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EPA's Carbon Dioxide Rule for Existing Power Plants: Economic Impact Analysis of Potential State Plan Alternatives for West Virginia

CBER
Center for Business and Economic Research

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Prepared for
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Table of Contents

Executive Summary

The findings of this report are intended to assist the West Virginia Department of Environmental Protection (WVDEP) in satisfying the requirements of West Virginia House Bill 2004 (HB 2004). HB 2004 requires an assessment of the feasibility of submitting a state plan for compliance with Section 111(d) of the Clean Air Act, also known as the Clean Power Plan. The analysis within this report provides information for three of the 11 information items requested along with the initial feasibility assessment. This report provides information specifically related to items 1, 4 and 9, noted below:

1. Consumer impacts, including any disproportionate impacts of energy price increases on lower income populations;
4. Market-based considerations in achieving performance standards;
9. The impacts of closing the unit, including economic consequences such as expected job losses at the unit and throughout the state in fossil fuel production areas including areas of coal production and natural gas production and the associated losses to the economy of those areas and the state, if the unit is unable to comply with the performance standard.

To examine these questions, the Center for Business and Economic Research at Marshall University (CBER) reviewed existing research on compliance impacts and considerations. CBER analyzed data broadly describing West Virginia's economy and the role of the power generation industry. Using the AURORAxmp model Energy Ventures Analysis, Inc. (EVA) provided analysis on the energy market impacts of potential compliance – estimating levels of electricity generation, wholesale electricity prices, natural gas and carbon prices – under a business as usual (BAU) and broad compliance scenarios defined by four critical characteristics of potential compliance – the choice of a mass- or rate-based plan, with and without national trading.

With Regional Economic Models, Inc. PI+ (REMI PI+) CBER then used the results of EVA's analysis to estimate changes in power generation industry sales in West Virginia and the broader potential economic impact to the state of these sales changes, including estimating changes to electricity prices. CBER also evaluated the potential impacts of hypothetical plant closures with Economic Modeling Specialists, Inc. (EMSI) input-output model.

This report does not entail a comprehensive analysis of national compliance on West Virginia, nor does it constitute an accounting of outcomes from a fully specified compliance plan. As with other previous studies, outcomes are sensitive to the decisions of other states, dynamics in the market for natural gas, global energy and fuel markets, and prices associated with renewable energy and energy efficiency. For example, the impacts of reduced demand for West Virginia coal in other states as a result of 111(d) compliance is not included. Key Findings of the report are summarized below.

West Virginia Context

- West Virginia is a net exporter of electricity, with 55 to 60 percent of total generation supplied to customers in other states.
- West Virginia has ten coal-fired power plants, with 19 separate generating units, affected by 111(d).
- Fossil Fuel Electric Power Generation, which includes coal and natural gas generation, in West Virginia accounts for 94 percent of all state employment in the Electric Power Generation Industry.
- Electric Power Generation and Coal Mining are high wage industries in the state.
- West Virginia power producers account for about 15 percent of demand for West Virginia coal.
- 85 percent of demand for West Virginia coal derives from other states, principally Pennsylvania, Ohio and North Carolina, and global markets.
- About 80 percent of West Virginia coal consumed within the US goes to the electric power sector, with about 19 percent used for coke plants and other industrial plants.
- West Virginia power producers source slightly more than 50 percent of their coal from West Virginia and the remainder from other states.
- Emissions goals for West Virginia are equivalent to EPA's goals for fossil fuel-fired units.
- The final rule calls for a 37 percent reduction in the rate of carbon dioxide emissions, and equivalently a 29 percent reduction in the mass of CO_2 emitted by power producers.

Energy Market Analysis

- West Virginia power producers remain competitive under BAU and national trading scenarios.
  - Under BAU, electricity generation initially increases in West Virginia compared to recent years, but declines towards 2040 as units retire in line with planned depreciation cycles.
  - Electricity generation in compliance scenarios with national trading are comparable to BAU compared with non-trading scenarios, due to lower resulting prices for CO_2.
  - With a robust national emissions trading program, CO_2 emissions from West Virginia-based EGUs will not decrease, and may even increase relative to recent levels.
- Rate-based scenarios yield lower electricity generation than mass-based scenarios in general.
- Natural gas prices are projected to increase under all compliance scenarios, driven by export markets and increasing demand for electricity.
- Wholesale energy market prices are projected to increase under all compliance scenarios.
- The robustness of the emission trading regime is critical to resulting CO_2 prices and generation levels for affected EGUs.

Statewide Economic Impact of Potential Plan Alternatives

- Reductions in electricity generation lead to losses of state economic output and employment.
- Losses from scenarios with national trading are smaller than those estimated for non-trading scenarios.
- The Construction, Utilities, Mining, Retail Trade and Healthcare and Social Assistance sectors absorb the largest impacts.

Hypothetical Plant Closure Impacts

- Plants in more rural regions exhibit a larger economic impact within their sub-regions.
- Hypothetical individual plant closures result in lost sales ranging from $36 million to $285 million within individual regions, and employment losses of 118 to 863 jobs.
- Sales impacts are generally less than three percent of total sub-regional sales.
- Employment impacts account for less than 1.5 percent of total sub-regional employment.

Fossil Fuel Producing Industry Impacts

- West Virginia coal consumption follow similar patterns to electricity generation under scenarios analyzed.
    - National trading scenarios are comparable to BAU with increases in production over recent years and declines by 2040 consistent with the anticipated retirement of existing coal-fired capacity.
    - No trading scenarios yield larger reductions in West Virginia coal consumption by West Virginia-based EGUs.
- Mining industry employment impacts largely accrue to the coal mining sector.
- Oil and gas industry impacted employment comprises a smaller share of mining employment impacts.
- When considering hypothetical plant closures permanent loss of coal sales from larger plants yield larger impacts on statewide coal employment.
- Coal production losses also result in declines in severance tax revenues collected by the State.

Potential Consumer Impacts

- Reductions in electricity generation from BAU yield higher wholesale prices and higher retail prices.
- Additional costs from purchasing allowances or ERCs may be passed onto consumers.
- Costs of replacement capacity may further increase electricity rates, particularly under no trading scenarios.
- Premature plant retirement will result in remaining asset value and reductions in tax burdens that may or may not be passed along to ratepayers as savings.
- Low income households pay a higher share of their total income towards electricity and are more sensitive to price impacts.

Market Considerations

- Natural gas prices are expected to rise due to increased demand for exports and by the power generation industry, maintaining coal's relative competitiveness.
- Reductions in carbon dioxide and associated NO_x and SO_x emissions in the Eastern U.S. may result in health benefits, but specific estimates are difficult to quantify.
- Many scenarios will not result in decreased emissions from affected EGUs in West Virginia.
- Waste coal plants provide environmental benefits which may be curtailed by declines in production.
- Premature plant closures will result in remaining asset value and possible loss of fiscal revenues.
- Future market prices for energy (MWh) and capacity (MW) will influence actual results.
- Renewable energy development in West Virginia may be higher or lower than what assumed in this analysis, and is not necessarily dependent on the levels of generation from affected EGUs.

Compliance Options

- The rate approach to compliance in the absence of national trading is considered an inferior option as many West Virginia-based plants will likely retire prematurely due to limited opportunities to trade emission credits and uncertainties over how lost energy and capacity would be replaced.
- West Virginia benefits immensely from a trading regime at the national level.

1 – Introduction

Under West Virginia House Bill 2004 (HB 2004) passed by the West Virginia Legislature in 2015, the West Virginia Department of Environmental Protection (WVDEP) must submit a report regarding the feasibility of complying with the federal rule under Section 111(d) of the Clean Air Act (CAA) 40 CFR 60, Subpart UUUU, also known as the Clean Power Plan (CPP). The feasibility analysis must include an assessment of eleven factors identified by the legislature as well as necessary changes to state law to create a compliance plan. HB 2004 notes that the performance standards for coal-fired and natural-gas fired electric generating units in the state are to be based only on actions that can be reasonably undertaken at a unit without "switching from coal to other fuels or limiting the economic utilization of the unit."[1] If a plan is determined to be feasible, WVDEP must then develop a compliance plan.

In addition to assessing the feasibility of submitting a plan, the comprehensive analysis mandated by the legislature includes an assessment of a variety of impacts to consumers, the environment, and the electricity system. To assist WVDEP in meeting this requirement, the Center for Business and Economic Research (CBER) analyzed potential economic and consumer impacts of different CPP state compliance scenarios for West Virginia. The analysis contained in this report only considers West Virginia's potential compliance actions as it was beyond the scope of this study to analyze the potential actions of other states. Where possible, this report notes how other states' choices may impact modeled results.

HB 2004 contains eleven information items required in the feasibility study. CBER's analysis provides information specifically related to items 1, 4 and 9, noted below:

1. Consumer impacts, including any disproportionate impacts of energy price increases on lower income populations;
4. Market-based considerations in achieving performance standards;
9. The impacts of closing the unit, including economic consequences such as expected job losses at the unit and throughout the state in fossil fuel production areas including areas of coal production and natural gas production and the associated losses to the economy of those areas and the state, if the unit is unable to comply with the performance standard.

This report provides a brief overview of major components of the final version of 111(d) and summarizes key points of existing research on implementation impacts. Subsequent sections provide context for implementation considerations in West Virginia illustrating the state's power market profile, particularly for affected electric generating units (EGUs). The analysis contained herein focuses on estimating economic impacts, including potential ratepayer impacts, from a set of illustrative implementation scenarios: business as usual (BAU), mass-based compliance with and without national trading, and rate-based compliance with and without national trading. The analysis also provides estimates for sub-regional economic impacts associated with complete closure of affected EGUs. Finally, the report discusses market considerations for plan design including allowance allocations (under a mass-based approach) including incentives for early investments in renewables and energy efficiency; approaches for addressing leakage, such as adopting the new source complement; and potential impacts that may not be captured in the economic modeling, such as replacement capacity and tax impacts.

[1] West Virginia Code **§22-5-20**

1.1 About the Authors

Center for Business and Economic Research

Since 1994, the Center for Business and Economic Research (CBER) at Marshall University has been providing data, applied research and analysis to a variety of state and local agencies, and private organizations. With backgrounds in regional economic development, labor economics, and energy and resource economics, CBER has completed a variety of projects for and in collaboration with state agencies such as the West Virginia Department of Environmental Protection, the Division of Energy, and the West Virginia Legislature, including the Sub-committee on Local Finance, and the Senate Sub-committee on Education. Projects have included economic impact, industry and market analyses, and regulatory and policy analyses. CBER staff also have experience presenting to the West Virginia Legislature including the Joint Select Committee on Tax Reform and the Joint Committee on Government and Finance. A listing of completed projects can be found at www.marshall.edu/cber/publications.

Energy Ventures Analysis, Inc.

Energy Ventures Analysis, Inc. (EVA) is an energy consulting firm located in Arlington, VA. EVA is focused on economic, financial and risk analysis for the electric power, coal, natural gas, petroleum, and renewable, and emissions sectors. Since 1981, EVA has been publishing supply, demand and price forecasts as part of its FUELCAST subscription service for these energy sectors. EVA's clients span the entire market and include electric utilities, fuel producers, fuel transporters, commodity traders, regulators, and financial institutions. EVA licenses the AURORAxmp model developed by EPIS, Inc. and has spent considerable time and resources in customizing the input assumptions regarding many items including fuel and variable O&M costs, heat rates, new plant costs, plant retirement and additions and retrofit vs. retire decision-making. A number of companies use the same model and purchase EVA delivered fuel-price data. EVA has assessed a number of regulations including Mercury & Air Toxics Standard (MATS), Cross State Air Pollution Rule (CSAPR), Regional Haze programs, and State Renewable Portfolio Standards.

1.2 Purpose of the Study and Limitations

The purpose of this study is to provide analysis of the potential impacts to the state of different compliance alternatives. This study is among the first to conduct analysis on the final version of 111(d).

This report does not entail a comprehensive analysis of national compliance on West Virginia, nor does it constitute an accounting of outcomes from a fully specified compliance plan. As specific details regarding compliance options and industry decisions are unknown, this study employs standard assumptions within the energy and economic models to produce a limited set of estimates.

Impacts not considered within this report are:

- The full impact of 111(d), including:
    - the impact of reduced demand for WV coal from affected EGUs in other states
    - the potential health impacts of reduced carbon and criteria emissions

- Additional impacts of replacing retired coal-fired generating capacity, and associated energy, in the scenarios where the State does not participate in a trading regime. This omission is most significant in a rate approach without national trading, due the large amount of coal-fired generation capacity that is retired early.
- Potential impacts of capital spending on plant efficiency improvements, per EPA Building Block 1.
- The full impact of utilizing the CEIP.
- A scenario where trading opportunities are moderate. In reality the impacts of this rule may well fall somewhere in between those evaluated in this analysis, which simulates the extremes of possible outcomes.

Because this analysis makes no assumptions about capital spending on plant efficiency improvements, per EPA Building Block 1, no increases in fixed generation costs are modeled. This analysis also assumes that transmission and distribution costs are unaffected by the rule.

This study provides a broad characterization of how a state plan may impact the energy market within the state, including the power generation and coal mining industries. Results are intended to be illustrative and should be interpreted with care. As with other previous studies, outcomes are sensitive to the decisions of other states, dynamics in the market for natural gas, global energy and fuel markets, and prices associated with renewable energy and energy efficiency.

2 – The Clean Power Plan

2.1 Overview

Under Section 111(d) of the Clean Air Act (CAA) and 40 CFR 60 Subpart UUUU, the US Environmental Protection Agency (EPA) has finalized the rule known as the Clean Power Plan (111(d)) in which EPA establishes standards for the carbon dioxide (CO_2) emissions of two types of existing electric generating units (EGUs): fossil fuel-fired electric steam generating units (coal, oil and gas) and stationary combustion turbines (natural gas combined cycle (NGCC)).[2] The goal of 111(d) is to reduce national carbon dioxide emissions by 32 percent of 2005 levels by 2030.[3]

The EPA has established the emissions guidelines for EGUs. Individual states must develop and implement plans for compliance.[4] States may develop their own customized plans, or accept the federal rule which EPA may apply to any state that does not submit an approvable plan.[5] While states may select various options for compliance if they submit an approvable state plan, accepting the federal rule requires implementing the elements specified by EPA. States forgo the ability to choose any details of the compliance approach.[6] States may later submit their own strategy which if approved allows them

[2] 80 Fed. Reg. 64661 (October 2015). https://www.gpo.gov/fdsys/pkg/FR-2015-10-23/pdf/2015-22842.pdf, hereafter CPP Rule, 64,663; DeMeester and Adair (2015a)
[3] CPP Rule 64,665
[4] Hawaii, Alaska and the two U.S. territories Guam and Puerto Rico are excluded from compliance as EPA states they do not have sufficient information to establish the BSER for these areas. Vermont and the District of Columbia are also exempted as they do not have affected EGUs. CPP Rule 64,664
[5] CPP Rule 64, 668; 80 Fed. Reg.64966 https://www.gpo.gov/fdsys/pkg/FR-2015-10-23/pdf/2015-22848.pdf, hereafter Proposed Federal Rules, 64,967
[6] Proposed Federal Rules 64,968

to “exit the federal plan.”[7] The proposed federal plan includes mass- and rate-based model trading rules. EPA anticipates finalizing model trading rules in summer of 2016, but will not specify a final federal rule prior to applying it to states that do not submit their own approvable plans.[8]

The final rule indicates that states must submit a plan by September 6, 2016; however, states unable to submit a final plan may request an extension with their initial submittal. Final plans would then be due September 6, 2018;[9] the Supreme Court recently granted a stay pending legal challenges to the rule.[10]

In its final rule EPA outlines performance standards determined on the basis of the Best System of Emissions Reduction (BSER) for the two subcategories of affected EGUs. The BSER provides the building blocks, or actions EPA has determined affected EGUs may take to achieve emissions reductions. States may utilize these buildings blocks in their compliance plans, but are not limited to these actions. The three building blocks EPA has applied to EGUs are:[11]

1 – Heat rate improvements at existing affected coal-fired units
2 – Shifting generation to existing NGCC units
3 – Shifting generation to zero-emitting sources

While the proposed plan specified emissions standard in terms of state goals, the final rule includes source-level rates, as well as state-level mass and rate goals.[12] The source-specific goals are 1,305 lbs/MWh for fossil fuel-fired steam units and 771 lbs/MWh for stationary combustion turbines.[13] State goals were developed based on the source-specific rates and the state generation mix.[14] The interim compliance period for the final rule is an eight year term from 2022 to 2029, as opposed to the ten-year period beginning in 2020 in the proposed rule.[15] The interim period is further subdivided into three steps – 2022-2024, 2025-2027, 2028-2029 – forming a “gradual glide path” to final compliance in 2030.[16]

The final rule contains the following performance standards for West Virginia.[17] As noted in Table 1, West Virginia’s final rate goal is equivalent to the EPA’s rate goal for fossil fuel-fired steam units, reflective of the heavy representation of these EGUs in the state’s generation mix. As noted in the table, states have the option of adopting the “new source complement” provision as part of their plans. According to EPA, the new source complement is a means for states to “address the potential emissions leakage to new sources” under a mass-based approach.[18] This option essentially allows a state a larger initial emissions budget if it chooses to include new sources among its affected EGUs. For West Virginia the new source complement increases allowable emissions by approximately 1 percent. Emissions goals are discussed in greater detail in a subsequent section.

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[7] Proposed Federal Rules 64,969
[8] Proposed Federal Rules 64,969
[9] CPP Rule 64,669
[10] http://www.supremecourt.gov/orders/courtorders/020916zr3_hf5m.pdf Accessed March 16, 2016
[11] CPP Rule 64,667
[12] CPP Rule 64,672
[13] CPP Rule 64,667
[14] CPP Rule 64,820-5
[15] Ibid
[16] CPP Rule 64,673
[17] CPP Rule 64,824-5; 68,889
[18] CPP Rule 64,887-9

Table 1 West Virginia CO_2 Emissions Performance Rates and Mass Goals

	Interim goal*	Final goal
Emissions Performance Rates (lbs /MWh)	1,534	1,305
Emission Mass Goals (short tons)	58,083,089	51,325,342
New Source Complement (short tons)	*602,940*	*531,966*

*Interim goal is the average of goals specified along EPA's glide path
Source: 80 Fed. Reg. 64661 (October 2015).

2.2 New Source Complement and Leakage

The EPA has stated in the 111(d) documents that it is concerned about "leakage" of CO_2 emissions from existing to new fossil fuel-fired plants under state plans as opposed to shifting generation to new non-fossil fuel-fired sources. Leakage is defined as "the potential of an alternative form of implementation of the BSER (e.g., the rate based and mass-based state goals) to create a larger incentive for affected EGUs to shift generation to new fossil fuel-fired EGUs relative to what would occur when the implementation of the BSER took the form of standards of performance incorporating the subcategory-specific emission performance rates representing the BSER."[19]

Thus, EPA requires mass-based plan approaches to address leakage. According to the EPA "[r]ate –based goals do not…implicate leakage"[20], "where the form of the goal ensures sufficient incentive to affected existing EGUs to generate and thus avoid leakage, similar to the CO_2 emission performance rates."[21]

The New Source Complement option is designed to limit emissions from both existing and new sources of CO_2. According to the rule

> "…a state plan designed to meet a state mass-based CO_2 goal for affected EGUs plus a new source complement could involve a mass- based emission budget trading program that, under state law, applies to both affected EGUs, as well as new fossil fuel-fired EGUs. The program requirements for affected EGUs would be federally enforceable, while the program requirements for other fossil fuel-fired EGUs would be state-enforceable."[22]

Under a mass approach the New Source Complement adds to the tons of CO_2 allowances that can be emitted by fossil fuel-fired power plants in West Virginia. However, at the EPA-proposed levels a maximum of 835,000 tons of CO_2 is allocated in the second compliance period. This proposed amount of additional allowances would not cover emissions associated with even one new 600 MW natural gas combined-cycle (NGCC) plant emitting CO_2 at a rate of 900 lbs. CO_2/MWh, the generation-weighted average for NGCC units listed in the EPA database.[23] Although no new NGCC plants are currently under construction in West Virginia, at least three are in the planning or permitting process. If West Virginia

[19] CPP Rule 64,822
[20] CPP Rule 64,823
[21] CPP Rule 64,821
[22] CPP Rule 64,834, footnote 793
[23] A new 600-MW NGCC plant operating at 75% capacity factor would emit about 1.8 million tons of CO_2 per year. 600 X .75 X 8760 X 900 lbs. CO_2/MWh = 1,773,900 tons CO_2.

chooses a mass-based approach these plants will need allowances in order to operate if the new source complement option is utilized.

Due to concern over the impact of 111(d) on existing affected EGUs, the authors conclude that the new source complement approach is unlikely to be utilized by the State of West Virginia as a compliance strategy. For these reasons, the new source complement was not analyzed beyond the current discussion.

2.3 Clean Energy Incentive Program

While the proposed rule included demand-side energy efficiency (EE) measures as a fourth building block, this component is not included in the BSER in the final rule,[24] although it is still available to states as part of their compliance plans.[25] Instead EE is considered under the Clean Energy Incentive Program (CEIP), an optional component of 111(d) designed to motivate early action through offering incentives for qualifying renewable (RE) and EE investments in low income communities in early compliance periods.[26] With the CEIP, states may set aside allowances (if mass-based) or generate early emissions rates credits (ERCs under rate-based programs) to allocate towards qualifying projects. EPA will match these allocations such that every two MWh of qualifying RE will receive one state and ERC or equivalent allowances. Every two qualifying MWh of qualifying EE in low-income communities will receive two ERCs or equivalent allowances.[27] "EPA will match up to the equivalent of 300 million short tons in total credits during the CEIP program life."[28] EPA intends to implement the CEIP on behalf of a state in the federal plan.[29]

CEIP set-asides are reserved for solar and wind generation and for low-income energy efficiency. The CEIP establishes a system to award credits to qualifying projects that have generation in 2020 or 2021. Goals of the program are to ensure that momentum to no-carbon energy continues and to provide a jumpstart on compliance.

A state's CEIP set-aside amount is calculated based on its national share of the change in CO_2 emissions from the adjusted baseline (2012) to the final mass goal. The share is out of a total set-aside of 300 million tons of allowances nationwide from the first compliance period. For West Virginia, the CEIP set-aside amounts to 3,506,890 tons. Matching allowances or ERCs are assigned pro-rata by state. States can only obtain the match if they have awarded their own ERCs/allowances. As stated in a frequently asked questions document, "to generate the credits, states would effectively borrow from their mass-based or rate-based compliance targets for the interim 2022-2029 compliance period. EPA would provide its share of credits from a to-be-established reserve."[30]

[24] CPP Rule 64,738
[25] CPP Rule 64,673
[26] CPP Rule 64,829
[27] CPP Rule 64,676
[28] McCarthy et al (2016). p. 24
[29] Proposed Federal Rules 65,000
[30] McCarthy et al (2016). p. 24

"Renewable energy projects would receive one credit (either an allowance or ERC) from the state and one credit from EPA for every two MWh of solar or wind generation. EE projects in low-income communities would receive double credits: For every two MWh of avoided electricity generation, EE projects will receive two credits from the state and two credits from EPA.

2.4 Other Implementation Considerations

To implement the 111(d) rule, states may choose an "emission standards" plan – either rate-based or mass-based performance standards, or "state measures" plan.[31] The latter option is designed to allow states to use their own mechanisms to achieve their performance standards. While state mechanisms may not be federally enforceable, these plans must include a federally enforceable "backstop" should they fail to obtain their emissions goals.[32] For states that choose a mass-based plan, the final rule requires the plans to address the issue of "leakage" or "shifts in generation to unaffected fossil fuel-fired sources" that may "result in increased emissions."[33]

Another change from the proposed to the final rule is that states must consider electricity reliability in their plans.[34] To that end, the final rule contains a "reliability safety-valve", a provision to exempt "reliability-critical affected EGUs" and apply alternative standards.[35] The proposed federal plan contains no similar provision as "inflexible requirements are not imposed on specific plants."[36] As EPA believes the proposed federal plan entails sufficiently robust trading, affected EGUs "can obtain allowances or credits if needed."[37]

Multi-state plans are accepted under the final rule, provided that all states utilize the same type of plan. Additionally, the final rule allows states to submit trading ready plans but also retain their individual performance standards, unlike in the proposed rule.[38]

In addition to choosing either an emission standards or state measures plan, and specifying whether the plan will be rate- or mass-based, details left to the states include: method for distributing allowances (under mass-based plans); provisions to address leakage or otherwise demonstrate it is not an issue (under mass-based plans); accounting methods for ERCs (under rate-based plans); specific mechanisms for monitoring, reporting and trading. Figure 1 summarizes these design elements.[39]

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[31] CPP Rule 64,826-64,840
[32] CPP 64,835-6
[33] CPP Rule 64,821-3
[34] CPP Rule 64,849
[35] CPP Rule 64,867-8
[36] Proposed Federal Rules 64,982
[37] Ibid
[38] CPP Rule 64,839
[39] DeMeester, J. et al (2015)

Figure 1 Plan Design Components

	Plan Parameter	State Plan	Proposed Model Rule	Proposed Federal Plan
Mass & Rate	Glide path?	Adjustable if interim rate is met on average between 2022-2029	Uses EPA-defined glide path from final CPP rule	Uses EPA-defined glide path from final CPP rule
	Trading?	Broad flexibility to determine parameters for trading	Trading ready -- i.e., can trade with any other state with a similar plan approach and linked tracking system[a]	Trading ready -- i.e., can trade with any other state with a similar plan approach and linked tracking system[b]
Mass	How to allocate allowances?	No Restrictions	Allocations to affected EGUs based on historic generation (2010-2012): includes set-asides for CEIP, certain renewable energy, and output-based allocation to NGCC[c]	Allocations to affected EGUs based on historic generation (2010-2012): includes set-asides for CEIP, certain renewable energy, and output-based allocation to NGCC[c]
	How to meet the requirement on the risk of leakage?	Adopt new source complement, use allowance allocation to balance incentives, other state approaches	Uses allowance allocation to balance incentives	Uses allowance allocation to balance incentives
	CEIP?	Opt-in, determine size of state pool of matching allowances	Includes the CEIP with full pool of matching allowances; states can opt out	CEIP participation required; state can reallocate a smaller number of matching allowances
Rate	What resources other than affected EGUs can generate Emissions Rate Credits?	State flexibility to propose additional eligible resources with the exclusion of any source covered by CO_2 new source performance standards, energy storage, and carbon offsets	All wind, all solar, geothermal, hydropower, wave, tidal qualified biomass, waste-to-energy, new/uprate nuclear, non-affected combined heat and power, energy efficiency/demand-side management	On-shore utility-scale wind, utility-scale solar PV, concentrated solar power, geothermal power, new/uprate nuclear, utility-scale hydropower
	ERC Accounting	Broad flexibility to specify ERC and Gas Shift-ERC accounting methods in plan	ERC & GS-ERC accounting methods defined[d]	ERC & GS-ERC accounting methods defined
	CEIP?	Opt in; state must determine how to maintain emissions performance during compliance	Included; mechanism for maintaining emissions integrity to be determined; states can opt out	Included; mechanism for maintaining emissions integrity to be determined

a. If a state uses the model rule, it might add specifics about trading partners or geographic scope.

b. In a federal plan, states lose the ability to dictate trading partners and geographic scope.

c. The EPA takes comment on the allowance method. It encourages states to determine their own allocation method in both the proposed federal plan and model rule.

d. States can propose new accounting methods with EPA approval.

Source: Table reproduced from DeMeester and Adair (2015a)

3 – Existing Research

Studies on the impact of the EPA's 111(d) rule focus primarily on energy market dynamics – emissions, generation mix, fuel production and prices, and electricity prices. Estimates exist at the state, regional and national level; however, studies on sub-state dynamics as those mandated by HB 2004 (such as at the power plant or unit level) are scarce. [40] Some studies also include an accounting of potential job impacts. Analyses vary as to the inclusion of only direct impacts (e.g. only jobs associated with power plants or extraction industries) versus indirect (downstream effects of energy consuming industries and households).[41]

Most existing studies were completed prior to the final rule, and include a range of potential implementation scenarios characterizing possible rate- and mass-based compliance approaches. While reports on potential state level impacts exist, many have been conducted by or on behalf of a broad range of industry, interest and advocacy groups rather than by or for state regulatory agencies.[42] This report examined existing research covering this spectrum. Common themes emerge regardless of study perspective.

3.1 Changes from Proposed to Final Rule

As noted previously, the final rule contains some revisions over the proposed rule. These revisions include:

- restricting the list of affected EGUs to only fossil fuel-fired steam units (coal, oil and gas) and stationary combustion turbines (NGCC);
- revisions to the BSER, including reductions to the heat rate improvement targets and removal of demand side EE;
- recalculated emissions standards, including source-level and state-level mass and rate standards;
- delaying the onset of the interim compliance period from 2020 to 2022;
- allowing individual state plans to be trading ready; and the reliability safety valve.[43]

Even with these changes, from a modeling standpoint the basic structure of 111(d) remains the same from the proposed to final rule. While these changes may have implications for details of the creation and implementation of a state plan, results of existing studies are not necessarily invalidated. For example, in ERCOT's analysis of the final rule they note that "though EPA made a number of modifications in the final rule, the most impactful for the stringency of limits for Texas is EPA's shift to a uniform national approach for setting the standards."[44] The report goes on to note that the changes to

[40]See EIA (May 2015); ERCOT (2015); PJM (2015a); PJM (2015b); Ross et al (2015); Gumerman et al (2014); MISO (2014); NERA Economic Consulting (2014); Southern Environmental Law Center (2014); Southwest Power Pool (2014); Stanton et al (2014);

[41] Bivens (2015); SELC (2014); EPA (2015)

[42] E.g. Stanton et al (2014) for the National Association of State Utility Consumer Advocates; NERA (2014) for American Coalition for Clean Electricity, American Fuel & Petrochemical Manufacturers, Association of American Railroads, American Farm Bureau Federation, Electric Reliability Coordinating Council, Consumer Energy Alliance and National Mining Association; Marathon Petroleum Company (2015); WVU College of Law Center for Energy and Sustainable Development, Downstream Strategies and Appalachian Stewardship Foundation (2015); Bureau of Business and Economic Research at University of Montana for NorthWestern Energy (2015)

[43] CPP Rule; PJM (2015c); Ramseur and McCarthy (2015)

[44] ERCOT (2015) p.1

the final rule affected the "timing and magnitude of the required reductions for Texas."[45] The report also specifies that "ERCOT conducted a modeling analysis using similar assumptions" for both the proposed and the final rule.[46]

The lack of specificity a priori in the particular structure of compliance plans, even under the final rule, as well as the uncertainty regarding other states' actions, necessitates that any studies evaluating potential impacts rely on a range of assumptions. Changes to the set of affected units and performance standards may impact the relative magnitude of impacts for a given state, but underlying dynamics do not necessarily change. Thus, findings of existing studies completed before the publication of the final rule remain generally instructive of major themes and dynamics. Celebi (2015) notes that the phase in of compliance requirements and trading ready platforms may reduce some reliability concerns, but the market for allowances or ERCs is still undetermined and depends heavily on the choices of individual states.

3.2 Importance of Other States' Actions

As with the proposed rule, the relative costs of different compliance options for individual states depends on the actions of other states.[47] Existing research cannot fully account for the potential range of possible outcomes from other states. Results obtained from current analyses may not be realized once compliance decisions have been made.

3.3 Common Themes

General commonalities exist among report findings, such as the conclusion that regional trading provides greater flexibility and generally lower carbon prices relative to individual state plans without trading.[48] Critical assumptions influencing model results include prices for building renewable capacity, fuel prices including natural gas, and ability of coal-fired units to implement heat rate improvements.[49] Energy efficiency measures often are not modeled, but rather assumed and impact compliance outcomes.[50] For example, EPA's (2015) analysis relies heavily on assumptions of energy efficiency programs reducing demand for electricity, thus relaxing compliance requirements and costs on producers. Similarly, following EPA's methodology a study on the impacts in Virginia found lower retail electricity costs despite higher electricity rates, due to reduced demand from energy efficiency measures.[51]

In most models energy efficiency generally manifests as the least-cost measure to compliance through reducing energy demand, followed by switching generation to natural gas and lastly new zero-emitting

[45] Ibid
[46] Ibid
[47] Celebi (2015)
[48] PJM (March 2015); Ross et al (2015); EPA (2015)
[49] Ibid
[50] PJM (2015a); EPA (2015); Hopkins (2015)
[51] SELC (2014)

capacity.[52] However, effective energy efficiency measures may increase energy demand. Hopkins (2015) goes on to note "while energy efficiency is a policy-efficient tool, assumptions about how much energy efficiency is available, and what it costs program administrators and participants in the end, can result in a wide variation in overall compliance costs."[53]

3.4 Energy Market Findings

Studies generally estimate reduced coal-fired generation, and switching to natural gas and non-emitting sources. This result is largely by design of 111(d).[54] For example, Gumerman et al (2014) find that the 111(d) compliance leads to about a 13 percent reduction in existing coal capacity for North Carolina relative to Business as Usual (BAU). Ross et al (2015) estimate up to a 45 percent reduction for Southeastern states under a rate-based approach covering only existing units, with a smaller reduction estimated for a mass-based plan. Estimates from NERA's (2014) national model range from 29 to 71 percent reduction in coal-fired generation and coal unit retirements between 18 to 69 percent in their evaluation of rate-based compliance scenarios. A recent study by the Bureau for Business and Economic Research at the University of Montana (2015) found that compliance with the 111(d) rule in Montana will require closure of current facilities, installation of new, lower-emitting facilities and changes in the wholesale and retail markets. At particular risk is the state's Colstrip facility and the surrounding region.

