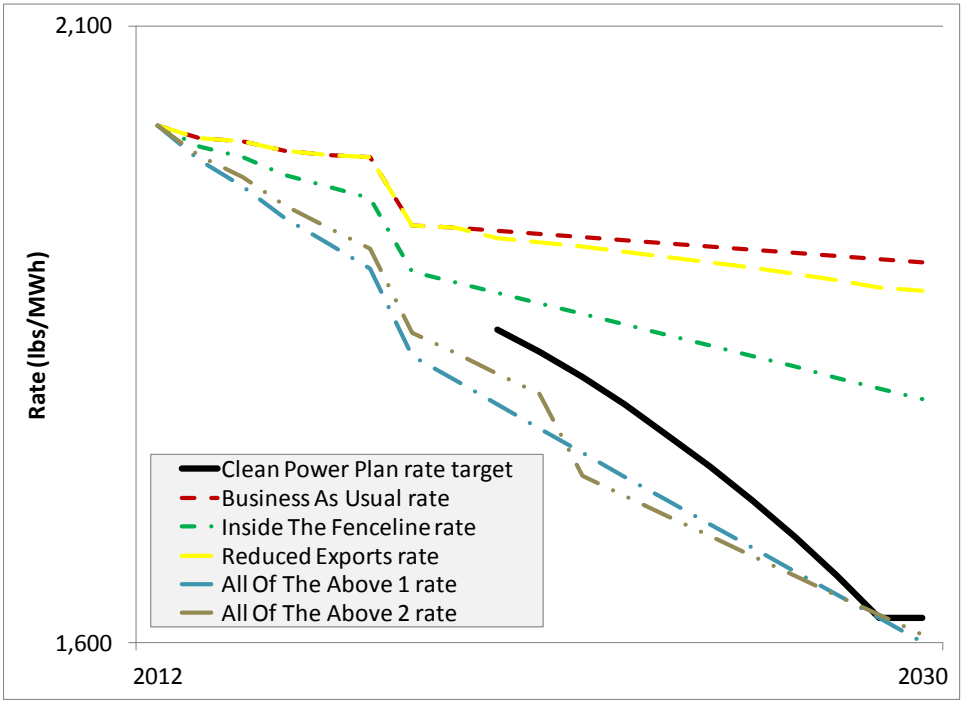
The Clean Power Plan and West Virginia:

Compliance Options and New Economic Opportunities



James Van Nostrand
Evan Hansen
Beren Argetsinger
Joseph James

WVU College of Law
Center for Energy & Sustainable Development

101 Law School Drive
Suite 270
Morgantown, WV 26505
www.energy.law.wvu.edu

Downstream Strategies

295 High Street
Suite 3
Morgantown, WV 26505
www.downstreamstrategies.com

WVU LAW
CENTER FOR ENERGY & SUSTAINABLE DEVELOPMENT

Downstream Strategies
building capacity for sustainability

Appalachian Stewardship Foundation

June 15, 2015

The Clean Power Plan and West Virginia:

Compliance Options and New Economic Opportunities

James Van Nostrand, Evan Hansen, Beren Argetsinger, Joseph James

ABOUT THE AUTHORS

James Van Nostrand, J.D., LL.M., M.A., Associate Professor and Director, Center for Energy & Sustainable Development, WVU College of Law. Mr. Van Nostrand is the founding director of the Center. Before coming to West Virginia University in 2011, he had a successful career in private law practice, directed a New York–based environmental NGO, and served as senior advisory staff at a state utility regulatory agency.

Evan Hansen, M.S., President, Downstream Strategies. Mr. Hansen founded Downstream Strategies, an environmental consulting company in West Virginia, in 1997. He explores resource and environmental problems and solutions in three areas: energy, water, and land.

Beren Argetsinger, J.D., M.E.M., Fellow for Energy & Environmental Law & Policy, Center for Energy & Sustainable Development, WVU College of Law. Mr. Argetsinger provides legal and policy analysis on federal and state climate, energy, and environmental law and policy.

Joseph James, B.A., Staff Scientist, Downstream Strategies. Mr. James collects and analyzes energy and emissions data and performs policy analyses.

Center for Energy & Sustainable Development

The Center is an energy and environmental public policy and legal research organization that promotes practices that balance the continuing demand for energy resources and their associated economic benefits, alongside the need to reduce the environmental impacts of developing the earth's natural resources. The Center's 2014 annual national energy conference examined the impacts of regulation of power plant CO_2 emissions on coal-dependent states and highlighted options for those states moving forward.

James Van Nostrand
james.vannostrand@mail.wvu.edu
energy.law.wvu.edu

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.

Evan Hansen
ehansen@downstreamstrategies.com
www.downstreamstrategies.com

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.

www.appalachianstewards.org

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 CO_2 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 regulation.

Following the conference and the release of the proposed Clean Power Plan rule 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 Clean Power Plan. The Discussion Paper also included a number of policy recommendations. This report builds upon the preliminary analysis from the Discussion Paper by modeling several additional scenarios and by expanding the discussion of policy recommendations.

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. The Appalachian Stewardship Foundation 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 (CP3T), 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 are grateful to Timothy Banach (Executive Director, Northeast Clean Heat and Power Initiative); Tom Bourgeois (Deputy Director, Pace Energy & Climate Center); Anne Hampson (Project Manager, ICF International); Jeff Simcoe (former Energy Program Project Manager, Downstream Strategies); and Jim Staudt (Principal, Andover Technology Partners) for sharing their expertise. We are also grateful to Ted Boettner (Executive Director, West Virginia Center on Budget and Policy), Patrick Knight (Associate, Synapse Energy Economics); Jeremy Richardson (Senior Energy Analyst, Union of Concerned Scientists); and Walton C. Shepherd (Staff Attorney, Natural Resources Defense Council) for their review and thoughtful comments on this report.

TABLE OF CONTENTS

EXECUTIVE SUMMARY ..... **VIII**

1. INTRODUCTION **1**

2. THE CLEAN POWER PLAN: REGULATION OF CARBON POLLUTION FROM EXISTING POWER PLANTS **3**

2.1 CLEAN POWER PLAN BASICS 3
2.2 RATE- AND MASS-BASED PERFORMANCE STANDARDS 6
2.3 MULTI-STATE PLANNING AND COORDINATION 7

3. THE WEST VIRGINIA ENERGY ECONOMY **9**

3.1 THE WEST VIRGINIA POWER SECTOR 10
3.2 THE WEST VIRGINIA COAL INDUSTRY 12
3.3 THE WEST VIRGINIA NATURAL GAS INDUSTRY 15

4. FLEXIBLE COMPLIANCE OPTIONS: A MENU OF EMISSION REDUCTION OPPORTUNITIES **18**

4.1 COAL-FIRED POWER PLANTS 18
4.1.1 Heat rate improvement 18
4.1.2 Co-firing and repowering 18
4.1.3 Operational changes 19
4.2 NATURAL GAS 19
4.2.1 Natural gas combined cycle plants 20
4.2.2 Combined heat and power 21
4.3 RENEWABLE ENERGY 21
4.3.1 Wind 22
4.3.2 Solar 22
4.3.3 Hydropower 22
4.4 END-USE ENERGY EFFICIENCY 23

5. APPLYING EMISSION-REDUCTION OPPORTUNITIES TO THE WEST VIRGINIA POWER SECTOR **24**

5.1 BUSINESS AS USUAL SCENARIO 28
5.2 INSIDE-THE-FENCELINE SCENARIO 30
5.3 REDUCED EXPORTS SCENARIO 32
5.4 ALL-OF-THE-ABOVE SCENARIOS 34
5.5 DISCUSSION 39

6. POLICY RECOMMENDATIONS **46**

6.1 REMOVE LEGISLATIVE RESTRICTIONS ON STATE PLAN DEVELOPMENT 46
6.2 ADOPT AN ENERGY EFFICIENCY RESOURCE STANDARD 47
6.3 ADOPT A RENEWABLE ENERGY PORTFOLIO STANDARD 48
6.4 ADOPT POLICIES THAT ENCOURAGE INVESTMENT IN CLEAN DISTRIBUTED GENERATION RESOURCES 48
6.5 ENCOURAGE GREATER USE OF THE STATE'S NATURAL GAS RESOURCES 49
6.6 ISSUE REVISED INTEGRATED RESOURCE PLANNING REQUIREMENTS FOR ELECTRIC UTILITIES 50
6.7 WORK WITH PJM STATES TO COORDINATE STATE PLANS AND EXPLORE OPTIONS FOR PARTICIPATING IN A MULTI-STATE PLAN 51
6.8 SUPPORT REGIONAL ECONOMIC DEVELOPMENT INITIATIVES 52

7. CONCLUSIONS **54**

REFERENCES **55**

APPENDIX A: DETAILED MODELING ASSUMPTIONS **62**

TABLES

Table 1: Application of the building blocks to calculate West Virginia's 2030 emission limit 4
Table 2: Recent and projected coal plant retirements in West Virginia 10
Table 3: Comparing Best System of Emission Reduction measures with measures modeled in the scenarios . 26
Table 4: Percent of total projected load by resource, 2030 39
Table 5: West Virginia coal production and coal burned in West Virginia power plants, 2013 (million tons) ... 41
Table 6: Projected coal prices, West Virginia coal burned, and severance taxes, 2012-2030 44
Table 7: Capacity factors by generation type: All scenarios 62
Table 8: Emission factors by generation type 62
Table 9: 2012 Installed capacity by generation type: All scenarios 63
Table 10: Future installed capacity by generation type: Business As Usual, Inside-The-Fenceline, and Reduced Export scenarios 63
Table 11: Future installed capacity by generation type: All-Of-The-Above 1 scenario 63
Table 12: Future installed capacity by generation type: All-Of-The-Above 2 scenario 64

FIGURES

Figure 1: Application of building blocks in setting the final emission limit for West Virginia 5
Figure 2: Interim and final emission rate reduction requirements for the Appalachian Highlands states 5
Figure 3: Electricity generation by source in West Virginia, 2013 9
Figure 4: West Virginia coal production and employment, 1990-2013 12
Figure 5: Coal, natural gas, and other severance tax collection in West Virginia, 2003-2014 14
Figure 6: Value of West Virginia coal exports to other countries, 2010-2014 14
Figure 7: West Virginia natural gas production, 1967-2013 16
Figure 8: Compliance with the rate-based target for all scenarios 27
Figure 9: Compliance with the mass-based target for all scenarios 27
Figure 10: Electricity generation by source under the Business As Usual scenario 29
Figure 11: Compliance with the rate-based and mass-based targets under the Business As Usual scenario 29
Figure 12: Electricity generation by source in the Inside-The-Fenceline scenario 31
Figure 13: Compliance with the rate- and mass-based targets in the Inside-The-Fenceline scenario 31
Figure 14: Electricity generation by source in the Reduced Exports scenario 33
Figure 15: Compliance with the rate- and mass-based targets in the Reduced Exports scenario 33
Figure 16: Electricity generation by source in the All-Of-The-Above 1 scenario 37
Figure 17: Compliance with the rate- and mass-based targets in the All-Of-The-Above 1 scenario 37
Figure 18: Electricity generation by source in the All-Of-The-Above 2 scenario 38
Figure 19: Compliance with the rate- and mass-based targets in the All-Of-The-Above 2 scenario 38
Figure 20: Renewables as a percentage of total load and as a percentage of in-state retail sales, 2030 39
Figure 21: West Virginia coal-fired capacity for all scenarios 40
Figure 22: Coal-fired power plant capacity factors for all scenarios 41
Figure 23: Projected West Virginia coal burned in West Virginia power plants, 2012-2030 42
Figure 24: Projected severance tax on West Virginia coal burned in West Virginia power plants, 2012-2030 . 43

ABBREVIATIONS

ACEEE	American Council for an Energy Efficient Economy
AREPS	Alternative and Renewable Energy Portfolio Standard
BCF	billion cubic feet
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
DG	distributed generation
EERS	Energy Efficiency Resource Standard
EGU	electric generating unit
EIA	Energy Information Administration
EPA	Environmental Protection Agency
FERC	Federal Energy Regulatory Commission
FY	fiscal year
GHG	greenhouse gas
HB	House Bill
IRP	integrated resource plan
lbs	Pounds
kWh	kilowatt-hour
MMcf	million cubic feet
MW	megawatt
MWh	megawatt-hour
NGCC	natural gas combined cycle
NREL	National Renewable Energy Laboratory
NSPS	new source performance standard
PJM	PJM Interconnection
PSC	Public Service Commission
PV	photovoltaic
RGGI	Regional Greenhouse Gas Initiative
RPS	Renewable Portfolio Standard
SCORE	Southern Coalfields Organizing and Revitalizing the Economy
SOAR	Shaping Our Appalachian Region
TSD	technical support document

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 U.S. 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 are expected to be finalized in the summer of 2015.

This report focuses on the proposed Clean Power Plan, which sets state-specific standards that would reduce carbon dioxide pollution from existing power plants. The proposed 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.

In this report, we review the proposed 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. While some changes to the proposed rule can be expected in the final rule, including the possibility that emission targets could move up or down, the emission reduction and associated socio-economic benefits of the compliance measures identified in this report will likely remain unchanged.

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 proposed Clean Power Plan.

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

The proposed Clean Power Plan would result in a 30% reduction of CO_2 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 proposed rule provides guidance for states to translate 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 2,019 pounds per megawatt-hour in 2012 to 1,620 pounds per megawatt-hour in 2030. Under a mass-based standard, West Virginia would be required to reduce carbon dioxide emissions from 72,327 thousand short tons in 2012 to 60,149 thousand short tons by 2030.

The U.S. Environmental Protection Agency established each state's pollution reduction targets based on the emission-reduction potential of the Best System of Emission Reduction, defined as a combination of measures, or "building blocks," that can be implemented at individual generating units and across the

broader electric system. The building block measures summarized below are widely used by states and utilities across the country.

1. Improve the heat rate at existing coal plants by 6%.
2. Redispatch natural gas combined cycle power plants to operate at a 70% capacity factor.
3. Expand generation from new non-hydropower renewable resources and preserve generation from at-risk and under-construction nuclear power plants.
4. Reduce the amount of generation required from fossil fuel–fired power plants through demand-side energy efficiency.

While the building blocks were used to develop each state's targets, they are not prescriptive for the purposes of determining a state's future electric sector profile, or resource mix. Instead, the Clean Power Plan provides states broad flexibility in selecting from the building blocks or using other measures not identified in the building blocks to meet the emission reductions required under the rule. In West Virginia, for example, additional compliance measures could include 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. Building block and non–building block measures are collectively referred to as compliance measures.

Applying emission-reduction opportunities to the West Virginia power sector

This report presents five scenarios that incorporate different compliance measures at different levels (See Figure ES-1). 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, and in some situations, how various combinations could result in West Virginia falling short of achieving compliance. The scenarios only model effects on generation and emissions 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 first two scenarios would not achieve compliance with the Clean Power Plan. They illustrate the pollution reduction limitations that arise from maintaining the status quo and from restricting the menu of available emission reduction measures to a narrow set of options. The scenarios modeled in this report that do not achieve compliance are:

- **Business As Usual.** This scenario reflects an emissions and generation profile that is a continuation of previous trends under existing policies and energy programs in West Virginia. Business As Usual illustrates a projected future energy mix absent the Clean Power Plan, if West Virginia continued under current energy and environmental policies. Business As Usual would not put West Virginia on track to achieve compliance with emission limits under the proposed Clean Power Plan.

- **Inside-The-Fenceline.** This scenario illustrates the emission reductions that could be achieved at West Virginia coal plants if certain legislative directives are strictly interpreted to restrict compliance measures to heat rate improvements at coal-fired power plants. It models the 6% heat rate improvement at coal plants estimated as part of the Best System of Emission Reduction. This is likely a high-end estimate for heat rate improvements at West Virginia coal plants and demonstrates that restricting compliance measures to heat rate improvements does not achieve the required emission reductions under either a rate- or mass-based compliance regime.

The other scenarios demonstrate three possible pathways by which West Virginia could achieve compliance. 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. The final two compliance scenarios illustrate how an "all-of-the-above" energy strategy would put West Virginia on a path to achieve compliance with the Clean Power Plan and advance economic development goals through an expanded energy economy.

- **Reduced Exports.** This scenario illustrates how a performance standard based solely on direct emission limits placed on coal plants—without the benefit of additional measures such as renewable energy or energy efficiency—could lower total emissions through reduced utilization of West Virginia coal plants. This scenario suggests that West Virginia could meet a mass-based target by ratcheting down net electricity exports over time so as to meet emission limits. Under this scenario, the amount of electricity generated, and carbon dioxide emitted, by coal plants would be reduced. Unlike the All-of-the-Above scenarios, however, the reduced generation from coal plants would not be replaced by other in-state generation or demand-side resources. One possible implication of this scenario would be that states that have traditionally imported electricity from West Virginia would have to reduce demand, increase in-state generation, or import generation from other states.

- **All-Of-The-Above 1.** This scenario presents the first of two "all-of-the-above" options and demonstrates how West Virginia could achieve compliance and 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 a new natural gas combined cycle plant, modest levels of natural gas co-firing at two coal-fired power plants, and new renewable energy, combined heat and power, and demand-side energy efficiency to achieve compliance under either a rate- or mass-based performance standard.

- **All-Of-The-Above 2.** This scenario utilizes the same measures as the first All-Of-The-Above scenario, but the level of each measure is adjusted. It illustrates a second possible pathway to achieve the required emission reductions under either a rate- or mass-based performance standard. Coal-fired generation would remain the main source of electricity generation in West Virginia, but by incorporating many other energy resources, West Virginia could retain the economic, social, and environmental benefits of developing new energy resources, maintain its position as a major electricity exporter, and meet its obligations under the Clean Power Plan.

The Business As Usual and Inside-The-Fenceline scenarios are not effective compliance options without additional multi-state or regional compliance components such as an emission trading program (See Figures ES-2 and ES-3). These scenarios demonstrate that West Virginia would not meet its rate- or mass-based targets by continuing previous trends under existing policies and energy programs, nor can West Virginia meet its targets by limiting itself to achieving emission reductions through heat rate improvements at coal-fired power plants alone.

Reducing exports of electricity generated in West Virginia could allow the state to meet a mass-based standard, but this strategy would not lead to compliance under a rate-based standard (See Figure ES-4). Further, reducing exports would cut back on the amount of electricity generated without investing in alternative supply- or demand-side resources. One potential consequence is that, as coal mines and power plants lay off employees; displaced workers would find few opportunities to develop other energy resources, such as renewable energy, demand-side energy efficiency, or combined heat and power. This scenario also raises important considerations about how the potential compliance options in one state—particularly net exporting states like West Virginia—could affect other states and how the pathways adopted by other states can similarly affect West Virginia. These cross-border implications underscore the need for multi-state coordination and planning.

Under both All-Of-The Above scenarios, West Virginia could meet its Clean Power Plan obligations under either a rate- or a mass-based standard (See Figures ES-5 and ES-6). An all-of-the-above compliance strategy would also create a framework upon which West Virginia could stimulate growth in the development of the state's other energy resources. This could help West Virginia retain the economic benefits of being a major electricity-exporting state, create new employment opportunities across the state's energy sector, and increase access to distributed generation and demand-side energy efficiency resources to insulate consumers from electricity rate hikes and better control their energy bills.

