MODELING A LOW-COST APPROACH TO CLEAN POWER PLAN COMPLIANCE FOR VIRGINIA

Insights from the State Tool for Electricity Emissions Reduction

STEER

State Tool for Electricity Emissions Reduction

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Advanced Energy Economy Institute would like to acknowledge the contributions of the Energy Foundation to the development of the STEER modeling framework. In addition, we would like to acknowledge the work of Professor Jeremiah Johnson and his graduate students of the University of Michigan for their work on the core model development.

STEER VIRGINIA: MODELING A LOW-COST APPROACH TO CLEAN POWER PLAN COMPLIANCE

Introduction

On August 3, 2015, the U.S. Environmental Protection Agency (EPA) released the final rule for carbon emissions from existing power plants, called the Clean Power Plan (CPP). To implement the Clean Power Plan, states have the authority to develop their own compliance plan, using strategies that best fit within the context of each state's unique energy portfolio and policy priorities. The State Tool for Electricity Emissions Reduction (STEER) is a resource for regulators and stakeholders to help them better assess a wide variety of technology and service options available to states for carbon emission reduction.

STEER was developed by the University of Michigan and 5 Lakes Energy for the Advanced Energy Economy Institute. STEER is being delivered to a number of states as a free, open-access tool so that anyone with an interest in thinking about how to implement the Clean Power Plan will have access to the necessary data and calculations for an informed analysis. It is delivered as an Excel spreadsheet with a user manual. After downloading the tool, evaluating each scenario that a user might consider takes only a few minutes, enabling the user to develop a deeper understanding of the tradeoffs and considerations in implementing the Clean Power Plan. STEER is unique in that it considers economic impacts, including rate impacts to multiple customer classes, for any compliance scenarios. The model has a default set of data, which is composed of publicly available data for Virginia; however, a user can incorporate more granular data if available.

STEER Virginia can be downloaded from info.AEE.net/steer.

Summary Findings

This paper presents the results of two specific scenarios that are representative of multiple runs of STEER conducted utilizing a wide range of assumptions. These assumptions include projected prices for a variety of power sources, as well as other costs associated with Clean Power Plan compliance, such as carbon allowances. For each scenario, STEER identifies the combination of generation sources, efficiency improvements, and other mitigation measures that represents the lowest cost means of compliance with Clean Power Plan standards for Virginia in 2030.

In this paper, we examine how Virginia is able to reach compliance with the Clean Power Plan in 2030 under two scenarios: (a) with PJM sales growth projections and Dominion Virginia Power's 2015 energy efficiency potential study extrapolated to the entire state; and (b) with PJM sales growth projections and the State Corporation Commission (SCC)'s 2008 energy efficiency potential study. Under neither scenario is any existing generating plant expected to close beyond those already announced for retirement. Certain components of a mitigation plan, such as energy efficiency improvements in both the distribution network and end-use of electricity by customers, are present in both scenarios as they are cost-saving measures, even outside of the Clean Power Plan.

In Scenario A there is a minor rate increase seen, less than a half of a penny per kilowatt hour, compared with a business-as-usual projection. In Scenario B, the scenario using the SCC's efficiency potential study, we see a decrease in electric rates compared with business-as-usual. In neither scenario do we see significant costs imposed on Virginia ratepayers as a result of Clean Power Plan compliance. The result is likely due to the substantial contribution to compliance made by low-cost resources such as energy efficiency and renewable

