below. The average forecast differences provide information on how close forecast growth rates are to actual West Virginia coal production growth rates. For instance, to construct the one-step-ahead forecast differences for Northern Appalachian coal production (from EIA), I compare the forecast growth rate Northern Appalachian coal production (one step ahead) to the actual West Virginia coal production rate. The results of this analysis tell us how useful the EIA forecasts of Northern Appalachia coal production are in forecasting West Virginia coal production. As shown in the table, average growth rate differences for the Northern Appalachian forecast from EIA were 1.80 percent. This means that on average, the one-year-ahead forecast of the Northern Appalachian coal production growth rate was 1.80 percentage points above the actual West Virginia coal production growth rate.

<table>
<thead>
<tr>
<th>Forecast Provider</th>
<th>Forecast Geography</th>
<th>Coal Type</th>
<th>One Step Forecasts</th>
<th>Average Growth Rate Differences*</th>
<th>Average Absolute Growth Rate Differences</th>
<th>Annual Steps Ahead</th>
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</thead>
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<td>Energy Information Admin.</td>
<td>Northern Appalachian</td>
<td>All</td>
<td>8</td>
<td>1.80, 2.71, 5.58</td>
<td>4.17, 7.12, 6.30</td>
<td>8.10, 6.42</td>
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<td></td>
<td>Central Appalachian</td>
<td>All</td>
<td>8</td>
<td>-1.66, 2.04, 1.18</td>
<td>3.14, 5.39, 6.30</td>
<td>4.33, 4.79</td>
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<td>Global Insight</td>
<td>Northern Appalachian</td>
<td>Steam</td>
<td>6</td>
<td>-5.55, -2.14, 1.80</td>
<td>6.26, 10.49, 4.24</td>
<td>7.13</td>
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<td></td>
<td>Central Appalachian</td>
<td>Steam</td>
<td>6</td>
<td>3.95, 5.20, 1.11</td>
<td>8.27, 12.55, 6.74</td>
<td>8.91</td>
</tr>
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<td>Hill &amp; Associates</td>
<td>Northern Appalachian</td>
<td>Steam</td>
<td>3</td>
<td>-5.55, -1.36, 0.71</td>
<td>6.11, 12.55, 6.74</td>
<td>4.63, 4.23</td>
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<td></td>
<td>Central Appalachian</td>
<td>Steam</td>
<td>3</td>
<td>1.86, 0.69, 1.96</td>
<td>2.25, 4.03, 3.67</td>
<td>4.23, 3.54</td>
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<td>West Virginia</td>
<td>Steam</td>
<td>3</td>
<td>0.02, 10.81, 5.72</td>
<td>7.12, 10.81, 5.72</td>
<td>6.98</td>
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<td>Marshall University</td>
<td>West Virginia</td>
<td>All</td>
<td>1</td>
<td>-0.63, 8.94, 8.21</td>
<td>0.63, 1.53, 8.94</td>
<td>8.21, 3.70</td>
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<td>West Virginia University</td>
<td>West Virginia</td>
<td>All</td>
<td>13</td>
<td>0.40, 1.65, 0.14</td>
<td>3.58, 5.09, 4.92</td>
<td>5.21, 4.70</td>
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</tbody>
</table>

Growth rate differences show the difference between the predicted growth rate (for each geography and coal type) and the West Virginia coal production growth rate.

*Positive (negative) values indicate over (under) prediction on average.

NA is Not Available. The Hill & Associates and Marshall University models have not produced enough forecasts to be evaluated at four years ahead.

Forecasts Evaluated:
- EIA: Annual Energy Outlook 1997-2005

As the table shows, the results are generally similar to the internal forecast evaluation results. The forecast differences rise as the forecast horizon rises, as is usually the case. At the one-year-ahead horizon, average absolute growth rate differences range from 0.63 percent to 8.27 percent. At the four-year-ahead horizon, average absolute growth rate differences range from 4.23 percent to 8.21 percent. Overall, the forecast differences are, in general, lower for the forecasts produced by Marshall University, and West Virginia University, than they are for EIA, Global Insight and Hill & Associates. The average absolute growth rate differences (averaged across forecast horizons) are used to construct the weights required to compute the final West Virginia coal production forecast.
Construction of the Consensus Forecast

The West Virginia consensus coal production forecast is constructed as the linear combination of seven coal production forecasts from five forecast providers (following Granger (1989)). This linear combination amounts to computing a weighted average of the forecast growth rates, where the weights are computed as functions of average absolute forecast differences. The average absolute forecast differences are drawn from Table 3 above and are the average across the four forecast horizons.