Administrative, policy and transfer costs broadly constitute the categories of compliance costs considered. These costs generally include capital costs of improvements to existing coal-fired units[55] and administrative costs of monitoring and reporting.[56] Policy costs entail impacts on retail electricity prices which are influenced by the wholesale energy market dynamics.[57]

Gumerman et al (2014) and Ross et al (2015) characterize allowance costs as zero-sum transfer within the economy, and thus do not include them as an incremental cost of 111(d). In other words, the prices associated with allowances or ERCs will impact generation and consumption decisions by transferring costs. For a given level of production, the relative price of energy will be more expensive reflective of the cost of carbon not currently accounted for by the industry. All other relevant considerations held constant, the compliance costs and transfer costs may translate to higher prices for consumers.

3.5 Economic and Employment Impacts

A few existing studies also consider economic impacts in terms of employment changes resulting from 111(d) implementation. For most the multiplier effect is not the central focus of the analysis. In general, where job gains are projected to occur they result from new facility construction and heat rate

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[52] Hopkins (2015)
[53] Ibid p. 8-9
[54] Bevins (2015); Ross et al (2015); Gumerman et al (2014);
[55] Gumerman et al (2015); EPA (2015a);
[56] EPA (2015a);
[57] Ross et al (2015)

improvements.[58] SELC's (2014) analysis for Virginia, which follows EPA's methodology in its Regulatory Impact Analysis (RIA) includes estimates of jobs created due to heat rate improvements and new capacity construction, which are one-time and estimated to be modest. Jobs are estimated to be lost from plant retirement, and in coal mining. The report notes that states are not obligated to pursue energy efficiency, thus job impacts depend entirely on how states choose to pursue EE. In the RIA, EPA treats demand-side energy efficiency differently for rate-based versus mass-based compliance. The former is modeled as decisions undertaken by EGUs and the latter as measures adopted by states.[59] Further the report notes that while EPA uses full-time equivalents (FTEs) in most of their job impacts, EE jobs also include part-time positions.

Bivens (2015), in an analysis of the proposed rule, focuses specifically on employment impacts, finding net job gains nationally beginning in 2020 and continuing at a slower rate through 2030. These gains however are generally in lower-skilled occupations. Similar to SELC (2014), job gains result from construction of new facilities and zero-emitting generation capacity. Job losses are more likely to occur in "poorer states…lead[ing] to transition challenges for workers and communities responding to the CPP."[60] Bivens (2015) further estimates potential employment impacts related to changes in electricity prices and estimates an additional 100,000 jobs lost nationally as a potential maximum resulting from a 5 percent increase in electricity prices.[61] Overall, Bivens concludes that employment impacts will be relatively modest, however they will be distributed unevenly across the states.

In August 2015, EPA released its revised RIA based on the final rule. The revised analysis included estimates from impacts on retail electricity prices, coal prices, coal production, natural gas prices and use for power. EPA reports changes in terms of job-years, or the amount of work accounted for one full-time equivalent in one year. Thus estimates contain both full- and part-time jobs.[62] EPAs estimates include a reduction of 25,000 to 26,000 job-years in 2025, and a net decrease in about 30,000 to 34,000 job-years by 2030 in the electricity, coal and natural gas sectors.[63] The RIA goes on to estimate a net job gain of 53,000 to 82,000 jobs nationally in 2030 from one-percent growth in energy efficiency programs, approximately 2 to 3 jobs for every $1 million of expenditure.[64]

The UMT BBER (2015) study estimated that the closure of the Colstrip facility would result in a loss of 7,000 jobs statewide in 2025, more than half of which would occur in the region surrounding the facility. Job impacts were most heavily concentrated in state and local government and construction sectors, and generally higher wage jobs. Further, the study estimated a $1.5 billion loss in economic output and net outmigration of more than 10,000 people resulting from complete closure. While closure resulted in

[58] Bivens (2015); SELC (2014); EPA (2015a)
[59] EPA (2015a)
[60] Bivens (2015), p. 4
[61] Bivens (2015), p.13-14
[62] EPA (2015a)
[63] EPA (2015a), pp.6-22-6-25
[64] EPA (2015a), pp.6-30-6-31.

negative fiscal impacts through loss of tax revenue, lower property tax burdens were passed onto ratepayers in the form of lower electricity rates.

3.6 Previous Results Specific to West Virginia

A few previous studies provide findings of their analysis specific to West Virginia. Van Nostram et al (2015) examined potential compliance strategies for West Virginia, determining that performance standards cannot be met with a "business as usual" (BAU) or "inside the fenceline" approach only. Such strategies would require some form of multi-state trading to be effective. According to the authors compliance can only be achieved through scenarios that include heat rate improvements; co-firing and repowering with natural gas and plant retirements (both currently prohibited as components of a state plan under HB 2004); new natural gas capacity; renewable energy capacity which "has limits to… development within the state", and combined heat and power facilities which also may be limited in the absence of state provided incentives.[65] The study also notes that while power producers within West Virginia utilize coal mined in the state, the actions of other states will likely have a larger impact on the state's coal industry.

With regards to specific impacts estimated for West Virginia, the range of results indicate general increases in electricity prices. NERA's (2014) analysis of the proposed CPP estimates a 10 to 14 percent increase in delivered electricity price impacts. Also based on the proposed rule PJM (2015a) forecasted possible carbon prices for states in the region. For West Virginia prices range from $6/ton to $18.90/ton with a state-only approach depending on the extent of renewables, energy efficiency measures and entry of new NGCC facilities. More restrictive assumptions on available alternatives to existing generation lead to higher carbon prices. Limited natural gas capacity increases the estimated price of carbon to $18.90.

Based on the final rule, EVA estimated wholesale price impacts and capital investments necessary to achieve compliance under state-only mass-based approaches without interstate trading. Assuming lowest-cost state strategies, EVA (2015) finds wholesale prices will increase in West Virginia by about 30 percent by 2030, in a scenario in which all new fossil units except gas turbines are covered under 111(d). The report also estimates $165 million in new capital investment will be required in West Virginia to provide replacement power capacity.[66] Further, EVA's (2015) analysis assumed no allowance banking.

4 – West Virginia Context

4.1 Economic Overview

West Virginia's economy is characterized by strong contributions to state gross domestic product (GDP) from the Government, Mining[67], and Finance, Insurance, Real Estate, Rental and Leasing industries each

[65] Van Nostrom et al (2015) p.21
[66] EVA (2015) p.12
[67] Industry categories are the U.S. Bureau of Economic Analysis standard aggregate industry groupings which are mutually exclusive. https://bea.gov/regional/rims/rimsii/download/64IndustryListB.pdf

of which constitute more than 10 percent of economic output. In terms of employment, Government remains the largest sector. Educational Services, Health Care and Social Assistance, and Retail Trade also manifest as large employers. Table 2 contains GDP and Employment statistics for the state.[68]

Table 2 West Virginia GDP and Employment by Industry

Industry	GDP ($M) (2013)	Share of Total	Employment (2014)	Share of Total
Government	$11,691	16.7%	156,758	17.1%
Mining	$9,381	13.4%	45,458	5.0%
Finance, insurance, real estate, rental, and leasing	$8,990	12.8%	53,283	5.8%
Manufacturing	$7,306	10.4%	50,812	5.6%
Educational services, health care, and social assistance	$7,003	10.0%	137,132	15.0%
Professional and business services	$4,984	7.1%	90,570	9.9%
Retail trade	$4,972	7.1%	106,375	11.6%
Wholesale trade	$3,214	4.6%	24,645	2.7%
Construction	$3,107	4.4%	48,093	5.3%
Arts, entertainment, recreation, accommodation, and food services	$2,683	3.8%	85,219	9.3%
Transportation and warehousing	$2,165	3.1%	26,174	2.9%
Information	$1,589	2.3%	11,170	1.2%
Other services, except government	$1,499	2.1%	48,488	5.3%
Utilities	$1,165	1.7%	5,342	0.6%
Agriculture, forestry, fishing, and hunting	$328	0.5%	24,552	2.7%
Total	$70,077	100%	914,071	100%

Source: US Bureau of Economic Analysis. Percentages may not sum to 100 due to rounding.
Footnote 68 contains industry descriptions.

4.2 Electric Power Generation Industry

Within West Virginia, the Electric Power Generation Industry (NAICS 22111), a subset of the Utilities supersector, employs approximately 2,800 individuals with average earnings of $137,000.[69] Earnings includes total compensation – wages, benefits and profits.[70] While employment in the industry has decreased regionally and nationally since 2001, the statewide decline has been about 10 percentage points less than the nation as a whole. Sixty of the nation's power generation establishments are located

Industries consist of multiple subsectors. For example, Government includes Federal Civilian, Federal Military and State and Local government. The Mining industry contains Oil and Gas Extraction, Mining (except Oil and Gas), and Support Activities for Mining. Educational Services includes elementary, secondary, post-secondary and all other educational services. For a detailed list of BEA industry codes please see http://www.bea.gov/regional/pdf/rims/406%20Industry%20List%20A.pdf

[68] 2013 is the most recent year with complete data at the industry level for GDP, and 2014 for employment.

[69] The Census Bureau defines the Electric Power Generation sector as an industry containing "establishments primarily engaged in operating electric power generation facilities. These facilities convert other forms of energy, such as water power (i.e., hydroelectric), fossil fuels, nuclear power, and solar power, into electrical energy. The establishments in this industry produce electric energy and provide electricity to transmission systems or to electric power distribution systems."

[70] EMSI defines earnings as inclusive of wages, salaries, profits, benefits and other compensation. Thus wages are a subset of earnings.

within West Virginia. An establishment is "a single physical location where business is conducted or where services or industrial operations are performed."[71] Thus a firm may own or operate more than one establishment, and different establishments for a firm may conduct different functions or operations. For example, within the Electric Power Generation sector a firm may have an establishment responsible for producing power (e.g. an EGU) and an establishment for administrative operations. Thus, power plants themselves are one type of establishment within the industry sector and represent a subset of total industry employment.

Table 3 Electric Power Generation (NAICS 22111), 2015

Region	Employment	Average Earnings	Establishments*	%-Change Employment since 2001
West Virginia	2,819	$137,480	60	-34%
US	158,878	$151,273	3,234	-43%

Source: EMSI, 2015 Q3 Estimates
*2014 estimate

The Power Generation industry is comprised of subsectors disaggregated by fuel source. Within West Virginia, fossil fuel generation (NAICS 221112), which includes electricity generated from both coal and natural gas, accounts for the vast majority, 94 percent, of the industry as measured by employment. For the nation as a whole, fossil fuels constitute about 61 percent of Power Generation employment, with nuclear power comprising the next largest share. Hydroelectric and wind power represent the balance of industry employment in West Virginia.

Table 4 Sub-Industry Employment Breakdown for Electric Power Generation, 2015

NAICS	Description	Total Employment		Percentage of Employment	
		West Virginia	United States	West Virginia	United States
221112	Fossil Fuel Electric Power Generation	2,656	97,212	94%	61%
221111	Hydroelectric Power Generation	135	5,140	5%	3%
221115	Wind Electric Power Generation	28	3,376	1%	2%
221113	Nuclear Electric Power Generation	0	47,660	0%	30%
221114	Solar Electric Power Generation	0	1,725	0%	1%
221116	Geothermal Electric Power Generation	0	1,251	0%	1%
221117	Biomass Electric Power Generation	0	1,484	0%	1%
221118	Other Electric Power Generation	0	1,029	0%	1%
Total		2,819	158,878		

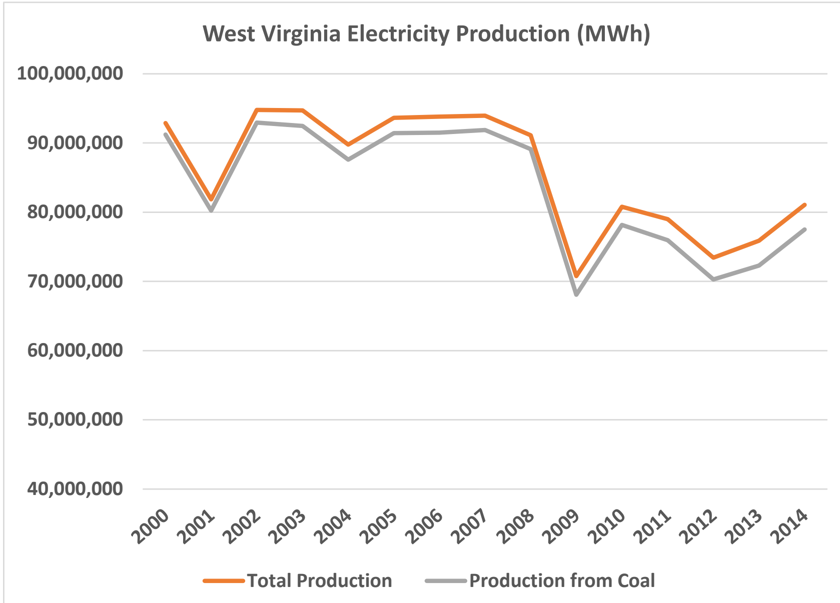
Source: EMSI, 2015 Q3 Estimates

In 2014, 96.2 percent of electricity generated in West Virginia was from coal-fired power plants. About 2.7 percent was produced by wind and hydro-power, with natural gas plants largely supplying the remaining 1 percent of generation as needed. The share of coal-fired generation has fallen somewhat

[71] U.S. Census Bureau, https://www.census.gov/econ/susb/definitions.html

since the early 2000s due primarily to the addition of wind capacity. Figure 2 illustrates the total production of electricity in West Virginia and the amount generated from coal. Coal-fired generation has fallen in recent years due to low gas prices and a competitive position in regional power markets.

Figure 2 Total Electricity Production in West Virginia and Production from Coal (MWh), 2000-2014



Source: EIA.

West Virginia is a net exporter of electricity. In 2014, plants within the State produced 79.2 million MWh of electricity and in-state customers consumed 32.7 million MWh. Table 5 describes the total generation (MWh) and capacity (MW) characteristics of power plants located in West Virginia. This data includes plants that closed in 2015 (Kammer – 600 MW, Kanawha River - 400 MW, and Phil Sporn - 580 MW) which amounted to 1,580 MW of coal-fired capacity.

Table 5 West Virginia Electricity Generation and Capacity by Resource, 2014

Resource	MWh	Share MWh	MW Summer Capacity	Share MW
Coal	76,244,260	96.2%	13,538	87.7%
Hydro	713,154	0.9%	198	1.3%
Natural Gas	653,291	0.8%	1,071	6.9%
Other	162,125	0.2%	47	0.3%
Wind	1,451,383	1.8%	583	3.8%
Total	79,224,213	100.0%	15,437	100.0%

Source: EIA-923 and Inventory of Operating Generators (as of September 2015).

The Power Generation industry employs a broad range of occupations at varying wage levels.[72] Twenty different occupations are represented within the industry with average wages ranging from about $33,000 (Office Clerks, General) to $92,000 (Electrical Engineers) annually. Table 6 displays the top five detailed occupations in the sector and average wages in West Virginia as of 2014. Power plant operators represent about one-fifth of occupations with an average wage of nearly $70,000. Customer Service Representatives and First-Line Supervisors of Production and Operating Workers together account for another fifth of occupations in the state sector. Other occupations within the sector include Business and Financial, Management, Transportation and Material Moving, and Engineering occupations for example.[73]

Table 6 Top Power Generation Occupations in West Virginia, 2014

Description	**Employment**	**Average Wage**
Power Plant Operators	560	$69,870
Customer Service Representatives	240	$38,620
First-Line Supervisors of Production and Operating Workers	230	$68,880
Power Distributors and Dispatchers	210	$76,939
Electrical and Electronics Repairers, Powerhouse, Substation, and Relay	190	$73,900

Source: US Bureau of Labor Statistics, Occupational Employment Statistics

[72] The US BLS reports occupations for the Power Generation, Transmission and Distribution Industry, and for Transmission and Distribution. Power Generation occupations were approximated using the difference of the two reported industries.
[73] For a complete list of occupations please see the US BLS Occupational Employment Statistics.

4.3 West Virginia Coal-Fired Power Plants

Currently in West Virginia six power companies operate ten coal-fired power plants throughout the state. Eight of the ten use pulverized coal as the fuel source and two use fluidized bed technology with waste coal. Table 7 contains characteristics of the power plants currently operating in West Virginia.

Table 7 Operating Coal-Fired Power Plants in West Virginia, 2015

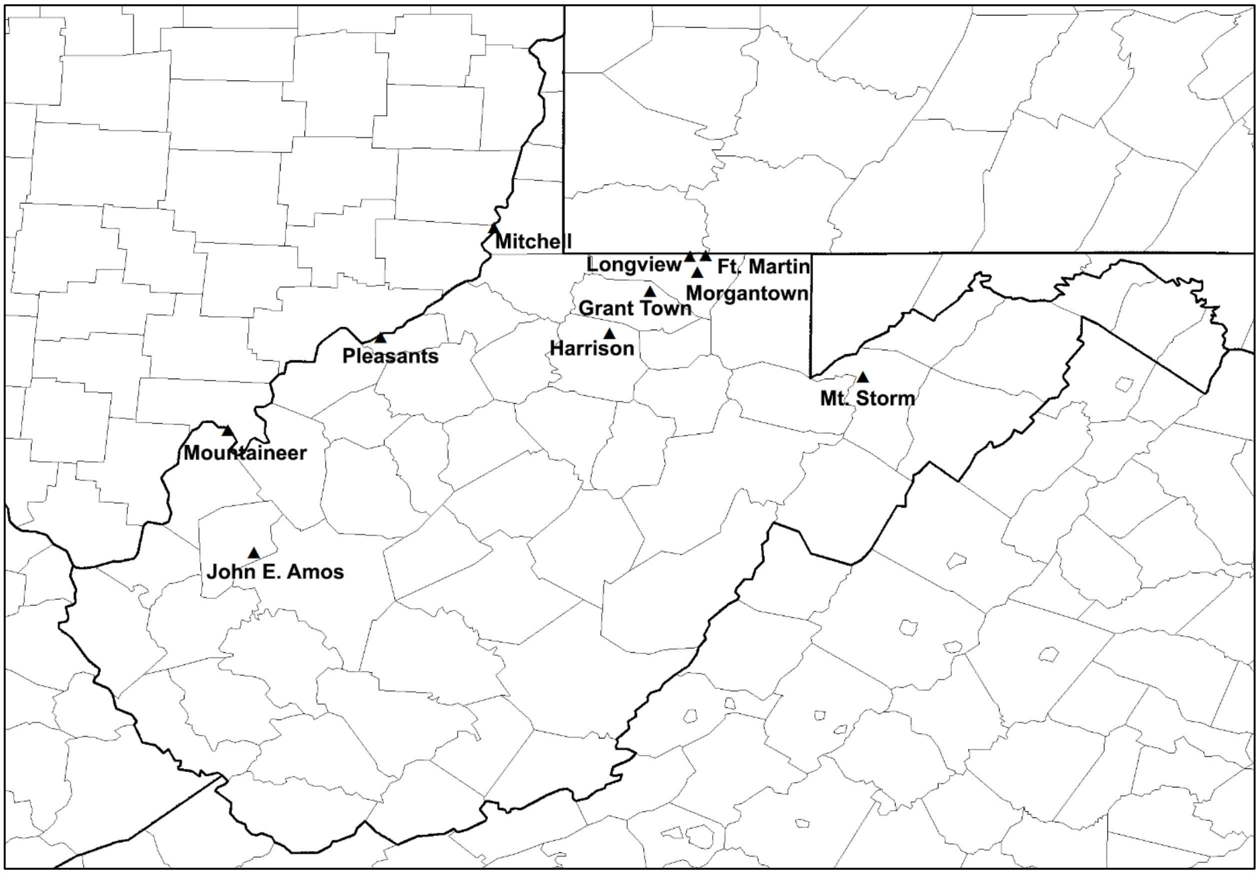
Plant	Owner	Unit	Operational Year	Nameplate/ Summer/Winter Capacity (MW)	Minimum Load[74] (MW)	Generating Technology
Grant Town	American Bituminous	1	1992	95.7, 80, 80	32	Fluidized Bed
John E Amos	Appalachian Power	1 2 3	1971 1972 1973	816.3, 800, 800 816.3, 800, 800 1300, 1300, 1299	300 300 600	Pulverized Coal, Supercritical
Mountaineer	Appalachian Power	1	1980	1300, 1299, 1299	500	Pulverized Coal, Supercritical
Ft. Martin	FirstEnergy	1 2	1967 1968	576, 552, 552 576, 546, 546	220 220	Pulverized Coal, Supercritical
Morgantown Energy	Morgantown Energy Assoc.	1	1991	68.9, 50, 50	15	Fluidized Bed, Subcritical
Mt. Storm	Dominion/ Virginia Power	1 2 3	1965 1966 1973	570.2, 554, 569 570.2, 555, 570 522, 520, 537	265 265 300	Pulverized Coal, Subcritical
Mitchell	Wheeling Power/AEP	1 2	1971 1971	816.3, 770, 770 816.3, 790, 790	370 410	Pulverized Coal, Supercritical
Harrison	FirstEnergy	1 2 3	1972 1973 1974	684, 652, 662 684, 651, 661 684, 651, 661	375 375 375	Pulverized Coal, Supercritical
Pleasants	FirstEnergy	1 2	1979 1980	684, 664, 650 684, 664, 650	375 375	Pulverized Coal, Supercritical
Longview	GenPower	1	2011	807.5, 700, 700	280	Pulverized Coal, Supercritical

Source: EIA, December 2015

[74] The minimum load at which the generator can operate at continuously.

West Virginia's coal-fired power plants are predominantly located in the northern and western portions of the state, on or near the border, as displayed in Figure 3.

Figure 3 Coal-Fired Power Plant Locations



In West Virginia, electricity is largely supplied to in-state customers by vertically-integrated utilities owning generation, transmission and distribution assets, and regulated by the WV Public Service Commission (WVPSC). A few small cooperatives and municipal utilities provide distribution services but do not own generation or transmission assets. In 2014, a little over one million electricity customers in West Virginia demanded 32.7 million MWh of electricity. This data is shown in Table 8, by major customer class.

Table 8 Bundled Retail Electricity Sales in West Virginia by Customer Class, 2014

Customer Class	Revenue (Thousand Dollars)	Number of Customers	Sales (MWh)	Average Retail Price (cents/kWh)
Commercial	$ 629,468	140,698	7,876,429	$ 0.080
Industrial	$ 753,085	12,146	12,828,949	$ 0.059
Residential	$ 1,119,698	862,869	11,990,728	$ 0.093
Total	$ 2,502,251	1,015,713	32,696,106	$ 0.077

Source: EIA-861 schedules 4A & 4D and EIA-861S.

Electricity generated in West Virginia but not purchased in-state is transmitted to retail electricity customers in neighboring states or is sold in the wholesale market. The regional wholesale market is operated by the PJM Regional Transmission Operator (RTO)/ Independent System Operator (ISO), the entity responsible for coordinating supply and demand of wholesale power. PJM coordinates the movement of wholesale electricity in all or parts of Delaware, Illinois, Indiana, Kentucky, Maryland, Michigan, New Jersey, North Carolina, Ohio, Pennsylvania, Tennessee, Virginia, West Virginia and the District of Columbia. PJM's major responsibilities include coordinating the regional energy market, maintaining a Reliability Pricing Model to ensure adequate capacity is available to serve load, and scheduling and evaluating requests for transmission services.[75]

The portion of electricity generated in WV and sold in the wholesale market varies from year to year depending on market conditions. The Pleasants and Longview plants produce power solely for the wholesale market and are exempt from WVPSC regulation. A portion of output produced by regulated plants owned by Monongahela Power/FirstEnergy and Appalachian Power is also sold in the wholesale market. Because these utilities have retail customers in WV, their rates are regulated by the WVPSC and customers receive a portion of the revenue from those wholesale sales. These sales are credited against the cost of delivering electricity to customers based on ownership share of the facilities. This revenue is available as long as these plants have excess energy to sell at a marginal cost[76] that is below the wholesale price.

Compliance with 111(d) must occur within the constraints of this market setting, which includes layers of physical and economic protocols developed to maintain reliability and provide fair compensation to generators and providers of capacity. This setting complicates analysis of the impact of the rule, as WV-

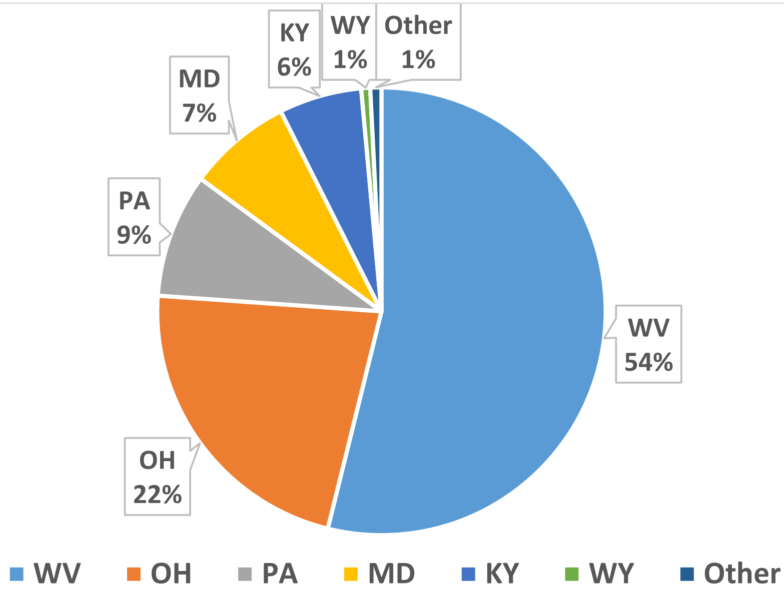
[75] PJM (2015d). PJM Markets and Operations. http://www.pjm.com/markets-and-operations.aspx
[76] Variable costs of producing a MWh of electricity. Capital and other fixed costs are not included.

based EGUs supply the needs of electricity customers beyond the borders of the state as well as customers located in WV.

4.4 Fuels and Sourcing

Coal-fired power plants located in West Virginia source varying portions of coal inputs from West Virginia coal mines. For the time period 2010 through 2014, 54 percent of coal distributed to WV-based power plants was produced in West Virginia. As shown in the following figure Ohio, Pennsylvania, Maryland and Kentucky were also significant suppliers of coal to WV-based plants. Details of coal sourcing by plant are shown in Figure 4 and Table 9.

Figure 4 Coal Sourcing for all WV Power Plants, 2010-2014 Total



Source: EIA-923 and EIA-860 Reports.

Table 9 Coal Sourcing by West Virginia-Based Power Plants (tons), 2010-2014 Total

	WV	OH	PA	MD	KY	Other
John E Amos	13,211,942	11,524,553	38,059		2,310,387	432,766
Fort Martin	8,532,430	617,679	2,706,236		613,475	913,067
Harrison	23,839,609	997				
Mitchell	13,901,275	26,141			2,591,575	111,858
Mt Storm	3,700,774		4,643,949	10,606,422	36,786	
Pleasants	961,907	13,394,922	11,567		2,162,288	523,730
Mountaineer	7,247,350	5,911,803	125,786		725,907	61,273
Grant Town	2,785,880					
Morgantown	1,947,337					
Longview			5,148,511			
Total	**76,128,504**	**31,476,095**	**12,674,108**	**10,606,422**	**8,440,418**	**2,042,694**

Source: EIA-923 and EIA-860 Reports.

Total West Virginia demand accounts for about 15 percent of total distribution (all commercial and industrial sources including demand for both thermal and metallurgical coal) of coal mined in the state. Table 10 contains estimates of total distribution. In recent years, about 55 percent of coal demand derives from other states and 30 percent from international exports.

Thus, about 85 percent of demand for West Virginia coal is driven by global market conditions and demand in other states. As such, other states' compliance decisions, such as Pennsylvania, North Carolina and Ohio who account for nearly 40 percent of the coal distribution, will impact the West Virginia coal industry.

Table 10 Distribution of Coal Mined in West Virginia, (Tons)

Destination	2010	2011	2012	2013	Total for 2010-2013	% of Total Distribution
West Virginia	20,186,270	17,963,973	17,801,828	18,176,517	**74,128,588**	15.0%
Pennsylvania	13,442,636	14,369,457	14,931,463	16,387,261	**59,130,817**	12.0%
North Carolina	16,305,972	16,142,304	11,657,812	8,380,436	**52,486,524**	10.6%
Ohio	14,396,777	13,367,832	7,434,252	7,941,889	**43,140,750**	8.7%
Total Other Domestic	42,078,915	34,301,559	20,147,689	18,725,627	**115,253,790**	23.4%
Total Domestic	*106,410,570*	*96,145,125*	*71,973,044*	*69,611,730*	***344,140,469***	*69.8%*
Total Foreign	*28,343,140*	*35,046,200*	*47,484,000*	*38,168,800*	***149,042,140***	*30.2%*
Total Foreign and Domestic	*134,753,710*	*131,191,325*	*119,457,044*	*107,780,530*	***493,182,609***	*100.0%*

Source: EIA, Annual Coal Distribution Report (2015).

Nationally, West Virginia coal is predominantly purchased for use in the electric power sector as illustrated in Table 11. Within West Virginia, about 92 percent of coal is consumed by the electric power sector with the remaining 8 percent used for coke plants and other industrial plants. In Pennsylvania and Ohio coke plants constitute a larger share of consumption, 26 and 16 percent respectively. Similarly, across all other states that consume West Virginia coal about one-third is used by coke and industrial plants and two-thirds by the electric power sector.

Table 11 Domestic Distribution of West Virginia Coal by Consumer Type, 2010-2013

Destination	Coke Plant	Commercial/ Institutional	Electric Power Sector	Industrial Plants Excluding Coke
West Virginia	5.0%	0.0%	91.7%	3.3%
Pennsylvania	26.6%	0.1%	73.1%	0.2%
North Carolina	0.0%	0.1%	99.6%	0.3%
Ohio	16.5%	0.6%	80.4%	2.4%
Total Other Domestic	20.9%	0.5%	69.0%	9.6%
Total Domestic	14.7%	0.3%	80.7%	4.3%

Source: EIA, Annual Coal Distribution Report (2015).

Coal mining (NAICS 2121) consists of two industries – Bituminous Underground Coal Mining (NAICS 212112) and Bituminous Coal and Lignite Surface Mining industries (212111). About one-quarter of total industry employment for Coal Mining exists within West Virginia. While employment nationally has declined 11.5 percent since 2001, employment in West Virginia has only declined 1.2 percent. Considering the period from 2011 to 2015, employment has declined by 29 percent in West Virginia and by 24 percent nationally, eroding large gains experienced in the prior decade.[77] Average earnings in the industry, inclusive of benefits and profits, are similar in West Virginia as for the nation as a whole.

Table 12 Coal Mining (NAICS 2121), 2015

Region	Employment	Average Earnings	Establishments*	%-Change Employment since 2001
West Virginia	16,343	$102,434	280	-1.2%
US	66,401	$101,252	1,182	-11.5%

Source: EMSI, 2015 Q3 Estimates

West Virginia's coal mining industry contains 44 different occupations ranging in annual average wages from about $23,000 (Janitors and Cleaners, except for Maids and Housekeeping Cleaners) to $112,800 (Construction Managers).[78] The top five occupational categories account for about 45 percent of total industry employment. Average wages range from about $40,000 to almost $75,000 annually for these occupations.

Table 13 Top Coal Mining Occupations West Virginia, 2015

Description	Employment	Average Wage
Roof Bolters, Mining	2090	$ 56,780
Operating Engineers and Other Construction Equipment Operators	1840	$ 44,440
Electricians	1460	$ 58,540
First-Line Supervisors of Construction Trades and Extraction Workers	1450	$ 74,860
Helpers--Extraction Workers	1090	$ 41,790

Source: US Bureau of Labor Statistics, Occupational Employment Statistics

4.5 Emissions Goals

EPA has established interim and final statewide goals in three forms:[79]

- A rate-based state goal measured in pounds per megawatt hour (lb/MWh);
- A mass-based state goal measured in total short tons of CO_2;
- A mass-based goal with a new source complement measured in short tons of CO_2.

[77] Over the period considered, coal mining employment grew 40% from 2001 until 2011 when it peaked in the state at 23,095.
[78] For a complete list of occupations please see the US BLS Occupational Employment Statistics.
[79] http://www.epa.gov/cleanpowerplan/fact-sheet-components-clean-power-plan

Table 14 describes the EPA mass CO_2 emission goals for the State of West Virginia compared to 2012 emission levels. These goals are short tons of CO_2 emissions from affected EGUs, and are equal to the number of CO_2 allowances that will be made available. The allowances may be given away to EGUs, or other entities, at no cost or they may be auctioned. This analysis assumes all allowances are given to affected EGUs at no cost.