Figure ES-1: Compliance with the (A) rate-based and (B) mass-based target for all scenarios

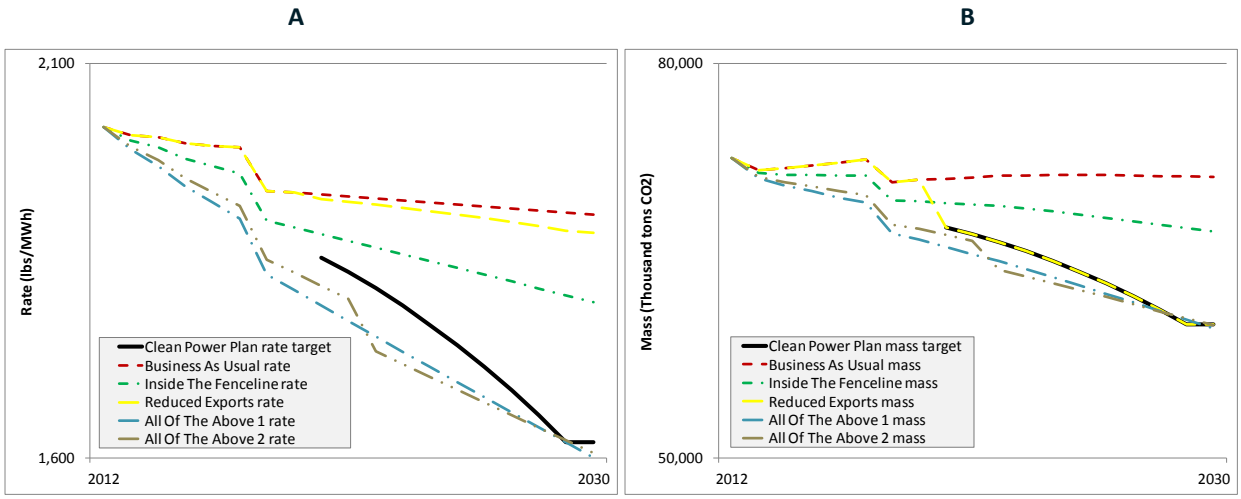


Figure ES-2: Compliance with the rate-based and mass-based targets under the Business As Usual scenario

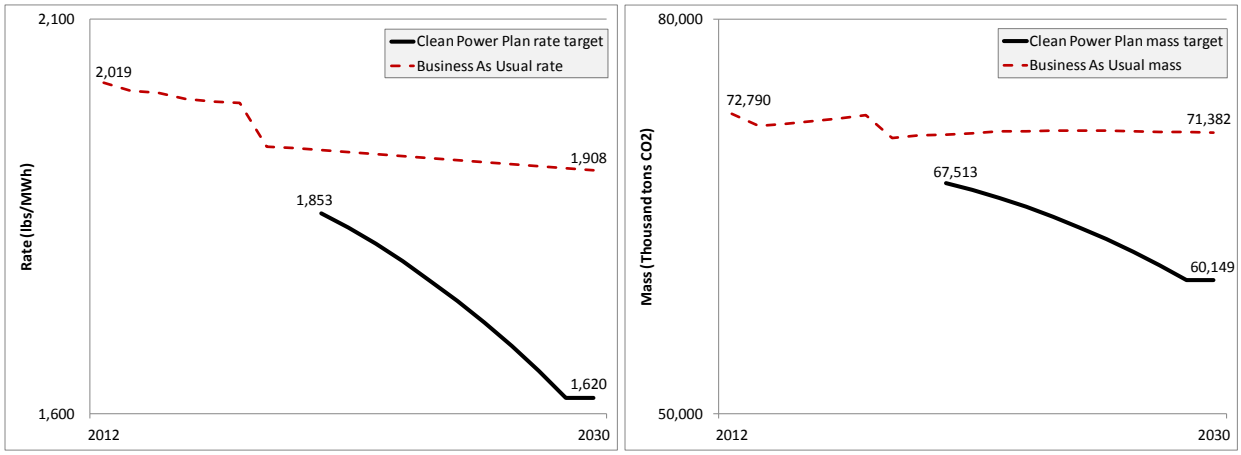


Figure ES-3: Compliance with the rate- and mass-based targets in the Inside-The-Fenceline scenario

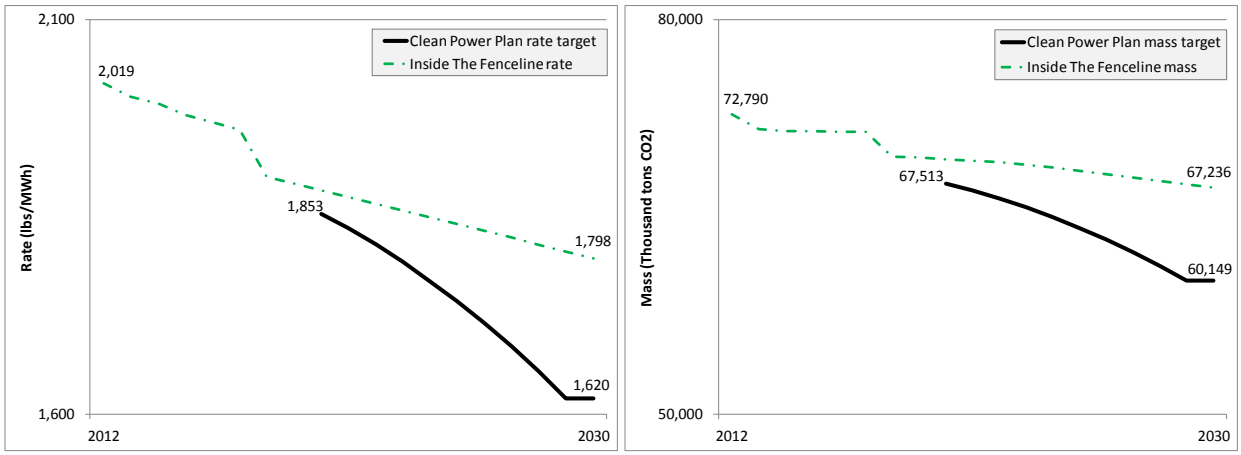


Figure ES-4: Compliance with the rate- and mass-based targets in the Reduced Exports scenario

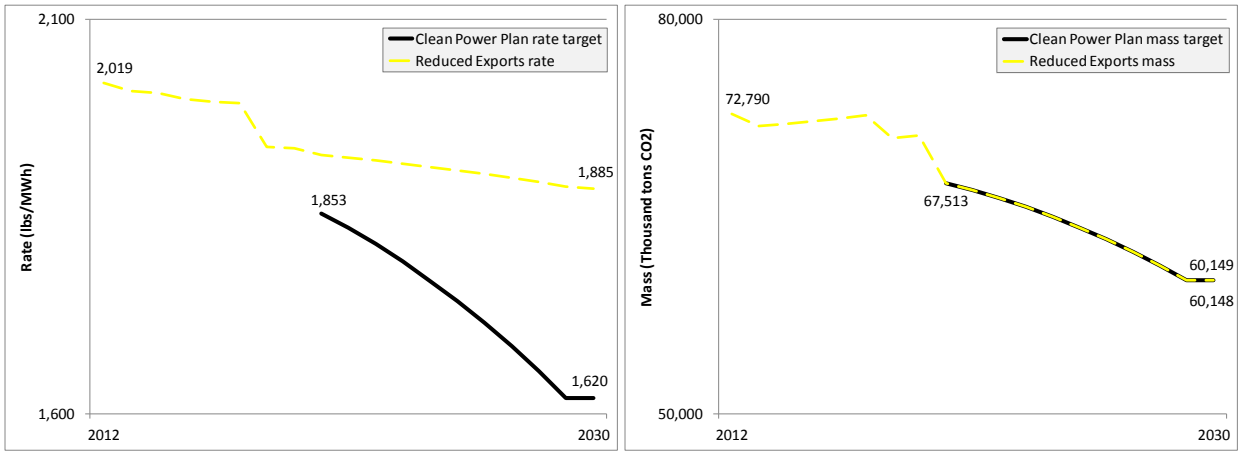


Figure ES-5: Compliance with the rate- and mass-based targets in the All-Of-The-Above 1 scenario

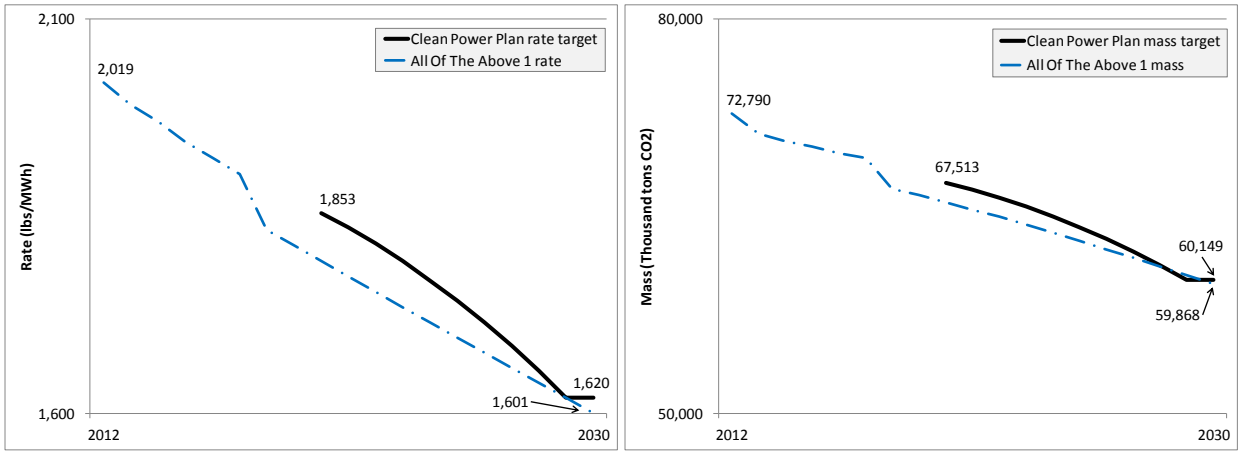
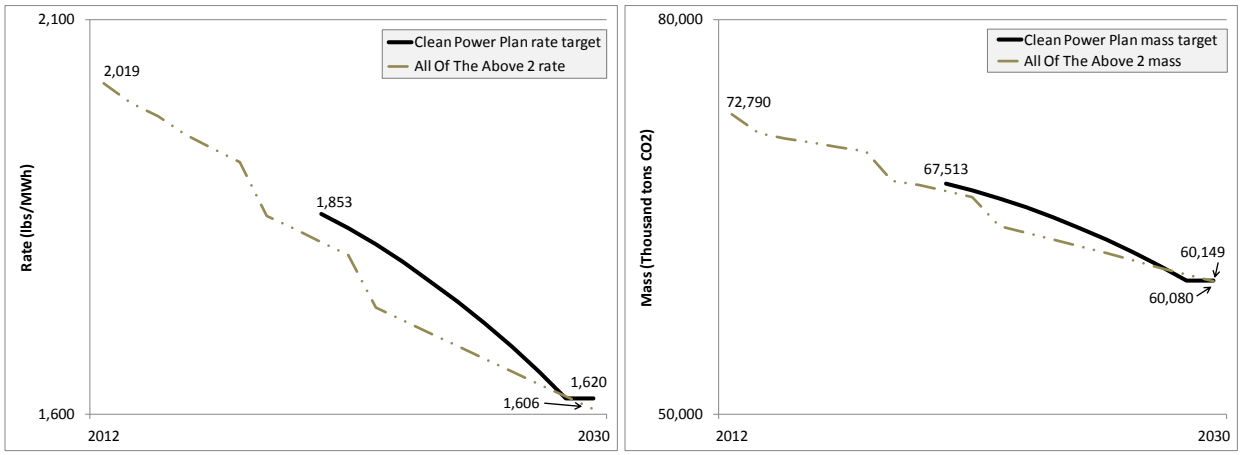


Figure ES-6: Compliance with the rate- and mass-based targets in the All-Of-The-Above 2 scenario



The compliance scenarios highlight an important fact about Clean Power Plan compliance: West Virginia power plants will be expected to burn less coal. It is important, however, to distinguish the impacts of West Virginia's plan to comply with the Clean Power Plan from the impacts of compliance decisions made by other states. A total of 112.8 million tons of coal were mined in West Virginia in 2013, but only 29.3 million tons of coal was burned at West Virginia power plants—17.0 million tons mined in West Virginia and 12.3 million tons mined elsewhere. West Virginia's Clean Power Plan compliance pathway, therefore, will have minimal impact on coal mining activity within the state, and depending on future coal prices, West Virginia may actually see an increase in severance taxes from West Virginia coal burned at West Virginia power plants. If current trends in natural gas production continue, West Virginia will continue to see substantial growth in natural gas severance tax revenue that could more than offset broader declines total coal severance taxes.

Policy recommendations

The proposed Clean Power Plan requires states to submit a state plan to the U.S. 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. This report offers legislative and regulatory policy recommendations that West Virginia could implement to foster a comprehensive energy strategy that would 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. adopt an Energy Efficiency Resource Standard,
3. adopt a Renewable Energy Portfolio Standard,
4. adopt policies that encourage investment in clean distributed generation resources,

5. encourage greater use of the state's natural gas resources,
6. issue revised integrated resource planning requirements for electric utilities,
7. explore options to partner with neighboring states to develop a multi-state plan, 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 proposed 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. 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 (CO_2) 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 (NSPS) for CO_2 emissions from new power plants under Section 111(b) of the CAA.[1] EPA followed the publication of the NSPS rule with the publication of the proposed the Clean Power Plan to establish CO_2 emission guidelines for existing power plants under Section 111(d) in June 2014.[2] Also in June 2014, EPA proposed CO_2 standards for modified and reconstructed power plants under section 111(b).[3] Each of these rules is expected to be finalized during the summer of 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.

The proposed Clean Power Plan sets state-specific standards that would result in a 30% reduction of CO_2 pollution from power plants in the U.S. by 2030, as compared with 2005 levels (EPA 2014(a)). The proposed 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 reduction requirements will vary by state, given each state's current infrastructure, resource strengths and constraints, energy policy frameworks, and other considerations. The proposed rule does not dictate which measures states must use, or the level of reduction any particular compliance measure must achieve. The flexibility built into the proposed 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 CO_2 pollution reduction strategies, it also poses important challenges—particularly for states that have traditionally depended upon

[1] Standards of Performance for Greenhouse Gas Emissions From New Stationary Sources: Electric Utility Generating Units, 79 Fed. Reg.1430 (Jan. 8, 2014) (to be codified at 40 C.F.R. pts 60, 70, 71, and 98). EPA had previously published draft 111(b) NSPS rules in April 2012 (see Standards of Performance for Greenhouse Gas Emissions for New Stationary Sources: Electric Utility Generating Units, 77 Fed. Reg. 22392 (Apr. 2012)), but that proposal was withdrawn with the publication of the January 8th rule. (EPA 2014(b))

[2] Carbon Pollution Emission Guidelines for Existing Stationary Sources: Electric Generating Units, 79 Fed. Reg. 34830 (June 18, 2014) (to be codified 40 C.F.R. part 60). (EPA 2014(a))

[3] Carbon Pollution Standards for Modified and Reconstructed Stationary Sources: Electric Utility Generating Units, 79 Fed. Reg. 34960 (June 18, 2014) (to be codified 40 C.F.R. part 60). (EPA 2014(c))

coal for electric generation and coal mining for economic development. Because coal-fired power plants emit over twice the amount of CO_2 pollution as natural gas–fired power plants and are responsible for nearly 80% of total power sector CO_2 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 coal is burned at 16 major power plants located within West Virginia, fueling approximately 95% of the electricity produced in the state. 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 CO_2 pollution emitted from power plants will result in reduced reliance on coal-fired power plants in West Virginia and across the county, which will reduce demand for West Virginia coal.

In this report, we review the proposed 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.

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

2.1 Clean Power Plan basics

The proposed Clean Power Plan provides state-specific CO_2 emission guidelines expressed in the form of an emission rate—pounds of CO_2 per megawatt-hour of net electricity produced (lbs/MWh). The rule also provides guidance for states to translate rate-based limits into mass-based limits (total CO_2 emissions in tons) (EPA 2014(g)). West Virginia's Clean Power Plan obligations require CO_2 emissions reductions from a rate of 2,019 lbs/MWh in 2012 to 1,620 lbs/MWh by 2030 (EPA 2014(a)). Alternatively, under a mass-based approach, West Virginia could choose to reduce its total power sector CO_2 emissions from 72,327 thousand short tons in 2012 to 60,149 thousand short tons by 2030 (EPA 2014 (d)).[4] Rate- and mass-based performance standards are discussed further in Section 2.2 of this Chapter.

States must meet their emission reduction obligations over two compliance periods – an interim and a final compliance period. The interim compliance period would require states to meet an average emission limit—under either the rate- or mass-based standard—from 2020 to 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 2014(a)).[5] This report focuses on the final compliance period. Following the issuance of the final rule, each state must develop a state plan that demonstrates how the state will meet its emission targets during the prescribed compliance periods. State plans are discussed further in Section 2.3 of this Chapter.

The CAA requires that EPA base emission guidelines on the Best System of Emission Reduction (BSER). EPA defined the BSER as a combination of measures, or "building blocks," that can be implemented at individual generating units and across the broader electric system and based each state's emission target on the application of the BSER to that state's existing electric generation profile (EPA 2014(a)). The building block measures summarized below are widely used by states and utilities across the country to reduce CO_2 and other pollutants.

1. Improve the heat rate at existing coal plants by 6% (2% from equipment upgrades, 4% from operational best management practices).
2. Redispatch natural gas combined cycle (NGCC) power plants to operate at a 70% capacity factor.
3. Expand generation from new non-hydropower renewable resources (13% national average by 2030) and preserve generation from at-risk and under-construction nuclear power plants.
4. Reduce the amount of generation required from fossil fuel–fired power plants through demand-side energy efficiency (10.7% average national cumulative savings by 2030).

Due to the unique makeup of each state's electricity mix, the contribution of each building block to a state's target, and the quantity of emission reductions achievable through the application of the BSER, vary from state-to-state. For instance, West Virginia's emission target is based in large part on the emission-reduction potential of non-hydropower renewable energy under Building Block 3, whereas North Carolina's limit is based largely on the emission reduction potential for redispatching existing NGCC plants under Building Block 2 (See Table 1, Figure 1, and Figure 2).

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. This means that states may achieve their required emission reductions through any combination of the building block measures and

[4] This report was released prior to the publication of the final rule. Rate- and mass-based emission limits, and other elements of the proposed rule could change under the final rule.

[5] 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.

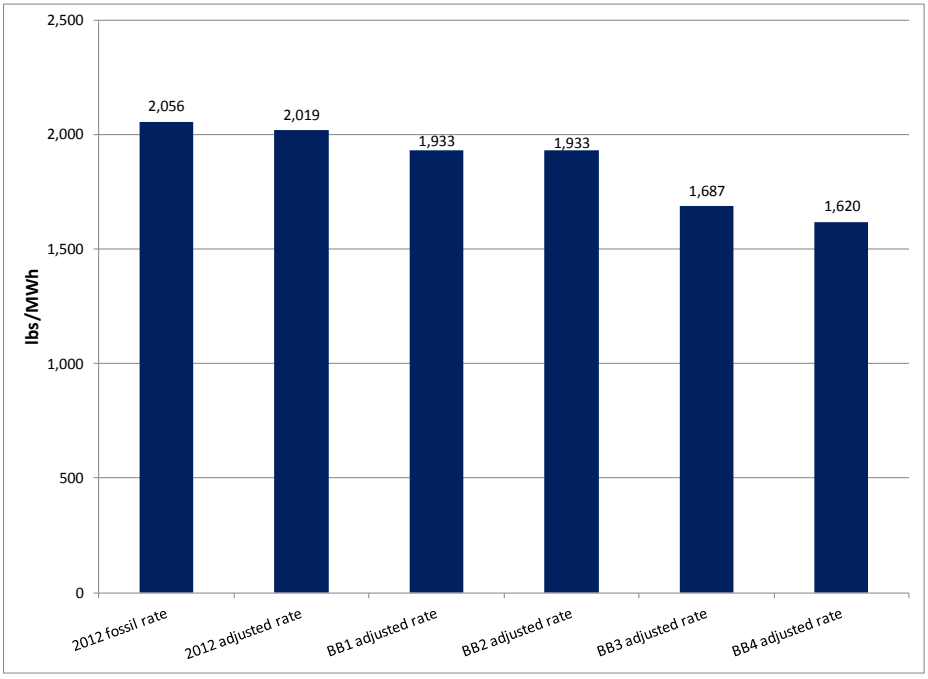
other, non-building block measures. This report refers to both building block and non–building block measures collectively as compliance measures. West Virginia has many compliance measures that can be deployed to achieve its required reductions, including improving the heat rate at existing coal plants; 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 2014(a)).

Table 1: Application of the building blocks to calculate West Virginia's 2030 emission limit

Building block	Description	Percent of reduction in limit
1: Improve heat rates at coal-fired power plants	Achieve a 6% heat rate improvement in each state's coal fleet. Improving the heat rate reduces the amount of fuel needed to generate the same amount of electricity, thereby reducing emissions. EPA estimates that a 2% heat rate improvement can be achieved through equipment upgrades and a 4% improvement through operational best management practices.	20%
2: Re-dispatch existing NGCC plants	Reduce emissions from the most carbon-intensive fossil plants—coal, and oil and gas steam plants—by re-dispatching existing NGCC plants to achieve a 70% capacity factor. Generating electricity from natural gas plants produces less than half the CO_2 emissions as generating electricity from coal plants. There are no existing NGCC plants in West Virginia; therefore, Building Block 2 did not affect West Virginia's target.	0%
3: Increase non-hydropower renewables and preserve nuclear	Substitute coal generation with new non-hydropower renewable resources such as wind and solar and preserve generation from at-risk and under-construction nuclear power plants. In West Virginia, EPA estimates that non-hydropower renewables can grow from 2% of total generation to 14% between 2012 and 2030. There are no nuclear generating facilities in operation or under construction in West Virginia; therefore, the nuclear portion of Building Block 3 did not affect West Virginia's target.	62%
4: Improve end-use energy efficiency	Reduce electricity demand through end-use energy efficiency. Starting in 2017, EPA projects that energy efficiency savings in West Virginia can grow by 0.2% annually and reach a national best practices level of 1.5% annual savings in 2024 and thereafter. EPA estimates that demand-side energy efficiency can reduce retail demand in West Virginia 10.71% by 2030.	17%

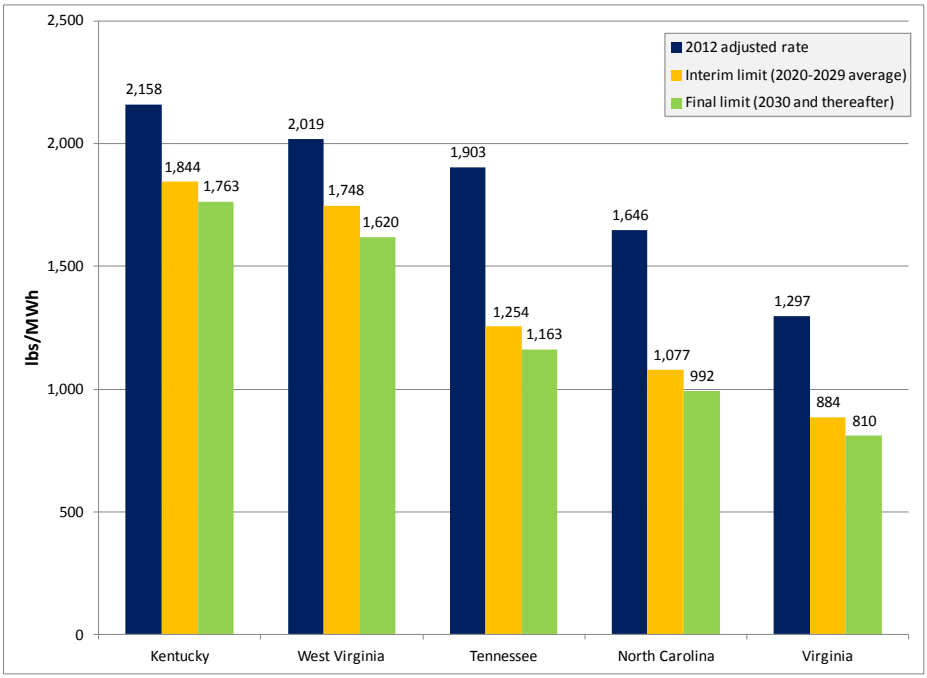
Source: EPA 2014(a). Note: Total percentage does not equal 100% due to rounding.

Figure 1: Application of building blocks in setting the final emission limit for West Virginia



Source: EPA 2014(e). Because the building blocks reflect fossil and non-fossil measures, the corresponding emission limits reflects a composite emission rate including fossil and zero-emission technologies. This result is reflected in the "adjusted rate."

Figure 2: Interim and final emission rate reduction requirements for the Appalachian Highlands states



Source: EPA 2014(e).

2.2 Rate- and mass-based performance standards

The proposed 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 CO_2 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 CO_2 emissions; rather, it requires a reduction in CO_2 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. Some potential combinations of measures that could lead to compliance under a rate-based standard are described in greater detail in Chapter 5.

While the emission targets are proposed in the form of a rate, the Clean Power Plan provides states the option to translate their rate-based emission target into a mass-based emission target (EPA 2014(g)). A mass-based limit is expressed in terms of a total tons of CO_2 emitted from the state's affected electric generating units (EGUs).[6] The mass-based limit is calculated by multiplying a state's final rate goal (as described in the Clean Power Plan) by total generation (EPA 2014(g)). Compliance with a mass-based standard ensures that the total amount of CO_2 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 be achieved by reducing the amount of CO_2 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.