The forecast of the growth rate for West Virginia coal production in year \( t \) is computed as follows:

\[
\text{West Virginia Coal Production Growth Rate}_t = \sum \omega_i \times \text{Coal Production Growth Rate}_{i,t},
\]

where \( i \) indexes the seven forecasts to be combined and \( \omega_i \) is the weight applied to the coal production growth rate for forecast \( i \).

The weights \( (\omega_i) \) are constructed from the average absolute growth rate differences (averaged across horizons) shown in Table 3. They are constructed as follows:

\[
\omega_i = \frac{1}{\sum_d \frac{1}{d_i}},
\]

where \( d_i \) is the average absolute growth rate forecast difference (averaged across horizons). Thus, by definition, the weights sum to 1.0 and the forecast provider with the smallest (largest) average absolute growth rate differences gets the largest (smallest) weight in the combined forecast.

Using this formula and the data from Table 3, the weights \( (\omega_i) \) used to combine forecasts are shown in Table 4. Note that the weight for the Hill & Associates forecast is computed from their forecast differences averaged across their three geographies.
Table 4
Weights Used to Combine Coal Production Growth Rate Forecasts

<table>
<thead>
<tr>
<th>Forecast Provider</th>
<th>Geography</th>
<th>Weight (ωi)*</th>
<th>Last Year</th>
<th>Forecast</th>
</tr>
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<td>Energy Information Admin.</td>
<td>Northern Appalachian Region</td>
<td>0.12</td>
<td></td>
<td>2030</td>
</tr>
<tr>
<td></td>
<td>Central Appalachian Region</td>
<td>0.16</td>
<td></td>
<td>2030</td>
</tr>
<tr>
<td>Global Insight</td>
<td>Northern Appalachian Region</td>
<td>0.11</td>
<td></td>
<td>2030</td>
</tr>
<tr>
<td></td>
<td>Central Appalachian Region</td>
<td>0.09</td>
<td></td>
<td>2030</td>
</tr>
<tr>
<td>Hill &amp; Associates</td>
<td>Average Across Geographies</td>
<td>0.14</td>
<td></td>
<td>2024</td>
</tr>
<tr>
<td>Marshall University</td>
<td>West Virginia</td>
<td>0.21</td>
<td></td>
<td>2030</td>
</tr>
<tr>
<td>West Virginia University</td>
<td>West Virginia</td>
<td>0.16</td>
<td></td>
<td>2010</td>
</tr>
</tbody>
</table>

*These are the weights when all forecasts are available. When forecast data for a provider are exhausted the weights are re-adjusted to sum to one for the remaining forecasts.

Finally, the consensus forecast for West Virginia coal production growth rates generate forecast coal production levels using the following:

\[ \text{W.Va. Coal Production Level}_1 = \text{W.Va. Coal Production Level}_{1-1} \times (1 + \text{W.Va. Coal Production Growth Rate}_{1}) \]
Appendix II

Summary of Component Forecasts

Energy Information Agency
Publication: Annual Energy Outlook 2006
Publication Date: February 2006
Coal Type: All
Geography: Northern Appalachia, Central Appalachia¹
Forecast Horizon: 2005-2030

Assumptions:

Macroeconomic Growth:
U.S. real GDP growth at an average of 3.0 percent per year during the 2004-2030 period. Rate varies slightly from year to year and is based on the Global Insight macroeconomic forecast.

