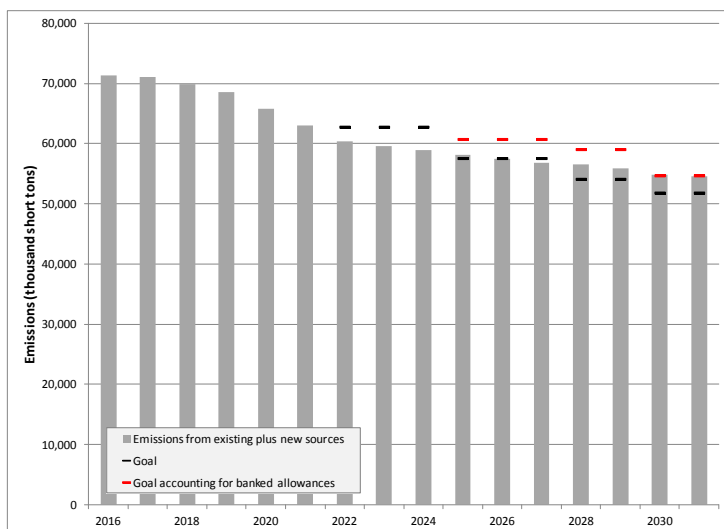
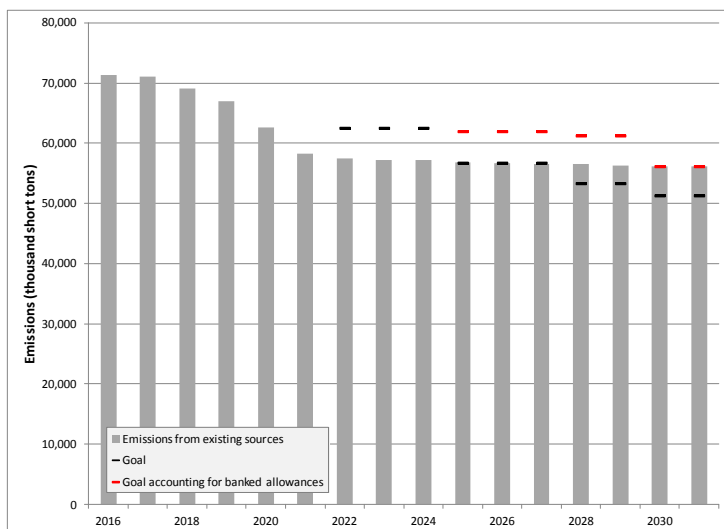


Expanding Economic Opportunities for West Virginia under the Clean Power Plan



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Downstream Strategies

Downstream Strategies is a West Virginia-based environmental consulting firm with a core belief in the importance of protecting the environment and linking economic development with natural resource stewardship. Our projects fit within one or more of our program areas—energy, water, and land—and most projects also utilize one or more of our tools, which include geographic information systems, monitoring and remediation, and stakeholder involvement and participation.

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Appalachian Stewardship Foundation

The Foundation was founded to mitigate the damage to the environment caused by energy development and use, to reduce greenhouse gas emissions, and to protect freshwater streams and tributaries. Its vision is for environmental values to lead our energy future, with the least amount of energy necessary to provide the goods and services we need.

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ABOUT THE PROJECT

This project is supported through a grant from the Appalachian Stewardship Foundation and is part of a joint initiative of the Center for Energy & Sustainable Development and Downstream Strategies to engage policymakers and stakeholders on climate and energy policies that would help West Virginia build a more sustainable energy and economic future.

In February 2014, the Center for Energy & Sustainable Development hosted its third annual national energy conference. The conference, titled “Regulation of CO₂ Emissions from Existing Power Plants: Flexibility and the Path Forward for Coal Dependent States,” brought together experts from government, industry, academia, and the environmental community to discuss the then-anticipated U.S. Environmental Protection Agency proposal to regulate carbon dioxide emissions from existing power plants. The conference highlighted challenges facing West Virginia and other coal-dependent states as the economics of coal-fired generation becomes less attractive, thereby reducing demand for West Virginia–mined coal as a result of lower-cost alternatives and increasingly stringent environmental regulations.

Following the conference and the release of the draft Clean Power Plan in June 2014, the Center and Downstream Strategies partnered to assess potential carbon dioxide emission reduction opportunities in the West Virginia power sector. In October 2014, the Center and Downstream Strategies issued a Discussion Paper, “Carbon Dioxide Emission Reduction Opportunities for the West Virginia Power Sector,” which presented an initial modeling scenario demonstrating the feasibility of reaching the required emission reductions under the draft Clean Power Plan. The Discussion Paper also included a number of policy recommendations.

In June 2015, the Center and Downstream Strategies issued its final report analyzing implementation strategies under the draft Clean Power Plan, “The Clean Power Plan and West Virginia: Compliance Options and New Economic Opportunities.” That report built upon the preliminary analysis from the Discussion Paper by modeling several additional scenarios and by expanding the discussion of policy recommendations.

On August 3, 2015, the U.S. Environmental Protection Agency issued the final Clean Power Plan and its proposed Federal Implementation Plan. This report presents our analysis of the final rule and an updated analysis of possible scenarios for West Virginia to achieve compliance under that rule. This report also includes revised policy recommendations that reflect relevant developments since the issuance of our June 2015 report.

ACKNOWLEDGEMENTS

We express our appreciation to the Appalachian Stewardship Foundation for its generous financial support to make this project possible. The Appalachian Stewardship Foundation was founded to mitigate damage to the environment caused by energy development and use, to reduce greenhouse gas emissions, and to protect freshwater streams and tributaries. It envisions that environmental values will lead our energy future, with the least amount of energy necessary to provide the goods and services we need.

We express our appreciation as well to Synapse Energy Economics, Inc., which created and shared its Clean Power Plan Planning Tool, the model that we used to run the scenarios in this report. In particular, we acknowledge the invaluable assistance provided by Associate Patrick Knight and Chief Executive Officer Bruce Biewald. We also thank Beren Argetsinger (formerly a Fellow at the Center and currently an Associate at Keyes, Fox & Wiedman), Jeremy Richardson (Senior Energy Analyst, Union of Concerned Scientists), and Walton C. Shepherd (Staff Attorney, Natural Resources Defense Council) for their assistance.

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ABBREVIATIONS

ACEEE	American Council for an Energy Efficient Economy
AEP	American Electric Power
AREPS	Alternative and Renewable Energy Portfolio Standard
AWEA	American Wind Energy Association
BSER	best system of emission reduction
CAA	Clean Air Act
CHP	combined heat and power
CO ₂	carbon dioxide
CP3T	Clean Power Plan Planning Tool
DEP	Department of Environmental Protection
DOE	Department of Energy
DG	distributed generation
DSIRE	Database of State Incentives for Renewables & Efficiency
EERS	Energy Efficiency Resource Standard
EGU	electric generating unit
EIA	Energy Information Administration
EPA	Environmental Protection Agency
EPRI	Electric Power Research Institute
ERC	emission rate credit
FERC	Federal Energy Regulatory Commission
FY	fiscal year
GHG	greenhouse gas
GWh	gigawatt-hour
HB	House Bill
IRP	integrated resource plan
lbs	pounds
kWh	kilowatt-hour
MACED	Mountain Association for Community Economic Development
MMcf	million cubic feet
MW	megawatt
MWh	megawatt-hour
NGCC	natural gas combined cycle
NRDC	Natural Resources Defense Council
NREL	National Renewable Energy Laboratory
NSC	new source complement
Penn PUC	Pennsylvania Public Utility Commission
PJM	PJM Interconnection
PSC	Public Service Commission
PV	photovoltaic
RPS	Renewable Portfolio Standard
SCORE	Southern Coalfields Organizing and Revitalizing the Economy
SEIA	Solar Energy Industries Association
SOAR	Shaping Our Appalachian Region
WV SUN	West Virginia Solar United Neighborhoods

EXECUTIVE SUMMARY

Global climate change is a defining challenge of the 21st Century that requires leadership from the world's largest economies and high levels of cooperation throughout the international community. In June 2013, President Obama released his Climate Action Plan to cut carbon pollution in the United States and lead international efforts to address climate change. The President directed the Environmental Protection Agency to work with states, industry, and other stakeholders to develop carbon dioxide pollution standards for both new and existing power plants pursuant to the Agency's authority to regulate air pollutants under the Clean Air Act. In September 2013, the Agency proposed new source performance standards for carbon dioxide pollution from new power plants under Section 111(b) of the Clean Air Act. In June 2014, it proposed the Clean Power Plan to establish carbon dioxide emission guidelines for existing power plants under Section 111(d). Both rules were finalized in August 2015 and published in the Federal Register in October 2015.

In 2015, the U.S. joined 194 other countries in promising to curb carbon dioxide and other greenhouse gas emissions, develop other ways to mitigate the impacts and to make communities more resilient to climate change. These proposals, called the "Intended Nationally Determined Contributions," were submitted to the United Nations prior to negotiations leading up to the Paris Agreement in December 2015. The U.S. committed to reduce its greenhouse gas emissions by 26-28 percent below the 2005 level in 2025, and to make "best efforts" to reduce emissions by 28 percent. That would include curbs on carbon dioxide, methane, nitrous oxide, perfluorocarbons, sulfur hexafluoride and nitrogen trifluoride, all of which contribute to global warming.

This report focuses on the Clean Power Plan, which sets state-specific standards that would reduce carbon dioxide pollution from existing power plants. The Clean Power Plan provides states flexibility in the design and implementation of state plans and broad discretion in selecting pollution reduction measures and market-based mechanisms to achieve the required reductions. In this report, we review the Clean Power Plan and some of the flexible compliance options available to states; summarize historic and recent trends in the West Virginia energy sector; and identify emission-reduction opportunities related to energy efficiency, renewable energy, coal-fired power plants, and expanded use of the state's natural gas resources. We then present results from modeling scenarios that demonstrate the feasibility of meeting West Virginia's Clean Power Plan obligations. Finally, we offer policy recommendations that would help to put West Virginia on track to meet carbon pollution standards while further expanding the state's energy sector, promoting economic growth, creating new job opportunities, and providing energy savings to consumers.

This report does not offer analysis on how any particular compliance pathway in West Virginia may affect other states, nor does it evaluate how other states' compliance pathways will affect West Virginia. The scenarios, compliance measures, and policy recommendations presented in this report offer a starting point for additional analysis by West Virginia lawmakers, regulators, utilities, and other stakeholders to evaluate the many different compliance options and state plan pathways available to West Virginia under the final Clean Power Plan.

The Clean Power Plan: Regulation of carbon pollution from existing power plants

The Clean Power Plan is designed to produce a 32 percent reduction of carbon dioxide pollution from power plants in the U.S. by 2030, as compared with 2005 levels. It sets state-specific emission limits in the form of an emission rate—pounds of carbon dioxide per megawatt-hour of net electricity produced. The final rule also translates rate-based limits into mass-based limits (total carbon dioxide emissions in tons). West Virginia's Clean Power Plan obligations require emissions reductions from a rate of 2,064 pounds per megawatt-hour in 2012 to 1,305 pounds per megawatt-hour in 2030. Under a mass-based standard, West Virginia would be required to reduce carbon dioxide emissions from 72,319 thousand short tons in 2012 to 51,325 thousand short tons by 2030 if only existing sources are considered or 51,857 thousand short tons if

both existing and new sources are considered. The targets represent a significant challenge for West Virginia: the rate-based target requires a 37 percent reduction in carbon dioxide emissions per megawatt-hour, while the mass-based approach requires a 29 percent reduction in total emissions from existing sources.

The Clean Power Plan provides states broad flexibility in developing a strategy for achieving the target carbon dioxide emissions. In West Virginia, for example, compliance measures could include improving the efficiency at which coal is burned to generate electricity at existing power plants (heat rate improvements); increased deployment of the region's natural gas resources, such as through new natural gas combined cycle power plants, combined heat and power facilities, and natural gas co-firing or repowering at coal power plants, expanding generation from renewable resources, such as hydropower, wind and solar; and reducing the amount of generation required from fossil fuel-fired power plants through demand-side energy efficiency. This report examines the potential for each of these compliance options for West Virginia.

Applying emission-reduction opportunities to the West Virginia power sector

This report presents two scenarios that incorporate different compliance measures at different levels. The two compliance scenarios—the Existing Sources Scenario and the Existing Plus New Sources Scenario—both demonstrate how various combinations of compliance measures could be used in West Virginia to reduce power sector carbon dioxide emissions. The scenarios are not meant as precise predictions of the future; instead they illustrate how various combinations of measures could enable the state to achieve compliance. The scenarios model effects on generation and emissions only in West Virginia; due to modeling constraints, they do not incorporate regional dispatch, emission trading, or other multi-state considerations for electricity markets or state planning pathways. Still, the scenarios highlight important trends and broad implications regarding decisions that will be made in the coming months and years regarding West Virginia's approach to Clean Power Plan compliance. These trends and implications become most clear when comparing results across scenarios.

The final rule sets emission targets that states must meet over four compliance periods: 2022-2024, 2025-2027, 2028-2029, and 2030 and beyond. West Virginia can choose from various rate-based or mass-based compliance targets; we assume that West Virginia will choose a mass-based approach, as recommended in the West Virginia Department of Environmental Protection's Feasibility Report. Our scenarios are designed to comply with two different mass-based compliance targets. If West Virginia chooses to comply with existing sources only, then new natural gas combined cycle plants will be covered under 111(b), and not under 111(d). West Virginia's target decreases gradually to a final mass-based target of 51,325 thousand short tons. The Existing Sources Scenario illustrates one combination of measures that could enable the state to achieve compliance with these targets. This scenario does not address the issue of "leakage." (As part of compliance with the Clean Power Plan, the Environmental Protection Agency requires mass-based state plans to address the issue of "emissions leakage," which results from the incentives under a mass-based plan to shift generation and emissions to new fossil-fired power plants outside the program.)

Because nearly 1,900 megawatts of new natural gas combined cycle units are expected to come online in West Virginia before 2021, addressing leakage presents a challenge for West Virginia plan compliance. West Virginia can address the leakage issue by including these new plants under Section 111(d) and using the New Source Complement under the Clean Power Plan, which provides a slightly higher mass-based target to accommodate emissions from new sources. In this case, West Virginia's target decreases gradually to a final mass-based target of 51,857 thousand short tons. The Existing Plus New Sources Scenario illustrates one combination of measures could enable the state to achieve compliance with these targets. This scenario directly addresses the issue of leakage.

To model the scenarios, we used the Clean Power Plan Planning Tool version 2.2, which was developed by Synapse Energy Economics, Inc. CP3T is a Microsoft Excel-based, open source spreadsheet tool.

Both scenarios modeled in this report demonstrate combinations of compliance measures that would reduce carbon dioxide emissions to achieve compliance with the Clean Power Plan. While many other compliance scenarios are possible, the scenarios presented here demonstrate how various energy resources can be deployed at different levels to reduce carbon dioxide pollution. Table ES-1 summarizes the measures modeled in each scenario; additional details are provided in Sections 5.1 and 5.2 and in Appendix A.

- **Existing Sources.** This scenario demonstrates how West Virginia could achieve compliance with mass-based compliance targets applied to existing sources only. West Virginia would maintain its role as a major electricity exporter through the use of a mix of generation and demand-side resources. This scenario illustrates how high levels of coal-fired generation can be combined with new natural gas combined cycle plants, modest levels of natural gas co-firing at two coal-fired power plants, and modest levels of new renewable energy and demand-side energy efficiency. This scenario does not address the issue of leakage.
- **Existing Plus New Sources.** This scenario demonstrates how West Virginia could achieve compliance with mass-based compliance targets applied to existing and new sources, thereby directly addressing the issue of leakage. Compared with the Existing Sources Scenario, this scenario includes additional natural gas combined cycle capacity starting in 2030 and additional renewable energy and demand-side energy efficiency starting in 2018. In addition, it includes heat rate improvements at West Virginia's coal-fired power plants. Even with this greater diversification of electricity generation sources, coal-fired generation would remain the main source of electricity generation in West Virginia. But by incorporating many other energy resources, West Virginia could actually generate new jobs, tax revenues, and environmental benefits of developing new energy resources, while maintaining its position as a major electricity exporter.

Table ES-1: Measures modeled in the scenarios

Measure	Existing Sources	Existing Plus New Sources
Improve heat rates at coal-fired power plants	N/A	3% improvement
Increase non-hydropower renewables	2.8% of total generation by 2030	4.4% of total generation by 2030
Improve end-use energy efficiency	Cumulative savings of 5% by 2030	Cumulative savings of 15% by 2030
Hydropower	2.0% of total generation by 2030	2.4% of total generation by 2030
New natural gas combined cycle plants	595 MW in 2018; additional 1,235 MW in 2020	595 MW in 2018; additional 1,235 MW in 2020; additional 245 in 2030
Natural gas co-firing	15% co-firing at two plants—one in 2020 and the other in 2022	15% co-firing at two plants—one in 2020 and the other in 2022
Electricity exports	2012 exports continue through 2030	2012 exports continue through 2030

Figure ES-1: Compliance in the Existing Sources Scenario

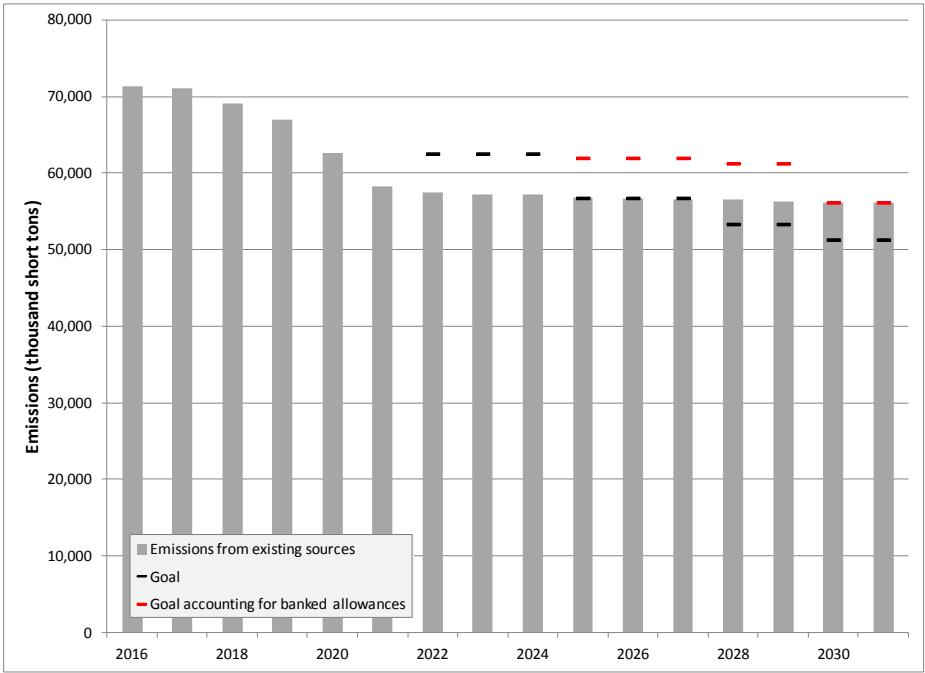


Figure ES-2: Compliance in the Existing Plus New Sources Scenario

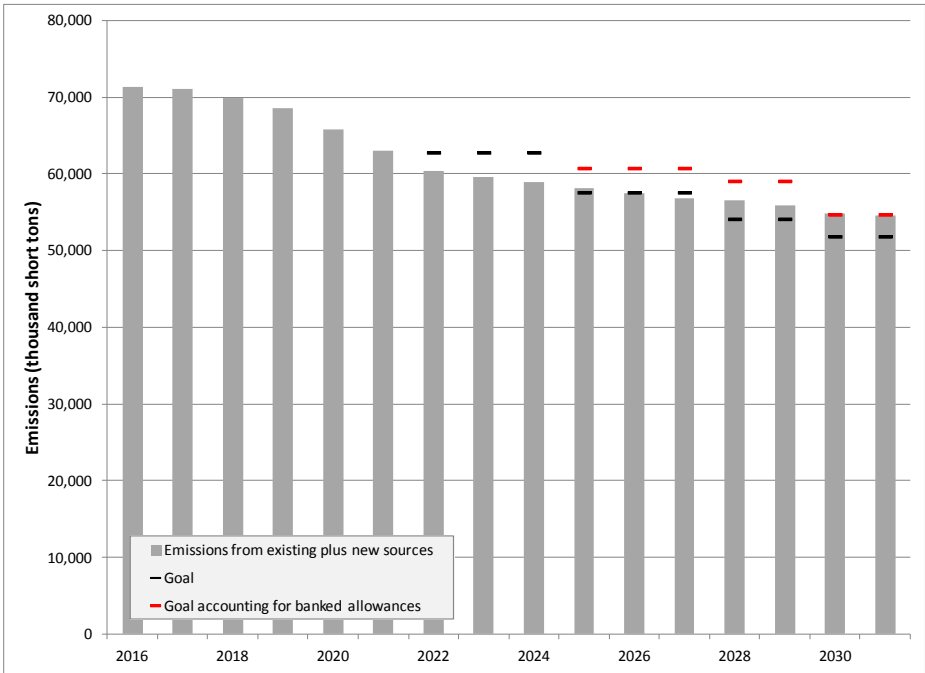


Table ES-2 highlights the resource mix projected under each scenario in 2030. In the Existing Sources Scenario, coal accounts for 77 percent of total load (including energy efficiency), and in the Existing Plus New Sources Scenario, this percentage declines to 67 percent. Most of the remainder is generated by new natural gas combined cycle plants, although energy efficiency and renewables account for an increasing percentage, as compared with current levels.

Table ES-2: Percent of total projected load by resource, 2030

Resource	Existing Sources Scenario	Existing Plus New Sources Scenario
Coal	77%	67%
Natural gas combined cycle	15%	18%
Energy efficiency	3%	8%
Renewables	5%	7%
NGGT and other gases	<1%	<1%

The compliance measures and scenarios presented above offer some insights into how various emission reduction measures could affect the West Virginia power sector in the absence of regional dispatch modeling, emission trading, and other market and Clean Power Plan compliance considerations beyond the scope of this report. This analysis highlights a number of important considerations for West Virginia and offers insights into areas that state lawmakers and regulators could explore further with lawmakers and regulators in other states.

The challenges for West Virginia under the Clean Power Plan are significant, but they are not insurmountable. West Virginia can meet these challenges and help revitalize communities and attract new investments in a more diversified economy through smart policy choices that provide incentives for the deployment of the state's energy efficiency, renewable energy, and natural gas resources to complement its coal resources. Targeted policy changes and a state plan that emphasizes an all-of-the-above energy approach will help West Virginia maintain its position as a major energy exporter; capture the economic, consumer, and environmental benefits of an expanded energy economy; and put the state on track to meet its carbon dioxide pollution limits under the Clean Power Plan.

