AEE INSTITUTE

ADVANCED ENERGY INDUSTRIES

ASSESSING VIRGINIA'S ENERGY FUTURE

Employment Impacts of Clean Power Plan Compliance Scenarios

Prepared by Meister Consultants Group

April 2015

This report was prepared for the Advanced Energy Economy Institute and the Virginia Advanced Energy Industries Coalition by Meister Consultants Group, Inc.

About AEEI

The Advanced Energy Economy Institute (AEEI) is a 501(c)(3) charitable organization whose mission is to raise awareness of the public benefits and opportunities of advanced energy. AEEI provides critical data to drive the policy discussion on key issues through commissioned research and reports, data aggregation and analytic tools. AEEI also provides a forum where leaders can address energy challenges and opportunities facing the United States. AEEI is affiliated with Advanced Energy Economy (AEE), a 501(c)(6) business association, whose purpose is to advance and promote the common business interests of its members and the advanced energy industry as a whole.

About VAEIC

Virginia Advanced Energy Industries Coalition (VAEIC) promotes policies that support open markets for clean and secure advanced energy technologies in order to create jobs and position Virginia as a magnet for talent and innovation in the advanced energy sector. VAEIC represents the leading clean, advanced energy technologies with an economic interest in Virginia and a commitment to prudent energy policies. Utilizing our coalition's commercial and political strength and deploying our collective capabilities, we are transforming the Virginia energy landscape.

About MCG

Meister Consultants Group, Inc. (MCG) is an international sustainability consulting firm specializing in renewable energy policy and strategy development. With affiliates in the United States and Europe, MCG is a global leader in clean energy policy, climate change planning, and stakeholder dialogue. MCG works with clients across the globe, from multi-national finance institutions; to federal, state and local governments; to philanthropic foundations. MCG's unique approach provides solutions that are grounded in global best practices yet are tailored to local contexts.

Copyright 2015 Advanced Energy Economy Institute and Virginia Advanced Energy Industries Coalition.

ABOUT AEEI (p. i)

ABOUT VAEIC (p. i)

TABLE OF CONTENTS (p. ii)

EXECUTIVE SUMMARY (p. 1)

BACKGROUND (p. 3)

MODELING APPROACH (p. 6)

SCENARIO CONSTRUCTION (p. 8)

EMPLOYMENT MODELING (p. 18)

CONCLUSIONS (p. 25)

EXECUTIVE SUMMARY

Virginia's energy industry is undergoing a major transition as it retires older power plants and builds new infrastructure to meet the needs of citizens while simultaneously planning to meet federal environmental regulations. The most notable regulatory obligation is the development of a plan for implementing the U.S. Environmental Protection Agency's (EPA's) Clean Power Plan (CPP), which will require a transition to low and zero-carbon energy resources.

The final rule for EPA's CPP, expected by mid-summer 2015, sets CO_2 emission rate targets for each state. To calculate these reduction targets, EPA established a "Best System of Emission Reduction" (BSER) based on four "Building Blocks." These Building Blocks are: (1) efficiency improvements at coal-fired generating units; (2) reduced utilization of coal-fired units due to increased generation by existing natural gas combined cycle power plants; (3) increased generation from zero-emissions renewable energy and nuclear power plants; and (4) reduced energy consumption due to energy efficiency programs. EPA used these Building Blocks for calculation purposes when setting emission rate targets, but they are not prescriptive compliance mechanisms.

Under EPA's Clean Power Plan, Virginia is tasked with reducing its carbon emissions rate from eligible generators to 810 pounds of CO_2 emitted per MWh (lbs CO_2/MWh) by the year 2030, a 44 percent reduction from the state's 2012 emissions rate, calculated by EPA to be 1,438 lbs CO_2/MWh. It is important to note that many different CPP compliance scenarios are possible given that states are allowed to develop plans that do not follow EPA's Building Block calculations. With Virginia's unemployment rate at its lowest rate since 2008,[1] policymakers are eager to understand the employment implications of different compliance scenarios, so that they can develop an implementation plan that will maintain the state's progress.

In both scenarios, compliance with CPP would provide substantial employment benefits for Virginia.

The Assessing Virginia's Energy Future report considers the employment outcomes of two possible CPP compliance strategies. Specifically, this report summarizes employment modeling that compares CPP implementation scenarios to a "business as usual" future by looking at new labor in Virginia associated with building and operating new power plants and efficiency improvement projects and labor lost from plants retiring and other planned changes. The analysis considers a "Diversified Portfolio" that achieves compliance by implementing changes already planned by utilities, most of the Building Block measures contemplated by EPA, and some additional renewable energy and energy efficiency. Since Virginia has long examined ways to limit its electricity imports, which provide just under 40 percent of the state's electricity, the report also considers an "Import Reduction" scenario that utilizes additional renewable energy, energy efficiency, and natural gas generating resources to eliminate the state's electricity imports while also meeting EPA's emission reduction target for the state.

Both scenarios incorporate changes to the state's electric system that are already planned by Virginia's major electric utilities, Virginia Electric Power Company (Dominion) and Appalachian Power Company (APCO). As described in Dominion's and APCO's most recent Integrated Resource Plans, the two utilities plan to either

1. As of December 2014, Virginia's unemployment rate was 4.8%. Virginia Employment Commission, Press Release (Jan. 27, 2015). Available at: http://virginialmi.com/?page=3&print=1&release=226.

retire or convert to other fuels a substantial amount of coal-fired generation, to implement a strong suite of renewable energy and energy efficiency programs, and to construct several high-efficiency natural gas combined cycle power plants. These changes reflect the changing economics of the electric power sector, as rapidly evolving generation and energy efficiency technologies and operational innovations are creating opportunities for attractive return on investments through improved efficiencies. These planned changes will also reduce Virginia's emissions rate, helping it reach its targets under the CPP. In this report, employment benefits from already-planned capacity changes are separated out in this analysis to isolate the employment impacts of the CPP.

As different types of compliance actions have employment impacts over varying lengths of time, we discuss employment impacts primarily in terms of job-years. The job-year impacts are calculated by multiplying each job gained or lost by the number of years in the study period over which it is gained or lost. We measure job-year impacts until 2030, the year in which states are to comply with EPA's emissions targets. This analysis follows the approach used by EPA in its Regulatory Impact Analysis in considering only direct jobs impacts, not the indirect nor induced employment produced by impacts of these direct jobs on other economic sectors, with the exception of including upstream employment impacts on coal and natural gas extraction industries.

In both scenarios, we found compliance with the CPP would provide substantial net employment benefits for Virginia. By 2030, the Diversified Portfolio option will result in 54,231 cumulative additional job years that result from compliance actions, and the Import Reduction scenario will result in 122,912 job-years, more than double the employment gains of the Diversified Portfolio scenario. These numbers are in addition to the 7,964 net job-years that will be created by changes that are already planned by the state's utilities. Under the Diversified Portfolio scenario, job gains will peak in 2029, with more than 5,700 net jobs that year, near the current employment in beverage production in Virginia. Under the Import Reduction scenario, the employment peak will come in 2027, with 12,600 additional jobs that year – nearly equal to existing jobs in commercial construction.[2]

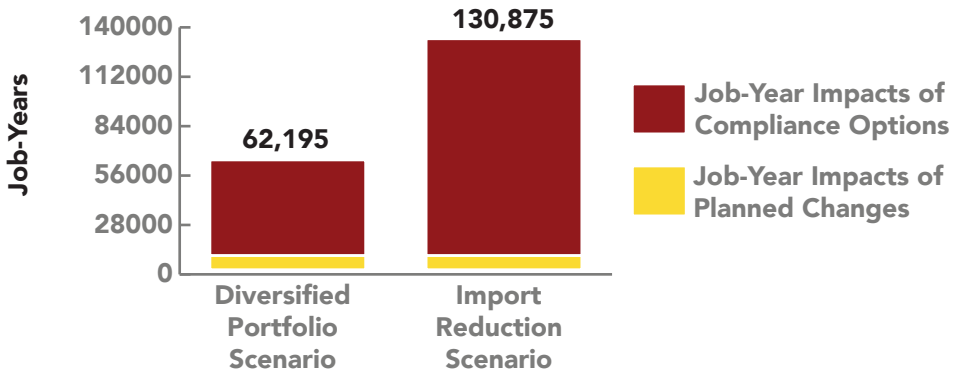


Figure 1. Summary of Cumulative Employment Impacts by Compliance Scenario

After considering different compliance strategies, this report finds that the CPP can lead to substantial direct job creation in Virginia. These employment benefits will be even greater if the state adopts a compliance plan that aims to simultaneously increase the state's energy self-sufficiency at the same time. Given these findings, Virginia should be able to craft a compliance strategy for EPA's Clean Power Plan that will drive market growth of Virginia's energy economy and maximize employment benefits for the state.

2. U.S. Bureau of Labor Statistics, available at: http://www.bls.gov/iag/tgs/iag312.htm; http://www.bls.gov/iag/tgs/iag236.htm

BACKGROUND

An Overview of the Clean Power Plan

On June 2, 2014, the U.S. Environmental Protection Agency (EPA) issued a proposed rule under Section 111(d) of the Clean Air Act, which would for the first time regulate CO_2 emissions from existing power plants. This regulation, also known as the Clean Power Plan (CPP), will be finalized in mid-summer of 2015. Modeling indicates that the CPP will reduce national carbon emissions by 30 percent by the year 2030 from 2005 levels.