Environmental:
Those environmental restrictions that are fully spelled out in law or regulation by October 31, 2005 are included. Electricity producers comply with CAAA90, as well as the new Clean Air Interstate Rule (CAIR) and the Clean Air Mercury Rule (CAMR). For CAIR, NOx Phase I caps become effective in 2009, while Phase I caps for SO2 become effective in 2010. More stringent Phase II limits for both become effective in 2015. CAMR is also implemented in two phases, with Phase I beginning in 2010 and more stringent Phase II requirements effective in 2018.

Natural Gas Prices:
The lower 48 wellhead price of natural gas is projected to rise by 0.3 percent per year, from $5.49 per mcf in 2004 to $5.92 per mcf in 2030 in 2004 dollars.

Electricity Growth:
Electricity sales are forecast to grow an average of 1.6 percent per year through 2030. Coal’s share of electricity generation (net for load) remains stable at 55 percent from 2004-2030.

¹ Northern Appalachia includes Pennsylvania, Maryland, Ohio, and Northern West Virginia. Northern West Virginia includes all mines in the following counties (formerly defined as Coal-Producing Districts 1, 3, & 6): Barbour, Brooke, Braxton, Calhoun, Doddridge, Gilmer, Grant, Hancock, Harrison, Jackson, Lewis, Marion, Marshall, Mineral, Monongalia, Ohio, Pleasants, Preston, Randolph, Ritchie, Roane, Taylor, Tucker, Tyler, Upshur, Webster, Wetzel, Wirt, and Wood.

Central Appalachia includes Southern West Virginia, Virginia, Eastern Kentucky, Northern Tennessee. Southern West Virginia includes all mines in the following counties (formerly defined as Coal-Producing Districts 7 & 8): Boone, Cabell, Clay, Fayette, Greenbrier, Kanawha, Lincoln, Logan, Mason, McDowell, Mercer, Mingo, Nicholas, Pocahontas, Putnam, Raleigh, Summers, Wayne, and Wyoming.
Coal Mining Productivity:
Growth in coal mining productivity declines from an annual average rate of 5.9 percent per year during the 1980-2002 period to 0.4 percent during the 2004-2030 period. This is attributed to higher stripping ratios and the additional labor needed to maintain underground mines, which offsets productivity gains from improved equipment and technology. Productivity is expected to diminish in some eastern mines as operations move to more marginal reserve areas. In addition, regulatory restrictions on surface mines and fragmentation of underground reserves limit productivity gains in the Appalachia.

Summary Coal Production Forecast for Central and Northern Appalachia.

The EIA forecast for Central and Northern Appalachian coal production is summarized in Figure 10 and Table 5. The forecast calls for Central Appalachian coal production to gradually trend down from the 223 million ton per year range in 2006-2007 to the 155 million ton level by 2017, where it remains for the rest of the forecast period. This decline is due to tightening environmental regulations, depletion of easily mineable reserves, and increased competition from western production of lower sulfur coal (which is expected to become an increasingly popular option for eastern power plants).

In contrast, Northern Appalachia coal production is forecast to rise sharply from 155.5 million tons in 2006 to 201.6 million tons in 2010. Production plateaus in the neighborhood of 200 million tons per year until 2022, when growth accelerates. By 2030, EIA forecasts Northern Appalachian coal production to hit 240.7 million tons. This increase stems from the impact of gradual additions to emission abatement technology, that tends to make the use of higher sulfur coal more attractive.

![Figure 10](image-url)

Northern Appalachia includes Pennsylvania, Maryland, Ohio, and Northern W.Va. Central Appalachia includes Southern W.Va., Virginia, Eastern Kentucky, and Northern Tennessee.
## Table 5
**EIA Forecast**
**Regional Coal Production**
**Annual Energy Outlook 2006**
*(Millions of Tons)*