Table 14 111(d) Interim and Final Mass Emission Goals and Set-Asides for State of West Virginia (short tons)

	Actual Emissions	Interim Goals / Set-Asides			Final Goal
	2012	**2022-2024**	**2025-2027**	**2028-2029**	**2030 & After**
Total Mass-Based Goal	72,318,917	62,557,024	56,762,771	53,352,666	51,325,342
Share From EGUs Retired Prior to 2016	4,354,112	3,788,314	3,652,988	3,433,529	3,303,060
New Source Complement		247,419	834,677	788,613	531,966
Total With New Source Complement		62,804,443	57,597,448	54,141,279	51,857,307
Set Asides for RE (5%)		3,127,851	2,838,139	2,667,633	2,566,267
Set Asides for CEIP		3,506,890			

Source: EPA Clean Power Plan Fact Sheet: State at a Glance – West Virginia, Technical Support Document: Allowance Allocation - Appendix A and Appendix B.

The EPA's rate CO_2 emission goals for the State of West Virginia are shown in Table 15. Because West Virginia-based EGUs are all coal-fired units these rates are equivalent to the nationwide goal for all fossil steam units. EGUs must reduce the rate of emissions by about 37 percent by 2030 compared to actual 2012 emission levels. Because physical emissions reduction to these levels is not possible with current technology, EGUs will be required to purchase ERCs from zero or low-emitting generators to dilute emissions.

Table 15 111(d) Interim and Final Emission Rate Goals for State of West Virginia (lbs/MWh)

2012 Rate	2022-2024	2025-2027	2028-2029	2030 & After
2,064	1,671	1,500	1,380	1,305

Source: EPA Clean Power Plan Fact Sheet: State at a Glance – West Virginia

The decision of whether to choose a mass or rate-based compliance approach is likely to be based on the economic impact to consumers and the economy. Under a mass-based approach affected EGUs could comply with the rule by reducing electricity generation to the approximate levels shown in Table 16. This is representative of compliance without the benefit of emissions trading, but is a simple path to compliance.

Table 16 Equivalent Generation from West Virginia EGUs (MWh) Under Mass-Based Approach

2012 MWh	2022-2024	2025-2027	2028-2029	2030 & After
70 million	61 million	55 million	52 million	50 million

Source: CBER calculations based on 2012 emission rates

In the absence of trading of ERCs with other states, the rate-based approach will be more expensive for WV-based EGUs. Under a rate-based approach, plants have to meet a specific average emission rate of

1,671 lbs CO_2/MWh in the first compliance period. This standard must be met regardless of how much energy the plant produces. Thus, for the WV-based EGUs to produce 61 million MWh of electricity, as would be possible in 2022-2024 under a state plan with no set-asides, the plants would have to purchase an additional 14 million ERCs (MWh of carbon-free electricity) to sufficiently dilute their emission rate of 2,056 lbs/MWh. These purchases represent an incremental cost over that of complying under a mass-based approach, where compliance could be achieved simply by reducing output and by only using allowances that may even be distributed free of charge.

5 – Modeling Approach

The analysis in the report occurs in several phases, each of which relies on assumptions to produce estimates. The models are not perfect representations of the markets under consideration, but rather are simplifications of complex systems to illustrate potential dynamics. Models rely on historical data and a series of assumptions regarding initial conditions to approximate future outcomes and quantities of interest. Results are illustrative of the direction and relative magnitude of effects and should be interpreted with care. In many cases, results constitute a possible maximum or minimum effect as factors that may offset measured impacts are not necessarily captured by the modeling.

The modeling approach has two primary phases:

1. The impact of compliance on the performance of West Virginia-based EGUs in the wholesale electricity market.
2. The impact of any changes to plant output and associated changes in electricity supply, including cost of supply, on the economy of West Virginia.

In the first phase, using AURORAxmp EVA modeled energy market dynamics resulting from different broad compliance scenarios. This modeling assumes that EGUs operate in the most efficient manner based on their technical characteristics and market constraints. EVA's modeling produces estimates of total generation (GWh) for West Virginia EGUs and potential carbon prices (for allowances or ERCs depending on mass- or rate-based compliance), as well as wholesale electricity prices (PJM West) and natural gas prices (Henry Hub).

Other critical assumptions in EVA's modeling include relative prices for constructing new renewable capacity and energy savings from deployment of energy efficiency measures. These values do not change under different scenarios considered. Alternative actions of individual EGUs, such as spending on capital for heat rate improvements, are not captured by the modeling.

EVA modeling considers two potential trading regimes - national trading and no interstate trading. These are the most extreme trading scenarios that may illustrate potential upper and lower bounds of estimates. CBER then calculated allowances and ERCs required to meet compliance, and total estimated carbon costs accruing to West Virginia consumers based on EVA's estimates of carbon prices and electricity generation.

The scenarios used for analysis, described in greater detail subsequently, illustrate the range of different potential outcomes from four critical characteristics of potential compliance – the choice of a mass- or rate-based plan, with and without national trading. These scenario specifications are consistent with the existing research described previously.

While the energy market modeling accounts for a 5-percent set-aside of allowances for RE, other implementation characteristics cannot be captured within the modeling framework. Specifically, initial allowance distribution beyond free allocation based on current production efficiency, low-income energy efficiency deployment from CEIP set-asides, and use of the new source complement are implementation details not captured in the modeling. These implementation details may ultimately yield results different from the estimated outcomes.

In the second phase of modeling, CBER then used EVA's results as inputs to the economy-wide model developed by Regional Economic Models Incorporated (REMI), PI+, to estimate the economic impact to the state of West Virginia of the changes to electricity generation. REMI PI+ is a proprietary, dynamic model widely used in the assessment of policy and economic changes to capture potential changes in employment, earnings, and output.[80]

To evaluate potential impacts, CBER translated EVA's electricity generation results to industry sales. The economic impacts evaluated consist of:

- the direct effect (changes in sales, employment and earnings for the power generation sector),
- the indirect effect (changes to other industries in West Virginia that supply the power sector, including coal mining)
- and induced effects (changes to the economy from changes in household purchases as a result of price and income effects).

Thus, estimated changes in generation from different compliance scenarios are used to calculate resulting changes in economic activity, employment and income for the state.

The economic impact model only considers changes within the state of West Virginia and does not consider the behavior of other states or global markets. Further, the impact model does not consider the potential for exporting surplus state production in any industry that results from a loss of in-state demand.

In addition to the energy market and statewide economic impact modeling, sub-regional impacts of hypothetical plant closures were assessed using Economic Modeling Specialists, Inc. (EMSI) Analyst input-output model. EMSI Analyst provides estimates and forecasts of labor market, industry and occupation data based on the compilation of standard public data sources such as the US Bureau of Labor Statistics and US Bureau of Economic Analysis. EMSI also provides estimates based on their proprietary methodologies for imputing data censored from public sources due to data quality and reporting requirements.[81]

[80] For more information on REMI please see http://www.remi.com/products/pi
[81] For more on EMSI please see http://www.economicmodeling.com/data/usa-data/

To simulate hypothetical plant closure impacts, sub-regions surrounding power plants were first defined using labor market data. Employment in Fossil Fuel Electric Power Generation was then eliminated from the sub-regional economy. The analysis assumes that individuals do not find other employment elsewhere within the sub-regions. Re-employment potentially mitigates overall estimated impacts by generating replacement jobs and income.

6 – 111(d) Compliance Scenarios Modeled

The base of the evaluation is the impact of compliance on West Virginia's existing coal generation fleet, the affected EGUs that must comply with the rule. The resulting performance of West Virginia-based EGUs in the wholesale market will determine the impact of the rule on generation assets and associated economic activity. Plants will perform differently under the various compliance scenarios. Including this type of analysis is an important aspect of evaluating the impacts of this rule as electric utilities in most states do not operate in isolation. For West Virginia, the volume of electricity demanded by in-state customers is less than half of total electricity generation, making the industry economically significant to the state as an export industry.

To simulate the potential economic impact of compliance in West Virginia five broad scenarios were assessed. These scenarios include variations of an approvable (by US EPA) state approach to reach either the mass or rate emissions goals of the rule.

The scenarios modeled are:

- Option Zero - Business as Usual (BAU)/No CPP/No Carbon Regulation
- Option 1a - Mass CPP Compliance Approach In-State Only - No Trading
- Option 1b - Rate CPP Compliance Approach In-State Only - No Trading
- Option 2a - Mass CPP Compliance Approach - National Trading
- Option 2b - Rate CPP Compliance Approach - National Trading

The mass scenarios include the RE set-asides, at five percent of total allowances. This set-aside is included as an approach to address potential leakage of emissions from new fossil generating units, as required by the EPA. The CEIP is not explicitly modeled in this analysis due to uncertainty over the impact of the program. Primary uncertainties are: 1) whether the value of the allowances will actually induce any new RE investment in WV under a mass approach with trading, 2) the net economic impact of expenditures on low-income energy efficiency programs, and 3) how the distribution of those allowances will impact EGUs.

Critical variables within these simulations are:

1. **The robustness of the emissions trading regime that is developed.** The trading scenarios modeled here assume participation at the national level. Partial participation of states in a given trading regime will reduce the number of available allowances or ERCS for West Virginia EGUs. CO_2 prices will be lower under a more robust and uniform trading system, helping West Virginia EGUs maintain their competitiveness.

2. **The actual level of natural gas prices leading up to and during the 2022 to 2030 compliance period.** Natural gas power plants compete directly with the West Virginia-based affected EGUs

in the wholesale electricity market. The BAU scenario within this analysis projects a rise in gas prices to a level that results in coal-fired generators recovering a share of the market that was lost in recent years. This projected rise is based on expectations of growing demand for gas for power generation combined with expansion of LNG exports from the US, following initial exports in February 2016 from the Sabine Pass LNG facility.

3. **RE development and EE measures have different value in rate versus mass approaches.** In a rate approach, EE and RE may have more value as these resources can generate additional revenue via ERCs. The amount of RE development that may occur in West Virginia, due to 111(d) or that would occur anyway, will depend on relative cost and value. It is assumed that current utility EE programs will continue, and expand, irrespective of the influence of the rule.

4. **The actual carbon prices that will result from development of a trading regime.** Carbon prices are a critical factor in establishing the actual impact of 111(d) and are tied to the robustness of a trading regime.

6.1 Other Modeling Assumptions and Considerations

New Source Complement and Leakage

As noted previously, states submitting mass-based plans must specify how they will address potential leakage of carbon dioxide emissions to new sources. Two potential approaches are the new source complement and the renewable energy (RE) set-aside. To address the leakage issue this impact simulation includes the renewable energy (RE) set-asides, at 5% of total allowances as a compliance strategy. This provision reduces the number of allowances available to affected EGUs. In contrast, the new source complement effectively increases the number of allowances available within in a state; although the additional allowances are not intended to cover the emissions of existing units. Analysis of how adoption of the new source complement may affect electricity generation decisions was beyond the scope of the current analysis.

Energy Efficiency

Energy efficiency has value to electricity customers from several perspectives. Reducing consumption reduces expenditures and induces more productive use of resources. Efficiency measures can also increase the comfort of living and working spaces, such as through replacing old appliances, upgrading insulation and weatherization.[82] Further, reductions in energy usage resulting from energy efficiency measures may postpone or reduce the need to add additional supply-side resources, which may facilitate compliance.[83]

In this analysis the BAU and 111(d) compliance scenarios assume the same energy efficiency (EE) savings as a simplifying assumption as it was beyond the scope of the present study to examine the particular dynamics of energy efficiency programs. The cumulative energy savings from energy efficiency programs

[82] http://aceee.org/sites/default/files/pdf/fact-sheet/state-cpp/wv-facts.pdf

[83] Ibid. According to ACEEE, energy efficiency may help West Virginia achieve 26% of its compliance goals.

are assumed to generate ERCs, including savings from utility programs initiated after 2012, and are subtracted from the number of ERCs needed to be purchased to meet rate targets. In the compliance cases EVA's analysis accounts for reduced energy demand from increased wholesale prices, but as these reductions are not explicitly due to energy efficiency measures no ERCs are created.[84]

EVA's projected cumulative EE savings in 2022 are for the years 2013 through 2022. On an annual basis these projections amount to about 150,000 MWh, which for comparison is double the 77,000 MWh saved by FirstEnergy and Appalachian Power's programs in 2013.[85] Thus, these projections incorporate potential savings from multiple EE initiatives, such as those enabled by the Industrial Assessment Center at WVU for example or independent efforts. Table 17 displays the estimated cumulative energy efficiency savings incorporated into the analysis.

Table 17 Modeled Energy Cumulative Energy Efficiency Savings by WV Electricity Customers (million MWh)

2022	2023	2024	2025	2026	2027	2028	2029	2030
1.5	1.7	1.9	2.1	2.3	2.6	2.8	3.0	3.3

Source: EVA analysis

As West Virginia-based utilities are already engaging in low-income EE programs, and due to the state having a high share of low-income households, these initiatives are considered priorities that are likely to continue.[86] With respect to the impact of the set-asides within the CEIP, because the credits allocated to low-income programs are matched by EPA, the net impact to EGUs of having fewer credits may be neutral. This leaves the cost-effectiveness of these programs as the primary issue, an assumptive exercise that was beyond the scope of the present study.

7 – Energy Market Analysis

Wholesale market modeling is conducted by Energy Ventures Analysis (EVA) using AURORAxmp, a chronological hourly dispatch model that simulates power plant dispatch based on relative marginal cost of generation. CBER then calculated necessary allowances and ERCs and total carbon costs.

Consistent with results from existing research, scenarios that incorporate trading yield smaller reductions in generation (GWh) from affected EGUs. National trading results in GWh comparable to BAU for a mass-based plan and to a lesser extent for a rate-based plan. It is important to note that these results assume that all states engage in the trading program. Should fewer states participate, the supply of available allowances or ERCs will be smaller than assumed in the results below.

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[84]EVA incorporates a price-demand elasticity analysis where electricity demand is adjusted downwards in proportion to the increase in wholesale power prices relative to the base case. The demand elasticity is a proxy for changes in customer behavior in the face of increasing power prices, but this reduction does not generate ERCs.

[85] The Energy Efficiency and Renewable Tracker Fall 2014

[86] For example, Appalachian Power advertises an array of energy efficiency programs for residential and business customers. See http://takechargewv.com/residential/default.aspx; https://appalachianpower.com/save/business/

Both state-only compliance approaches will result in early plant retirements relative to BAU, whereas in either case with national trading no plants are projected to retire until after 2030. The results also illustrate that a rate-based plan with no trading is prohibitively restrictive, reducing electricity generation by nearly 75 percent of the BAU and national trading cases. This approach represents a worst-case scenario that would not likely be voluntarily entered into by state regulators. Additional impacts to electricity prices that are not estimated in this analysis would also occur related to replacing the share of lost generation and capacity needed to supply WV-based customers. As such, this scenario is likely to have negative economic impacts beyond what is estimated.

7.1 Approach

The major outputs from EVA's modeling are as follows:

At the unit level:

- Generation
- Fuel consumption
- Energy and capacity revenue
- Fuel, variable operating & maintenance costs, emissions costs
- Emissions by type

At the market level:

- Energy pricing
- Capacity pricing
- Carbon allowance prices
- Retirements and new builds

This model was selected due to the ability to simulate energy market performance on a unit basis and trading of CO_2 allowances or credits on a national basis. To calibrate the model, EVA forecasts fuel costs for each plant. Additionally, the modeling employs assumptions regarding electricity demand growth, renewables, energy efficiency, and distributed generation. For a more detailed discussion of EVA's modeling methodology please see the appendix.

7.2 Energy Market Results

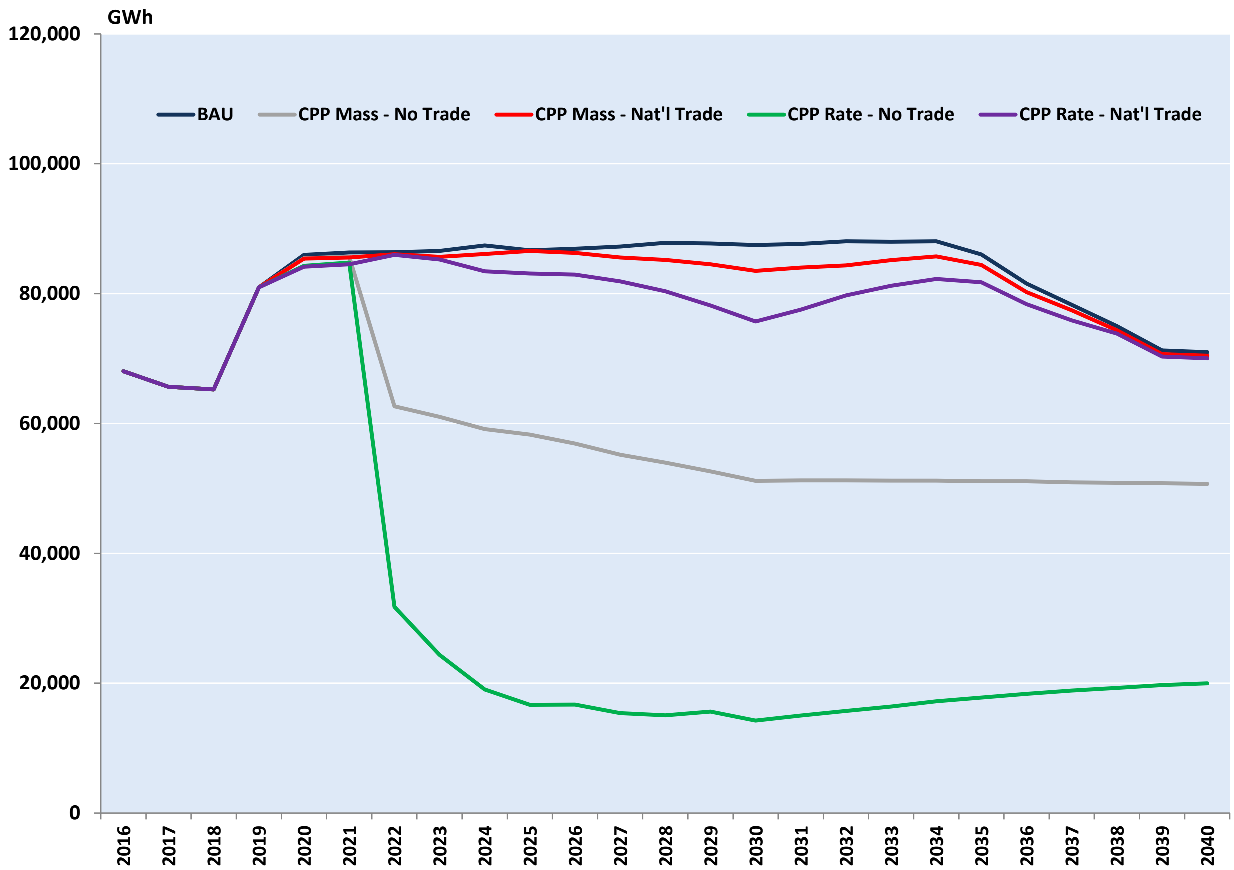
Electricity Generation

Figure 5 shows EVA's baseline BAU/"No Carbon" generation (GWh) for West Virginia-based EGUs compared to the four primary compliance scenarios. In EVA's BAU scenario coal-fired generation increases above recent levels, rising to a peak of 88 million MWh in 2032–2034. This level is comparable to average annual coal-fired generation in 2000-2009. After this time period, output is projected to fall as plants begin to retire in line with planned depreciation cycles. By 2040, generation is projected to be about 71 million MWh, a return to generation seen in 2012-2013.

After 2018, generation is projected to rise from current levels in the baseline scenario due to increases in natural gas prices, as projected by EVA. Initial increases in electricity generation for all scenarios stem from the competitiveness of West Virginia-based EGUs. These producers are able to supply power to the regional market at a lower cost than other alternatives and are thus attractive sources of energy (MWh) and capacity (MW) beyond West Virginia's borders.

In general, rate-based scenarios result in lower electricity generation in West Virginia than their mass-based counterparts. In the scenarios where no trading is available, coal-fired generation from West Virginia-based EGUs falls rapidly beginning in 2022. The rate-based case without trading produces the most severe reduction in generation. The BAU and national trading scenarios converge to similar generation levels in 2040, when much existing coal-fired capacity is anticipated to be fully depreciated and some capacity has retired.

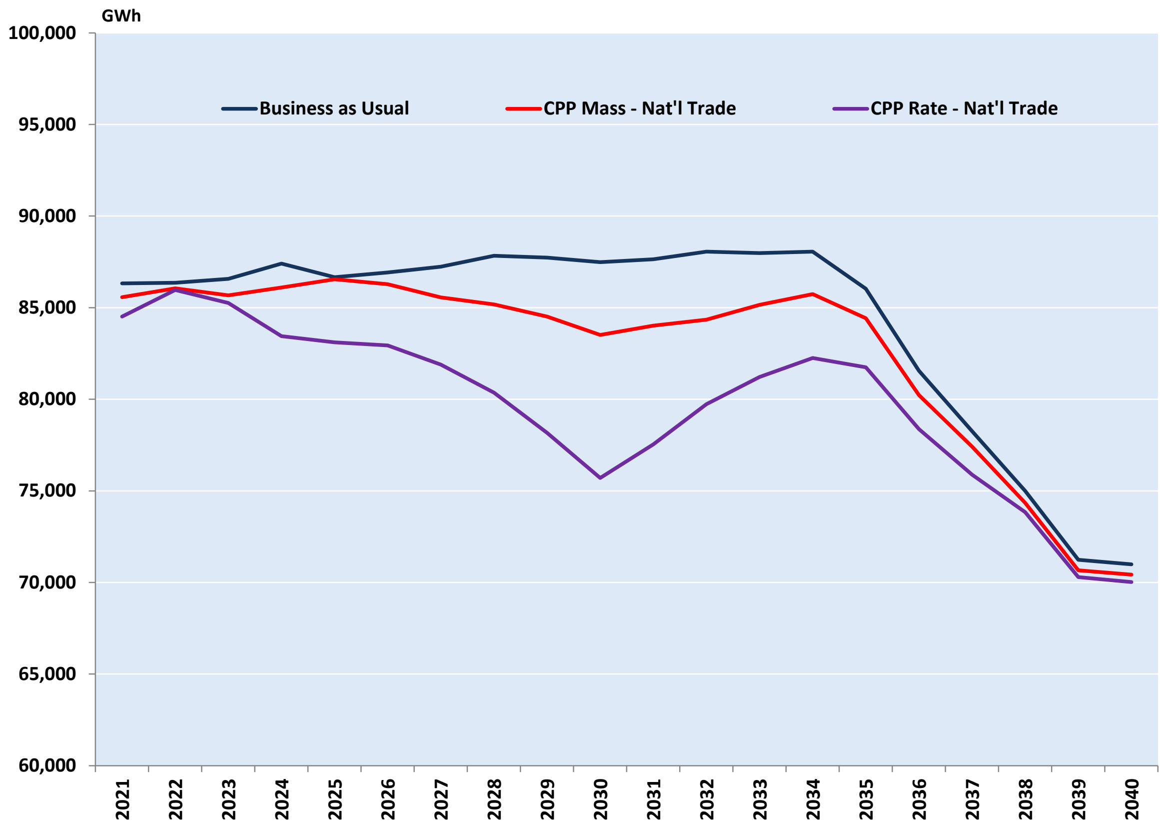
Figure 5 Coal-Fired Power Generation Projections (GWh), BAU vs Compliance Scenarios



Source: EVA Analysis

Figure 6 displays the BAU and national trading scenarios in closer detail. While all three cases result in higher generation than the no-trading cases as displayed previously, the rate-based scenario projects a greater decline in generation towards the end of the interim compliance period in 2030.

Figure 6 West Virginia Coal-Fired Electricity Generation (GWh), BAU vs. National Trading Scenarios

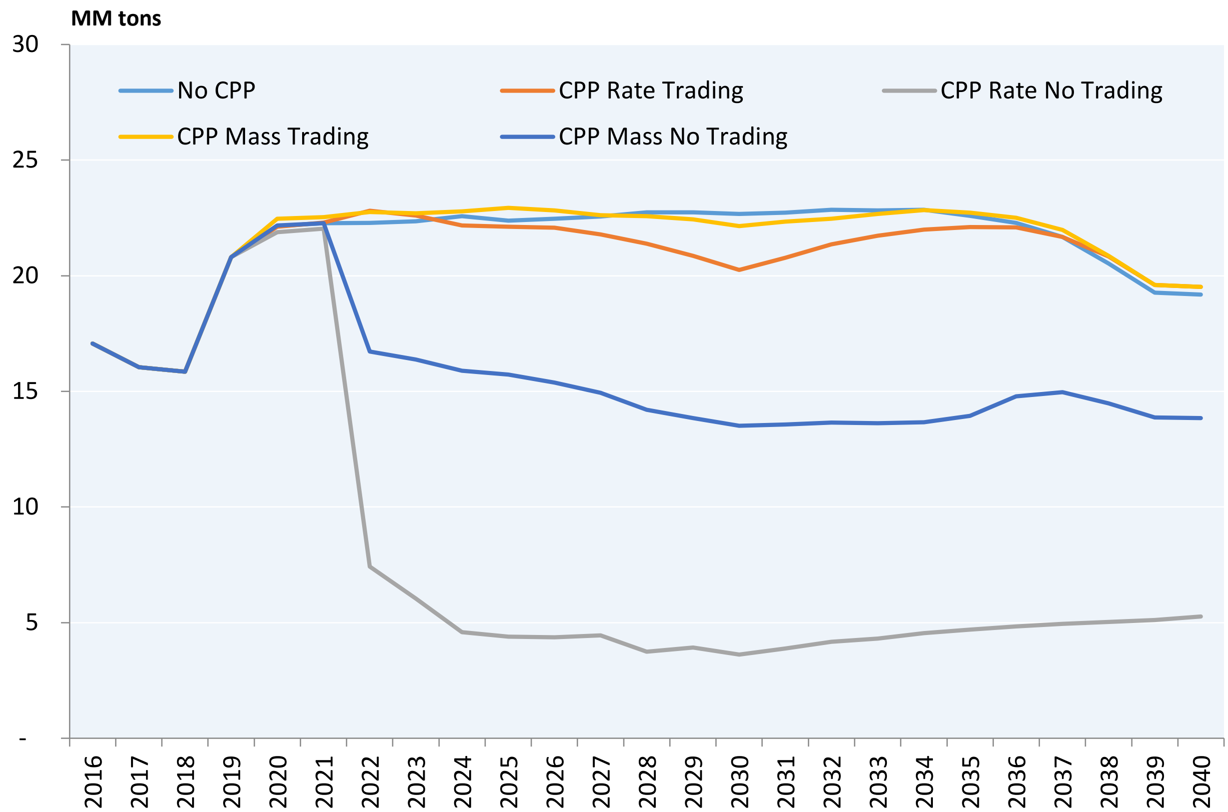


Source: EVA Analysis

Consumption of West Virginia Coal

EVA's analysis of energy market dynamics provided estimates of West Virginia coal consumption under the five scenarios considered. As displayed in Figure 7, the consumption of West Virginia coal by coal-fired power plants based in the state is projected to increase over the lows expected in 2016 through 2018, consistent with projected increases in power generation. As noted previously, natural gas prices are projected to increase under national trading scenarios in the initial period maintaining coal's competitiveness. The relative levels of consumption are maintained throughout the compliance period consistent with varying generation for each approach.

Figure 7 Consumption of West Virginia Coal
by Coal-Fired Power Plants in West Virginia (MM Tons), BAU vs Compliance Scenarios



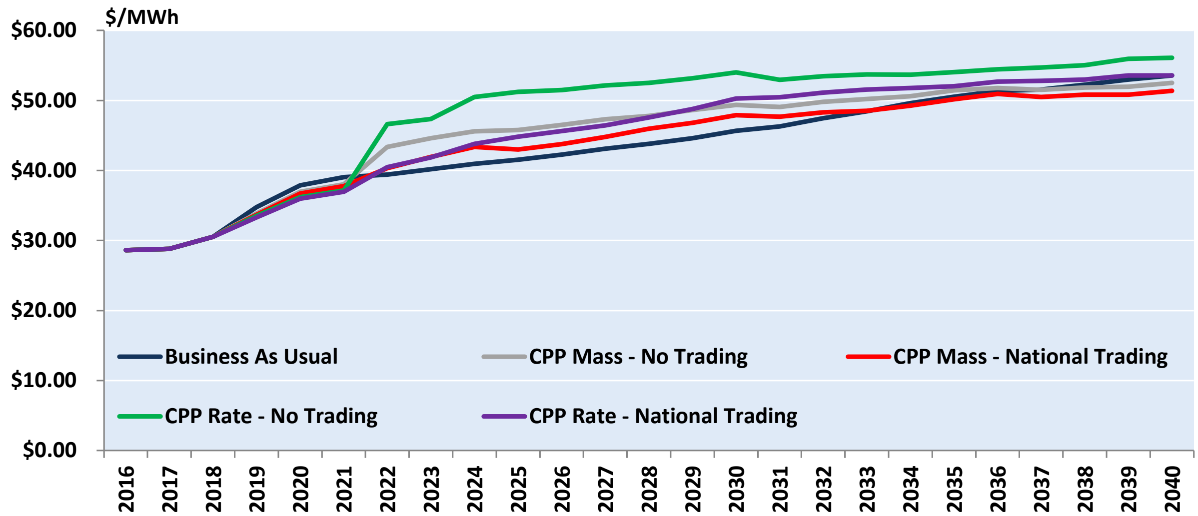
Source: EVA Analysis

Under the national trading scenarios, West Virginia coal consumption at West Virginia-based EGUs is comparable to BAU. Under the no trading cases, West Virginia coal consumption declines relative to BAU. In the mass-based scenario, consumption is 75 percent of BAU in 2022 and about 60 percent in 2030. In the rate-scenario, consistent with the severe decline in power generation, coal consumption is about one-third of BAU in the interim compliance period and drops to about 16 percent of BAU by 2030. Detailed consumption estimates appear in the appendix.

Wholesale Electricity Prices

As part of its modeling, EVA also forecasts natural gas prices and wholesale electricity prices. These projections are important components of future generation levels under each scenario. Wholesale electricity prices are the locational marginal price[87] (LMP) average for PJM West, where West Virginia-based EGUs are located. Figure 8 displays the projected wholesale LMP for all scenarios considered. Prices are expected to rise in all scenarios, with the rate-based scenarios resulting in the highest prices compared to the BAU. In general, the model indicates wholesale prices between $40/MWh and $50/MWh at the beginning of the interim compliance period and $50/MWh to $60/MWh in 2040.

Figure 8 EVA-Projected Wholesale (LMP) Electricity Prices for PJM West ($2015/MWh)



Source: EVA Analysis

Natural Gas Prices

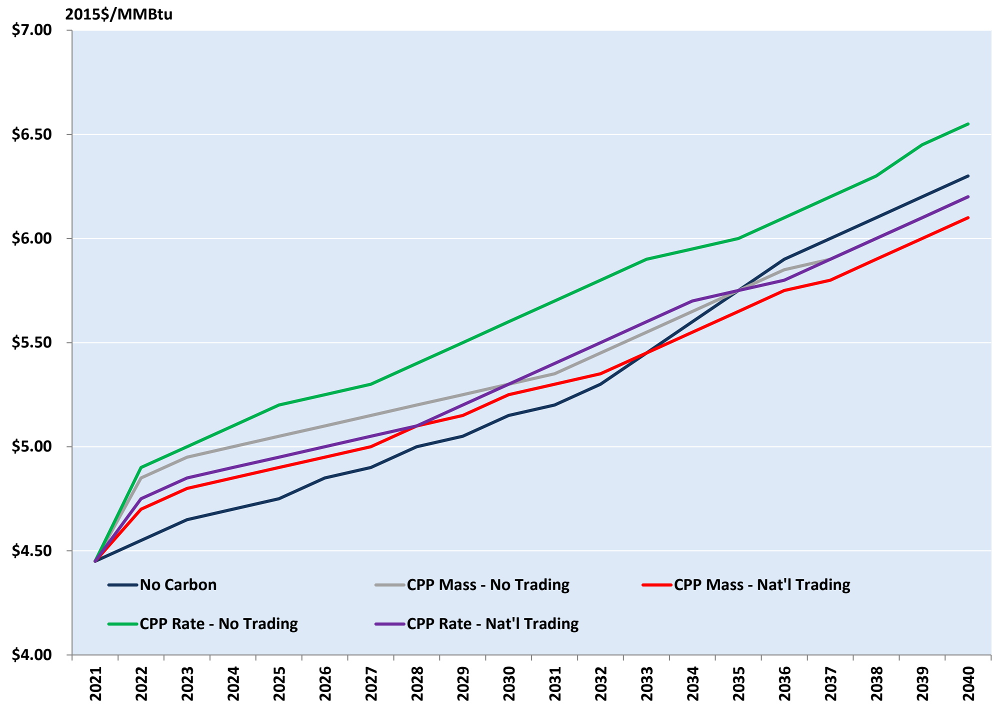
Figure 9 contains EVA's projected natural gas prices at the Henry Hub. As a reference point, these projections are lower than what the US EIA uses as Reference Case values in its 2015 AEO. EIA's analysis projects Henry Hub prices in 2020 to be $4.88/MMBtu, in 2025 to be $5.46/MMBtu, and in 2030 to be $5.69/MMBtu (in $2013).[88]

The results indicate rising natural gas prices for all scenarios considered, with prices between $5.00/MMBtu and $5.50/MMBtu by 2030 and between $6.00/MMBtu and $6.50/MMBtu by 2040. The largest increase results under the rate-based case without interstate trading. The retirement of more coal-fired capacity places additional pressures on the natural gas market thus leading to a higher natural gas prices. While BAU displays the lowest projected natural gas prices initially until 2030, BAU is associated with a faster increase in natural gas prices afterwards. National trading scenarios, both mass- and rate-, are associated with the lowest projected natural gas prices in the model. As noted

[87] LMP is a location-based wholesale price based on the physical flow of energy, rather than a contractual price. It includes a value for area transmission congestion and transmission losses in addition to energy value.
[88] http://www.eia.gov/forecasts/aeo/

previously, robust national trading scenarios potentially maintain the competitiveness of coal-fired EGUs reducing pressures on natural gas prices.