In order to set individual reduction targets for each state, EPA identified a variety of adequately demonstrated emission reduction options, which it categorized into four "Building Blocks." These Building Blocks cumulatively comprise the "Best System of Emission Reductions" (BSER). EPA applied BSER to each state's electricity system to calculate emission rate reduction targets, but states are free to ignore the Building Blocks and develop their own mix of emissions-reducing actions to meet their targets.

While the four Building Blocks are not prescriptive, they are key to understanding how EPA derived individual state targets. The four Building Blocks are:

1. Reducing emissions from existing coal-fired units through heat rate improvements that increase coal plant efficiency;

2. Increasing utilization of existing natural gas combined cycle power plants in order to reduce CO_2 from higher-emitting fossil generating units;[3]

3. Increasing generation from zero-emission resources, including nuclear, wind, solar, and other renewable technologies; and

4. Reducing electricity consumption through utility-run energy efficiency programs.

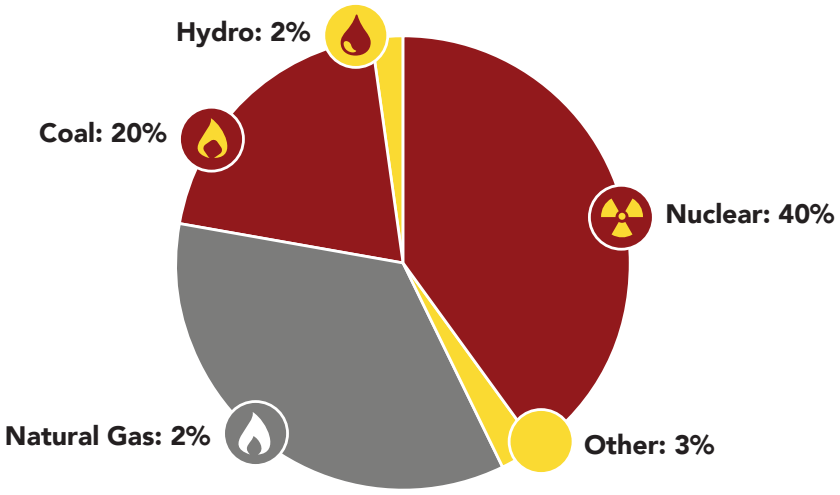
The mix of emission reduction methods in each state can—and likely will—include a combination of the technologies in EPA's Building Blocks. However, states are not obligated to meet the Building Block targets and can instead outperform or underperform in these individual categories. In addition, states can employ other technologies not considered by EPA, such as demand response, various distributed generation technologies, private sector energy efficiency, combined heat and power, energy storage, and transmission and distribution efficiency upgrades, etc. The only important metrics are the interim emission rate (to be met as an average rate over 2020 to 2029) and the final emission rate (to be met thereafter). For Virginia, the final 2030 target is 810

3. According to EPA's plant-level emissions statistics, coal power plants in Virginia have an average emissions rate of 2,268 lbs/MWh, and its NGCC facilities have an average emissions rate of 903 lbs/MWh.

lbs/MWh by 2030, a 44 percent reduction compared to a baseline rate of over 1,438 lbs/MWh in 2012, and an interim target of an average rate of 884 lbs/MWh from 2020 to 2029.

The CPP also allows states to coordinate regionally and convert mass-based emission reduction targets; however, these options are outside the scope of this report and are not considered in the scenarios outlined here.

Virginia's Energy Sector in Brief



Virginia is a net energy importer, with more than 40 percent of its electricity needs being met by out-of-state power plants in 2012.[4] Of the electric power that is produced in Virginia, nearly all is generated by a combination of nuclear power (40 percent of in-state generation), natural gas (35 percent), and coal (20 percent).
Virginia's electricity market is vertically integrated, having been re-regulated by legislation in 2007 after a brief move toward partial-deregulation that began in 1998.[5] Although deregulation did not last, one key change made during the transitional period has persisted: in 2004, Virginia's utilities joined the PJM Interconnection, a regional transmission operator that controls wholesale electricity transmission in all or part of thirteen states and Washington, D.C.[6]

The state's investor-owned utilities (IOUs) and member-owned cooperative utilities are regulated by the Virginia State Corporation Commission (SCC), which is led by three commissioners elected by the Virginia General Assembly.[7] The state's largest IOU, Virginia Electric & Power Company (Dominion), a subsidiary of Dominion Resources, serves 64 percent of Virginia's residential customers. Appalachian Power Company (APCO), the second-largest IOU and a subsidiary of American Electric Power, serves 14 percent of residential customers in the state.

4. EIA VA State Electricity Profile 2012, Table 10. There are indications that imports have declined a few percentage points from 2012 to 2015.
5. Energy Information Administration, Virginia Restructuring Suspended (Apr. 2007), available at: http://www.eia.gov/electricity/policies/restructuring/virginia.html.
6. Federal Energy Regulatory Commission, Commission Conditionally Approves "PJM South" (Oct. 2004), https://www.ferc.gov/media/news-releases/2004/2004-4/10-05-04.asp.
7. State Corporation Commission, "Electric Companies Regulated by The SCC," https://www.scc.virginia.gov/pue/elec/reg_cos.aspx; State Corporation Commission, "About the Commissioners," https://www.scc.virginia.gov/comm/about.aspx.

Both Dominion and APCO participate in the state's voluntary renewable portfolio standard (RPS). Passed by legislation in 2007 and expanded in 2009, this RPS set a target of 15 percent renewable generation by 2025 based on 2007 base-year electricity sales. The voluntary RPS allows renewable energy credits (RECs), existing hydropower, and certified research and development investments to count towards compliance; and includes multipliers for electricity generated from solar energy, animal waste, and both onshore and offshore wind.[8] As of 2013, Dominion had achieved 68 percent of its target for the previous year, and APCO had fulfilled its 2012 target.[9]

In addition to a voluntary RPS, Virginia also enacted a voluntary energy efficiency goal in 2007, setting a target of 10 percent savings by 2022 relative to 2006 base-year electricity sales.[10] While this goal is non-binding, utilities are required to include demand-side resources in their integrated resource plans (IRPs).[11] However, to date the state has not fully leveraged the cost effective suite of energy efficiency technologies and services that can save customers money, reduce energy imports, and strengthen the state economy.

Recent IRPs filed by Dominion and APCO—which provide 15-year forecasts and resource plans—indicate that the state's electric utilities are already preparing for major changes in the industry that will significantly alter the state's electricity generation profile. Since EPA's 2012 baseline, Dominion and APCO have converted five coal units to run on either biomass or natural gas, and have retired the five generating units at the Potomac River Generating Station. In their IRPs, Dominion and APCO describe plans to retire nine more generating units and to repower two with natural gas. Combined, these changes will remove 2,934 MW of coal capacity, 42 percent of all coal generation in Virginia in 2012. The utilities have also added or plan to add (either in IRPs or via subsequent announcements) 5,555 MW of new natural gas, solar, and biomass capacity by 2020. Dominion Virginia is also considering an additional 1,450 MW of new nuclear capacity.[12]

Among non-hydro renewable energy technologies, Virginia has invested most heavily so far in biomass and landfill gas, which together accounted for 4 percent of the state's generation in 2012. Projects range from the 122 MW industrial wood waste and black liquor facility in Covington to the state's 309 landfill gas generation units, which average 400 kW in capacity.[13] While only 12.6 MW of solar has been installed in Virginia through 2013[14], Dominion also recently announced a commitment to install 400 MW of solar by 2020.[15] Dominion has secured one of the only federal leases for offshore wind development granted to date, in an area roughly 30 miles offshore from Virginia Beach.

While these changes alone will result in substantial emissions reductions, Virginia will need to deploy additional measures in order to comply with the CPP. Decisions around Virginia's compliance strategy will not only shape the state's energy future but also its economy. The subsequent sections of this report will explore the employment outcomes of different compliance scenarios in the state.

8. http://law.lis.virginia.gov/vacode/title56/chapter23/section56-585.2/
9. Dominion's compliance filing: https://www.scc.virginia.gov/pue/renew/dvp_renew_13.pdf and APCO's compliance filing: https://www.scc.virginia.gov/pue/renew/apco_renew_13.pdf.
10. Virginia Senate Bill 1416 (Apr. 4, 2007), available at: https://leg1.state.va.us/cgi-bin/legp504.exe?071+ful+CHAP0933.
11. Virginia Senate Bill 311 (2008), available at: https://leg1.state.va.us/cgi-bin/legp504.exe?081+ful+SB311ER+pdf.
12. Dominion, Virginia Integrated Resource Plan 2014 (Aug. 29, 2014), available at: https://www.dom.com/library/domcom/pdfs/corporate/integrated-resource-planning/va-irp-2014.pdf.
13. EPA 2012 eGRID data
14. IREC US Solar Market Trends 2014 report
15. http://markets.financialcontent.com/stocks/news/read?GUID=29215317

MODELING APPROACH

This analysis compared the employment impacts of the investments necessary in Virginia to comply with the CPP against those of a business-as-usual baseline forecast. For both the baseline and compliance scenarios, this began with forecasting the supply mix of Virginia's electric power sector from the 2012 baseline out to the 2030 compliance target date. The modeling team drew upon the existing work and expertise of a broad group of businesses, academic and related stakeholders who also reviewed the proprietary model developed to conduct this analysis.