<table>
<thead>
<tr>
<th></th>
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</thead>
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<td>214.4</td>
<td>223.9</td>
<td>222.9</td>
<td>212.5</td>
<td>204.6</td>
<td>201.6</td>
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<td>Northern Appalachia</td>
<td>160.8</td>
<td>155.5</td>
<td>172.1</td>
<td>182.1</td>
<td>195.3</td>
<td>201.6</td>
<td>4.6</td>
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<tr>
<td>Central + Northern</td>
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<td>379.4</td>
<td>395.0</td>
<td>394.6</td>
<td>399.9</td>
<td>403.2</td>
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<td>184.2</td>
<td>176.9</td>
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<td>166.7</td>
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<td>209.1</td>
<td>209.7</td>
<td>208.2</td>
<td>206.9</td>
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<td>Central + Northern</td>
<td>393.1</td>
<td>393.3</td>
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<td>379.4</td>
<td>373.6</td>
<td>366.0</td>
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<td>203.1</td>
<td>203.8</td>
<td>204.5</td>
<td>205.5</td>
<td>206.6</td>
<td>0.1</td>
</tr>
<tr>
<td>Central + Northern</td>
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<td>358.5</td>
<td>357.9</td>
<td>360.5</td>
<td>359.0</td>
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<td>152.8</td>
<td>156.5</td>
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<td>154.5</td>
<td>154.1</td>
<td>0.2</td>
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<tr>
<td>Northern Appalachia</td>
<td>208.6</td>
<td>211.2</td>
<td>216.2</td>
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<td>384.5</td>
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<th>2030</th>
<th>Ann.Gr.(%)</th>
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</thead>
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<td>Central Appalachia</td>
<td>153.5</td>
<td>153.0</td>
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<td>Northern Appalachia</td>
<td>235.0</td>
<td>240.7</td>
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<tr>
<td>Central + Northern</td>
<td>388.5</td>
<td>393.7</td>
<td>1.3</td>
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**Global Insight, Inc.**
Publication: U.S. Energy Outlook 2005
Publication Date: August 2005
Coal Type: Steam Coal
Geography: Central Appalachia, Northern Appalachia
Forecast Horizon: 2005-2030

**Assumptions:**

*Macroeconomic Growth:*
U.S. real GDP growth at 3.2 percent per year 2004-2010; 3.0 percent per year 2010-2015; 3.0 percent per year 2015-2020; 2.8 percent per year 2020-2030.

*Environmental:*
The Global Insight forecast assumes the implementation only of known environmental policy, including CAIR and CAMR. The Global Insight forecast assumes no global warming policy is enacted.

*Natural Gas Prices:*
The lower 48 wellhead price of natural gas is projected to decline by 0.6 percent per year, from $5.49 per Tcf in 2004 to $4.65 per Tcf in 2030 in 2004 dollars.

*Electricity:*
Electricity generation (net energy for load) is forecast to grow by 1.8 percent per year from 2004-2030. Coal’s share of electricity generation (net for load) falls from 55 percent in 2004 to 52 percent by 2030.

*Coal Mining Productivity:*
Productivity is expected to continue rising during the forecast, which generates moderate declines in coal prices during the forecast.

**Summary Steam Coal Production Forecast for Central and Northern Appalachia.**

Figure 11 and Table 6 summarize the Global Insight forecast for steam coal production for Central and Northern Appalachia. The forecast calls for Central Appalachia steam coal production to drop from the 170 million tons per year range in 2005 down to the 125 million tons range by 2015, before recovering at rising back to the 150 million tons range by 2030. The production declines through 2015 are driven by tightening environmental restrictions and massive investment in pollution abatement equipment by electric power producers. These investments make higher sulphur coals more competitive and combine with the exhaustion of easily mineable reserves in the region to drive production down.
Coal production in Northern Appalachia rises from about 135 million tons in 2005 to 180 million tons by 2015, and continues to rise to about 230 million tons per year by the end of the forecast. The strong increase in production of Northern Appalachia steam coal is influenced by the continued expected investment in pollution control equipment, which tends to make the higher sulfur coal found in the region more competitive.

**Figure 11**

*Global Insight Forecast*

*Regional Steam Coal Production*

*U.S. Energy Outlook 2005*

Northern Appalachia includes Pennsylvania, Maryland, Ohio, and Northern W.Va.