Policy recommendations

The Clean Power Plan requires states to submit a state plan to the Environmental Protection Agency that, among other things, demonstrate how it will achieve emission performance levels that comply with the emission limits prescribed by the Clean Power Plan. The emission reduction opportunities summarized above are some of the options that West Virginia could evaluate and potentially include in a state plan. Understanding the full interaction of these, and other measures would involve an analysis of complex dispatch, pricing, reliability, environmental compliance (including compliance with carbon dioxide limits), and other considerations and coordination among the West Virginia Department of Environmental Protection and the Public Service Commission, those agencies' counterparts in other states, PJM Interconnection, utilities, independent power producers, and other entities.

Changes in state policies can help West Virginia better capture the emission-reduction opportunities and economic benefits that could result from developing an all-of-the-above energy strategy. The availability of low-cost allowances through emissions trading may enable West Virginia's coal plants to continue operating at existing levels, as discussed in the West Virginia Department of Environmental Protection's Feasibility Report. The modeling of likely scenarios in emissions trading markets also highlights the opportunities available to West Virginia to take advantage of the economic activity that will be generated in a low-carbon economy. West Virginia is currently not well-positioned to take advantage of these opportunities. A number of policy changes are necessary to stimulate the investment in allowance-generating activities

within West Virginia, such as scaled-up energy efficiency programs and accelerated development of renewable resources.

This report offers legislative and regulatory policy recommendations that West Virginia could implement to foster a comprehensive energy strategy to put the state on a path toward compliance with the Clean Power Plan, while at the same time providing consumers reliable electricity services at reasonable costs, growing the state economy, and reducing the impact of energy production and use on the environment. These policy recommendations are to:

1. remove legislative restrictions on state plan development,
2. issue revised integrated resource planning requirements for electric utilities,
3. adopt an Energy Efficiency Resource Standard,
4. adopt a Renewable Energy Portfolio Standard,
5. encourage greater use of the state's natural gas resources,
6. adopt policies that encourage investment in clean distributed generation resources,
7. explore options to partner with neighboring states to develop a multi-state plan with emissions trading, and
8. support integrated regional economic development initiatives.

Conclusions

Achieving compliance with the Clean Power Plan presents a number of challenges for West Virginia. The state's heavy reliance on coal-fired electricity generation and the importance of the coal industry in the state economy mean that West Virginia will bear a disproportionate impact from the rule as less coal is burned at power plants within the state, and as other states that have historically imported West Virginia coal reduce their consumption. Burning less West Virginia coal at power plants—both within West Virginia and around the country—means fewer coal mining jobs and reduced severance tax revenue for the state and municipalities. While these challenges appear stark in the face of carbon pollution mandates, they have persisted in West Virginia for decades and in recent years have grown increasingly more pressing as market forces converged with increasingly stringent environmental regulations. West Virginia is uniquely positioned to adapt to these changes and meet the many challenges facing the Mountain State. While West Virginia power plants must reduce coal consumption to comply with the Clean Power Plan, the state's utilities can at the same time make new investments in other energy resources developed in West Virginia.

Policymakers in West Virginia can mitigate the negative impacts of the Clean Power Plan and take advantage of the opportunities it presents by utilizing the full flexibility provided by the rule to shape a strategy for West Virginia that reflects its unique circumstances and leverages its strengths. West Virginia is fortunate in that it has tremendous energy resources in addition to coal, and these other resources—including natural gas, renewable energy (wind, solar, hydropower), and energy efficiency—are relatively untapped. Implementing the legislative and regulatory policy recommendations in this report would create a climate that promotes new investment in renewable and distributed generation technologies, energy efficiency, and natural gas-fired generation. The availability of emissions trading under the Clean Power Plan provides a relatively low-cost compliance pathway for West Virginia, given the projected supply of emissions allowances from other states that have more low-carbon resources and more aggressive energy efficiency programs than West Virginia. At the same time, the modeling of likely scenarios in emissions trading markets highlights the opportunities available to West Virginia to take advantage of the economic activity that will be generated in a low-carbon economy. By spurring innovation and diversifying the state's electric power sector, Clean Power Plan compliance would reduce carbon pollution and provide West Virginians with energy savings and new economic opportunities.

1. INTRODUCTION

Global climate change is a defining challenge of the 21st Century that requires leadership from the world's largest economies and high levels of cooperation throughout the international community. Without decisive action to significantly reduce global greenhouse gas (GHG) emissions, global temperatures are estimated to rise by as much as 11.5 degrees Fahrenheit by the end of the century (EPA 2015(a)). The effects of rising atmospheric GHG concentrations are already observed in the form of increasing average global temperatures; changes in the patterns and amount of precipitation; increased incidence of severe storms and droughts; reduced ice, snow, and permafrost cover; rising sea levels; increased ocean acidity; and other impacts (EPA 2015(a)). The effects we observe today will continue to intensify as GHG concentrations continue to rise, putting human health, infrastructure, and natural ecosystems at increased risk of even more serious disruption.

In June 2013, President Obama released his Climate Action Plan to cut carbon pollution in the U.S. and lead international efforts to address climate change. The President directed the U.S. Environmental Protection Agency (EPA) to work with states, industry, and other stakeholders to develop carbon dioxide (CO₂) pollution standards for both new and existing power plants pursuant to EPA's authority to regulate air pollutants under the Clean Air Act (CAA).

In January 2014, EPA proposed new source performance standards for CO₂ emissions from new power plants under Section 111(b) of the CAA (EPA 2014(b)). In June 2014, EPA followed the publication of this rule with the publication of the proposed Clean Power Plan to establish CO₂ emission guidelines for existing power plants under Section 111(d) (EPA 2014(a)). Also in June 2014, EPA proposed CO₂ standards for modified and reconstructed power plants under Section 111(b) (EPA 2014(c)). Each of these rules was finalized in August 2015 and was published in the Federal Register in October 2015 (EPA 2015(b)). The rules are the first-ever federal standards for carbon pollution from power plants. They are fundamental to demonstrating U.S. leadership on climate action and essential to U.S. efforts to foster international cooperation to stabilize global GHG emissions.

Later in 2015, the U.S. joined 194 other countries in promising to curb CO₂ and other GHG emissions and to develop other ways to mitigate the impacts and to make communities more resilient to climate change. These proposals, called the "Intended Nationally Determined Contributions," were submitted to the United Nations prior to negotiations leading up to the Paris Agreement in December 2015. The U.S. committed to reduce its GHG gas emissions by 26-28 percent below the 2005 level in 2025, and to make "best efforts" to reduce emissions by 28 percent. That would include curbs on CO₂, methane, nitrous oxide, perfluorocarbons, sulfur hexafluoride, and nitrogen trifluoride, all of which contribute to global warming.

The Clean Power Plan sets state-specific standards that would result in a 32 percent reduction of CO₂ pollution from power plants in the U.S. by 2030, as compared with 2005 levels (EPA 2015(e)). The rule provides states flexibility in the design and implementation of state plans and broad discretion in selecting pollution-reduction measures and market-based mechanisms to achieve the required reductions. The costs and potential of different measures and state plan pathways to meet the reduction requirements will vary by state, given each state's current infrastructure, resource strengths and constraints, energy policy frameworks, and other considerations. The Clean Power Plan does not dictate which measures states must use or the level of reduction any particular compliance measure must achieve. The flexibility built into the rule means that states have latitude to develop tailored strategies that allow them to take advantage of the emission-reduction technologies and pathways that make the most sense to individual states. This approach recognizes that each state is in the best position to identify emission-reduction strategies that best fit that state's resource mix and electric power market structure, thereby facilitating the development of compliance strategies that further other state policy objectives.

While the Clean Power Plan provides states broad discretion in developing CO₂ pollution-reduction strategies, it also poses important challenges—particularly for states that have traditionally depended upon coal for electric generation and coal mining for economic development. Because coal-fired power plants emit over twice the CO₂ pollution as natural gas-fired power plants and are responsible for nearly 80 percent of total power sector CO₂ emissions, coal plants will shoulder the largest share of the pollution-reduction responsibility (EPA 2015(d)). This is a critical fact for West Virginia because, as recently as 2012, coal was burned at 16 major power plants within the state. In 2013, coal fueled approximately 95 percent of the electricity produced in West Virginia. Almost three-fifths of that electricity is exported to surrounding states. West Virginia is also the second-largest coal-producing state in the country, supplying coal to other parts of the U.S. and abroad. Local communities rely on jobs provided by coal mining and its support industries, and state, county, and municipal budgets rely on funds provided by coal severance taxes. Limiting the amount of CO₂ pollution emitted from power plants will result in reduced reliance on coal-fired power plants in West Virginia and across the country, which will reduce demand for West Virginia coal.

In this report, we review the Clean Power Plan and some of the flexible compliance options available to states; summarize historic and recent trends in the West Virginia energy sector; and identify emission-reduction opportunities related to energy efficiency, renewable energy, coal-fired power plants, and expanded use of the state’s natural gas resources. We then present results from modeling scenarios that demonstrate the feasibility of meeting West Virginia’s Clean Power Plan obligations. Finally, we offer policy recommendations that would help put West Virginia on track to meet carbon pollution standards while further expanding the state’s energy sector, promoting economic growth, creating new job opportunities, and providing energy savings to consumers.

2. THE CLEAN POWER PLAN: REGULATION OF CARBON POLLUTION FROM EXISTING POWER PLANTS

2.1 Clean Power Plan basics

Under Section 111(d) of the CAA, EPA determines the best system of emission reduction (BSER) that has been demonstrated for a particular pollutant (in this case, CO₂) and a particular group of sources (in this case, electric generating units, or EGUs) by examining technologies and measures already being used. In the final Clean Power Plan, EPA determined that BSER consisted of three “building blocks:”

- **Building Block 1:** Reducing the carbon intensity of electricity generation by improving the heat rate of existing coal-fired power plants.
- **Building Block 2:** Substituting increased electricity generation from lower-emitting natural gas plants for reduced generation from higher-emitting coal-fired power plants.
- **Building Block 3:** Substituting increased electricity generation from new zero-emitting renewable energy sources (e.g., wind and solar) for reduced generation from existing coal-fired power plants.

EPA stated that, in determining the BSER, it considered the ranges of reductions that can be achieved at coal, oil, and gas plants at a reasonable cost by application of each building block, taking into account how quickly and to what extent the measures encompassed by the building blocks could be used to reduce emissions.

EPA applied the building blocks to all coal plants and all natural gas power plants in each of the three established regional electricity interconnects to produce regional emission performance rates for each category which, in turn, were used to determine CO₂ emission performance rates for the country that represent the BSER. The same CO₂ emission performance rates were then applied to all affected sources in each state to determine state-specific CO₂ emission guidelines expressed in the form of an emission rate—pounds of CO₂ per megawatt-hour (lbs/MWh) of net electricity produced.

EPA then established each state’s pollution reduction targets based on the portfolio of carbon-emitting resources within the respective states. All state goals fall within a range of 771 lbs/MWh (for those states that have only natural gas-fired power plants) to 1,305 lbs/MWh (for those that have only coal or oil plants) (EPA 2016). Each state’s goal is based upon the mix of these two types of plants within that state. Because West Virginia has only coal-fired generation and no existing natural gas-fired baseload generation, the state target of 1,305 lbs/MWh is at the highest end of the range. In other words, compared to other state goals under the Clean Power Plan, West Virginia has the least stringent state goal in terms of lbs/MWh. With respect to the level of emissions reductions, however, the target represents a significant challenge: West Virginia’s Clean Power Plan obligations require emissions reductions from a rate of 2,064 pounds per MWh in 2012¹ to 1,305 lbs/MWh in 2030—a 37 percent reduction (EPA 2015(c)).

The final rule also translates rate-based limits into mass-based limits (total CO₂ emissions in short tons). Under a mass-based standard, West Virginia would be required to reduce CO₂ emissions from 72,319 thousand short tons in 2012 to 51,325 thousand short tons by 2030 if only existing sources are considered. If both existing and new sources are considered, emissions would need to be reduced to 51,857 thousand short tons. Rate- and mass-based performance standards are discussed further in Section 2.2.

¹ The Clean Power Plan uses 2012 as the comparison year for compliance.

States must meet their emission reduction obligations over two compliance periods—an interim period (2022-2029) and a final compliance period (2030 and beyond). The interim compliance period is further divided into three “step” periods: 2022 through 2024, 2025 through 2027, and 2028 through 2029. The final compliance period would require states to meet a final limit by 2030 and maintain (or further reduce) that level of emissions thereafter (EPA 2015(e)).²

Table 1: West Virginia state goals (thousand short tons)

	2022-2024	2025-2027	2028-2029	Interim	Final
Existing sources only	62,557	56,763	53,353	58,083	51,325
Existing plus new sources	62,804	57,597	54,141	58,686	51,857

Source: EPA 2015(c).

Each state is required to develop a state plan that demonstrates how the state will meet its emission targets during the prescribed compliance periods. States may choose between two plan types to meet their goals:

- **Emissions Standards Plan:** This would include source-specific requirements that ensure all affected EGUs within the state meet their required emissions performance rates or a state-specific rate-based or mass-based goal.
- **State Measures Plan:** This would include state-level policies, such as renewable energy standards and programs to improve end-use energy efficiency, that are not included as federally enforceable components of the plan. The state measures, alone or in conjunction with federally enforceable requirements, must result in affected EGUs meeting the state’s goal. A backstop of federally enforceable standards on affected EGUs is required to be included, which would be triggered in the event the state measures fail to result in the affected EGUs achieving the required emissions reductions on schedule. Given the absence of state policies in West Virginia that would result in achieving the levels of CO₂ reductions required under the Clean Power Plan, the State Measures pathway will not be discussed as a viable compliance option for West Virginia in this report. Section 6 presents a number of policy recommendations that would result in a package of state measures that may make this compliance approach feasible in the future, but it does not warrant serious consideration as a compliance strategy given the current state of play in West Virginia.

State plans are discussed further in Section 2.3 of this chapter.

The Clean Power Plan recognizes that states are in the best position to determine how to meet emission limits and allows states significant flexibility in developing state plans. West Virginia has many compliance measures that can be deployed to achieve its required reductions, including improving the heat rate at existing coal plants; developing new wind, solar, and hydropower resources; increasing end-use energy efficiency savings; and integrating more natural gas–fueled resources into the state’s energy mix. The Clean Power Plan also provides states the option to develop state plans based on rate- or mass-based performance standards, the option of working in partnership with other states to coordinate the development of single-state plans or to develop multi-state plans, and the flexibility to incorporate emission trading and other market-based mechanisms as part of a compliance strategy (EPA 2015(e)).

² States selecting a mass-based performance regime would have until 2032 to meet the final compliance period limit. Under the mass-based regime, compliance is measured using three-year rolling averages.

2.2 Rate- and mass-based performance standards

The Clean Power Plan expresses each state's emission limit in the form of an emission rate. The rate is calculated by dividing the total amount of CO₂ released from fossil power plants in the state by the amount of electricity generated (from fossil and non-fossil generation resources, as well as the amount of generation avoided as a result of new end-use energy efficiency). Compliance with a rate-based standard ensures that the emission intensity of a state's electric power sector does not exceed the rate prescribed in the rule. Importantly, compliance with the rate-based standard does not necessarily require a reduction in total CO₂ emissions; rather, it requires a reduction in CO₂ emission rate, or intensity. In West Virginia, compliance with a rate-based standard could entail reducing generation from higher-emitting coal plants and substituting that generation with lower or non-emitting resources such as natural gas, renewable energy, or energy efficiency.

While the emission targets are in the form of a rate, the final Clean Power Plan translates each state's rates into masses and provides states the option to comply with these mass-based emission targets (EPA 2016). A mass-based limit is expressed in terms of a total tons of CO₂ emitted from the state's affected EGUs.³ Compliance with a mass-based standard ensures that the total amount of CO₂ emitted from a state's electric sector does not exceed the prescribed limit, or cap. Importantly, and in contrast with a rate-based standard, a mass-based standard provides an upper limit on total allowable emissions, regardless of whether those emissions are generated by lower- or higher-rate sources. Compliance with a mass-based standard is achieved by reducing the amount of CO₂ emitted from affected EGUs. In West Virginia, compliance with a mass-based standard could entail reducing generation from coal plants, or a combination of reduced generation from coal plants with increased generation from natural gas and renewable energy in addition to avoided generation from energy efficiency. Some potential combinations of measures that could lead to compliance under a mass-based standard are described in greater detail in Chapter 5.

EPA requires that mass-based state plans address the issue of "emissions leakage," which results from the incentives under a mass-based plan to shift generation and emissions to new fossil-fired power plants outside the program. According to the final rule,

"mass-based implementation in a state plan can unintentionally incentivize increased generation from unaffected new EGUs as a substitute action for reducing emissions at units subject to the existing source mass goal in ways that would negate the implementation of the BSER and would result in increased emissions." (EPA 2015(e), 64823)

In addition to the problem of increased emissions, there is an issue of equity: affected EGUs within the program would be burdened with the cost of allowances necessary to match their level of CO₂ emissions, while generation from unaffected new EGUs would not be required to bear those costs. These unaffected new EGUs are likely to be new natural gas combined cycle (NGCC) plants. In order to ensure that the standards of performance applied to the affected EGUs are, in the aggregate, at least equivalent with the rate-based emissions performance rates, states are required to address leakage if they use a mass-based approach in their state plans.

As will be discussed later in this report, nearly 1,900 megawatts (MW) of new NGCC units are expected to come online in West Virginia before 2021, and thus addressing leakage presents a challenge for West Virginia plan compliance. Although these new power plants will be required to comply with the emissions performance standards adopted by EPA under Section 111(b) of the CAA and will assuredly achieve compliance with these standards, such compliance does not address the leakage issue. These highly efficient NGCC units can be expected to operate at a fairly high capacity factor and, although natural gas-fired units

³ Power plants covered by the rules are referred to as affected EGUs, and the terms "power plant" and "EGU" are used interchangeably in this report. EPA defines an affected EGU as a stationary combustion turbine, steam generating turbine unit, or integrated gasification combustion turbine that is (1) capable of combusting more than 250 MMBtu/MWh heat input of fossil fuel and (2) constructed for the purpose of supplying one-third or more of its potential net electric output capacity and more than 219,000 MWh to any utility distribution system. See EPA 2015(f).

emit about one half of the CO₂ per MWh as coal-fired units, they can be expected to contribute to aggregate CO₂ emissions that will exceed the mass-based target for West Virginia. The most straightforward approach to address leakage is to adopt the “existing plus new” source mass limits—or new source complement (NSC)—which is an option available to the states under the Clean Power Plan.⁴ Under the NSC option, new sources would be covered under the state plan in the same manner as existing sources, and would be required to have sufficient allowances to cover their CO₂ emissions. (This would address the equity issue described above: new NGCC units would bear allowance costs in the same manner as existing EGUs.) According to PJM’s preliminary analyses, regulating new 111(b) resources under the NSC approach reduces CO₂ emissions more than any other compliance pathway, although resulting in slightly higher wholesale electric prices and emissions compliance costs (PJM 2016(a)). In the final rule, EPA specified a new source CO₂ complement for each state—essentially an allotment of additional allowances to encourage states to address leakage through the NSC approach. For West Virginia, the NSC is an additional 531,966 short tons of CO₂, thereby increasing the mass goal by 1 percent, to 51,857,307 short tons of CO₂. (EPA 2015(c))

As discussed Chapter 3, a significant amount of coal-fired generating capacity in West Virginia has recently retired. Any CO₂ reductions resulting from these retirements are an element to be considered in meeting the required reductions for West Virginia under the Clean Power Plan. The possibility of these retirements resulting in emission reductions that are sustained through the compliance periods depends on a number of factors, including wholesale electric market conditions, whether West Virginia adopts rate- or mass-based standards, and whether that retired generation is replaced with cleaner energy resources or by increased utilization of remaining coal plants in West Virginia or by other resources outside of West Virginia.

2.3 Multi-state planning and coordination; the role of emissions trading

Section 111(d) of the CAA requires each state to develop a state plan that demonstrates how the state will meet its carbon pollution reduction requirements under the Clean Power Plan. Under the final rule, states were required to submit a final plan, or an initial submittal with an extension request, by September 6, 2016. With an extension, final complete state plans were required to be submitted no later than September 6, 2018. As discussed in the next section, however, the U.S. Supreme Court on February 9, 2016 issued a stay of Clean Power Plan implementation, until such time as judicial review of the final rule is complete. In the event the Clean Power Plan is upheld, these deadlines will likely be extended by a period of time corresponding to the duration of the stay.

If EPA approves a state plan, the plan becomes a federally enforceable obligation under the CAA. If EPA rejects a state plan, or if a state does not submit a state plan, EPA may impose a federal plan for that state. As noted earlier, the proposed federal plan was issued by EPA for comment on August 3, 2015, and was published in the Federal Register on October 23, 2015 (EPA 2015(b)).

The West Virginia Department of Environmental Protection (DEP) is responsible for developing and submitting West Virginia’s state plan, but the participation of other state agencies, such as the Public Service Commission (PSC) and the Division of Energy, is central to the state’s ability to effectively assess compliance options and work with surrounding states, PJM Interconnection (PJM),⁵ utilities, and other stakeholders.

The state plan process includes assessing short- and long-term energy needs and resource availability; the cost and availability of various measures to reduce emissions under the Clean Power Plan; and state policies and regulations to determine if changes can or need to be made to facilitate the deployment of compliance measures needed for that state. The state plan process provides a framework within which states can examine how different combinations of resources and measures could achieve rate-

⁴ “If a state adopts an EPA-provided mass budget that includes the state mass-based CO₂ goal for affected EGUs plus a new source CO₂ emissions complement, this option could be presumptively approvable.” EPA 2015(e), 64888.

⁵ PJM is the regional transmission organization that 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 2015(d)).

or mass-based performance standards, and the possible role of emissions trading to achieve compliance with the Clean Power Plan. As noted above, the CO₂ emissions rates of each of West Virginia's coal-fired power plants far exceed the 1,305 lbs/MWh emissions rate standard under a rate-based approach; without carbon capture and sequestration, coal plants are incapable of meeting that level of emissions performance. In order to achieve compliance under a rate-based approach, the Clean Power Plan contemplates a system of emissions trading whereby a unit with a noncompliant, higher emissions rate would need to purchase emission rate credits (ERCs) in the amount necessary to cover such excess emissions. ERCs are generated by zero- or low-carbon sources of generation (such as renewable sources or natural gas-fired generation that outperforms the emissions performance requirement) or energy efficiency. These ERCs essentially allow the noncompliant unit to adjust its emissions rate to achieve compliance.