As discussed Chapter 3, a significant amount of coal-fired generating capacity in West Virginia has retired, or is scheduled to retire by the end of 2015. The CO_2 reductions that result 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, 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.

Under a rate-based standard, because the rate is calculated based on pounds of CO_2/MWh, the scheduled coal plant retirements will have only a marginal impact on the overall emission rate unless the retired coal generation is replaced with new generation from lower-emitting resources such as renewable energy or natural gas, or energy efficiency. Under a mass-based standard, the scheduled coal plant retirements could result in reductions in total emissions that can be credited toward compliance if that retired generation is replaced with lower or non-emitting resources in West Virginia (such as natural gas, renewable energy, or energy efficiency) or if it is replaced with generation or energy efficiency resources in other states. As discussed in Chapter 5, under either a rate- or a mass-based standard, the emission

[6] Power plants covered by the rules are referred to as "affected electric generating units" (EGU) 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 1/3 or more of its potential net-electric output capacity and more than 219,000 MWh to any utility distribution system. *See* Clean Power Plan, Goal Computation Technical Support Document *available at* http://www2.epa.gov/sites/production/files/2014-06/documents/20140602tsd-goal-computation.pdf

reductions that would result from planned retirements are insubstantial if that generation is replaced with generation from new coal plants or increased utilization of existing coal plants in West Virginia.

2.3 Multi-state planning and coordination

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 proposed rule, state plans must be submitted to EPA by the summer of 2016. States also have the option to submit multi-state plans, which would be due by the summer of 2018. 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. EPA is expected to release a draft federal plan later this summer (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,[7] 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- or mass-based performance standards. It also presents opportunities to coordinate with other states on the development of individual state plans or to partner with other states to develop multi-state plans. Multi-state planning is not required under the proposed rule, but because of the dynamic interstate nature of the electric grid, multi-state cooperation can provide new or enhanced compliance pathways and result in significant compliance cost-reduction benefits (PJM 2015(c)).

Governors and attorneys general from numerous states, and some federal lawmakers, have suggested that states should not engage in the state plan process or develop and submit state plans while legal challenges to the rule are pending (Burnett 2015). This "just say no" approach to the Clean Power Plan would leave those states without the opportunity to identify the many options available to states and would put those states at a disadvantage with respect to compliance planning and collaboration with neighboring states. The state plan process is critical for evaluating state and regional energy needs and available resources, and collaborating with stakeholders and regulatory bodies in other states to share information on potential compliance strategies would potentially benefit all parties. Under a "just say no" approach, states forego the opportunity to work with their neighbors. Ultimately, if no state plan is submitted, this strategy invites the EPA to impose a federal plan. Given that EPA lacks familiarity with West Virginia characteristics and capabilities, a federal plan imposed on West Virginia would likely lead to higher compliance costs than if West Virginia acts to develop its own compliance strategy and exercises the broad flexibility afforded under the proposed rule.

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

[7] 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), http://www.pjm.com/about-pjm/who-we-are.aspx.

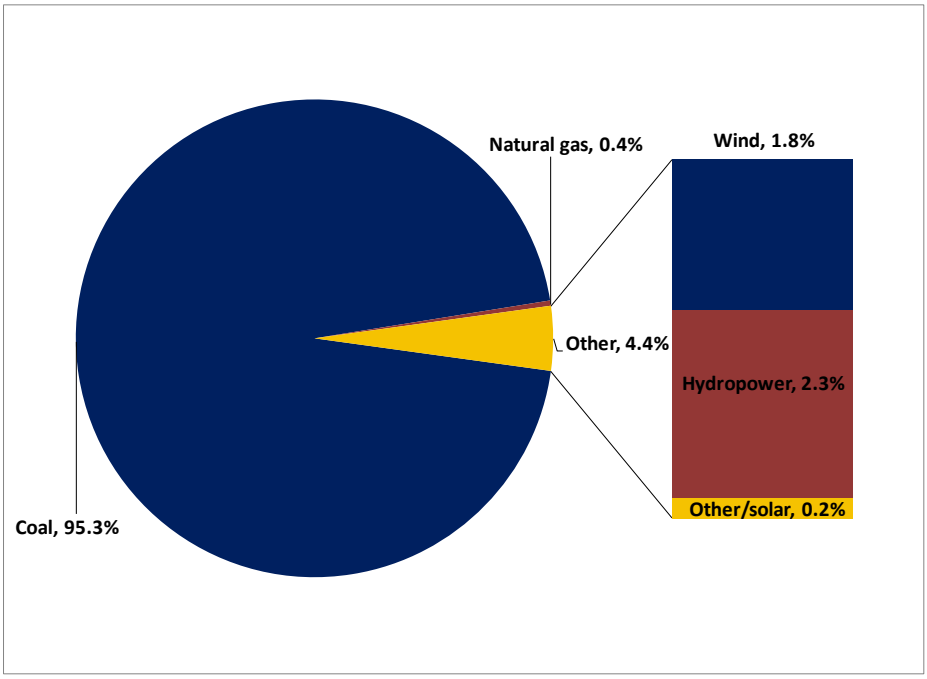
Virginia coal plants or the effect of meeting higher end-use energy efficiency targets in West Virginia on insulating consumers from projected electricity price increases that could result under various compliance scenarios. By taking advantage of the broad flexibility provided under the Clean Power 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.

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)).[8] 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% 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% of its annual electricity generation (EIA 2015(a)). West Virginia also has abundant renewable energy resources and has yet to tap into achieving 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 coal (See Figure 3). 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 the Mountain State 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 3: Electricity generation by source in West Virginia, 2013



Source: EIA 2015(m).

[8] The U.S. Energy Information Administration 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. In West Virginia, electric distribution utilities can also own electric generating resources.[9] 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); Monongahela Power (MonPower) and Potomac Edison (both of which are subsidiaries of FirstEnergy); Black Diamond Power Company; and the Harrison Rural Electrification Association. The American Electric Power 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(d)).

Sixteen coal plants operated in West Virginia in 2012, generating approximately 95% of the electricity produced in the state. Hydropower and wind generated the majority of the remaining 4%. (See Table 2). While coal plants in West Virginia accounted for only 4.4% of total load in PJM in 2012, West Virginia coal output accounted for 20% of PJM's total coal output (PJM 2015(c)). West Virginia's coal plants are aging, however, and six of the plants that operated in 2012 have either deactivated (retired) or are scheduled to deactivate in 2015—representing a loss of approximately 17% of the state's total generating capacity (PJM 2015(a)). As seen in 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 and projected coal plant retirements in West Virginia

Plant	Nameplate capacity (MW)	Age (years)	Deactivation date	2012 CO2 emissions rate (lbs/MWh)
Albright	278	59	September 2012	2,462
Rivesville	110	68	September 2012	N/A
Willow Island	213	63	September 2012	3,724
Phillip Sporn	1,105	62	Unit 5: 2010. Units 1-4: Expected June 2015	2,200
Kammer	713	53	Expected June 2015	2,113
Kanawha River	439	58	Expected June 2015	2,277
Total/Average	**2,858**	**60**		

Source: PJM 2015(a).

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(g). 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(a)).

[9] 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% in 2005 to 39% 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(k)). Despite increasingly unfavorable market conditions for coal-fired power plants, Appalachian Power Company and Wheeling Power Company recently purchased the Amos and Mitchell power stations, respectively, from affiliates in the American Electric Power holding company structure, and First Energy similarly sold 80% of its interest in the Harrison power station to MonPower, its operating company in West Virginia (PSC 2013). The decisions by American Electric Power 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.

In June 2014, following the purchase of those coal plants, the American Electric Power subsidiaries—Appalachian Power Company and Wheeling Power Company—filed for a 17% overall rate increase, and the FirstEnergy subsidiaries—MonPower and Potomac Edison—filed for a 16.5% increase in residential rates. Under the requested increases, Appalachian Power Company and Wheeling Power Company residential customers using 1,000 kWh per month would see their monthly bill rise from $94.00 to $115.77 (Appalachian Power Company 2014). MonPower and Potomac Edison residential customers using 1,000 kWh per month would see their monthly bill rise from $92.62 to $107.98 (MonPower 2014).

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% 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 (ACEEE 2014(b)). By contrast, West Virginia ranks forty-sixth (ACEEE 2014(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.

American Electric Power affiliates in West Virginia achieved energy efficiency savings of 0.13%, 0.31%, 0.30%, and 0.34% from 2011 to 2014, respectively (Kunkel, 2015). Its subsidiaries in neighboring Ohio are required to meet energy efficiency savings of 22% by 2027 (DSIRE 2015(a)). FirstEnergy affiliates in West Virginia have an energy efficiency savings target of 0.1% per year from 2013 to 2018 to achieve a cumulative savings of 0.5% over a five-year period (PSC 2013). By contrast, its subsidiaries in neighboring Pennsylvania achieved an average savings of 3.3% from 2009 to 2013 and are required to meet a cumulative energy efficiency savings of between 4.6% and 5.3% of 2010 sales by 2016 (DSIRE 2015(b)).[10] The absence of an array of energy efficiency programs in West Virginia is a major reason why West Virginia ranks forty-sixth in the country with respect to energy efficiency—and why West Virginians use much more electricity to receive the same level of energy services compared with consumers in more energy-efficient states (ACEEE 2014(b)).

Similar to West Virginia's virtually untapped energy efficiency potential, renewable energy resources accounted for only 4% of total electric generation in West Virginia in 2012. 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. Renewable energy resource potential in the West Virginia power sector is discussed further in Chapter 4.

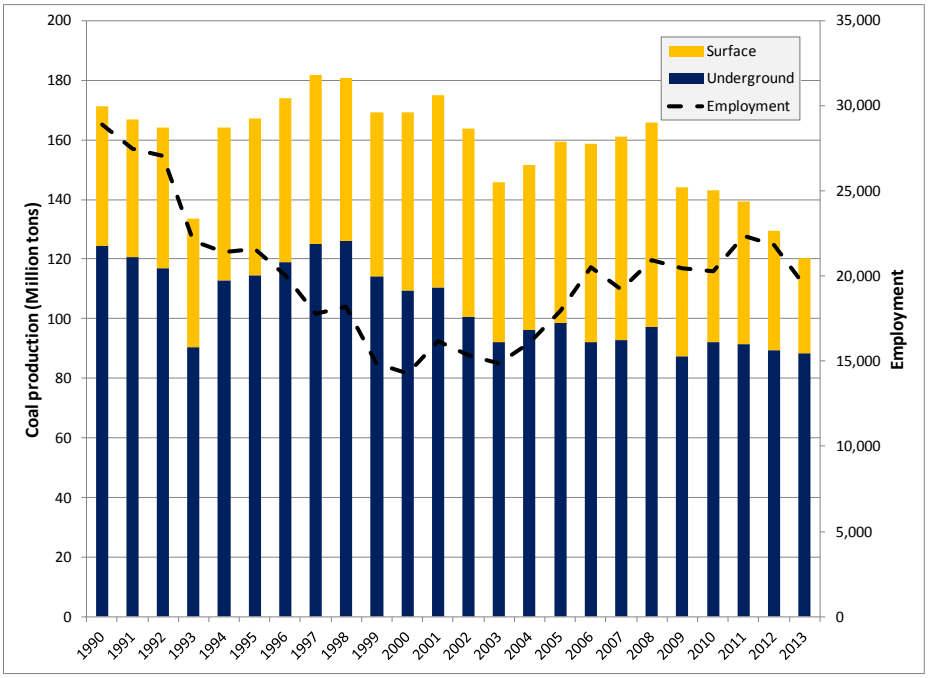
[10] The First Energy utilities operating in Pennsylvania with savings targets in parentheses are: Met-Ed (5.3%), West Penn (4.6%). Penelec (5.2%), and Penn Power (5.0%). Targets are the combined Act 129 Phase I and Phase II requirements for each utility. The annual sales period is measured from June to May. Phase I began in June 2009, and Phase II will conclude in May 2016. *See* Pennsylvania Public Utility Commission, Electric Distribution Company Act 129 Reporting, http://www.puc.state.pa.us/filing_resources/issues_laws_regulations/act_129_information/electric_distribution_company_act_129_reporting_requirements.aspx.

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 4). Fewer and fewer West Virginians work in the state's coal mines as mechanization replaces the need for human labor, the most economic coal seams reach the end of their productive life, competition from other energy sources—such as natural gas and renewable energy—becomes 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.[11]

Figure 4: West Virginia coal production and employment, 1990-2013



Source: MHS&T 2015.

Coal production costs are a significant factor impacting the West Virginia coal mining sector, particularly in southern West Virginia, with 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

[11] In addition to the recently proposed Clean Power Plan and NSPSs for power plant CO_2 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).

standards (Lego 2015). This partly explains more recent declines in coal production in southern West Virginia. In January 2015, Alpha Natural Resources notified nearly 100 workers at West Virginia coal mines that it plans to idle operations, and in May, Murray Energy Corporation announced layoffs of over 1,400 workers in West Virginia (Vorhees 2015; Conti 2015).

Electric generators accounted for 93% 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% (EIA 2014(f)). 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% in 2008 to 44% by 2012 (EIA 2015(c)). During that same period, North Carolina utilities increased their use of natural gas for electric generation from 3% to 17% (UCS 2014(a)). 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)).

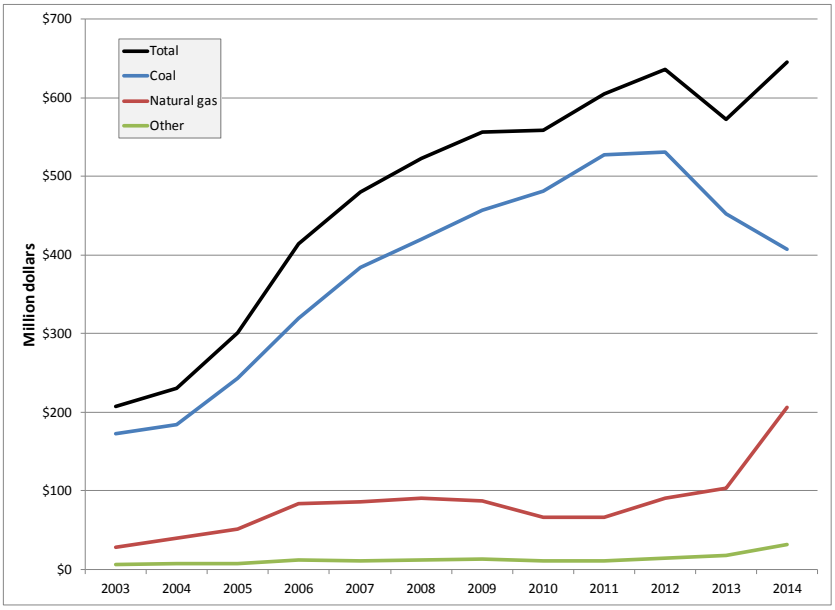
In addition to the employment and electric generation benefits of coal, West Virginia depends on coal production for severance tax revenue. Severance tax revenue (from all sources) accounted for 9% of total state taxes in fiscal year (FY) 2010—the seventh-highest percentage of any state (O'Leary 2011).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

West Virginia levies a 5% 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% are provided to local governments.[12] 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.[13] Beginning in FY 2012/2013, the state began apportioning part of the state portion to local governments. The share began at 1% in 2012/2013 and increases 1% per year to 5% in FY 2016/2017 (Fed. of Tax Adm'rs 2015).

As illustrated in Figure 5, 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. This decline has impacted coal-producing counties around the state particularly hard. Some local government agencies have responded with layoffs and pay reductions for county employees (Maher 2015).

[12] Some coal production is taxed at a different rate.
[13] W. Va. Code § 11-13A-6.

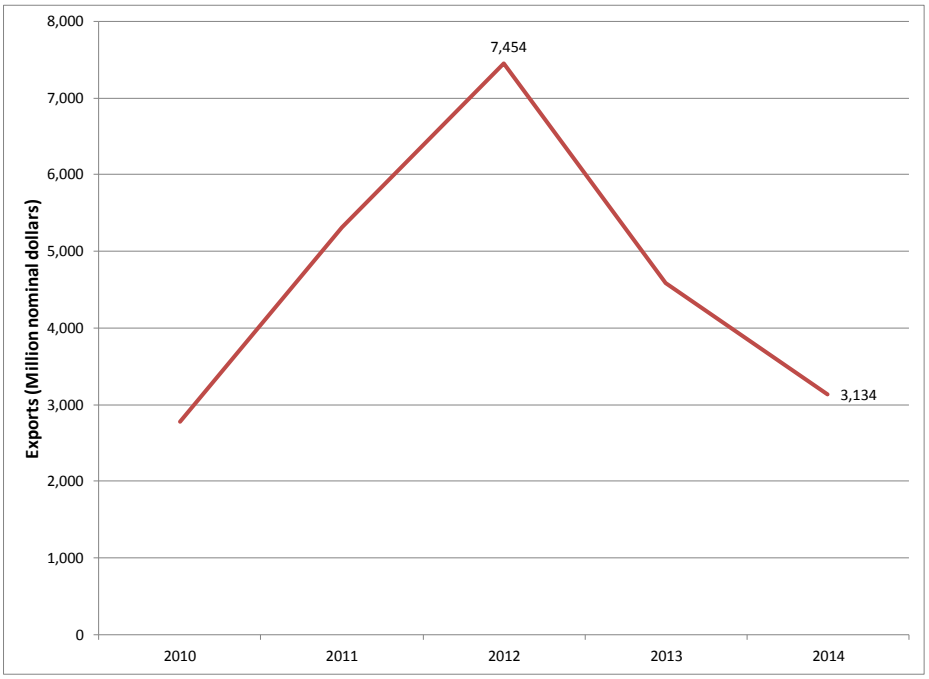
Figure 5: Coal, natural gas, and other severance tax collection in West Virginia, 2003-2014



Source: Fed'n of Tax Adm'rs 2015. Note: Years are fiscal years.

As illustrated in Figure 6, 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 6: Value of West Virginia coal exports to other countries, 2010-2014



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

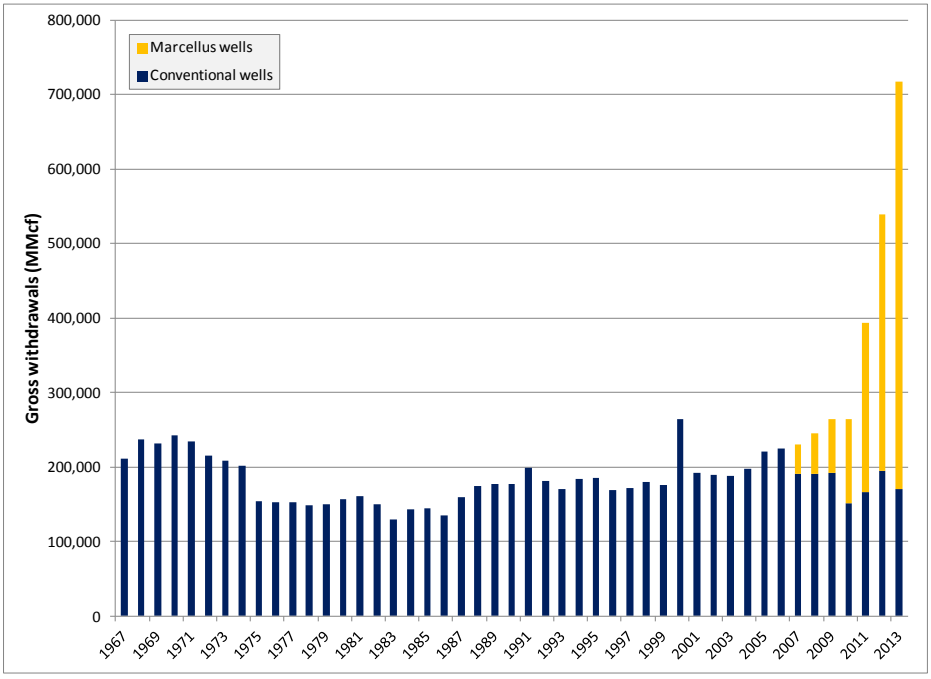
Numerous factors have contributed to declining production in West Virginia coal. Shifts occurring in the electric power sector both internationally and domestically suggest a more evenly distributed mix of resources will be used to generate electricity. EIA projects that under the proposed Clean Power Plan, on a national basis from 2014-2040, coal plant retirements will increase to 90 GW from the estimated 40 GW over that same time period without the Clean Power Plan (EIA 2015(k)). 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% 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 7, 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)). According to the West Virginia University College of Business and Economics, West Virginia natural gas production is 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 7: West Virginia natural gas production, 1967-2013



Source: EIA 2015(j).

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 (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(k)). 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.

Like the severance tax levied on coal, West Virginia levies a 5% severance tax on the gross value of natural gas production.[14] For natural gas, 90% percent of the severance tax revenue is allocated to the state, and the remaining 10% is allocated to counties and municipalities.[15] 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 5, 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 (Fed. of Tax Adm'rs 2015).

West Virginia's natural gas resources will play an important role as West Virginia'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 proposed Moundsville NGCC plant. 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 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.

[14] W. Va. Code § 11-13A-5a.
[15] W. Va. Code § 11-13A-5a.

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

In 2012, 16 coal plants generated approximately 95% of the electricity produced in West Virginia and accounted for 20% of the total coal output in the PJM region (PJM 2015(c)). In order to meet the CO_2 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 compliance measures that were analyzed in this report and that are available in West Virginia. The compliance 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, co-firing and repowering, and dispatch changes that reduce the run time of coal-fired power plants. Each of these options can be achieved at the coal-fired power plant and 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 electric generating unit, 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. West Virginia coal plants produced electricity at an average heat rate of 2,056 lbs CO_2/MWh in 2012. For the purpose of calculating CO_2 reduction potential, EPA estimated that existing coal-fired power plants across the country can achieve, on average, a 6% heat rate improvement (EPA 2014(a)). An average 6% heat rate improvement at West Virginia power plants would reduce the average emission rate of fossil generating resources in the state to 1,933 lbs/MWh. Alternatively, 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% to 3% (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% use of natural gas, although some modifications may allow for up to a 30-50% co-firing capability (Reinhart 2012).

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 Facility, and Longview plants. The remaining plants would require modifications to co-fire with natural gas (EPA 2014(h)). 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 2014, 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 (VA SCC 2014). Those conversions are underway and expected to be completed by late 2015 or early 2016 (VA SCC 2014). 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(h)).

Co-firing and repowering are straightforward and technologically feasible strategies for reducing emissions, but they require plant-specific analysis of additional permitting issues, capital requirements, and other considerations. These may be attractive compliance measures that could be implemented at some coal plants in West Virginia and should be evaluated as additional Clean Power Plan compliance options. Co-firing and repowering are explicitly prohibited under current West Virginia law for the purpose of reducing CO_2 emissions for Clean Power Plan compliance.[16] The potential for co-firing with natural gas to reduce power plant CO_2 emissions is discussed further in Chapter 5.