Central Appalachia includes Southern W.Va., Virginia, Eastern Kentucky, and Northern Tennessee.
Table 6
Global Insight Forecast
Regional Steam Coal Production
U.S. Energy Outlook 2005
(Millions of Tons)

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<th></th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
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<td>159.6</td>
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<td>Central + Northern</td>
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<td>Central + Northern</td>
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<td>311.0</td>
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<tbody>
<tr>
<td>Central Appalachia</td>
<td>129.7</td>
<td>132.1</td>
<td>133.9</td>
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<td>129.3</td>
<td>131.1</td>
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<td>189.5</td>
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<td>200.3</td>
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<td>Central + Northern</td>
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<table>
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<tr>
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<th>2023</th>
<th>2024</th>
<th>2025</th>
<th>2026</th>
<th>2027</th>
<th>2028</th>
<th>Ann.Gr. (%)</th>
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<tr>
<td>Central Appalachia</td>
<td>133.2</td>
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<td>Northern Appalachia</td>
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<td>1.7</td>
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<tr>
<td>Central + Northern</td>
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<td>342.1</td>
<td>346.0</td>
<td>351.7</td>
<td>357.0</td>
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<table>
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<th></th>
<th>2029</th>
<th>2030</th>
<th>Ann.Gr. (%)</th>
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</thead>
<tbody>
<tr>
<td>Central Appalachia</td>
<td>143.9</td>
<td>146.1</td>
<td>1.5</td>
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<tr>
<td>Northern Appalachia</td>
<td>224.8</td>
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<td>1.9</td>
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<tr>
<td>Central + Northern</td>
<td>368.7</td>
<td>375.1</td>
<td>1.7</td>
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Hill & Associates
Publication: The Outlook for U.S. Steam Coal Long-Term Forecast to 2024
Publication Date: August 2005
Coal Type: Steam Coal only
Geography: State of West Virginia, Northern West Virginia, Southern West Virginia
Forecast Horizon: 2005-2024

Assumptions:

Macroeconomic Growth:
Hill & Associates uses EIA assumptions regarding real GDP growth.

Environmental:
Hill & Associates assume the 19+2 State SIP Call for NOx (including portions of Georgia and Missouri) is in place through 2008. EPA Clean Air Interstate Rule (CAIR) and Clean Air Mercury Rule (CAMR) effective as currently written. For SO2, CAIR utilizes a national cap-and-trade system which devalues available permits, beginning in 2010 with further devaluations in 2015, to reduce emissions. For NOx, CAIR replaces the SIP call with a cap-and-trade system similar to SO2. CAMR introduces a new cap-and-trade system for mercury (Hg). No CO2 limits.

Natural Gas Prices:
Natural gas prices (Henry Hub in constant 2005 dollars) gradually drop from near $7/mmBTU in 2005 to the $5/mmBTU range by 2010. Natural gas price trend up through the remaining forecast years, reaching $8/mmBTU by 2024.

Electricity:
Hill & Associates uses EIA assumptions regarding energy demand growth during the forecast.

Coal Mining Productivity:
Productivity growth is assumed to be 1 percent per year on a mine-by-mine basis for all regions during the forecast.

Summary Steam Coal Production Forecast for West Virginia
The Hill & Associates forecast for West Virginia steam coal production is summarized in Figure 12 and Table 7 below. Hill & Associates expect West Virginia steam coal production to remain stable in the neighborhood of 130 million tons, when more strict regulations regarding SO2 are assumed to come into effect, and then to trend down to the 120 million tons level in 2016, when production rebounds strongly to the 145 million tons range.
As the figure shows, southern West Virginia steam coal production trends down during the forecast, this is likely due to the declining reserve base for high quality coal in the area, particularly reserves with favorable geologic conditions for low mining costs. According to Hill & Associates, Central Appalachian high quality coal (a region which includes southern West Virginia) are not good enough for a plant to avoid scrubbing costs after SO2 limits are reduced. As more plants have to scrub with the lower limits, they will opt for much less expensive mid-sulfur or high-sulfur coal instead of using compliance or near-compliance coal in their scrubbed boilers.