Similarly, using a mass-based approach, an EGU can achieve compliance through the purchase of emissions allowances through an emissions trading program, which would take advantage of allowances made available through zero- or low-carbon generating sources or energy efficiency programs. The Clean Power Plan allows the trading of ERCs (in the case of rate-based standards) or allowances (in the case of mass-based standards) within a single state, on a multi-state or regional approach, or nationally, as determined by each state in its compliance plan. A limiting factor is that trading is not permitted between a mass-based state and a rate-based state. Section 5.4 below includes a further discussion of the emissions trading approaches contemplated by the Clean Power Plan—and the implications for West Virginia.

Thus, each state in its compliance plan must decide whether (1) it will choose to comply on a rate-based or mass-based approach, and (2) the extent to which it will allow trading of ERCs or allowances (i.e., in-state, regionally, or nationally). As discussed further in Section 5.4, the DEP Feasibility Report modeled four primary potential state compliance pathways under the Clean Power Plan. It concluded that a mass-based state plan with national trading of allowances would be the preferred approach for West Virginia in terms of minimizing the impact on coal-fired generation and the broader impacts on the state's economy (DEP 2016).

The following chapters offer insights into how West Virginia's abundant energy resources can help the state meet its Clean Power Plan obligations. The state's lawmakers, regulators, and stakeholders can build upon the analysis and results presented in this report to further evaluate West Virginia's options for meeting its Clean Power Plan obligations. Additional analyses might include the effect of multi-state compliance planning and regional emission trading mechanisms on projected electricity demand from West Virginia coal plants or the effect of meeting higher end-use energy efficiency targets in West Virginia on insulating consumers from projected electricity price increases that could result under various compliance scenarios. By taking advantage of the broad flexibility provided under the Clean Power Plan, and by coordinating with other states, West Virginia can find cost-effective compliance solutions that serve the dual purpose of expanding other sectors of the state's energy economy and promoting new opportunities for economic growth.

2.4 Legal challenges to the Clean Power Plan

Following the publication of the Clean Power Plan in the Federal Register on October 23, 2015, West Virginia and 27 other states sought judicial review in the D.C. Circuit Court of Appeals on October 27, 2015. Petitioners also sought a stay of implementation of the Clean Power Plan, pending the outcome of the legal challenges. On January 21, 2016, the D.C. Circuit Court of Appeals denied the motion for a stay. On January 26, 2016, Petitioners filed their request for a stay with the U.S. Supreme Court. On February 9, 2016, the U.S. Supreme Court granted the requested stay, on a 5-4 vote, with Justice Antonin Scalia part of the five-justice majority. Four days later, Justice Scalia passed away. The impact of the stay is to suspend the implementation schedule of the Clean Power Plan which, as noted earlier, otherwise required states to submit either a state plan to comply, or obtain a two-year extension, by September 6, 2016.

Thereafter, the D.C. Circuit Court of Appeals ordered an expedited briefing schedule, and set oral arguments for June 2-3, 2016, before a three-judge panel. Shortly before oral arguments, however, the D.C. Circuit Court of Appeals canceled oral argument and rescheduled it for September 27, 2016 before a nine-judge *en banc* panel. Given the schedule for oral argument, the almost-certain appeal therefrom will not reach the U.S. Supreme Court until sometime in mid-2017. Although President Obama has nominated Judge Merrick Garland from the D.C. Circuit Court of Appeals for the vacant seat on the Supreme Court, U.S. Senate leaders have indicated that confirmation hearings will not be scheduled prior to the November 2016 elections. In the event of a 4-4 decision at the U.S. Supreme Court, the appellate decision remains in effect, thereby increasing the significance of the *en banc* decision of the D.C. Circuit Court of Appeals, expected late in 2016 or early in 2017.

2.5 Relevant regulatory developments in West Virginia

During the 2015 legislative session, the West Virginia Legislature enacted House Bill (HB) 2004, codified at West Virginia Code § 22-5-20, which included a number of provisions associated with Clean Power Plan implementation in West Virginia. Among other things, HB 2004 requires prior legislative approval before filing any West Virginia compliance plan with the EPA. HB 2004 also directed the West Virginia DEP to prepare a feasibility study regarding the state's ability to comply with the Clean Power Plan, and to submit this study to the Legislature no later than 180 days following finalization of the federal rule. As noted above, the Clean Power Plan was published in the Federal Register on October 23, 2015. In compliance with HB 2004, the West Virginia DEP submitted its feasibility study to the Legislature on April 20, 2016 (DEP 2016).

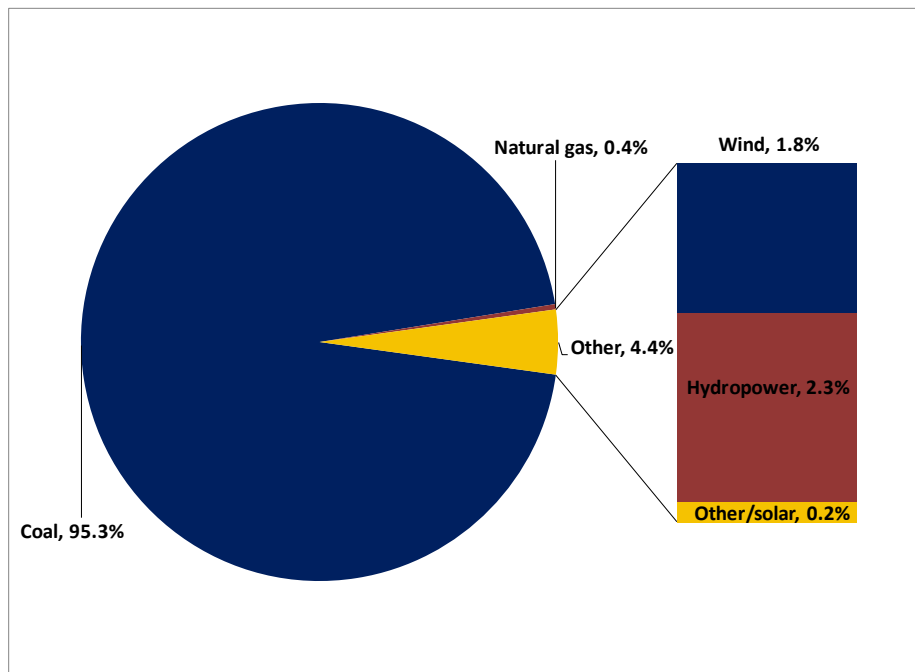
In addition to requiring legislative approval of any state compliance plan and directing the preparation of a feasibility study, HB 2004 contains substantive provisions that affect the scope of the compliance strategies that the DEP may deploy in preparing a state compliance plan. These limitations are discussed in Section 6.1 below. The DEP's Feasibility Report also makes a number of recommendations regarding West Virginia's compliance strategy, which are referenced throughout this report. Finally, the Feasibility Report includes a number of findings regarding the possible role of interstate emissions trading as part of West Virginia's compliance strategy, which are discussed in Section 5.4 below.

3. THE WEST VIRGINIA ENERGY ECONOMY

West Virginia is the fifth-largest energy-producing state in the country, and energy production is a cornerstone of the West Virginia economy (EIA, 2015(a)).⁶ West Virginia is the second-largest coal-producing state in the country and the ninth-largest natural gas producer (EIA 2015(a)). The mining sector accounted for 17.8 percent of the West Virginia's total gross domestic product in 2013, meaning that West Virginia derived a larger percentage of gross domestic product from mining than any other state except Wyoming and Alaska (EIA 2014(a)). In addition to its mineral resource base, West Virginia is a major electricity producer, exporting nearly 60 percent of its annual electricity generation (EIA 2015(a)). West Virginia also has abundant renewable energy resources and has yet to tap into its end-use energy efficiency potential.

Longstanding energy policies that support the development and use of coal have created an electric power sector that is nearly exclusively dependent upon that fuel (See Figure 1). While coal will remain an important element of the state's energy economy for decades to come, the social, economic, and environmental costs of coal dependence puts West Virginia at a competitive disadvantage as the national economy shifts to cleaner, more flexible, and lower-cost energy resources. West Virginia's diverse energy resource base means, however, that it is uniquely positioned to adapt to these changes. In doing so, West Virginia can expand its energy economy, provide new economic opportunities to West Virginians, and meet environmental standards. This chapter reviews West Virginia's electric power sector and coal and natural gas industries.

Figure 1: Electricity generation by source in West Virginia, 2013



Source: EIA 2015(k).

⁶ EIA ranks states based on total energy production measured in British thermal units.

3.1 The West Virginia power sector

The electric power sector in the U.S. is a highly regulated industry with primary oversight provided on the state level by the PSC and on the federal level by the Federal Energy Regulatory Commission (FERC). In West Virginia, electric distribution utilities can also own electric generating resources.⁷ A utility that owns both the distribution and generation assets is referred to as a vertically integrated utility. The PSC in West Virginia determines electric customer rates based on cost-of-service regulations. When a utility invests capital to serve its customers, the cost of providing that service is recovered in the electric rates charged to customers by the utility. For vertically integrated utilities, the cost of procuring electric generation, including ownership of generation assets, is part of the cost of service reflected in electric rates.

West Virginia electric customers are served by six utilities—Appalachian Power Company and Wheeling Power Company (both of which are subsidiaries of American Electric Power, or AEP); Monongahela Power (MonPower) and Potomac Edison (both of which are subsidiaries of FirstEnergy); Black Diamond Power Company; and the Harrison Rural Electrification Association. The AEP and FirstEnergy utilities are members of PJM, the regional transmission organization that coordinates the movement of wholesale electricity in 13 states and Washington D.C. (PJM 2015(c)).

Sixteen coal plants operated in West Virginia in 2012, generating approximately 95 percent of the electricity produced in the state. Hydropower and wind generated the majority of the remaining 4 percent (See Figure 1). While coal plants in West Virginia accounted for only 4.4 percent of total load in PJM in 2012, West Virginia coal output accounted for 20 percent of PJM's total coal output (PJM 2015(b)). West Virginia's coal plants are aging, however, and six of the plants that operated in 2012 have since deactivated—representing a loss of approximately 17 percent of the state's total generating capacity (PJM 2015(a)) (See Table 2). The retiring plants have operated for an average of 60 years and have reached the end of their useful life, absent significant upgrade or retrofit investments.

Table 2: Recent coal plant retirements in West Virginia

Plant	Nameplate capacity (MW)	Deactivation date	2012 CO ₂ emissions rate (lbs/MWh)
Albright	278	September 2012	2,462
Rivesville	110	September 2012	N/A
Willow Island	213	September 2012	3,724
Phillip Sporn	1,105	Unit 5: February 2012. Units 1-4: June 2015	2,200
Kammer	713	June 2015	2,113
Kanawha River	439	June 2015	2,277
Total	2,858		

Sources: PJM 2015(a) and the CP3T model.

West Virginia is one of the few states east of the Mississippi with no nuclear or NGCC plants. Historically, West Virginia's utilities have produced inexpensive electricity from coal plants, providing consumers in West Virginia and in surrounding states with some of the lowest electricity rates in the country. Low electricity rates, however, do not necessarily translate to low electricity bills. In 2013, average residential electric rates in West Virginia were 9.52 cents per kilowatt-hour (cents/kWh), and consumers' average monthly electricity bill was \$106.44. By contrast, average residential electric rates in California for 2013 were 16.19 cents/kWh, but consumers' average monthly electric bill was \$90.19 (EIA 2015(f)). On a national basis, West Virginia falls in the lower half of all states when ranked from lowest to highest electricity bills, and West Virginia is among the top ten states in the country with respect to residential electricity expenditures as a percent of median income (ACEEE 2013).

⁷ Generating units not owned by utilities are referred to as merchant generating plants.

Rising coal costs, reduced demand, environmental regulation, and increasingly cost-competitive alternatives are affecting the economics of existing coal-fired generation. The market share of coal in the national electric power sector declined from 50 percent in 2005 to 39 percent in 2013 (EIA 2015(b); EIA 2014(b)). The Energy Information Administration (EIA) projects that coal-fired generation will continue to decline as a percentage of total U.S. generation under the Clean Power Plan (EIA 2015(i)). Despite increasingly unfavorable market conditions for coal-fired power plants, Appalachian Power Company and Wheeling Power Company recently purchased shares of the Amos and Mitchell power stations, respectively, from affiliates in the AEP holding company structure, and FirstEnergy similarly sold 80 percent of its interest in the Harrison power station to MonPower, its operating company in West Virginia (PSC 2013). The decisions by AEP and FirstEnergy to transfer these former merchant generating plants to their West Virginia rate-regulated subsidiaries shifts the economic risk of these plants' future viability from private investors to West Virginia ratepayers.

Rising electricity rates can be mitigated through energy management programs, such as demand-side energy efficiency. As noted above, California's electricity rates are 70 percent higher than rates paid by consumers in West Virginia, yet consumers in California pay on average over \$16 less per month than consumers in West Virginia. One major factor in this difference is that California ranks second in the country in energy efficiency; by contrast, West Virginia ranks forty-fifth (ACEEE 2015(b)). Not only do electric utilities in West Virginia provide much lower levels of energy efficiency than utilities in California; West Virginia utilities also provide significantly lower levels than their affiliated utilities in neighboring states.

AEP affiliates in West Virginia achieved energy efficiency savings of 0.13 percent, 0.31 percent, 0.30 percent, and 0.34 percent from 2011 to 2014, respectively (Kunkel, 2015). Appalachian Power, AEP's largest subsidiary in West Virginia, plans to increase demand-side resources, including energy efficiency, from 2.9 percent to 4.1 percent of nameplate capacity mix by 2026 (PSC 2015(a)). Meanwhile, its subsidiaries in neighboring Ohio are required to meet energy efficiency savings of 22 percent by 2027 (DSIRE 2015(a)). FirstEnergy affiliates in West Virginia have an energy efficiency savings target of 0.1 percent per year from 2013 to 2018 to achieve a cumulative savings of 0.5 percent over a five-year period (PSC 2013). By contrast, its subsidiaries in neighboring Pennsylvania achieved an average savings of 3.3 percent from 2009 to 2013 and are required to meet a cumulative energy efficiency savings of between 4.6 percent and 5.3 percent of 2010 sales by 2016 (DSIRE 2015(b)).⁸

Similar to West Virginia's virtually untapped energy efficiency potential, renewable energy resources accounted for only 4 percent of total electric generation in West Virginia in 2013. The integration of these resources, with additional natural gas-fired generation, would provide greater resource diversity in the state's electric power sector and support a broad-based energy production economy throughout the state. The renewable energy resource potential in the West Virginia power sector is discussed further in Chapter 4.

3.2 The West Virginia coal industry

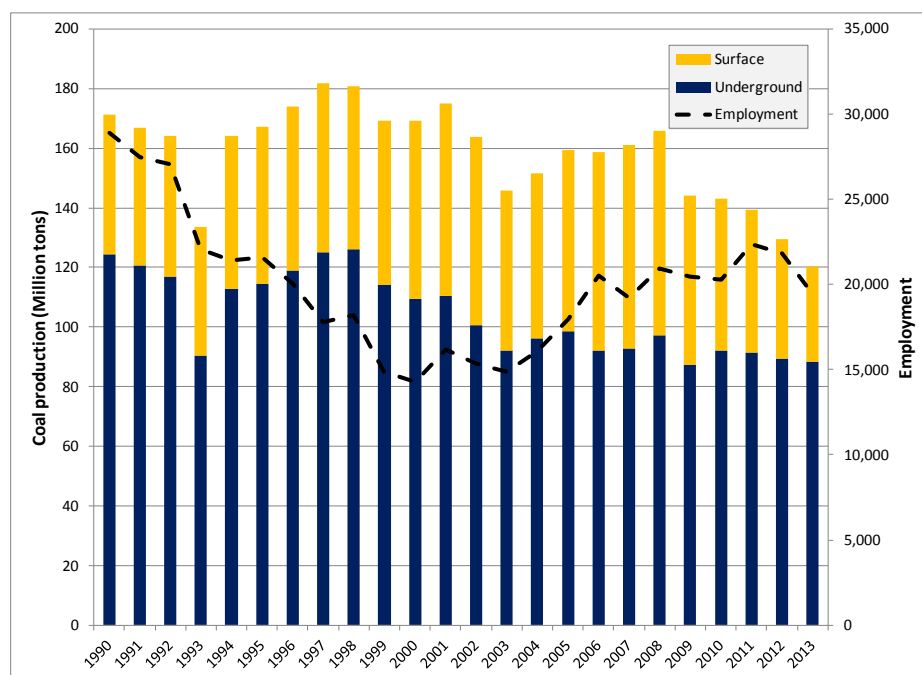
West Virginia coal mines have operated since the mid-19th century and currently ship coal to over 20 states and abroad (EIA 2015(c)). For over a century and a half, the vast coal reserves of West Virginia, and Appalachia, have fueled power plants across the country. Today, coal is West Virginia's leading export and contributes hundreds of millions of dollars in direct revenue to the state economy.

West Virginia is the largest coal-producing state east of the Mississippi, but coal mining in the state has entered a period of dramatic decline, particularly in southern West Virginia (See Figure 2). Fewer and fewer West Virginians work in the state's coal mines as mechanization replaces the need for human labor,

⁸ The FirstEnergy utilities operating in Pennsylvania with savings targets in parentheses are: Met-Ed (5.3 percent), West Penn (4.6 percent), Penelec (5.2 percent), and Penn Power (5.0 percent). Targets are the combined Act 129 Phase I and Phase II requirements for each utility. The annual sales period is measured from June to May. Phase I began in June 2009, and Phase II concluded in May 2016. See Penn PUC 2015.

the most economic coal seams reach the end of their productive life, other energy sources—such as natural gas and renewable energy—become more cost-competitive, growth in demand for electricity remains low, and increasingly stringent regulations cause coal companies and power generators to internalize more of the health and environmental costs of coal production and coal-fired electric generation (McIlmoil and Hansen 2010; McIlmoil et al. 2013).⁹

Figure 2: West Virginia coal production and employment, 1990-2013



Source: West Virginia Office of Miners' Health Safety and Training 2015.

Coal production costs are a significant factor impacting the West Virginia coal-mining sector, particularly in southern West Virginia, which falls within the Central Appalachian coal basin. While Central Appalachian coal is characterized by its low sulfur content, the installation of scrubber technologies at more and more coal plants across the country has meant that these plants could burn higher-sulfur coal from other regions, such as the Northern Appalachian and Eastern Interior coal basins, and still meet air emission standards (Lego 2015). This partly explains more recent declines in coal production in southern West Virginia.

In recent years, West Virginia coal miners have lost their jobs, and coal companies have declared bankruptcy. In the first month of 2016, over 1,800 coal miners were laid off in West Virginia (Lawrence 2016). In April, Peabody Energy Corporation, the largest coal producer in the U.S., followed Arch Coal Inc., Alpha Natural Resources, Patriot Coal Corporation, and others in filing for bankruptcy (Miller 2016). In the future, West Virginia coal production is projected to continue to fall (Lego and Deskins 2016).

Electric generators accounted for 93 percent of all coal consumed for energy in the U.S. in 2013. Industrial and commercial end users accounted for the majority of the remaining 7 percent (EIA 2014(f)).

⁹ In addition to the recently proposed Clean Power Plan and new source performance standards for power plant CO₂ emissions, other recent EPA regulations that impact coal-fired power plants include: The Water Intake Structures Rule: National Pollutant Discharge Elimination System—Final Regulations To Establish Requirements for Cooling Water Intake Structures at Existing Facilities and Amend Requirements at Phase I Facilities, Final Rule 79 Fed. Reg. 48300 (Aug. 15, 2014); The Mercury Air Toxics Standards Rule: National Emission Standards for Hazardous Air Pollutants From Coal and Oil-Fired Electric Utility Steam Generating Units and Standards of Performance for Fossil-Fuel-Fired Electric Utility, Industrial-Commercial- Institutional, and Small Industrial- Commercial-Institutional Steam Generating Units, Final Rule 77 Fed. Reg. 9304 (Feb. 16, 2012); and The Cross State Air Pollution Rule: Rulemaking To Amend Dates in Federal Implementation Plans Addressing Interstate Transport of Ozone and Fine Particulate Matter, Interim Rule 71 Fed. Reg. 71663 (Dec. 3, 2014).

Actions by electric utilities to increase their use of other fuels, such as natural gas and renewable resources, have contributed to the decline in power sector demand for coal. Indeed, domestic electric power sector consumption of West Virginia coal has declined dramatically in recent years from just under 120 million short tons in 2007 to just over 54 million short tons in 2014 (EIA 2015(d)). Similarly, West Virginia's coal exports to other counties have declined in recent years as well (Lego 2015). These trends are likely to continue, particularly in domestic markets, as utilities that historically imported significant amounts of West Virginia coal continue their transition to cleaner, more cost-competitive resources.

For instance, North Carolina, which imports more coal than any other state except Texas—and which is the second-largest importer of West Virginia coal—reduced its coal consumption as a percentage of total electricity generation from 61 percent in 2008 to 44 percent by 2012 (EIA 2015(c)). During that same period, North Carolina utilities increased their use of natural gas for electric generation from 3 percent to 17 percent (Union of Concerned Scientists 2014). Renewable generation in North Carolina is also growing rapidly and displacing coal-fired generation. In 2014, 397 MW of solar capacity was installed in North Carolina, bringing total installed solar capacity to over 1,000 MW statewide (SEIA 2015(a)).

In addition to the employment and electricity generated from coal, West Virginia depends on coal production for severance tax revenue. Severance tax revenue (from all sources) accounted for 9 percent of total state taxes in fiscal year (FY) 2010—the seventh-highest percentage of any state (O'Leary 2011). While coal mining is still responsible for the majority of severance taxes collected by the state—63 percent in FY 2014—this percentage has declined significantly from previous years. From FY 2010-2013, coal provided no less than 81 percent of severance tax revenue collections in any year (Federation of Tax Administrators 2015).