Figure 9 EVA-Projected Henry Hub Natural Gas Prices ($2015/MMBtu)



Source: EVA Analysis

Demand for natural gas, and resulting price pressures, come from both the demand for natural gas in the power sector as well as the export market. Natural gas prices are expected to rise due to increased demand from new and existing gas-fired power plants and due to expanding U.S. LNG exports, which began in February 2016 at the Sabine Pass LNG facility.[89] According to EIA's *Natural Gas Weekly* "the five LNG export facilities currently under construction in the United States, including Sabine Pass, will have a total liquefaction capacity of 9.2 Bcf/d, which is equivalent to 13% of current domestic natural gas production. Nearly all of this capacity has been fully or partially contracted and is scheduled to be in service by 2019."

CO_2 Costs

The price of electricity will increase under most 111(d) compliance scenarios due to EGUs absorbing costs of emissions through the purchases of allowances or ERCs. Carbon dioxide (CO_2) costs add to the variable cost of power generation as it is an amount that must be added per MWh of plant output.

[89] http://www.eia.gov/naturalgas/weekly/archive/2016/02_25/index.cfm

CO_2 costs are assigned to electricity customers in dollar amounts. Industrial, commercial and residential customers absorb different shares of costs, based on the share of variable generation revenue utilities receive from each customer class. Electricity rates for industrial customers are lower than for other customer classes as the distribution grid is not as extensive for these customers. Thus, variable generation costs are a larger share of retail rates for industrial customers, who may thus see a larger impact from additions of CO_2 costs to electricity prices. Customer shares of variable generation expenses utilized in this analysis are 42% for industrial customers, 22% for commercial customers and 36 percent for residential customers.[90]

West Virginia-based EGUs will be required to purchase allowances or ERCs under all compliance scenarios with the exception of the mass scenario without trading. In that scenario, the EGUs comply with the mass-based carbon emission target by reducing output; however, allowances may still have value if they are able to be sold by EGUs on a secondary market.

For the mass approaches it is assumed that allowances are given to generators for free. In the mass approach with no trading, generators are assumed to comply by reducing generation and thus there is no increase in cost of generation related to purchasing allowances. In spite of these assumptions, a "shadow price"[91] for CO_2 prices was calculated by EVA that represents a resulting cost of optimizing the mix of generation within the State of West Virginia to get to the emissions limit.

Table 18 Shadow CO_2 Prices Under an In-State Only Mass-Based Approach

Year	WV Allowance Price ($2015/short ton)
2022	$10.70
2023	$11.77
2024	$12.57
2025	$12.68
2026	$13.59
2027	$14.54
2028	$15.24
2029	$15.92
2030	$16.69

Source: EVA Analysis

In contrast, in the mass scenario with trading West Virginia-based EGUs remain competitive electricity producers and exceed the CO_2 targets. EGUs must purchase allowances at the national allowance price to generate. This analysis assumes that CO_2 allowances are allocated to EGUs based on historical generation, i.e. no special provisions are made to assign allowances in favor of in-state users of

[90] Data provided by the WVPSC, Utilities Division.
[91] A shadow price is a non-market price of CO_2 representing a hypothetical surcharge to the price of electricity to emit. In this no-trading scenario there is no market for CO_2 and no explicit cost.

electricity. Thus, West Virginia-based electricity consumers must absorb a portion of the cost. The remaining cost is absorbed by EGUs and passed on to wholesale or out-of-state retail customers as market conditions allow.

Table 19 displays the estimated allowance prices and total values under a mass-based national trading scenario. Allowance prices, and associated total cost to EGUs and West Virginia consumers, rise throughout the compliance period as the emissions target becomes more stringent. Total allowance value is the value of allowances the affected EGUs must purchase, and can afford to purchase and still remain competitive electricity suppliers. This value increases from $112 million in 2022 to $324 million in 2030. The estimated cost to West Virginia consumers from carbon allowances, as determined by the share of electricity generated that is consumed within the state, is initially $47 million and increases to $138 million under this scenario. The remaining value is assigned to wholesale generation or to retail customers in other states. As mentioned previously, if fewer states participate in mass-based trading then the number of available allowances is likely to be lower, and the allowance price higher which would result in higher cost of allowances.

Table 19 Projected CO_2 Costs and Allowances Needed Under Mass-Based National Trading

	2022	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**
U.S. Allowance Price ($2015/short ton)	$4.35	$4.76	$5.44	$5.65	$6.21	$6.89	$7.46	$8.24	$9.43
# Allowances Needed by WV EGUs (million)	25.7	25.3	25.8	32.1	31.8	31.0	34.0	33.4	34.4
Total Allowance Cost/Value ($2015M)	$112	$121	$140	$181	$197	$214	$254	$275	$324
Cost to WV Consumers ($2015M)	$47	$51	$59	$76	$83	$90	$107	$116	$138

Source: Allowance prices are EVA projections. Allowances needed are CBER calculations.

Due to the nature of coal-fired generation, ERCs must be purchased in both rate scenarios, although the levels are fewer in the no-trading case because generation is much lower. Tables 20 and 21 display the estimated ERC prices resulting from the rate-based scenarios with and without national trading. In a rate-based scenario with national trading, West Virginia-based EGUs remain competitive in the wholesale market and maintain fairly high levels of generation with emission rates (lbs/MWh) that exceed the standard. ERC prices, and associated total cost to EGUs and West Virginia consumers, rise throughout the compliance period as the emissions target becomes more stringent.

Table 20 Projected CO_2 Costs and ERCs Needed for West Virginia under Rate-Based National Trading

	2022	2023	2024	2025	2026	2027	2028	2029	2030
U.S. ERC Price ($2015/MWh)	$11.41	$12.52	$13.72	$15.02	$16.47	$18.22	$19.64	$21.72	$24.68
# ERCs Needed by WV EGUs (million)	19.8	19.6	19.2	30.8	30.7	30.3	39.3	38.3	43.6
Total ERC Cost/Value ($2015M)	$226	$246	$264	$462	$506	$553	$773	$831	$1,075
Cost to WV Consumers ($2015M)	$78	$82	$84	$163	$175	$187	$271	$285	$377

Source: ERC prices are EVA projections. ERCs needed are CBER calculations.

Under the rate scenario without trading, ERC sales are confined to state borders. This restriction causes ERC prices to be much higher as opportunities for trade are very limited. This scenario reduces the competitive position of West Virginia-based EGUs, causing several units to close and total generation to be greatly reduced to a level that is less than in-state demand. This reduction causes the amount of ERCs needed to be much lower than the rate scenario with trading and thus results in lower CO_2 costs to consumers. **However, evaluation of this scenario based solely on CO_2 costs is not complete because the additional cost complexities of procuring replacement energy and capacity required to meet in-state demand under this scenario are not included. As such, there may be additional costs as electricity must be imported or new facilities constructed to satisfy in-state demand.**

Table 21 Projected ERC Values and ERCs Needed Under a Rate Scenario Without Trading

	2022	2023	2024	2025	2026	2027	2028	2029	2030
WV Demand[92] minus Total Generation (GWh)	(4,427)	(11,979)	(17,467)	(19,874)	(20,015)	(21,473)	(21,951)	(21,438)	(22,993)
ERC Price in WV ($2015/MWh)	$102.62	$94.67	$86.50	$84.58	$80.70	$69.64	$68.85	$65.15	$65.58
# ERCs Needed (million)	7.3	5.6	4.4	6.2	6.2	5.7	7.4	7.6	8.2
Total ERC Cost/ Value ($2015M)	$750	$531	$379	$522	$499	$397	$507	$498	$536
Cost to WV Consumers ($2015M)	$162	$62	$(7)	$41	$22	$(11)	$21	$13	$14

Source: ERC prices are EVA projections. ERCs needed are CBER calculations.

[92] Estimates based on growth rates used by FirstEnergy and Appalachian Power in their Integrated Resource Plans.

8 – Statewide Economic Impacts of Potential Plan Alternatives

The results of EVA's energy market simulations are used to estimate the economic impact of resulting changes in plant MWh and consumer electricity expenditures using the economy-wide input-output model developed by Regional Economic Models, Inc. (REMI). REMI PI+ was chosen as an economic impact model as it is a dynamic model that allows simulation of economic changes over time, thus matching the eight-year timeframe of 111(d). REMI PI+ also includes a variety of macroeconomic variables such as output (industry sales volume) and GDP (gross domestic product).

CBER estimated the corresponding changes to in-state energy industry sales. Changes to industry sales were then used in the economic impact model to estimate changes to statewide employment, earnings and economic activity. CBER calibrated the economic impact model to better account for the size of the state's electricity generating industry and linkages to the state's coal economy.

As noted previously, the trading scenarios result in higher generation from West Virginia-based EGUs than scenarios without access to national trading. Scenarios with higher generation result in smaller impacts to the statewide economy relative to non-trading scenarios that yield larger declines in generation.

While trading scenarios yield smaller losses to the economy, producing emissions above the EPA-mandated levels also result in higher electricity prices for in-state customers due to the need to purchase allowances or credits to offset those emissions. While the declines in fossil-fuel fired EGU output drive results for West Virginia, installation of new RE capacity was also considered. As noted in Table 25, estimated new RE capacity in West Virginia due to the implementation of 111(d) ranges from 120 MW to 180 MW, depending on the scenario.

8.1 Approach

The REMI PI+ model is a dynamic forecasting and policy analysis tool that incorporates econometric and input-output analysis. The input-output aspect of the model contains detailed data on 160 industries and the inter-industry relationships that represent economic activity, e.g. demand for goods and services by industries and households, employment, output (sales value). The REMI model of the West Virginia economy includes a baseline "regional control" forecast of the future that includes levels of projected output, employment and contribution to state GDP for each industry in the model.

Changes in the value of electricity generation sales are based on:

1. EVA's projections for generation from affected EGUs
2. EVA's projections for wholesale electricity prices
3. Estimates of the share of electricity generated for wholesale v. retail markets
4. The variable cost share of total generation revenue

CBER calibrated the REMI PI+ model to more accurately reflect West Virginia's power generation sector and changes resulting from 111(d) compliance. Please see the appendix for more detail on the model calibration. Further, estimates include assumptions regarding new RE capacity and savings from EE programs, as well as projected natural gas prices.

The economic impact of 111(d) is based largely on the resulting change in generation from West Virginia-based EGUs as the plants comply with the rule. Reductions to generation result in reduced economic output from the electricity generating industry in the form of fewer sales to retail and wholesale customers.

Categories of impacts include:

- Direct impacts to output of the power generation industry
- Indirect impacts of reduced output by power generation to the coal industry and other supplier industries, e.g. construction
- Cost of allowances/ERCs and the resulting impact on electricity expenditures by industrial, commercial and residential electricity customers
- Addition of renewable energy capacity
- Resulting total direct and indirect economic impacts at the State level from the above changes to the economy

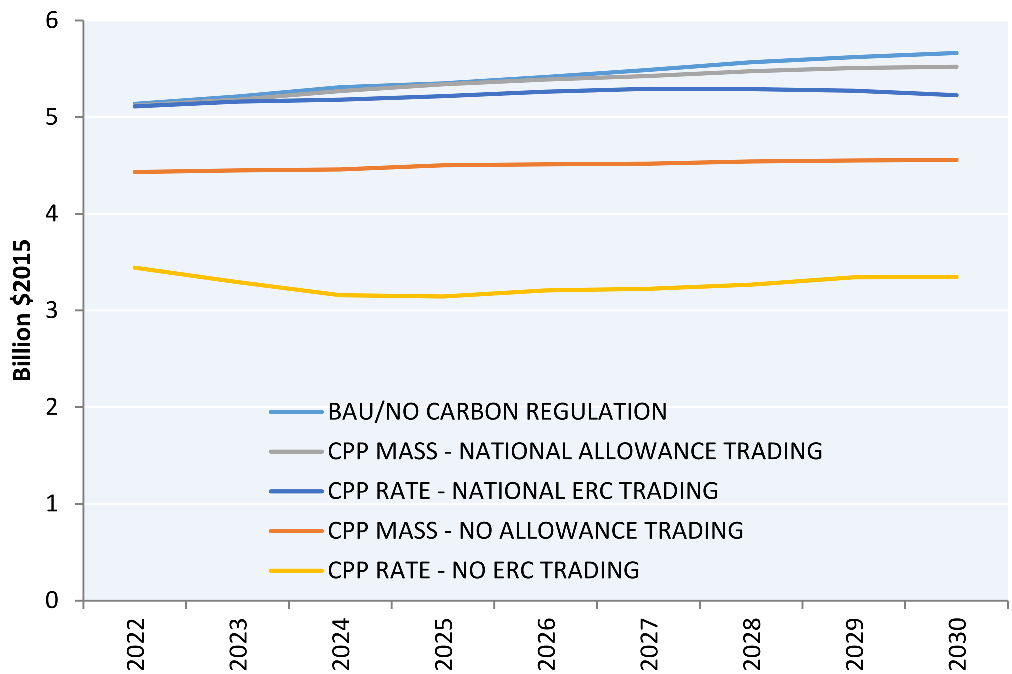
These impacts are evaluated in terms of changes to overall economic output (industry sales), state gross domestic product (GDP) and employment. Impacts resulting from the potential compliance scenarios are compared to the baseline BAU/No-Carbon baseline model. Impacts are simulated using the REMI model.

8.2 Economic Impact Results

Electricity Industry Impacts

The first set of impacts are those accruing to the electricity industry, the primary direct impacts. Based on estimated reductions in generation, the models indicate industry sales within the state decline relative to BAU by as little as $140 million in 2030 in the mass approach with national trading to as much as $2.3 billion in a rate approach with no trading.

Figure 10 Output Impacts - Power Generation Industry West Virginia (billion $2015), 2022-2030



Source: REMI PI+ and CBER calculations

Consistent with results from the energy market analysis, reductions in sales relative to the BAU case are modest for national trading scenarios.

Retail Price Impacts

Changes to retail electricity prices in West Virginia are estimated for the national trading scenarios based on EIA data for electricity sales revenue from sales to West Virginia-based customers in 2014 and the additional costs of acquiring allowances or ERCs. To estimate changes in electricity prices, the value of allowance or ERC costs accruing to West Virginia were added to 2014 electricity sales revenue. This comparison to 2014 is a simplifying assumption that real electricity prices are unchanged over the study period. Table 22 contains the results.

Estimated retail prices in West Virginia increase under both mass- and rate-based national trading scenarios, however the increase is more pronounced for rate-based. These price increases are estimated gross effects of the consumer-borne costs of CO_2 compared to current electricity expenditures. The net effects of future price changes are not evaluated, including any price increases from ordinary changes in the cost of delivering electricity. These prices changes are calculated outside the impact analysis and are not inputs to the REMI PI+ model.[93]

Table 22 Estimated Changes to West Virginia Retail Electricity Prices Under National Trading

	2022	2023	2024	2025	2026	2027	2028	2029	2030
Mass-Based	1.9%	2.0%	2.4%	3.1%	3.4%	3.6%	4.3%	4.7%	5.6%
Rate-Based	3.1%	3.3%	3.4%	6.6%	7.1%	7.5%	10.9%	11.5%	15.2%

Source: CBER calculations from REMI and EVA data

Assuming modest growth in national electricity prices, prices in West Virginia are projected to increase faster than the nation overall, as illustrated by the estimates in Table 23. National energy prices are assumed to increase about 1 to 2 percent under a mass-based scenario and 1 to 6 percent under a rate based scenario.

Table 23 Estimated Changes to West Virginia Retail Prices Relative to National Prices Under National Trading

	2022	2023	2024	2025	2026	2027	2028	2029	2030
Mass-Based	1.1%	1.2%	1.4%	1.8%	2.0%	2.2%	2.6%	2.8%	3.3%
Rate-Based	1.9%	2.0%	2.0%	3.9%	4.2%	4.5%	6.5%	6.8%	9.0%

Source: CBER calculations from REMI and EVA data

For the mass scenario, these calculations assume CO_2 allowances are distributed to all affected EGUs based on historical generation. In reality, the allocation could be designed to favor consumers by distributing allowances only to EGUs that supply West Virginia-based customers.

Impacts from Renewable Energy

As noted previously, compliance with 111(d) relies heavily on the capacity of EGUs to switch generation from higher emitting sources of carbon to lower or zero-carbon sources, such as renewable technologies. The National Renewable Energy Laboratory (NREL) estimates renewable technical potential for states "based on renewable resource availability and quality, technical system performance, topographic limitations, environmental and land use constraints."[94] These estimates are shown in Table 24 and reveal that there are significant amounts of renewable energy that could be developed in West Virginia, particularly for solar and enhanced geothermal resources. However, these technical estimates ignore both the cost of development and the contribution of such capacity to electricity system reserve margins that must be maintained for reliability. As discussed in more detail subsequently, a smaller portion of renewable capacity may be counted for reliability planning (see capacity credit values shown in Table 33 page 67). In other words, the technical potential of renewable

[93] REMI's baseline assumptions already include increases in electricity prices for residential customers relative to the nation as a whole. REMI projects the relative price of electricity delivered to the industrial and commercial sectors in West Virginia to be unchanged through the study period and remain lower than the national average
[94] Lopez et al (2012) p.iv

generation differs from the economic potential. NREL estimates that generally West Virginia is grouped among those states the lowest economic potential for renewable capacity, not exceeding 3 TWh for all RE technologies combined.[95]

Table 24 Renewable Technical Potential, 2012

Technology	Generation Potential (GWh)		Potential Generation Capacity (GW)		Installed[96] Capacity (MW)
	US Total	WV Share	US Total	WV Share	WV Current
Urban utility-scale PV	**2,231,694**	0.14%	**1,218**	2	0
Rural utility-scale PV	**280,613,217**	0.02%	**152,974**	31	0
Rooftop PV	**818,733**	0.52%	**665**	4	3.5
Concentrating solar power	**116,146,245**	0.00%	**38,066**	0	NA
Onshore wind power	**32,784,005**	0.02%	**10,955**	2	583
Offshore wind power	**16,975,802**	N/A	**4,224**		NA
Biopower	**488,326**	0.55%	62	0	NA
Hydrothermal power	**301,382**	0.00%	**38**	0	NA
Enhanced geothermal	**31,344,696**	0.83%	**3,976**	33	0
Hydropower	**258,953**	1.70%	**60**	1	198

Source: Lopez et al (2012)

For this analysis, CBER assumes additions of RE capacity in West Virginia for all scenarios as a share of total RE capacity additions modeled by EVA for the PJM region. EVA's projections include capacity additions of both solar and wind in the PJM region due to the existence of renewable portfolio standards and carbon markets, although the technologies are still not competitive with fossil resources during the evaluation period, i.e. the technologies are not automatically selected as capacity additions.

EVA projects RE to be added in the BAU case as well as in the CPP scenarios, although additional RE capacity is installed due to the CPP. For this analysis, RE capacity additions in WV are assumed based on WV's share of the five percent RE set-aside.[97] This results in about 30 MW of solar and 90 MW of wind capacity, except in the rate scenario without national trading which results in 70 MW of solar and 110 MW of wind. The rate scenario without national trading induces more RE capacity additions due to higher ERC prices.

New RE capacity added in WV results in temporary gains in construction employment and small additions to operations and maintenance (O&M) employment in the electricity generation industry. For this analysis, the construction impacts are assumed to occur over the years 2022-2024. These additions are summarized in Table 25.

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[95] Brown et al (2015). Only when evaluating the economic potential for utility-scale photovoltaic, assuming full capacity value and value of avoided external costs, does West Virginia's economic potential exceed the lowest range. Estimated economic potential is 54 TWh for this case.

[96] U.S. DOE/EIA; Solar Energy Industries Association (2015). *Solar Spotlight: West Virginia*.

[97] CBER assumption.

Table 25 Assumptions of New Renewable Energy Generating Capacity in West Virginia Due to the CPP

Scenario	Solar MW	Wind MW	Construction Jobs	O&M Jobs	Annual MWh
Rate – No Trading	70	110	551	19	315,815
All Other	30	90	272	12	406,302

Source: EVA Analysis, JEDI Model[98] and CBER calculations

In terms of RE provisions of the CEIP the results depend on the value of the allowances. In a rate scenario, RE generation can generate ERCs and may provide more value to consumers. In the mass scenario with national trading the value of allowances may not be high enough to induce any new RE in West Virginia. In that event the additional set-aside may then revert to the EGUs.

Both Appalachian Power and Monongahela Power have indicated in their Integrated Resource Plans that they expect to need additional capacity resources within the next few years and prior to 111(d) implementation. The utilities indicate that this need is due to multiple conditions including planned downgrades of current hydro and wind capacity values by the RTO, projected increases in peak winter customer load and increased reserve requirements.[99, 100] Thus, although additional RE capacity is likely to be built, the need for generation with firm capacity during the winter months may be a higher priority for the utilities.

Total Statewide Impacts

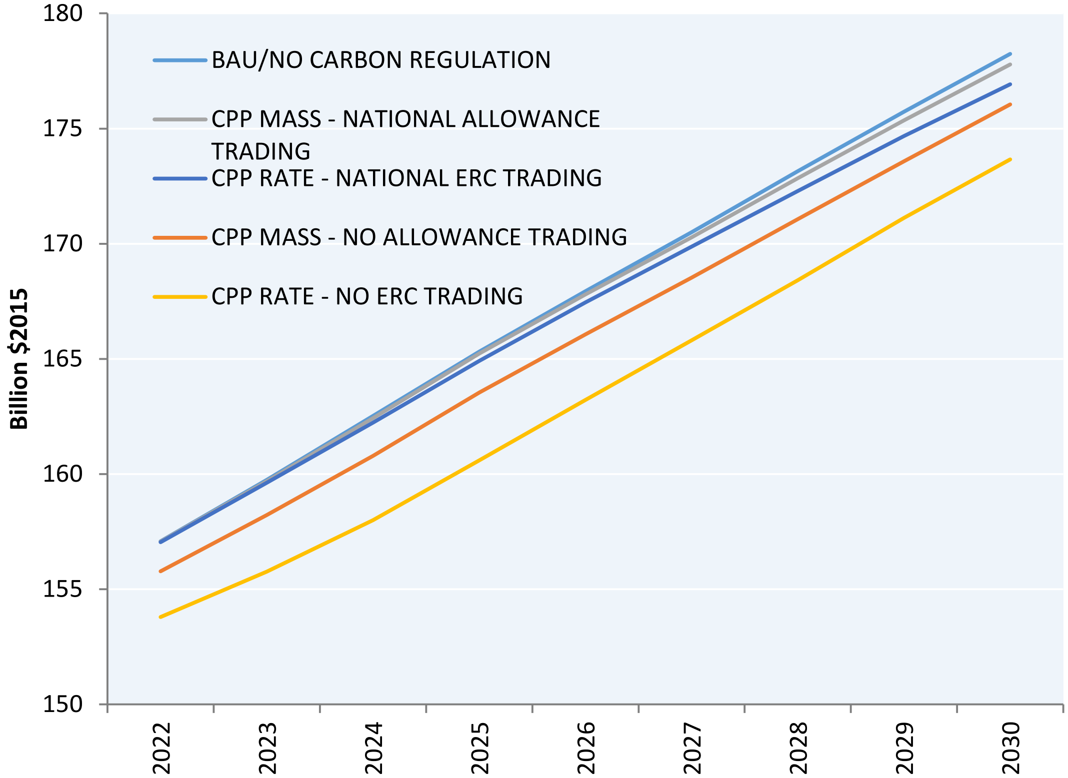
Output Impacts

Reductions in fossil fuel-fired EGU sales yield reductions in total statewide economic activity, measured as the value of output. As displayed in Figure 12, total output for the state is projected to increase under all scenarios, but from different starting points. Reductions in statewide economic output relative to BAU are more severe under a rate-based no-trading scenario, ranging from about $3.29 billion in 2022 to $4.6 billion, a decline of 2.6 percent, in 2030. Although as stated previously, analysis of the impacts of the rate scenario with no trading is considered incomplete due to the extreme level of reduced generation and capacity, and uncertainty as to how it will be replaced. Detailed impact estimates relative to BAU are included in the appendix.

Consistent with energy market results, national trading scenarios produce smaller losses to state economic activity. Reductions to economic output manifest around 2024, the end of the first interim compliance period, for a rate-based plan and continue to increase to almost $1.5 billion in total losses in 2030. A mass-based plan with robust national trading results in smaller losses, less than $500 million in total in 2030.

[98] JEDI is the Jobs and Economic Development Impact model available through the National Renewable Energy Laboratory (NREL). For more information please see http://www.nrel.gov/analysis/jedi/
[99] Monongahela Power/Potomac Edison (2015). 2015 Integrated Resource Plan.
[100] Appalachian Power (2015). 2015 Integrated Resource Plan.

Figure 11 Impacts to Total Output for West Virginia (Billions $2015), 2022-2030

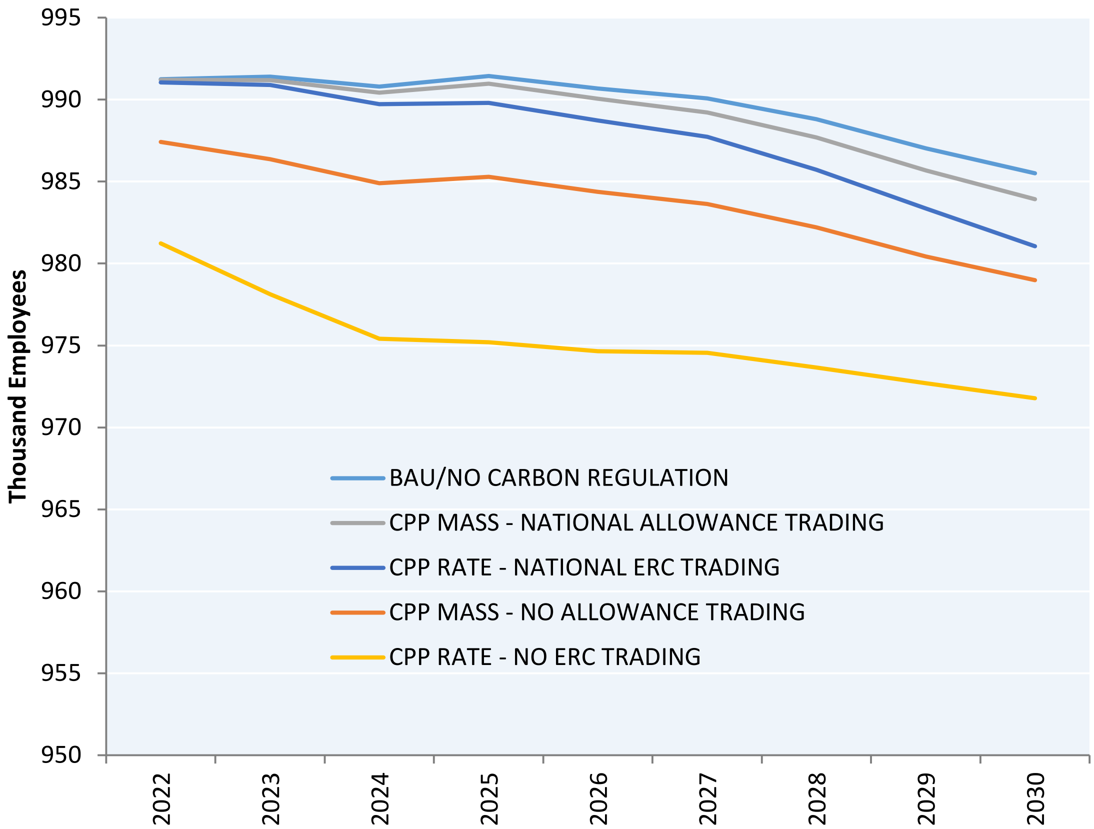


Source: REMI PI+ and CBER calculations

Employment Impacts

In general, statewide employment is projected to decline under all scenarios. Total employment statewide follows similar patterns to changes in output. The rate-based scenario with no trading yields the largest estimated employment losses, beginning with a reduction of 10,000 jobs in 2022 relative to BAU and peaking in 2025 with -16,000 jobs lost compared with BAU. National trading scenarios result in average annual employment losses of fewer than 1,000 (mass-based) to about 2,000 (rate-based) jobs relative to BAU over the 8-year compliance period. Employment impacts are shown in Figure 12. Detailed impact estimates relative to BAU are included in the appendix.

Figure 12 Total Employment Impacts for West Virginia (thousands), 2022-2030



Source: REMI PI+ and CBER calculations

More granular examination of employment impacts reveals details of the industries most affected by reductions in sales from power generation. Results are displayed in Table 26. Under all compliance scenarios, the construction sector is the most affected sector with declines representing loss of supply-chain activity related to power plant maintenance. The importance of the construction industry to the power generation industry is illustrated by the fact that for every one job lost (or gained) to power generation, another 1.1 jobs are lost (or gained) in construction due to indirect demand by the power generation industry.[101]

Similar to patterns noted previously, scenarios without trading produce larger declines relative to BAU. As noted previously, this analysis omits consideration of replacement capacity and heat rate improvements that may be pursued by EGUs. These activities may produce positive one-time construction impacts.

Table 26 Average Estimated Employment Impacts for Top 5 Industries Relative to BAU, 2022-2030

Sector	National Trading		No Trading	
	Mass	Rate	Mass	Rate
Construction	-197	-583	-1,582	-3,827
Utilities	-56	-181	-891	-2,101
Mining	-29	-174	-951	-2,303
Retail Trade	-91	-237	-535	-1,313
Healthcare and Social Assistance	-48	-122	-225	-552

Source: CBER calculations from REMI PI+ output

Mining Industry Employment Impact

Examination of employment changes by industry indicate that among Mining sectors Coal Mining generally comprises more than half of the impact compared with Oil and Gas Production. Table 27 contains the breakdown of mining employment impacts. Consistent with patterns observed previously, no trading scenarios yield the largest reductions in employment relative to BAU. Detailed employment estimates are in the appendix.

Table 27 Annual Average Mining Employment Change Relative to BAU, 2022-2030

Sector	National Trading		No Trading	
	Mass	Rate	Mass	Rate
Mining (ALL TYPES)	-30	-174	-951	-2,303
Coal Mining	*11*	*-62*	*-634*	*-1,544*
Oil & Gas Production	*-18*	*-40*	*-21*	*-54*
Support Activities for Mining (All types)	*-22*	*-71*	*-294*	*-700*

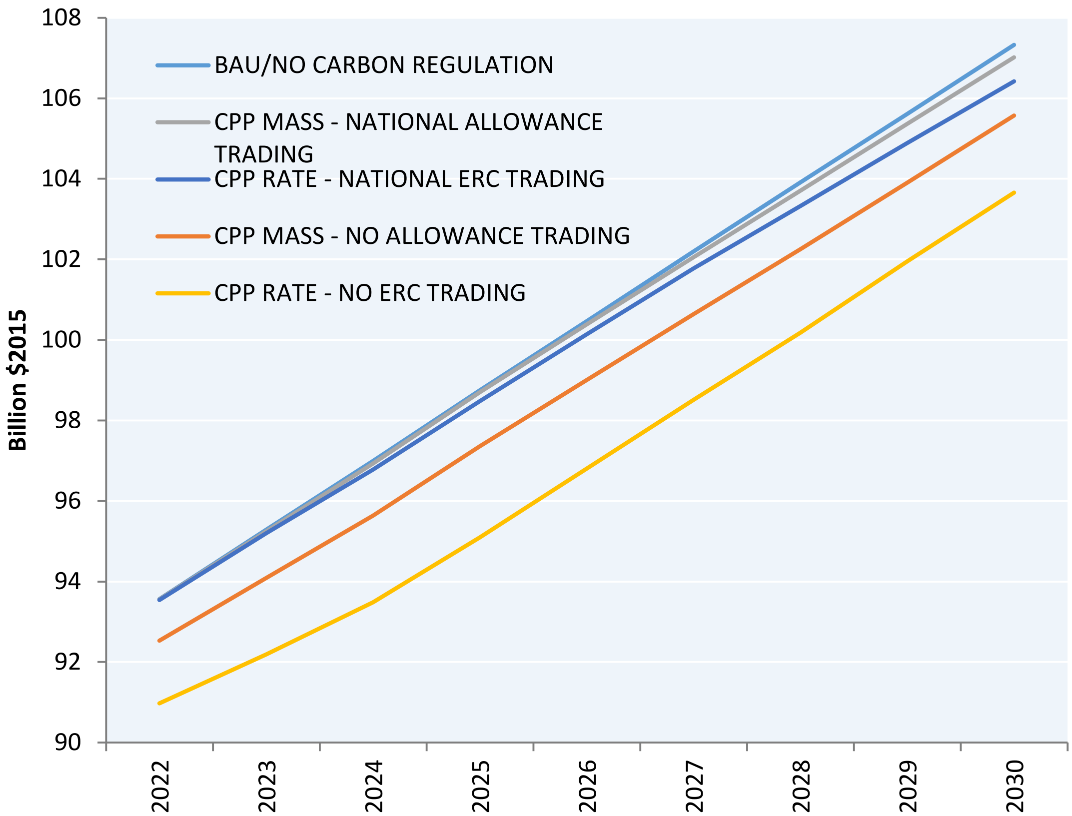
Source: CBER calculations from REMI PI+ output

[101] REMI model output for PI+ West Virginia v1.7.1 (Build 3904)..