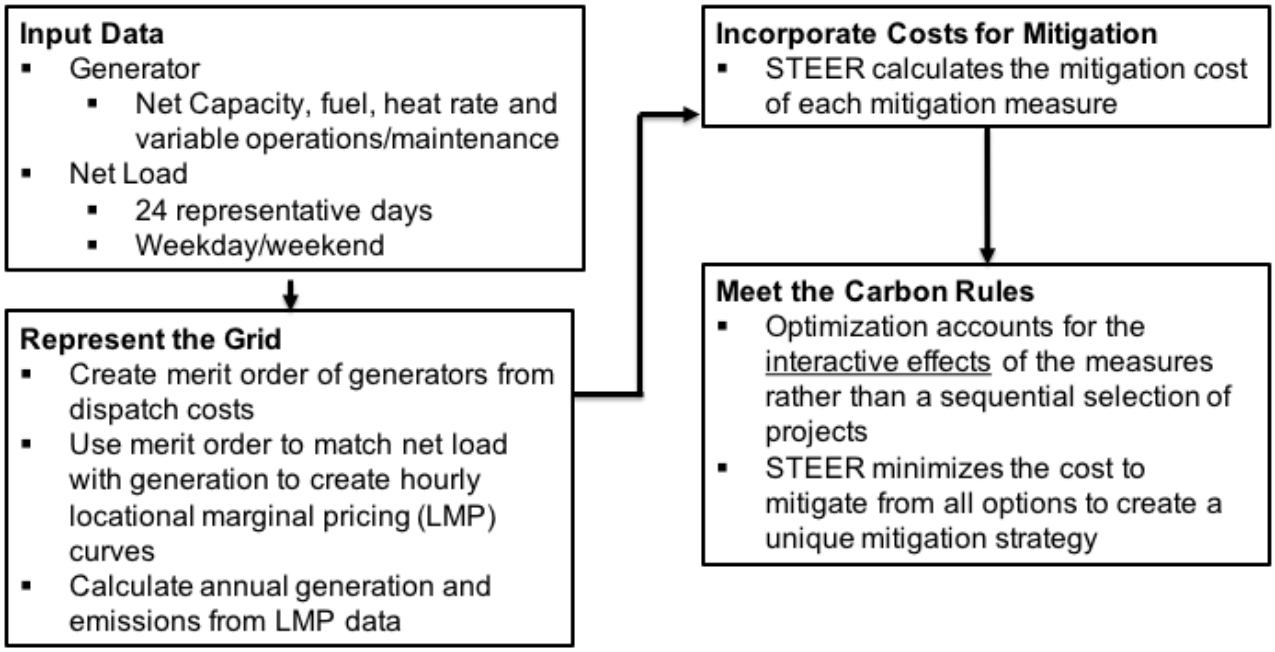
energy. The scenarios shown here demonstrate that Virginia can achieve its required carbon reduction targets without imposing significant costs on ratepayers compared with business as usual.

How STEER Works

STEER is an integrated resource planning tool tailored specifically to find the least-cost way for a state to implement the Clean Power Plan. Integrated resource planning is a mathematical method used by utilities and utility regulators to find the best plan for a utility to meet its obligations. It assures adequate power generation by modeling the use of power plants as needed to meet peak load with a reserve margin. It finds the lowest cost to supply needed power by "dispatching" the plants with lowest operating cost to satisfy load in each hour and by "building" new power plants (or alternative technology that provides megawatt-hours generation or "negawatt-hours" of demand reduction) of the kind and location that minimize the state's total utility bill.

STEER can be run for each individual Clean Power Plan compliance year from 2022 through 2030. Since STEER is run for a single compliance year, any "build," be it a generation facility or energy efficiency deployment, is assumed to occur before the analysis year and is available for use in the analysis year. STEER is able to optimize for lowest cost of power supply while making sure that total carbon emissions from the power sector are below Virginia's target under the Clean Power Plan. The logical flow of STEER is illustrated in the following diagram.

Figure 1. STEER Operational Flow Chart



STEER incorporates a wide variety of measures that are available to mitigate carbon emissions from Virginia's power system. These measures include the following:

- Improving the fuel efficiency of existing power plants, based on either generic assumptions or plant-specific engineering studies, as available
- Changing the dispatch order of power plants to preferentially run those that produce fewer carbon emissions per unit of electricity produced
- Implementing more energy-efficient commercial and residential building codes
- Implementing more demand response resources to lower demand peaks
- Implementing more energy performance contracting to reduce electricity consumption in buildings and campuses

- Implementing utility energy efficiency programs beyond what is currently required by the state
- Using smart grid technologies, including Volt-VAR optimization, to improve efficiency in electricity distribution networks
- Promoting distributed renewable generation through net metering and similar practices
- Reducing use of coal plants by substituting new, less carbon-intensive generation resources, such as:
    - Industrial cogeneration of heat and electricity using natural gas
    - Utility-scale natural gas combined cycle plants
    - New nuclear plants
    - On-shore and off-shore wind farms
    - Utility-scale solar installations
    - Hydropower generators both at dams and in-stream at locations without impoundments and tubine retrofits to existing impoundments
    - Generators fueled by landfill gas or gas produced from anaerobic digesters
    - Municipal solid waste plants
    - Power plants fueled by biomass such as mill wastes, urban wood waste, agricultural residue
    - Blending biomass with coal to fuel existing coal plants
    - Natural gas fuel cells
- Using pumped storage or battery systems to make excess low-carbon power available at other times
- Changes in the amount of power exported by Virginia to other states

STEER models the interactions of carbon mitigation measures by recomputing the effects of measures not yet chosen in light of measures already chosen. For example, heat rate improvements performed at an existing coal plant will affect the results of redispatch to natural gas generation elsewhere in the state.