The Baseline scenario built upon the 2012 generation and emissions profiles used by EPA in its analysis. The baseline forecast incorporated planned capacity additions, retirements, and conversions either completed by Dominion and APCO to date or included in their most recent Integrated Resource Plans (IRPs) and then continued the trend of principally building out new gas resources to keep pace with projected demand through 2030.[16]

A pair of compliance scenarios were then constructed to compare to this baseline forecast. The CPP allows for flexibility in the approaches that states may take to realizing emissions reductions, and each of the many compliance pathways that Virginia may pursue would have its own impact on the state's energy portfolio and resulting employment.[17] The purpose of this study was not to capture every possible scenario for compliance that Virginia could consider, but rather to model the employment impacts of two scenarios under active discussion in the state:

1. A "Diversified Portfolio" scenario, which combines a variety of compliance actions to reduce Virginia's emission rate to the target level. This scenario starts with the planned capacity changes under the

2. IRPs and then adds implementation of levels of coal-to-gas redispatch, renewable energy generation, retained nuclear generation, and energy efficiency saving laid out in EPA's Building Blocks analysis.[18] The remainder of the emission reductions are sourced from the addition of new renewable energy and energy efficiency resources.

3. An "Import Reduction" scenario, which includes all of the resource changes in the Diversified Portfolio scenario but also assumes that Virginia would simultaneously work to drive imports to zero by 2030. There are a number of ways to drive down imports. This scenario examines a future in which the reduction of

16. Dominion provides two scenarios in its IRP, a base plan and a fuel diversity plan that reflects anticipated changes due to the Clean Power Plan. In order to identify planned capacity changes that are likely to occur even without CPP compliance, only the capacity changes from the base plan are included in the baseline forecast.
17. One of the other compliance approaches that has been discussed for Virginia centers on Dominion building the North Anna 3 nuclear reactor. While new nuclear is an allowed compliance option under the CPP, a scenario involving North Anna 3 was not included in this analysis for a couple of reasons. First, Dominion has not committed to building the plant, and the earliest that the plant could be constructed would be in the fall of 2027. Given the complexity of nuclear projects, delays could easily carry the plant beyond the compliance period. Second, Dominion plans to later close North Anna 1 and 2 meaning net nuclear would remain roughly constant.
18. EPA has determined 5.8% of national nuclear capacity to be "at risk", an amount which it applies universally to all states rather than attributing to individual nuclear plants. EPA allows states to include 5.8% of their nuclear generation in emissions calculations if no nuclear capacity is retired.

Virginia's energy imports—and the corresponding expansion of in-state energy resources—would provide an opportunity to tap the state's substantial renewable energy and energy efficiency resources while also adding some natural gas generation.

The analysis of the scenarios considers the full range of impacts on employment in Virginia. These include labor associated with building and operating new power plants and carrying out efficiency improvements, labor lost at retired power plants, upstream labor impacts on Virginia's coal mining and natural gas extraction sectors, and labor losses due to the avoided construction of new capacity that was built in the baseline forecast but avoided in compliance scenarios due to the pursuit of alternate energy resources.

As compliance actions will affect multiple industries and impact both temporary construction and permanent operations and maintenance labor, employment impacts for the two scenarios were considered in terms of direct job-years that were counted cumulatively until 2030, the year in which states are to reach CPP compliance. The job-year impacts are calculated by multiplying each job gained or lost by the number of years in the study period over which it is gained or lost. This analysis follows the approach used by EPA in its Regulatory Impact Analysis in considering only direct jobs impacts, not the indirect nor induced employment produced by impacts of these direct jobs on other economic sectors, with the exception of including upstream employment impacts on coal and natural gas extraction industries.[19]

19. Direct jobs include only jobs that contribute directly to the changes being implemented under these scenarios, for example, construction and maintenance jobs at new generating facilities. Indirect jobs are jobs in fields or industries that support or supply direct economic activity, such as manufacturing jobs that provide construction materials. Induced jobs are those that result from increased spending due to new direct and indirect jobs in the region.

SCENARIO CONSTRUCTION

A more detailed description of the Baseline scenario, Diversified Portfolio scenario, and Import Reduction scenario is provided below.

Baseline Scenario

The Baseline scenario used generating-unit data provided by EPA to determine the initial 2012 mix of in-state generation.[20] The generation profile was and then built out over time to account for planned capacity additions, retirements, and conversions either already completed or planned by Dominion and APCO. The Baseline scenario assumed an initial 2012 net import percentage of 42 percent[21] and a demand growth rate of 1.14 percent per year.[22]

The table below summarizes the capacity changes completed since 2012 or currently planned by Dominion and APCO. The two utilities have already retired or plan by 2020 to retire or repower 2,934 MW of coal capacity, 42 percent of all coal generation in the state. The utilities also already have or plan to add 4,762 MW of NGCC capacity, an increase of 110 percent over 2012 levels, as well as 566 MW of biomass and solar.

20. Specifically, the analysis uses the 2012 unit-level generating data provided by EPA using the eGRID methodology, used by EPA as the basis for its own analysis of the Clean Power Plan.
21. Virginia's average import rate over the last five years of data available from Energy Information Administration's State Electricity Profile for Virginia. EPA's goal-setting calculations also assume a 42% 2012 import rate for Virginia.
22. The weighted average projected growth rates included in Dominion and APCO's IRPs.

Year	Type	Technology	Plant Name	Capacity (MW)
2013	Repower	Coal	Altavista Power Station	-71.1
2013	Repower	Biomass	Altavista Power Station Biomass	51
2013	Repower	Coal	Bremo Bluff	-254.2
2013	Repower	NGCC	Bremo Bluff Natural Gas	227
2013	Repower	Coal	Hopewell Power Station	-71.1
2013	Repower	Biomass	Hopewell Power Station Biomass	51
2013	Retirement	Coal	Potomac River	-514
2013	Repower	Coal	Southampton Power Station	-71.1
2013	Repower	Biomass	Southampton Power Station Biomass	51
2015	Retirement	Coal	Chesapeake 1-4	-578
2015	Retirement	Coal	Clinch River	-230
2015	Retirement	Coal	Glen Lyn	-337.5
2015	Addition	NGCC	Warren	1,337
2016	Addition	NGCC	Brunswick	1,375
2016	Repower	Coal	Clinch River 1-2	-484
2016	Repower	NGCC	Clinch River 1-2	484
2016	Addition	Solar	Solar Power Partnership	13
2016	Retirement	Coal	Yorktown	-323
2017	Addition	Solar	Remington Solar Facility	20
2020	Addition	NGCC	Unnamed CC	1,566

Table 2. Schedule of Planned Capacity Additions, Retirements, and Repowering Projects in Virginia

These planned changes will alter Virginia's energy supply mix and associated emissions profile as natural gas and renewable energy generation increase and coal generation decreases. The utilities' planned changes will amount to a substantial increase in in-state generation, primarily natural gas. This growth will be enough to outpace forecasted demand growth through 2020 and partially reduce imports from neighboring states.[23]

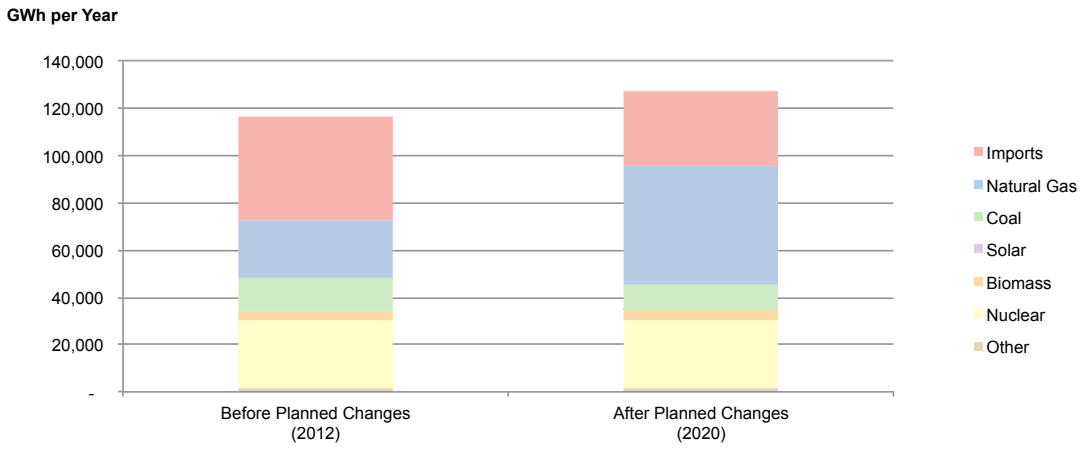


Figure 2. Virginia Energy Supply Mix Before and After Planned Capacity Changes

The planned retirement of coal plants, construction of lower-emissions natural gas plants, and the consideration of both new and existing renewable energy resources will reduce Virginia's emissions rate by over 25 percent, to 1,050 lbs/MWh.

Virginia's utilities do not have any planned capacity changes after 2020 in their IRPs. As utilities have not indicated any long-term plans to continue to reduce electricity imports into Virginia, the Baseline scenario assumes that business-as-usual long-term capacity growth will keep pace with demand growth, but will not cause any further change in imports after 2020. The scenario also assumes that post-2020 capacity additions will be NGCC facilities in a manner consistent with the trend displayed in the utility IRPs.