Impacts to State GDP

Impacts to GDP are also similar in magnitude to output impacts. Figure 13 displays the impacts to GDP. Compared to BAU in 2030 state GDP is lower by 0.3% in the mass case with national trading and by 3.4% in the rate case with no trading. Detailed impact estimates relative to BAU are included in the appendix.

Figure 13 Total GDP Impacts for West Virginia ($2015 Billion), 2022-2030



Source: REMI PI+ and CBER calculations

Impacts to State Severance Tax Revenues

Aside from direct employment and indirect economic activity, another important economic linkage to coal production in West Virginia is the severance tax. Severance tax revenues are distributed among the general revenue fund, infrastructure bond fund and workers compensation debt fund. Revenues are used to provide government services, including educational services in coal-producing counties.[102] "The tax rate on natural resources, except timber, are generally 5.0 percent of gross receipts."[103]

Severance tax rates applied to coal range depending on coal seam thickness with 5 percent being the maximum rate and 1 percent the current minimum. Additional taxes also apply include the Special Two-Cent tax and the Reclamation Tax. Coal is also subject to additional taxes "for the benefit of local governments" which is distributed to counties and municipalities throughout the state, principally coal

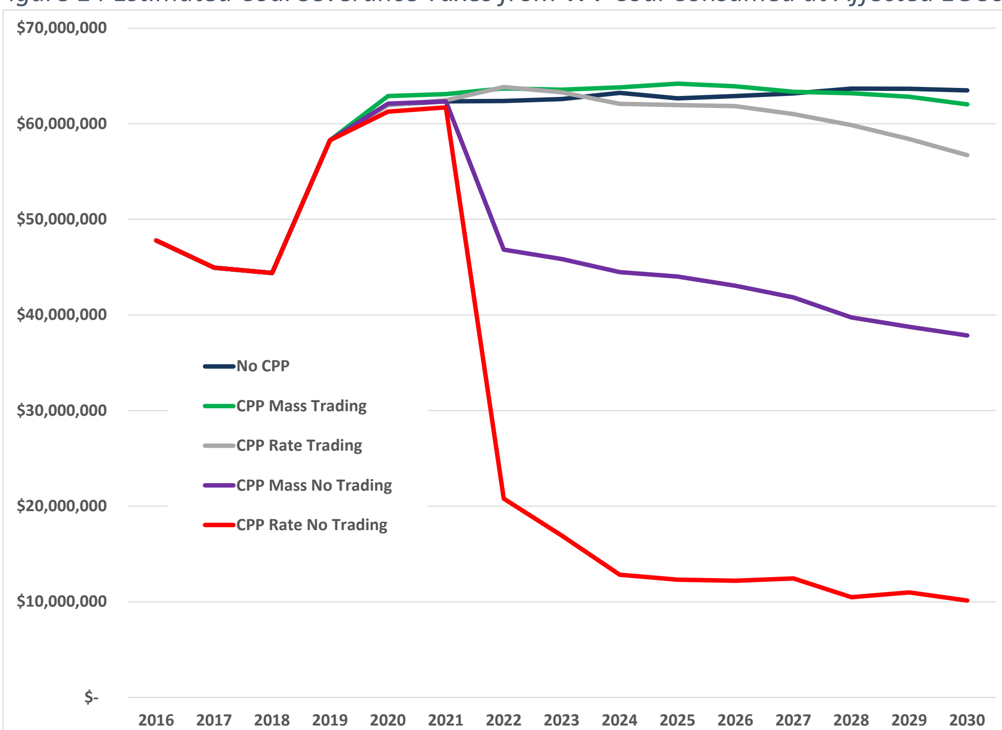
[102] Tax Commissioner of West Virginia (2015). p. 54 http://tax.wv.gov/Documents/Legal/TaxLawReport.51.pdf
[103] Ibid

producing counties.[104] Companies may be eligible for "tax credits that may be applied against Severance Tax Liability".[105] Thus, the effective severance tax rate varies across producers depending on the applicability of rates and credits.

Assuming a constant coal price of $56/ton across all scenarios and applying a simple 5 percent rate, CBER approximated the value of severance tax revenue under each scenario. Figure 14 displays estimates of coal severance tax from West Virginia coal projected to be consumed at affected EGUs under scenarios evaluated, including BAU.

In 2022, estimated severance tax revenue is comparable under trading scenarios to BAU consistent with the relative competitiveness of West Virginia's coal-fired electric power generation. By 2030 revenues with a rate scenario are about 11 percent lower than BAU and about 2 percent lower with a mass-based approach with national trading. Scenarios without trading yield more severe reductions, consistent with previous patterns. Loss in aggregate estimated revenues by 2030 are 40 percent under a mass-based and 84 percent with a rate-based plan.

Figure 14 Estimated Coal Severance Taxes from WV Coal Consumed at Affected EGUs4



Source: EVA Analysis and CBER calculations

[104] Ibid

[105] Tax Commissioner of West Virginia (2015). p. 55

9 – Impact of Hypothetical Plant Closure

9.1 Approach

To provide information regarding potential impacts from unit closure in the sub-regions surrounding the power plants, CBER utilized the EMSI's input-output model.[106] EMSI produces estimates of employment and sales impacts for the sub-regions based on 2013 national input-output (I-O) tables. As these areas are defined as those surrounding the power plants, effects for other regions of the state are not included. The model only considers purchases and spending effects within the defined sub-region. Even though many of the power plant sub-regions include portions of neighboring states, only the West Virginia portions were considered in the analysis. Further, power plants may draw labor or supplies from other parts of West Virginia beyond their sub-region borders. With the exception of statewide coal employment impacts, the hypothetical closure analysis does not consider impacts outside of these sub-regions.

Power plant local sub-regions were determined using United States Census Bureau data on Commuting (Journey to Work) Flows.[107] Sub-regions were defined on the basis of where workers reside. Closures were simulated as a reduction in employment of the affected industry, Fossil Fuel Electric Power Generation sector (NAICS 221112). Estimates of EGU direct employment and industry employment were used to approximate complete closure. Please see the appendix for more detail.

Impact estimates are illustrative and should be interpreted with care. The estimates thus reflect the potential impact of complete plant closure to the extent permissible by the data. For plants consisting of more than one unit, partial closure would result in smaller impacts than estimated. The analysis also assumes that individuals do not find other employment elsewhere within the sub-regions. Re-employment potentially mitigates overall estimated impacts by generating replacement jobs and income.

As noted previously, power plant sub-regions overlap and counties may be represented multiple times. As such estimated impacts for individual plants should not be aggregated as double counting will occur overstating aggregating impacts. Also, impacts consider only the loss of these individual sources of coal demand. As noted previously, West Virginia-based EGUs account for about 15 percent of demand for West Virginia coal. Dynamics in external markets are not captured in the analysis and may offset or exacerbate estimated impacts.

National I-O tables may underestimate in-state linkages between fossil fuel power generation and mining sectors for West Virginia. To address this limitation, potential reductions in statewide coal sales were used to estimate employment impacts to the fossil fuel production industries resulting from potential plant closure.

As noted in Table 28, the employment sub-regions of most of the power plants stretch into surrounding states. Power plant sub-regions were defined based on worker flow data, which is described in greater detail subsequently. Also noted in the table, several counties appear in more than one region –

[106] Economic Modeling Specialists, Inc.
[107] http://www.census.gov/hhes/commuting/data/

Harrison, Marion, Monongalia, Preston, and Taylor. Thus, power plant regions are not mutually exclusive and a county may be impacted by a change in operations by more than one power producer.

Table 28 West-Virginia Coal-Fired Power Plant Sub-regions

County	Power Plant	Counties in Region	State
Putnam	John E Amos	Cabell, Jackson, Kanawha, Lincoln, Mason, Putnam	WV
		Gallia	OH
Monongalia	FirstEnergy (FE) Fort Martin Power Station, Morgantown Energy Facility (MEA), Longview Power LLC	Harrison, Marion, Monongalia, Preston, Taylor,	WV
		Fayette, Greene	PA
Harrison	FirstEnergy (FE) Harrison Power Station	Barbour, Doddridge, Harrison, Lewis, Marion, Monongalia, Taylor, Upshur	WV
Marshall	Mitchell	Marshall, Ohio, Wetzel	WV
		Washington	PA
		Belmont, Jefferson, Monroe	OH
Grant	Mt. Storm	Grant, Hardy, Mineral, Pendleton, Randolph, Tucker	WV
Pleasants	FirstEnergy (FE) Pleasants Power Station	Pleasants, Ritchie, Tyler, Wood	WV
		Washington	OH
Mason	Mountaineer	Jackson, Mason, Putnam	WV
		Gallia, Jackson, Meigs	OH
Marion	Grant Town Power Plant	Harrison, Marion, Monongalia, Preston, Taylor	WV

Table 29 contains socioeconomic characteristics for the West Virginia sub-regions surrounding the power plants. The region around Mitchell Power Plant is the smallest in terms of population but the highest in terms of per capita personal income, which includes all sources of income such as transfer payments and dividends for example. The sub-region for John E. Amos is the largest, with nearly 422,000 people and is situated within the largest labor market with almost 250,000 workers. With the exception of the Mountaineer sub-region, all of the power plan sub-regions have poverty rates in excess of the national average; although all are below the statewide average. Please see the appendix for a distribution of employment by industry within each sub-region.

Table 29 Socioeconomic Characteristics of Power Plant Sub-regions, 2014

Power Plant	Population	Total full-time and part-time employment	Average wages and salaries	Per capita personal income	Poverty Rate
Mt. Storm	96,915	46,539	$ 34,071	$ 32,688	17.4%
FE Harrison	312,398	179,330	$ 43,690	$ 38,310	17.7%
Grant Town	279,884	161,440	$ 43,956	$ 39,411	17.2%
Mitchell	91,732	56,572	$ 40,912	$ 40,907	16.6%
Mountaineer	112,912	47,396	$ 43,524	$ 36,207	15.5%
FE Fort Martin; MEA; Longview	279,884	161,440	$ 43,956	$ 39,411	17.2%
FE Pleasants	112,980	62,134	$ 39,109	$ 36,241	17.9%
John E. Amos	421,805	248,161	$ 42,816	$ 39,567	17.6%
West Virginia	1,850,326	914,071	$ 40,589	$ 36,132	18.4%
United States	318,857,056	185,798,800	$ 51,552	$ 46,049	15.8%

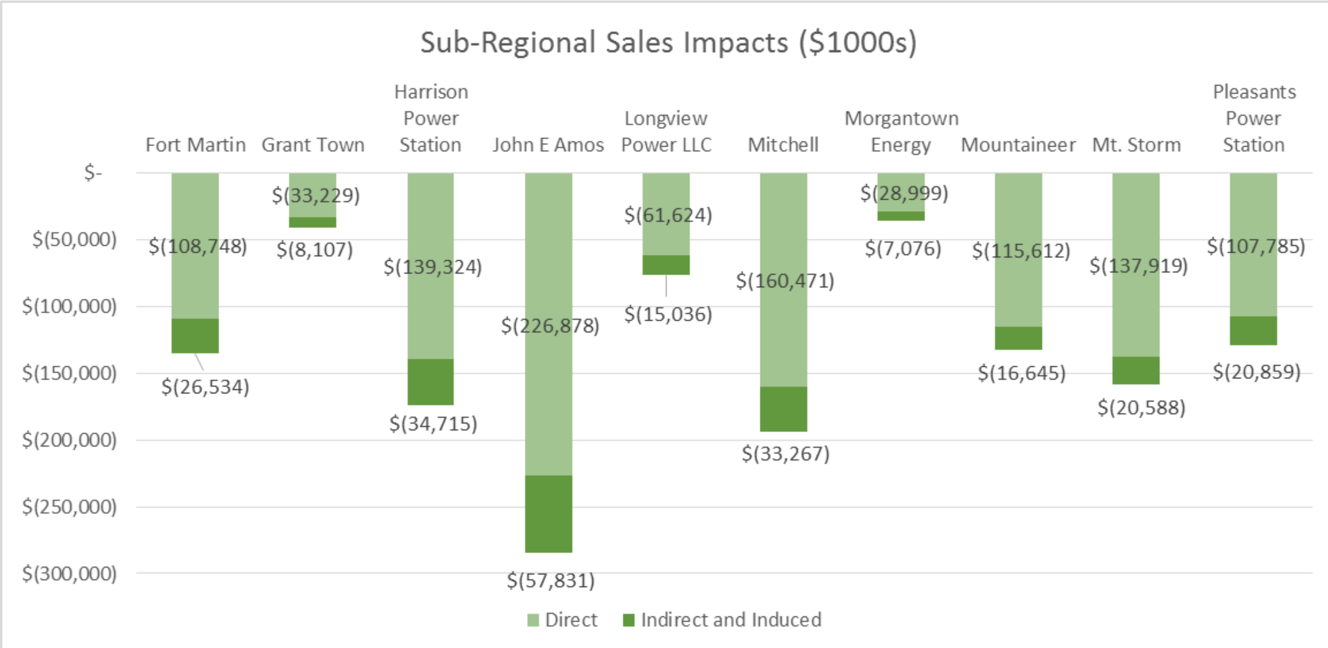
Source: CBER calculations from Bureau of Economic Analysis, Regional Economic Accounts, Census Bureau, Small Area Income and Poverty Estimates

9.2 Results

Figures 15 through 18 contain the results from the sub-regional hypothetical plant closure impact analysis. In general, the majority of impacts within each region consist of the direct effect, or the loss of sales and employment at the plant itself. Regional sales multipliers range from 1.14 to 1.25, indicating that within a given region the sales lost at additional businesses constitutes an additional $0.14 to $0.25 of lost economic activity for every dollar of lost power plant sales within the region. Sales impacts are based on the portion of industry sales retained within the sub-region.[108] Magnitude of multiplier effects, also known as the indirect and induced effect, depend on the size of the sub-regions and existence of supplier industries within the region.

[108] As noted previously, industry earnings for power generation exceed wages partly due to the inclusion of profits. Sales generated by West Virginia-based EGUs are not necessarily retained entirely within West Virginia and are likely distributed as earnings to other locations, such as where company headquarters are located. Sales not retained within the state, or power plant sub-region, constitute leakage and do not generate local economic impacts.

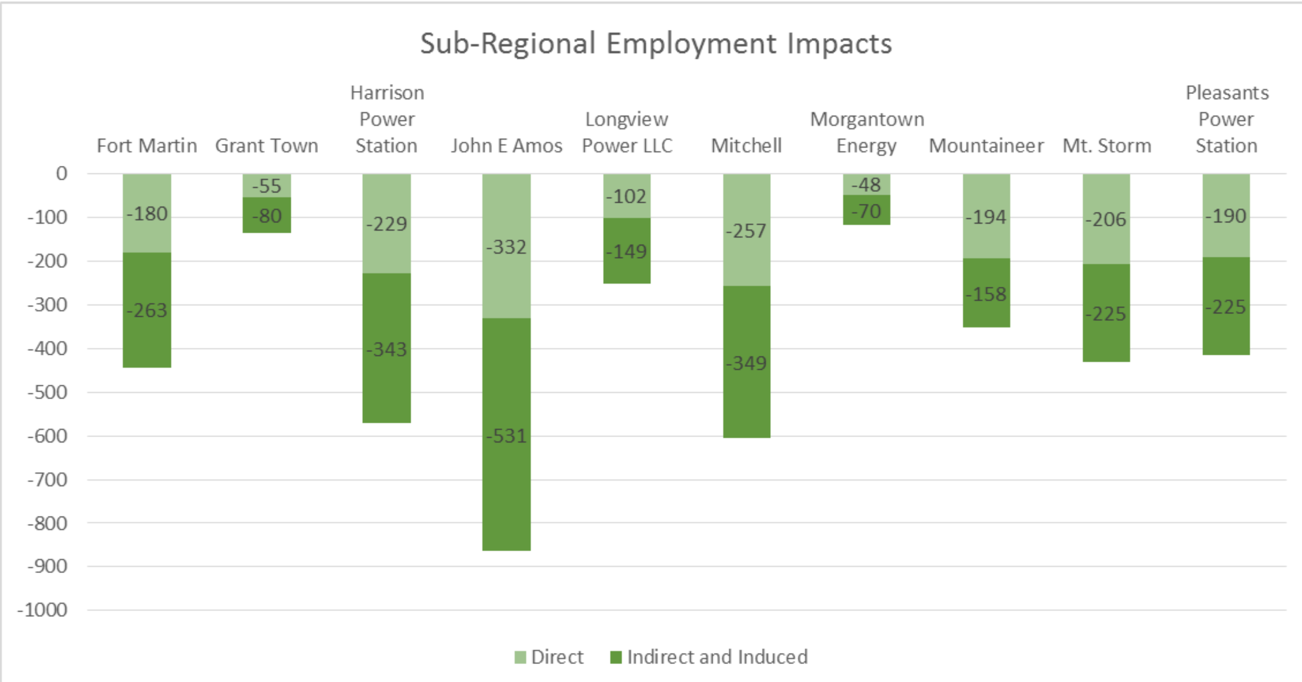
Figure 15 Total Sub-Regional Sales Impacts from Hypothetical Plant Closures



Source: EMSI, 2015 Q3 Estimates and CBER calculations. Based on 2013 national Input-Output tables.

Indirect and induced employment impacts within the sub-regions are generally larger than the direct impacts, or loss of plant employment, as displayed in Figure 16. Multipliers associated with job impacts range from 1.8 to 2.6. As with sales, larger sub-regions generally see larger impacts in absolute terms.

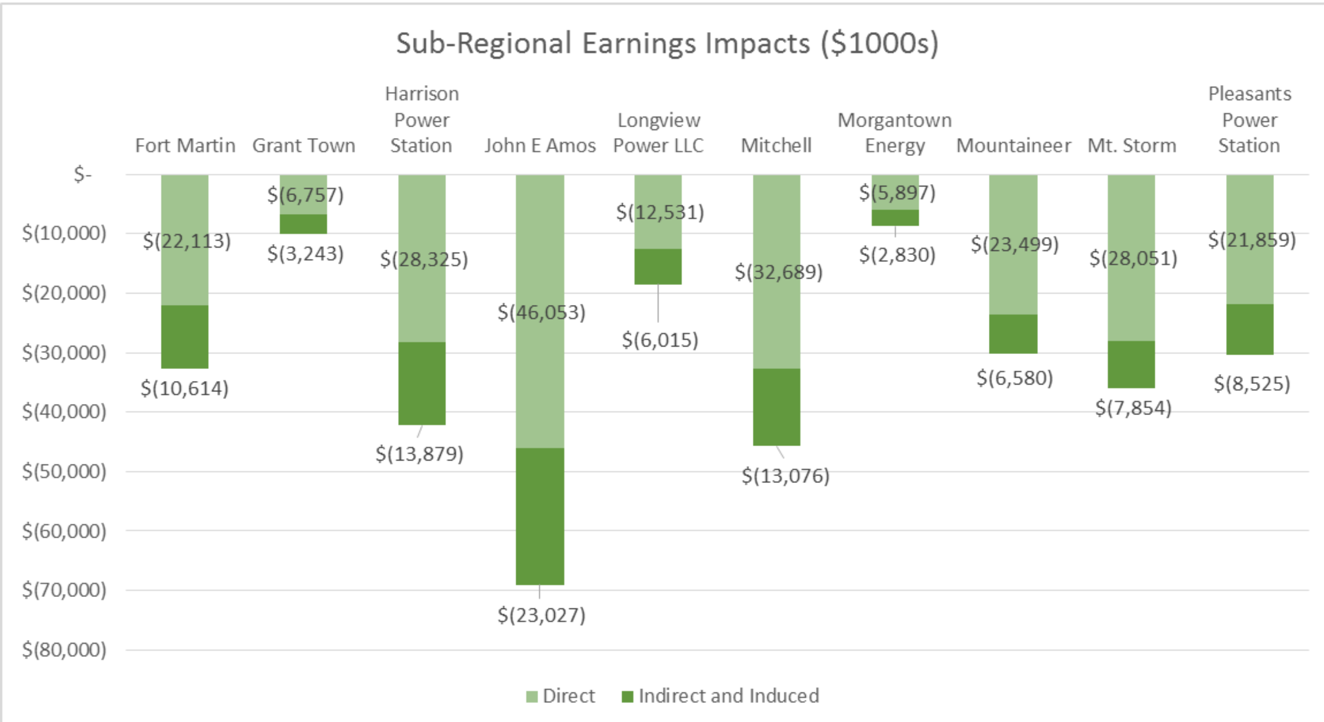
Figure 16 Employment Impacts from Hypothetical Plant Closures



Source: EMSI, 2015 Q3 Estimates and CBER calculations. Based on 2013 national Input-Output tables.

Similar to output impacts, earnings impacts are dominated by the direct effect or loss of earnings from the power plants directly. Recall that earnings includes benefits and profits. Figure 17 displays the results.

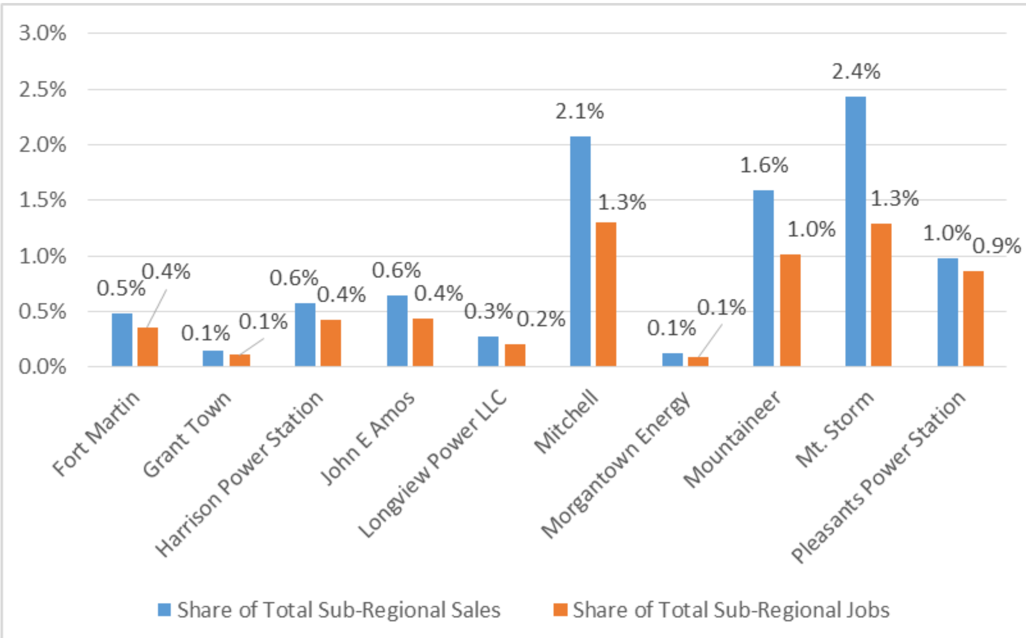
Figure 17 Earnings Impacts from Hypothetical Plant Closures



Source: EMSI, 2015 Q3 Estimates and CBER calculations. Based on 2013 national Input-Output tables.

To provide additional context for evaluating hypothetical closures, losses within each sub-region were compared with the area totals. While the absolute numbers range from $35 million to $284 million in lost sales, generally representing less than 3 percent of total economic output of each sub-region. Job loss estimates range from 120 to 870 jobs, accounting for less than 1.5 percent of total sub-regional jobs. The relative magnitude of impacts vary across each sub-region. Generally speaking, for sub-regions that are relatively small in economic terms the hypothetical closure exhibits a larger proportional impact than within sub-regions that represent larger or more diverse economic areas.

Figure 18 Impacts as Share of Sub-Regional Totals



Source: CBER calculations from EMSI, 2015 Q3 Estimates. Based on 2013 national Input-Output tables

In general, the affected industry exhibits the largest individual job impact, with remaining jobs lost occurring across industries within the sub-regions. Across all sub-regions, job loss is greatest in the Government sector consistent with existing research (see Table 51 in the appendix). Lost employment within Government constitute 10 to 15 percent of the job loss within each sub-region. Health Care and Social Assistance and Retail Trade are also heavily affected sectors. Retail employment accounts for between 4 and 8 percent of lost jobs, and similarly for Health Care and Social Assistance.

These patterns are generally consistent with the distribution of employment by industry within the sub-regions (See Table 50 in the Appendix.) Government tends to have the largest share of total employment, from about 15 to 22 percent across the sub-regions, followed by Health Care and Social Assistance and Retail Trade. Within the Pleasants and Mountaineer sub-regions Manufacturing also represents a substantial share, accounting for more than 10 percent of total employment in each region.[109]

9.3 Impacts on State Fossil Fuel Industry

The potential impact hypothetical individual plant closures may have on the state's mining economy was assessed by reducing sales of bituminous coal by the estimated value of annual purchases of West Virginia coal.[110] The estimated annual value of West Virginia coal sales to each plant was estimated using the annual average of coal consumption and delivered prices for the years 2010-2014. Table 30 contains the estimated coal sales reductions used to model the impact of each hypothetical closure at an average delivered price of $56/ton. Sales were then allocated to the Bituminous Underground Coal Mining (NAICS 212112) (70 percent) and Bituminous Coal and Lignite Surface Mining industries (212111) (30 percent).[111]

West Virginia Coal Sales and Severance Tax Revenues

EGU annual purchases of West Virginia coal range from $4 million to $282 million. Associated severance tax revenues range from about $248,000 to $14 million. Hypothetical premature plant closures represent a one-time permanent reduction in coal sales and severance tax revenues from a BAU scenario.

Table 30 Estimated Annual Purchases of West Virginia Coal[112]

Power Plant	Reduction in Coal Sales	Associated Severance Tax Revenues
FirstEnergy Fort Martin Power Station	$100,985,768	$5,049,288
FirstEnergy Harrison Power Station	$282,154,231	$14,107,712
FirstEnergy Pleasants Power Station	$11,384,672	$569,234
John E Amos	$156,370,238	$7,818,512
Mitchell	$164,528,854	$8,226,443
Mountaineer	$85,776,175	$4,288,809
Mt Storm	$43,800,594	$2,190,030
Morgantown Energy Facility[113]	$4,953,995	$247,700

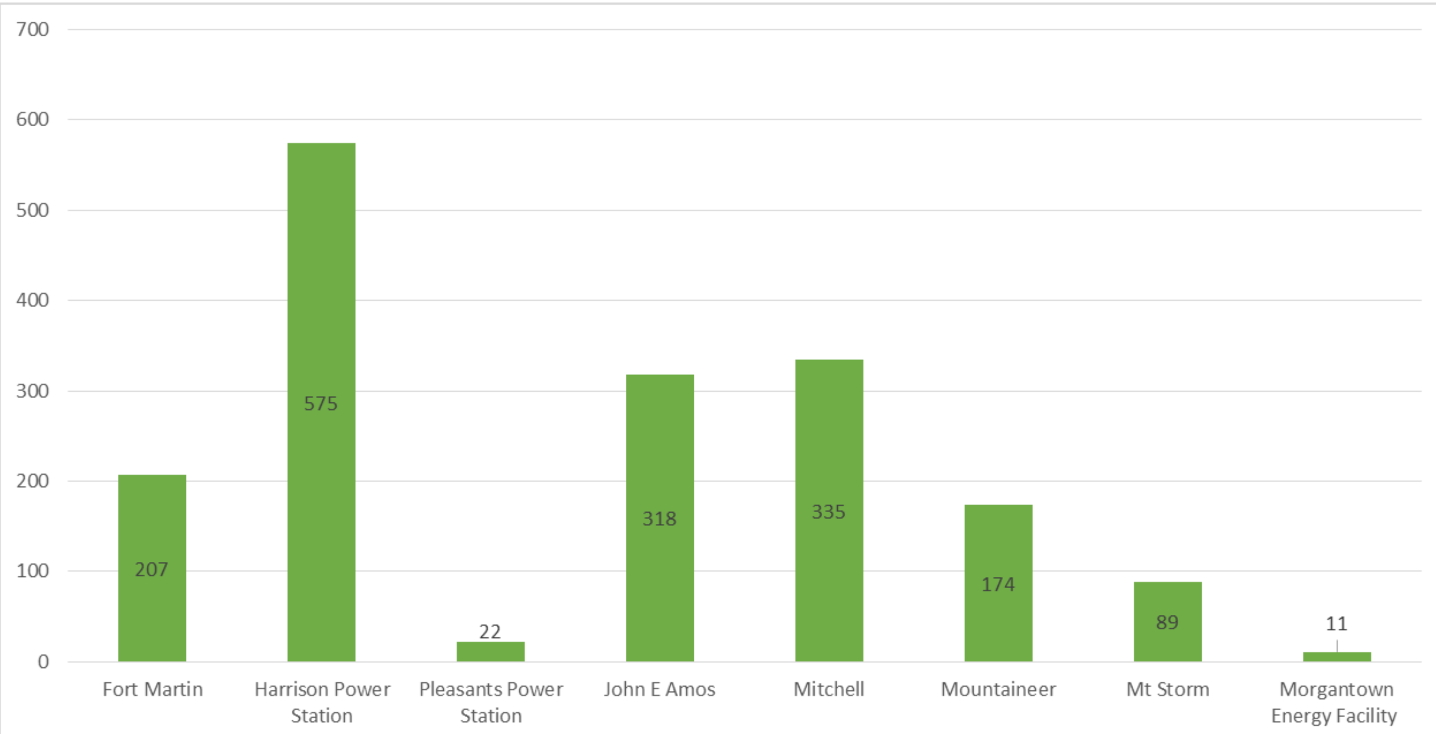
Source: CBER calculations from EIA-923 and EIA-860 Reports.

[109] As noted previously, impacts for coal mining may be understated due to underestimation of industry linkages by national I-O tables. Sub-region mining employment is largest as a share of total employment within the Mitchell and Harrison sub-regions. See Table 42 in the appendix.
[110] For consistency waste coal purchases are excluded. Grant Town is excluded as available data indicate all fuel consists of waste coal and not purchased coal.
[111] Allocations were determined based on the share of industries sales estimates for West Virginia from EMSI, Inc. and are consistent with data on coal production by state from US EIA (2013).
[112] Available data for the years 2010-2014 indicate all coal purchases for Longview Power LLC are sourced in Pennsylvania.
[113] Only purchases of bituminous coal as reported in the data are included for Morgantown Energy Associates.

Employment Impacts

Within West Virginia, reductions in power generation sales lead to losses predominantly in coal mining, with Support Activities for Oil and Gas being the other affected industry within the supersector. Losses in coal mining account for 99 percent of all estimated fossil fuel-related job losses within the state. Job losses are greater for plants like Harrison that purchase larger amounts of West Virginia coal.

Figure 19 Statewide Fossil Fuel Jobs Lost due to Hypothetical Plant Closure



Source: EMSI, 2015 Q3 Estimates. Based on 2013 national Input-Output tables

9.4 Coal-Fired Power Plant Depreciation

In states like West Virginia, where electricity supply remains a vertically-integrated service, the capital costs of utility power plants are paid for by ratepayers over a schedule that is determined at the time of investment. For many existing coal-fired power plants, these capital costs include fairly recent and large-scale investment in pollution control equipment made to comply with requirements of the Clean Air Act in the 2000s.