4.1.3 *Operational changes*

As of 2012, six coal plants with a combined capacity of 2,858 MW have retired or plan to retire by 2015. The emissions avoided by no longer generating electricity from these sources can help West Virginia achieve compliance under the Clean Power Plan, particularly on a mass basis. Emission reductions from these retirements can be captured if the load formerly supplied by these retired units is replaced by low- or zero-emission resources, including out-of-state resources, in-state energy efficiency or renewable energy, in-state natural gas, or in-state coal plants with lower heat rates.

PJM observed in its Clean Power Plan analysis that West Virginia's coal plants are among the lowest-cost thermal resources in the PJM region, and it is likely that these plants would be dispatched ahead of other resources in PJM, even if new renewables and energy efficiency are built in West Virginia (PJM 2015(c)). Absent a multi-state or regional plan that facilitates compliance through emission trading or another mechanism to allocate carbon credits and payments, West Virginia coal plants could require operational limits on the amount of electricity that can be generated from a particular unit to ensure that total statewide emissions do not exceed a prescribed threshold. An operational limit could be established to meet mass-based standards. A limit could also be part of a strategy to meet a rate-based standard, if coupled with increased generation from non- or lower-emitting resources such as energy efficiency, renewables, or natural gas.

An operational limit affects the economic utilization of the unit and is explicitly prohibited under current West Virginia law for the purpose of reducing CO_2 emissions for Clean Power Plan compliance.[17] The potential for operational limits to reduce carbon pollution are 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% of total U.S. shale gas production (EIA 2014(e)). West Virginia is one of the largest producers of shale gas and is production in the

[16] W. Va. Code Ann. § 22-5-20.
[17] W. Va. Code Ann. § 22-5-20.

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. This report assumes that the generation and emissions from new NGCC and CHP facilities are captured under the Clean Power Plan.

Because CO_2 emissions from new NGCC plants will be regulated under the NSPS rule issued under Section 111(b) of the CAA, EPA requested comment in the proposed Clean Power Plan on whether generation and emissions from new NGCC plants should be included under the final 111(d) rule as part of a state's emissions rate or budget, or whether only the emissions reductions that result from new NGCC plants displacing generation from existing affected EGUs should be included in the calculation of a state's emission rate or budget (EPA 2014(a)). EPA discussed this consideration further in the technical support document (TSD) for translating rate-based goals to mass-based equivalents. In the TSD, EPA proposed and provided guidance on two methods by which states could translate their rate-based goals to mass-based equivalents. The first method translates the rate target to a mass-based equivalent under the assumption that only emissions from existing affected power plants are counted toward a state's total emission budget (EPA 2014(g)). The second method sets a mass-based equivalent under the assumption that emissions from both existing affected plants and new plants (such as new NGCC) are counted toward a state's total emission budget. This report assumes that generation and emissions from NGCC plants are included in rate- and mass-based calculations, as proposed under the second method discussed in the rate-to-mass TSD.

4.2.1 *Natural gas combined cycle plants*

NGCC power plants are more efficient, emit less CO_2 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 CO_2 reduction potential from existing NGCC plants, EPA estimated that the utilization of existing NGCC plants across the country could be increased to a 70% 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 has been proposed for construction in Moundsville. The Moundsville plant is expected to bring 549 MW of high-efficiency capacity into service as early as 2018 (PJM 2015(b)).

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, has filed three memoranda of understanding with county commissions in West Virginia regarding the construction of additional NGCC plants. (Marcellus Drilling 2015). If built, two of these plants would provide an additional 1,300 MW of capacity in Brooke County—one plant with 750 MW of capacity and the other with 550 MW. The capacity of the third plant in Harrison County is not yet publicly available (Marcellus Drilling 2015).

Although a memorandum of understanding does not contractually obligate Energy Solutions Consortium to build the plants, these filings underscore investor interest in natural gas–fired generation and suggest that West Virginia is likely to add more NGCC generation capacity in the next decade. If these new NGCC facilities are built, they could 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 2012(b)). 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% of installed CHP capacity (DOE 2012(b)). 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 2012(b)).

West Virginia currently has 169 MW of installed CHP capacity and has significant potential for future growth (EIA 2015(l)). According to 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). The potential for CHP to reduce power sector emissions is discussed in greater detail in Chapter 5.

4.3 Renewable energy

Renewable energy resources accounted for over 13% of total U.S. electricity generation in 2014 (EIA 2015(h)). In West Virginia, renewables—primarily hydropower and wind—account for only 4% of total electric generation (EIA 2014(c)). For the purpose of calculating CO_2 reduction potential from non-hydropower renewables in West Virginia, EPA estimated that these sources could grow to 14% by 2030 (EPA 2014(a)).

While there are limits to renewable energy development within the state, there is still the potential for renewable energy to play a significant role in reducing the emission intensity of West Virginia's electric power sector. The proposed rule contemplates that a state may take credit for the emission reductions that are achieved from renewable energy projects located in that state or in another state, so long as any out-of-state project is implemented in response to a renewable portfolio standard or other measure requiring the development renewable energy in the state that is claiming the credit for those reductions (EPA 2015(a)). Depending on the language of the final rule, the technical and economic potential for renewable energy development in West Virginia may not be a limiting factor in the state's ability to incorporate higher levels of renewable energy in a state plan, if states are allowed to include out-of-state projects under certain conditions.

As discussed in Section 6.3 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. While EPA did not estimate the potential for incremental hydropower to reduce carbon pollution when setting state goals in the proposed Clean Power Plan, the proposed rule allows states to credit incremental hydropower toward compliance (EPA 2014(a)). This section discusses the availability of wind, solar, and hydropower resources in West Virginia.

4.3.1 *Wind*

Wind power supplied 4.4% of total U.S. generation in 2014 and over 5% of total electric generation in 19 states (AWEA 2015(b)). Advancements in wind technology have reduced wind energy costs 43% over the past four years and support projections for future growth in wind generation nationally—and in West Virginia (AWEA 2014(c)). 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 583 MW of installed wind capacity and another 160 MW permitted for construction (W. Va. 2014(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). 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% 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% and 30% above 2012 levels (SEIA 2015(b)).

West Virginia currently has 1.9 MW of total installed solar capacity, 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). West Virginia can achieve similar or greater levels of solar installation at homes and businesses 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.

4.3.3 *Hydropower*

Nationally, hydropower accounts for over half of all renewable generation in the U.S. and approximately 7% of total electric generation (NHA 2015). Thirteen facilities provide a total of 371 MW of hydropower capacity in West Virginia and account for approximately 2% of the state's electric generation (EPA 2014(a)). While the proposed Clean Power Plan does not consider the potential for new ("incremental") hydropower development in the calculation of state emission targets, the proposed rule does allow states to credit any emission reductions that result from incremental hydropower development toward compliance with emission limits (EPA 2014(a)). For West Virginia, this means that CO_2 emissions displaced by incremental hydropower could be credited toward compliance under the Clean Power Plan.

A number of incremental 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 the Federal Energy Regulatory Commission (West Virginia 2014(a)). Furthermore, the Department of Energy estimates that West Virginia has 210 MW of incremental

hydropower capacity at existing dams that do not currently produce hydroelectric power (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(a)). The potential for incremental 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 CO_2 and other harmful pollutants (ACEEE 2014(a); EPA 2014(a)). For purposes of calculating the CO_2 emission reduction potential of energy efficiency in West Virginia, EPA estimated that end-use energy efficiency can reduce in-state electricity demand by 10.71% by 2030 (as compared to business-as-usual projections) (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% (0.1% 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% 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% 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(a)). In 2014, nine of the top 10 states identified by ACEEE in its 2014 State Energy Efficiency Scorecard had adopted binding energy efficiency resource requirements (DSIRE 2015; ACEEE 2014(b)). West Virginia does not have an energy efficiency standard and ranked forty-sixth in the ACEEE Scorecard, meaning that it has significant opportunity for improvement (ACEEE 2014(b)). The state could likely achieve significantly higher levels of energy efficiency than projected by EPA (Van Nostrand 2013(a); ACEEE 2014(a)). The potential for energy efficiency to reduce power sector carbon emissions is discussed further in Chapter 5.

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

The scenarios presented in this chapter build upon and replace the compliance scenario modeled in our previous discussion paper (Van Nostrand 2014) and offer suggestions on how various combinations of compliance measures could be used in West Virginia to reduce power sector CO_2 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. Since the draft Clean Power Plan rule was proposed, other reports and analyses have reviewed various compliance measures and analyzed state plan pathways that, in addition to this report, could provide additional ideas and guidance for West Virginia lawmakers and regulators engaged in the state plan process (See, e.g., PJM 2015(c), NACAA 2015).

The proposed rule sets emission targets that states must meet over the interim (2020-2029) and final (2030) compliance periods. West Virginia's final rate-based target is 1,620 lbs/MWh, and its final mass-based target is 60,149 thousand short tons.[18] The scenarios presented here illustrate how various combinations of measures could enable the state to achieve compliance and, in some situations, how various combinations would result in West Virginia falling short of achieving compliance with its final emission targets. While this report does not explicitly address the interim compliance period, the scenarios that achieve compliance in 2030 also achieve compliance during the interim period. Table 3 summarizes the measures modeled in each scenario; additional details are provided in the text that follows in Sections 5.1 through 5.4 and in Appendix A.

To model the scenarios, we used the Clean Power Plan Planning Tool (CP3T), which was developed by Synapse Energy Economics, Inc. CP3T is a Microsoft Excel–based, open source spreadsheet tool (Synapse 2015). We used version 1.4, and included some adjustments to model the emission reduction impacts of CHP, natural gas co-firing, and hydropower resources.

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, or other states in PJM, may adopt to meet Clean Power Plan obligations.

The first two scenarios presented would not achieve compliance with the Clean Power Plan. These scenarios illustrate the limitations that arise as a result of policies that maintain the status quo or that restrict the menu of available emission reduction measures to a narrow set of options. The scenarios modeled in this report that do not achieve compliance are:

[18] See Translation of the Clean Power Plan Emission Rate-Based CO_2 Goals to Mass-Based Equivalents Technical Support Document for additional information on translating rate-based targets to mass-based equivalents. EPA proposes and provides guidance on two possible methods by which states could translate their rate-based goals to mass-based equivalents. These methods are not exclusive and states may propose additional methods that result in different mass-based translations. The first method translates the rate target to a mass-based equivalent under the assumption that only emissions from existing affected power plants are counted toward a state's total emission budget. Under this method, West Virginia's mass limit would be 52,636 thousand metric tons, or 58,022 thousand short tons, of CO_2. The second method sets a mass-based equivalent under the assumption that emissions from both existing affected plants and new plants (such as new NGCC) are counted toward a state's total emission budget. Under this method, West Virginia's mass limit would be 54,566 thousand metric tons, or 60,149 thousand short tons. This paper assumes mass-based compliance is calculated under the second method and expresses mass-based emissions in short tons.

- **Business As Usual.** This scenario reflects an emissions and generation profile that is a continuation of previous trends under existing policies and energy programs in West Virginia. Business As Usual illustrates a projected future energy mix absent the Clean Power Plan, if West Virginia continued under current energy and environmental policies. Business As Usual would not put West Virginia on track to achieve compliance with emission limits under the proposed Clean Power Plan.

- **Inside-The-Fenceline.** This scenario illustrates the emission reductions that could be achieved at West Virginia coal plants if certain legislative directives are strictly interpreted to restrict compliance measures to heat rate improvements at coal-fired power plants. It models the 6% heat rate improvement at coal plants estimated as part of the Best System of Emission Reduction. This is likely a high-end estimate for heat rate improvements at West Virginia coal plants and demonstrates that restricting compliance measures to heat rate improvements does not achieve the required emission reductions under either a rate- or mass-based compliance regime.

These two scenarios demonstrate that West Virginia would not meet its rate- or mass-based targets by continuing previous trends under existing policies and energy programs, nor can West Virginia meet its targets by limiting itself to achieving emission reductions through heat rate improvements at coal-fired power plants without additional multi-state or regional compliance components such as an emission trading program.

The other scenarios modeled in this report demonstrate three possible combinations of compliance measures that could reduce CO_2 emissions to achieve compliance with the proposed 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 CO_2 pollution.

- **Reduced Exports.** This scenario illustrates how a performance standard based solely on direct emission limits placed on coal plants—without the benefit of additional measures such as renewable energy or energy efficiency—could lower total CO_2 emissions through reduced utilization of West Virginia coal plants. This scenario suggests that West Virginia could meet a mass-based target by ratcheting down net electricity exports over time so as to meet emission limits. Under this scenario, the amount of electricity generated, and CO_2 emitted, by coal plants would be reduced. Unlike the All-of-the-Above scenarios, however, the reduced generation from coal plants would not be replaced by other in-state generation or demand-side resources. One possible implication of this scenario would be that states that have traditionally imported electricity from West Virginia would have to reduce demand, increase in-state generation, or import generation from other states.

- **All-Of-The-Above 1.** This scenario presents the first of two “all-of-the-above” options and demonstrates how West Virginia could achieve compliance and 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 a new natural gas combined cycle plant, modest levels of natural gas co-firing at two coal-fired power plants, and new renewable energy, combined heat and power, and demand-side energy efficiency to achieve compliance under either a rate- or mass-based performance standard.

- **All-Of-The-Above 2.** This scenario utilizes the same measures as the first All-Of-The-Above scenario, but the level of each measure is adjusted. It illustrates a second possible pathway to achieve the required emission reductions under either a rate- or mass-based performance standard. Coal-fired generation would remain the main source of electricity generation in West Virginia, but by incorporating many other energy resources, West Virginia could retain the economic, social, and environmental benefits of developing new energy resources, maintain its position as a major electricity exporter, and meet its obligations under the Clean Power Plan.

The Reduced Exports scenario illustrates how significant reductions in coal-fired generation can achieve reductions in CO_2 emissions sufficient to meet a mass-based standard. The final two scenarios illustrate how an "all-of-the-above" energy strategy would put West Virginia on a path to achieve compliance with the Clean Power Plan under either a rate- or a mass-based standard. These scenarios also incorporate additional compliance measures that advance economic development goals through an expanded energy economy.

Figure 8 and Figure 9 illustrate the CO_2 emission rates and tons of CO_2 emissions associated with each of the five scenarios.

Table 3: Comparing Best System of Emission Reduction measures with measures modeled in the scenarios

	EPA's target (BSER)	Business As Usual	Inside-The-Fenceline	Reduced Exports	All-Of-The-Above 1	All-Of-The-Above 2
Building block						
1: Improve heat rates at coal-fired power plants	6% improvement	N/A	6% improvement	N/A	3% improvement	1% improvement
2: Re-dispatch existing NGCC plants	N/A to WV	N/A to WV	N/A to WV	N/A to WV	N/A to WV	N/A to WV
3: Increase non-hydropower renewables	14% of total generation by 2030	3% of total generation by 2030	3% of total generation by 2030	3% of total generation by 2030	7% of total generation by 2030	5% of total generation by 2030
4: Improve end-use energy efficiency	Cumulative savings of 10.71%	Cumulative savings of 2.5% by 2030	Cumulative savings of 2.5% by 2030	Cumulative savings of 2.5% by 2030	Cumulative savings of 10% by 2030	Cumulative savings of 13% by 2030
Other						
Hydropower	N/A	N/A	N/A	N/A	2.2% of total generation by 2030	3.1% of total generation by 2030
New NGCC plants	N/A	549 MW by 2018	549 MW by 2018	549 MW by 2018	549 MW by 2018	549 MW by 2018; additional 549 MW by 2022
Combined heat and power	N/A	N/A	N/A	N/A	757 MW by 2030	316 MW by 2030
Natural gas co-firing	N/A	N/A	N/A	N/A	10% co-firing at two plants by 2030	30% co-firing at two plants by 2030
Electricity exports	2012 exports continue through 2030	2012 exports continue through 2030	2012 exports continue through 2030	2012 exports reduced, 2020-2030 to meet mass-based limit	2012 exports continue through 2030	2012 exports continue through 2030

Source: EPA 2014(a). Other measures as 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 provided for the All-Of-The-Above scenarios represent 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.

Figure 8: Compliance with the rate-based target for all scenarios

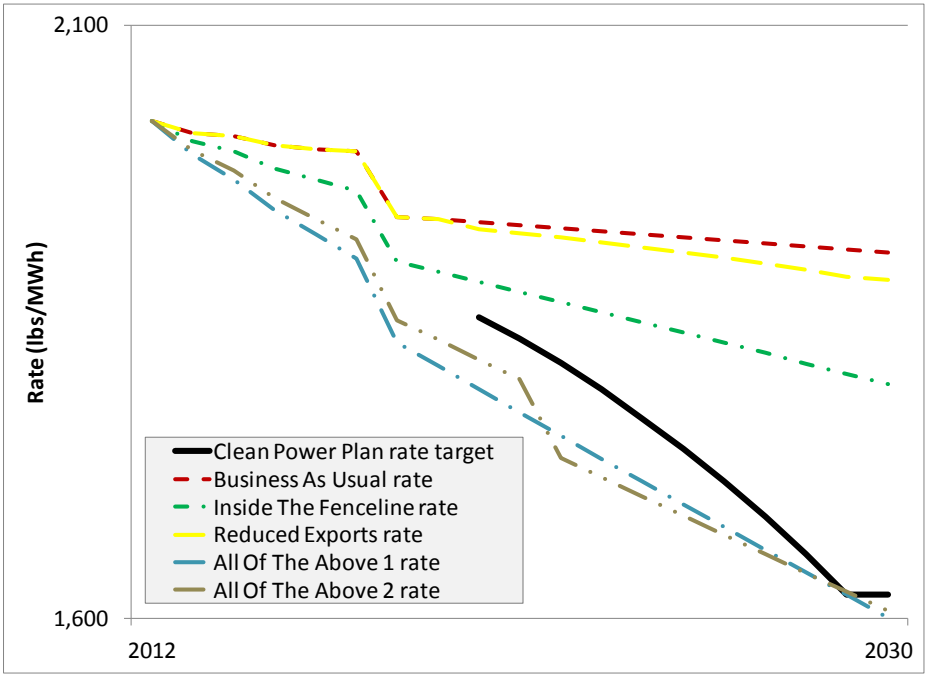
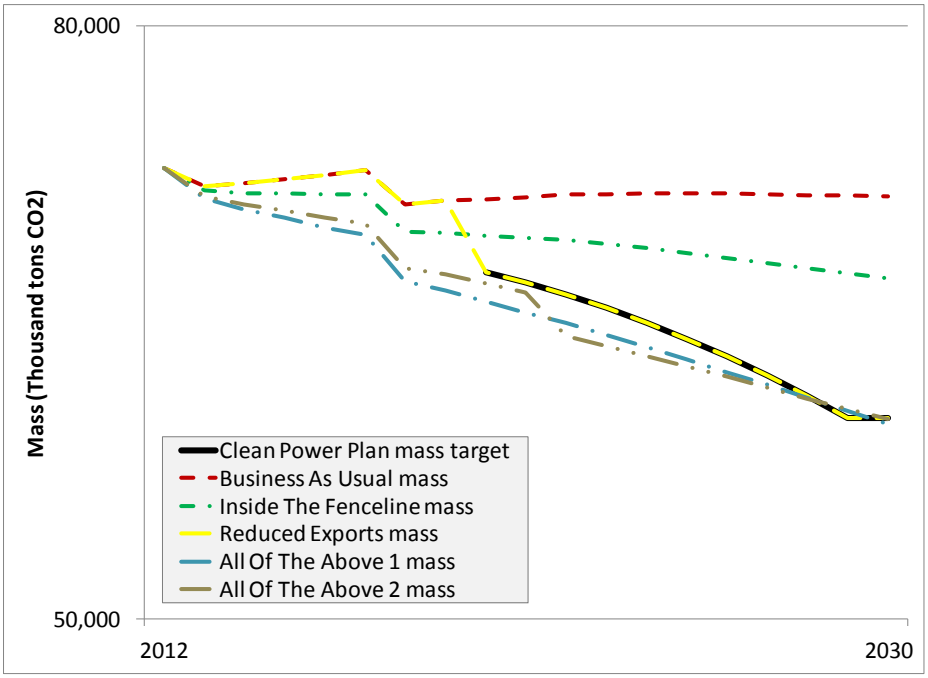


Figure 9: Compliance with the mass-based target for all scenarios



5.1 Business As Usual scenario

The Business As Usual scenario models a continuation of previous trends through 2030 (See Appendix A). Coal plants that have retired since 2012, or which are slated for retirement, are retired on schedule. As shown above in Table 2, these include the Albright, Rivesville, Willow Island, Phillip Sporn, Kammer, and Kanawha River plants. While these retirements reduce the total capacity of West Virginia's coal fleet, they do not result in substantial emission reductions because remaining coal plants in West Virginia run at higher capacity factors in the future to replace the generation lost to these retirements.

One new power plant, the Moundsville NGCC plant, comes on-line under its announced schedule, and no new coal plants are built. Demand-side energy efficiency and renewable energy (wind and solar) grow marginally, while no new biomass, hydropower, or CHP generation is built. The coal plants that remain open operate at an average capacity factor of approximately 60% (See Figure 22 below).

Business As Usual Highlights in 2030

- No heat rate improvements at coal-fired power plants
- Coal plants account for 89% of total load
- Moundsville NGCC plant comes online in 2018, new NGCC accounts for 4% of total load
- No new CHP is built, existing CHP accounts for 1% of total load
- Wind and solar grow marginally , no new hydropower is built
- Renewables account for 5% of total load
- Demand-side energy efficiency savings grows marginally to 2.5% of retail sales and accounts for 1% of total load

As illustrated in Figure 10, West Virginia's electricity generation continues to be dominated by coal. The only significant change is the resource mix is that the 549-MW Moundsville NGCC plant becomes operational and displaces a significant amount of coal-fired electricity in West Virginia. The addition of the Moundsville NGCC plant reduces West Virginia's emission rate and total emissions (See Figure 11). Still, business as usual is not an effective compliance option, and significant additional reductions are necessary to meet the rate- or mass-based emission targets.