Over the complete time period of 2012 to 2030, the business-as-usual Baseline scenario forecasts significant change in Virginia's generation mix. Virginia's coal generation decreases by nearly 3,800 GWh from 2012 to 2030 in the Baseline scenario, dramatically shrinking the role that coal plays in the state's power supply. With an additional 2,638 MW of capacity constructed between 2020 and 2030, natural gas generation more than doubled from 2012 to 2030 to supply nearly half of Virginia's energy needs. Since the forecasted capacity additions outpace both planned retirements and projected demand growth, net imports decline in the Baseline scenario by nearly 8,000 GWh from 2012 to 2030. Figure 3 illustrates the evolution of Virginia's supply mix over time in the Baseline scenario. The change in the supply mix reduces Virginia's emissions rate to 1,024 lbs/MWh by 2030, a substantial reduction from 2012 levels but short of its CPP target of 810 lbs/MWh.

23. As a result of planned changes, Virginia's electricity imports decline on a percentage basis from nearly 40% of the state's electricity supply in 2012 to 24% in 2020

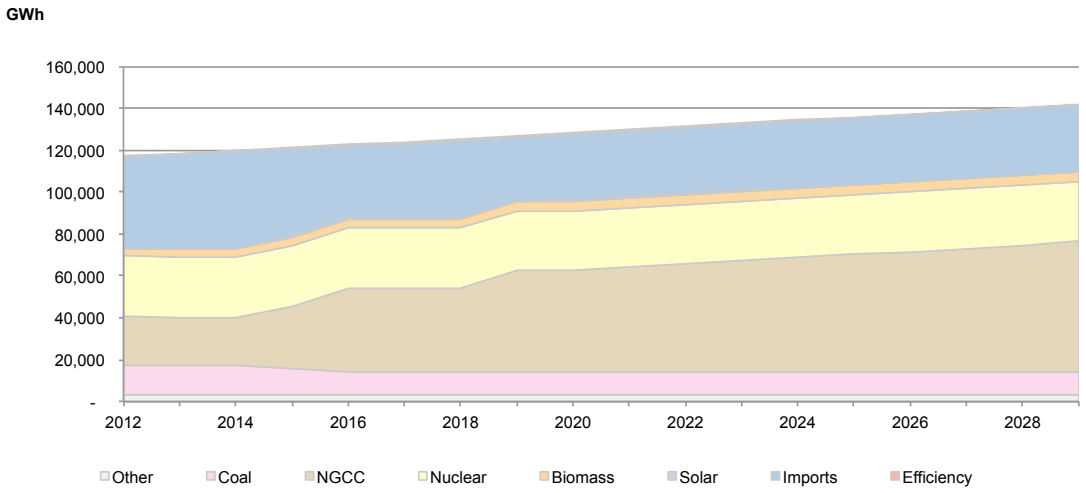


Figure 3. Generation by Fuel by Year, Baseline Scenario

Diversified Portfolio Scenario

As with the Baseline scenario, the Diversified Portfolio scenario incorporated the planned capacity changes in Dominion and APCO's IRPs through 2020. In addition those changes, this scenario includes a series of actions based on EPA's Building Blocks that will reduce Virginia's emissions rate of 810 lbs/MWh by 2030.

Although it conflicts with the CPP's Building Block 1, the scenario assumed that Virginia will not achieve any emissions reductions from heat rate improvements (HRIs) at its existing coal power plants. The exclusion of HRI emissions savings is based on Dominion's assertion[24] that it has already made significant investment in coal plant heat rate efficiency and that EPA's estimate of 6 percent savings potential is, in their view, too aggressive.[25] Consistent with the CPP's Building Block 2, the scenario assumed that generation will be redispatched from coal plants to the state's NGCC plants such that the existing and under construction NGCC fleet reaches an average capacity factor of 70 percent.[26] In EPA's analysis, the increase in NGCC generation is counterbalanced by a decrease in coal, oil, and natural gas combustion turbine (NGCT) generation. However, Virginia's oil and NGCT plants have very low capacity factors,[27] indicating that they are used primarily in peak load situations. Therefore, this analysis included only coal-to-NGCC redispatch.

24. Dominion Resource Service, Inc. Comment to the Environmental Protection Agency on the Carbon Pollution Guidelines for Existing Stationary Sources, November 2014.
25. Because so much of Virginia's coal capacity is already in the process of being retired or modified to use other fuels, including emissions savings from HRI would have a minimal impact on the final results. Including a fleet wide heat rate improvement of 6%, as assumed in EPA's analysis, would lower Virginia's emissions rate by an additional 13 lbs/MWh. Because HRI is a less labor-intensive emissions reduction strategy than alternative compliance methods, including HRI in the analysis would decrease net employment impact of the Diversified Portfolio scenario by 2,000 job-years through 2030.
26. Virginia's NGCC plants had a capacity factor of 61% in 2012, well above the national average of 46%, so a ramp up to 70% represents a moderate increase compare to other states. Currently, NGCC facilities in Virginia can and often do exceed capacity factors of 70%. For example, Dominion's Bear Garden Power Station, a NGCC facility, achieved a capacity factor of 78.2% in 2012 (Dominion Virginia 2014 IRP). In its analysis, EPA found that over 10% of NGCC plants nationwide achieved capacity factors over 70% in 2012, and that over 2.5% of NGCC plants reach capacity factors over 80% (EPA GHG Abatement Measures Technical Support Document for the Clean power Plan, June 2014).
27. NGCT plants in Virginia operate with an average capacity factor of 4%, and oil plants operate with an average capacity factor of 1%, as calculated using EPA's 2012 eGRID data.

In 2012, Virginia's NGCC plants had a fleet wide capacity factor of 61 percent. An increase in this fleet wide capacity factor to 70 percent (including in newly constructed plants), as is envisioned under EPA's Building Block 2, would result in an increase in NGCC generation of approximately 5,300 GWh per year.[28] As a result of coal-to-gas redispatch, coal generation decreased by 1,500 GWh per year. This decline was in addition to the reduction of 3,800 GWh in annual coal generation that was assumed based on coal plants retirements that utilities have already planned in their IRPs. As with EPA's assumptions in its Building Block analysis, it was assumed that adjustments to dispatching processes would be completed by 2020. After already accounting for the emissions reduction of planned capacity changes, coal-to-gas redispatch would reduce Virginia's emissions rate from 1,050 lbs/MWh to 1,012 lbs/MWh. Table 3 compares the installed capacity, annual generation, and capacity factor of Virginia's NGCC and coal energy fleets in 2012 and in 2020, accounting for both planned capacity changes and coal-to-gas redispatch.[29]

	2012 Energy Mix		2020 Energy Mix (Accounting for Planned Changes Only)		2020 Energy Mix (Accounting for Planned Changes and Redispatch)	
	NGCC	Coal	NGCC	Coal	NGCC	Coal
MW Installed	4,346	6,926	9,335	3,992	3,992	3,992
GWh Produced	23,070	14,481	57,243	6,792	3,992	3,992
Capacity Factor	61%	24%	70%	19%	3,992	3,992

Table 3. NGCC and Coal Capacity and Generation Changes due to Planned Changes and Redispatch[30]

The Diversified Portfolio scenario assumes that no new nuclear capacity will be constructed in Virginia, but that the state's existing nuclear fleet will stay in service. Under Building Block 3, EPA has determined that 5.8 percent of existing national nuclear capacity is "at risk", and allows states to claim emissions reductions credit for 5.8 percent of non-retired nuclear capacity.[31] Assuming that Virginia does not retire any of its nuclear generating units, it is able to claim 5.8 percent of the 28,700 GWh generated by in-state nuclear plants towards its emissions target, which is included in this analysis. Along with planned changes, coal-to-gas redispatch, and existing renewable energy and efficiency resources, this reduces Virginia's emissions rate to 988 lbs/MWh.

28. As per EPA's methodology, only NGCC plants that were in operation or under construction by January 2014 are included in the redispatch calculation. Of planned natural gas capacity additions in Virginia, only the Brunswick and Warren NGCC plants meet EPA's threshold for inclusion.
29. Only NGCC plants which are eligible for coal-to-gas redispatch are included in this table. Virginia's utilities plan to construct an additional 2,620 MW of NGCC capacity by 2020, but this capacity does not meet EPA's threshold for eligibility for achieving savings through redispatch.
30. Because the coal plants scheduled to be retired have the lowest capacity factors, their retirement results in an increase in the fleet-wide capacity factor between 2012 and 2020.
31. EPA applies the 5.8% universally to all states with an existing nuclear fleet rather than identifying individual nuclear plants that are "at risk."