In addition, STEER allows the user to choose different plan types as laid out in the final Clean Power Plan issued by EPA. The model allows the user to choose a mass-based target or a rate-based target for the state. Under the mass-based target, users can choose to apply the new source complement and allow new gas plants to be built, or the user can use existing power plant emissions only without the new natural gas plant option.

Uses and Limitations of STEER

STEER can serve as a fast, straightforward model for regulators and stakeholders to use in the early stages of compliance planning. While utilities have proprietary software to analyze the ultimate state plan, STEER can help stakeholders cross-check various proposals and assumptions on their own.

Although the STEER Model is a comprehensive modeling tool that uses the same underlying decision framework of proprietary modeling software packages used by utilities and grid operators, there are important limitations to note. The model does not consider transmission constraints when calculating the least-cost mitigation options. In addition, the model calculates the least-cost plan for the single year chosen by the user (which is typically 2030), and the model does not aggregate year-by-year results over a period of time. Also, STEER is designed for individual states, not regions or regional transmission operator territories, although STEER does allow for the accounting of electricity imports and exports. Finally, as described above, STEER considers the full range of carbon mitigation technologies and services, but in a given state, some technologies or services might be technically available yet inaccessible due to existing policies. For example, demand response is a cost effective mitigation option in many states, yet the policy suite in some states does not allow for demand response. The user should be mindful of these limitations when considering the results of STEER.

Energy efficiency measures are incorporated into STEER based on the energy efficiency potential study prepared for Dominion Virginia Power in 2015 or a similar statewide study prepared for the State Corporation

Commission in 2008.[1] Energy efficiency programs typically try to influence purchase decisions when equipment is to be replaced, so energy efficiency potential studies typically report the savings that can be achieved in the 10th year through continuous application of the program for 10 years. STEER treats energy efficiency potential in this way, and so will overstate energy efficiency potential if the programs are not operated continuously for the 10 years prior to the modeled year.

STEER was not developed with the intention of weighing the differences between mass-based and rate-based implementation plans. However, as the choice of plan type does not prohibit any mitigation options, the specifics of the actual plan implementation, not the type, will dictate the outcomes. Note that STEER does not examine how a state might allocate or trade credits within the state, although it does allow the user to determine how many allowances would be required to meet the overall state carbon emissions target for the given year.

Virginia's Options for Clean Power Plan Compliance

How Virginia should implement the Clean Power Plan needs to be determined with full engagement of stakeholders representing the diverse interests of the people and businesses in Virginia. Issues such as future generation mix and rate impacts are of major concern to regulators, businesses, and ratepayers alike, and need to be taken into consideration. STEER is a flexible tool that stakeholders can use to help with those deliberations.

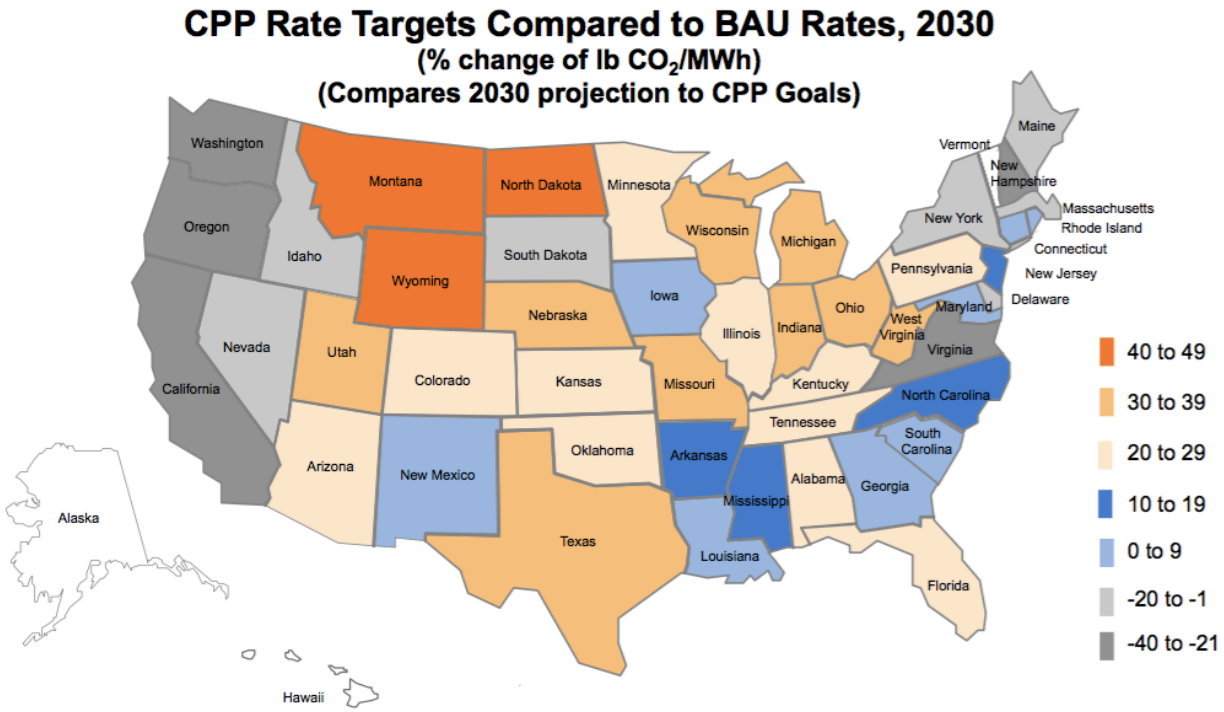
Taking into account Virginia's carbon emissions goal as established in the final rule and the scope of mitigation measures that can be used for compliance, STEER provides certain insights into how Virginia can reach its emissions goal at low cost. STEER users will be able to run a variety of scenarios to test different assumptions and outcomes, but through our initial examination, we have noticed some important themes.