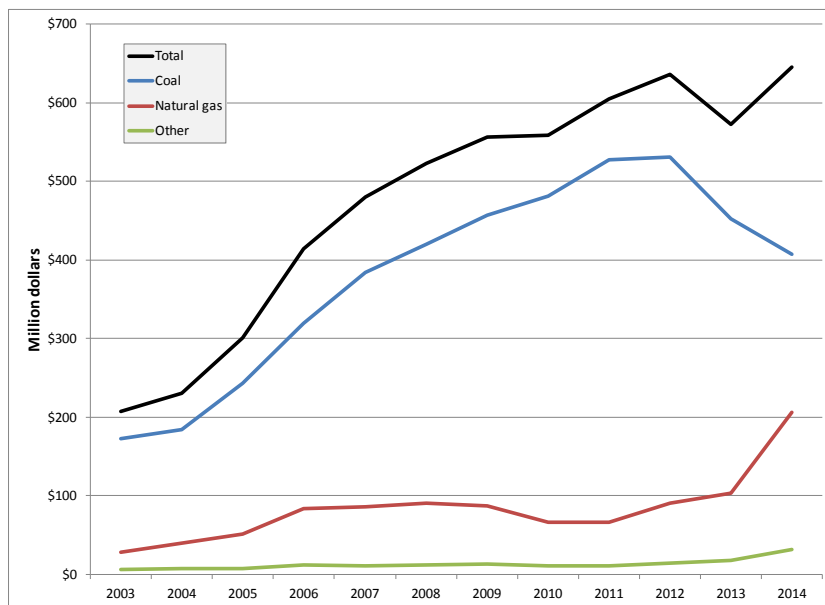
West Virginia levies a 5 percent severance tax for coal on the value of coal production and processing. Ninety-three percent of collections are allocated to the state, and the remaining 7 percent are provided to local governments.¹⁰ Three-fourths of the local government portion is distributed to the state's coal-producing counties based on that county's coal production level. The remaining one-fourth is apportioned to all counties in the state based on population.¹¹ Beginning in FY 2012/2013, the state began apportioning part of the state portion to local governments. The share began at 1 percent in 2012/2013 and increases 1 percent per year to 5 percent in FY 2016/2017 (Federation of Tax Administrators 2015).

As illustrated in Figure 3, coal severance taxes have declined sharply in recent years. After reaching \$531 million in FY 2012, coal severance taxes declined to \$407 million in FY 2014. FY 2014 remains the only year that natural gas severance taxes more than offset the decrease in coal severance taxes (Hansen et al. 2016).

¹⁰ Some coal production is taxed at a different rate.

¹¹ W. Va. Code § 11-13A-6.

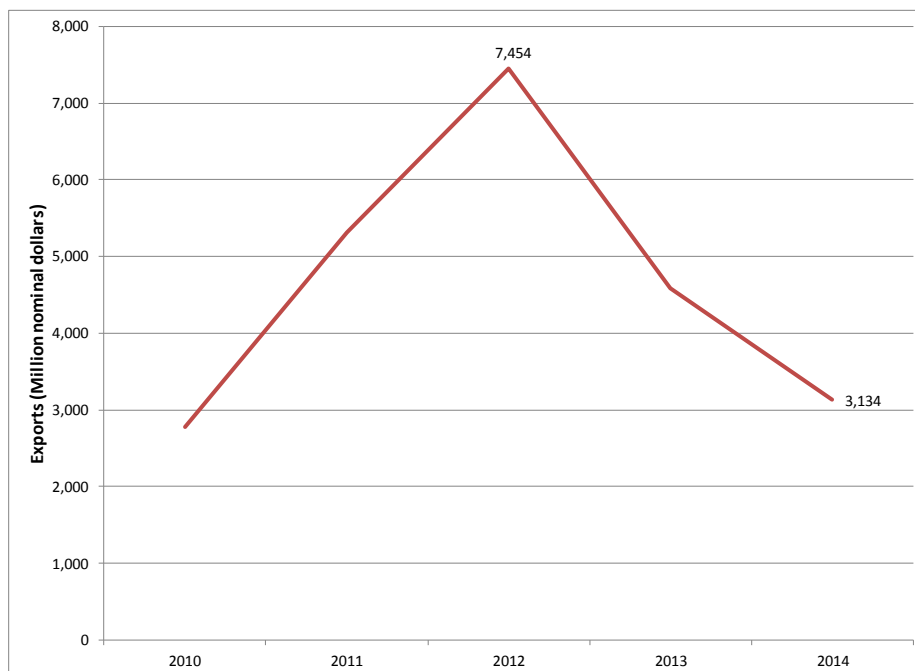
Figure 3: Coal, natural gas, and other severance tax collection in West Virginia, 2003-2014



Source: Federation of Tax Administrators 2015. Note: Years are fiscal years.

As illustrated in Figure 4, the value of West Virginia coal exports in 2014 decreased to less than half of the peak value in 2012. While declining production trends are likely to continue as the domestic electric power sector becomes less reliant on coal and international exports continue to decline, the continued decline in severance tax revenues from coal production could be mitigated if coal prices rise in the future.

Figure 4: Value of West Virginia coal exports to other countries, 2010-2014



Source: Lego 2015, Table 1, originally sourced from International Trade Administration.

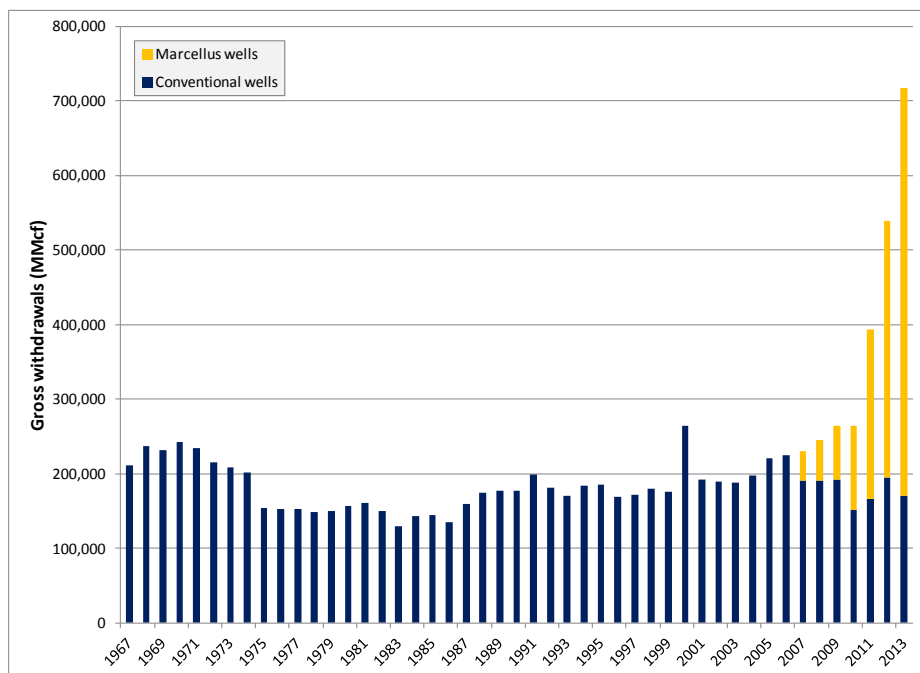
Numerous factors have contributed to declining production in West Virginia coal. Shifts occurring in the electric power sector both internationally and domestically suggest a more evenly distributed mix of resources will be used to generate electricity. EIA projects that under the Clean Power Plan, on a national basis from 2016-2040, coal plant retirements will increase to 100 GW from the estimated 60 GW over that same time period without the Clean Power Plan (EIA 2016). While coal will remain an integral resource in the U.S. power supply for decades to come, less reliance on coal to fuel the national economy means West Virginia must continue to explore economic opportunities outside of coal production to adapt its economy to changing national and international energy markets. West Virginia has an abundance of energy resources and can adapt to these changes through smart policy choices that foster an investment climate that encourages the development of West Virginia's natural gas, renewable energy, and energy efficiency resources.

3.3 The West Virginia natural gas industry

The Marcellus Shale and Utica Shale are among the most prolific and rapidly growing shale-producing formations in the country (EIA 2014(e); EIA 2014(g)). The Marcellus Shale accounts for nearly 40 percent of total U.S. shale gas production (EIA 2014(e)). Pennsylvania and West Virginia are the largest producers of Marcellus Shale gas, and West Virginia has enormous opportunity to grow the state economy by capitalizing on its vast Marcellus and Utica resources.

As shown in Figure 5, natural gas production in West Virginia has nearly tripled since 2009, growing to over 717,000 million cubic feet (MMcf) in 2013 due to the development of the state's shale gas resources (EIA 2015(e)). West Virginia's natural gas production has been projected to double between 2014 and 2019 (Sartarelli 2015). In-state natural gas consumption has also grown from 109,000 MMcf in 2009 to 140,000 MMcf in 2013, but like West Virginia coal, the majority of the natural gas produced in the state is exported. The balance between in-state production and consumption suggests that a significant increase in the use of natural gas for electric generation and commercial, industrial, or residential applications could be met with natural gas produced in West Virginia.

Figure 5: West Virginia natural gas production, 1967-2013



Source: EIA 2015(h).

West Virginia sits atop a portion of the Marcellus and Utica Shale plays that is rich in both dry gas (i.e., methane) and natural gas liquids (i.e., butane, ethane, or propane) (EIA 2014(e); EIA 2014(g)). Methane is used in numerous applications, such as heating for homes and businesses and as a fuel for electric generation. Natural gas liquids are also used to heat homes and businesses but have other chemical properties that make them especially valuable in industrial applications, including as a feedstock for petrochemicals (EIA 2012).

As natural gas production has grown in West Virginia, investment interest in industries that depend on natural gas as a feedstock has grown as well. Plastics are the state's second-largest product sector, behind coal, and are projected to continue to grow as new investment in the sector is attracted to West Virginia's abundant low-priced natural gas resources (Witt 2013). Because of the state's ability to produce ethane and other natural gas liquids, West Virginia has attracted the interest of developers of ethane cracker plants. Cracker plants are very large industrial facilities that utilize ethane to produce the petrochemical ethylene (J. Smith 2014). These facilities are highly energy intensive and require large land areas. Because of their size and complexity, an ethane cracker can support approximately 10,000 jobs during the construction phase and 350-1,200 permanent jobs (Allegheny Front 2015). The growing investment interest in West Virginia around the state's vast natural gas resources points to the significant opportunity to capitalize on the value-added potential of natural gas in West Virginia-based businesses and manufacturing.

In addition to the manufacturing and industrial significance of shale gas in West Virginia, on a national basis, natural gas will play an important role in Clean Power Plan compliance, particularly during the interim compliance period (EIA 2015(i)). West Virginia is uniquely positioned to offset revenue lost from declining demand for coal with new revenue from increasing demand for natural gas in the electric power sector—and, in fact, a new NGCC plant is under construction in Moundsville, and two additional NGCC plants are in the planning stages.

Like the severance tax levied on coal, West Virginia levies a 5 percent severance tax on the gross value of natural gas production.¹² For natural gas, 90 percent of the severance tax revenue is allocated to the state, and the remaining 10 percent is allocated to counties and municipalities.¹³ Like the local distribution of coal severance taxes, three-quarters of the local government portion is distributed to gas-producing counties, while the remaining one-quarter is allocated to all counties in the state based on population. As severance tax revenue from coal production has declined in recent years, severance tax revenue from natural gas has grown (See Figure 3, above). Between FY 2013 and FY 2014, natural gas severance taxes doubled from \$103 million to \$206 million—an increase of more than the twice the \$45 million decline in coal severance taxes over this same period (Federation of Tax Administrators 2015).

West Virginia's natural gas resources will play an important role as the state's economy adapts to changes occurring in national energy markets. In addition to providing a fuel source for out-of-state power plants, West Virginia's gas resources can play an important role in supplying West Virginia-based natural gas-fired generation, including the new Moundsville NGCC plant, scheduled to begin operation in 2018, and two additional NGCC plants scheduled to begin operation in 2020. It can also provide other economic benefits, including expanding the state's chemical and plastics manufacturing base while supplying a low-cost fuel source for combined heat and power (CHP) facilities located at industrial and commercial sites.

While West Virginia's natural gas resources hold significant promise to diversify the energy economy of West Virginia and grow the state economy, policymakers are rightly cautious about changes that simply transition from over-reliance on one resource (i.e., coal) to over-reliance on another resource (i.e., natural gas) over the long term. The benefits of new natural gas development can be captured (and the drawbacks of over-reliance avoided) by adopting policy frameworks that promote the development of all of West Virginia's

¹² W. Va. Code § 11-13A-5a.

¹³ W. Va. Code § 11-13A-5a.

energy resources—coal, natural gas, renewables, and energy efficiency—and that foster a regulatory climate that encourages investment in industries that support the extraction, manufacture, development, and use of these resources so they may grow in response to the needs of West Virginians and adapt to changes in national and international demand.

4. FLEXIBLE COMPLIANCE OPTIONS: A MENU OF EMISSION REDUCTION OPPORTUNITIES

In 2012, the year against which Clean Power Plan emission reduction targets are calculated, 16 coal plants generated approximately 95 percent of the electricity produced in West Virginia and accounted for 20 percent of the total coal output in the PJM region (PJM 2015(b)). In order to meet the CO₂ emission limits under the Clean Power Plan, significant reductions must come from West Virginia's coal-fired power plants or a combination of other compliance measures. This chapter reviews the range of compliance measures that are available in West Virginia. The measures are organized into four categories that describe the resource or technology from which, or at which, emission reductions can be achieved: coal-fired power plants, natural gas, renewable energy, and end-use energy efficiency.

4.1 Coal-fired power plants

Coal-fired power plants offer a number of opportunities through which emission reductions can be achieved. This section reviews the potential for heat rate improvements and for co-firing and repowering. These options would result in direct emission reductions from individual generating units.

4.1.1 Heat rate improvement

Heat rate is a measure of thermal efficiency of an EGU, typically represented as the amount of energy required to generate one kWh of electricity. A unit with a lower, or more efficient, heat rate can generate the same amount of electricity but consume less fuel, as compared with a unit with a higher, less-efficient heat rate. Heat rate is affected by many variables, including the quality of coal burned, boiler technology, equipment maintenance, emission-control technologies, operational characteristics, and other factors.

For the purpose of calculating CO₂ reduction potential, EPA estimated that existing coal-fired power plants can achieve, on average, a 4.3 percent heat rate improvement in the Eastern Interconnection, within which West Virginia is located (EPA 2015(f)). Some estimates suggest that coal plants can achieve higher heat rate improvements than estimated by EPA, while others suggest that the most economic efficiency upgrades have already been made, and the potential for additional improvements is closer to 1 percent to 3 percent (EPA 2014(a)). The potential for heat rate improvements to provide emission reduction benefits is discussed further in Chapter 5.

4.1.2 Co-firing and repowering

Co-firing existing coal plants with natural gas offers another option for reducing carbon pollution from the state's coal-fired power plants at the plants themselves. Converting a coal boiler to co-fire with natural gas can range from a relatively minimal to a major facility modification (Staudt 2014). A typical co-firing application can allow for 10-20 percent use of natural gas, although some modifications may allow for up to a 30-50 percent (Reinhart et al. 2012). CO₂ emissions are reduced approximately 4 percent for every 10 percent of natural gas co-firing (EPRI 2000). As discussed in Section 4.5 below, the FirstEnergy IRP examines the possible co-firing of natural gas with coal at its Harrison and Fort Martin coal plants.

Approximately one-third of the coal-fired generating capacity expected to be operating in West Virginia after 2015 is equipped to co-fire with natural gas. These units include the Harrison, Pleasants, Grant, Morgantown Energy Associates, and Longview plants. The remaining plants would require modifications to co-fire with natural gas (EPA 2014(e)). The cost, degree of modification, and need for new infrastructure to facilitate natural gas co-firing vary considerably from plant to plant. For instance, depending on the facility, new natural gas pipeline capacity may be required to deliver sufficient fuel to these plants to facilitate co-

firing. For those facilities currently equipped with co-firing capabilities and access to natural gas supplies, co-firing provides a potentially low-cost emission-reduction measure.

Repowering coal boilers with natural gas is another compliance option that could be implemented at coal-fired power plants in West Virginia. In 2013, the Virginia State Corporation Commission granted Appalachian Power Company (which also operates in Virginia) permission to convert two coal-fired units at its Clinch River generating facility into units fired by natural gas ; these conversions are underway (Virginia State Corporation Commission 2013). In West Virginia, the Mitchell power station, which is now partially owned by Appalachian Power Company, while not currently equipped to co-fire with natural gas, would require only 4.4 miles of new pipeline to provide natural gas supplies sufficient to facilitate the full repowering of the facility (EPA 2014(e)).

Co-firing and repowering are straightforward and technologically feasible strategies for reducing emissions, but plant-specific analysis of additional permitting issues, capital requirements, and other considerations are needed. Co-firing and repowering may be attractive compliance measures that could be implemented at some coal plants in West Virginia and should be evaluated as Clean Power Plan compliance options. As discussed in Section 6 below, current law in West Virginia does not permit co-firing and repowering of coal-fired power plants for the purpose of reducing CO₂ emissions for Clean Power Plan compliance.¹⁴ The potential for co-firing with natural gas to reduce power plant CO₂ emissions is discussed further in Chapter 5.

4.2 Natural gas

Natural gas prices have declined dramatically in recent years due to technological breakthroughs that have unleashed unprecedented development of the nation's vast shale gas resources. The Marcellus Shale is one of the most prolific shale plays in the country and accounts for nearly 40 percent of total U.S. shale gas production (EIA 2014(e)). West Virginia sits atop the Marcellus Shale and is one of the largest producers of shale gas. Production in the state is projected to grow. The construction of new NGCC plants, co-firing existing coal plants with natural gas, and building new natural gas-fueled CHP facilities would expand the use of West Virginia-produced natural gas in the state's power sector and deliver consumers low-cost natural gas-fired electric generation and provide important emission-reduction benefits. The compliance measures discussed in this section would result in emission reductions if generation from new NGCC plants or CHP facilities displaced generation from existing coal plants or other existing and higher-emitting oil or gas steam plants.

As discussed above, the final Clean Power Plan acknowledges that new NGCC plants may result in increased emissions as a result of incentives under a mass-based plan to shift generation and emissions to new fossil-fired power plants outside the program. The West Virginia compliance plan will need to address this "emissions leakage" issue, which can be tackled by including any new NGCC plants within the program and using the mass-based limit including the NSC.

4.2.1 Natural gas combined cycle plants

NGCC power plants are more efficient, emit less CO₂ and other pollutants, are less expensive to build, and provide the electric grid a more adaptive generation resource than coal-fired power plants. For the purpose of calculating the CO₂ reduction potential from existing NGCC plants, EPA estimated that the utilization of existing NGCC plants across the country could be increased to a 70 percent capacity factor to replace an equivalent amount of generation from the most carbon-intensive fossil plants—coal, and oil and gas steam plants (EPA 2014(a)). While no NGCC plants currently operate in West Virginia, one is now being

¹⁴ W. Va. Code Ann. § 22-5-20.

built in Moundsville. The Moundsville plant is expected to bring 595 MW of high-efficiency capacity into service in 2018 (Quantum 2016).

Other NGCC plants are under consideration for construction in West Virginia as well. In the past year, Energy Solutions Consortium, LLC, a New York-based company, announced plans to build two additional natural gas-fired plants in West Virginia. A 750-MW plant will be constructed in Brooke County at Follansbee, fueled with natural gas produced in the Utica Shale and with the capability of switching to burn high amounts of ethane. Energy Solutions Consortium will build another plant in Harrison County at Clarksburg, a 550-MW facility that will take advantage of the output of the Marcellus Shale. Both plants have an expected in-service date of June 1, 2020.

All three plants will employ a highly efficient NGCC design that will meet the CO₂ emissions standards under EPA's Section 111(b) rules for new natural gas-fired units. When these new NGCC facilities are completed, they will contribute significantly to West Virginia's carbon reduction efforts under the Clean Power Plan. The carbon emission reduction potential of new NGCC plants is discussed further in Chapter 5.

4.2.2 Combined heat and power

CHP facilities provide 82,000 MW of generating capacity at over 3,700 industrial and commercial facilities across the country (DOE and EPA 2012). In addition to providing on-site generation for larger customers, CHP facilities achieve substantial improvements in energy efficiency. Waste heat that would otherwise be released to the atmosphere is instead used to heat and cool buildings or meet thermal needs of industrial processes, thereby displacing the need for additional fuel or electricity use to power heating or cooling processes.

CHP installations can use a variety of fuels, but natural gas is the most common, accounting for 72 percent of installed CHP capacity (DOE and EPA 2012). The addition of CHP resources, particularly at large commercial and industrial facilities, contributes to grid reliability, limits congestion, reduces transmission losses, improves business competitiveness through energy efficiency and energy cost management, and provides emission-reduction benefits by displacing generation and emissions from coal-fired power plants (DOE and EPA 2012).

West Virginia currently has 169 MW of installed CHP capacity and has significant potential for future growth (EIA 2015(j)). According to the American Council for an Energy Efficient Economy (ACEEE), West Virginia has approximately 1,700 MW of remaining technical potential for CHP and 588 MW of that potential is economically viable if utilities in the state provide additional incentives to commercial and industrial consumers to develop these resources (ACEEE 2012). Without those incentives, however, ACEEE estimates that only 71 MW of additional CHP capacity is economically viable in West Virginia (ACEEE 2012).

While CHP holds promise in West Virginia, it is not included in our scenarios of Clean Power Plan compliance options in Chapter 5.

4.3 Renewable energy

Renewable energy resources accounted for over 13 percent of total U.S. electricity generation in 2014 (EIA 2015(g)). In West Virginia, renewables—primarily hydropower and wind—account for only 4 percent of total electricity generation (EIA 2014(c)).

As discussed in Section 6.4 below, West Virginia's former Alternative and Renewable Energy Portfolio Standard (AREPS) provided that the state's utilities could meet renewable energy targets with renewable energy projects developed out-of-state. If West Virginia were to adopt this report's recommendation to enact a true Renewable Portfolio Standard (RPS), a similar provision could be included that would allow West

Virginia utilities to meet their RPS requirements with out-of-state renewable energy projects. This section discusses the availability of wind, solar, and hydropower resources in West Virginia.

4.3.1 Wind

Wind power supplied 4.4 percent of total U.S. generation in 2014 and over 5 percent of total electric generation in 19 states (AWEA 2015(b)). Advancements in wind technology have reduced wind energy costs 43 percent over the past four years and support projections for future growth in wind generation nationally—and in West Virginia (AWEA 2014). Wind energy supplies an important and growing zero-emission electricity resource and provides other benefits to the national economy. The wind industry supports over 50,000 jobs across the country, and in 2012 alone, wind energy developers invested \$25 billion in new wind projects in the U.S. (AWEA 2015(a)).

West Virginia has 637 MW of installed wind capacity¹⁵ and another 556 MW listed in the PJM Queue (PJM 2016(b)). The National Renewable Energy Laboratory (NREL) estimates that between 1,883 MW and 2,772 MW of total wind energy potential exists in West Virginia (NREL 2011). Appalachian Power recently announced that it had reached agreement for the long-term purchase of 120 MW of new wind energy from NextEra Energy Resources's planned Bluff Point Wind Energy Center, to be constructed in Jay and Randolph Counties, Indiana (Electric Light & Power 2016). Appalachian Power had issued a Request for Proposals earlier in 2016 that resulted in 12 wind project proposals. The potential for wind energy to reduce power sector carbon emissions is discussed further in Chapter 5.