Figure 10: Electricity generation by source under the Business As Usual scenario

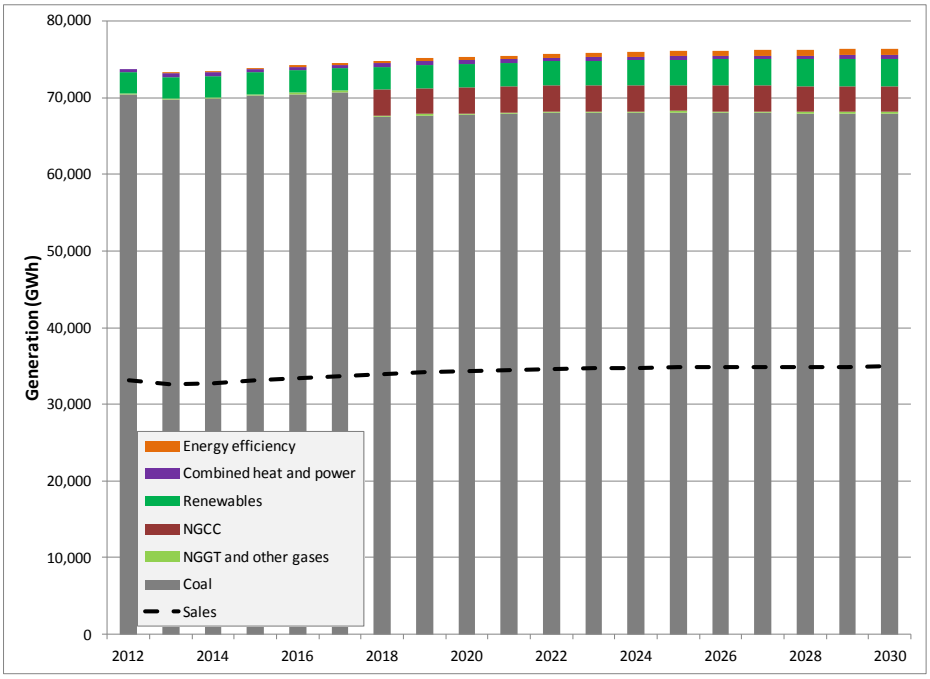
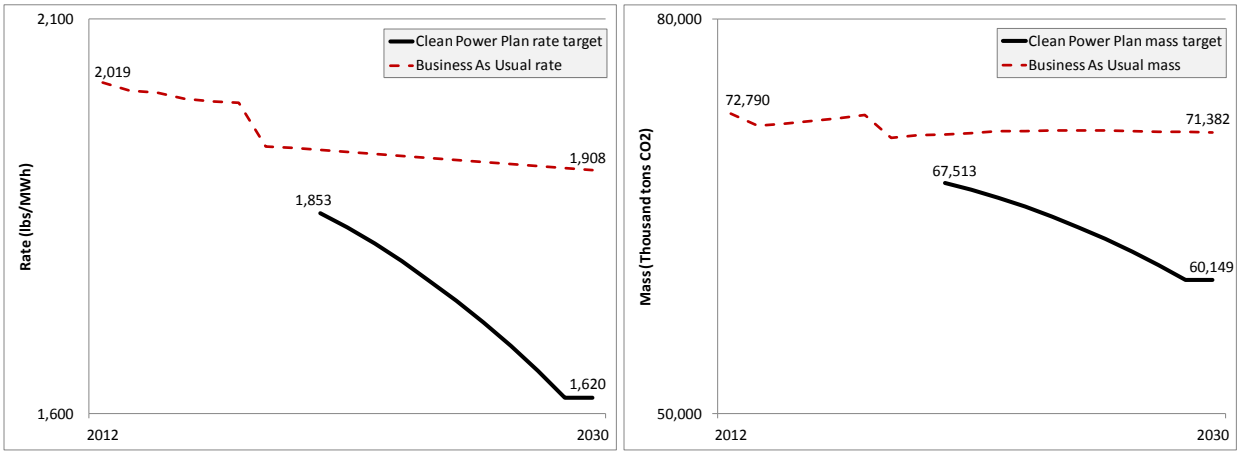


Figure 11: Compliance with the rate-based and mass-based targets under the Business As Usual scenario



5.2 Inside-the-Fenceline scenario

Inside-the-fenceline emission reduction measures are those that can be achieved at an individual generating unit, or power plant. These measures can include efficiency improvements, limiting the amount of electricity that is produced, fuel switching or co-firing with less carbon-intensive fuels, or other measures taken at the plant that result in direct emission reductions.

In 2015 the West Virginia Legislature passed, and the Governor signed into law, House Bill (HB) 2004. HB 2004 provides guidance to DEP regarding the development of a state plan.[19] Under HB 2004, DEP is precluded from considering fuel-switching, repowering, or any measures that affect the economic utilization of a unit when setting performance standards. The Inside-the-Fenceline scenario models the CO_2 emission reductions that could be expected if DEP developed performance standards based solely on heat rate improvements at individual power plants—to the exclusion of other compliance options such as demand-side energy efficiency, renewable energy, fuel switching, repowering, or the many other options available under the Clean Power Plan. This limitation would prevent West Virginia from meeting its emission reduction targets on an individual state basis.

The Inside-The-Fenceline scenario illustrates the emission reduction result that could be achieved if DEP developed emission performance standards based solely an average heat rate improvements of 6% at coal-fired power plants in operation after 2020. The 6% improvement is the average improvement that EPA estimates is likely achievable at coal plants across the country under Building Block 1 of the BSER. This is likely an aggressive target for coal plants in West Virginia because many of the older, less-efficient plants that would likely have room for more significant efficiency improvements have recently retired or announced retirement dates that will occur before the compliance timeline begins. This scenario does illustrate, however, what is likely a best-case scenario for achievable reductions in CO_2 emissions in the event that DEP sets performance standards based solely on heat rate improvements at coal plants.

Inside-The-Fenceline Highlights in 2030

- 6% heat rate improvements at coal-fired power plants
- Coal generation accounts for 89% of total load
- Moundsville NGCC plant comes online in 2018, new NGCC accounts for 4% of total load
- No new CHP is built, existing CHP accounts for 1% of total load
- Wind and solar grow marginally and no new hydropower is built
- Renewables account for 5% of total load
- Demand-side energy efficiency grows marginally to achieve a cumulative savings of 2.5% of retail sales and accounts for 1% of total load

As illustrated in Figure 12, total electricity generation remains at the same level as the Business As Usual scenario. Generation is dominated by coal, and the only significant change in generating capacity is the opening of the Moundsville NGCC plant. Energy efficiency and renewable energy sources increase marginally. The Moundsville plant, together with the heat rate improvements at coal-fired power plants, result in West Virginia's emission rate and total mass emissions declining over time, as illustrated in Figure 13.

Limiting emission reduction opportunities to inside-the-fenceline heat rate improvements, West Virginia would not meet its rate- or mass-based limit on a statewide basis. The Inside-The-Fenceline scenario shows that a restrictive approach to compliance limits West Virginia from utilizing other, potentially more

[19] W. Va. Code Ann. § 22-5-20.

cost-effective measures as part of a compliance strategy. As discussed in the policy recommendations below, in order to ensure that DEP has the tools it needs to develop a cost-effective compliance strategy that leverages all of West Virginia strengths, the West Virginia Legislature should amend HB 2004 to allow DEP to consider all available compliance measures, including emission trading and other market-based mechanisms, as provided under the Clean Power Plan.

Figure 12: Electricity generation by source in the Inside-The-Fenceline scenario

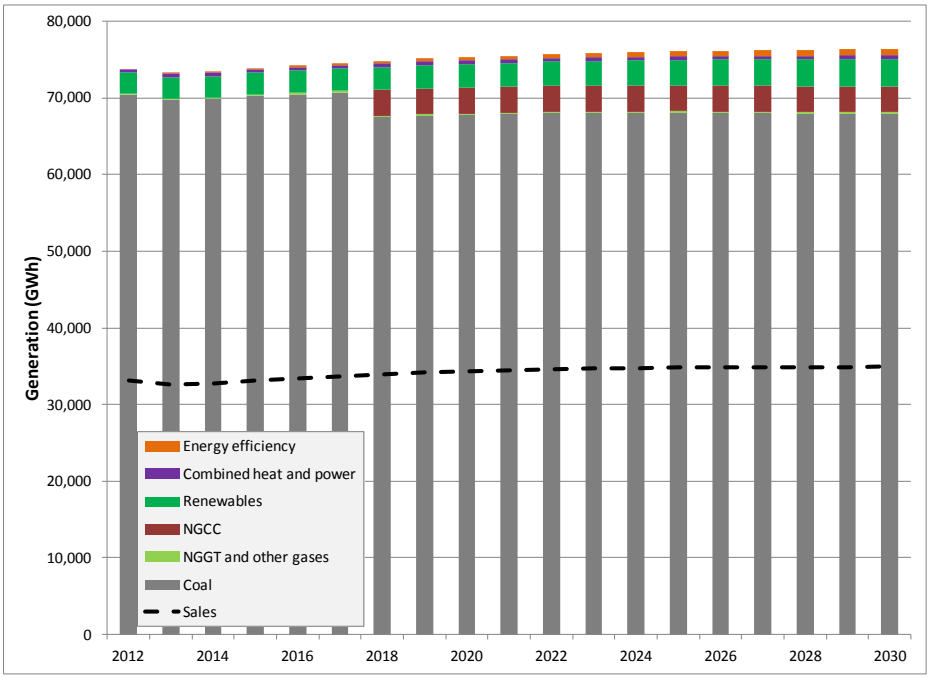
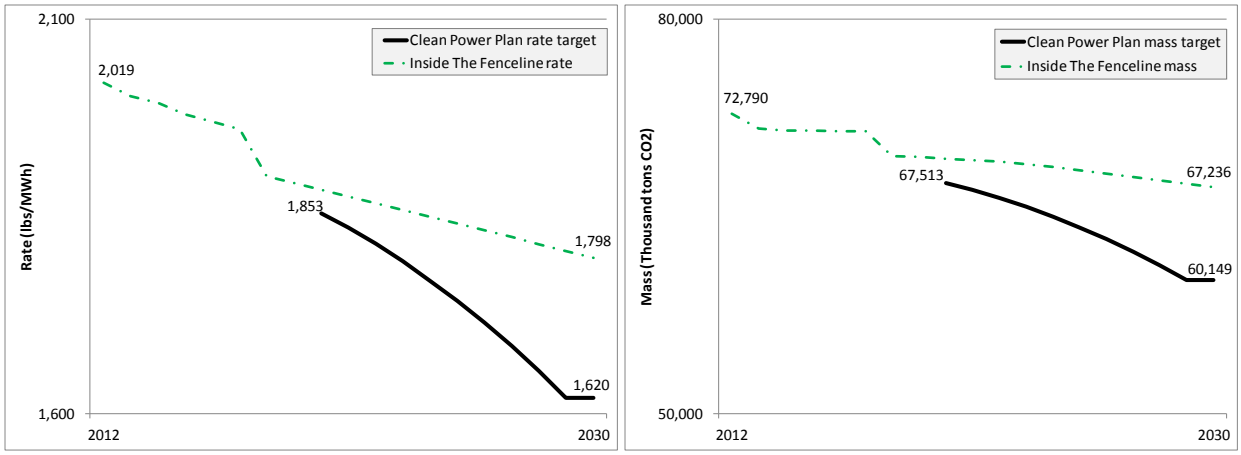


Figure 13: Compliance with the rate- and mass-based targets in the Inside-The-Fenceline scenario



5.3 Reduced Exports scenario

West Virginia exports almost three-fifths of the electricity it produces to surrounding states within the PJM region, and West Virginia's coal plants represent 20% of PJM's total coal output. The Reduced Exports scenario illustrates how West Virginia could achieve compliance under a mass-based standard by reducing the amount of electricity generated by the state's coal-fired power plants each year.

This scenario is similar to the Business As Usual scenario in that growth in renewable energy, demand -side energy efficiency, and natural gas are the same (See Appendix A). The Reduced Exports scenario includes the addition of the Moundsville NGCC plant and marginal increases in renewable energy and demand-side energy efficiency, but does not include any new CHP or natural gas co-firing. As illustrated in Figure 15, this scenario provides a pathway for compliance under a mass-based standard by reducing electricity production from coal plants each year such that total CO_2 emissions meet the mass-based limits for West Virginia over the interim and final compliance periods. In 2030, electricity generation in West Virginia under the Reduced Exports scenario would total 65,416 GWh, as compared with 76,414 GWh in the Business As Usual Scenario—a 9% decrease.

Reduced Exports Highlights in 2030

- Net-electricity exports are reduced 9% from 2020-2030
- No heat rate improvements are made at coal-fired power plants
- Coal plants account for 87% of total load
- Moundsville NGCC plant comes online in 2018, new NGCC accounts for 5% of total load
- No new CHP, existing CHP accounts for 1% of total load
- Wind and solar grow marginally and no new hydropower is built,
- Renewables account for 5% of total load
- Demand-side energy efficiency grows marginally to achieve a cumulative savings of 2.5% of retail sales and accounts for 1% of total load

The Reduced Exports scenario illustrates how West Virginia could achieve compliance under a mass-based regime by taking no additional steps outside the Business as Usual scenario except to limit the economic utilization of coal plants within the state. Figure 22, below, shows the change in average capacity factor over time at all West Virginia coal plants under the Reduced Exports scenario. Because West Virginia coal plants represent one-fifth of the total coal generation in the PJM footprint, limiting the economic utilization of West Virginia's coal plants could impact wholesale prices, shift the dispatch of other PJM resources, raise reliability issues, and more broadly impact the compliance decisions made in other PJM states.

This scenario highlights the importance of evaluating the effects of actions taken in one state—particularly net exporting states like West Virginia—on other states as well as the effect of compliance actions taken by other states on West Virginia. The electric grid is a dynamic, interconnected system that operates across political boundaries. The actions that utilities or power producers take in one state have implications for how grid operators and regulators coordinate the overall operation of the bulk power system in order to maintain grid reliability and ensure that consumers receive reasonably priced electricity. Reducing total generation in West Virginia by approximately 10% would have broader system implications, and those issues would need to be addressed in the state planning process. This issue is not unique to West Virginia, however, and if some economic utilization limitations were used as a compliance measure for West Virginia, potential reliability or other issues that may result can be resolved through coordination and planning with PJM, regulators, utilities, and stakeholders in neighboring states.

While the Reduced Exports scenario highlights how Clean Power Plan compliance can implicate cross-border issues, it underscores the importance of interstate cooperation and coordination for the purposes of Clean Power Plan compliance planning, regardless of the state plan pathway or emission reduction strategies selected. Energy and environmental regulators in West Virginia should continue

conversations with their counterparts in neighboring states and devote resources to exploring opportunities for multi-state coordination and the potential for multi-state planning. West Virginia could find new solutions to its compliance challenges that would allow it to maintain higher utilization levels for the coal plants within the state if those emissions can be offset by energy efficiency, additional renewable energy, or increased utilization of natural gas resources in a partner state.

Figure 14: Electricity generation by source in the Reduced Exports scenario

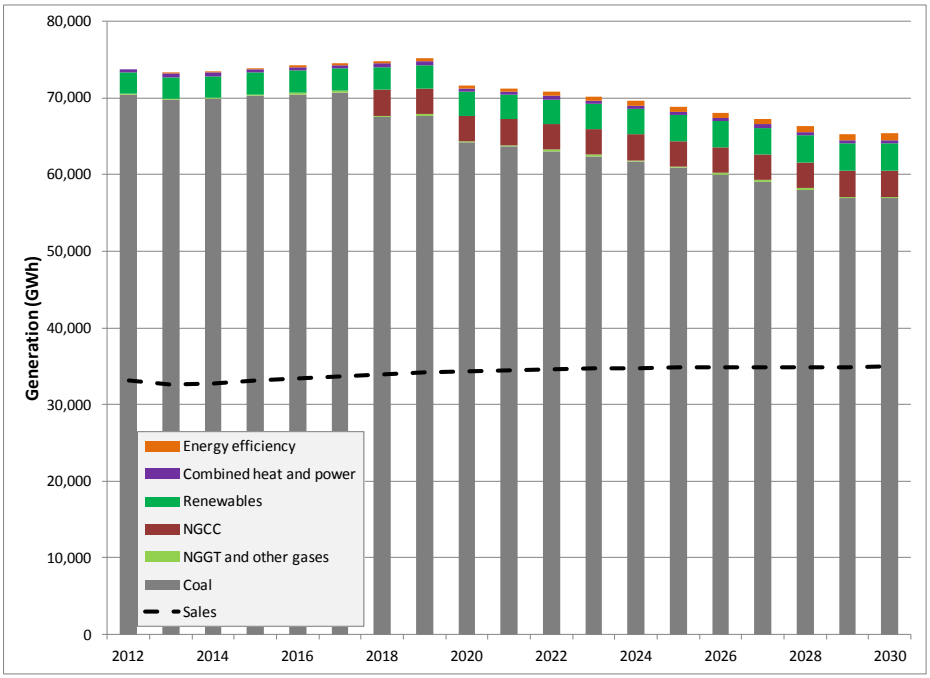
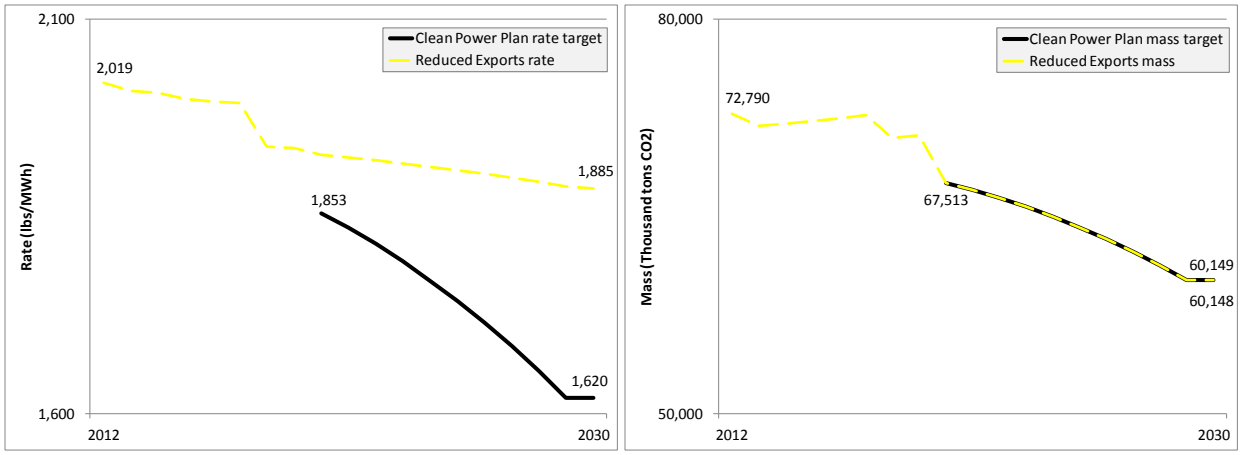


Figure 15: Compliance with the rate- and mass-based targets in the Reduced Exports scenario



Note: The Reduced Exports mass matches the Clean Power Plan mass target starting in 2020.

5.4 All-Of-The-Above scenarios

An all-of-the-above energy strategy for reducing CO_2 pollution from West Virginia power plants assumes that West Virginia electric generation will experience modest growth from current levels, but that the supply will be met from a more diverse group of resources than in the past (See Appendix A). Developing an 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. An all-of-the-above strategy would also provide consumer benefits of increased access to distributed generation and demand-side energy efficiency and would better insulate consumers from electricity rate hikes. By taking advantage of the flexible compliance measures allowed under the Clean Power Plan, West Virginia could incorporate an all-of-the-above energy strategy to achieve compliance with rate- and mass-based performance standards. The All-Of-The-Above scenarios presented in this report demonstrate two possible combinations of a wide array of resource measures that West Virginia could incorporate in a state plan to achieve its required emission reductions. These scenarios show that 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.

Both of the All-Of-The-Above scenarios include heat rate improvements at coal-fired power plants—3% and 1%, respectively. The heat rate improvements estimated in the All-Of-The-Above scenarios are well below the levels EPA used to calculate emission reduction targets in the BSER. The 3% and 1% improvements are based on our assumptions 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 are scheduled to retire before the compliance period begins.

As in the other three scenarios, both All-Of-The-Above scenarios assume that the Moundsville NGCC plant becomes operational in 2018. The All-Of-The-Above 2 scenario assumes that a second NGCC plant of the same size also becomes operational in 2022. As discussed above in Section 4.2.1, several new NGCC plants have been proposed in West Virginia. NGCC plants are the most common type of new generation proposed in the PJM interconnection queue, followed by wind. Low natural gas prices, high fuel efficiency, greater operational flexibility, and lower construction costs than nuclear and other

All-Of-The-Above 1 Highlights in 2030

- 3% heat rate improvement at coal-fired power plants
- 10% natural gas co-firing at two coal-fired power plants
- Coal plants account for 74% of total load
- Moundsville NGCC plant comes online in 2018, new NGCC accounts for 4% of total load
- CHP grows to 757 MW to account for 7% of total load
- Wind, solar and hydropower grow to account for 9% total load
- Demand-side energy efficiency grows to achieve cumulative savings of 10% of retail sales and accounts for 5% of total load

All-Of-The-Above 2 Highlights in 2030

- 1% heat rate improvement at coal-fired power plants
- 30% natural gas co-firing at two coal-fired power plants
- Coal plants account for 75% of total load
- Moundsville NGCC plant comes online in 2018, and a second NGCC plant comes online in 2022, new NGCC accounts for 9% of total load
- CHP grows to 316 MW through 2030, CHP accounts for 2% of total load
- Wind, solar, and hydropower grow to account for 8% of total load
- Demand-side energy efficiency grows to achieve cumulative savings of 13% of retail sales and accounts for 6% of total load

fossil fuel plants have led to rapid growth in the market share of natural gas in the nation's electric power sector. National trends in the development of natural gas–fired generation, the retirement of significant coal-fired capacity in West Virginia, West Virginia's position as a major natural gas–producing state, and current constraints on pipeline capacity to transport Marcellus gas outside of the region suggest that utilities and power producers will look favorably to the construction of NGCC facilities in the state going forward. The CP3T model calculates emission reductions derived from the integration of new NGCC facilities by replacing coal-fired generation with an equal amount of NGCC generation. The difference in emissions between coal and NGCC generation is the emission-reduction benefit.[20]

The All-Of-The-Above scenarios also both contemplate a significant increase in generation from natural gas–fired CHP. As described above, ACEEE estimates approximately 1,700 MW of remaining technical potential for CHP in West Virginia and further estimates that 588 MW of that potential is economically viable if utilities in the state are provided additional incentives. The All-Of-The-Above 1 scenario assumes that this capacity is achieved by 2030, and the All-Of-The-Above 2 scenario assumes that one-quarter of this goal is achieved by 2030.