In the year 2030, all of West Virginia's remaining regulated coal-fired generating units will have about $1 billion of undepreciated book value tied to West Virginia electricity customers. Most of the units are scheduled to be fully depreciated in 2040, with a few units scheduled to be depreciated in the 2030s. For compliance scenarios where plants are closed prior to full depreciation, the remaining book value is a continuing cost to customers. The following table provides estimates of West Virginia customers' jurisdictional share of the remaining book value of regulated coal-fired power plants in the state. A portion of value is assigned to electricity customers in neighboring states and is not paid for by WV customers. These values do not include the rate of return allowed to regulated utilities on capital investment or the cost of tearing down the plants, and can thus be considered conservative in that actual post-closure costs would likely exceed book value. Table 31 displays the total value of projected remaining value.

Table 31 Projected Remaining Book Value of Active Regulated Coal Plants in WV

Year End	Projected Remaining Value ($Billion) - WV Jurisdictional	Year End	Projected Remaining Value ($Billion) - WV Jurisdictional
2015	$3.163	2028	$1.316
2016	$3.021	2029	$1.174
2017	$2.879	2030	$1.032
2018	$2.736	2031	$0.890
2019	$2.594	2032	$0.748
2020	$2.452	2033	$0.635
2021	$2.310	2034	$0.528
2022	$2.168	2035	$0.421
2023	$2.026	2036	$0.314
2024	$1.884	2037	$0.207
2025	$1.742	2038	$0.117
2026	$1.600	2039	$0.039
2027	$1.458	2040	$ 0

Source: WV PSC, Utilities Division.

9.5 Potential tax impacts and considerations

The effects upon state and local taxation from EGU closure or a reduction in generation are difficult to quantify due to a variety of valuation approaches, rates and applicable tax credits. Effects can be broadly characterized as impacts arising from changes in revenues associated with reduced industry worker income taxes, ad valorem property taxes of utility properties and business and occupation taxes. As noted previously, reduction in state coal sales may also result in severance tax revenue losses.

Sales of electricity are exempt from the WV Sales Tax to avoid double taxation of those sales in conjunction with the (B&O) Tax.[114]

While power plant closure may have fiscal impacts related to the value of the property and sales, income tax revenue may also decline due to employment losses, assuming individuals do not find new employment elsewhere within the state. Average wages and salaries within the power plant sub-regions range from about $39,000 to $44,000, as reported previously (see Table 29). This value falls within the 6 percent income tax bracket for West Virginia, thus the 6% rate is applied to total estimated

[114] WV Code §11-15-9(a)(1)

wage and salary losses.[115] Total wages and salaries lost for each hypothetical closure are approximated by applying the average wages and salaries within each region to the total estimated job loss.

As displayed in Table 32, total lost personal income tax revenue ranges from about $311,000 to $2.2 million. Hypothetical closures associated with larger employment losses are associated with larger losses to income tax revenue. When compared with the total personal income tax revenue collected by the state, about $1.81 billion in FY15[116], the losses comprise from 0.02 to 0.12 percent of total personal income tax revenues.

Table 32 Estimated Potential State Income Tax Impact from Hypothetical Plant Closure

Power Plant Sub-Region	Lost Income Tax Revenue	Share of Total State Income Tax Revenues for FY15
Fort Martin	$1,168,364	0.06%
Grant Town	$ 356,048	0.02%
Harrison Power Station	$1,499,442	0.08%
John E Amos	$2,216,994	0.12%
Longview Power LLC	$1,698,479	0.09%
Mitchell	$1,487,570	0.08%
Morgantown Energy	$ 311,212	0.02%
Mountaineer	$ 919,223	0.05%
Mt. Storm	$ 881,082	0.05%
Pleasants Power Station	$ 973,811	0.05%

Source: CBER calculations from US BEA, EMSI, WV Dept. of Revenue, and Tax Foundation data

10 – Discussion

The analyses illustrate the potential reductions in electricity generation, associated sales (output) and employment and resulting statewide economic impacts from four potential state plan compliance scenarios. Decreases in economic activity in West Virginia result both from reductions in electricity generation as well as from imposition of CO_2 prices in the form of allowances or ERCs. Additionally, potential impacts of plant closures highlight linkages between EGUs and their resident communities as well as with the state's coal industry.

The impact modeling broadly characterizes the dynamics resulting from potential state plan scenarios; although other considerations not captured within the models also bear mention. For example, a mass-based state strategy will entail articulating a method for allocating allowances. This analysis assumes electricity generation is distributed across generators in the most efficient manner to minimize costs, implicitly distributing allowances according to production efficiency. The state may choose an alternate method such as auctioning.

[115] http://taxfoundation.org/article/state-individual-income-tax-rates-and-brackets-2016
[116] http://www.budget.wv.gov/reportsandcharts/revenueestimates/Documents/GRFEbM2015.pdf
Accessed March 10, 2016

While CO_2 reductions may result in health benefits for West Virginia citizens, estimates are difficult to quantify and attribute specifically to state reductions in emissions. Further, health benefits associated with emissions reductions may be driven largely by reductions in NO_x and SO_2, pollutants which are regulated in a separate rule. Additionally, in non-trading scenarios that severely curtail generation to less than in-state demand, options for capacity replacement must be considered. Further, waste coal plants provide an environmental benefit through operations, but these benefits may be impacted if compliance results in reduced operations.

10.1 Allowance allocation

For a state that chooses a mass-based approach, allowance allocation is one of the critical design questions in state plan development.[117] EPA provides guidelines in the model rules and proposed federal plan, but states are not required to use the guidelines and can construct their own allocation method. Under a mass-based plan, allowances function like a commodity with value and the allocation method determines who has access to the associated revenue.

As noted in the energy market results, the total value of the allowances that would be purchased under a mass national trading scenario ranges from almost $112 to $324 million per year throughout the compliance period based on the estimated U.S. price of CO_2 ($4.35 to $9.43/ton). As mentioned previously, EVA's energy market modeling assumes a least-cost allocation of generation – more efficient generators generate more output, thus obtaining more allowances at a fixed price. Even in a scenario without trading, allowances may still have value as they can presumably be sold or exchanged on a secondary market at least within the state.

Because there is no predetermined mode or method of allowance allocation, and because the method will determine who has access to the value of the allowances, states should determine their plan goals and develop an appropriate allocation methodology.[118] Plan goals may include minimizing transaction costs or compensating ratepayers, among other objectives.[119] Examples of allocation options include:

1. Allocate only to affected units;
2. Allocate to all generators, included non-covered sources;
3. Allocate to Load-Serving Entities (LSEs);
4. Allocate to Entities other than power producers;
5. Auction allowances.[120]

Allocation methods can reward past behavior (such as output allocations for which allowances accrue to facilities that have implemented voluntary emissions reduction technology), be set aside for future projects or entrants (such as RE), or be used to offset increase costs to ratepayers. Additionally, allocation can be constructed to assist waste coal plants that may provide environmental benefits which compliance with 111(d) may otherwise curtail.[121] The extent to which allowance costs are passed

[117] Litz and Murray (2016)
[118] Ibid
[119] Litz and Murray (2016) pp 17-19.
[120] Litz and Murray (2016)
[121] Legere (2015) http://powersource.post-gazette.com/powersource/policy-powersource/2015/01/06/Waste-coal-plants-a-poor-fit-with-carbon-emission-rules/stories/201501060014

through to ratepayers depends on the nature of regulation in the market and whether allowances constitute an explicit cost or are acquired free of charge.[122]

10.2 Capacity Replacement in Scenarios Without Emissions Trading

In scenarios where regulated coal-fired capacity is retired prior to full depreciation, replacement capacity will need to be acquired to serve West Virginia-based customers. When faced with a capacity shortfall, West Virginia-based utilities would need to purchase replacement energy and capacity on the open market for their customers or invest in new generating capacity.

The possible outcomes under such decisions are not modeled here due to the complexity of selecting future prices for capacity and energy. Variables and major influencing factors include:

- Amount of energy (MWh) needed – population, economic activity, energy efficiency
- Price of energy in the wholesale market – relative price of natural gas and coal, level of renewables in the market, level of nuclear generation
- Amount of capacity (MW) needed – level of demand, reliability standards (reserve margins, capacity credit by resource class[123]), peak in winter vs. summer, demand response activity (initiated either by utilities or by regional aggregators)
- Price of capacity in the market – level of supply, requirements to be a firm supplier, penalties for non-performance
- Amount of remaining book value of regulated EGUs that are retired prior to depreciation
- Projection for how these variables will change through 2030

Due to intermittency, if capacity is replaced with wind or solar, a smaller portion of the capacity of those plants is allowed to be counted for reliability planning. Currently, PJM allows 38 percent of nameplate solar capacity and 13 percent of nameplate wind capacity to be counted.[124] These values are based on average capacity value during the peak hours of demand in summer months, the critical target period for ensuring adequate power is available to meet load. By contrast, coal steam and natural gas combined-cycle (NGCC) plants can receive capacity credit for closer to 90 and 95 percent of summer capability after subtracting forced outage rates.[125]

Replacement capacity within a compliance scenario where coal-fired capacity is likely to close is most likely to come from NGCC plants. This conclusion is based on the relative economics of generation combined with high levels of capacity value.[126] Relative economics are compared in the Table 33 using estimates of levelized cost of electricity (LCOE) by resource. Levelized costs and average capacity factors

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[122] Litz and Murray (2016)
[123] Capacity credit is the portion of total capacity a generating resource can count, for reliability purposes, as being available to meet demand.
[124] PJM Interconnection (2015e). "2015 PJM Reserve Requirement Study, 11-year Planning Horizon: June 1st 2015 - May 31st 2026."
[125] Ibid.
[126] The capacity value of a plant is the portion of capacity that can be counted for the purpose of satisfying capacity obligations. This value varies by region and by generating technology.

are nationwide values from EIA and are estimates of the cost of installations in the year 2020.[127] LCOE is the per-MWh cost of building and operating a generating plant over an assumed financial life and duty cycle, and thus includes both fixed and variable costs of generation.

Table 33 Levelized Cost of Electricity for Select Generating Technologies ($2013/MWh)

Plant Type	EIA New System LCOE in 2020 - $2013 /MWh	EIA Capacity Factor[128]	PJM Capacity Credit[129]	Estimate of Cost in WV[130] ($/MWh)	Capacity Factor in West Virginia[131]
NGCC (advanced)	$72.6	87%	Up to 95%	NA	NA
Solar PV	$125.3	25%	38%	$120[132]	18.2%
Onshore Wind	$73.6	36%	13%	$57[133]	34%
Steam Coal (conventional)	$95.10	85%	Up to 90%	$55 to $65[134]	50% to 80%[135]

10.3 Environmental considerations with waste coal plants

Two circulating fluidized-bed (CFB) EGUs are included in this analysis, the Grant Town and Morgantown Energy Associates plants. Both of these plants utilize waste coal mined from gob piles at older mining sites. The primary benefit of using this material is the recovery of energy that was discarded from less efficient mining operations.

This coal is of a lower energy content, with much of it consisting of acidic material. Use of this spoil is environmentally beneficial, as it removes material from an area where it may contribute to water quality degradation. The two plants use about 850,000 tons of waste coal per year. If not used, much of this refuse may instead remain in impoundments or ponds that may then require additional reclamation expense due to their acidic properties. The CFBs also produce ash that can be beneficially used at mine reclamation sites.

[127] EIA (2015). Estimated levelized cost of electricity (LCOE) for new generation resources, 2020. *AEO 2015*. http://www.eia.gov/forecasts/aeo/electricity_generation.cfm

[128] The capacity factor of a plant is the average utilization of capacity on an annual basis. It is typically based on either the nameplate capacity or the summer capacity of the plant.

[129] For NGCC and coal, simple assumption obtained by subtracting the class average forced outage rate. For wind and solar is class average as calculated by PJM.

[130] NREL's System Advisor Model for wind in NE WV and solar (2-axis tracking) in Charleston, WV; current WV-based coal generators.

[131] Ibid.

[132] Includes the Federal Investment Tax Credit at 30%.

[133] Includes the Federal Production Tax Credit at $23/MWh.

[134] Estimated based on recent (2014-2015) generation revenues and generation.

[135] Estimated using 2012-2014 data for net generation and summer capacity. Waste coal plants have higher rates.

10.4 Potential health impacts

EPA has developed methods to monetize economic benefits associated with reduced emissions, including carbon emissions. For CO_2 emissions, the agency's RIA incorporates estimates of impacts from CO_2 emissions changes on the global climate and related impacts such as sea level rise. The RIA of the final rule notes that monetized benefits were based largely on reductions in NO_x and SO_2 which are anticipated to account for at least 90 percent of potential health impacts.[136] The resulting monetized damages are used to estimate the welfare effects of quantified changes in CO_2 emissions.

The base of the impact is a metric that estimates the monetary value of impacts associated with marginal changes in CO2 emissions in a given year that includes:

- net changes in agricultural productivity and human health,
- property damage from increased flood risk, and
- changes in energy system costs, such as reduced costs for heating and increased costs for air conditioning.

EPA uses a range of values to estimate possible benefits of reduced emissions. As stated in the RIA, these values are $12, $40, $60, and $120 per short ton of CO_2 emissions in the year 2020.[137] The applicability of these likely damages to the State of West Virginia, and the resulting avoidance of those damages is uncertain. For example, as national trading scenarios do not entail substantial reductions in emissions from West Virginia EGUs it is difficult to project the resulting health benefits accruing to West Virginia from these scenarios. Therefore, these welfare effects are not included in this analysis.

As a broad characterization, existing research based on the proposed rule estimates monetized health impacts accruing to the Eastern Region range from a low of $16 billion in 2020 (from a regional approach) to maximum of $62 billion in 2030. This region consists of 37 states including West Virginia.[138]

Within the RIA benefits were estimated at a regional level as opposed to individual state level.[139] Estimating benefits at a state level would be subject to a substantial degree of uncertainty, as health co-benefits are not solely dependent upon the actions of the state but of others as "pollutants can travel significant distances after being emitted."[140] In addition to the emissions reductions themselves, resulting health impacts also depend on "population density, air quality response, interstate pollution transport, and base case heath [sic] incidence rates."[141]

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[136] EPA (2015a). P ES-6
[137] EPA (2015a).
[138] SELC (2014). Pp. 9-10.
[139] EPA (2015a). P ES-6
[140] SELC (2014). P. 8
[141] SELC (2014). P. 11

10.5 Summary of Potential Consumer Impacts

Relative to a BAU scenario, compliance with 111(d) results in reductions in electricity generation. Reducing the supply of available electricity will result in higher retail and wholesale prices in general. Further, costs associated with acquiring allowances or ERCs to produce electricity may entail an additional cost to passed onto consumers, depending on the extent to which these costs are explicit (e.g. allowances are auctioned).

In scenarios without trading, particularly the rate-based scenario, in-state generation is curtailed relative to BAU and may require replacement capacity. Capital costs for replacement capacity, whether new NGCC or from renewable sources would likely be passed onto consumers. If additional electricity must be purchased on the wholesale market then consumers may face higher prices than estimated under these scenarios. Regulated plants that are retired prematurely will have remaining book value. Additionally, premature plant closures may result in loss of fiscal revenue such as property taxes depending on how the asset is valued. The extent to which electricity rates will still account for remaining asset value and changed tax burdens of prematurely retired facilities is unknown.

To the extent that electricity rates may rise, lower income households may be relatively more impacted than higher income households. National data illustrate the significance of electricity spending to households of different income levels. As noted in Table 34, households in the lowest income quintile spend approximately 10 percent of their income before taxes on electricity. This share is more than twice that of households in the second quintile, and 10 times that of the wealthiest households. These data do not account for any tax credits or incentives households may receive to offset energy expenditures.

Table 34 US Total Income and Electricity Spending by Quintile, 2014

Year	Lowest 20	Second 20	Third 20	Fourth 20	Highest 20
Total Income before taxes	$10,308	$27,028	$47,056	$76,988	$172,952
Electricity Expenditures	$ 1,066	$ 1,328	$ 1,483	$ 1,611	$ 1,932
Percent of Income before taxes spent on electricity	10.34%	4.91%	3.15%	2.09%	1.12%

Source: US Bureau of Labor Statistics, Consumer Expenditure Survey

11 – Summary and Conclusions

In West Virginia, fossil fuel-fired units constitute the vast majority of electricity generation. The industry is characterized by high wages. Slightly more than half of coal purchased for generation is sourced within West Virginia; however, only about 15 percent of coal mined in West Virginia is consumed by power plants in the state. About 85 percent of coal is exported to other states or global markets, thus the compliance decisions of other states is likely to have a proportionally greater impact on the state's coal industry.

Results of the analyses are sensitive to assumptions regarding natural gas prices, which are expected to increase thus maintaining competitiveness of West Virginia coal-fired power plants. Consistent with other existing analysis results also depend on underlying assumptions regarding prices for renewable energy capacity and the extent of energy efficiency. Further, the analysis does not consider the impact of the compliance decisions of other states. Other states' plans may impact West Virginia either through coal industry demand, wholesale electricity prices, and participation in a trading regime with West Virginia.

In general, the results suggest that national trading scenarios, either mass or rate-based, may approximate a BAU outcome in West Virginia, provided that all states participate in a single trading regime. This will result in the maximum possible amount of available allowances or ERCs at the lowest potential market price. In contrast, a scenario in which interstate trading is not available heavily restricts the amount of in-state generation, reducing output by about one-third of BAU in initial years under the mass-based scenario, and nearly 80 percent under a rate-based scenario.

Energy market analysis indicates that non-trading scenarios may lead to premature unit closures, which then generate additional potential costs above and beyond the impact of removing the generation from the state economy. While in-state demand may still be satisfied with in-state generation under a mass-based plan with no trading, a rate-based plan without trading likely necessitates purchasing electricity from the wholesale market, as well as capacity, to meet demand in-state. This impacts of this scenario are compounded by the remaining book value of regulated plants that will exist with early retirement. For most plants this value is not expected to be fully recovered until 2040, and will remain a liability to ratepayers even with closure.

This analysis includes set-asides for renewable energy in the allowance budget. Under national trading scenarios, the prices associated with these set-asides are insufficient to promote new RE capacity within the state based on economics. However, this analysis assumes some RE capacity is built in West Virginia, as a share of the modest amount of new RE capacity assumed for the larger PJM region. In reality, the amount of RE actually installed may differ from this assumed amount.

Premature plant closures may impact their surrounding regions, resulting in sales and employment losses. Closures are likely to be more significant within more rural regions where power plant sales and employment constitute a larger portion of total activity and employment. Larger plants are associated with larger demand from the state’s coal mining industry and thus estimated to have larger impacts on coal employment resulting from complete closure.

Electricity prices may rise due to reduced generation as well as the imposition of CO_2 costs. Additionally, costs of constructing replacement generation or heat improvements may also increase costs. Consumers potentially may benefit from rate reductions is savings on taxes from prematurely retired facilities. Although fiscal revenues may be adversely impacted at state and local levels if plant closures result in lost property or personal income tax revenues. The extent of regulation in the market is a determinant of which costs or savings are passed along to consumers.

Lower income households spend proportionally more of their income on electricity and thus are likely to be more sensitive to price changes. Energy efficiency programs targeted at low-income households may mitigate the effect of price increases.

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Appendix

Energy Market Modeling Methodology

EVA licenses the AURORAxmp modeling software to model and assess future market outcomes. AURORAxmp is a chronological hourly dispatch model that simulates the operations of North American power markets. On the supply side, generating capacity is modeled at the unit level with all operating characteristics including capacity, heat rate, ramp rate, and outages. On the demand side, peak and total electric load are input for regions that conform to Independent System Operator (ISO) zones such as PJM, New York ISO, ISO New England, MISO, SPP, and CAISO. In utility-centric regions such as the Southeast and the West, load is input by NERC region or sub-region, as appropriate.

For each hour, the model develops a regional supply curve that matches generation with demand such that it is met at the least cost while still honoring unit operating parameters, transmission limitations, and other constraints. To model the Clean Power Plan, a CO_2 limitation in the form of tons of CO_2 (for a mass-based analysis) or lbs. of CO_2 per MWh (for a rate-based analysis) is applied and becomes an additional system constraint. AURORAxmp determines the least-cost way to meet the carbon constraints by determining the carbon price necessary to achieve compliance with the CO_2 limitation. The carbon price, which is sometimes referred to as a shadow carbon price, serves to "re-shuffle" the dispatch order so that higher emitting units now have higher costs and therefore generate less frequently, allowing the emission limitation to be met.

While AURORAxmp software comes with default settings and data, EVA has improved its forecasting capability by customizing many of the inputs. For example, EVA has customized the fuel prices for each plant based upon EVA's own forecasts of fuel prices combined with an analysis of the specific transportation costs. EVA uses its own assumptions as to electricity demand growth, renewables, energy efficiency, and distributed generation. To ensure an accurate representation of future supply, EVA maintains a database on plant retirements and performs individual retrofit versus retire analyses for plants which are expected to require capital investments in order to comply with new regulations. EVA regularly updates its capital cost assumptions for new capacity so that the most economic capacity will be constructed by the model in future years.

Economic Impact Modeling Calibration

This analysis implements a change to REMI's forecast by changing forecasted variables to simulate various possible policy outcomes. The following regional control variable was changed in the REMI model[142] to match the assumptions of each 111(d) compliance scenario modeled.

Pre-Simulation Changes:
Electricity generation industry output ($2015 billion) – adjustment to regional control to match EVA-forecasted generation and associated value of electricity

Changes in the value of electricity generation sales are based on:

5. EVA's projections for generation from affected EGUs
6. EVA's projections for wholesale electricity prices
7. Estimates of the share of electricity generated for wholesale v. retail markets
8. The variable cost share of total generation revenue

Projections for electricity generation were translated into economic output by assigning estimated prices to segments of supply. Supply is segmented by the amount of generation estimated to be provided for retail and wholesale customers. These shares were estimated based on historical generation and demand data at the plant and state level.
Segments of supply (and associated output value) are:

- West Virginia-based customers (total revenue from retail sales)
- on-system retail customers in other states (estimate of retail sales revenue minus transmission and distribution revenue)
- wholesale market (wholesale sales in MWh times projected wholesale electricity prices)

These adjustments increased the default value of output for the industry by 95 percent in 2014, and by 86 percent on average through 2030. The analysis applies REMI's baseline real inflation rates to future retail sales revenue.

The value of generation, associated with a decrease (or increase) in MWh relative to the BAU scenario, is based on the price determined to represent the supply segment. For West Virginia-based customers and for retail customers in other states this value is the variable cost of generation, a value of approximately $27/MWh.[143] For these customers other costs of supply (distribution, transmission, and all capital and fixed generation costs) are assumed to be unaffected by a changed in generation and would still be recovered in electricity rates. EVA-forecasted wholesale electricity prices for PJM-West were applied to the estimated level of generation for the wholesale market.

Potential EGU revenue from the PJM capacity market was not included in this calculation. The capacity market is a source of revenue paid to generators that make successful bids to provide capacity via the

[142] PI+ West Virginia v1.7.1 (Build 3904).
[143] Based on utility data provided by the WVPSC, Utilities Division.

Reliability Pricing Model (RPM) auction. Therefore, the estimates of total industry output and resulting changes from the 111(d) compliance scenarios could be lower than actual industry sales.

Simulation changes for each compliance scenario modeled include one or more of the following variables:

1. Electricity generation industry output ($2015 billion)
    a. Reductions from reduced generation from coal-fired EGUs
    b. Additions from new wind and solar capacity
2. Coal industry output ($2015 billion) – negative adjustment to counter REMI's use of a national expenditure profile for the electricity generation industry
3. Natural gas industry output ($2015 billion) – positive adjustment to counter REMI's use of a national expenditure profile for the electricity generation industry
4. Consumer spending on electricity, broken down by industrial, commercial and residential sectors ($2015 billion) – increases matching CO_2 allowances or ERCs needed
5. Electricity price shares relative to the nation for the industrial, commercial and residential sectors (index) – based on estimated change in electricity prices associated with coal-centric generation mix relative to the U.S.

Sub-Regional Closure Impact Methodology

The Commuting Flow data contains information on where people live and work, for example containing estimates of the number of individuals in Cabell County who work in Putnam County. Data for the power plant home counties were analyzed to determine the surrounding counties within which workers most likely would reside. Counties from which workers commute were screened for two criteria to determine their inclusion in the power plant sub-region. Counties were included in the sub-region if the estimated number of workers exceeded the estimated margin of error. A second series of refinements then screened for those counties making the greatest contributions of estimated worker flow. The resulting sub-regions account for at least 95 percent of commuting workers for the power plant home county.

Closures were modeled as a reduction of employment in the Fossil Fuel Electric Power Generation sector (NAICS 221112), equal to the either the minimum of industry-reported plant employment or county-level industry employment as estimated by EMSI.[144] For example, in Monongalia County there are three power plants each with employment less than total county employment; however total reported employment at the three plants exceeds county industry employment. Without a reliable method to segment county employment among the plants, reported plant employment is used for the individual impacts.

[144] For two plants reported employment exceeded the estimated number of employees within the county in the relevant industry. It may be the case that some employees may be included in other industries, such as Electric Power Transmission, Control and Distribution for example.

Fiscal Considerations related to Power Plants

West Virginia 110CSR1M - *Valuation of Public Utility Property for Ad Valorem Property Tax Purposes*[145] outlines the appraisal, at market value, of property subject to taxation as public utilities. Under this rule, the WV State Tax Commissioner provides tentative assessments of fair market value using the unit method as a guide for the Board of Public Works in establishing final assessed values for property tax purposes (110-1M-4.1). The Tax Commissioner has the authority to consider and employ one of three generally accepted approaches to value: 1) cost, 2) income and 3) market data (110-1M-4.2).

- The cost approach measures the original cost of the asset less applicable depreciation made up of physical deterioration, functional obsolescence and economic obsolescence (110-1M-4.2.1).
  - Physical deterioration is defined within the rule as "a loss in value due to wear and tear in service" (110m-1M-2.14)
  - Functional obsolescence refers to a loss in value arising from "changes in style, taste, or technology" (110-1M-2.8)
  - Economic obsolescence refers to factors affecting value such as "changes in use, legislation that restricts or impairs property rights, or changes in supply and demand relationships" (110-1M-2.5)
- The income approach involves the capitalization of net operating income after taxes, but before interest on long-term debt (110-1M-4.2.2).
- The market data approach attempts to adjust for the limited number of public service corporation sales by using actively traded stocks and bonds by utility class to make reasonable valuation estimates (110-1M-4.2.3).

The West Virginia Business and Occupation (B&O) tax applies to public utilities and electric power producers, as well as gas storage businesses and producers of synthetic fuels from coal.[146] The tax rates depend upon the activity in question and are applied to a base of generating capacity or the amounts of electricity sold. The following table provides a brief summary of selected (B&O) rates and the base to which they are applied.

[145] West Virginia Legislative Rule Title 110, Series 1M Valuation of Public Utility Property for Ad Valorem Property Tax Purposes - http://tax.wv.gov/Documents/LegislativeRules/LegislativeRule.Title-110.Series-1M.pdf. Accessed February 2, 2016.
[146] Fifty-First Biennial Report – Tax Commissioner of West Virginia (October, 2015) - http://tax.wv.gov/Documents/Legal/TaxLawReport.51.pdf. Accessed February 3, 2016.

Table 35 Business and Occupation Tax Rates for Electric Power Companies

Activity	WV Code Citation	Tax Base	Tax Rate
Generating or producing electricity for sale, profit or commercial use	§11-13- 2o(b)(1)	Generating capacity	$22.78 per KW
Generating or producing electricity for sale, profit or commercial use by a unit which has installed a flue gas desulfurization system	§11-13-2o(b)(1)	Generating capacity	$20.70 per KW
Selling electricity that is not generated or produced in West Virginia by the taxpayer	§11-13-2o(b)(2)	Electricity sold	$0.0019 per KWH
Selling electricity that is not generated or produced in West Virginia by the taxpayer and sale is to a plant location of a customer engaged in a manufacturing activity, if the contract demand at such plant location exceeds 200,000 kilowatts per hour per year	§11-13-2o(b)(2)	Electricity sold	$0.0005 per KWH

Source: Rates and descriptions reproduced from *Fifty-First Biennial Report – Tax Commissioner of West Virginia (October, 2015).*

Taxable generating capacity for generating units placed into service after March 10, 1995 equals 40 percent of nameplate capacity (versus five percent for peaking units).[147] An annual credit of $500 is provided for each business engaged in the activities in the State that are subject to the (B&O) Tax. A variety of additional tax credits may be applied against (B&O)Tax liabilities in some cases including the Economic Opportunity Tax Credit, the Industrial Expansion or Revitalization Credit for Electric Power Producers and the Credit for Reducing Utility Charges to Low-Income Families.[148]

The majority of personal income tax collections are deposited in the State General Revenue fund, with smaller amounts dedicated to the Workers Compensation Debt Fund and the Refund Reserve Fund.[149] The primary recipients of levied property taxes are boards of education through the Public School Support Program (PSSP), with county commissions, municipalities and the State receiving smaller portions.[150] It should be noted that reductions in the tax base and taxes levied have the potential to lower the "local share" for a given school district, thus potentially increasing State appropriations under the PSSP aid formula.[151] Revenue generated by the (B&O) Tax is deposited in the State General Revenue Fund.[152]

[147] WV Code §11-13-2o
[148] Fifty-First Biennial Report – Tax Commissioner of West Virginia (October, 2015) - http://tax.wv.gov/Documents/Legal/TaxLawReport.51.pdf. Accessed February 3, 2016.
[149] Fifty-First Biennial Report – Tax Commissioner of West Virginia (October, 2015) - http://tax.wv.gov/Documents/Legal/TaxLawReport.51.pdf. Accessed February 3, 2016.
[150] Ibid
[151] For a detailed description of the PSSP's calculations, please see http://wvde.state.wv.us/finance/pssp/2015-2016/PSSP%2016%20Executive%20Summary%20-%20Final%20Comps.pdf. Accessed February 2, 2106.
[152] Fifty-First Biennial Report – Tax Commissioner of West Virginia (October, 2015) - http://tax.wv.gov/Documents/Legal/TaxLawReport.51.pdf. Accessed February 3, 2016.