The remaining emissions reductions necessary to achieve Virginia's target of 810 lbs/MWh come from new renewable energy and energy efficiency resources under the Diversified Portfolio scenario. As such, the scenario assumed an expansion of renewable energy and energy efficiency slightly beyond the conservative amounts outlined in Building Blocks 3 and 4.[32] Using a projection of the technical potential of solar and land-based wind resources in Virginia created by VAEIC's working group, the modeling team created a ramp rate for the introduction of renewable energy and energy efficiency resources in Virginia and the proportion of new resources to come from solar, land-based wind, and energy efficiency. The amount of new renewables and efficiency to be added was then scaled so that Virginia's emissions rate would hit the target of 810 lbs/MWh by 2030. By 2030, 4,767 GWh/year of additional solar energy, 2,230 GWh/year of additional wind energy, and 10,712 GWh/year of additional energy efficiency are incorporated into Virginia's energy mix under the Diversified Portfolio scenario. When combined with existing and planned renewable energy and energy efficiency resources, this yields a total of 11,863 GWh of renewable energy generation by 2030 and 11,406 GWh of avoided generation through energy efficiency.[33]

In the Diversified Portfolio scenario, natural gas generation will still grow substantially as a result of planned additions and coal-to-gas redispatch, but not by as much as in the Baseline scenario. Due to changes in dispatch patterns, coal generation would decline to 63 percent of its 2012 level by 2030. The difference in generation would be made up by new renewable energy and energy efficiency resources. By 2030, new and existing renewable energy resources account for 8.3 percent of Virginia's supply needs by 2030, and energy efficiency would provide a load reduction of 8 percent under baseline levels.

If Virginia meets the renewable energy and energy efficiency targets that it has set for itself, it will be able to achieve the levels of renewable energy and energy efficiency penetration needed to meet its target emissions threshold under the Diversified Portfolio scenario. This level of renewable energy is well below the 15 percent voluntary target that Virginia has set for 2025 based on 2007 sales (which corresponds to 12.5 percent of projected supply needs in 2030). The level of energy efficiency is roughly equivalent to Virginia's voluntary target of 10 percent efficiency savings in 2022 based on 2006 sales (which corresponds to 8.0 percent of projects supply needs in 2030).

It is worth noting that this load reduction from energy efficiency will generate cost savings for Virginia's ratepayers. Accounting for Virginia's 5.7 percent transmission and distribution line losses,[34] Virginians will avoid purchasing roughly 10,500 GWh of electricity per year by 2030 due to efficiency investments, and will avoid purchasing over 61,000 cumulative GWh through 2030. Based on current and projected average retail rates in Virginia,[35] these savings translate into $6.7 billion dollars (roughly $800 per capita) in avoided utility bills through 2030.

32. The amount of new and existing efficiency and renewables included in the Diversified Portfolio scenario is 6% higher than the 11,192 GWh of renewables and 10,807 GWh of efficiency that EPA projects to be added in their computation of Virginia's emissions target.
33. This new generation would come from constructing an additional 6,450 of wind and solar capacity, and an additional 500 MW of NGCC capacity.
34. Virginia's average T&D line losses over the last five years of data available from Energy Information Administration's State Electricity Profile for Virginia
35. Virginia's average retail rate for all sectors in 2014 was $0.092/kWh (EIA Electric Power Monthly). EIA's Annual Energy Outlook projects that regional electric rates (in the SERC Virginia-Carolina regional grid reliability area) will increase at an annual rate of roughly 1.5% from 2014 through 2030.

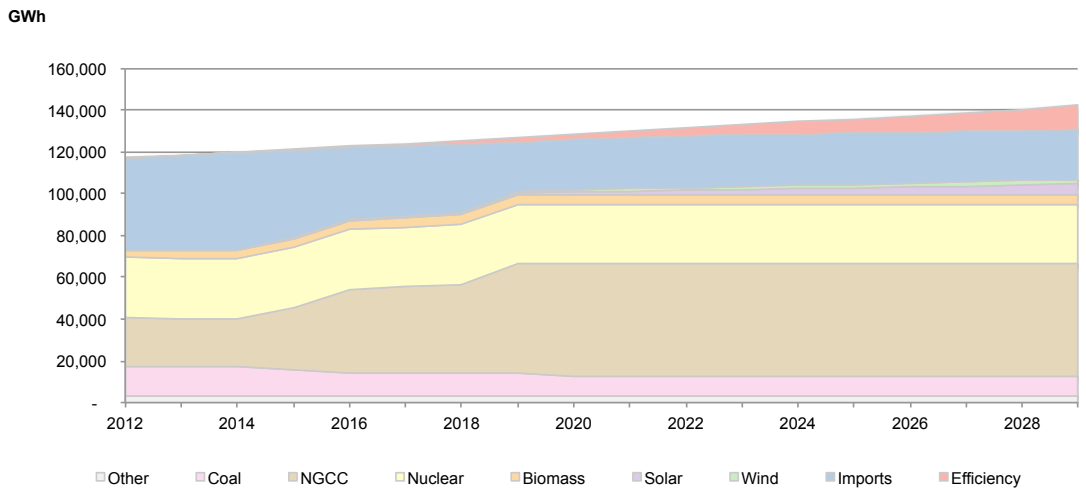


Figure 4. Generation by Fuel by Year, Diversified Portfolio Scenario

Import Reduction Scenario

The Import Reduction scenario models the same changes to Virginia's energy system as the Diversified Portfolio scenario, but also assumes that the state will simultaneously work to reduce imports, which will make up 24 percent of the state's energy needs in 2020, to zero by 2030. By driving down imports, Virginia would receive the economic and employment benefits of keeping utility expenditures within the state. There are a number of ways that Virginia could reduce imports. The Import Reduction scenario analyzed a future in which Virginia committed to using this expansion of in-state resources as an opportunity to tap its substantial renewable energy and energy efficiency resources along with some additional natural generation.

To accomplish this, Virginia would need to develop 23,900 GWh/year of additional in-state resources by 2030. Building on currently planned capacity additions in Virginia, these additional resources would be a combination of renewable energy, energy efficiency, and combined cycle natural gas generation. For the purposes of this analysis, it is assumed that Virginia would develop double the efficiency and renewable resources (in MWh terms) utilized in the EPA's BSER calculations and add 3,210 GWh/year of NGCC generation by 2030. In this scenario, renewable energy would provides 16 percent of Virginia's total supply needs by 2030, energy efficiency 15 percent, and natural gas generation 40 percent, with the remaining 29 percent coming from nuclear, coal, and other resources.

The renewable energy and energy efficiency levels are demonstrably achievable for Virginia, based on available resources, and are consistent with policy target levels set by neighboring states. Among Virginia's neighbors, Maryland has in place a mandatory RPS with a target of 20 percent by 2022. North Carolina's RPS targets 12.5 percent renewable energy penetration by 2021, 75 percent of which must be met by new renewable energy resources. In light of these targets, a renewable energy penetration rate of 16 percent by 2030 is reasonable.

Virginia's utilities also currently have voluntary goals of achieving 10 percent energy efficiency savings by 2022 relative to 2006 sales. A policy roadmap laid out by ACEEE demonstrates that Virginia could use efficiency to satisfy 19 percent of its energy needs by 2025 using a variety of policy steps that have been used with success in other states.[36] Additionally, neighboring states have goals that are more aggressive than Virginia's. Maryland, for example, has set mandatory 15 percent energy efficiency savings target for 2015 relative to 2007 levels and is in the process of developing additional targets for future years.[37]

The additional NGCC generation of 3,210 GWh/year by 2030 would require 524 MW of new NGCC capacity, roughly a tenth of the capacity of the five NGCC plants currently planned by Dominion and APCO.

The Import Reduction scenario ultimately leads to 11,934 GWh/year of new solar energy, 5,584 GWh/year of new wind energy, and 20,921 GWh/year of energy efficiency compared to the baseline forecast, as well as a reduction of 5,448 GWh/year of natural gas because of avoided baseline construction. The combination of the new renewable energy, energy efficiency, and in-state natural gas generating resources make Virginia import-free, and not only meets the EPA target but drives Virginia's emissions rate down further, to 650 lbs/MWh by 2030. In providing this type of emission reduction, the state would not only capture the employment potential associated with these technologies, but also position itself to profit from any type of regional compliance mechanism that could develop over time.

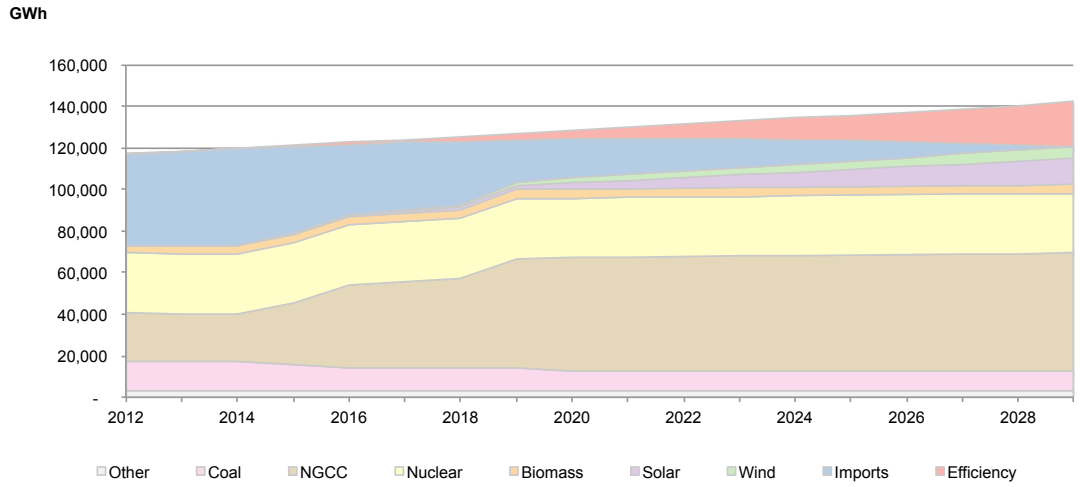


Figure 5. Generation by Fuel by Year, Import Reduction Compliance Scenario

36. American Council for an Energy-Efficient Economy. Energizing Virginia: Efficiency First, September 2008.
37. Maryland's electricity demand has decreased between 2007 to 2014, meaning the energy efficiency target is slightly higher than 15 percent of 2015 total supply.