Both All-Of-The-Above scenarios also include a small amount of natural gas co-firing. In the All-Of-The-Above 1 scenario, two West Virginia coal-fired power plants achieve 10% co-firing, which is assumed to be possible without investments in new equipment (Staudt 2014). The All-Of-The-Above 2 scenario includes a more aggressive, 30% co-firing target. Achieving this target may require additional investments at the plant and/or pipeline capacity additions.

Both All-Of-The-Above scenarios include increases in wind and solar power over current levels. In the All-Of-The-Above 1 scenario, wind and solar grow to 7% of total generation (50% of the EPA estimate in the BSER), and in the All-Of-The-Above 2 scenario, wind and solar grow to 5% of total generation (30% of the EPA estimate in the BSER). Biomass generation remains at 2012 levels in both All-Of-The-Above scenarios.

Wind capacity increases to 2,106 MW by 2030 in the All-Of-The-Above 1 scenario, and to 1,398 MW by 2030 in the All-Of-The-Above 2 scenario (See Appendix A). Both of the All-Of-The Above scenario assumptions for wind capacities are less than the NREL upper-bound estimate for West Virginia wind potential (2,772 MW), and the All-Of-The-Above 1 assumption is below NREL's lower-bound estimate (1,883 MW) (NREL 2011).

Solar capacity increases to 410 MW in both All-Of-The Above scenarios. While this is a significant increase from current levels of less than 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 photovoltaic (NREL 2012). In neighboring states, Ohio, Maryland, and Pennsylvania installed solar capacities in 2013 reached 91, 152, and 236 MW (SEIA 2015(b)). If these trends continue, the solar capacity in these states will grow substantially through 2030. The increase in solar in the All-Of-The-Above scenarios reaches 1% 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.

Hydropower is expanded modestly in both All-Of-The-Above scenarios, based on the assumption that West Virginia could develop additional hydropower resources at currently non-powered dams and through small scale hydropower projects. As described above, the Department of Energy estimates that West

[20] See Section 4.2 for further discussion of the treatment of new NGCC plants (which would also be subject to CO_2 standards under the proposed section 111(b) NSPS) under the proposed Clean Power Plan.

Virginia has 210 MW of additional hydropower capacity at existing dams that do not currently produce hydroelectric power.

The CP3T model calculates the emission reduction potential from new wind, solar and hydropower resources by displacing coal-fired generation and emissions with an equal amount of generation from zero-emission renewable energy sources.

Both All-Of-The-Above scenarios include increases in energy efficiency savings from current levels. All-Of-The-Above 1 models cumulative energy efficiency savings of 10% by 2030 and All-Of-The-Above 2 models savings of 13% by 2030. The energy efficiency estimates calculated for the All-Of-The-Above scenarios is based on a number of factors. First, the ACEEE estimates that West Virginia could achieve 23% energy efficiency savings from 2012 levels by 2030 (ACEEE 2014(a)). Second, the end-use energy efficiency savings that American Electric Power 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. Third, the West Virginia Legislature proposed legislation in 2013 that would require West Virginia utilities to achieve 15% cumulative savings and 15% peak demand savings by 2027. These estimates all suggest that EPA's estimate of 10.71% is the very low end of the energy efficiency savings potential in West Virginia, and utilities in the state could achieve much higher levels than modeled in the All-Of-The-Above scenarios. The CP3T model calculates emission reductions from energy efficiency by reducing the need for coal-fired generation and the associated emissions.

As illustrated in Figure 17 and Figure 19, the All-Of-The-Above scenarios demonstrate two possible combinations of emission reduction measures that West Virginia could employ to comply with either rate- or mass-based performance standards. Figure 22, below, shows that over time, the capacity factors of coal-fired power plants in West Virginia will gradually decline in both of these scenarios, reaching an average capacity factor of approximately 50% by 2030.

Declines in coal-fired generation at West Virginia power plants will result in less demand for West Virginia coal, putting additional pressure on state and local tax revenues and coal-based jobs (See Figure 5, above). As compared with the Reduced Exports scenario, however—which depicts a similar decline in average coal plant capacity factors, coal use, and coal-related jobs—the All-Of-The-Above scenarios provide a compliance approach that takes advantage of an expanded energy economy that could offset losses in one sector of the state's energy economy with increases in jobs in other sectors, such as renewable energy, demand-side energy efficiency, CHP, and new construction of NGCC or natural gas co-fired facilities. Similarly, and importantly, as discussed in Chapter 3 above, severance tax losses from the coal mining sector are already being offset by increases in severance taxes generated by increased natural gas production. Natural gas production in West Virginia is expected to double by 2020. Projections that many states will rely heavily on natural gas as a compliance measure under the Clean Power Plan suggest that demand for West Virginia natural gas will continue to grow and suggest that the West Virginia power sector would benefit from increased utilization of this abundant in-state resource as well.

Figure 16: Electricity generation by source in the All-Of-The-Above 1 scenario

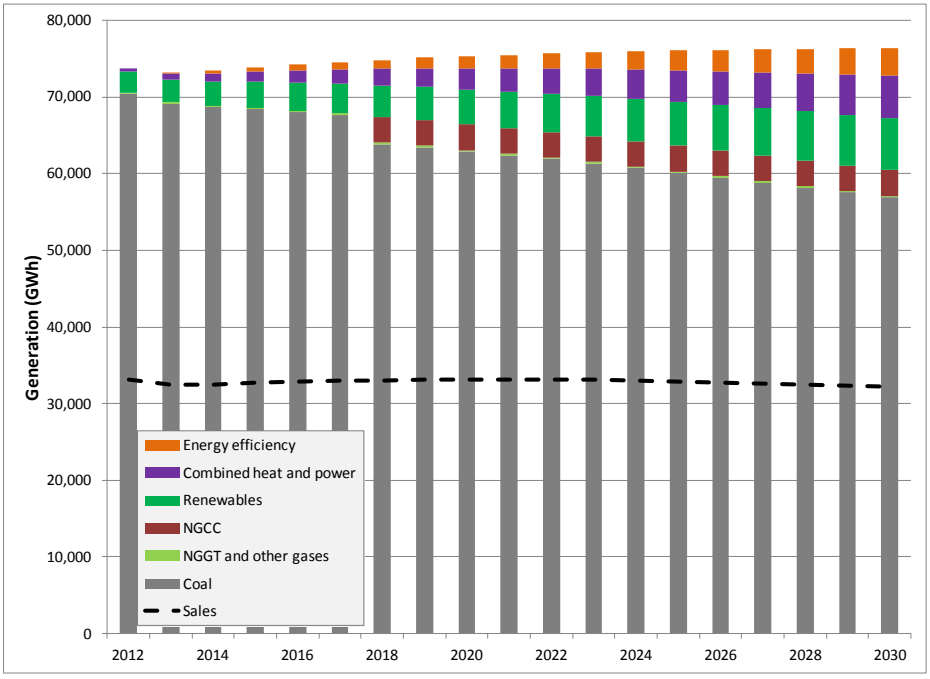


Figure 17: Compliance with the rate- and mass-based targets in the All-Of-The-Above 1 scenario

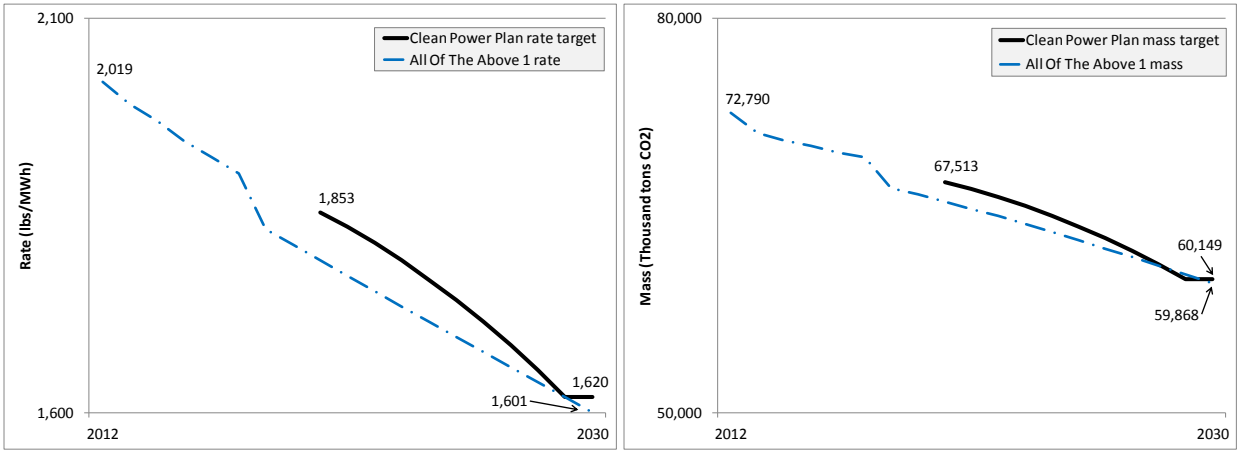


Figure 18: Electricity generation by source in the All-Of-The-Above 2 scenario

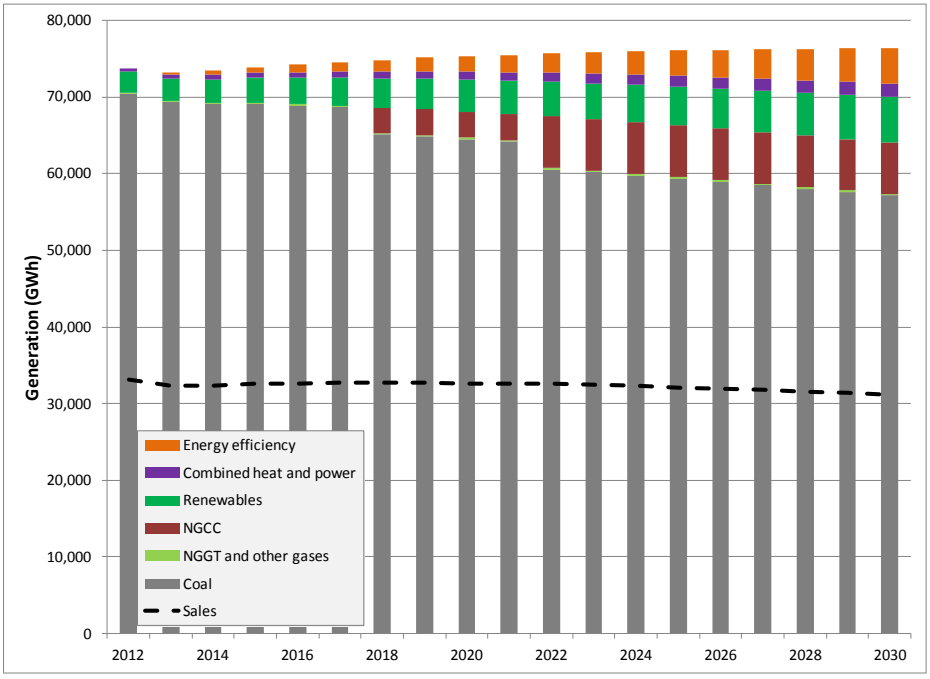
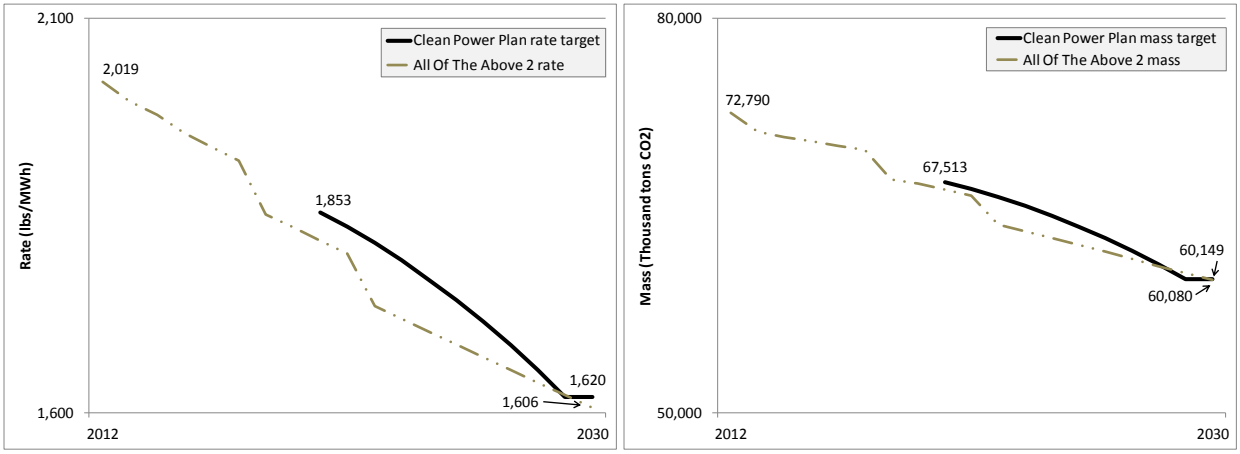


Figure 19: Compliance with the rate- and mass-based targets in the All-Of-The-Above 2 scenario



5.5 Discussion

Table 4 highlights the resource mix projected under each scenario in 2030. In the Business As Usual and Inside-The-Fenceline scenarios, coal accounts for 89% of total load (including energy efficiency), and in the Reduced Exports scenario, this percentage declines marginally to 87%. In contrast, coal accounts for only 74% and 75% of total load in the All-Of-The-Above scenarios. The remainder is generated by different mixes of NGCC, renewables, energy efficiency, CHP, and NGGT and other gases.

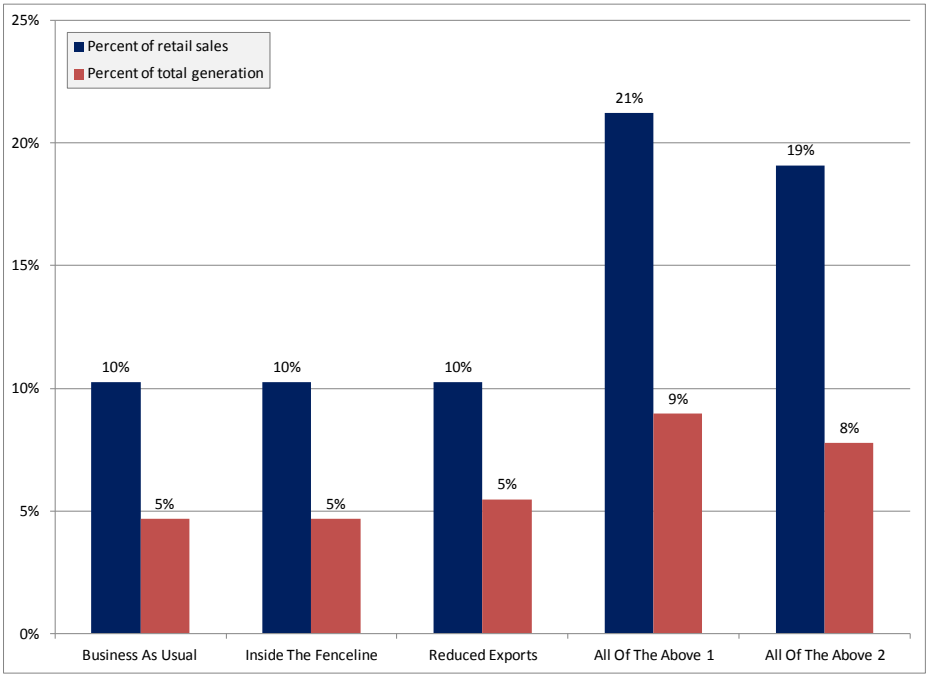
Table 4: Percent of total projected load by resource, 2030

Resource	Business As Usual	Inside-The-Fenceline	Reduced Exports	All-Of-The-Above 1	All-Of-The-Above 2
Coal	89%	89%	87%	74%	75%
NGCC	4%	4%	5%	4%	9%
Renewables	5%	5%	5%	9%	8%
Energy efficiency	1%	1%	1%	5%	6%
Combined heat and power	1%	1%	1%	7%	2%
NGGT and other gases	<1%	<1%	<1%	<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% goal as a percent of total retail sales. Figure 20 compares both percentages for each scenario. Renewables reach twice the level of in-state sales in the All-Of-The-Above scenarios as compared to the other scenarios, reaching 21% and 19% of total in-state retail sales by 2030.

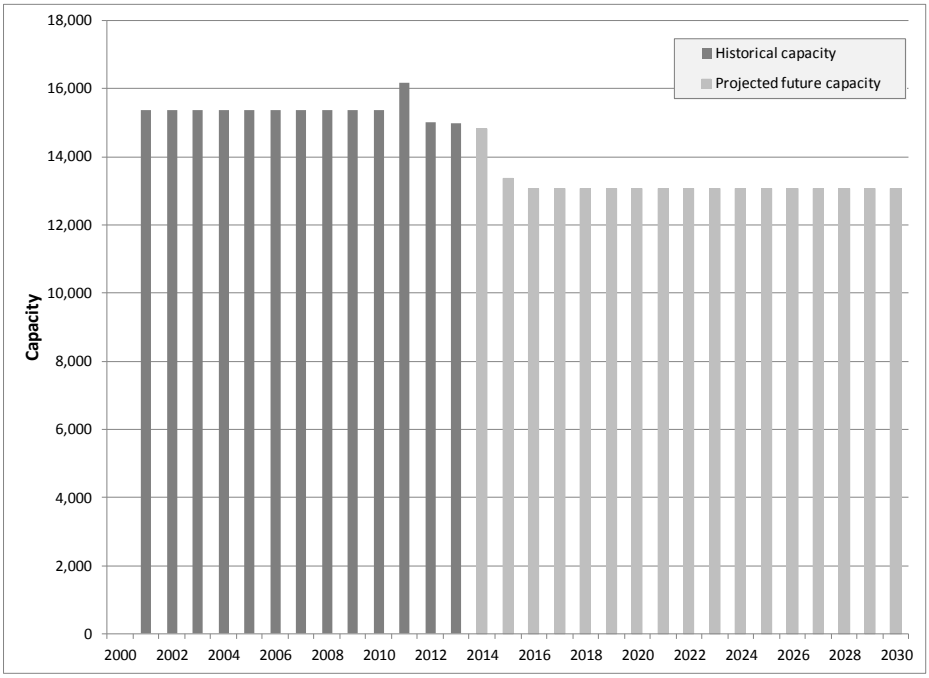
Figure 20: Renewables as a percentage of total load and as a percentage of in-state retail sales, 2030



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 distributed generation resources keep demand growth low, and new renewable resources and natural gas 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(h)). As shown in Figure 21, 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 provide emission reduction benefits that can be captured for compliance purposes, but must be coupled with additional measures to ensure that West Virginia meets its Clean Power Plan obligations.

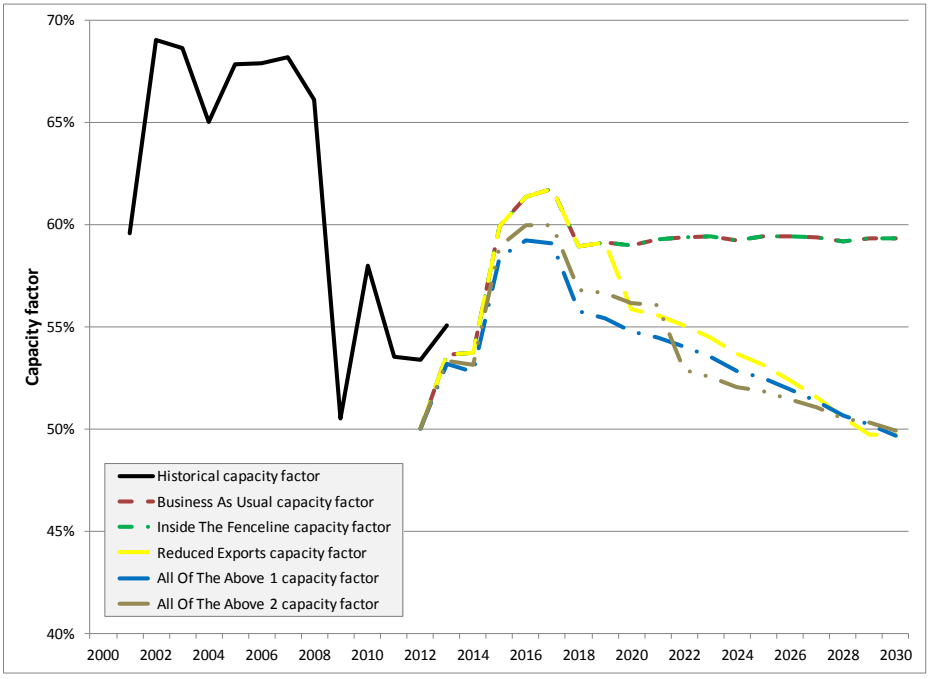
Each of the compliance scenarios modeled in this report rely in part on reduced reliance on coal-fired generation. The average capacity factors for West Virginia coal plants was between 60-70% every year from 2001-2008 but decreased sharply from 2009-2013 in response to the recession and increasing competitiveness of other resources—primarily natural gas and renewables (See Figure 22). As additional coal-fired power plants retire through 2015, the average capacity factor of remaining plants actually increases, because the plants that remain open are likely to run more often to meet electricity demand in the PJM market. After 2015, however, important differences among the scenarios with respect to coal plant operations become apparent. In the two non-compliance scenarios—Business As Usual and Inside-the-Fenceline—the average capacity factor remains at approximately 60%. In contrast, average capacity factors steadily decline through the interim compliance period to approximately 50% by 2030 in all three compliance scenarios.

Figure 21: West Virginia coal-fired capacity for all scenarios



Sources: Historical capacities from EIA 2015(l). 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 22: Coal-fired power plant capacity factors for all scenarios



Sources: Historical capacity factors from EIA 2015(l), EIA 2015(m). Scenario capacity factors from the analysis performed for this report. Note: The capacity factors for the Business As Usual and Inside-The-Fenceline scenarios are the same.

The compliance 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's analysis projects that as a result of the Clean Power Plan, coal plant retirements around the country will reach 90 GW instead of the projected 40 GW by 2040 and that Central and Northern Appalachian coal production will decrease by 44 million tons by 2030 (EIA 2015(k)).

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% was imported from other states. Of the 112.8 million tons of coal mined in West Virginia in 2013, only 15% was burned at West Virginia power plants. West Virginia's Clean Power Plan 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 an all-of-the-above 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(o). Coal burned in West Virginia power plants from EIA 2015(c).