Virginia Is Well Positioned to Comply with the Clean Power Plan

With the release of the Clean Power Plan final rule in August 2015, Virginia saw a significant reduction in the stringency of its interim and final targets as compared to the proposed rule. The 2030 final goal is set at an achievable 934 lb/MWh, in the middle of the pack. Based on EPA's projections, Virginia is set to hit a rate of 959 lb/MWh by 2020, even without the Clean Power Plan, so the state's 2030 targets are certainly achievable (see Figure 2).

[1] "ENERGIZING VIRGINIA: EFFICIENCY FIRST," American Council for an Energy-Efficient Economy, Summit Blue Consulting, ICF International, Synapse Energy Economics; September 2008. https://dmme.virginia.gov/DE/LinkDocuments/GEC/Energizing_VA_EfficiencyFirst_ACEEE_September2008.pdf

Figure 2. Clean Power Plan Targets Compared to Business-as-Usual in 2030



Source: https://blog.epa.gov/blog/wp-content/uploads/2015/08/State-tables-tab-2.pdf
Analysis by Advanced Energy Economy

Virginia has many different options for securing the remaining emission reductions required by the Clean Power Plan. Over several runs of the STEER model, energy efficiency and renewable energy are consistently the lowest cost mitigation options for the state. With significant energy efficiency potential, the state has an untapped resource in utility energy efficiency and network efficiency improvements. Network efficiency technologies include dynamic volt-VAR control and conservation voltage reduction.

Least-Cost Compliance Scenarios Include Renewables and Energy Efficiency

In each of the following scenarios, both energy efficiency (utility, non-utility, and network efficiency efforts) and renewable energy contribute a significant amount to Virginia's least-cost compliance. More importantly, the scenarios demonstrate that compliance with the Clean Power Plan does not have to significantly increase costs for Virginia's electricity customers. In fact, the STEER model shows that, under certain scenarios, the actions taken under Clean Power Plan implementation may marginally lower the cost of electric power.

The graphs below illustrate potential low-cost mitigation options for the year 2030 specifically for Virginia, under a rate-based plan, for which the state's major utility has expressed preference.[2] These are merely a few of the hundreds of scenarios that a user could run to examine projected outcomes. The particular scenarios shown here do not consider changes in the price of natural gas or the use of carbon trading credits, at various prices, as mitigation options, though such scenarios could be run through STEER to project outcomes. Since Virginia can go well beyond the EPA established target, it would appear that the state could generate additional credits, either emission rate credits or allowances, depending on its plan choice, for sale to other states.

[2] E&E News, "Dominion Airs Hopes for VA State Compliance Plan," (19 Nov. 2015), available at http://www.eenews.net/climatewire/2015/11/19/stories/1060028289

In Scenario A, the model uses Dominion Virginia Power's 2015 estimates for energy efficiency potential. Since Dominion Virginia's study only covers its service territory (approximately 60% of the state), the model has extrapolated the efficiency potential to the rest of the state. In this scenario, retail sales are anticipated to increase 0.9% annually between 2015 and 2025 in the Mid-Atlantic region as is projected by PJM. This growth is accounted for in this scenario, with a 113.5% retail sales increase over today's sales in 2030.