Comparing Generation and Emissions Under the Scenarios

The table below compares the Virginia's 2012 electricity mix to the 2030 mix in the Baseline scenario and the two compliance scenarios. In each case, natural gas generation increased and coal generation decreased significantly. In the two compliance scenarios, new generation from renewable energy sources and new energy efficiency savings were combined to substantially increase the amount of electricity demand that was met by zero emission technologies and services.

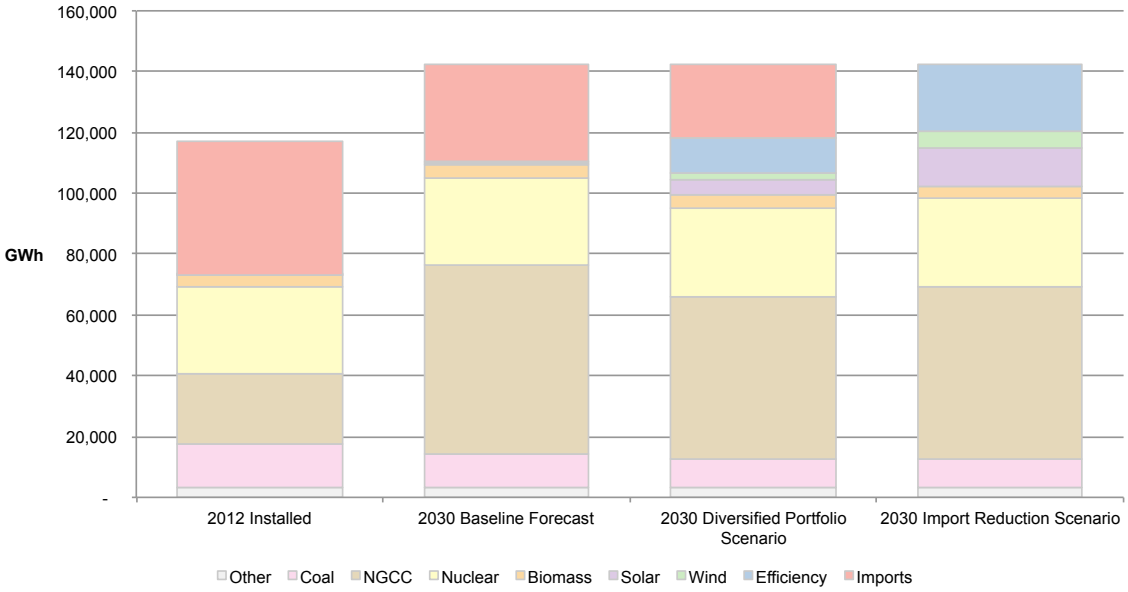


Figure 6. Virginia Energy Supply Mix in 2012 and 2030, by Compliance Scenario

Under both compliance scenarios, Virginia's 2012 generation capacity, adjusted for the planned additions and retirements outlined in the utility IRPs through 2020, will account for 96,700 GWh of generation, 68 percent of the state's total supply need. The remaining 45,500 GWh (32 percent) will come from a blend of these new resources and imports from other states depending on the scenario. In the Diversified Portfolio scenario, resources are combined so that the final portfolio provides an emissions rate at the EPA target level of 810 lbs/MWh by 2030 and also meets EPA's interim target for 2020-2029 average emissions, with an average rate of 874 lbs/MWh for those years (compared to a target of 884 lbs/MWh). In the Import Reduction scenario, the combination of renewable energy, energy efficiency, and new in-state natural gas generating resources to make Virginia import-free not only meets the EPA target but drives Virginia's emissions rate down further, to 650 lbs/MWh by 2030, with an average rate of 770 lbs/MWh from 2020 to 2029.

In both scenarios, the majority of emissions reductions needed to meet EPA's target for Virginia are obtained without any resources beyond those already planned by the state's major utilities. Specifically, planned plant retirements, additions, and conversions, existing renewable energy and efficiency programs, the retention of nuclear resources, and the maximization of coal-to-gas redispatch would lower Virginia's emissions rate from baseline rate of 1,024 lbs/MWh to 988 lbs/MWh by 2030, 72 percent of the way to the target of 810 lbs/MWh. The progression of emissions reductions over time was very similar for the two scenarios. The following figures display the sources of emissions reductions by year in the two compliance scenarios.

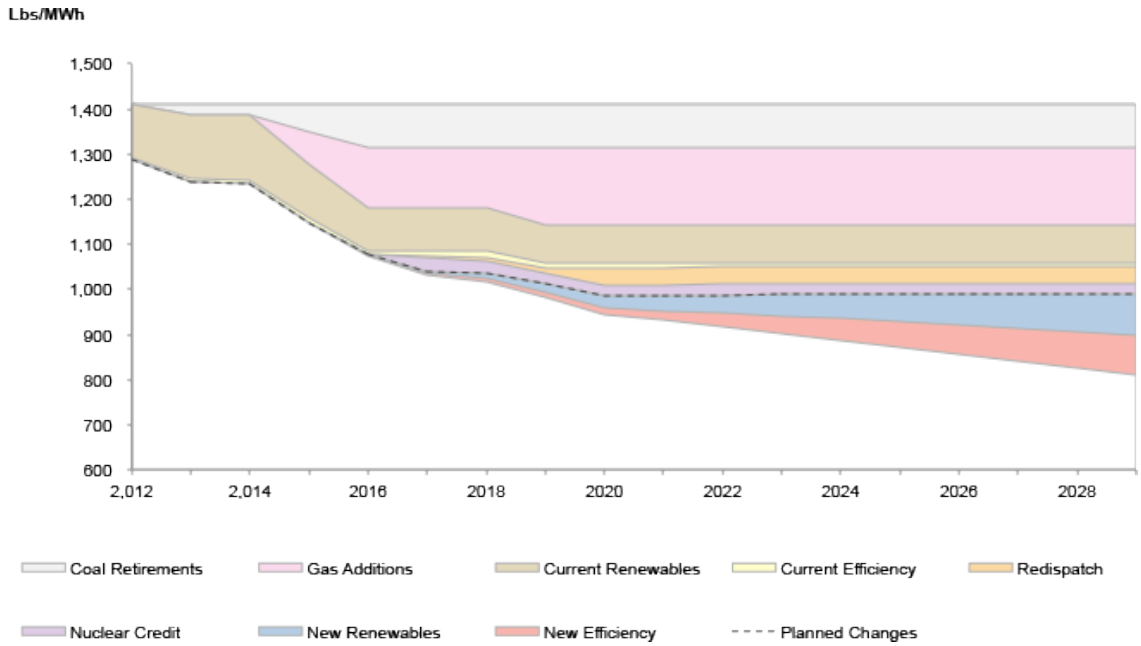


Figure 7. Emissions Reductions by Source, Diversified Portfolio Scenario

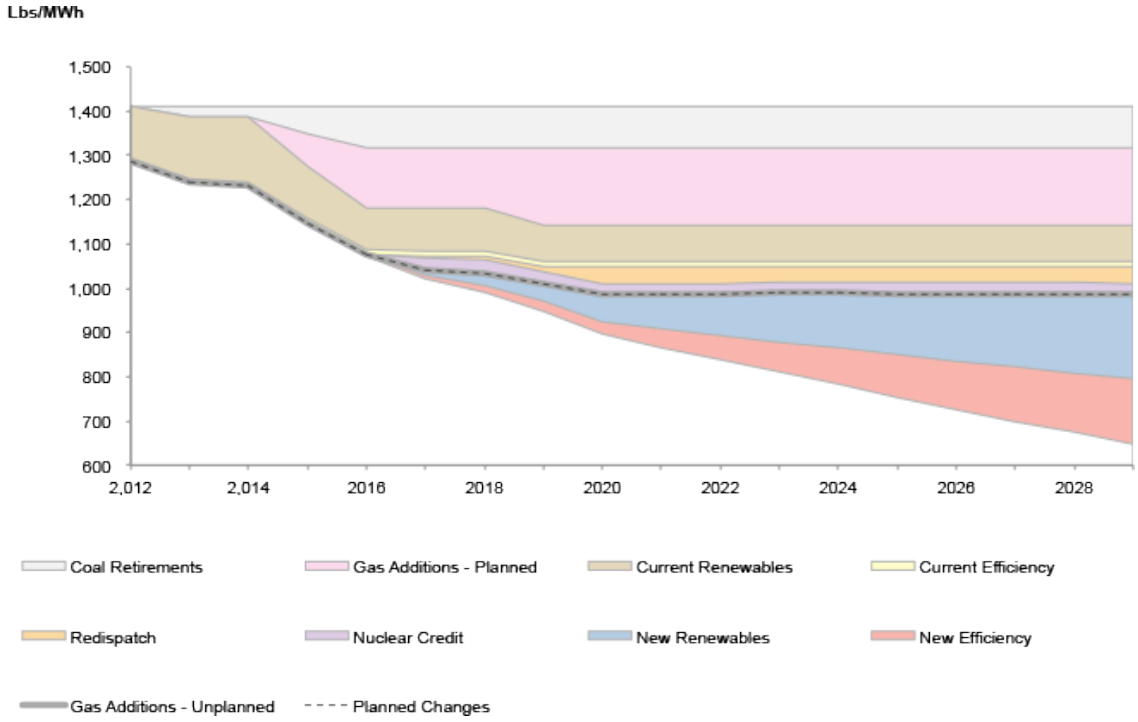


Figure 8. Emissions Reductions by Source, Import Reduction Scenario

EMPLOYMENT MODELING

Approach and Assumptions

The assessment of the employment impacts of the two compliance scenarios was based on the methods used by EPA in its own analysis of the CPP.[38] As with EPA's analysis, only direct jobs impacts are considered, not the indirect nor induced employment produced by impacts of these direct jobs on other economic sectors,[39] with the exception of including upstream employment impacts on coal and natural gas extraction industries. Affected job types considered in this analysis include labor associated with building and operating new power plants, carrying out energy efficiency improvements, labor lost at retired power plants, upstream labor impacts on Virginia's coal mining and natural gas extraction sectors, and labor losses due to the avoided construction of new capacity that would have been built in the absence of a CPP compliance strategy. Given that the state's energy future will affect multiple industries and impact both temporary construction and permanent operations and maintenance labor, employment impacts for the scenarios were considered in terms of direct job-years and counted cumulatively through 2030, the final year of full compliance under the CPP.[40]