4.3.2 Solar

U.S. solar power capacity increased by nearly 7,000 MW in 2014, bringing total installed solar capacity in the U.S. to 20,000 MW (SEIA 2015(b)). The U.S. solar industry supports over 142,000 jobs and is one of the fastest-growing energy sectors in the country (Solar Foundation 2013). Solar installations in 2014 grew by 30 percent from 2013 levels and accounted for over one-third of total installed electric generating capacity in 2014 (SEIA 2015(c)). The solar industry is benefiting from declining manufacturing and installation costs, growing consumer demand for alternative energy, and evolving state energy policies that support the development of distributed energy resources (EIA 2014(d)). In 2013, the neighboring states of Ohio, Maryland, and Pennsylvania had installed solar capacities of 91, 152, and 236 MW, respectively, an increase of between 19 percent and 30 percent above 2012 levels (SEIA 2015(b)).

A recent accounting of solar in West Virginia placed its capacity at 1.9 MW, but the industry has the potential for significant growth throughout the state (PSC 2014). NREL estimates 4,200 MW of technical capacity for solar power in West Virginia (NREL 2012). Demand for solar power in West Virginia is growing, as evidenced by the number of solar cooperatives that have formed around the state, including those in Morgantown, Charleston, Wheeling, Fayette County, and Monroe County (WV SUN 2015). In 2014 and 2015, WV SUN facilitated the installation of nearly 300 kW of distributed solar capacity (CPN 2016). Additionally, at the utility scale, a 6-MW grid-connected solar photovoltaic (PV) installation is planned for Crawley, West Virginia in Greenbrier County (M. Smith 2014; Solano, 2016). If constructed, this would be West Virginia's first utility-scale solar facility. West Virginia can achieve similar or greater levels of solar installations as neighboring states and ensure that consumers are able to access emission-free, low-cost electricity provided by solar power. The potential for solar power resources to reduce power sector carbon emissions is discussed further in Chapter 5.

¹⁵ CP3T default in 2014, based on EIA Form EIA-923 data.

4.3.3 Hydropower

Nationally, hydropower accounts for over half of all renewable generation in the U.S. and approximately 7 percent of total electric generation (National Hydropower Association 2015). Thirteen facilities provide a total of 324 MW of hydropower capacity in West Virginia (EPA 2015(f), Appendix 1-5) and account for approximately 2 percent of the state's electric generation (EIA 2015(k)).

A number of new hydropower opportunities exist in the state. In 2014, proposals to construct five new hydropower facilities in West Virginia, totaling 457 MW of capacity, possessed or had pending preliminary permits from FERC (PSC 2014). These include a 30-MW project planned for the Tygart Lake Dam in Taylor County and a 14-MW project planned for Jennings Randolph Dam on the North Branch Potomac River in Mineral County (Sinclair 2016).

Furthermore, the DOE estimates that West Virginia has 210 MW of potential new hydropower capacity at existing dams (DOE 2012). Existing, non-powered dams are particularly attractive as new, emission-free energy resources because developing these facilities can be achieved with lower development costs, with less technological and business risk, and in a shorter timeframe than hydropower development that includes new dam construction (DOE 2012). The potential for hydropower to reduce power sector carbon emissions is discussed further in Chapter 5.

4.4 End-use energy efficiency

End-use energy efficiency is a low-risk, low-cost energy resource that provides direct savings to consumers, encourages investment across other sectors of the economy, displaces the need for costly investments in new energy supply infrastructure, creates new employment opportunities, and reduces emissions of CO₂ and other harmful pollutants (ACEEE 2014; EPA 2014(a)).

As noted in Chapter 3, West Virginia utilities are achieving much lower energy efficiency savings compared to the savings achieved by these same utilities operating in other states. For example, the West Virginia affiliates of FirstEnergy planned to achieve a cumulative energy efficiency savings of 0.5 percent (0.1 percent per year) of their 2009 retail sales through 2013 and, as part of the settlement terms under the Harrison plant acquisition, agreed to extend this 0.1 percent per year target an additional five years to 2018 (PSC 2013). If these utilities were required to achieve similar energy efficiency savings as FirstEnergy's affiliates are required to achieve in neighboring Pennsylvania, West Virginia consumers would see average energy efficiency savings of 1.0 percent per year (DSIRE 2015(b)). Energy efficiency has great potential to displace the need for pollution-intensive coal-fired electric generation, while saving consumers money and supporting high-quality, local jobs (ACEEE 2015(a)).

Many states around the country have adopted policies to facilitate the deployment of energy efficiency, recognizing its value as an energy resource, a proven job creator, and an economic stimulant. (ACEEE 2014). In 2015, ten of the top 11 states identified by ACEEE in its 2015 State Energy Efficiency Scorecard had adopted binding energy efficiency resource requirements (DSIRE 2015(c)); ACEEE 2015(b)). West Virginia does not have an energy efficiency standard and ranked forty-fifth in the ACEEE Scorecard, meaning that it has significant opportunity for improvement (ACEEE 2015(b)). The state could likely achieve significantly higher levels of energy efficiency through adoption of an energy efficiency resource standard (EERS) or more rigorous integrated resource plan (IRP) requirements that require utilities to treat energy efficiency as a resource alongside supply-side options (Van Nostrand 2013(a); ACEEE 2014). The potential for energy efficiency to reduce power sector carbon emissions is discussed further in Chapter 5.

4.5 Integrated resource planning and emission reduction opportunities

In 2014, the West Virginia Legislature enacted an IRP requirement for electric utilities, codified at West Virginia Code § 24-2-19. In its subsequent General Order No. 184.35, the PSC directed the investor-owned electric utilities in the state to submit IRPs to the PSC by January 1, 2016 (PSC 2015(d)). On December 30, 2015, the AEP subsidiaries Appalachian Power and Wheeling Power filed their IRPs with the PSC, as did FirstEnergy on behalf of its MonPower and Potomac Edison Company subsidiaries (PSC 2015(a), (b), (c)). These IRP filings contain information that is highly relevant to West Virginia’s strategy for achieving compliance with the Clean Power Plan.

Appalachian Power’s IRP shows a capacity shortfall beginning in 2021. It relies upon sophisticated modeling to develop an “optimum” portfolio of resources, both supply- and demand-side, to meet this anticipated supply gap. Energy efficiency and demand-response resources were treated on an integrated and consistent basis, as is required in integrated resource planning; the plan refers to energy efficiency “as a readily deployable, relatively low cost, and clean energy resource that provides many benefits.”(PSC 2015(a))

The Appalachian Power IRP also incorporates additional solar and wind, which are shown to be cost-effective under the various modeling scenarios. In addition, the IRP included development of a “Hybrid” plan, which accelerated wind (from 2023 to 2018), solar (from 2025 to 2018), and battery storage (2025). This hybrid plan includes:

- 10 MW of large-scale solar energy by 2018, growing to 260 MW by 2025;
- 150 MW of wind energy by 2018, growing to 750 MW by 2025 (integration of wind was priced at \$63/MWh in 2017, which excludes the impact of extending the production tax credits past 2016). It is worth noting that on June 3, 2016, Appalachian Power announced it had reached agreement for the long-term purchase of 120 MW of new wind energy from NextEra Energy Resources’s planned Bluff Point Wind Energy Center to be constructed in Jay and Randolph Counties, Indiana (Electric Light & Power 2016). Appalachian Power had issued a Request for Proposals earlier in 2016 that resulted in 12 wind project proposals. The price bid by NextEra Energy Resources was \$46 per MWh (Patton 2016);
- an increase in renewables from 5 percent to 15.9 percent over the planning period (capacity);
- energy efficiency (including volt variable optimization programs) growing to 3.1 percent of energy by 2025, and 118 MW of capacity (4.1 percent). Notably, the Appalachian Power IRP treated energy efficiency as “a stand-alone resource,” to be included in the portfolio of optimized resources in its appropriate size, with a commitment to develop the necessary energy efficiency programs to procure the level of energy efficiency savings resulting from its modeling of optimized portfolio resources (PSC 2015(a));
- growth of distributed solar at 5 percent per year, and totaling 14 MW by 2025; and
- 10 MW of battery storage resources in 2025. (PSC 2015(a))

According to Appalachian Power’s IRP, this hybrid plan is only \$5 per year/residential customer more expensive than the “optimal” plan under the “base” commodity pricing assumption, and \$13 per year under the “no carbon price” assumption (PSC 2015(a)).

Wheeling Power’s IRP, on the other hand, confirms that the purchase of 50 percent of the Mitchell Power Plant, a coal-fired generating unit located in the Northern Panhandle, provided more capacity and energy than Wheeling Power will need in the foreseeable future. Wheeling Power owns about 780 MW of capacity, as compared with a load of about 470 MW, which does not grow over next 10 years. With respect to energy requirements, Wheeling Power has only 3,645 gigawatt-hour (GWh) of loads, as compared with

4,428 GWh of generation. The cost of this oversupply worsens as the remaining 17.5 percent of the Mitchell plant is added to rates in 2020. (Only 82.5 percent of the Mitchell plant is included in Wheeling Power's rates through 2019.) As a result of this capacity addition, Wheeling Power's IRP includes no modeling of additional resources—as none is necessary—and no assumed expansion of energy efficiency programs—as there is no need to do so. (PSC 2015(b))

FirstEnergy's IRP, filed on behalf of its subsidiaries MonPower and Potomac Edison, describes significant load growth—3.1 percent per year from 2010-2014—which is projected to continue at 2.2 percent from 2015-2020 “driven by increased load in the natural gas sector.” As a result, FirstEnergy is projecting a capacity shortfall of 700 MW in 2020 and growing to 850 MW by 2027. (PSC 2015(c)) The FirstEnergy IRP expresses a very different outlook than Appalachian Power's with respect to the role of energy efficiency and renewable energy. With respect to energy efficiency, FirstEnergy plans to continue its current programs at a savings level of 0.1 percent per year, with cumulative 1.0 percent in savings by 2018. The IRP notes that “[b]ecause of the significant nature of MonPower's capacity shortfall, demand side resource options will not meet MonPower's obligations. . . . Programs to reduce demand cannot consistently and reliably fulfill the long term need for supply side resources on this scale.” (PSC 2015(c) p. 56)

With respect to renewable energy sources, the FirstEnergy IRP anticipates no meaningful role, concluding that solar, geothermal, new hydro, and tidal resources are “not economic options” within service territories “based on the current state of development for those technologies or for meteorological or geographical reasons.” (PSC 2015(c)) According to the FirstEnergy IRP, these “intermittent” resources have very little capacity value and tend to be “significantly more expensive than other options.” (PSC 2015(c))

A noteworthy development in FirstEnergy's IRP is its proposal to co-fire its Harrison and Fort Martin coal plants with natural gas (i.e., natural gas would comprise 10 to 20 percent of the fuel supply), at a cost of \$55-80 million for each unit (\$85 per MW for Harrison and \$140 per MW for Ft. Martin). According to the FirstEnergy IRP, CO₂ emissions would decrease by about 4 percent for every 10 percent of co-firing with natural gas, thereby bringing the coal units more in line with the emissions performance rates under the Clean Power Plan (PSC 2015(c)).

Another remarkable statement in the FirstEnergy IRP is a reference to the possibility of purchasing an existing coal-fired generating plant—later acknowledged to be the Pleasants Station (Brown 2016)—at a cost of \$57/MWh. (PSC 2015(c)) According to the FirstEnergy IRP, this is the lowest-cost evaluated option, with the second lowest-cost option the building of an NGCC, which would cost 23 percent more than acquiring existing generating facilities (\$70/MWh versus \$57/MWh). The IRP concludes, however, that such a plant could not be built within the time frame needed, “leaving MonPower short of capacity for several years.”

5. APPLYING EMISSION-REDUCTION OPPORTUNITIES TO THE WEST VIRGINIA POWER SECTOR

As discussed earlier, the Clean Power Plan is designed to produce a 32 percent reduction of CO₂ pollution from power plants in the U.S. by 2030, as compared with 2005 levels. It sets state-specific emission limits in the form of a CO₂ emission rate—lbs/MWh. The final rule also translates rate-based limits into mass-based limits (total CO₂ emissions in tons). West Virginia’s Clean Power Plan obligations require emissions reductions from a rate of 2,064 lbs/MWh in 2012 to 1,305 lbs/MWh in 2030, a 37 percent reduction. Under a mass-based standard, West Virginia would be required to reduce CO₂ emissions from 72,319 thousand short tons in 2012 to 51,325 thousand short tons by 2030 if only existing sources are considered—a 29 percent reduction—or 51,857 thousand short tons if both existing and new sources are considered. Under the Clean Power Plan, each state can choose whether to adopt the rate-based or mass-based approach to compliance.

The scenarios presented in this chapter replace those modeled in our 2015 report (Van Nostrand et al. 2015) and our 2014 discussion paper (Van Nostrand et al. 2014), which were based on the draft rule. Here, we offer two new compliance scenarios—the Existing Sources Scenario and the Existing Plus New Sources Scenario—both of which demonstrate how various combinations of compliance measures could be used in West Virginia to reduce power sector CO₂ emissions. These scenarios offer a starting point for evaluating how emission reduction measures could work together as part of West Virginia’s compliance strategy and are intended to help inform the broader state plan process; they are not meant as precise predictions of the future. In addition to identifying key trends during the compliance periods, these scenarios can also be used to compare results across scenarios.

The final rule sets emission targets that states must meet over four compliance periods: 2022-2024, 2025-2027, 2028-2029, and 2030 and beyond. As described above, West Virginia can choose from various rate-based or mass-based compliance targets; we assume that West Virginia will choose a mass-based approach.

Our scenarios are designed to comply with two different mass-based compliance targets. If West Virginia chooses to comply with existing sources only, then new NGCC plants will be covered under 111(b), and not under 111(d). West Virginia’s target decreases gradually to a final mass-based target of 51,325 thousand short tons. The Existing Sources Scenario illustrates one combination of measures that could enable the state to achieve compliance with these targets. This scenario does not address the issue of leakage.

If West Virginia chooses to comply with both existing and new sources, then new NGCC plants will be covered under Section 111(d), along with the state’s existing coal-fired power plants. In this case, West Virginia’s target decreases gradually to a final mass-based target of 51,857 thousand short tons. The Existing Plus New Sources Scenario illustrates one combination of measures could enable the state to achieve compliance with these targets. This scenario directly addresses the issue of leakage.

To model the scenarios, we used the Clean Power Plan Planning Tool (CP3T) version 2.2, which was developed by Synapse Energy Economics, Inc. CP3T is a Microsoft Excel-based, open source spreadsheet tool (Knight, 2015).

Our screening-level scenarios are meant to highlight important trends and the broad implications of decisions that will be made in the coming months and years regarding West Virginia’s approach to Clean Power Plan compliance. The scenarios model only how the various combinations of compliance measures could affect generation and emissions in West Virginia. Due to modeling constraints, the scenarios do not incorporate regional dispatch, emission trading, or other regional electricity market or Clean Power Plan compliance pathway considerations that West Virginia. The scenarios also do not incorporate measures that other states in PJM may adopt to meet their Clean Power Plan obligations.

Both scenarios modeled in this report demonstrate combinations of compliance measures that would reduce CO₂ emissions to achieve compliance with the Clean Power Plan. While many other compliance scenarios are possible, the scenarios presented here demonstrate how various energy resources can be deployed at different levels to reduce CO₂ pollution. Table 3 summarizes the measures modeled in each scenario; additional details are provided in Sections 5.1 and 5.2 and in Appendix A.

- Existing Sources.** This scenario demonstrates how West Virginia could achieve compliance with mass-based compliance targets applied to existing sources only. West Virginia would maintain its role as a major electricity exporter through the use of a mix of generation and demand-side resources. This scenario illustrates how high levels of coal-fired generation can be combined with new NGCC plants, modest levels of natural gas co-firing at two coal-fired power plants, and modest levels of new renewable energy and demand-side energy efficiency. This scenario does not address the issue of leakage.
- Existing Plus New Sources.** This scenario demonstrates how West Virginia could achieve compliance with mass-based compliance targets applied to existing and new sources, thereby directly addressing the issue of leakage. Compared with the Existing Sources Scenario, this scenario includes additional NGCC capacity starting in 2030 and additional renewable energy and demand-side energy efficiency starting in 2018. In addition, it includes heat rate improvements at West Virginia's coal-fired power plants. Even with this greater diversification of electricity generation sources, coal-fired generation would remain the main source of electricity generation in West Virginia. But by incorporating many other energy resources, West Virginia could actually generate new jobs, tax revenues, and environmental benefits of developing new energy resources, while maintaining its position as a major electricity exporter.

Table 3: Measures modeled in the scenarios

Measure	Existing Sources	Existing Plus New Sources
Improve heat rates at coal-fired power plants	N/A	3% improvement
Increase non-hydropower renewables	2.8% of total generation by 2030	4.4% of total generation by 2030
Improve end-use energy efficiency	Cumulative savings of 5% by 2030	Cumulative savings of 15% by 2030
Hydropower	2.0% of total generation by 2030	2.4% of total generation by 2030
New NGCC plants	595 MW in 2018; additional 1,235 MW in 2020	595 MW in 2018; additional 1,235 MW in 2020; additional 245 in 2030
Natural gas co-firing	15% co-firing at two plants—one in 2020 and the other in 2022	15% co-firing at two plants—one in 2020 and the other in 2022
Electricity exports	2012 exports continue through 2030	2012 exports continue through 2030

Source: Modeled in this report. Note: Appendix A includes capacity factors, emission factors, and installed capacity for each generation type and scenario. For non-hydropower renewables and for hydropower, the percent of total generation represents the percentage of total load, which includes supply-side resources plus energy efficiency. These percentages are not directly comparable to state renewable portfolio standards, which are typically expressed as a percentage of in-state retail sales.

5.1 Existing Sources Scenario

The goal of the Existing Sources Scenario is to meet West Virginia's mass-based target for existing sources only: 51,325 thousand short tons by 2030. In this scenario, West Virginia will generate electricity from a more diverse group of resources than in the past (See Figure 6 and Appendix A).

This scenario assumes that the Moundsville NGCC plant becomes operational in 2018 and that two additional NGCC plants become operational in 2020. As discussed above in Sections 3.3 and 4.2.1, the Moundsville plant is already under construction, and the other two NGCC plants are in the PJM queue.

These new NGCC plants go a long way toward achieving compliance with a mass-based target based on existing sources only, because generation from new NGCC plants will replace coal-fired generation at existing EGUs and the new emissions from the NGCC plants would fall outside of Section 111(d). CO₂ emissions from the state's EGUs are therefore reduced. (See the Existing Plus New Sources Scenario for a discussion of how new NGCC facilities impact compliance with a mass-based target for existing plus new sources.)

In addition to new NGCC plants, the Existing Sources Scenario includes increases in wind and solar generation over current levels, which, together, grow to 5 percent of total load by 2030. The CP3T model calculates the emission reduction potential from new renewable resources by displacing coal-fired generation and emissions with an equal amount of generation from zero-emission energy sources. Hydropower and biomass generation remain at 2012 levels in this scenario.

More specifically, wind capacity increases to 840 MW by 2030 (See Appendix A). This assumption for wind capacity is significantly less than the NREL upper- and lower-bound estimates for West Virginia wind potential (2,772 MW and 1,883 MW, respectively) (NREL 2011). Further qualifying this level of resource integration, Appalachian Power, in its IRP, has planned for 750 MW of additional wind capacity by 2025 (PSC 2015(a)). Applying this level of wind capacity per customer across the entire state, more than 1,600 MW of wind capacity would be added between 2016 and 2025.¹⁶

Solar capacity increases to 125 MW in the Existing Sources scenario. While this is a significant increase from the current level of approximately 2 MW, the technical potential for expanded solar generation coupled with the experience with solar development in surrounding states suggest that this level of growth in West Virginia is entirely achievable. NREL estimates that West Virginia has the technical potential for 41,000 MW of solar. 4,000 MW of that technical potential is rural distributed rooftop solar PV (NREL 2012). The installed solar capacities in the neighboring states of Ohio, Maryland, and Pennsylvania reached 91, 152, and 236 MW in 2013 (SEIA 2015(b)). If these trends continue, the solar capacity in these states will grow substantially through 2030. The increase in solar in the Existing Sources scenario reaches less than 1 percent of the NREL technical potential, suggesting that West Virginia has enormous potential for solar development and could likely achieve higher levels of solar penetration with the right mix of interconnection, net metering, and other state policies.

Existing Sources Scenario Highlights in 2030

- 15% natural gas co-firing at two coal-fired power plants
- Coal plants account for 77% of total load
- Moundsville NGCC plant comes online in 2018, two other NGCC plants come online in 2020, and new NGCC accounts for 15% of total load
- Wind, solar, and hydropower grow to account for 5% total load
- Demand-side energy efficiency grows to achieve cumulative savings of 5% of retail sales and accounts for 3% of total load

¹⁶ Not all of Appalachian Power's planned wind development would be in West Virginia; however, this comparison is still instructive.

The Existing Sources Scenario also includes increases in energy efficiency savings from current levels: cumulative energy efficiency savings of 5 percent by 2030. The ACEEE estimates that West Virginia could achieve 23 percent energy efficiency savings from 2012 levels by 2030 (ACEEE 2014). Further, the end-use energy efficiency savings that AEP and FirstEnergy affiliates in Ohio and Pennsylvania have achieved in recent years, and are required to achieve as part of state energy efficiency mandates, suggest that West Virginia utilities could achieve similar levels of savings. In addition, the West Virginia Legislature proposed legislation in 2013 that would require West Virginia utilities to achieve 15 percent cumulative savings and 15 percent peak demand savings by 2027.¹⁷ These estimates all suggest that a cumulative energy efficiency savings of 5 percent is very achievable. The CP3T model calculates emission reductions from energy efficiency by reducing the need for coal-fired generation and the associated emissions.

This scenario also includes a small amount of natural gas co-firing. Two West Virginia coal-fired power plants—FirstEnergy’s Fort Martin and Harrison plants—achieve 15 percent co-firing in 2020 and 2022, respectively. This is consistent with FirstEnergy’s IRP (PSC, 2015(c)).

As illustrated in Figure 6, while this scenario includes a mix of new NGCC, renewable energy, energy efficiency, and natural gas co-firing, changes in electricity generation are dominated by a shift from existing coal-fired EGUs to new NGCC plants.

In the first compliance period, 2022-2024, the state over-complies with the interim target. This is illustrated in Figure 7, where the emissions from existing EGUs (the gray bars) are less than the target (black lines). Allowances generated by over-complying in the first compliance period are banked and used to increase the targets for the next compliance period, 2025-2027. The adjusted targets are shown as red lines. In 2025-2027, the state again over-complies with the adjusted target; therefore, the next interim target for 2028-2029 is again adjusted upward. Once again, emissions in 2028-2029 over-comply with that period’s adjusted target; therefore, the final target is again adjusted upward. In 2030-2031, the state just meets the adjusted final target. Additional measures may be required after 2031 to ensure continued compliance with the final target.