As illustrated in Figure 23, in the Business-As-Usual scenario (which does not achieve compliance), West Virginia's coal-fired power plants are projected to burn almost 16 million tons of West Virginia coal each year through 2030. In the Inside-The-Fenceline scenario, the amount of West Virginia coal decreases to approximately 15 million tons annually by 2030, because efficiency improvements at the power plants result in the generation of the same amount of electricity with less coal. As compared with the Business-As-Usual scenario, the three scenarios that achieve compliance would result in a reduction of approximately 3 million tons of coal burned annually by 2030.

Figure 23: Projected West Virginia coal burned in West Virginia power plants, 2012-2030

Note: The 2013 values in this chart are modeled and differ slightly from the actual values in Table 5.

One implication of burning less West Virginia coal at West Virginia power plants is the impact on severance tax revenues. Severance tax payments are calculated based on the tax rate multiplied by the gross value of the coal produced. If West Virginia power plants burn less West Virginia coal, then coal severance tax receipts will decline unless West Virginia mines can expand their markets in other states or countries, or unless the price of coal increases.

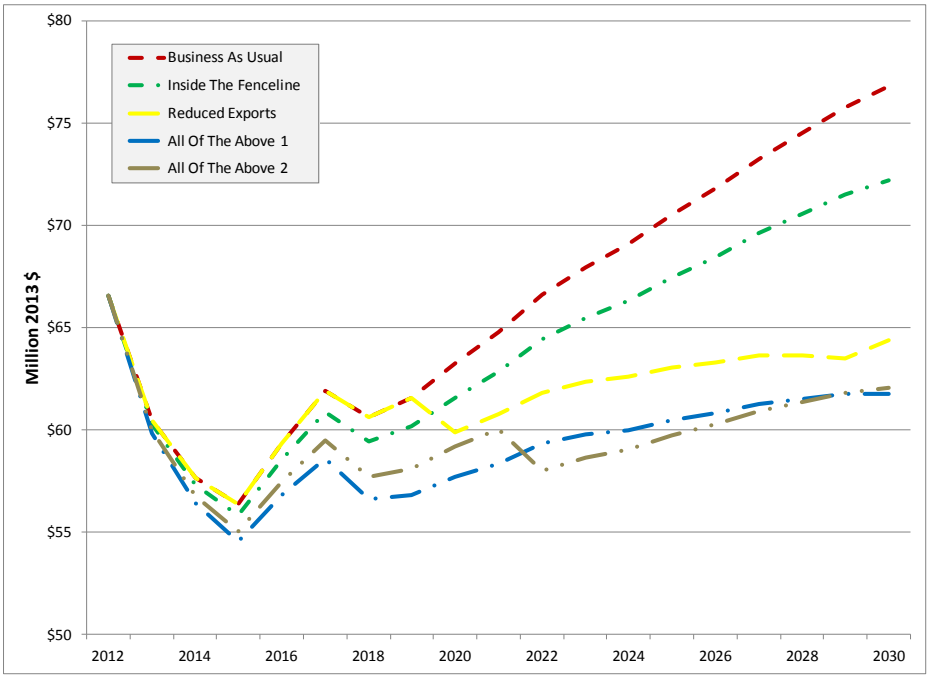
According to recent projections, even without implementation of the Clean Power Plan, coal severance taxes will decline in the future as a result of lower production volumes. The state share of coal severance tax revenue is projected to decline to $265.2 million in FY 2019 (W. Va. 2013). In our Clean Power Plan scenarios, however, severance tax collections are generally projected to increase after 2015 for West Virginia coal burned at West Virginia power plants, due to projected higher coal prices more than making up for reductions in coal production. This is also partially a function of the fact that West Virginia power plants burn only 15% of total coal produced in West Virginia, and small declines in production attributed to in-state coal plants can be offset by small increases in price.

As illustrated in Figure 24 and Table 6, projected coal severance taxes collected on West Virginia coal burned in West Virginia power plants in 2030 totals approximately $77 million in the Business-As-Usual scenario. The All-Of-The-Above scenarios result in severance tax collections of approximately $62 million in 2030. While these results show a reduction in severance tax collections in 2030 due to Clean Power Plan

compliance of approximately $15 million, collections in 2030 are actually projected to exceed collections in 2015 in both All-Of-The-Above scenarios.

As discussed in Section 3.3, severance taxes are also collected on natural gas produced in West Virginia. Natural gas production is growing rapidly in West Virginia and as power producers around the country continue to make fuel selection choices that favor natural gas for cost and environmental compliance purposes, demand for West Virginia natural gas is projected to remain strong. Additionally, all five scenarios project that the Moundsville NGCC plant will become operational in 2018, and the All-Of-The-Above 2 scenario projects that a second NGCC plant of the same size will become operational in 2022, further cementing the importance of natural gas in the West Virginia energy sector through the Clean Power Plan compliance periods.

Figure 24: Projected severance tax on West Virginia coal burned in West Virginia power plants, 2012-2030



Source: Projected coal prices are weighted averages of Northern Appalachian and Central Appalachian projected minemouth prices from EIA 2015(I). West Virginia coal burned from this report.

Table 6: Projected coal prices, West Virginia coal burned, and severance taxes, 2012-2030

	2012	2015	2020	2025	2030
Projected coal price (2013 $/ton)	81	69	80	89	97
Business As Usual					
West Virginia coal burned (thousand tons)	16,486	16,359	15,775	15,847	15,817
Severance tax (million 2013 $)	67	56	63	70	77
Inside-The-Fenceline					
West Virginia coal burned (thousand tons)	16,486	16,196	15,356	15,163	14,871
Severance tax (million 2013 $)	67	56	62	67	72
Reduced Exports					
West Virginia coal burned (thousand tons)	16,486	16,359	14,933	14,169	13,256
Severance tax (million 2013 $)	67	56	60	63	64
All-Of-The-Above 1					
West Virginia coal burned (thousand tons)	16,486	15,832	14,382	13,593	12,719
Severance tax (million 2013 $)	67	55	58	60	62
All-Of-The-Above 2					
West Virginia coal burned (thousand tons)	16,486	15,974	14,753	13,423	12,774
Severance tax (million 2013 $)	67	55	59	60	62

Source: Projected coal prices are weighted averages of Northern Appalachian and Central Appalachian projected minemouth prices from EIA 2015(l). West Virginia coal burned from this report.

The capacity factor, coal production, and severance tax results highlight important implications of the five 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. The All-Of-The-Above 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. In contrast, the Reduced Exports scenario achieves compliance on a mass basis by limiting electricity production at coal plants. While coal-related jobs and tax revenues will decline under this scenario just as they do in the All-Of-The-Above scenarios, the Reduced Export scenario does not provide the additional benefits of new economic activity that result from making homes and businesses more energy efficient, creating the investment climate that encourages the development of distributed generation resources, and bringing additional value to the state through increased use of natural gas produced in West Virginia.

The All-Of-The-Above scenarios would achieve compliance under a rate- or mass-based performance standard 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 CO_2 pollution limits under the Clean Power Plan. The following chapter offers policy recommendations that West Virginia could adopt to help achieve these goals.

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 CO_2 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.

6.1 Remove legislative restrictions on state plan development

In 2014, the West Virginia Legislature passed and the Governor signed in to law HB 4346 to provide guidance to the DEP on the development of a state plan. In 2015, West Virginia adopted HB 2004 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 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. Such a limitation would remove many of the compliance options available under the Clean Power Plan from consideration by the DEP when developing a state plan for West Virginia. The compliance measures and scenarios explored in this report offer just of few of the many pathways to compliance that DEP could present to the Legislature in a report describing the feasibility of creating a state plan for West Virginia. 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. In its report to the Legislature, DEP could recommend that HB 2004 be amended to allow the DEP to consider all available options under the Clean Power Plan and remove the requirement that DEP receive the express consent of the majority of both houses of the Legislature prior to submitting a state plan to EPA.

6.2 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-four 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 Energy Efficiency Resource Standards (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 see even higher bills this year following new, double-digit rate increases requested by the state's utilities. 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% of 2011 electricity sales by 2027 and saving 15% 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 American Electric Power 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% 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.

6.3 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 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.[21]

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 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[22].

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 strongly to integrate more solar photovoltaic (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 6.4).

The RPS should also include provisions that allow out-of-state renewable energy projects to satisfy West Virginia's renewable energy targets. As discussed in Section 3.1 above, the Clean Power Plan may allow states to credit toward compliance those renewable energy projects that are developed out of that state in response to a renewable energy standard of the state claiming the credit. Failure to have a RPS in place, on the other hand, could preclude out-of-state renewable projects from being attributed to West Virginia for Clean Power Plan compliance purposes.

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 CO_2 reduction requirements under the Clean Power Plan.

6.4 Adopt policies that encourage investment in clean distributed generation resources

Distributed generation (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 not owned by distribution utilities, but instead by customers, and sited at, or very near, a customer's home or business. Investment in

[21] Expanding the definition of "renewable" to encourage co-firing biomass with coal would take advantage of the state's considerable biomass potential and reduce CO_2 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; however, EPA solicited comment in the proposed Clean Power Plan on how biomass co-firing should be treated under the rule. EPA may provide further guidance on biomass co-firing in the final rule, and this option could be explored as a potential compliance measure for West Virginia.

[22] West Virginia 2009. W.Va. Code § 24-2F-1 et seq.

DG, particularly solar PV, has increased dramatically in recent years as equipment and installation costs have declined significantly (Barbose 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 state 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, by creating uncertainty and increasing the risks associated with investment in DG resources. HB 2201 should either be repealed or implemented by the PSC in such a matter that leaves existing net metering regulations in place.

In addition, enactment of an RPS, as proposed in Recommendation 6.3 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 6.2 above, would also promote the development of DG resources, by allowing CHP—which is sited on customer premises—to be used to meet EE 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 (IRP) 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.

6.5 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 over the past five 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.

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 IRP (discussed below). 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 CO_2 emission limits under the Clean Power Plan.

6.6 Issue revised integrated resource planning requirements for electric utilities

IRP is a process that requires utilities to 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.[23] 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 (Energy Policy Act 1992). The "integrated" aspect of IRP 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 IRP.[24] The PSC issued an order in March 2015 requiring West Virginia utilities to submit resource plans by January 1, 2016 and at least every five years after that date (PSC 2015). The guidelines are limited to requiring utilities to file an IRP that includes 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 utility resource plans. Many of the other elements commonly included as part of the IRP process in most other states are missing as well. 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.

[23] Energy Policy Act of 1992, § 111(d)(19), 16 U.S.C. § 2602(19).
[24] W.Va. Code § 24-2-19.

A robust IRP requirement will 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 will also provide a transparent framework for evaluating and securing the lowest-cost compliance options under the Clean Power Plan.

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

The proposed Clean Power Plan establishes CO_2 pollution limits on an individual state basis, but it provides states the option of working together to demonstrate compliance on a multi-state basis. This flexibility recognizes that electricity is transmitted across state lines and that local measures often impact regional power sector emissions (EPA 2014(f)). 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, however, 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. 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 also greatly reduces 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 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 Kentucky, a similar effort was launched in 2013 by Governor Steve Beshear and U.S. Congressman Hal Rodgers. Governor Beshear and Congressman Rodgers 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 Summit attracted 1,700 residents of Kentucky and the surrounding region.

Since the Summit, 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 are 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. The state's heavy reliance on coal-fired electric generation and the importance of the coal industry in the state economy mean that coal plants in West Virginia will burn less coal, and that other states that have historically imported West Virginia coal will also burn less coal. Burning less West Virginia coal at West Virginia power plants, and power plants around the country means less work for West Virginia coal miners and less severance tax revenue for the state and local municipalities. While these challenges appear stark in the face of carbon pollution mandates, the long-term loss of coal jobs in West Virginia has persisted for decades, and in recent years declines in coal jobs and coal severance tax revenues have grown increasingly more pressing as market forces converge with increasingly stringent environmental regulations. West Virginia has the resources to meet these challenges, however, and can usher in new economic opportunities throughout the Mountain State.

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 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 distributed generation technologies, energy efficiency, natural gas–fired generation, and 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.

Developing an all-of-the-above energy policy in West Virginia would help West Virginia take advantage of additional cost-effective compliance measures available under the Clean Power Plan while at the same time capture the other socio-economic 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 socio-economic 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.

REFERENCES

ACEEE 2012. Anna Chittum & Terry Sullivan, *Coal Retirements and CHP Investment Opportunity*, AMERICAN COUNCIL FOR AN ENERGY EFFICIENT ECONOMY (Sept. 2012), *available at* http://www.aceee.org/research-report/ie123.

ACEEE 2013(a). Max Neubauer, et al., *A Guide to Growing an Energy Efficient Economy in Mississippi*, AMERICAN COUNCIL FOR AN ENERGY EFFICIENT ECONOMY (Nov. 2013), *available at* http://www.aceee.org/research-report/e13m.

ACEEE 2013(b). Annie Downs, et al., *The 2013 State Energy Efficiency Scorecard, American Council for an Energy Efficient Economy* AMERICAN COUNCIL FOR AN ENERGY EFFICIENT ECONOMY (2013), *available at* http://www.aceee.org/sites/default/files/publications/researchreports/e13k.pdf.

ACEEE 2014(a). Sara Hayes, et al. *Change Is in the Air: How States Can Harness Energy Efficiency to Strengthen the Economy and Reduce Pollution*, AMERICAN COUNCIL FOR AN ENERGY EFFICIENT ECONOMY (Apr. 2014), *available at* http://www.aceee.org/research-report/e1401.

ACEEE 2014(b). Annie Gilleo, et al., *The 2014 State Energy Efficiency Scorecard*, AMERICAN COUNCIL FOR AN ENERGY EFFICIENT ECONOMY (2014), *available at* http://aceee.org/state-policy/scorecard.

ACEEE 2015(a). *Energy Efficiency and Economic Opportunity, Fact Sheet*, AMERICAN COUNCIL FOR AN ENERGY EFFICIENT ECONOMY, www.aceee.org/sector/local-policy.

Allegheny Front 2015. *Frequently Asked Questions about Ethane Crackers*, ALLEGHENY FRONT http://www.alleghenyfront.org/story/frequently-asked-questions-about-ethane-crackers.

APCo 2014. *News Release, Appalachian Power, Wheeling Power seek increase in West Virginia to cover growing operating costs*, APPALACHIAN POWER COMPANY (June 30, 2014), https://www.appalachianpower.com/info/news/viewRelease.aspx?releaseID=1589.

AWEA 2014(a). *Press Release, Wind Turbine Technology Played Key Role in Wind Energy's Record Breaking Growth and Cost Decline*, AMERICAN WIND ENERGY ASSOCIATION (Mar. 14, 2014), http://www.awea.org/MediaCenter/pressrelease.aspx?ItemNumber=6218.

AWEA 2014(b). AMERICAN WIND ENERGY ASSOCIATION, U.S. WIND INDUSTRY SECOND QUARTER 2014 MARKET REPORT (July 31, 2014), http://awea.files.cms-plus.com/FileDownloads/pdfs/2Q2014%20AWEA%20Market%20Report%20Public%20Version%20.pdf.

AWEA 2014(c). *Press Release, American Wind Power Sees Unprecedented Growth Entering 2014*, AMERICAN WIND ENERGY ASSOCIATION (Jan. 2014), http://www.awea.org/MediaCenter/pressrelease.aspx?ItemNumber=6044.

AWEA 2015(a). *Wind 101 the Basics of Wind Energy*, AMERICAN WIND ENERGY ASSOCIATION, http://www.awea.org/Resources/Content.aspx?ItemNumber=900&navItemNumber=587.

AWEA 2015(b). *Wind was largest source of new electricity in 2014, Congress still must provide long-term policy certainty*, AMERICAN WIND ENERGY ASSOCIATION (Mar. 5, 2015), http://www.awea.org/MediaCenter/pressrelease.aspx?ItemNumber=7294.

Barbose 2013. Barbose, G., et al., *Tracking the Sun VI: An Historical Summary of the Installed Price of Photovoltaics in the United States from 1998 to 2012*, LAWRENCE BERKELEY NATIONAL LABORATORY (July 2013), *available at* http://emp.lbl.gov/sites/all/files/lbnl- 6350e.pdf.

Burnett 2015. *Sen. McConnell, States Challenge EPA Clean Power Plan*, Climate Change Weekly # 167, HEARTLAND INSTITUTE (Apr. 10 2015), http://news.heartland.org/newspaper-article/2015/04/10/sen-mcconnell-states-challenge-epa-clean-power-plan.

Conti 2015. David Conti, *Murray, Alpha notify West Virginia coal miners of layoffs*, TRIBLIVE, May 22, 2015, http://triblive.com/business/headlines/8421397-74/coal-murray-energy#axzz3cejXIZs1.

DOE 2012(a). U.S. DEP'T OF ENERGY, AN ASSESSMENT OF ENERGY POTENTIAL AT NON-POWERED DAMS IN THE UNITED STATES (Apr. 2012), *available at* http://energy.gov/eere/water/downloads/assessment-energy-potential-non-powered-dams-united-states.

DOE 2012(b). U.S. DEP'T OF ENERGY & U.S. ENVTL. PROT. AGENCY, COMBINED HEAT AND POWER: A CLEAN ENERGY SOLUTION (Aug. 2012), *available at* http://www1.eere.energy.gov/manufacturing/distributedenergy/pdfs/chp_clean_energy_solution.pdf.

DSIRE 2013. *Energy Efficiency Resource Standards*, DATABASE FOR STATE INCENTIVES FOR RENEWABLES & EFFICIENCY (Feb. 2013), *available at* http://www.dsireusa.org/documents/summarymaps/EERS_map.pdf.

DSIRE 2015(a). *Energy Efficiency Portfolio Standard: Ohio*, DATABASE FOR STATE INCENTIVES FOR RENEWABLES & EFFICIENCY, http://programs.dsireusa.org/system/program/detail/4542.

DSIRE 2015(b). *Energy Efficiency and Conservation Requirement for Utilities: Pennsylvania*, DATABASE FOR STATE INCENTIVES FOR RENEWABLES & EFFICIENCY, http://programs.dsireusa.org/system/program/detail/4514.

DSIRE 2015(c). DATABASE FOR STATE INCENTIVES FOR RENEWABLES & EFFICIENCY, http://www.dsireusa.org/.

EIA 2012. *What are natural gas liquids and how are they used*, TODAY IN ENERGY, U.S. ENERGY INFORMATION ADMINISTRATION (Apr. 20, 2012), http://www.eia.gov/todayinenergy/detail.cfm?id=5930.

EIA 2014(a). *Energy production and other mining account for a large percentage of some state economies*, TODAY IN ENERGY, U.S. ENERGY INFORMATION ADMINISTRATION (Aug. 7, 2014), http://www.eia.gov/todayinenergy/detail.cfm?id=17451.

EIA 2014(b). U.S. ENERGY INFORMATION ADMINISTRATION, ELECTRIC POWER MONTHLY (Aug. 25, 2014), *available at* http://www.eia.gov/electricity/monthly/pdf/epm.pdf.

EIA 2014(c). *West Virginia State Energy Profile*, U.S. ENERGY INFORMATION ADMINISTRATION (Mar. 27, 2014), http://www.eia.gov/state/print.cfm?sid=WV.

EIA 2014(d). *Natural Gas, Solar and Wind Lead Power Plant Capacity Additions in First Half of 2014*, TODAY IN ENERGY, U.S. ENERGY INFORMATION ADMINISTRATION (Sept. 9, 2014), http://www.eia.gov/todayinenergy/detail.cfm?id=17891.

EIA 2014(e). *Marcellus Region Production Continues Growth*, TODAY IN ENERGY, U.S. ENERGY INFORMATION ADMINISTRATION (Aug. 5, 2014), http://www.eia.gov/todayinenergy/detail.cfm?id=17411.

EIA 2014(f). U.S. ENERGY INFORMATION ADMINISTRATION, QUARTERLY COAL REPORT, APRIL – JUNE 2014 (2014), http://www.eia.gov/coal/production/quarterly/.

EIA 2014(g). *Ohio's Utica Region now included in EIA's monthly Drilling Productivity Report*, TODAY IN ENERGY, U.S. ENERGY INFORMATION ADMINISTRATION (Aug. 12, 2014), http://www.eia.gov/todayinenergy/detail.cfm?id=17511.

EIA 2015(a). *State Profile and Energy Estimates, West Virginia*, U.S. ENERGY INFORMATION ADMINISTRATION, http://www.eia.gov/state/?sid=WV.

EIA 2015(b). *Frequently Asked Questions, What is U.S. Electricity Generation by Fuel Source?*, U.S. ENERGY INFORMATION ADMINISTRATION, http://www.eia.gov/tools/faqs/faq.cfm?id=427&t=3.

EIA 2015(c). U.S. ENERGY INFORMATION ADMINISTRATION, ANNUAL COAL DISTRIBUTION REPORT 2015 (2015), http://www.eia.gov/coal/distribution/annual/.

EIA 2015(d). U.S. ENERGY INFORMATION ADMINISTRATION, ANNUAL COAL DISTRIBUTION REPORT 2015: DATA ARCHIVE (2015), http://www.eia.gov/coal/distribution/annual/archive.cfm, http://www.eia.gov/coal/distribution/annual/archive/2013/d_13state.xls.

EIA 2015(e). *Natural Gas Gross Withdrawals and Production*, U.S. ENERGY INFORMATION ADMINISTRATION, http://www.eia.gov/dnav/ng/ng_prod_sum_a_EPG0_VGM_mmcf_a.htm.

EIA 2015(f). *State Electricity Profiles, West Virginia Electricity Profile 2012*, U.S. ENERGY INFORMATION ADMINISTRATION, http://www.eia.gov/electricity/state/westvirginia/.

EIA 2015(g). U.S. ENERGY INFORMATION ADMINISTRATION, 2013 AVERAGE MONTHLY BILL- RESIDENTIAL, *available at* http://www.eia.gov/electricity/sales_revenue_price/pdf/table5_a.pdf.

EIA 2015(h). *Renewables Share of U.S. Energy Consumption Highest since 1930s*, TODAY IN ENERGY, U.S. ENERGY INFORMATION ADMINISTRATION (May 28, 2015) *available at* http://www.eia.gov/todayinenergy/detail.cfm?id=21412.

EIA 2015(i). *Electricity Data Browser*, U.S. ENERGY INFORMATION ADMINISTRATION http://www.eia.gov/electricity/data/browser/.

EIA 2015(j). *West Virginia Natural Gas Gross Withdrawals and Production*, U.S. ENERGY INFORMATION ADMINISTRATION http://www.eia.gov/dnav/ng/ng_prod_sum_dcu_swv_a.htm.

EIA 2015(k). U.S. ENERGY INFORMATION ADMINISTRATION, ANALYSIS OF IMPACTS OF THE CLEAN POWER PLAN (May 2015) *available at* http://www.eia.gov/analysis/requests/powerplants/cleanplan/.