Employment impacts from added natural gas capacity, added renewable energy capacity, and retired coal capacity were calculated from NREL's JEDI models, which provide estimates of direct jobs associated with both the construction of new plants and their continued operations and maintenance.[41] The construction and O&M job-years per MW associated with each fuel are summarized below:[42]

38. EPA also sets emissions targets for the period from 2020 to 2029. Virginia's target is an average emissions rate of 884 lbs/MWh in those years. This threshold is met by the Diversified Portfolio scenario (874 lbs/MWh) and Import Reduction (868 lbs/MWh) scenarios.
39. EPA (2014) Regulatory Impact Analysis: Clean Power Plan Proposed Rule.
40. Direct jobs include only jobs that contribute directly to the changes being implemented under these scenarios, for example, construction and maintenance jobs at new generating facilities. Indirect jobs are jobs in fields or industries that support or supply direct economic activity, such as manufacturing jobs that provide construction materials. Induced jobs are those that result from increased spending due to new direct and indirect jobs in the region.
41. In calculating job-years impacts, each job gained or lost is multiplied by the number of years in the study period over which it is gained or lost. We measure job-year impacts until 2030, the year in which states are to comply with EPA's emissions targets. In job-years terms, the 58,568 jobs created by compliance actions in the Diversified Portfolio scenario through 2030 are equivalent to the creation of 1,464 career-length jobs lasting 40 years each. In the year 2029, the last year of the compliance period, 5,622 more Virginians would be employed as a result of actions taken by the state to comply with the Clean Power Plan under the Diversified Portfolio scenario compared to the baseline forecast.
42. VAEIC consulted with solar and wind businesses with ongoing project development to provide input into the assumptions in the model.

Technology	Construction Jobs per MW	O&M Jobs per Year per MW
Natural Gas	1.28	0.05
Coal	N/A	0.14
Solar - Residential	14.50	0
Solar - Small Commercial	8.33	0
Solar - Large Commercial	7.13	0
Solar - Utility	3.61	0
Wind - Onshore	0.91	0.06
Biomass	3.04	0.50
Nuclear	6.26	0.62

Table 4. Construction Jobs per MW and Operations and Maintenance Jobs per Year per MW by Technology

Employment impacts from upstream coal and natural gas extraction that result from decreases in coal generation and increases in natural gas generation were also calculated, using EPA's methodology. In both cases, jobs were pro-rated according to the percentage of coal or natural gas used in Virginia's power plants that is extracted in Virginia. Based on EIA coal and natural gas distribution data, 34 percent of the coal used in Virginia's power plants is mined in Virginia, and 14 percent of the gas used in Virginia is extracted in Virginia.[43] As with EPA's analysis, this analysis assumed worker productivity values of 2.91 short tons of coal per employee-hour (the value for the Appalachian coal region) and 126 MMBTU of natural gas produced per employee-hour.

The energy efficiency jobs calculation was based on an IMPLAN analysis conducted by ICF International which calculated the investment required for and jobs resulting from an energy efficiency program that would maximize Virginia's efficiency potential. ICF's model resulted in capital costs per MWh saved of $492 in 2020, $502 in 2025, and $533 in 2030, as well as a rate of 7 job-years added per million dollars invested in that scenario. This analysis interpolated the annual cost-per-MWh figure to calculate annual figures and applied the jobs-per investment figure to each year.[44]

43. For retired coal plants, only the O&M jobs associated with lost plants was considered. Plant retirements could be expected to experience some short-term employment related to the decommissioning of the plant, but this is not considered in the analysis. NREL's models for biomass and wind projects are dependent on project sizes. The numbers presented in the table reflect jobs per MW for a 50 MW biomass project and a 100 MW wind energy project.
44. Coal data comes from the 2013 EIA Annual Coal Distribution Report, which provides the amount of coal produced in each state that is used by Virginia's electric power sector. Natural Gas data comes from EIA's state-level natural gas production, consumption, and interstate trade data. The gas data does not distinguish between gas imported for use in the state and gas that simply passes through the state in transit, and so it was assumed that the percentage of imports that is consumed in the state (as opposed to simply passing through to other states) is the same as the percentage of domestic production that is consumed in the state (as opposed to being exported to other states).

Modeling Results

As the tables below illustrate, the analysis indicates that CPP implementation will increase employment relative to the Baseline scenario in Virginia in either compliance scenario as the state invests in new generation resources across multiple technologies, each of which will lead to new energy jobs in the state. If Virginia chooses to adopt a policy of reducing net electricity imports to zero, employment gains will be particularly high as the state builds domestic capacity to account for the 37.5 percent of electricity sales that is currently purchased from out of state. This approach would also keep more of the money that Virginians spend on electricity in the state's economy.

The tables below display the job impacts (shown in cumulative job-years through 2030) for each scenario. The capacity changes between 2012 and 2020, which have either already occurred since 2012 or have been announced by Virginia's utilities, are included in both the Baseline and compliance scenarios and will create just under 8,000 job-years through 2030. While a substantial portion of Virginia's coal capacity will be retired, leading to job losses at both power plants and coal mines, these will be made up for by the substantial investment in new natural gas, renewable energy, and energy efficiency efforts in the state.

Job Type	Cumulative Job-Years
Construction and O&M Coal	-6,481
Natural Gas	9,291
Biomass	1,605
Solar	1,536
Extraction Coal	-1,738
Natural Gas	1,463
Energy Efficiency	2,288
Total	**7,964**

Table 5. Employment Impacts from Planned Capacity Changes in All Scenarios, 2014-2020 (job-years)

The Diversified Portfolio and Import Reduction compliance scenarios will lead to some job losses from avoided new power plant construction as the 2,638 MW of additional natural capacity that would have been built in the Baseline scenario between 2020 and 2030 to keep pace with demand growth would not be built in the compliance scenarios. The employment losses due to the avoided new construction total just over 4,300 cumulative job-years through 2030.

Job Type	Cumulative Job-Years
Construction and O&M Coal	-4,037
Extraction	-300
Total	**-4,337**

Table 6. Employment Impacts from Avoided Natural Gas Construction in Compliance Scenarios, 2020-2030 (job-years)

The various compliance actions included in the Diversified Portfolio and Import Reduction scenarios would create between 58,600 and 66,800 job-years from by 2030 (accounting for avoided natural gas construction). Including jobs gains from planned capacity additions through 2020, employment impacts by 2030 total 62,200 cumulative job-years in the Diversified Portfolio scenario and 130,900 job-years in the Import Reduction scenario. Employment impacts from the two compliance scenarios are compared below:

Job Type	Cumulative Job-Years	
	Diversified Portfolio Scenario	Import Reduction Scenario
Construction and O&M Natural Gas	0	855
Solar	20,596	51,562
Wind	1,398	2,318
Nuclear	0	0
Extraction Coal	-477	-477
Natural Gas	264	264
Energy Efficiency	36,787	72,727
Compliance Scenario Job-Years Total	**58,568**	**127,249**
Energy Efficiency	-4,337	-4,337
Energy Efficiency	7,964	7,964
Compliance Scenario Job-Years Total	**62,195**	**130,867**

Table 7. Employment Impacts by Compliance Scenario, 2014-2030 (job-years)

In both compliance scenarios, the energy efficiency and renewable energy (particularly solar) industries are projected to be major sources of job gains. Because these sectors involve a large number of small projects, they tend to be more labor intensive on a per-MW basis than other kinds of projects, such as large natural gas or nuclear facilities, leading to higher employment impacts.

Both compliance scenarios would drive net employment gains for the state. The Import Reduction scenario would result in far larger job gains, because additional investments would be made to replace out-of-state generating resources, many of them in highly labor-intensive energy efficiency and renewable energy sectors. The majority of job losses embedded in the overall increase in employment under the compliance scenarios come from either coal plant employment or upstream coal mining employment. Because Dominion and APCO already intend to retire a large amount of coal capacity in the state, many of these job losses will occur whether Virginia takes action to reduce emissions or not. In fact, 63 percent of all projected job losses were due to planned capacity changes rather than actions taken specifically to comply with the CPP.