The trend for northern West Virginia coal production is different. This is driven by the shift to higher-sulfur coal once scrubbers have been installed at electricity generating plants, in order to meet increasingly stringent environmental restrictions. Hill & Associates now believes that production from northern West Virginia (and Northern Appalachia) will begin to experience depletion of easily mineable reserves after 2016, which raises mining costs and reduces productivity. These factors moderate production gains near the end of the forecast period.
Table 7
Hill & Associates Forecast
W.Va. Steam Coal Production
Outlook for U.S. Steam Coal: Long-Term Forecast to 2024
(Millions of Tons)

<table>
<thead>
<tr>
<th></th>
<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>2005</td>
<td>79.3</td>
<td>48.3</td>
<td>127.6</td>
</tr>
<tr>
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<tr>
<td>2007</td>
<td>76.9</td>
<td>51.9</td>
<td>128.8</td>
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<tr>
<td>2008</td>
<td>74.4</td>
<td>56.4</td>
<td>130.8</td>
</tr>
<tr>
<td>2009</td>
<td>73.1</td>
<td>60.7</td>
<td>133.8</td>
</tr>
<tr>
<td>2010</td>
<td>65.6</td>
<td>61.8</td>
<td>127.4</td>
</tr>
<tr>
<td>2011</td>
<td>61.6</td>
<td>64.9</td>
<td>126.5</td>
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<tr>
<td>2012</td>
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</tr>
<tr>
<td>2014</td>
<td>58.5</td>
<td>58.8</td>
<td>117.3</td>
</tr>
<tr>
<td>2015</td>
<td>56.3</td>
<td>61.9</td>
<td>118.2</td>
</tr>
<tr>
<td>2016</td>
<td>51.1</td>
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<td>117.3</td>
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<tr>
<td>2018</td>
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<td>71.5</td>
<td>126.4</td>
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<tr>
<td>2019</td>
<td>55.0</td>
<td>80.8</td>
<td>135.8</td>
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<tr>
<td>2020</td>
<td>57.5</td>
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<td>142.9</td>
</tr>
<tr>
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<td>61.6</td>
<td>70.4</td>
<td>132.0</td>
</tr>
<tr>
<td>2022</td>
<td>65.6</td>
<td>79.9</td>
<td>145.5</td>
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</tr>
<tr>
<td>2024</td>
<td>62.8</td>
<td>78.7</td>
<td>141.5</td>
</tr>
</tbody>
</table>

W.Va. Central Appalachian coal is coal produced in the southern part of the state.
W.Va. Northern Appalachian coal is coal produced in the northern part of the state.
Marshall University CBER
Publication: Mountain State Clean Water Trust Fund
Publication Date: May 2001
Coal Type: All
Geography: State of West Virginia
Forecast Horizon: 2003-2030

Assumptions:

Macroeconomic Growth:
The forecast model directly uses the forecast for total Appalachian coal production during the 1998 to 2020 period published in the Annual Energy Outlook 2000 by EIA. This forecast calls for Appalachian production to fall from 470 million tons in 1998 to 385 million tons by 2020, an average annual decline of -0.9 percent per year. Within the EIA model, real GDP growth is forecast to average 2.2 percent per year through 2020.

Environmental:
The forecast assumes no additional restrictions on West Virginia surface mining operations. It embodies environmental assumptions used in the Annual Energy Outlook 2000. EIA assumes that Federal, State, and local environmental regulations on the books as of July 1, 1999 are observed. This includes restructuring in electricity generation to improve competition, phased reductions in SO₂ and NOₓ emissions by electricity generators required by the Clean Air Act Amendments of 1990. EIA does not include restrictions related to the NOx SIP Call in this forecast. EIA does include some elements, related to energy combustion and/or CO₂, of the Climate Change Action Plan developed by the Clinton Administration.

Natural Gas Prices:
From the Annual Energy Outlook 2000, real natural gas prices to electricity generators are projected to rise by 1.6 percent per year, from $2.34 per MBtu in 1998 to $3.33 per MBtu in 2020 in 1998 dollars.

Electricity Growth:
In the Annual Energy Outlook 2000, electricity sales are forecast to grow by 1.4 percent per year through 2020. Coal’s share of electricity generation rises slightly from 53.3 percent in 1998 to 55.4 percent by 2020.