Detailed Economic Impact REMI PI+ Results All Scenarios (Levels)

Table 36 Business As Usual (BAU)

BAU/NO CARBON REGULATION	2014	2015	2016	2017	2018	2019	2020	2021	2022
Total State Output (billion $2015)	$132.25	$135.26	$139.59	$143.17	$145.56	$148.55	$151.43	$154.20	$157.08
Total Electricity Industry Output (billion $2015)	$4.68	$4.12	$4.20	$4.17	$4.18	$4.72	$5.00	$5.08	$5.14
Total State Employment	933,423	951,750	967,124	979,029	980,547	982,750	985,391	988,102	991,248
Total Personal Income (billion $2015)	$69.22	$72.92	$77.06	$81.00	$84.44	$88.51	$92.62	$97.01	$102.00
State GDP (billion $2015)	$77.08	$ 79.13	$ 81.76	$ 84.00	$ 85.59	$ 87.73	$ 89.73	$ 91.61	$ 93.57
Employment by Major Sector:									
Construction	51,353	54,795	58,845	61,744	63,544	65,254	66,739	67,968	69,026
Utilities	5,259	5,209	5,121	5,015	4,871	4,743	4,631	4,534	4,450
Mining	47,176	48,858	49,547	49,501	49,135	49,016	49,123	49,438	49,995
Retail Trade	110,058	112,502	114,376	116,035	116,243	116,574	116,672	116,595	116,443
Healthcare and Social Assistance	128,512	131,637	134,756	137,802	139,438	141,230	143,157	145,216	147,461
Year	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	
Total State Output (billion $2015)	$159.76	$162.53	$165.32	$167.94	$170.50	$173.15	$175.73	$178.24	
Total Electricity Industry Output (billion $2015)	$5.21	$5.31	$5.35	$5.42	$5.49	$5.57	$5.62	$5.66	
Total State Employment	991,405	990,792	991,448	990,684	990,074	988,810	987,024	985,510	
Total Personal Income (billion $2015)	$106.21	$110.48	$115.90	$121.15	$126.28	$131.36	$136.44	$141.56	
State GDP (billion $2015)	$ 95.29	$ 97.00	$ 98.75	$100.47	$102.20	$103.91	$105.61	$107.33	
Employment by Major Sector (thousands):									
Construction	69,742	70,333	71,129	71,864	72,591	73,240	73,820	74,426	
Utilities	4,353	4,257	4,167	4,073	3,981	3,889	3,797	3,709	
Mining	50,201	50,316	50,379	50,339	50,265	50,103	49,883	49,655	
Retail Trade	115,731	114,963	114,586	113,983	113,317	112,528	111,625	110,725	
Healthcare and Social Assistance	149,270	150,680	152,208	153,461	154,835	156,030	157,152	158,301	

Table 37 Mass-Based National Allowance Trading

CPP MASS – National Allowance Trading	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**
Total State Output (billion $2015)	$132.25	$135.26	$139.59	$143.17	$145.56	$148.55	$151.43	$154.20	$157.07
Total Electricity Industry Output (billion $2015)	$4.68	$4.12	$4.20	$4.17	$4.18	$4.72	$5.00	$5.08	$5.12
Total State Employment	933,423	951,750	967,124	979,029	980,547	982,750	985,391	988,102	991,204
Total Personal Income (billion $2015)	$ 69.22	$ 72.92	$ 77.06	$ 81.00	$ 84.44	$ 88.51	$ 92.62	$97.01	$101.99
State GDP (billion $2015)	$ 77.08	$ 79.13	$ 81.76	$ 84.00	$ 85.59	$ 87.73	$ 89.73	$91.61	$93.56
Employment by Major Sector:									
Construction	51,353	54,795	58,845	61,744	63,544	65,254	66,739	67,968	69,053
Utilities	5,259	5,209	5,121	5,015	4,871	4,743	4,631	4,534	4,430
Mining	47,176	48,858	49,547	49,501	49,135	49,016	49,123	49,438	50,032
Retail Trade	110,058	112,502	114,376	116,035	116,243	116,574	116,672	116,595	116,423
Healthcare and Social Assistance	128,512	131,637	134,756	137,802	139,438	141,230	143,157	145,216	147,450
Year	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	
Total State Output (billion $2015)	$159.70	$162.43	$165.23	$167.81	$170.28	$172.84	$175.35	$177.78	
Total Electricity Industry Output (billion $2015)	$5.18	$5.27	$5.34	$5.39	$5.43	$5.47	$5.51	$5.52	
Total State Employment	991,184	990,424	990,966	990,062	989,215	987,695	985,690	983,927	
Total Personal Income (billion $2015)	$106.19	$110.44	$115.86	$ 21.09	$ 26.17	$131.22	$136.27	$141.34	
State GDP (billion $2015)	$ 95.25	$ 96.93	$ 98.71	$100.39	$102.06	$103.71	$105.37	$107.02	
Employment by Major Sector (thousands):									
Construction	69,716	70,266	70,962	71,674	72,349	72,929	73,454	73,996	
Utilities	4,317	4,212	4,156	4,045	3,924	3,802	3,698	3,590	
Mining	50,214	50,307	50,401	50,338	50,226	50,032	49,792	49,534	
Retail Trade	115,694	114,911	114,520	113,902	113,213	112,400	111,472	110,546	
Healthcare and Social Assistance	149,251	150,653	152,173	153,417	154,778	155,962	157,070	158,206	

Table 38 Mass-Based No Allowance Trading

CPP MASS – No Allowance Trading	2014	2015	2016	2017	2018	2019	2020	2021	2022
Total State Output (billion $2015)	$132.25	$135.26	$139.59	$143.17	$145.56	$148.55	$151.43	$154.20	$155.79
Total Electricity Industry Output (billion $2015)	$4.68	$4.12	$4.20	$4.17	$4.18	$4.72	$5.00	$5.08	$4.43
Total State Employment	933,423	951,750	967,124	979,029	980,547	982,750	985,391	988,102	987,414
Total Personal Income (billion $2015)	$69.22	$72.92	$77.06	$81.00	$84.44	$88.51	$92.62	$97.01	$101.63
State GDP (billion $2015)	$77.08	$79.13	$81.76	$84.00	$85.59	$87.73	$89.73	$91.61	$92.53
Employment by Major Sector:									
Construction	51,353	54,795	58,845	61,744	63,544	65,254	66,739	67,968	68,151
Utilities	5,259	5,209	5,121	5,015	4,871	4,743	4,631	4,534	3,638
Mining	47,176	48,858	49,547	49,501	49,135	49,016	49,123	49,438	49,234
Retail Trade	110,058	112,502	114,376	116,035	116,243	116,574	116,672	116,595	116,113
Healthcare and Social Assistance	128,512	131,637	134,756	137,802	139,438	141,230	143,157	145,216	147,302
Year	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	
Total State Output (billion $2015)	$158.23	$160.79	$163.54	$166.07	$168.52	$171.06	$173.58	$176.05	
Total Electricity Industry Output (billion $2015)	$4.45	$4.46	$4.50	$4.51	$4.52	$4.54	$4.55	$4.56	
Total State Employment	986,371	984,895	985,299	984,382	983,630	982,208	980,428	978,979	
Total Personal Income (billion $2015)	$105.72	$109.86	$115.22	$120.40	$125.45	$130.45	$135.48	$140.55	
State GDP (billion $2015)	$94.09	$95.64	$97.36	$99.00	$100.64	$102.26	$103.90	$105.57	
Employment by Major Sector (thousands):									
Construction	68,361	68,664	69,318	70,066	70,825	71,515	72,166	72,860	
Utilities	3,508	3,354	3,301	3,188	3,067	2,957	2,865	2,783	
Mining	49,326	49,343	49,429	49,376	49,284	49,073	48,862	48,653	
Retail Trade	115,306	114,458	114,054	113,424	112,731	111,914	110,996	110,086	
Healthcare and Social Assistance	149,076	150,457	151,982	153,230	154,596	155,781	156,899	158,044	

Table 39 Rate-Based National ERC Trading

CPP Rate – National ERC Trading	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**
Total State Output (billion $2015)	$132.25	$135.26	$139.59	$143.17	$145.56	$148.55	$151.43	$154.20	$157.04
Total Electricity Industry Output ($2015)	$4.68	$4.12	$4.20	$4.17	$4.18	$4.72	$5.00	$5.08	$5.11
Total State Employment	933,423	951,750	967,124	979,029	980,547	982,750	985,391	988,102	991,052
Total Personal Income (billion $2015)	$69.22	$72.92	$77.06	$81.00	$84.44	$88.51	$92.62	$97.01	$101.98
State GDP (billion $2015)	$77.08	$79.13	$81.76	$84.00	$85.59	$87.73	$89.73	$91.61	$93.54
Employment by Major Sector:									
Construction	51,353	54,795	58,845	61,744	63,544	65,254	66,739	67,968	69,006
Utilities	5,259	5,209	5,121	5,015	4,871	4,743	4,631	4,534	4,419
Mining	47,176	48,858	49,547	49,501	49,135	49,016	49,123	49,438	50,028
Retail Trade	110,058	112,502	114,376	116,035	116,243	116,574	116,672	116,595	116,401
Healthcare and Social Assistance	128,512	131,637	134,756	137,802	139,438	141,230	143,157	145,216	147,439

Year	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**
Total State Output (billion $2015)	$159.63	$162.23	$164.92	$167.45	$169.88	$172.29	$174.68	$176.93
Total Electricity Industry Output ($2015)	$5.16	$5.18	$5.22	$5.26	$5.29	$5.29	$5.27	$5.23
Total State Employment	990,886	989,726	989,810	988,723	987,728	985,714	983,366	981,062
Total Personal Income (billion $2015)	$106.16	$110.37	$115.73	$120.94	$126.00	$130.97	$135.96	$140.94
State GDP (billion $2015)	$95.20	$96.78	$98.48	$100.14	$101.78	$103.32	$104.89	$106.42
Employment by Major Sector (thousands):								
Construction	69,628	70,078	70,628	71,272	71,914	72,372	72,811	73,213
Utilities	4,295	4,120	4,030	3,924	3,795	3,634	3,492	3,340
Mining	50,188	50,210	50,264	50,198	50,073	49,828	49,544	49,240
Retail Trade	115,659	114,842	114,399	113,764	113,058	112,184	111,227	110,238
Healthcare and Social Assistance	149,233	150,618	152,112	153,348	154,701	155,852	156,945	158,046

Table 40 Rate-Based No ERC Trading

CPP Rate – No ERC Trading	2014	2015	2016	2017	2018	2019	2020	2021	2022
Total State Output (billion $2015)	$132.25	$135.26	$139.59	$143.17	$145.56	$148.55	$151.43	$154.20	$153.79
Total Electricity Industry Output (billion $2015)	$4.68	$4.12	$4.20	$4.17	$4.18	$4.72	$5.00	$5.08	$3.44
Total State Employment	933,423	951,750	967,124	979,029	980,547	982,750	985,391	988,102	981,232
Total Personal Income (billion $2015)	$69.22	$72.92	$77.06	$81.00	$84.44	$88.51	$92.62	$97.01	$101.03
State GDP (billion $2015)	$77.08	$79.13	$81.76	$84.00	$85.59	$87.73	$89.73	$91.61	$90.97
Employment by Major Sector:									
Construction	51,353	54,795	58,845	61,744	63,544	65,254	66,739	67,968	66,718
Utilities	5,259	5,209	5,121	5,015	4,871	4,743	4,631	4,534	2,500
Mining	47,176	48,858	49,547	49,501	49,135	49,016	49,123	49,438	47,984
Retail Trade	110,058	112,502	114,376	116,035	116,243	116,574	116,672	116,595	115,552
Healthcare and Social Assistance	128,512	131,637	134,756	137,802	139,438	141,230	143,157	145,216	147,031
Year	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	
Total State Output (billion $2015)	$155.77	$158.00	$160.60	$163.23	$165.80	$168.42	$171.12	$173.66	
Total Electricity Industry Output (billion $2015)	$3.30	$3.16	$3.15	$3.21	$3.23	$3.27	$3.34	$3.35	
Total State Employment	978,120	975,411	975,191	974,656	974,549	973,662	972,695	971,778	
Total Personal Income (billion $2015)	$104.90	$108.86	$114.09	$119.23	$124.27	$129.25	$134.30	$139.37	
State GDP (billion $2015)	$92.19	$93.48	$95.10	$96.81	$98.51	$100.18	$101.95	$103.66	
Employment by Major Sector (thousands):									
Construction	66,110	65,991	66,392	67,297	68,340	69,310	70,301	71,267	
Utilities	2,231	1,973	1,919	1,908	1,850	1,805	1,813	1,770	
Mining	47,858	47,742	47,839	47,887	47,934	47,812	47,743	47,612	
Retail Trade	114,599	113,649	113,173	112,557	111,898	111,095	110,224	109,337	
Healthcare and Social Assistance	148,747	150,094	151,600	152,869	154,263	155,461	156,604	157,759	

Detailed Economic Impact REMI PI+ Scenario Results Relative to BAU

Table 41 Mass-Based No Allowance Trading

	2022	2023	2024	2025	2026	2027	2028	2029	2030
Employment Changes (thousands)									
Total for West Virginia	-3.834	-5.034	-5.897	-6.149	-6.302	-6.445	-6.602	-6.596	-6.531
% Change	*-0.4%*	*-0.5%*	*-0.6%*	*-0.6%*	*-0.6%*	*-0.7%*	*-0.7%*	*-0.7%*	*-0.7%*
By Major Economic Group:									
Private Non-Farm	-3.413	-4.333	-4.984	-5.114	-5.174	-5.237	-5.319	-5.258	-5.156
Government	-0.421	-0.701	-0.913	-1.035	-1.128	-1.208	-1.283	-1.338	-1.375
Top 5 Impacted Sectors:									
CONSTRUCTION	-0.875	-1.38	-1.668	-1.81	-1.797	-1.766	-1.725	-1.654	-1.567
UTILITIES	-0.812	-0.845	-0.903	-0.866	-0.884	-0.914	-0.932	-0.932	-0.927
MINING (All types)	-0.761	-0.875	-0.973	-0.95	-0.963	-0.981	-1.03	-1.021	-1.001
Coal Mining	*-0.541*	*-0.567*	*-0.617*	*-0.596*	*-0.615*	*-0.644*	*-0.702*	*-0.710*	*-0.712*
Oil & Gas Production	*-0.032*	*-0.035*	*-0.034*	*-0.028*	*-0.024*	*-0.017*	*-0.012*	*-0.005*	*0.002*
Support Activities for Mining (All types)	*-0.185*	*-0.270*	*-0.319*	*-0.324*	*-0.322*	*-0.318*	*-0.314*	*-0.303*	*-0.289*
RETAIL TRADE	-0.33	-0.425	-0.504	-0.532	-0.559	-0.586	-0.614	-0.629	-0.639
HEALTHCARE AND SOCIAL ASSISTANCE	-0.158	-0.194	-0.222	-0.226	-0.231	-0.239	-0.249	-0.253	-0.257
Output Changes (billion $2015)									
Total for West Virginia	$ (1.30)	$ (1.53)	$ (1.75)	$ (1.79)	$ (1.87)	$ (1.98)	$ (2.09)	$ (2.15)	$ (2.19)
% Change	*-0.8%*	*-1.0%*	*-1.1%*	*-1.1%*	*-1.1%*	*-1.2%*	*-1.2%*	*-1.2%*	*-1.2%*
For Electricity Generation Industry	-0.71	-0.77	-0.85	-0.85	-0.90	-0.97	-1.03	-1.07	-1.11
% Change	*-13.7%*	*-14.7%*	*-16.0%*	*-15.9%*	*-16.7%*	*-17.7%*	*-18.5%*	*-19.0%*	*-19.5%*
GDP Changes (billion $2015)									
Total for West Virginia	$ (1.03)	$ (1.19)	$ (1.36)	$ (1.39)	$ (1.46)	$ (1.56)	$ (1.66)	$ (1.71)	$ (1.75)
% Change	*-1.1%*	*-1.3%*	*-1.4%*	*-1.4%*	*-1.5%*	*-1.5%*	*-1.6%*	*-1.6%*	*-1.6%*

Table 42 Mass-Based National Allowance Trading

	2022	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**
Employment Changes (thousands)									
Total for West Virginia	-0.044	-0.221	-0.369	-0.482	-0.621	-0.859	-1.115	-1.334	-1.583
% Change	*0.00%*	*-0.02%*	*-0.04%*	*-0.05%*	*-0.06%*	*-0.09%*	*-0.11%*	*-0.14%*	*-0.16%*
By Major Economic Group:									
Private Non-Farm	-0.033	-0.19	-0.315	-0.418	-0.536	-0.738	-0.948	-1.124	-1.323
Government	-0.011	-0.031	-0.053	-0.064	-0.085	-0.121	-0.167	-0.211	-0.259
Top 5 Impacted Sectors:									
CONSTRUCTION	0.027	-0.026	-0.066	-0.167	-0.19	-0.243	-0.311	-0.366	-0.43
UTILITIES	-0.02	-0.036	-0.044	-0.011	-0.027	-0.057	-0.087	-0.099	-0.119
MINING (All types)	0.036	0.013	-0.009	0.022	-0.001	-0.039	-0.072	-0.092	-0.121
Coal Mining	*0.046*	*0.033*	*0.019*	*0.048*	*0.030*	*0.004*	*-0.016*	*-0.025*	*-0.043*
Oil & Gas Production	*-0.004*	*-0.008*	*-0.010*	*-0.014*	*-0.017*	*-0.020*	*-0.024*	*-0.028*	*-0.032*
Support Activities for Mining (All types)	*-0.005*	*-0.011*	*-0.016*	*-0.012*	*-0.013*	*-0.021*	*-0.031*	*-0.038*	*-0.045*
RETAIL TRADE	-0.021	-0.037	-0.051	-0.066	-0.08	-0.104	-0.128	-0.153	-0.179
HEALTHCARE AND SOCIAL ASSISTANCE	-0.01	-0.019	-0.027	-0.035	-0.044	-0.056	-0.068	-0.082	-0.095
Output Changes (billion $2015)									
Total for West Virginia	$ (0.01)	$ (0.06)	$ (0.10)	$ (0.09)	$ (0.14)	$ (0.22)	$ (0.31)	$ (0.38)	$ (0.46)
% Change	*-0.01%*	*-0.04%*	*-0.06%*	*-0.05%*	*-0.08%*	*-0.13%*	*-0.18%*	*-0.21%*	*-0.26%*
For Electricity Generation Industry	-0.02	-0.03	-0.04	-0.01	-0.03	-0.06	-0.10	-0.11	-0.14
% Change	*-0.34%*	*-0.62%*	*-0.78%*	*-0.20%*	*-0.51%*	*-1.09%*	*-1.71%*	*-2.01%*	*-2.49%*
GDP Changes (billion $2015)									
Total for West Virginia	$ (0.01)	$ (0.04)	$ (0.07)	$ (0.04)	$ (0.08)	$ (0.14)	$ (0.20)	$ (0.25)	$ (0.31)
% Change	*-0.01%*	*-0.04%*	*-0.07%*	*-0.04%*	*-0.08%*	*-0.14%*	*-0.20%*	*-0.24%*	*-0.29%*

Table 43 Rate-Based No ERC Trading

	2022	2023	2024	2025	2026	2027	2028	2029	2030
Employment Changes (thousands)									
Total for West Virginia	-10.016	-13.285	-15.381	-16.258	-16.027	-15.525	-15.148	-14.328	-13.732
% Change	*-1.01%*	*-1.34%*	*-1.55%*	*-1.64%*	*-1.62%*	*-1.57%*	*-1.53%*	*-1.45%*	*-1.39%*
By Major Economic Group:									
Private Non-Farm	-8.933	-11.455	-13	-13.529	-13.118	-12.522	-12.081	-11.266	-10.683
Government	-1.082	-1.829	-2.381	-2.729	-2.909	-3.003	-3.067	-3.063	-3.05
Top 5 Impacted Sectors:									
CONSTRUCTION	-2.308	-3.632	-4.342	-4.737	-4.567	-4.251	-3.93	-3.519	-3.16
UTILITIES	-1.95	-2.122	-2.284	-2.248	-2.164	-2.131	-2.084	-1.984	-1.94
MINING (All types)	-2.012	-2.343	-2.573	-2.54	-2.452	-2.331	-2.292	-2.141	-2.042
Coal Mining	*-1.449*	*-1.547*	*-1.657*	*-1.609*	*-1.572*	*-1.528*	*-1.557*	*-1.497*	*-1.477*
Oil & Gas Production	*-0.092*	*-0.099*	*-0.097*	*-0.084*	*-0.063*	*-0.039*	*-0.022*	*-0.001*	*0.018*
Support Activities for Mining (All types)	*-0.465*	*-0.689*	*-0.812*	*-0.840*	*-0.809*	*-0.759*	*-0.707*	*-0.638*	*-0.579*
RETAIL TRADE	-0.891	-1.132	-1.313	-1.413	-1.425	-1.419	-1.433	-1.401	-1.388
HEALTHCARE AND SOCIAL ASSISTANCE	-0.43	-0.523	-0.585	-0.608	-0.591	-0.572	-0.569	-0.548	-0.543
Output Changes (billion $2015)									
Total for West Virginia	$ (3.29)	$ (3.98)	$ (4.54)	$ (4.72)	$ (4.71)	$ (4.70)	$ (4.73)	$ (4.61)	$ (4.58)
% Change	*-2.1%*	*-2.5%*	*-2.8%*	*-2.9%*	*-2.8%*	*-2.8%*	*-2.7%*	*-2.6%*	*-2.6%*
For Electricity Generation Industry	-1.70	-1.92	-2.15	-2.20	-2.21	-2.26	-2.30	-2.28	-2.32
% Change	*-33.0%*	*-36.8%*	*-40.5%*	*-41.2%*	*-40.8%*	*-41.2%*	*-41.3%*	*-40.6%*	*-40.9%*
GDP Changes (billion $2015)									
Total for West Virginia	$ (2.59)	$ (3.09)	$ (3.52)	$ (3.65)	$ (3.66)	$ (3.68)	$ (3.73)	$ (3.66)	$ (3.67)
% Change	*-2.8%*	*-3.3%*	*-3.6%*	*-3.7%*	*-3.6%*	*-3.6%*	*-3.6%*	*-3.5%*	*-3.4%*

Table 44 Rate-Based National ERC Trading

	2022	2023	2024	2025	2026	2027	2028	2029	2030
Employment Changes (thousands)									
Total for West Virginia	-0.196	-0.518	-1.066	-1.638	-1.96	-2.347	-3.096	-3.657	-4.448
% Change	*-0.02%*	*-0.05%*	*-0.11%*	*-0.17%*	*-0.20%*	*-0.24%*	*-0.31%*	*-0.37%*	*-0.45%*
By Major Economic Group:									
Private Non-Farm	-0.172	-0.455	-0.929	-1.425	-1.68	-1.992	-2.625	-3.071	-3.721
Government	-0.024	-0.063	-0.137	-0.214	-0.28	-0.355	-0.471	-0.586	-0.727
Top 5 Impacted Sectors:									
CONSTRUCTION	-0.02	-0.113	-0.255	-0.501	-0.592	-0.678	-0.868	-1.01	-1.213
UTILITIES	-0.031	-0.058	-0.137	-0.137	-0.149	-0.186	-0.255	-0.305	-0.369
MINING (All types)	0.033	-0.013	-0.105	-0.115	-0.141	-0.192	-0.275	-0.339	-0.415
Coal Mining	*0.051*	*0.022*	*-0.039*	*-0.024*	*-0.034*	*-0.068*	*-0.115*	*-0.153*	*-0.192*
Oil & Gas Production	*-0.008*	*-0.014*	*-0.021*	*-0.031*	*-0.039*	*-0.045*	*-0.058*	*-0.065*	*-0.078*
Support Activities for Mining (All types)	*-0.010*	*-0.021*	*-0.044*	*-0.059*	*-0.066*	*-0.077*	*-0.100*	*-0.118*	*-0.141*
RETAIL TRADE	-0.043	-0.072	-0.121	-0.187	-0.219	-0.259	-0.344	-0.398	-0.487
HEALTHCARE AND SOCIAL ASSISTANCE	-0.021	-0.037	-0.062	-0.095	-0.113	-0.133	-0.178	-0.207	-0.255
Output Changes (billion $2015)									
Total for West Virginia	$ (0.04)	$ (0.13)	$ (0.30)	$ (0.40)	$ (0.49)	$ (0.62)	$ (0.86)	$ (1.05)	$ (1.31)
% Change	*-0.03%*	*-0.08%*	*-0.19%*	*-0.24%*	*-0.29%*	*-0.37%*	*-0.50%*	*-0.60%*	*-0.74%*
For Electricity Generation Industry	-0.04	-0.13	-0.30	-0.40	-0.49	-0.62	-0.86	-1.05	-1.31
% Change	*-0.03%*	*-0.08%*	*-0.19%*	*-0.24%*	*-0.29%*	*-0.37%*	*-0.50%*	*-0.60%*	*-0.74%*
GDP Changes (billion $2015)									
Total for West Virginia	$ (0.03)	$ (0.09)	$ (0.22)	$ (0.27)	$ (0.33)	$ (0.42)	$ (0.59)	$ (0.72)	$ (0.91)
% Change	*-0.03%*	*-0.09%*	*-0.22%*	*-0.28%*	*-0.33%*	*-0.41%*	*-0.56%*	*-0.69%*	*-0.84%*

Detailed Economic Impact Scenario Input Assumptions

Table 45 Base Case - Business as Usual (BAU)

	2022	2023	2024	2025	2026	2027	2028	2029	2030
WV EGU Electricity Output (GWh)	86,361	86,575	87,410	86,665	86,921	87,238	87,832	87,732	87,480
MW Coal Plant Closure	0	0	0	0	0	0	0	0	0
WV Coal Consumption at EGUs (tons)	22,276,879	22,348,190	22,578,927	22,378,226	22,464,109	22,561,527	22,743,793	22,735,883	22,674,491
Cumulative EE Program Savings (MWh)	1,487,255	1,693,533	1,904,338	2,119,671	2,339,530	2,563,917	2,792,830	3,026,270	3,264,238
Cumulative New RE Capacity in PJM since 2012 (MW)	2,483	2,598	2,715	2,834	2,956	3,080	3,208	3,337	3,432
Wholesale (LMP) Electricity Price ($2015/MWh)	$39.41	$40.19	$40.96	$41.52	$42.27	$43.12	$43.82	$44.60	$45.68
Henry Hub Natural Gas Price ($2015/MMBtu)	$4.55	$4.65	$4.70	$4.75	$4.85	$4.90	$5.00	$5.05	$5.15

Table 46 Mass-Based No Allowance Trading

	2022	2023	2024	2025	2026	2027	2028	2029	2030
WV EGU Electricity Output (GWh)	62,629	61,008	59,124	58,297	56,905	55,166	53,958	52,598	51,171
Cost of CO_2 Allowances	$-	$-	$-	$-	$-	$-	$-	$-	$-
Cost of CO_2 Allowances to WV Customers	$-	$-	$-	$-	$-	$-	$-	$-	$-
MW Coal Plant Closure	1,600	-	-	-	-	-	-	-	-
WV Coal Consumption at EGUs (tons)	16,722,741	16,372,612	15,886,424	15,718,959	15,374,254	14,942,809	14,197,021	13,845,387	13,517,249
Cumulative EE Program Savings (MWh)	1,487,255	1,693,533	1,904,338	2,119,671	2,339,530	2,563,917	2,792,830	3,026,270	3,264,238
Cumulative New RE in PJM since 2012 from CPP (MW)	719	805	886	967	1,052	1,141	1,235	1,333	1,452
Cumulative New RE Capacity in WV Due to CPP (MW)	40	80	120	0	0	0	0	0	0
Change in Electricity Industry Output ($2015 Billion)	$(0.744)	$(0.809)	$(0.904)	$(0.903)	$(0.960)	$(1.031)	$(1.094)	$(1.139)	$(1.178)
Wholesale (LMP) Electricity Prices ($2015/MWh)	$43.37	$44.61	$45.62	$45.80	$46.50	$47.33	$47.79	$48.64	$49.38
Henry Hub Natural Gas Prices ($2015/MMBtu)	$4.85	$4.95	$5.00	$5.05	$5.10	$5.15	$5.20	$5.25	$5.30

Table 47 Mass-Based National Allowance Trading

	2022	2023	2024	2025	2026	2027	2028	2029	2030
WV EGU Electricity Output (GWh)	86,058	85,669	86,100	86,557	86,281	85,564	85,173	84,514	83,513
Value of Allowances ($2015/short ton)	$4.35	$4.76	$5.44	$5.65	$6.21	$6.89	$7.46	$8.24	$9.43
Cost of CO_2 Allowances	$112,088,478	$120,600,173	$140,168,354	$181,122,028	$197,288,645	$213,905,493	$254,014,229	$275,015,405	$324,244,335
Cost of CO_2 Allowances to WV Customers	$ 46,956,310	$ 50,610,705	$ 58,507,528	$ 76,364,876	$ 83,285,327	$ 90,350,290	$107,012,714	$116,163,650	$137,925,767
MW Coal Plant Closure	0	0	0	0	0	0	0	0	0
WV Coal Consumption at EGUs (tons)	22,749,619	22,699,620	22,784,920	22,928,639	22,824,854	22,618,771	22,568,195	22,436,741	22,151,054
Cumulative EE Program Savings (MWh)	1,487,255	1,693,533	1,904,338	2,119,671	2,339,530	2,563,917	2,792,830	3,026,270	3,264,238
Cumulative New RE in PJM since 2012 from CPP (MW)	719	805	886	967	1,052	1,141	1,235	1,333	1,452
Cumulative New RE Capacity in WV Due to CPP (MW)	40	80	120	0	0	0	0	0	0
Change in Electricity Industry Output ($2015 Billion)	$(0.009)	$(0.028)	$(0.041)	$(0.003)	$(0.020)	$(0.053)	$(0.085)	$(0.103)	$(0.127)
Wholesale (LMP) Electricity Prices ($2015/MWh)	$40.49	$41.88	$43.80	$44.83	$45.65	$46.44	$47.57	$48.79	$50.30
Henry Hub Natural Gas Prices ($2015/MMBtu)	$4.70	$4.80	$4.85	$4.90	$4.95	$5.00	$5.10	$5.15	$5.25

Table 48 Rate-Based No ERC Trading

	2022	2023	2024	2025	2026	2027	2028	2029	2030
WV EGU Electricity Output (GWh)	31,752	24,353	19,019	16,665	16,679	15,375	15,052	15,619	14,219
ERC Values ($2015/MWh)	$102.62	$94.67	$86.50	$84.58	$80.70	$69.64	$68.85	$65.15	$65.58
Cost of CO_2 ERCs	$750,236,805	$530,878,357	$378,796,208	$522,272,492	$498,719,288	$396,683,282	$507,421,923	$498,300,660	$536,491,401
Cost of CO_2 ERCs to WV Customers	$161,671,033	$62,454,914	$(6,609,756)	$40,910,074	$21,723,743	$(10,989,918)	$21,496,691	$13,312,437	$14,128,529
MW Coal Plant Closure	5,100	-	1,200	-	-	1,700	-	-	-
WV Coal Consumption at EGUs (tons)	7,427,434	6,043,720	4,582,877	4,395,750	4,359,255	4,443,743	3,746,637	3,923,876	3,618,294
Cumulative EE Program Savings (MWh)	1,487,255	1,693,533	1,904,338	2,119,671	2,339,530	2,563,917	2,792,830	3,026,270	3,264,238
Cumulative New RE in PJM since 2012 from CPP (MW)	719	805	886	1,042	1,352	1,441	1,685	2,083	2,202
Cumulative New RE Capacity in WV Due to CPP (MW)	60	120	180	0	0	0	0	0	0
Change in Electricity Industry Output ($2015 Billion)	$(1.760)	$(2.014)	$(2.276)	$(2.326)	$(2.335)	$(2.398)	$(2.437)	$(2.419)	$(2.460)
Wholesale (LMP) Electricity Prices ($2015/MWh)	$46.63	$47.35	$50.52	$51.22	$51.49	$52.14	$52.53	$53.18	$54.00
Henry Hub Natural Gas Prices ($2015/MMBtu)	$4.90	$5.00	$5.10	$5.20	$5.25	$5.30	$5.40	$5.50	$5.60

Table 49 Rate-Based National ERC Trading

	2022	2023	2024	2025	2026	2027	2028	2029	2030
WV EGU Electricity Output (GWh)	85,961	85,258	83,442	83,104	82,937	81,889	80,357	78,169	75,706
ERC Values ($2015/MWh)	$11.41	$12.52	$13.72	$15.02	$16.47	$18.22	$19.64	$21.72	$24.68
Cost of CO_2 ERCs	$225,932,204	$245,720,444	$263,669,842	$462,330,084	$506,245,894	$552,873,692	$772,683,727	$831,249,834	$1,074,673,056
Cost of CO_2 ERCs to WV Customers	$ 77,671,195	$ 81,920,424	$ 83,923,785	$163,100,412	$175,168,283	$186,804,056	$270,679,442	$285,391,833	$376,594,629
MW Coal Plant Closure	0	0	0	0	0	0	0	0	0
WV Coal Consumption at EGUs (tons)	22,803,324	22,604,589	22,169,272	22,123,689	22,083,148	21,786,382	21,381,440	20,855,408	20,252,875
Cumulative EE Program Savings (MWh)	1,487,255	1,693,533	1,904,338	2,119,671	2,339,530	2,563,917	2,792,830	3,026,270	3,264,238
Cumulative New RE in PJM since 2012 from CPP (MW)	719	805	886	967	1,052	1,141	1,235	1,333	1,452
Cumulative New RE Capacity in WV Due to CPP (MW)	40	80	120	0	0	0	0	0	0
Change in Electricity Industry Output ($2015 Billion)	$(0.012)	$(0.041)	$(0.125)	$(0.112)	$(0.127)	$(0.171)	$(0.241)	$(0.310)	$(0.385)
Wholesale (LMP) Electricity Prices ($2015/MWh)	$40.49	$41.88	$43.80	$44.83	$45.65	$46.44	$47.57	$48.79	$50.30
Henry Hub Natural Gas Prices ($2015/MMBtu)	$4.75	$4.85	$4.90	$4.95	$5.00	$5.05	$5.10	$5.20	$5.30

Sub-Regional Analysis Industry Detail

Table 50 Sub-region Employment Distribution by Industry, 2015

Industry	**John E. Amos**	**Pleasants**	**Mt. Storm**	**Mitchell**	**FE Harrison**	**Monongalia/Marion Plants**	**Mountaineer**
Total Employment	*196,662*	*48,268*	*33,369*	*46,618*	*134,898*	*122,576*	*34,709*
Crop and Animal Production	0.2%	0.1%	0.9%	0.1%	0.2%	0.1%	0.8%
Mining, Quarrying, and Oil and Gas Extraction	1.4%	1.6%	1.4%	6.9%	4.1%	3.1%	0.3%
Utilities	0.9%	0.8%	1.4%	1.0%	0.8%	0.9%	2.4%
Construction	4.7%	3.7%	3.7%	3.0%	4.3%	4.7%	8.3%
Manufacturing	6.4%	10.0%	18.3%	4.9%	5.8%	6.1%	12.9%
Wholesale Trade	3.4%	1.9%	1.4%	4.2%	2.5%	2.4%	5.5%
Retail Trade	12.2%	14.8%	11.3%	12.7%	11.9%	11.7%	12.4%
Transportation and Warehousing	2.8%	3.1%	3.3%	1.0%	2.6%	2.4%	5.0%
Information	1.3%	2.0%	2.0%	1.1%	1.1%	1.2%	0.8%
Finance and Insurance	3.5%	3.6%	2.3%	3.0%	1.8%	1.8%	2.5%
Real Estate and Rental and Leasing	1.3%	0.8%	0.7%	0.6%	1.2%	1.2%	1.4%
Professional, Scientific, and Technical Services	4.0%	2.1%	1.4%	3.5%	4.3%	4.5%	3.1%
Management of Companies and Enterprises	1.1%	0.5%	0.5%	2.0%	1.1%	1.2%	0.9%
Administrative and Support and Waste Management and Remediation Services	5.8%	5.6%	1.7%	5.1%	3.5%	3.7%	4.5%
Educational Services	0.7%	1.8%	1.9%	2.4%	1.5%	0.8%	0.3%
Health Care and Social Assistance	18.1%	15.8%	17.4%	17.8%	17.6%	17.3%	11.1%
Arts, Entertainment, and Recreation	1.0%	0.9%	0.5%	1.1%	0.7%	0.8%	1.3%
Accommodation and Food Services	8.4%	9.3%	7.2%	9.7%	9.5%	9.5%	7.8%
Other Services (except Public Administration)	4.2%	4.4%	3.3%	5.1%	3.7%	3.8%	4.0%
Government	18.6%	17.0%	19.3%	14.7%	21.7%	22.7%	14.8%
Unclassified Industry	0.026%	0.130%	0.037%	0.002%	0.024%	0.029%	0.033%

Source: EMSI, 2015 Q3 Estimates

Table 51 Sub-regional Impacts, Job Change by Industry

Industry	Fort Martin Power Station	Grant Town Power Plant	Harrison Power Station	John E. Amos	Longview Power LLC	Mitchell	Morgantown Energy	Mountaineer	Mt Storm	Pleasants Power Station
Crop and Animal Production	(0)	(0)	(0)	(1)	(0)	(0)	(0)	(0)	(0)	(0)
Mining, Quarrying, and Oil and Gas Extraction	(6)	(2)	(7)	(9)	(3)	(4)	(2)	(1)	(5)	(2)
Utilities	(182)	(55)	(231)	(335)	(103)	(258)	(48)	(196)	(207)	(191)
Construction	(18)	(6)	(24)	(40)	(10)	(19)	(5)	(16)	(21)	(15)
Manufacturing	(1)	(0)	(1)	(3)	(1)	(1)	(0)	(1)	(1)	(1)
Wholesale Trade	(3)	(1)	(4)	(10)	(2)	(4)	(1)	(3)	(2)	(2)
Retail Trade	(32)	(10)	(41)	(68)	(18)	(36)	(8)	(17)	(26)	(29)
Transportation and Warehousing	(7)	(2)	(9)	(17)	(4)	(7)	(2)	(5)	(5)	(6)
Information	(4)	(1)	(5)	(7)	(2)	(2)	(1)	(1)	(2)	(3)
Finance and Insurance	(9)	(3)	(11)	(26)	(5)	(11)	(2)	(5)	(7)	(10)
Real Estate and Rental and Leasing	(7)	(2)	(9)	(15)	(4)	(7)	(2)	(4)	(5)	(6)
Professional, Scientific, and Technical Services	(19)	(6)	(25)	(37)	(11)	(23)	(5)	(8)	(13)	(12)
Management of Companies and Enterprises	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)
Administrative and Support and Waste Management and Remediation Services	(11)	(3)	(15)	(31)	(6)	(14)	(3)	(7)	(7)	(13)
Educational Services	(4)	(1)	(6)	(8)	(3)	(8)	(1)	(2)	(3)	(4)
Health Care and Social Assistance	(34)	(10)	(46)	(78)	(19)	(41)	(9)	(15)	(30)	(32)
Arts, Entertainment, and Recreation	(4)	(1)	(5)	(9)	(2)	(4)	(1)	(2)	(3)	(3)
Accommodation and Food Services	(26)	(8)	(33)	(47)	(15)	(28)	(7)	(10)	(15)	(19)
Other Services (except Public Administration)	(15)	(5)	(20)	(31)	(8)	(19)	(4)	(9)	(14)	(14)
Government	(60)	(18)	(79)	(91)	(34)	(117)	(16)	(51)	(66)	(53)

Source: EMSI, 2015 Q3 Estimates. Based on 2013 national Input-Output tables.