Developing this all-of-the-above strategy for complying with the Clean Power Plan would create a framework upon which West Virginia could stimulate the development of the state’s other energy resources and retain the economic benefits of being a major electricity-exporting state. This strategy would also provide consumer benefits of increased access to distributed generation (DG) and demand-side energy efficiency and would better insulate consumers from electricity rate hikes. The Existing Sources Scenario demonstrates only one possible combination of a wide array of resource measures that West Virginia could incorporate in a state plan to achieve its required emission reductions. The menu of emission reduction measures available under an all-of-the-above energy strategy allows policymakers broad flexibility to select the appropriate level, or contribution, of emission reductions from each measure for inclusion in a state plan.

Also, compliance in this scenario depends on diversifying energy resources within West Virginia, rather than purchasing allowances from out of state. While the scenario includes economic impacts of a reduced reliance on West Virginia coal, it also captures the benefits of developing lower- or zero-emitting resources within West Virginia. Jobs and tax revenues will be generated when the three NGCC plants are built and operated in West Virginia, and when renewables, energy efficiency, and natural gas co-firing are installed. Instead of only suffering the consequences of a reduced reliance on coal-fired EGUs, this scenario also captures the benefits for West Virginia.

¹⁷ HB 2210, available at http://www.legis.state.wv.us/bill_status/bills_text.cfm?billdoc=hb2210%20intr.htm&yr=2013&sesstype=RS&i=2210.

Figure 6: Electricity generation by source in the Existing Sources Scenario

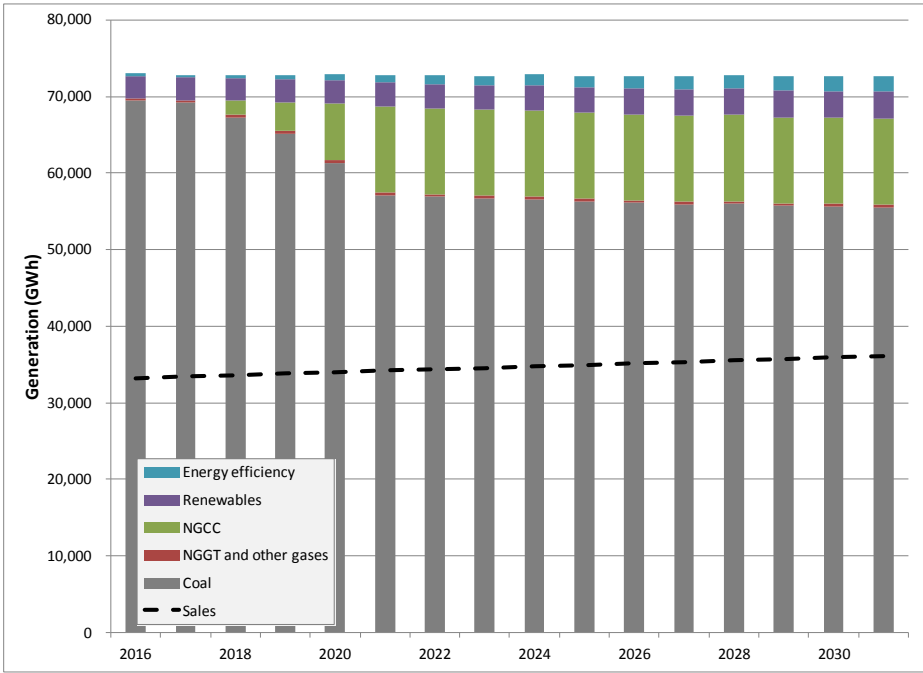
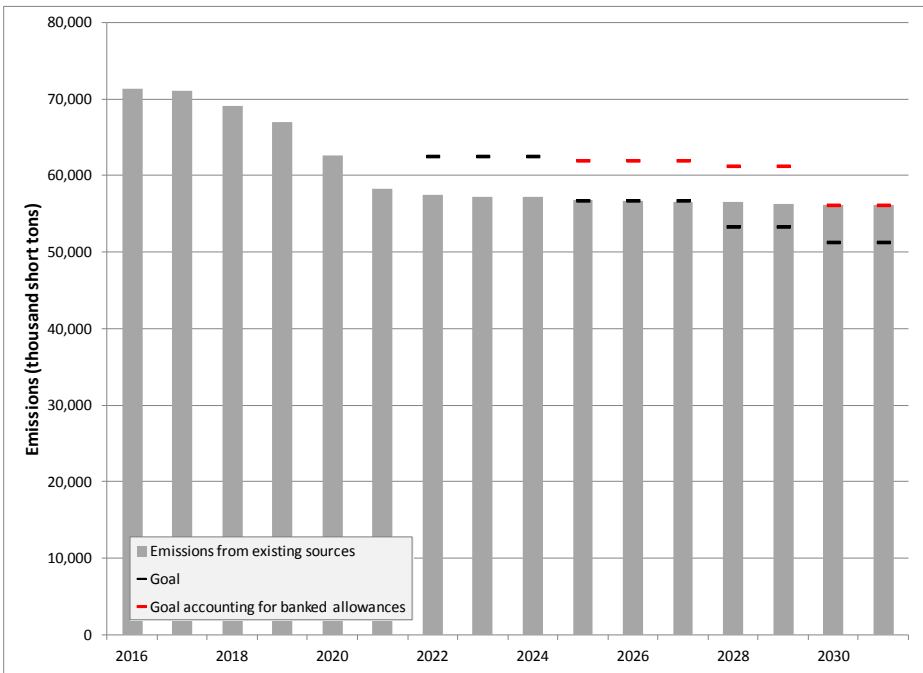


Figure 7: Compliance in the Existing Sources Scenario



5.2 Existing Plus New Sources Scenario

The goal of the Existing Plus New Sources Scenario is to meet West Virginia's mass-based target for existing plus new sources: 51,857 thousand short tons by 2030. In this scenario, West Virginia will generate electricity from an even-more diverse group of resources than the Existing Sources Scenario (See Figure 7 and Appendix A).

Consistent with the Existing Sources Scenario, this scenario assumes that the Moundsville NGCC plant becomes operational in 2018 and that two additional NGCC plants become operational in 2020. However, it adds one additional NGCC plant in 2030.

Regarding renewables, wind capacity increases to 1,219 MW, solar capacity to 356 MW, and hydropower capacity to 392 MW by 2030. These represent additions of 582 MW of wind, 356 MW of solar, and 68 MW of hydropower.¹⁸

The 2030 wind capacity, while greater than that in the Existing Sources Scenario, is still significantly less than the NREL lower-bound estimate for West Virginia wind potential (1,883 MW) (NREL 2011).

The 2030 solar capacity is also greater than that in the Existing Sources scenario; however, it is still less than 1 percent of the NREL technical potential, and the experience with solar development in surrounding states suggest that this level of growth in West Virginia is entirely achievable.

West Virginia can develop additional hydropower resources at currently non-powered dams and through small-scale hydropower projects. As described above, the DOE estimates that West Virginia has 210 MW of additional hydropower capacity at existing dams that do not currently produce hydroelectric power. In addition, in 2014, proposals to construct five new hydropower facilities in West Virginia, totaling 457 MW of capacity, possessed or had pending preliminary permits from FERC (PSC, 2014).

The Existing Plus New Sources Scenario also includes increases in energy efficiency savings from current levels: cumulative energy efficiency savings of 15 percent by 2030. While this is three times the savings in the Existing Sources Scenario, it still compares favorably with ACEEE estimates of achievable savings in West Virginia, savings that AEP and FirstEnergy affiliates in Ohio and Pennsylvania have achieved in recent years, and proposed legislation in West Virginia.

At existing EGUs, this scenario includes the same small amount of natural gas co-firing as the Existing Sources Scenario: 15 percent co-firing at the Fort Martin and Harrison plants. The Existing Plus New Sources Scenario, unlike the Existing Sources Scenario, includes a 3 percent heat rate improvements at coal-fired power plants. These improvements are below the 4.3 percent level that EPA calculated for the Eastern Interconnection, within which West Virginia is located (EPA 2015(f)). A lower percentage is based on the assumption that some of the most economic upgrades identified by EPA have already been made at West Virginia coal plants and that the plants with the highest potential for additional economic improvement are likely older plants that may retire before the compliance period begins.

Existing Plus New Sources Scenario Highlights in 2030

- 15% natural gas co-firing at two coal-fired power plants
- Coal plants account for 67% of total load
- Moundsville NGCC plant comes online in 2018, two other NGCC plants come online in 2020, one additional NGCC plant comes online in 2030 and new NGCC accounts for 18% of total load
- Wind, solar, and hydropower grow to account for 7% total load
- Demand-side energy efficiency grows to achieve cumulative savings of 15% of retail sales and accounts for 8% of total load

¹⁸ These additions are calculated against the 2014 capacities utilized in CP3T, which may differ from capacities reported elsewhere.

As illustrated by comparing Figure 8 with Figure 6, this scenario includes a greater mix of new energy resources as compared with the Existing Sources Scenario.

In the first compliance period, 2022-2024, the state over-complies with the interim target. This is illustrated in Figure 9, where the emissions from existing plus new sources (the gray bars) are less than the target (black lines). Allowances generated by over-complying in the first compliance period are banked and used to increase the targets for the next compliance period, 2025-2027. The adjusted targets are shown as red lines. In 2025-2027, the state again over-complies with the adjusted target; therefore, the next interim target for 2028-2029 is again adjusted upward. Once again, emissions in 2028-2029 over-comply with that period's adjusted target; therefore, the final target is again adjusted upward. In 2030-2031, the state just meets the adjusted final target. Additional measures may be required after 2031 to ensure continued compliance with the final target.

Similar to the Existing Sources Scenario, compliance in this scenario depends on diversifying energy resources within West Virginia, rather than purchasing allowances from out of state. While the scenario includes economic impacts of a reduced reliance on West Virginia coal, it also captures the benefits of developing lower- or zero-emitting resources within West Virginia. Jobs and tax revenues will be generated when the four NGCC plants are built and operated in West Virginia, and when renewables, energy efficiency, and natural gas co-firing are installed. Instead of only suffering the consequences of a reduced reliance on coal-fired EGUs, this scenario also captures the benefits for West Virginia.

Figure 8: Electricity generation by source in the Existing Plus New Sources Scenario

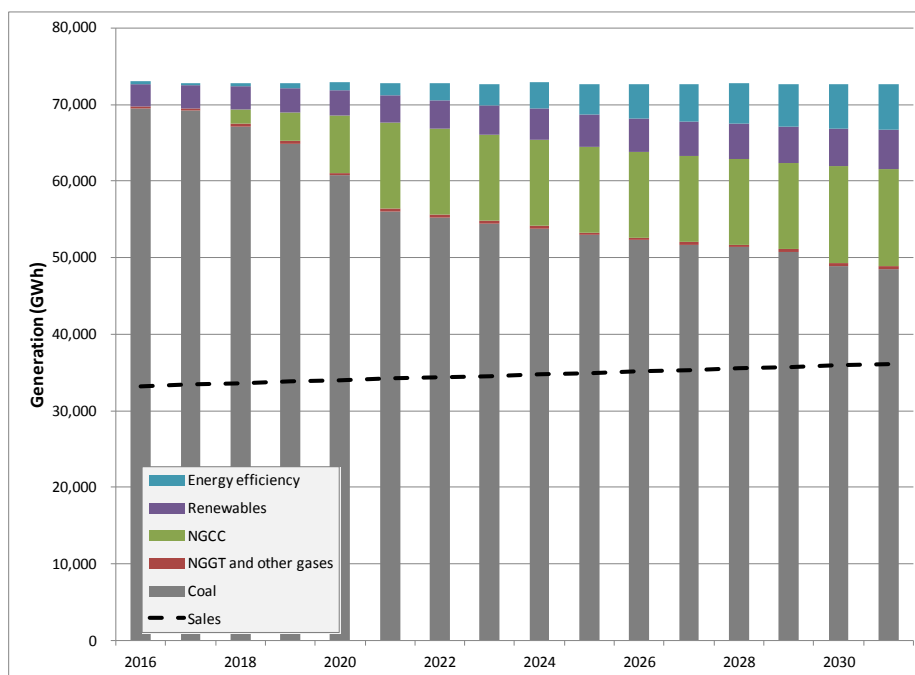
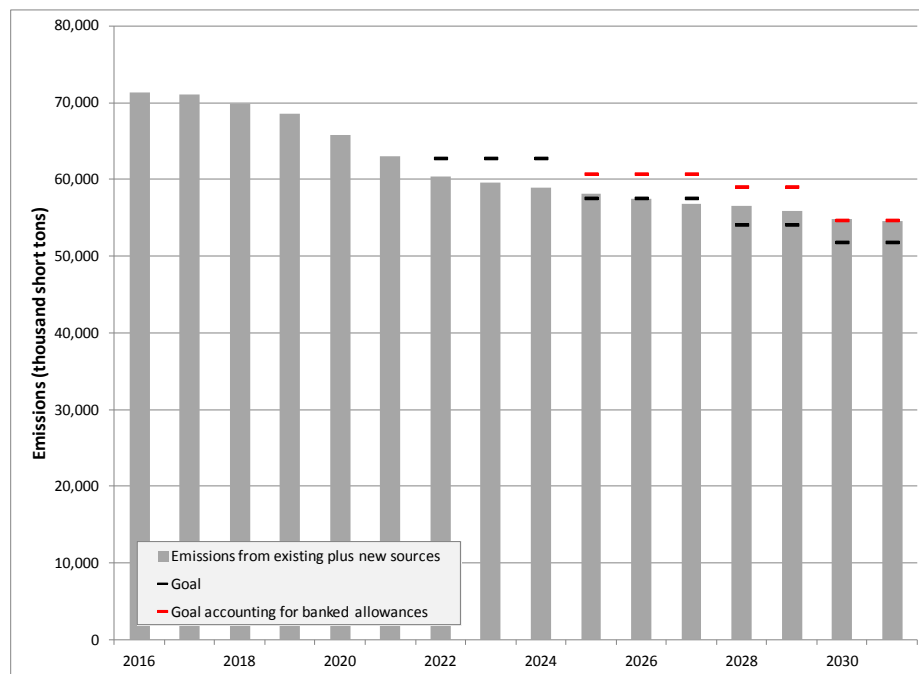


Figure 9: Compliance in the Existing Plus New Sources Scenario



5.3 Discussion

Table 4 highlights the resource mix projected under each scenario in 2030. In the Existing Sources Scenario, coal accounts for 77 percent of total load (including energy efficiency), and in the Existing Plus New Sources Scenario, this percentage declines to 67 percent. Most of the remainder is generated by new NGCC, although energy efficiency and renewables account for an increasing percentage, as compared with current levels.

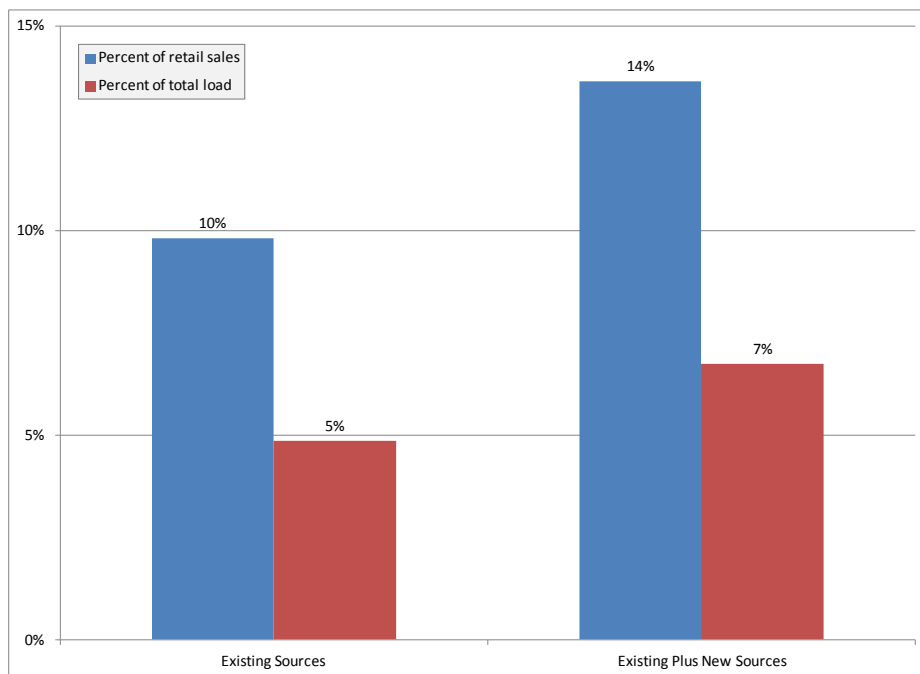
Table 4: Percent of total projected load by resource, 2030

Resource	Existing Sources Scenario	Existing Plus New Sources Scenario
Coal	77%	67%
NGCC	15%	18%
Energy efficiency	3%	8%
Renewables	5%	7%
NGGT and other gases	<1%	<1%

Note: These percentages represent the percentage of total load, which includes supply-side resources plus energy efficiency. Total percentages do not equal 100 due to rounding.

While the renewables percentages in Table 4 are expressed as a percentage of total load (including energy efficiency), state RPSs are often expressed as a percentage of in-state retail sales. West Virginia's former AREPS similarly expressed its 25 percent goal as a percent of total retail sales. Figure 10 compares both percentages for each scenario. Renewables reach 10 percent and 14 percent of total in-state retail sales by 2030 in the Existing Sources and the Existing Plus New Sources scenarios, respectively.

Figure 10: Renewables as a percentage of total load and as a percentage of in-state retail sales, 2030

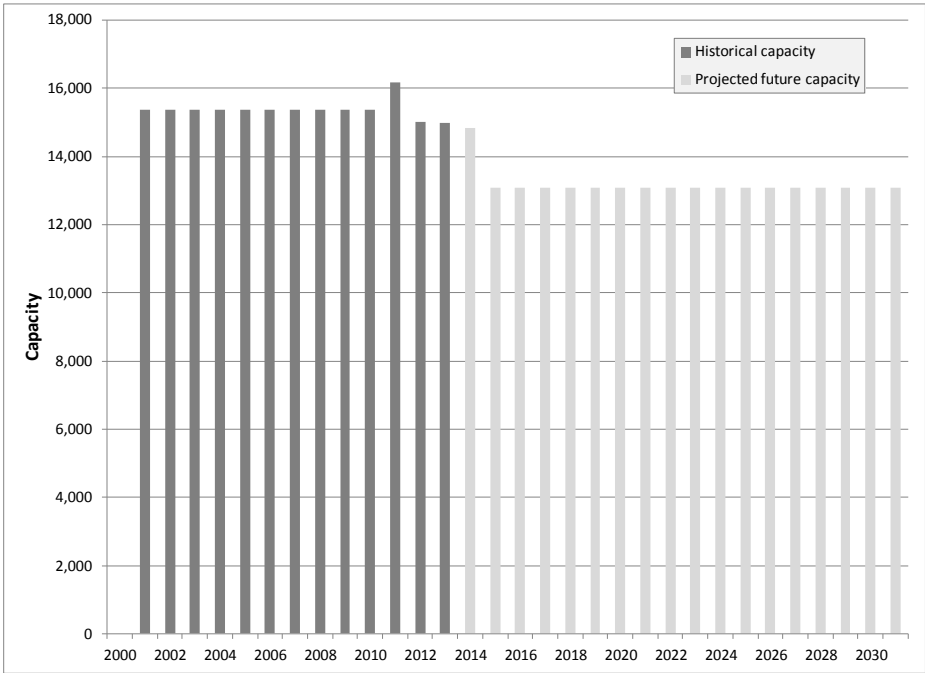


As discussed in Chapter 3, West Virginia has historically produced virtually all of its electricity from coal. This is changing—with or without the Clean Power Plan—as several of the state’s oldest and least-efficient plants have closed, energy efficiency and DG resources act to limit growth in demand, and new renewable resources and natural gas-fired generation coupled with low natural gas prices significantly reduce coal power plant margins. Coal-fired generation faces challenging market dynamics, and additional retirements are on the horizon as West Virginia’s coal fleet ages. Five of the 10 coal plants that will remain after 2015 will be 60 years of age or older by 2035 (EPA 2014(e)). As shown in Figure 11, the total nameplate capacity of coal-fired power plants in West Virginia declined recently, and this trend may continue into the near future if additional coal plants announce early retirements or repower with natural gas. These closures may provide emission reduction benefits that can be captured for compliance purposes, but they must be coupled with additional measures to ensure that West Virginia meets its Clean Power Plan obligations.

Both scenarios modeled in this report rely in part on reduced reliance on coal-fired generation. The average capacity factors for West Virginia coal plants was between 60-70 percent every year from 2001-2008 but decreased sharply from 2009-2013 in response to the recession and increasing competitiveness of other resources—primarily natural gas and renewables (See Figure 12). As coal-fired power plants retired through 2015, the average capacity factor of remaining plants actually increased, because the plants that remained open ran more often to meet electricity demand in the PJM market.

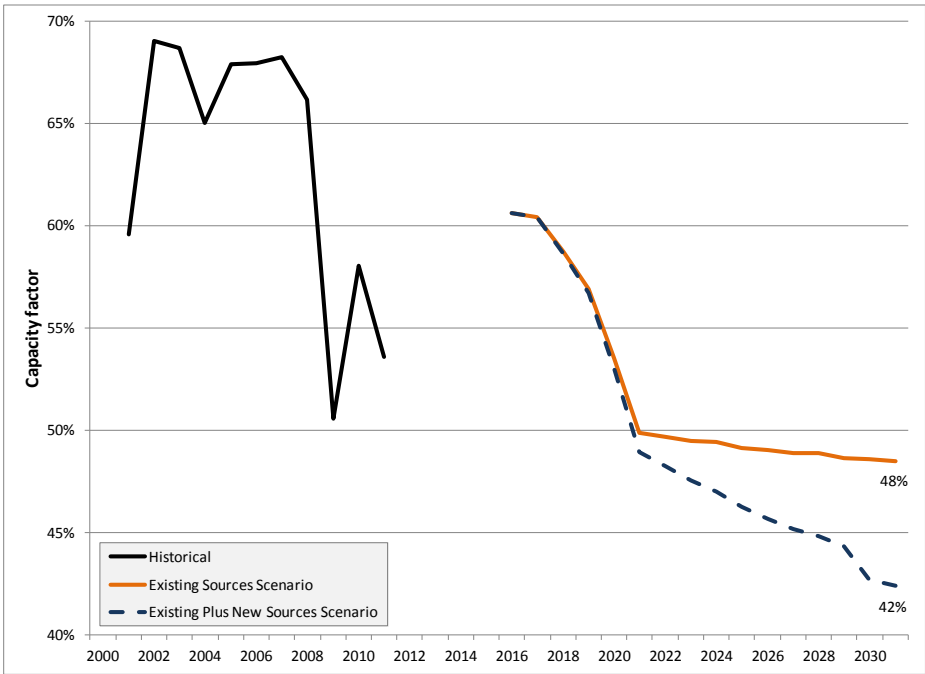
Capacities of coal-fired power plants begin to diverge in the scenarios starting in 2020, largely due to the additional renewables and energy efficiency deployed in the Existing Plus New Sources Scenario. By 2030, the average capacity factor in the Existing Sources Scenario declines to 48 percent, and the average capacity factor in the Existing Plus New Sources Scenario declines to 42 percent.