Coal Mining Productivity:
After rising by 6.7 percent per year from 1978 to 1998, the Annual Energy Outlook 2000 calls for coal mining productivity growth to slow to 2.3 percent per year.
Summary Coal Production Forecast for West Virginia

The MU EIA/CBER forecast, summarized in Figure 13 and Table 8, calls for West Virginia coal production to remain stable near 160 million tons until 2010, when production begins to drop toward the 140 million tons mark, which it reaches in 2018. Production then remains in the 140 range through the remainder of the forecast. The forecast likely reflects the expected impact of tougher environmental standards and gradually increasing environmental remediation technology. Tougher environmental standards drive production down starting in 2010, as low sulfur coal produced in the West increase competitive pressures. Coal production stabilizes by 2020 as increasing use of scrubbing technology makes higher sulfur coal a bit more competitive.

![Figure 13](chart.png)
## Table 8
Marshall University CBER Forecast
W.Va. Coal Production
Mountain State Clean Water Trust Fund Report
(Millions of Tons)

<table>
<thead>
<tr>
<th></th>
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</thead>
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<table>
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</thead>
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<table>
<thead>
<tr>
<th></th>
<th>2021</th>
<th>2022</th>
<th>2023</th>
<th>2024</th>
<th>2025</th>
<th>2026</th>
<th>Ann.Gr.(%)</th>
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</thead>
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<tr>
<td>EIA/CBER</td>
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<tr>
<th></th>
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<th>2029</th>
<th>2030</th>
<th>Ann.Gr.(%)</th>
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<tbody>
<tr>
<td>EIA/CBER</td>
<td>139.5</td>
<td>139.0</td>
<td>138.5</td>
<td>138.1</td>
<td>-0.4</td>
</tr>
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</table>
Assumptions:

Macroeconomic Growth:
The West Virginia forecast is based on a national forecast, produced by Global Insight, Inc., completed in October 2005. That forecast calls for the U.S. economy to sustain economic growth during the next five years. U.S. real GDP growth is forecast to average 3.2 percent per year during the 2005-2010 period.

Environmental:
Laws on the books at the time of the forecast are observed.

Natural Gas Prices:
After rising strongly again in 2005 and 2006, natural gas prices (as measured by the Producer Price Index for utility natural gas) are forecast to gradually decline during the 2007-2010 period. Even so, natural gas prices in 2010 remain 7.6 percent above 2003 levels.

Electricity:
Electricity sales are forecast to grow by 2.1 percent per year through 2010. Coal’s share of electric utility fuel use falls from 49.4 percent in 2005 to 48.2 percent by 2010.

Coal Mining Productivity:
After falling during the 2004-2005 period, coal mining productivity growth is expected to rise slowly (by 0.1 percent per year) through 2010. This rate is well below the average rate posted during the 1990s, when coal mining productivity growth averaged 5.4 percent per year.

Summary Coal Production Forecast for West Virginia

The WVU BBER forecast for West Virginia coal production is summarized in Figure 14 and Table 9. The forecast calls for coal production to rise from 2005 levels (about 154 million tons) to 163 million tons by 2009 as sustained U.S. and world growth generate demand for West Virginia coals (both steam and metallurgical). Coal production stabilizes around 160 million tons during 2009-2010 as production gains in the northern West Virginia coal fields are offset by production declines in the southern part of the state.
Figure 14
West Virginia University BBER Forecast
W.Va. Coal Production
West Virginia Economic Outlook 2006

![Graph showing West Virginia coal production forecast](image)

Table 9
West Virginia University BBER Forecast
W.Va. Coal Production
West Virginia Economic Outlook 2006
(Millions of Tons)

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<th>2007</th>
<th>2008</th>
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<td>West Virginia</td>
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<table>
<thead>
<tr>
<th>Year</th>
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<th>2010</th>
<th>Ann.Gr.(%)</th>
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<tr>
<td>West Virginia</td>
<td>161.3</td>
<td>158.5</td>
<td>-0.4</td>
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References