The employment impacts of compliance actions will take place over time, and will scale up as actions are taken to reduce emissions. The highest job impacts would come late in the compliance period, when efficiency investments have ramped up and the construction of renewable capacity, particularly solar, is ongoing.[45] In the Diversified Portfolio scenario, peak employment impacts will be reached in 2029, when efficiency and solar will drive a net gain of over 5,622 new jobs.[46] The year-by-year employment impacts of the Diversified Portfolio compliance scenario, and the breakdown of employment impacts by type, is shown in the figure below.

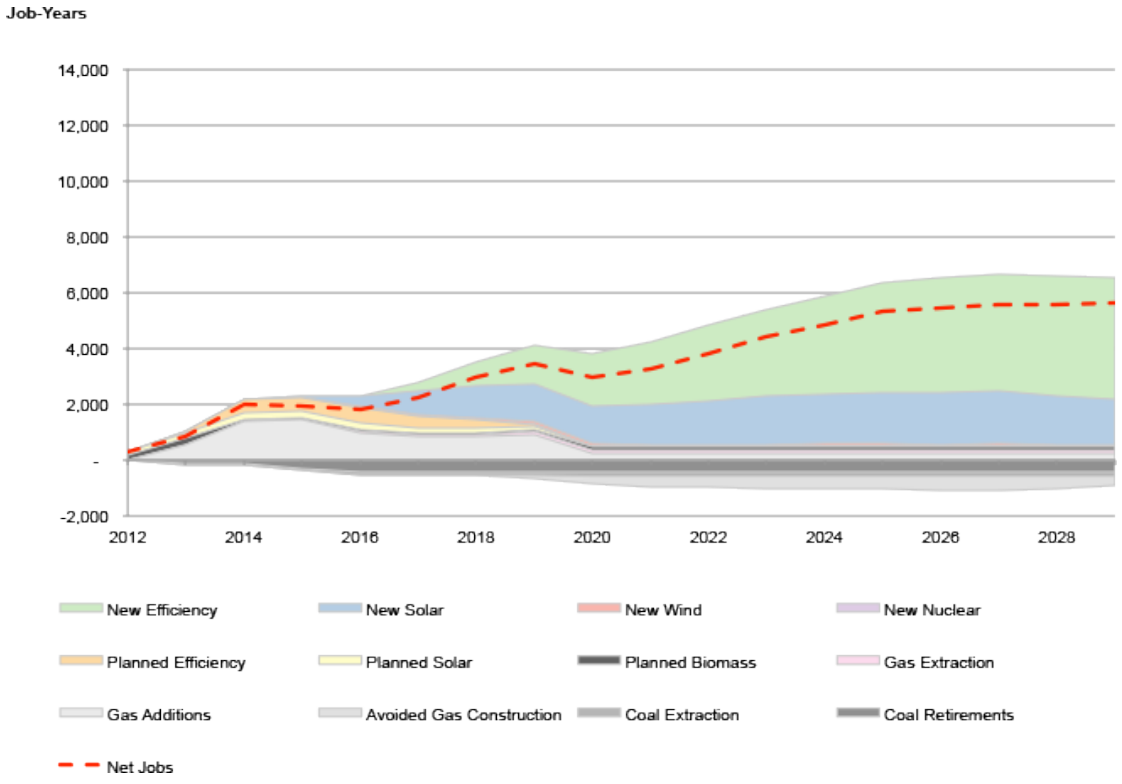


Figure 9. Employment Impacts by Year, Diversified Portfolio Scenario

45. As discussed in EPA's Regulatory Impact Analysis, energy efficiency jobs impacts are difficult to calculate for a variety of reasons. The methodology used here is consistent with previous approaches to estimating energy efficiency jobs impacts, such as the DEEPER model developed by the American Council for an Energy Efficient Economy.

Under the Diversified Portfolio compliance scenario, Virginia would create 56,700 net job-years from 2020 to 2030 as a result of compliance actions (including job losses due to avoided baseline natural gas construction). Counting planned capacity changes, jobs impacts increased to more than 61,400 cumulative job-years from 2014 to 2030. Peak employment impacts would come in 2025, when 5,900 new jobs were created.47

The jobs impact of the Import Reduction scenario was largely an amplified version of the impact of the Diversified Portfolio scenario. The reduction of imports via the development of new in-state resources—particularly from energy efficiency and distributed solar, both of which have strong employment benefits due to the large number of small projects which must be installed—create opportunities for thousands of new jobs in Virginia. Under that scenario, peak employment impacts will be reached in 2027, with the creation of 12,563 additional jobs in that year.[48] The year-by-year employment impacts are detailed in the figure below.

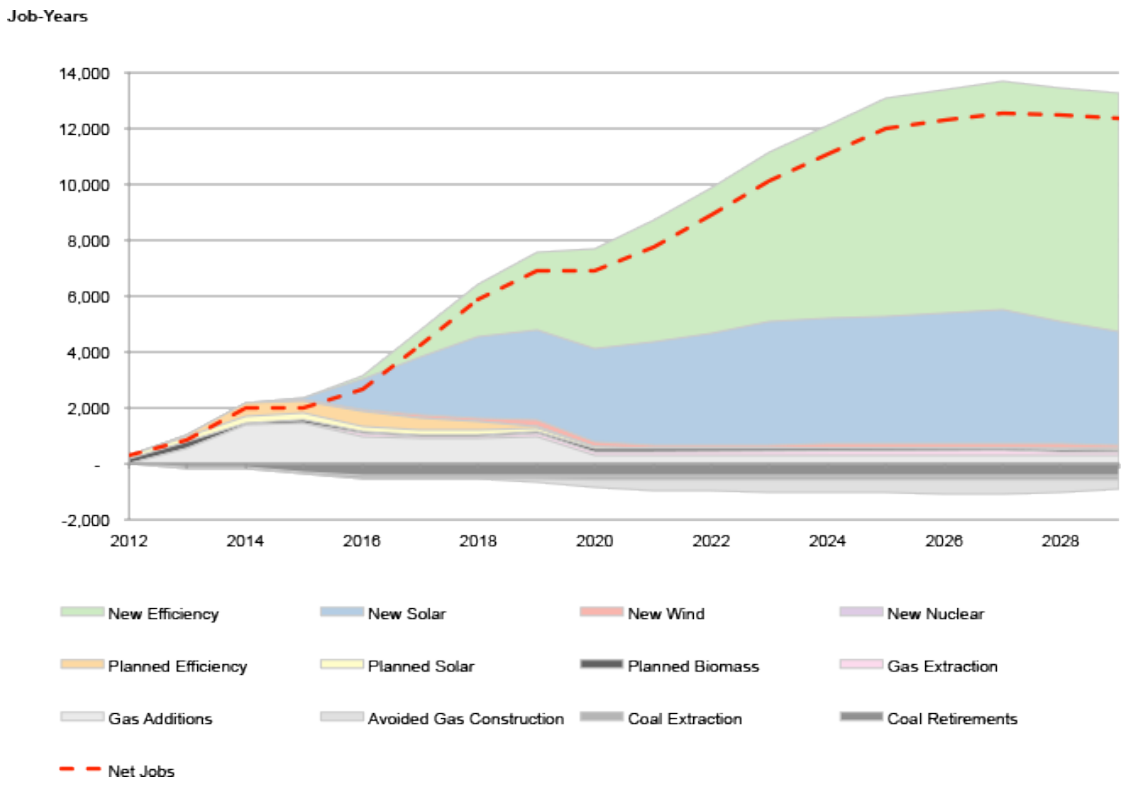


Figure 10. Employment Impacts by Year, Import Reduction Scenario

46. The timing of renewable energy and energy efficiency additions is based on EPA's analysis, which assumed that renewable and efficiency investments will scale up after 2020, and that all renewable capacity additions will be in place by 2027. This model slowly ramps up efficiency and renewables investments in the years leading up to 2020.

CONCLUSION

Under the EPA's CPP, Virginia has the opportunity to create new employment opportunities as the energy industry transitions to meet Federal environmental regulations. In both scenarios modeled, compliance with the Clean Power Plan will result in substantial net employment benefits for Virginia, with more than 54,000 cumulative added jobs-years under the Diversified Portfolio scenario and nearly 123,000 added job-years under the Import Reduction scenario. These numbers are in addition to the 7,964 job-years that will be created by changes that are already planned by the state's utilities. Under the Diversified Portfolio scenario, job gains will peak in 2029, with more than 5,600 net jobs that year, near the current employment in beverage production in Virginia. Under the Import Reduction scenario, the employment peak will come in 2027, with 12,563 additional jobs that year – nearly equal to existing jobs in commercial construction. Thus, Virginia can benefit substantially, in terms of added jobs, from compliance with the CPP, and dramatically more if it pursues a perennial goal of keeping more utility dollars in the Commonwealth.

Given these findings, Virginia should be able to craft a compliance strategy for EPA's CPP that will drive market growth of Virginia's energy economy and maximize employment benefits for the state.

47. If employment impacts from planned changes are not considered, peak jobs will increase to 5,715. This is because the long-term employment impacts of planned changes will be slightly negative, driven by lost Operations & Maintenance jobs at retired power plants.
48. If employment impacts from planned changes are not considered, peak jobs will increase to 12,631.

www.aee.net/aeei
@aeenet

www.vaadvancedenergy.org