Figure 11: West Virginia coal-fired capacity for both scenarios



Sources: Historical capacities from EIA 2015(j). Projected future capacities from the analysis performed for this report. Note: capacities are the same for all scenarios. Actual future capacities may be smaller if additional coal-fired power plants retire.

Figure 12: Coal-fired power plant capacity factors for all scenarios



Sources: Historical capacity factors from EIA 2015(j), EIA 2015(k). Scenario capacity factors from the analysis performed for this report.

The scenarios highlight an important fact about Clean Power Plan compliance: West Virginia power plants will be expected to burn less coal. These observations are also projected by EIA in a recent analysis of the impacts of the Clean Power Plan. EIA projects that under the Clean Power Plan, on a national basis from 2016-2040, coal plant retirements will increase to 100 GW from the estimated 60 GW over that same time period without the Clean Power Plan (EIA 2016).

It is important to distinguish the impacts of how West Virginia chooses to comply with the Clean Power Plan from the impacts of compliance decisions made by other states. As illustrated in Table 5, West Virginia power plants burned just over 29 million tons of coal in 2013. While 17 million tons of that coal was mined in West Virginia, 40 percent was imported from other states. Of the 112.8 million tons of coal mined in West Virginia in 2013, only 15 percent was burned at West Virginia power plants. West Virginia's Clean Power Plan compliance pathway, therefore, will have a small effect on the amount of coal mined in West Virginia. Other states' Clean Power Plan pathways will have a greater effect on West Virginia coal production as exports to those states for electricity generation decline (See discussion of North Carolina in Section 3.2). This report, however, focuses only on West Virginia to underscore the importance of evaluating how its energy strategy can help West Virginia achieve its Clean Power Plan obligations together with other economic development goals.

Table 5: West Virginia coal production and coal burned in West Virginia power plants, 2013 (million tons)

Total West Virginia coal production	Coal burned in West Virginia power plants		
	Mined in West Virginia	Mined in other states	Total
112.8	17.0	12.3	29.3

Source: Total West Virginia coal production from EIA 2015(l). Coal burned in West Virginia power plants from EIA 2015(c).

These results highlight important implications of the scenarios and underscore how the choices made by policymakers regarding Clean Power Plan compliance will affect the future makeup of the electric power sector and the state economy as a whole. Both scenarios present a diverse mix of compliance measures that offer significant emission reduction benefits as well other economic development benefits through the addition of new jobs, increased tax revenues, and an expanded energy economy that can provide a foundation for revitalizing communities throughout the state hit hardest by the recession and mine closures.

The scenarios would achieve compliance and provide numerous ancillary economic benefits. The Clean Power Plan explicitly provides for this type of flexibility in a state plan, and West Virginia would be well served to explore its options under an all-of-the-above energy strategy to Clean Power Plan compliance. While this report demonstrates two possible all-of-the-above approaches, there are many additional ways that West Virginia's diverse energy resources could be deployed to achieve compliance and support multi-sector economic growth.

The compliance measures and scenarios presented above offer some insights into how various emission reduction measures could affect the West Virginia power sector in the absence of regional dispatch modeling, emission trading, and other market and Clean Power Plan compliance considerations beyond the scope of this report. This analysis highlights a number of important considerations for West Virginia and offers insights into areas that state lawmakers and regulators could explore further with lawmakers and regulators in other states.

The challenges for West Virginia under the Clean Power Plan are significant, but they are not insurmountable. West Virginia can meet these challenges and help revitalize communities and attract new investments in a more diversified economy through smart policy choices that provide incentives for the deployment of the state's energy efficiency, renewable energy, and natural gas resources to complement its coal resources. Targeted policy changes and a state plan that emphasizes an all-of-the-above energy approach will help West Virginia maintain its position as a major energy exporter; capture the economic,

consumer, and environmental benefits of an expanded energy economy; and put the state on track to meet its CO₂ pollution limits under the Clean Power Plan. Chapter 6 offers policy recommendations that West Virginia could adopt to help achieve these goals.

5.4 The role of emissions trading in achieving compliance

The Clean Power Plan encourages the use of emissions trading as part of a compliance strategy. As noted above, emissions trading allows affected power plants to meet their emissions standards through ERCs under a rate-based standard or emissions allowances in the case of a mass-based standard. ERCs and allowances are produced by zero- or low-carbon generating sources or energy efficiency. As part of their compliance plans, states will determine the parameters of emissions trading, whether allowed on an in-state-only, multi-state or regional basis, or nationally.

The modeling performed in connection with the DEP Feasibility Report showed that using a mass-based compliance approach coupled with national emissions trading would be the “least impactful” for West Virginia, followed by a rate-based approach with national trading (DEP 2016). Other analyses have confirmed that the availability of multi-state emissions trading—either regionally or nationally—produces lower compliance costs for West Virginia than under an approach limited to in-state emissions trading. Preliminary modeling by PJM, for example, shows that under a rate-based approach, average ERC prices for the period 2022-2037 in West Virginia decline from \$19 per ERC with in-state-only emissions trading to \$14.40 under a regional compliance approach (PJM 2016(a)). Similarly, under a mass-based approach, average allowance prices are lower—\$13.50 versus \$16.60—under a regional compliance scenario (PJM 2016(a)). A key observation from the PJM analysis is that regional emissions trading allows coal-dominant states to lower their costs of buying allowances and thereby preserve the useful life of existing assets (PJM 2016(a)). The PJM analysis shows that West Virginia’s average annual CO₂ emissions would substantially exceed its state mass-based cap during the 2022-2037 period; the availability of relatively low-cost allowances allows West Virginia’s coal plants to continue operating, with the “excess” emissions covered through the purchase of emissions allowances from surrounding PJM states with excess allowances due to a lower-carbon profile. This compliance approach—in which West Virginia’s coal-fired power plants comply by purchasing allowances from other states—is fundamentally different from the approach discussed in this report (due to modeling limitations), in which generation from West Virginia’s coal-fired power plants is displaced by in-state zero- or low-emitting resources.

Analyses performed for the Natural Resources Defense Council (NRDC) by M.J. Bradley & Associates also show that emissions trading on a national scale will result in relatively low allowance prices. In fact, under a national trading scenario, the allowance price would be zero through 2025 and would rise only to \$4.14 per ton in 2030 (assuming current levels of energy efficiency savings) (M.J. Bradley & Associates 2016). Allowance prices would be slightly higher in 2030—\$6.05 per ton—if new 111(b) resources were included in the program with the NSC. Scaling up energy efficiency programs, however, would result in a reduction to those allowances prices, to \$2.97 per ton (M.J. Bradley & Associates 2016). Importantly for West Virginia, the M.J. Bradley analysis for NRDC shows that national emissions trading, coupled with increased the level of energy efficiency, results in a reduction in the amount of coal plant retirements (M.J. Bradley & Associates 2016). While it may seem counterintuitive that increasing investment in energy efficiency programs results in a lower level of coal plant retirements, supply and demand in the allowance market drives this result: increased energy efficiency savings result in a greater number of emissions allowances, thereby producing lower allowance costs, which thereby lowers the compliance costs for existing coal plants to continue operating by covering their “excess” emissions with low-cost allowances. The compliance approach modeled by M.J. Bradley is similar to that modeled by PJM: West Virginia’s coal-fired power plants would comply by purchasing allowances from other states. This approach is fundamentally different from the approach discussed in this report (due to modeling limitations), in which generation from West Virginia’s coal-fired power plants is displaced by in-state zero- or low-emitting resources.

The following section sets forth recommendations for West Virginia policymakers to consider as they formulate compliance strategies for West Virginia under the Clean Power Plan. The availability of low-cost allowances through emissions trading—which will enable West Virginia’s coal plants to continue operating at existing levels—is only one side of the analysis, and considers only the goal of minimizing the costs of compliance with the Clean Power Plan. The modeling of likely scenarios in emissions trading markets also highlights the opportunities available to West Virginia to take advantage of the economic activity that will be generated in a low-carbon economy. West Virginia is currently not well-positioned to take advantage of these opportunities. As discussed in the next section, a number of policy changes are necessary to stimulate the investment in allowance-generating activities within West Virginia, such as scaled-up energy efficiency programs and accelerated development of renewable resources.

6. POLICY RECOMMENDATIONS

State plans must, among other things, demonstrate how the state will achieve emission performance levels that comply with the emission limits prescribed by the Clean Power Plan. The emission reduction opportunities summarized above are some of the options that West Virginia could evaluate and potentially include in a state plan. Understanding the full interaction of these, and other measures, would involve an analysis of complex dispatch, pricing, reliability, environmental compliance (including compliance with CO₂ limits), and other considerations, as well as coordination among the DEP and the PSC, those agencies' counterparts in other states, PJM, utilities, independent power producers, and other entities.

The following policy recommendations explore legislative and regulatory policy changes that West Virginia could make to promote an all-of-the-above energy strategy. They support efforts to coordinate Clean Power Plan compliance strategies with other states to ensure that West Virginia can develop a state plan that meets its carbon reduction requirements and at the same time provides consumers reliable electricity services at a reasonable price, helps to grow the state economy, and reduces the impact of energy production and use on the environment. As noted earlier in this report, the State Measures pathway to achieving state compliance with the Clean Power Plan is not currently a realistic option for West Virginia, given the utter lack of policies that would result in the necessary reduction in CO₂ emissions to achieve compliance with the Clean Power Plan. Adoption of the recommendations set forth below may allow the state in the future to make a case for relying on the State Measures pathway to compliance, but this report assumes that West Virginia must proceed down the Emissions Standard pathway to achieve compliance.

6.1 Remove legislative restrictions on state plan development

In 2014, the West Virginia Legislature passed and the Governor signed into law HB 4346 to provide guidance to the DEP on the development of a state plan. In 2015, West Virginia adopted HB 2004, codified at W.Va. Code § 22-5-20, to amend a number of provisions in HB 4346. Key changes to the 2014 law include:

1. Adding a provision that requires DEP to submit to the Legislature a report within 180 days of the publication of the final Clean Power Plan assessing its effect on the state, the need for legislative or other changes in state law, and whether the creation a state plan is feasible. If the DEP determines a state plan is feasible, the report must explain why; if not, the report must estimate how long it would take DEP to create a state plan.
2. Removing language from HB 4346 that authorized DEP to use available compliance measures under the Clean Power Plan and adding language that explicitly precludes the use of some potential compliance measures.
3. Adding a provision that requires the DEP to receive the express consent of the majority of both houses of the Legislature prior to submitting a state plan to EPA.

A strict interpretation of HB 2004 suggests that DEP could be limited to developing performance standards based solely on the emission reduction potential of heat rate improvements at individual power plants.¹⁹ In its Feasibility Report, DEP took the position that the effect of certain provisions in W.Va. Code §§ 22-5-20-(e) and (f) would limit the compliance approaches that DEP may wish to use in developing a state plan (DEP 2016). Specifically, DEP interpreted the statute to allow consideration of only “inside the fence” measures (i.e., modification of individual generating units to improve their performance) and to preclude the trading of ERCs or allowances. The DEP Feasibility Report recommended that state law be changed to expressly permit a mass-based plan with trading as a means of compliance (DEP 2016).

¹⁹ During the 2016 legislative session, the West Virginia Legislature enacted Senate Bill 691, which granted DEP additional flexibility to depart from unit-specific performance measures and to use either a rate-based or mass-based approach.

Removing the limitations imposed in W.Va. Code § 22-5-20 is essential to afford DEP with maximum flexibility to choose among the various compliance options available under the Clean Power Plan when developing a state plan for West Virginia. The preferred path identified by DEP in its Feasibility Report, as discussed above, relies on the availability of trading ERCs or allowances as the least disruptive compliance strategy for West Virginia. The measures and scenarios explored in this report similarly assume that DEP will have at its disposal the full range of options provided under the Clean Power Plan, without limitation thereof by any provisions of West Virginia state law. The remaining policy recommendations that follow in this section offer some additional suggestions on legislative and other changes to West Virginia law that would assist DEP in developing a state plan that would put West Virginia on track to meet its obligations under the Clean Power Plan.

6.2 Issue revised integrated resource planning requirements for electric utilities

IRPs evaluate a full range of supply- and demand-side resource alternatives for meeting projected electric power demand in order to provide adequate and reliable service to customers at the lowest system cost. This range of alternatives includes, among other things, new generating capacity, power purchases, energy conservation and efficiency, CHP, district heating and cooling applications, and renewable energy resources.²⁰

The “integrated” aspect of IRPs ensures that a utility considers demand-side (e.g., conservation and energy efficiency) and other resources (e.g., customer-sited renewables and co-generation) on the same footing as the addition of traditional supply-side resources (large, utility-owned generating plants) when it evaluates options for meeting future system needs (Van Nostrand 2012).

West Virginia adopted legislation in 2014 requiring the state’s utilities to engage in integrated resource planning.²¹ The PSC issued an order in March 2015 requiring West Virginia utilities to submit IRPs by January 1, 2016 and at least every five years after that date (PSC 2015(d)). The guidelines are limited to requiring utilities to file IRPs that include a narrative summary describing:

1. the utility’s rationale for selecting any supply-side or demand-side resources to fulfill forecasted need;
2. the evaluation of alternatives considered for each resource option chosen; and
3. the internal planning process of the utility and how the IRP considers or incorporates PJM planning and implementation requirements and how it will satisfy PJM capacity obligations.

There is nothing in the 2014 legislation or in the PSC order that requires integration of supply-side and demand-side resources in the development of IRPs. FirstEnergy’s 2015 IRP, for example, fails to integrate energy efficiency as a resource, and in fact concludes that “[p]rograms to reduce demand cannot consistently and reliably fulfill the long term need for supply side resources,” (PSC 2015(c) p. 56) an analysis—or lack thereof—that utterly fails to fulfill the “integrated” requirement of integrated resource planning. FirstEnergy continues to pursue its path of meager energy efficiency savings—0.1 percent per year through 2018—withstanding the compelling evidence that energy efficiency is the most cost-effective tool for addressing utility resource needs as well as reducing GHG emissions. Under a properly formulated IRP requirement, FirstEnergy’s 2015 plan would have been rejected as noncompliant, and the utility would be required to begin planning to implement a path that pursues the long-term interests of its West Virginia ratepayers rather than the interests of its shareholders. (In sharp contrast, the Appalachian Power IRP treats energy efficiency as a “stand-alone resource” to be incorporated in an optimum resource portfolio, and it similarly integrates wind and solar resources as economically justifiable supply-side acquisitions.)

²⁰ Energy Policy Act of 1992, § 111(d)(19), 16 U.S.C. § 2602(19).

²¹ W.Va. Code § 24-2-19.

In addition to its rejection of energy efficiency as a resource and its dismissal of renewable resources as “expensive” and “intermittent,” FirstEnergy’s 2015 IRP lays the groundwork, without any supporting quantitative analysis, for the possible purchase of the Pleasants Power Station—a 1,300-MW coal-fired generating station constructed in the late 1970s and currently owned by its unregulated subsidiary, FirstEnergy Solutions. FirstEnergy’s regulated subsidiaries in West Virginia, MonPower and Potomac Edison, would purchase this plant. It is difficult to explain from the ratepayers’ perspective how acquisition of another coal-fired generating unit makes sense as a long-term resource strategy, given the carbon constraints imposed under the Clean Power Plan. The acquisition, apart from being completely contrary to the trend of other utilities in the U.S. to divest themselves of coal-fired generation (Platts 2016), would result in capacity and energy additions that seem to be far in excess of the needs of the MonPower and Potomac Edison ratepayers (Kunkel 2016). As in the case of FirstEnergy’s successful sale of 80 percent of its Harrison Power Station from its unregulated subsidiary to MonPower in 2013, FirstEnergy will likely contend that any excess capacity can be sold in the wholesale energy markets, thereby resulting in benefits for its regulated customers from acquisition of this “low cost producer” from FirstEnergy Solutions. At \$57 per MWh, however, this resource will likely not be “in the money” in the competitive PJM energy markets, and West Virginia ratepayers may be saddled with another non-competitive coal plant that, like the Harrison acquisition, contributes to upward rate pressures as the forecasted wholesale revenues fail to materialize. The harsh realities of the competitive wholesale marketplace in PJM can only be expected to worsen for coal plants in the medium-term, given the anticipated addition of nearly 1,900 MW of highly efficient NGCC plants in West Virginia over the next five years.

Many of the elements commonly included as part of the IRP process in most other states are missing under the West Virginia process. Additional guidance by the PSC is therefore necessary, and the PSC could issue a second order that provides specific IRP development guidelines that:

- require utilities to evaluate supply- and demand-side resources on a consistent and integrated basis;
- ensure that utility plans result in the selection of a portfolio of resources that represents a reasonable balance of costs and risks for the utility and its customers;
- require utility plans to evaluate resources over at least a 20-year planning horizon;
- require periodic plan updates at maximum intervals of every two years;
- include provisions for a transparent stakeholder process;
- require that utilities take carbon pollution requirements into consideration when evaluating resource alternatives; and
- provide guidance on how utility IRPs will be used subsequently for evaluating the prudence of utility resource acquisitions in future rate case proceedings.

A robust IRP requirement would ensure that energy efficiency, renewables, natural gas, coal, and other resources are evaluated on equal footing so that West Virginia consumers receive the benefit of a reliable energy system at the lowest system cost over the long term. Well-designed IRP rules would also provide a transparent framework for evaluating and securing the lowest-cost compliance options under the Clean Power Plan.

6.3 Adopt an Energy Efficiency Resource Standard

Energy efficiency programs offer consumers the tools to take control of their energy bills through appliance, equipment, heating, air conditioning, lighting, weatherization, and other upgrades that result in the use of less energy while still receiving the same level of energy service. Twenty-six states (including neighbors Ohio, Maryland, Pennsylvania, and Virginia) have energy efficiency mandates (either by legislation or regulatory order) that require utilities or state agencies to develop programs that help their customers implement end use energy efficiency improvements. The mandates are often referred to as EERSs. Some states require utilities to meet annual energy efficiency savings targets, while others require utilities to spend

a specified percentage of total retail sales on energy efficiency programs (DSIRE 2015(c)). Even though energy efficiency programs vary by state, they all bring energy savings benefits to consumers.

Unfortunately, utility customers in West Virginia do not have the same opportunity to access energy efficiency programs that customers of those same utilities have in neighboring states. As a result, West Virginia residents pay higher electricity bills than residents in most states and will likely see even higher bills as utilities continue to seek annual rate increases under the power cost recovery mechanism currently in place in West Virginia.²² The adoption of an EERS in West Virginia would provide tangible economic benefits to residents and business and a low-cost emission reduction measure under the Clean Power Plan.

In 2013, the Legislature considered, but failed to pass, HB 2210, the West Virginia Energy Efficiency Act. As proposed, the Act would set energy efficiency savings goals and direct the PSC to oversee the implementation of energy efficiency programs by the state's utilities. HB 2210 would establish an EERS target of saving 15 percent of 2011 electricity sales by 2027, and a second target of saving 15 percent of 2011 peak demand by 2027. To implement these targets, the bill would, among other things, direct the PSC to:

1. adopt ratemaking policies that provide direct cost recovery, decoupling, or other lost revenue recovery mechanisms and performance incentives;
2. require electric utilities to develop and implement energy efficiency and conservation programs that achieve verifiable electricity savings and peak demand reductions; and
3. require electric utilities to consult with the PSC regarding the design and adequacy of their electricity savings and demand reduction targets.

West Virginia could adopt energy efficiency legislation similar to that contemplated in HB 2210 to ensure that West Virginia consumers receive the same opportunity to access energy efficiency savings as utility customers in neighboring states. Ohio and Pennsylvania require AEP and FirstEnergy affiliates to meet energy efficiency goals, and in Kentucky, customers are benefiting from energy efficiency upgrades through the How\$martKY program. How\$martKY employs one of the many customer-based financing mechanisms—on-bill financing—to allow customers to pay for the customer portion of energy efficiency retrofits over time with the savings generated from the retrofits (MACED 2015).

West Virginia should adopt an EERS that requires the state's utilities meet an energy efficiency goal of at least 15 percent by 2030 and that sets goals for achieving a percentage of the cumulative 2030 target at five-year intervals. The EERS should require the state's utilities to invest in and facilitate energy efficiency upgrades for residential, commercial, and industrial energy customers. West Virginia has significant potential for efficiency gains through CHP, and the EERS savings target could be adjusted upward and provide for efficiency savings resulting from the installation of CHP at commercial or industrial customer facilities to be credited toward the utility meeting its EERS goals. This approach would increase the compliance options for meeting EERS requirements as well as incentivize development of natural gas-fired CHP installations. The EERS should provide guidance on the balance between utility and customer investment in energy efficiency, as well as rate recovery (such as decoupling) and financing mechanisms (such as on-bill financing) that the PSC should authorize or require utilities to adopt to better facilitate customer access to energy efficiency savings.

6.4 Adopt a Renewable Energy Portfolio Standard

Renewable energy is a rapidly growing component of the U.S. economy and provided the largest portion of new capacity additions and total electric generation in the U.S. in 2014. As discussed in Chapter 3 above, renewable energy, including wind, solar, and hydropower, has strong potential for future growth in

²² Utilities make an annual filing to adjust their rates under the Expanded Net Energy Charge mechanism. The most recent such filing for MonPower and Potomac Edison resulted in a 7.3 percent average rate increase. Case No. 15-1351-E-P (December 2015).

West Virginia. Twenty-nine states, including Maryland, Ohio, and Pennsylvania, have adopted renewable energy standards to incentivize the development of renewable energy resources in their state and to capitalize on the energy and economic benefits of including these resources as part of a diverse energy portfolio (DSIRE 2015(c)). West Virginia should adopt an RPS that includes binding targets for the development of new renewable energy resources such as wind, solar, and hydropower.²³

West Virginia enacted its AREPS in 2010, but that law was repealed in 2015. The AREPS required utilities to meet increasing percentages of their electricity supply through either “alternative” or “renewable” energy sources. The AREPS legislation was structured, however, so that utilities could meet the portfolio standard entirely with “alternative” resources—which included burning natural gas, tires, and coal—thereby creating no additional incentive for the development of renewable energy in West Virginia.²⁴

The Legislature could adopt a new RPS that requires a percentage of or retail or total electric generation be met with electricity generated from renewable energy sources. The RPS could set a target date of 2030 and provide interim target dates by which increasingly greater portions of the final target must be achieved. An RPS should also incorporate a carve-out requiring a percentage of the renewable energy standards be met with solar energy. Many states throughout the U.S. are moving to integrate more solar PV to take advantage of this increasingly cost-competitive distributed energy resource that brings diversification to a utility’s power supply portfolio and provides customers another tool by which to control their energy costs (see Policy Recommendation 6.5). Incentives such as an RPS with a solar carve-out would have a positive impact on renewable investment decisions. Development of a 6-MW grid-connected solar PV installation planned for Greenbrier County, West Virginia, for example, was delayed by a lack of in-state demand for renewable electricity, resulting in the need to wheel the electrical output of the project to New York (Solano, 2016).