EIA 2015(l). U.S. ENERGY INFORMATION ADMINISTRATION, EXISTING CAPACITY BY ENERGY SOURCE BY STATE, http://www.eia.gov/electricity/data.cfm#generation; http://www.eia.gov/electricity/data/state/existcapacity_annual.xls.

EIA 2015(m). U.S. ENERGY INFORMATION ADMINISTRATION, 2015 ANNUAL ENERGY OUTLOOK, http://www.eia.gov/forecasts/aeo/.

EIA 2015(n). U.S. ENERGY INFORMATION ADMINISTRATION, ELECTRICITY DATA BY STATE, http://www.eia.gov/electricity/data.cfm#generation, http://www.eia.gov/electricity/data/state/annual_generation_state.xls.

EIA 2015(o). U.S. ENERGY INFORMATION ADMINISTRATION, COAL PRODUCTION AND NUMBER OF MINES BY STATE AND MINE TYPE, 2013 AND 2012, *available at* http://www.eia.gov/coal/annual/xls/table1.xls.

EPA 2014(a). Carbon Pollution Emission Guidelines for Existing Stationary Sources: Electric Generating Units, 79 Fed. Reg. 34830 (June 18, 2014) (to be codified 40 C.F.R. pt. 60).

EPA 2014(b). Standards of Performance for Greenhouse Gas Emissions From New Stationary Sources: Electric Utility Generating Units, 79 Fed. Reg.1430 (Jan. 8, 2014) (to be codified at 40 C.F.R. pts 60, 70, 71, and 98).

EPA 2014(c). Carbon Pollution Standards for Modified and Reconstructed Stationary Sources: Electric Utility Generating Units, 79 Fed. Reg. 34960 (June 18, 2014) (to be codified 40 C.F.R. part 60).

EPA 2014(d). Carbon Pollution Emission Guidelines for Existing Stationary Sources: Electric Generating Units79 Fed. Reg. 34830 (June 18, 2014), Technical Support Document: Translation of the Clean

Power Plan Emission Rate-Based $C0_2$ Goals to Mass-Based Equivalents (PDF), Rate to Mass Translation Data File(xls).

EPA 2014(e). Carbon Pollution Emission Guidelines for Existing Stationary Sources: Electric Generating Units79 Fed. Reg. 34830 (June 18, 2014), Technical Support Document: State Goal Computation Appendix 1 and 2 (2014).

EPA 2014(f). Regulatory Impact Analysis for the Proposed Carbon Pollution Guidelines for Existing Power Plants and Emission Standards for Modified and Reconstructed Power Plants for Carbon Pollution Emission Guidelines for Existing Stationary Sources: Electric Utility Generating Units, Docket ID No. EPA-HQ-OAR-2013-0602 (June 2014).

EPA 2014(g). Translation of the Clean Power Plan Emission Rate-Based CO_2 Goals to Mass-Based Equivalents Technical Support Document for the Proposed Carbon Pollution Guidelines for Existing Power Plants and Emission Standards for Modified and Reconstructed Power Plants for Carbon Pollution Emission Guidelines for Existing Stationary Sources: Electric Utility Generating Units, Docket ID No. EPA-HQ-OAR-2013-0602 (June 2014).

EPA 2014(h). U.S. ENVT'L PROT. AGENCY, EPA'S POWER SECTOR MODELING PLATFORM V.5.13, TABLE 5-22: COST OF BUILDING PIPELINES TO COAL PLANTS; TABLE 5-23: COAL STEAM UNITS WITH NATURAL GAS CO-FIRING OPTION, http://www.epa.gov/airmarkets/programs/ipm/psmodel.html.

EPA 2014(i). U.S. ENVT'L PROT. AGENCY, EPA'S ANALYSIS OF THE CLEAN POWER PLAN, SUPPLEMENTAL DOCUMENTATION FOR THE PROPOSED CLEAN POWER PLAN, http://www.epa.gov/airmarkets/programs/ipm/cleanpowerplan.html.

EPA 2015(a). *Climate Change: Basic Information*, U.S. ENVT'L PROT. AGENCY, http://www.epa.gov/climatechange/basics/.

EPA 2015(b). *Fact Sheet, Clean Power Plan & Carbon Pollution Standards Key Dates*, U.S. ENVT'L PROT. AGENCY, http://www2.epa.gov/carbon-pollution-standards/fact-sheet-clean-power-plan-carbon-pollution-standards-key-dates.

EPA 2015(c). U.S. ENVT'L PROT. AGENCY, INVENTORY OF U.S. GREENHOUSE GAS EMISSIONS AND SINKS: 1990-2013 (2015), *available at* http://www.epa.gov/climatechange/ghgemissions/usinventoryreport.html.

EPA 2015(d). *Sources of Greenhouse Gas Emissions: Electricity Sector Emissions*, U.S. ENVT'L PROT. AGENCY, http://www.epa.gov/climatechange/ghgemissions/sources/electricity.html.

Fed'n of Tax Adm'rs 2015. FEDERATION OF TAX ADMINISTRATORS, SEVERANCE TAXES, http://www.taxadmin.org/fta/severance/statutes/wv_statutes.pdf.

Freeing The Grid 2015. FREEING THE GRID 2015, http://freeingthegrid.org/.

ICF 2015. U.S. DEPT. OF ENERGY & ICF INT'L., COMBINED HEAT AND POWER UNITS LOCATED IN WEST VIRGINIA, http://www.eea-inc.com/chpdata/States/WV.html.

Kessler 2014. *Member's Press Release, Kessler Announces SCORE Initiative*, SENATE PRESIDENT JEFF KESSLER (Oct. 16, 2014), http://www.legis.state.wv.us/News_release/newsrelease_RecordView1.cfm?RecordID=684.

Kunkel 2015. Appalachian Power Company and Wheeling Power Company, both dba American Electric Power Petition for Review and Determination of 2015 Energy Efficiency/Demand Response program rates, Direct Testimony of Catherine Kunkel, Case No. 15-0303-E-P (May 19, 2015).

Lego 2015. WEST VIRGINIA COLLEGE OF BUSINESS AND ECONOMICS, COAL PRODUCTION IN WEST VIRGINIA: 2015 - 2035 (2015) *available at* http://wvutoday.wvu.edu/n/2015/05/28/wvu-report-shows-coal-industry-faces-nearly-39-percent-decline-in-coal-production.

MACED 2015. *How$martKY Overview*, MOUNTAIN ASSOCIATION FOR COMMUNITY ECONOMIC DEVELOPMENT, http://www.maced.org/howsmart-overview.htm.

Maher 2015. Chris Maher, *Appalachian Communities Scraping By as Coal Taxes Drop*, THE WALL STREET JOURNAL, Apr. 10, 2015, http://www.wsj.com/articles/appalachian-communities-scraping-by-as-coal-taxes-drop-1428696029.

Marcellus Drilling 2015. *Big News: 3 More Marcellus-Powered Electric Plants Coming to WV*, MARCELLUS DRILLING NEWS (Mar. 2015), http://marcellusdrilling.com/2015/03/big-news-3-more-marcellus-powered-electric-plants-coming-to-wv/.

MHS&T 2015. W. VA. OFFICE OF MINER'S HEALTH SAFETY AND TRAINING, WEST VIRGINIA MINING STATISTICS 1996-2012, http://www.wvminesafety.org/STATS.HTM.

MonPower 2014. *News Release*, *Mon Power and Potomac Edison Amend West Virginia Public Service Commission Rate Case*, FIRSTENERGY (June 13, 2014), https://www.firstenergycorp.com/content/fecorp/newsroom/news_releases/mon- power-and-potomac-edison-amend-west-virginia-public-service-.html.

NACAA 2015. NAT'L ASS'N OF CLEAN AIR ADM'RS, IMPLEMENTING EPA'S CLEAN POWER PLAN: A MENU OF OPTIONS, (May 2015), http://www.4cleanair.org/NACAA_Menu_of_Options.

NHA 2015. *Hydropower is Available*, NAT'L HYDROPOWER ASS'N, http://www.hydro.org/why-hydro/available/.

NREL 2011. NAT'L RENEWABLE ENERGY LAB., ESTIMATES OF WINDY LAND AREA AND WIND ENERGY POTENTIAL (2011) *available at* http://apps2.eere.energy.gov/wind/windexchange/pdfs/wind_maps/wind_potential_80m_30percent.pdf.

NREL 2012. NAT'L RENEWABLE ENERGY LAB., U.S. RENEWABLE ENERGY TECHNICAL POTENTIALS: A GIS-BASED ANALYSIS, (July 2012) *available at* http://www.nrel.gov/docs/fy12osti/51946.pdf.

NREL 2015. PVWatts Calculator, NAT'L RENEWABLE ENERGY LAB., http://pvwatts.nrel.gov/.

O'Leary 2011. Sean O'Leary, *Investing in the Future, Making the Severance Tax Stronger for West Virginia*, West Virginia Center on Budget and Policy, *available at* www.wvpolicy.org/downloads/SeveranceTax022812.pdf.

PJM 2015(a). *PJM Generator Deactivation Summary Sheets*, PJM INTERCONNECTION http://www.pjm.com/planning/generation-deactivation/gd-summaries.aspx.

PJM 2015(b). PJM INTERCONNECTION, GENERATION INTERCONNECTION SYSTEM IMPACT STUDY REPORT FOR PJM INTERCONNECTION REQUEST QUEUE POSITION Y3-068, WASHINGTON 138 KV (June 2014) *available at* http://www.pjm.com/pub/planning/project-queues/impact_studies/y3068_imp.pdf.

PJM 2015(c). PJM INTERCONNECTION, PJM ECONOMIC ANALYSIS OF EPA'S PROPOSED CLEAN POWER PLAN: STATE-LEVEL DETAIL (Mar. 2, 2015).

PJM 2015(d). *PJM, Who We Are*, PJM INTERCONNECTION, http://www.pjm.com/about-pjm/who-we-are.aspx.

PSC 2013. *Monongahela Power Company and the Potomac Edison Company, Joint Stipulation and Agreement for Settlement*, Case No. 12-1571-E-P, W. VA. PUBLIC SERV. COMM'N (2013).

PSC 2014. W. VA. PUBLIC SERV. COMM'N, 2014 ALTERNATIVE AND RENEWABLE ENERGY RESOURCE PLANNING ASSESSMENT (2014) *available at* http://www.psc.state.wv.us/Special_Reports/Alternative_and_Renewable_Report_2014.pdf.

PSC 2015. W. VA. PUBLIC SERV. COMM'N, GENERAL ORDER 184.35, INTEGRATED RESOURCE PLANNING (Mar. 19, 2015).

Reinhart 2012. BRIAN REINHART, P.E. ET AL. PAPER OF THE YEAR, A CASE STUDY ON COAL TO NATURAL GAS FUEL SWITCH, BLACK & VEATCH (Dec. 2012) *available at* http://bv.com/Home/news/solutions/energy/paper-of-the-year-a-case-study-on-coal-to-natural-gas-fuel-switch.

Sartarelli 2015. JOSE SARTARELLI, 2015 WEST VIRGINIA ECONOMIC OUTLOOK, WEST VIRGINIA UNIVERSITY COLLEGE OF BUSINESS AND ECONOMICS (2015).

SEIA 2014. *Solar Energy Facts: Q2 2014*, SOLAR ENERGY INDUS. ASS'N, http://www.seia.org/sites/default/files/Q2%202014%20SMI%20Fact%20Sheet_0.pdf.

SEIA 2015(a). *North Carolina Solar*, SOLAR ENERGY INDUS. ASS'N, http://www.seia.org/state-solar-policy/north-carolina.

SEIA 2015(b). *State Solar Policy*, SOLAR ENERGY INDUS. ASS'N, http://www.seia.org/policy/state-solar-policy.

SEIA 2015(c). *U.S. Installs 6.2 GW of Solar PV in 2014, Up 30% over 2013*, SOLAR ENERGY INDUS. ASS'N, http://www.seia.org/news/us-installs-62-gw-solar-pv-2014-30-over-2013.

Smith 2014. Jennifer Smith, *WV could attract more cracker plants and spin-off companies*, METRO NEWS, Mar. 30, 2014, http://wvmetronews.com/2014/03/30/wv-could-attract-more-cracker-plants-and-spin-off-companies/.

SOAR 2014(a). RURAL POLICY RESEARCH INST., FINAL REPORT TO THE REGION: 2013 SOAR SUMMIT (Jan. 9, 2014) *available at* http://www.soar-ky.org/news-info/data-and-reports/.

SOAR 2014(b). KENTUCKY SOAR, PROGRESS REPORT: THE FIRST 90 DAYS, SHAPING OUR APPALACHIAN REGION, *available at* http://www.soar-ky.org/news-info/data-and-reports/.

SOAR 2015. *Shaping Our Appalachian Region*, KENTUCKY SOAR, http://www.soar-ky.org/about-us/.

Solar Foundation 2013. THE SOLAR FOUNDATION, NATIONAL SOLAR JOBS CENSUS 2013, *available at* http://www.thesolarfoundation.org/sites/thesolarfoundation.org/files/TSF%20Solar%20Jobs%20Census%202013.pdf.

Staudt 2014. JIM STAUDT, NATURAL GAS CONVERSION AND CO-FIRING FOR COAL-FIRED UTILITY BOILERS, ANDOVER TECHNOLOGY PARTNERS (Nov. 30, 2014).

Synapse 2015. PATRICK KNIGHT, CLEAN POWER PLAN PLANNING TOOL (CP3T) USER MANUAL VERSION 1.4, SYNAPSE ENERGY ECONOMICS (Apr. 14, 2015) *available at* http://synapse-energy.com/sites/default/files/tools/CP3T-User-Manual.pdf.

UCS 2014(a). UNION OF CONCERNED SCIENTISTS, BURNING COAL, BURNING CASH: 2014 UPDATE, NORTH CAROLINA'S DEPENDENCE ON IMPORTED COAL (2014) *available at* http://www.ucsusa.org/clean_energy/smart-energy-solutions/decrease-coal/burning-coal-burning-cash-2014-update-state-coal-imports.html#.VXICgM-6fDc.

UCS 2014(b). UNION OF CONCERNED SCIENTISTS, STRENGTHENING THE EPA'S CLEAN POWER PLAN (Oct. 2014) *available at* http://www.ucsusa.org/sites/default/files/attach/2014/10/Strengthening-the-EPA-Clean-Power-Plan.pdf.

Van Nostrand 2012. JAMES M. VAN NOSTRAND, THE CASE FOR INTEGRATED RESOURCE PLANNING IN WEST VIRGINIA, CENTER FOR ENERGY & SUSTAINABLE DEV. (Dec. 2012) *available at* http://energy.law.wvu.edu/r/download/148340.

Van Nostrand 2013(a). JAMES M. VAN NOSTRAND, THE CASE FOR ENERGY EFFICIENCY INVESTMENTS IN WEST VIRGINIA, CENTER FOR ENERGY & SUSTAINABLE DEV. (March 2013), *available at* http://energy.law.wvu.edu/r/download/155988.

Van Nostrand 2013(b). JAMES M. VAN NOSTRAND, THE CASE FOR PROMOTING UTILIZATION OF WEST VIRGINIA'S VAST NATURAL GAS RESOURCES: COMBINED HEAT AND POWER (CHP) FACILITIES, CENTER FOR ENERGY & SUSTAINABLE DEV. (Sept. 2013), *available at* http://energy.law.wvu.edu/r/download/169790.

Van Nostrand 2014. JAMES M. VAN NOSTRAND ET AL., EMISSION REDUCTION OPPORTUNITIES FOR THE WEST VIRGINIA POWER SECTOR, CENTER FOR ENERGY & SUSTAINABLE DEVELOPMENT (Oct. 2014) *available at* http://energy.law.wvu.edu/.

Vorhees 2015. Beth Vorhees, *Alpha Idles Coal Operations in Logan, Mingo Counties*, W. VA. PUBLIC BROADCASTING, Jan. 30, 2015, http://wvpublic.org/post/alpha-idles-coal-operations-logan-mingo-counties.

W. Va. 2013. W. VA. STATE TAX DEPT., REGULAR MINERAL SEVERANCE GROSS RECEIPT TAX FORECAST (Nov. 2013).

W. Va. 2014(a). W. VA. PUBLIC SERVICE COMM'N, 2014 ALTERNATIVE AND RENEWABLE ENERGY RESOURCE PLANNING ASSESSMENT (2014) *available at* http://www.psc.state.wv.us/Special_Reports/Alternative_and_Renewable_Report_2014.pdf.

W. Va. 2014(b). W. VA. DIV. OF ENERGY, RENEWABLE ENERGY IN THE STATE OF WEST VIRGINIA (June 2014), *available at* http://www.wvcommerce.org/App_Media/assets/doc/energy/june2014-presentations/01_-_Herholdt_Renewable_Energy_Conference.pdf.

W. Va. Coal Ass'n 2015. W. VA. COAL ASS'N, http://www.wvcoal.com/taxes.html.

Witt 2013. TOM WITT, BUILDING VALUE FROM SHALE GAS: THE PROMISE OF EXPANDING PETROCHEMICALS IN WEST VIRGINIA, WITT ECONOMICS LLC (Dec. 2013).

WV SUN 2015. *Harnessing Hometown Energy to Repower West Virginia*, WV SUN, http://www.wvsun.org/.

APPENDIX A: DETAILED MODELING ASSUMPTIONS

To model the five 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 across all five scenarios (See Table 7).

Table 7: Capacity factors by generation type: All 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.
CHP: Existing	29%	Calculated based on EIA coal CHP generation and capacity in West Virginia from 2009-2013 (EIA 2015(l), EIA 2015(m)).
CHP: New	92%	Calculated based on CHP generation and capacity in ACEEE's West Virginia "Utility Ownership Case Market Penetration" scenario (ACEEE 2012).
NGGT	1.4%	CP3T default for West Virginia.
Coal	Calculated by CP3T	Figure 22 illustrates the average capacity factor for each scenario and year.

Emission factors

The emission factors used for each generation type are the same across all five scenarios (See Table 8).

Table 8: 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	907	CP3T default, from USEPA Technical Support Document.
CHP: Existing	2,000	Calculated based on 2010 eGRID emissions and generation for all coal-fired power plants in West Virginia (rounded).
CHP: New	814	Calculated based on 2010 eGRID emissions and generation for natural gas CHP plants in California, Connecticut, Massachusetts, and New York for which the first generator was built between 2000 and 2009.
NGGT	1,336	CP3T default, based on 2012 eGRID emissions and generation.
Coal	1,832-3,030	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 2012 installed capacity for each generation type is the same for all five scenarios (See Table 9). While the future installed capacity is the same for the first three scenarios (Table 10), it differs for the two all-of-the-above scenarios (Table 11 and Table 12).

Table 9: 2012 Installed capacity by generation type: All scenarios

Generation type	2012 installed capacity (MW)	Note
Wind	583	Based on 2012 eGRID capacity.
Solar	0	Based on 2012 eGRID capacity, although the PSC reports 1.9 MW of distributed solar capacity in West Virginia (PSC 2014).
Biomass	3	Based on CP3T default for West Virginia, which is based on EIA State Historical Tables for 2012, Released December 2013.
Hydropower	371	Based on eGRID capacity in 2012 for West Virginia hydropower plants.
Energy efficiency	N/A	N/A
NGCC	0	N/A
CHP: Existing	169	Based on EIA coal CHP capacity in West Virginia from 2009-2013.
CHP: New	0	N/A
NGGT	1,205	Based on 2012 eGRID capacity.
Coal	15,009	Based on EIA.

Table 10: Future installed capacity by generation type: Business As Usual, Inside-The-Fenceline, and Reduced Export scenarios

Generation type	Future installed capacity (MW)	Note
Wind	874 by 2030	Based on fulfilling three-quarters of business-as-usual renewables growth with wind.
Solar	178 by 2030	Based on fulfilling one-quarter of business-as-usual renewables growth with solar.
Biomass	No change	N/A
Hydropower	No change	N/A
Energy efficiency	N/A	Cumulative savings of 2.5% by 2030.
NGCC	549 in 2018	Moundsville plant becomes operational in 2018.
CHP: Existing	No change	N/A
CHP: New	No change	N/A
NGGT	No change	N/A
Coal	13,072 by 2030	Based on capacity remaining after coal plant retirements.

Table 11: Future installed capacity by generation type: All-Of-The-Above 1 scenario

Generation type	Future installed capacity (MW)	Note
Wind	2,106 by 2030	Based on fulfilling 50% of USEPA's non-hydropower renewable CPP goal for West Virginia—first with 410 MW of installed solar capacity, and the rest with wind.
Solar	410 by 2030	Based on assumed achievable capacity.
Biomass	No change	N/A
Hydropower	439 by 2030	Based on 1% average annual growth.
Energy efficiency	N/A	Cumulative savings of 10% by 2030.
NGCC	549 in 2018	Moundsville plant becomes operational in 2018.
CHP: Existing	No change	N/A
CHP: New	588 by 2030	Based on CHP capacity in ACEEE's West Virginia "Utility Ownership Case Market Penetration" scenario (Chittum and Sullivan, 2012).
NGGT	No change	N/A
Coal	13,072 by 2030	Based on capacity remaining after coal plant retirements.

Table 12: Future installed capacity by generation type: All-Of-The-Above 2 scenario

Generation type	Future installed capacity (MW)	Note
Wind	1,398 by 2030	Based on fulfilling 30% of USEPA's non-hydropower renewable CPP goal for West Virginia—first with 410 MW of installed solar capacity, and the rest with wind.
Solar	410 by 2030	Based on assumed achievable capacity.
Biomass	No change	N/A
Hydropower	612 by 2030	Based on 3% average annual growth.
Energy efficiency	N/A	Cumulative savings of 13% by 2030.
NGCC	549 in 2018, 1,098 in 2022	Moundsville plant becomes operational in 2018, and a second plant of the same size becomes operational in 2022.
CHP: Existing	No change	N/A
CHP: New	147 by 2030	Based on one-quarter of the CHP capacity in ACEEE's West Virginia "Utility Ownership Case Market Penetration" scenario (Chittum and Sullivan, 2012).
NGGT	No change	N/A
Coal	13,072 by 2030	Based on capacity remaining after coal plant retirements.

Total electricity sales

Annual growth rates for total electricity sales, from EIA's Annual Energy Outlook 2013, were 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, including wind, solar, biomass, hydropower, energy efficiency, NGCC, CHP, and NGGT resources. In other words, as these resources increase in capacity in future years, more electricity is generated from these resources and less electricity is generated from coal.