Socioeconomic Characteristics

Table 52 Socioeconomic Characteristics by County, 2014

	Population	Total full-time and part-time employment	Average wages and salaries	Per capita personal income	All Ages in Poverty Percent
Barbour	16,766	5,859	$ 33,699	$29,702	21.4
Berkeley	110,497	45,364	$ 38,872	$35,836	13.2
Boone	23,714	8,631	$ 48,448	$31,526	22.5
Braxton	14,463	5,488	$ 31,899	$28,315	22.3
Brooke	23,530	11,658	$ 37,084	$36,225	14.7
Cabell	97,109	65,119	$ 39,925	$37,481	23.4
Calhoun	7,513	3,668	$ 45,112	$28,424	21
Clay	8,941	2,360	$ 31,399	$27,555	23.6
Doddridge	8,391	3,118	$ 42,142	$20,757	18.1
Fayette	45,132	15,247	$ 35,294	$30,314	22.6
Gilmer	8,618	3,774	$ 38,549	$26,457	31.1
Grant	11,687	5,786	$ 41,227	$31,789	16.7
Greenbrier	35,450	18,824	$ 34,557	$34,966	17.7
Hampshire	23,483	7,822	$ 30,656	$29,944	16.9
Hancock	30,112	12,005	$ 36,400	$35,814	14.6
Hardy	13,923	7,755	$ 29,979	$28,548	18
Harrison	68,761	46,561	$ 45,740	$43,048	16.1
Jackson	29,126	11,708	$ 37,248	$33,560	18.1
Jefferson	55,713	22,359	$ 37,500	$44,160	11.3
Kanawha	190,223	131,232	$ 44,123	$44,039	15.3
Lewis	16,414	9,431	$ 48,378	$36,695	17.4
Lincoln	21,561	4,414	$ 39,594	$27,096	23.7
Logan	35,348	12,700	$ 41,578	$33,446	22.2
McDowell	20,448	6,482	$ 43,552	$27,024	36.5
Marion	56,803	27,385	$ 41,258	$38,756	15.3
Marshall	32,416	18,022	$ 52,082	$40,005	16.9
Mason	27,016	8,738	$ 39,673	$28,654	22.3
Mercer	61,785	27,036	$ 35,011	$33,542	26.7
Mineral	27,578	10,810	$ 37,868	$35,599	16.4
Mingo	25,716	7,917	$ 46,225	$29,896	24.9
Monongalia	103,463	70,624	$ 44,825	$40,343	19.2
Monroe	13,582	4,174	$ 36,092	$28,577	17.3
Morgan	17,453	4,795	$ 31,657	$32,212	15.4
Nicholas	25,827	10,489	$ 35,047	$32,557	18.6
Ohio	43,328	32,503	$ 38,072	$44,621	15.3
Pendleton	7,371	3,097	$ 31,624	$34,519	18
Pleasants	7,634	4,104	$ 48,046	$38,707	15
Pocahontas	8,662	4,794	$ 30,185	$33,690	19.2
Preston	33,788	11,770	$ 38,892	$32,802	17
Putnam	56,770	26,950	$ 47,008	$41,160	11
Raleigh	78,241	41,071	$ 39,176	$36,180	20.2
Randolph	29,429	15,151	$ 31,747	$32,022	18.5
Ritchie	10,011	5,658	$ 40,217	$31,314	19.1
Roane	14,664	6,894	$ 34,871	$30,672	23.1

Summers	13,417	3,687	$ 31,834	$26,714	22.6
Taylor	17,069	5,100	$ 38,325	$34,375	17.2
Tucker	6,927	3,940	$ 33,682	$31,818	16.3
Tyler	9,098	3,512	$ 43,561	$31,415	17.9
Upshur	24,731	11,252	$ 35,644	$31,182	20.6
Wayne	41,122	11,446	$ 42,418	$29,767	20
Webster	8,834	2,973	$ 37,349	$26,692	27.1
Wetzel	15,988	6,047	$ 31,724	$32,672	19.7
Wirt	5,845	1,480	$ 28,379	$26,888	21.3
Wood	86,237	48,860	$ 38,040	$37,104	17.9
Wyoming	22,598	6,427	$ 44,105	$28,962	24.3
West Virginia	1,850,326	914,071	$ 40,589	$36,132	18.4
United States	318,857,056	185,798,800	$ 51,552	$46,049	15.8

Source: Bureau of Economic Analysis, Regional Economic Accounts
Census Bureau, Small Area Income and Poverty Estimates

Power Plant Sub-regions

Figure 20 John E. Amos Sub-region

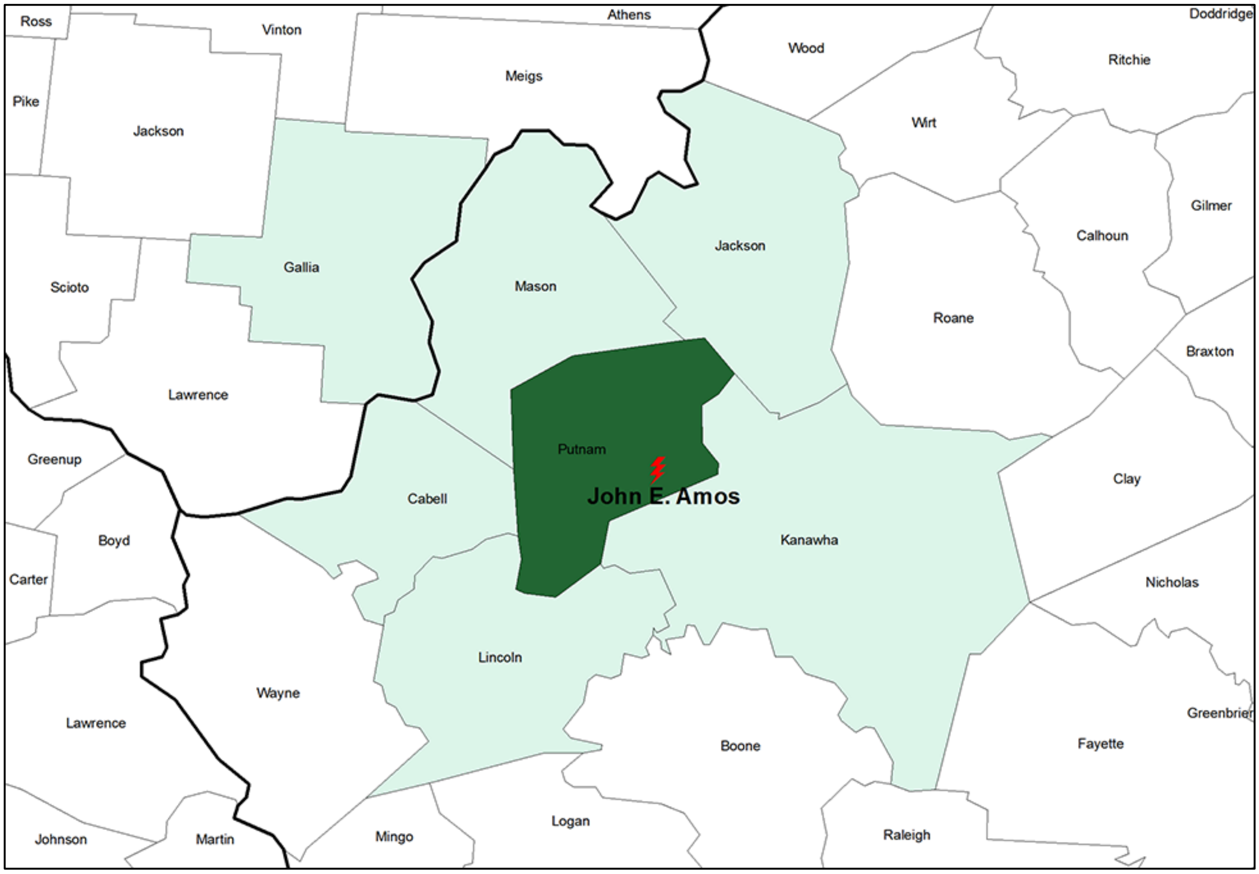

Figure 21 Monongalia Plants' Sub-region

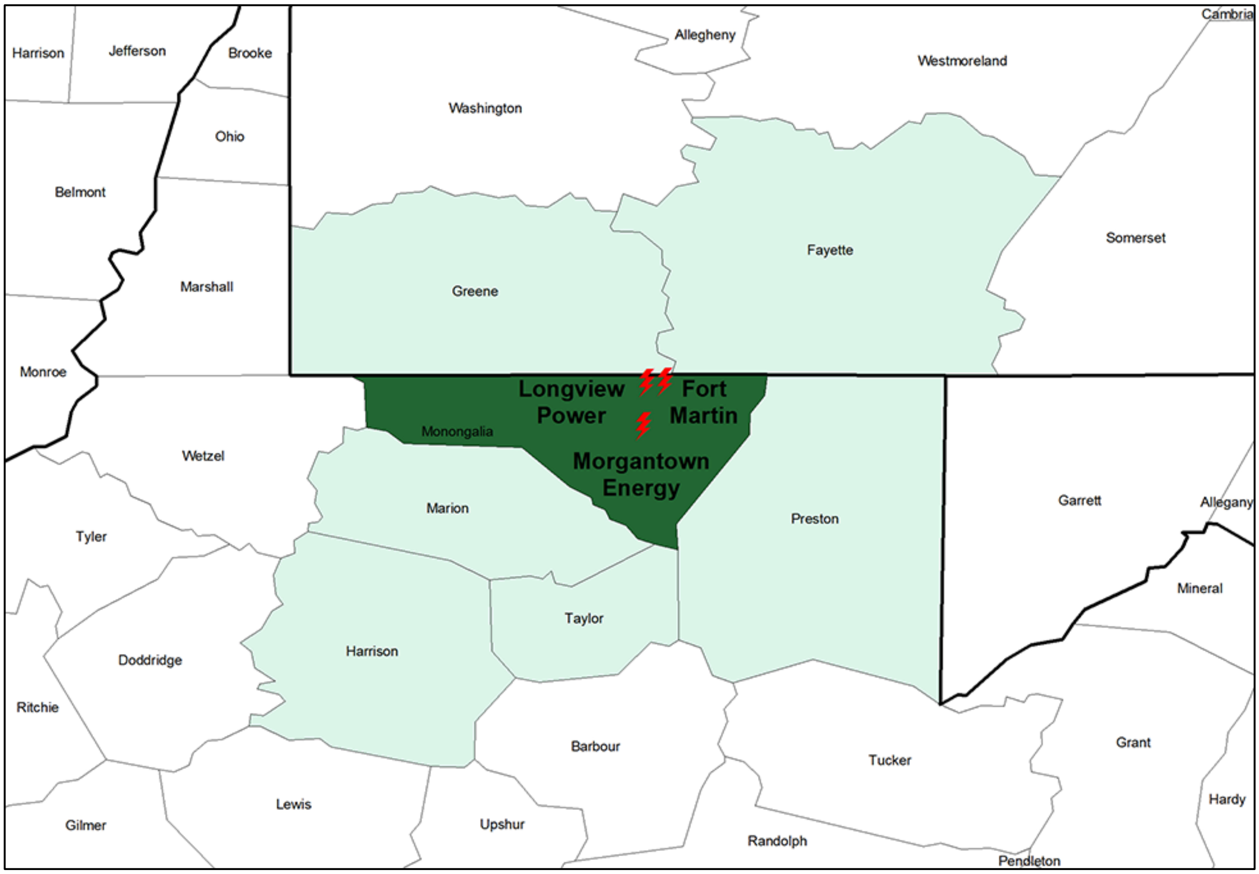

Figure 22 First Energy Harrison Power Station Sub-region

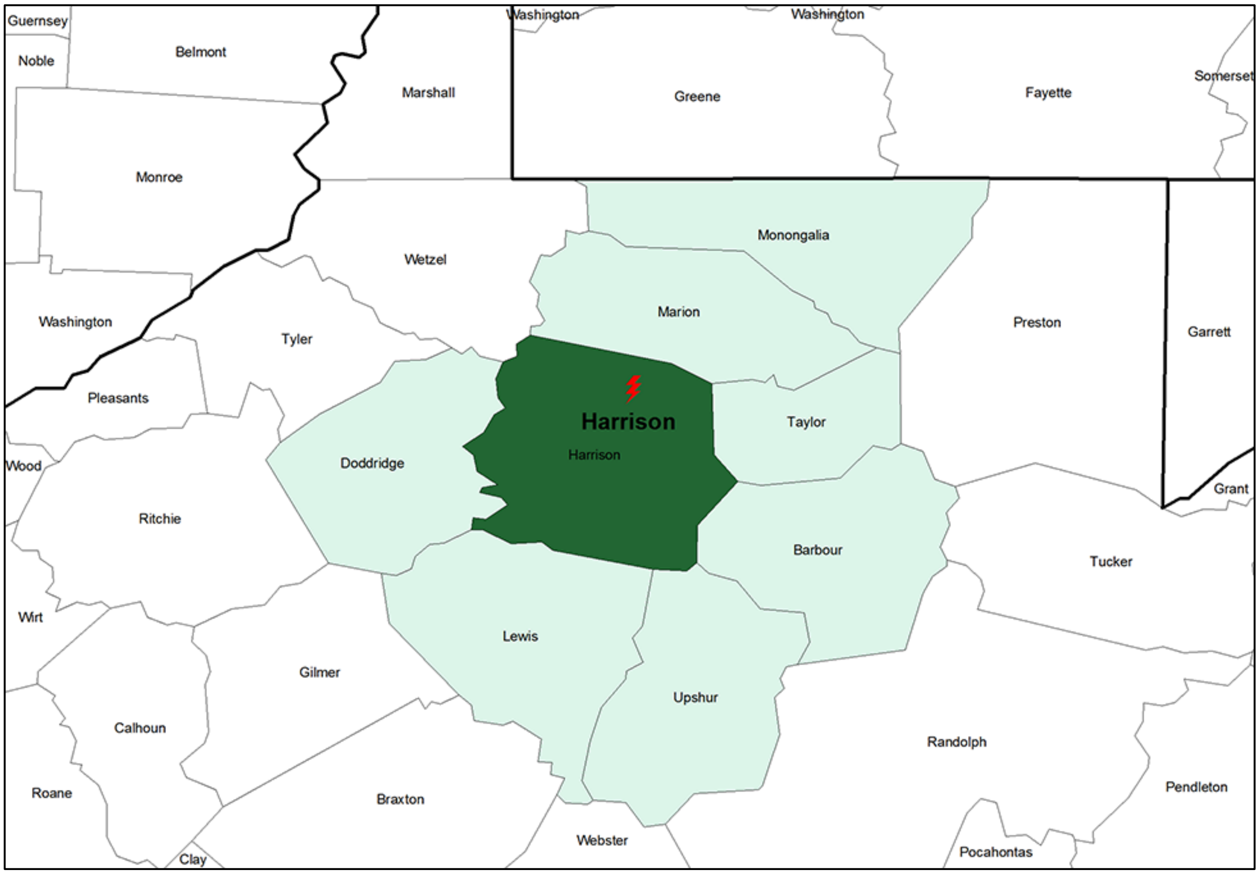

Figure 23 Mitchell Power Plant Sub-region

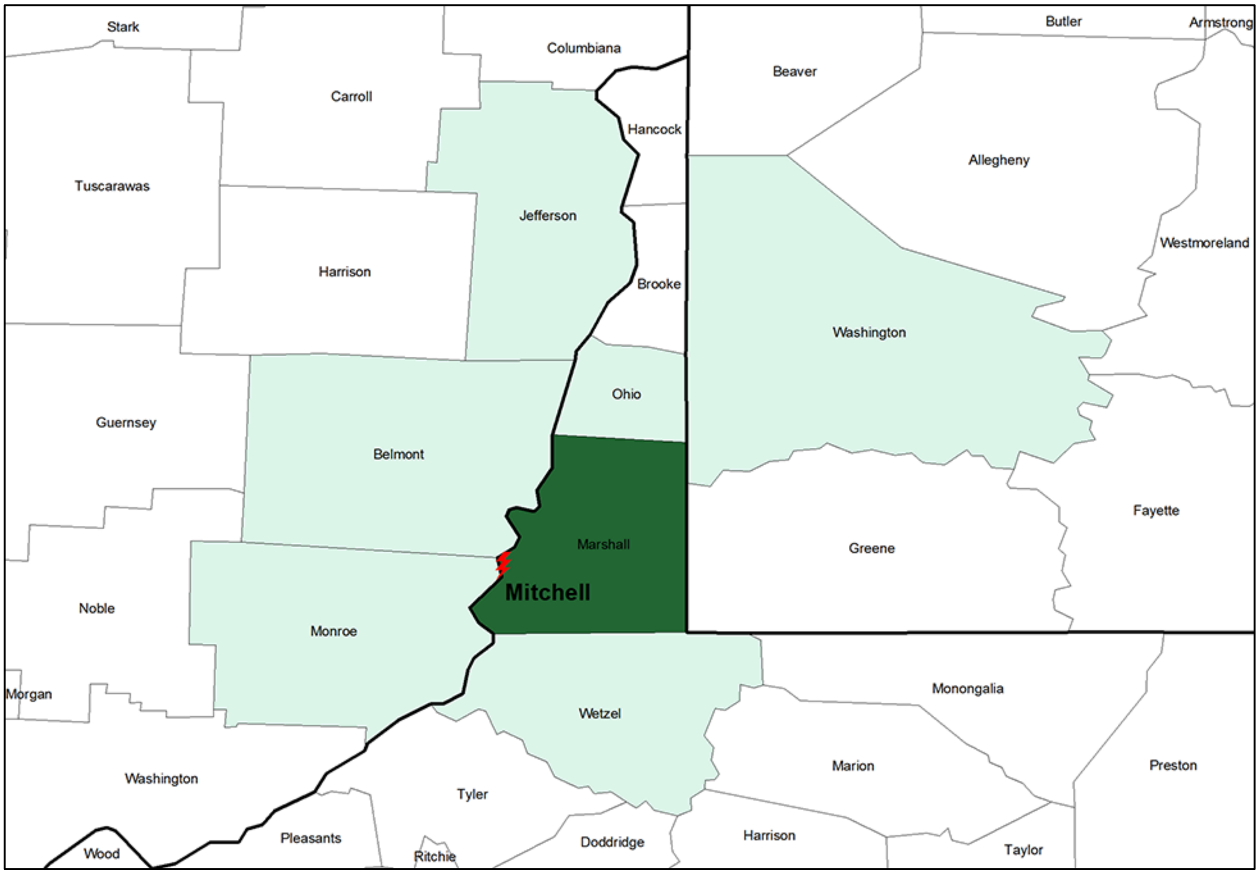

Figure 24 Mt. Storm Sub-region

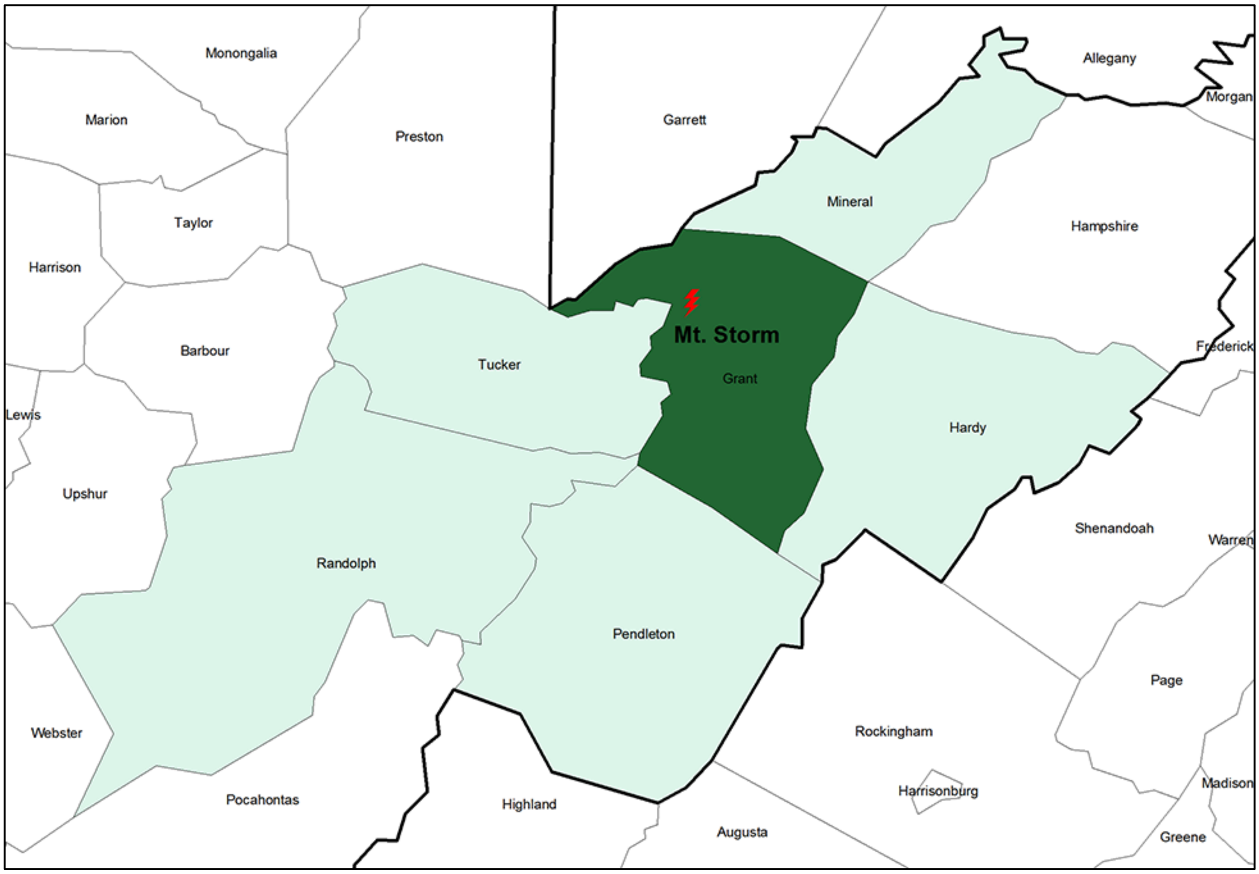

Figure 25 First Energy Pleasants Sub-region

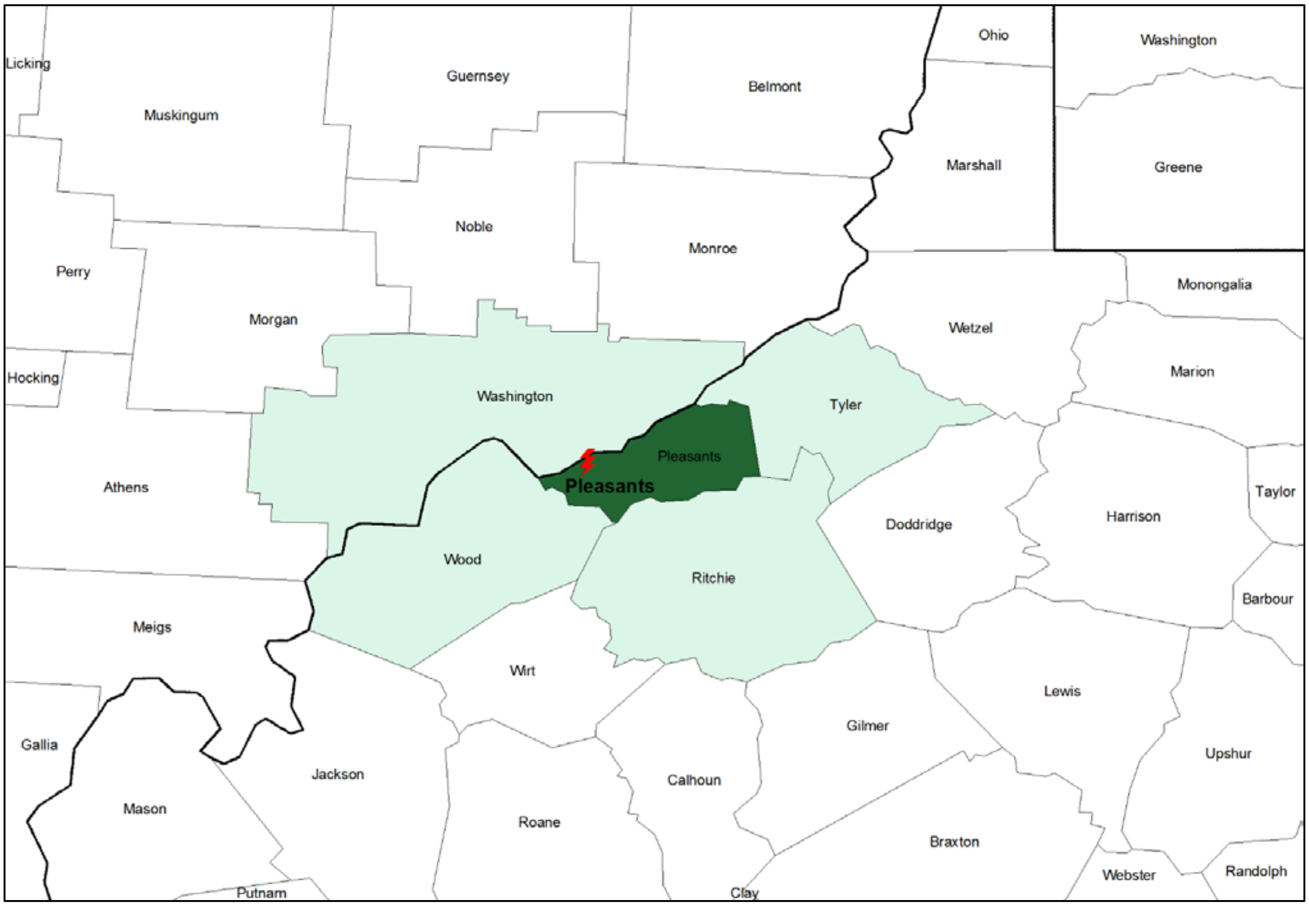

Figure 26 Mountaineer Sub-region

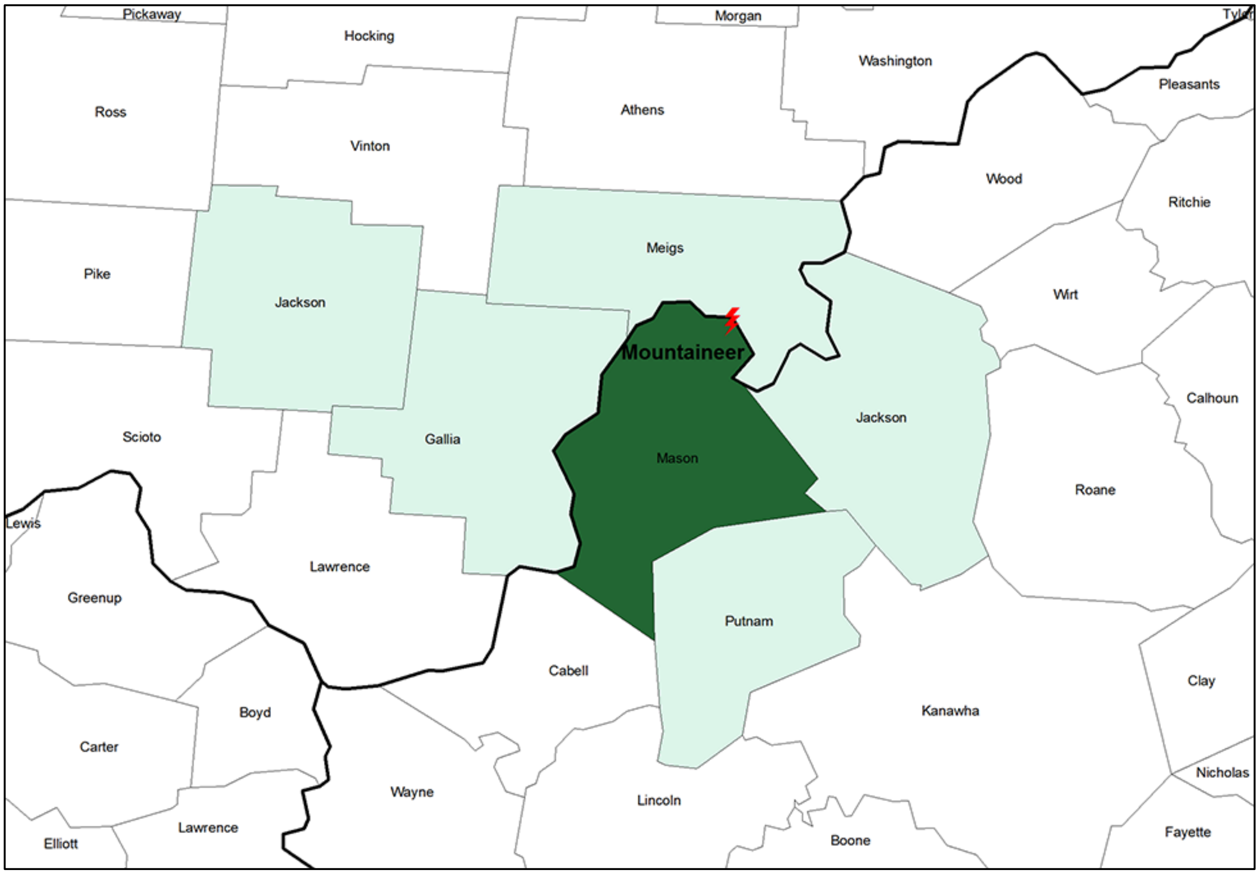

Figure 27 Grant Town Sub-region