The Legislature should consider adopting a binding RPS to incentivize new investment in West Virginia’s clean energy economy and help put West Virginia on target to meet its CO₂ reduction requirements under the Clean Power Plan.

6.5 Encourage greater use of the state’s natural gas resources

The Marcellus Shale is one of the largest shale gas deposits in the world and underlies nearly all of West Virginia and a significant part of several other states. Marcellus Shale gas production has grown steadily in recent years, and estimates for continued growth in the Marcellus are a major driver of projections for low natural gas prices in the U.S. over the long term. Low natural gas prices have contributed to lower wholesale electricity prices, and West Virginia could benefit from expanded use of its natural gas resources in the electric sector. The state should explore opportunities to integrate more natural gas into its electricity mix through the construction of new NGCC plants, facilitating and encouraging the installation of new CHP facilities, and co-firing or repowering existing coal plants with natural gas where feasible.

It is noteworthy that the three NGCC plants currently planned for West Virginia—at Moundsville, Clarksburg, and Follansbee—are merchant plants, while the investor-owned utilities serving the state continue to rely almost exclusively on coal-fired generation to serve their West Virginia customers. In the case of FirstEnergy, its IRP points toward acquisition of yet another merchant coal-fired plant (Pleasants Power Station) from its unregulated subsidiary (FirstEnergy Solutions) rather than investing in a new, highly efficient natural gas-fired generating unit, or purchasing a portion of the output of one of the new NGCC plants slated for completion within the next five years.

²³ Expanding the definition of “renewable” to encourage co-firing biomass with coal would take advantage of the state’s considerable biomass potential and reduce CO₂ emissions from existing coal plants. An assessment of how the state’s biomass resources could be utilized as a compliance measure under the Clean Power Plan is not evaluated in this report.

²⁴ W.Va. Code § 24-2F-1 et seq.

The DEP and PSC could work with West Virginia utilities to evaluate the costs, technical feasibility, and emission benefits of co-firing or repowering existing coal plants with natural gas through integrated resource planning. The Legislature could facilitate the development of high-efficiency natural gas-fired CHP systems by expanding net metering rules to accommodate CHP systems, providing financial incentives for CHP investment, and including a specific provision for CHP resources in energy efficiency legislation. The PSC could facilitate more rapid development and interconnection of CHP through a standard offer program to streamline the terms and conditions under which the state's electric utilities purchase electricity from customer-sited CHP facilities (Van Nostrand 2013(b)).

Greater integration of natural gas resources in West Virginia's electric system would diversify the state's electric sector, create additional demand for West Virginia-produced natural gas, support an expanded employment base, and play an important role in helping the state meet its CO₂ emission limits under the Clean Power Plan.

6.6 Adopt policies that encourage investment in clean distributed generation resources

DG resources are generating facilities (typically not more than 20 MW) that are interconnected to a local distribution system. DG resources include CHP, solar PV, anaerobic digestion, fuel cells, and other small-scale generation resources. These resources are typically owned by customers, not distribution utilities, and are sited at or very close to a customer's home or business. Investment in DG, particularly solar PV, has increased dramatically in recent years as equipment and installation costs have declined significantly (Barbose et al. 2013). State policies that facilitate interconnection and net metering, remove discriminatory utility tariffs, and facilitate alternative financing structures that provide customers different financing options are important factors in creating a market structure in which the benefits of DG resources can be realized by consumers, utilities, and grid operators.

West Virginia currently has interconnection and net metering policies in place that facilitate the development of DG resources by providing utility customers with certainty as to utility interconnection practices and the revenue they will receive for electricity produced through customer-sited generation (Freeing the Grid 2015). In 2015, however, the Legislature enacted HB 2201, which requires the PSC to ensure that net metering rates do not result in "cross-subsidization" of customer generators by customers who do not generate their own power. The enactment of HB 2201 creates uncertainty and casts some doubt on the prices that utilities will be required to pay for customer-generated power, given HB 2201's prohibition on "cross-subsidization," the complexities of the rate-setting process, and the poor track record of West Virginia utilities in facilitating customer-sited DG. Rather than stimulating the growth of small power production in West Virginia, and increasing the ability of individual West Virginians to take control over their energy costs by generating their own electricity, HB 2201 does precisely the opposite. It creates uncertainty and increases the risks associated with investment in DG resources.

In May 2015, the PSC appointed a net metering task force to undertake a review of net metering policies, as required by HB 2201 (PSC 2015(e)). That task force met for several months thereafter, and PSC staff filed its final report with the PSC in September 2015, recommending generally that "cross-subsidization" be defined narrowly to include only costs "directly incurred" by the utility to accommodate net metering customers—a recommendation that would largely leave the existing net metering provisions in place (PSC 2015(e)). Although most members of the net metering task force expressed support for the Staff position, both FirstEnergy and AEP dissented from those recommendations and urged the PSC to adopt a different approach for net metering customers that would impose additional charges (i.e., standby charges) and/or eliminate the utilities' obligation to purchase customer-generated energy at retail rates (PSC 2015(e)). Nine months later, the PSC has yet to act on the recommendations of the net metering task force, and the future of net metering in West Virginia remains uncertain.

In addition, enactment of an RPS, as proposed in Recommendation 6.4 above, would stimulate the development of DG resources, as utilities could meet their renewable energy procurement obligations by purchasing renewable energy generated by customers' solar PV, wind, and biomass resources. Enactment of an EERS, as proposed in Recommendation 6.3 above, would also promote the development of DG resources, by allowing CHP—which is sited on customer premises—to be used to meet energy efficiency requirements.

The PSC could also implement policies that facilitate the development of DG resources, such as through streamlined Standard Offer programs whereby the utilities purchase the output of customer-sited generation under standardized terms and conditions (Van Nostrand 2013(b)). Unless these resources fall within the scope of the Public Utility Regulatory Policies Act, or the existing net metering rules, utilities are under no obligation to integrate the output of DG resources. Finally, in the absence of a rigorous integrated resource planning process, utilities may reject customer-sited generation in favor of large utility-owned generating plants, even though that may be a higher-cost option with respect to utility rates over time. The PSC should consider enacting policies that promote the integration of DG resources and that measure utilities' performance by how well they meet their customers' energy needs rather than by how much electricity they can sell to their customers.

6.7 Work with PJM states to coordinate state plans and explore options for participating in a multi-state plan with emissions trading

The Clean Power Plan establishes CO₂ pollution limits on an individual state basis, but it provides states the option of working together to demonstrate compliance on a multi-state basis, and to allow multi-state emissions trading (either ERCs in the case of a rate-based approach or allowances in the case of a mass-based approach). This flexibility recognizes that electricity is transmitted across state lines and that local measures often impact regional power sector emissions (EPA 2015(b)). West Virginia exports nearly three-fifths of the electricity generated in the state, and the compliance options and other state plan pathways selected will have important implications in West Virginia, neighboring states, and across the broader PJM market.

The scenarios discussed in this report show how numerous compliance measures can be used to meet West Virginia's Clean Power Plan obligations. Importantly, due to modeling constraints, the scenarios presented here are incapable of incorporating the many market, dispatch, transmission, and other constraints and complexities of the regional grid. Similarly, the scenarios presented here do not attempt to project the mix of compliance measures other states will use or how the measures and pathways selected by other states will affect West Virginia. This report includes references to the findings in the DEP Feasibility Report regarding the modeling of multi-state emissions trading, preliminary analyses from PJM's modeling of Clean Power Plan compliance scenarios, and the results of modeling performed for NRDC that reflect a national emissions trading program. Other states are likely to adopt many of the compliance measures discussed in this report, and the impact of actions in other states scaling up demand-side energy efficiency programs—thereby reducing future growth in electricity demand—and making additional investments in DG and new central generation resources, will affect demand for electricity from West Virginia power plants. Working with other states for compliance purposes would allow West Virginia and partner states to build on their respective resource strengths, compare the cost-effectiveness of implementing compliance measures on an individual state basis versus a multi-state basis, explore market-based mechanisms to facilitate the deployment of the most cost-effective measures, and enhance opportunities to incorporate other state policy objectives into compliance planning.

This regional nature of the electric grid and West Virginia's prominent role in the PJM footprint highlights the need for West Virginia air and energy regulators to be intimately involved in discussions with surrounding states, PJM, utilities, and other stakeholders. West Virginia residents, business, and utilities are better served when West Virginia lawmakers and regulators participate in multi-state planning discussions

and advance regional strategies for Clean Power Plan compliance. The alternative, in the event West Virginia disengages from multi-state planning discussions or, worse, does not engage at all in any state plan process, would put West Virginia at a significant disadvantage. Disengaging from these processes would also greatly reduce opportunities for West Virginia policy makers and regulators to discuss and advance ideas with their counterparts in other states about how other policy goals, such economic development objectives, could be incorporated into Clean Power Plan compliance strategies. In the event West Virginia does not submit a state plan to EPA, EPA has the authority under the CAA to impose a federal plan for West Virginia. This is an undesirable outcome, and it is easily avoided.

Efforts by West Virginia air and energy regulators to engage in the state planning discussions with counterparts in other states should be strongly supported at all levels of government in West Virginia. The participation of West Virginia regulators and other government leaders in regional planning discussions will help to ensure that West Virginia is in the best position to develop a state plan that meets West Virginia's obligations under the Clean Power Plan and advances new economic opportunity throughout the Mountain State.

6.8 Support regional economic development initiatives

In October 2014, West Virginia State Senator Jeff Kessler announced the Southern Coalfields Organizing and Revitalizing the Economy (SCORE) initiative (Kessler 2014). The challenges facing southern West Virginia communities coping with job losses and declining revenue as a result of coal mine closures are many. The SCORE Initiative calls on residents and leaders to envision a revitalized southern West Virginia and give southern parts of the state opportunities to diversify the economy and strengthen families and communities (Kessler 2014). Topics for consideration under the SCORE Initiative include increased funding for tourism advertising and development; education and workforce development and retraining initiatives; dedicating money for viable redevelopment projects; agribusiness and rural development opportunities; increased broadband access; expanding and supporting intermodal transportation; exploring the development of coalbed methane reserves; and supporting clean coal research and development.

Other areas the SCORE Initiative could consider include exploring whether abandoned mine sites could be repurposed for development of renewable energy sources and how energy efficiency and distributed energy resources could benefit those communities most impacted by the decline in coal mining. These initiatives could be coupled with other ideas under consideration, such as workforce development and retraining initiatives. As discussed throughout this report, energy efficiency and DG resources hold great promise in West Virginia to help consumers better control their energy bills, and both are proven job creators. Workforce development in these areas could play an important role in making these resources and their associated socioeconomic benefits more available throughout West Virginia, and especially in those communities most impacted by the decline in coal mining.

Broadening the scope of the energy resource development goals of SCORE beyond coal resources could facilitate new research into how the state could capture the benefits of developing wind, solar, biomass, energy efficiency, and other less carbon-intensive resources. Including these efforts in the SCORE Initiative would help to focus lawmakers' attention on the efforts of those communities working to find new opportunities and would provide concrete solutions that lawmakers can act upon through legislative changes and partnerships with federal lawmakers and agencies equipped to provide additional support.

In April 2016, the Center for Energy and Sustainable Development, along with the Rockefeller School of Policy and Politics, presented a conference ("Building a Resilient West Virginia: Taking Control of the Mountain State's Future") that examined the issues faced by coal communities in the Central Appalachian region arising from the global transition to cleaner energy resources. Among other things, policymakers at the federal level are recognizing the pressing need for addressing the devastating impacts being borne by

coal communities arising from this “clean energy” transition. The conference examined the cause and effect of these trends in the coal industry, the economy-wide repercussions within Central Appalachia, and possible solutions for West Virginia that would put the state on a more resilient path. (Center for Energy and Sustainable Development 2016)

In Kentucky, then-Governor Steve Beshear and U.S. Congressman Hal Rodgers in 2013 launched the Shaping Our Appalachian Region (SOAR) Summit to bring together lawmakers, community and business leaders, and residents of eastern Kentucky to discuss challenges facing southern and eastern Kentucky and to think through ideas for addressing those challenges (SOAR 2014(a)). The challenges facing the region are underscored by high unemployment rates that have increased in recent years as coal mines continue to close. Governor Beshear highlighted the deeper challenges facing the region, however, noting that the region’s growth and economic development has been hampered for several decades “by a lack of infrastructure and other resources that communities need to grow and thrive.” (SOAR 2015). The goal of the SOAR Summit was to enable the region itself to assess its current challenges and discuss ideas that were underway that could be leveraged to capture emerging economic development opportunities (SOAR 2015). The 2013 SOAR Summit attracted 1,700 residents of Kentucky and the surrounding region. It was followed by the 2015 SOAR Summit and the 2016 SOAR Innovation Summit.

Since the summits, numerous initiatives have blossomed, and state and federal leaders announced the launch of several programs that will bring millions of dollars of investment to eastern Kentucky and support a strong foundation for continued SOAR initiatives. A few of the announced initiatives that followed the SOAR Summit include state, federal, and private funding (\$100 million) to expand high-speed broadband access; the designation of eight southeastern Kentucky counties hit hard by poverty and the loss of coal jobs as a federal “Promise Zone” to accelerate public-private partnerships, promote job creation and education opportunities, and improve access to federal grant programs; a Department of Education award (\$30 million) to boost education innovation; and a loan pool (\$2.6 million) to spur small business start-ups and expansions (SOAR 2014(b)).

Like SOAR, the SCORE Initiative could provide a framework for identifying challenges and bringing together the communities affected by the downturn in coal production to discuss ideas for fostering new economic opportunity in southern West Virginia and other parts of the state hard hit by mine closures and unemployment. West Virginia lawmakers and regulators could build on the experience of Kentucky’s SOAR process and utilize the SCORE Initiative to provide government, business, and community leaders working to provide new economic opportunities with the infrastructure, financial resources, and policy frameworks needed to achieve economic development goals. While coal has long been part of West Virginia’s social and economic fabric, the SCORE Initiative can provide a framework for evaluating how other energy development opportunities could help West Virginia bring new economic opportunities while at the same time reducing the environmental impacts of energy production and use.

Bipartisan support for the SOAR Initiative from the federal, state, and local government levels in Kentucky is helping to bring state, federal, and private investment commitments to eastern Kentucky. Similar results in West Virginia could be achieved through the sustained commitment of government, community, and business leaders to help build the foundation for a revitalized southern West Virginia.

7. CONCLUSIONS

Achieving compliance with the Clean Power Plan presents a number of challenges for West Virginia, which has historically relied on coal to generate most of its electricity and as an economic driver. Over time, coal-fired power plants in West Virginia will burn less coal, and other states that have historically imported West Virginia coal will also burn less coal. Increasingly stringent environmental regulations will converge with market forces that continue to make Central Appalachian coal less competitive—the development of cheap Marcellus Shale natural gas, the greater affordability of renewables, and the increasing cost of mining thinner and deeper coal seams. Even today, before Clean Power Plan implementation has even begun, coal production is decreasing, West Virginia coal miners are losing their jobs, coal companies are filing for bankruptcy, and severance tax revenues are declining.

West Virginia has the resources to meet these challenges, however, and can usher in new economic opportunities with appropriate planning and policies. To do so, policymakers must take advantage of the opportunities presented by the Clean Power Plan and utilize the full flexibility provided by the rule to shape a strategy for West Virginia that reflects its unique circumstances and leverages its strengths. West Virginia is fortunate to have tremendous energy resources in addition to coal, and these other resources—including natural gas, renewable energy (wind, solar, hydropower), and energy efficiency—are relatively untapped. By implementing the legislative and regulatory policy changes outlined in this report, West Virginia lawmakers and regulators would provide an investment climate that attracts new investment in renewable and DG technologies, energy efficiency, and natural gas-fired generation. West Virginia can also spur innovation in other areas that would diversify the state’s electric power sector, reduce carbon pollution, and provide West Virginians energy savings and new economic opportunities. Taking advantage of the emissions trading opportunities contemplated by the Clean Power Plan would provide West Virginia with a fairly low cost compliance strategy, by incorporating the relatively abundant ERCs and allowances from surrounding states having greater zero- and low-carbon resources and energy efficiency savings, as noted in the DEP Feasibility Report, to enable coal plants to continue operating. A better strategy would be to take advantage of the economic opportunities that will be created by emissions trading, through enactment of state policies that will encourage the development of zero- and low-carbon resources and energy efficiency savings within West Virginia. The state’s strategy for achieving compliance with the Clean Power Plan should focus not only on minimizing compliance costs, but should also consider the opportunities that are created by the economic activity stimulated by the Clean Power Plan.

Developing an all-of-the-above energy policy like those modeled in this report would help West Virginia take advantage of additional cost-effective compliance measures available under the Clean Power Plan, while at the same time capturing the other benefits of tapping into off of West Virginia’s energy resources. Leveraging all of West Virginia’s energy resources to reduce carbon pollution will also provide long-term benefits throughout the state as new jobs are created in new sectors of the state’s economy.

Navigating a path forward for West Virginia will require a comprehensive approach, both in terms of the energy resources deployed and the involvement of policymakers throughout both the state and federal government. Lawmakers, regulators, utility operators, and other stakeholders in West Virginia can build upon the results of this report and develop additional analyses to evaluate West Virginia’s options for meeting its obligations under the Clean Power Plan. Coordinating state planning efforts with other states and PJM will provide additional insights and new compliance avenues. West Virginia regulators deserve the full support of the state government to engage in regional planning discussions. Building on the analysis conducted for this report will enhance West Virginia’s ability to take advantage of the broad flexibility provided under the Clean Power Plan and serve the dual purpose of providing a framework for identifying opportunities to expand other sectors of the state’s energy economy and foster new opportunities for economic growth throughout the Mountain State.

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APPENDIX A: DETAILED MODELING ASSUMPTIONS

To model the two scenarios in CP3T, we utilized a combination of default values provided with the model, together with user-entered data and assumptions. This appendix documents key data inputs.

Capacity factors

The capacity factors used for each generation type are the same for both scenarios (See Table 6).

Table 6: Capacity factors by generation type: Both scenarios

Generation type	Capacity factor	Note
Wind	25.17%	Calculated based on 2012 eGRID wind generation and capacity in 2012 for West Virginia wind facilities.
Solar	13.7%	Calculated based on PVWatts information for West Virginia (NREL 2015).
Biomass	47%	CP3T default, based on 2012 eGRID data.
Hydropower	44.1%	Calculated based on 2012 eGRID hydropower generation and capacity in 2012 for West Virginia hydropower plants.
Energy efficiency	N/A	N/A
NGCC	70%	Assumption that matches EPA's BSER.
NGGT	3.1%	CP3T default for West Virginia for 2015 and later years.
Coal	Calculated by CP3T	Figure 12 illustrates the average capacity factor for each scenario and year.

Emission factors

The emission factors used for each generation type are the same for both scenarios (See Table 7).

Table 7: Emission factors by generation type

Generation type	Emission factor (lbs/MWh)	Note
Wind	0	Zero emissions renewable energy.
Solar	0	Zero emissions renewable energy.
Biomass	0	Zero emissions renewable energy.
Hydropower	0	Zero emissions renewable energy.
Energy efficiency	0	N/A
NGCC	1,030	EPA's New Source Performance Standard emission rate for NGCC (EPA 2015(g)).
NGGT	1,332	CP3T default, based on 2012 eGRID emissions and generation.
Coal	1,832-3,498	Varies by plant and unit. Emission factors shown are for plants/units active in 2012 with capacity factors above 5%. These emission factors decrease in scenarios that incorporate heat rate improvements and/or natural gas co-firing.

Installed capacity

The initial installed capacity for each generation type is the same for both scenarios (See Table 8), but the future installed capacities differ (Table 9 and Table 10).

Table 8: Initial installed capacity by generation type: Both scenarios

Generation type	Initial installed capacity (MW)	Note
Wind	637	CP3T default in 2014, based on EIA Form EIA-923 data.
Solar	0	CP3T default in 2014, based on EIA Form EIA-923 data, although the PSC reports 1.9 MW of distributed solar capacity in West Virginia (PSC 2014).
Biomass	1	CP3T default varies from 1 to 3 MW in 2012-2014.
Hydropower	324	CP3T default in 2014, based on EPA 2015(f), Appendix 1-5.
Energy efficiency	N/A	N/A
NGCC	0	N/A
NGGT	1,205	CP3T default.
Coal	16,010	CP3T default.

Table 9: Future installed capacity by generation type: Existing Sources Only Scenario

Generation type	Future installed capacity (MW)	Note
Wind	840 by 2030	Less aggressive goal than the Existing Plus New Sources Scenario
Solar	125 by 2030	Less aggressive goal than the Existing Plus New Sources Scenario
Biomass	No change	N/A
Hydropower	No change	N/A
Energy efficiency	N/A	Cumulative savings of 2.5% by 2030.
NGCC	1,830 by 2030	Moundsville operational in 2018, two additional plants in 2020
NGGT	No change	N/A
Coal	13,072 by 2030	Based on capacity remaining after coal plant retirements.

Table 10: Future installed capacity by generation type: Existing Plus New Sources Scenario

Generation type	Future installed capacity (MW)	Note
Wind	1,219 by 2030	More aggressive goal than the Existing Sources Only Scenario
Solar	356 by 2030	More aggressive goal than the Existing Sources Only Scenario
Biomass	No change	N/A
Hydropower	392 by 2030	More aggressive goal than the Existing Sources Only Scenario
Energy efficiency	N/A	Cumulative savings of 10% by 2030.
NGCC	2,075 in 2018	Moundsville operational in 2018, two additional plants in 2020, one additional plant in 2030
NGGT	No change	N/A
Coal	13,072 by 2030	Based on capacity remaining after coal plant retirements.

Total electricity sales

The average annual growth rate for West Virginia electricity sales for 2015 through 2031 from EIA's Annual Energy Outlook 2015 was used to model future total electricity generation in West Virginia. These values were provided within CP3T.

Displacement

In our scenarios, coal-fired generation in future years is displaced by all other energy resources. In other words, as renewables and NGCC increase in capacity in future years, more electricity is generated from these resources and less electricity is generated from coal.