The rate impact of 2030 compliance under Scenario A is $0.004/kWh, or less than one-half of a penny per kilowatt-hour over business-as-usual.

In Scenario B, the model uses the same assumptions as Scenario A except for energy efficiency potential. In the first scenario (Scenario A), the model uses Dominion Virginia Power's estimates for potential, extrapolating from the utility's service territory to the rest of the state. In the second scenario (Scenario B), the model uses the Virginia SCC's energy efficiency potential estimates from a statewide anlysis performed in 2008. While the two efficiency potential estimates used in Scenarios A and B yield notably different results due to differences in assumptions, both exhibit singificant contributions from energy efficiency and renewable energy, and both have minimal impacts on rates over business-as-usual

Both Scenario A and Scenario B allow for heat rate improvements up to 4.3% – the heat rate improvement deemed feasible by EPA for the Eastern Interconnection – at those existing coal-fired power plants for which the investment makes economic sense. Additionally, the cost of natural gas in 2030 is assumed to be $6.22/MMBtu, the U.S. Energy Information Administration (EIA)'s forecasted price for natural gas in 2030.[3]

The rate impact of 2030 compliance under Scenario B is negative; ratepayers can anticipate a rate decrease of $0.002 per kilowatt-hour less than business-as-usual.

Figures 3 and 4 show the changes in capacity needed to achieve the CPP targets in each scenario, while Figures 5 and 6 show the change in generation associated with each scenario. Under Scenario A, coal and gas capacity remain relatively unchanged while renewable capacity, in particular solar capacity, expands substantially (Figure 3). Scenario B also maintains relatively unchaged coal and gas capacity but significantly less additional renewable capacity. In Figures 5 and 6, there is an overall decrease in generation with fossil generation decreasing while renewable generation increases, despite the assumption (based on PJM's demand forecast) of additional load growth. The primary difference between Figures 5 and 6 is the size of the role played by energy efficiency in least-cost compliance. The major difference between the two scenarios is the stronger role for energy efficiency in Scenario B, as shown in Figures 7 and 8.

[3] 2015 Annual Energy Outlook, Energy Information Administration. http://www.eia.gov/forecasts/aeo/

Figure 3. Scenario A: Capacity Under Least-Cost 2030 CPP Compliance

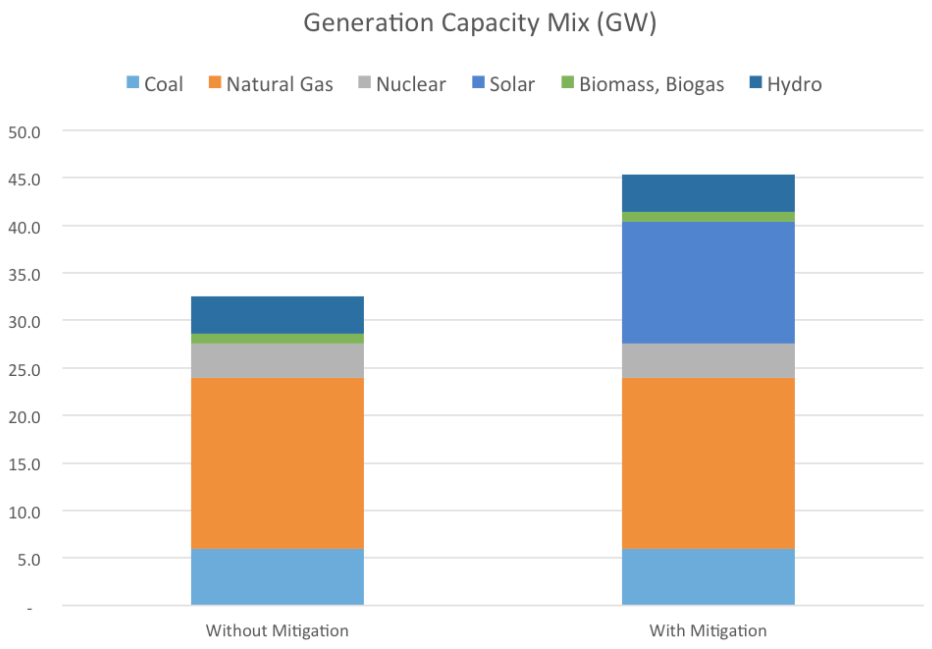


Figure 4. Scenario B: Capacity Under Least-Cost 2030 CPP Compliance

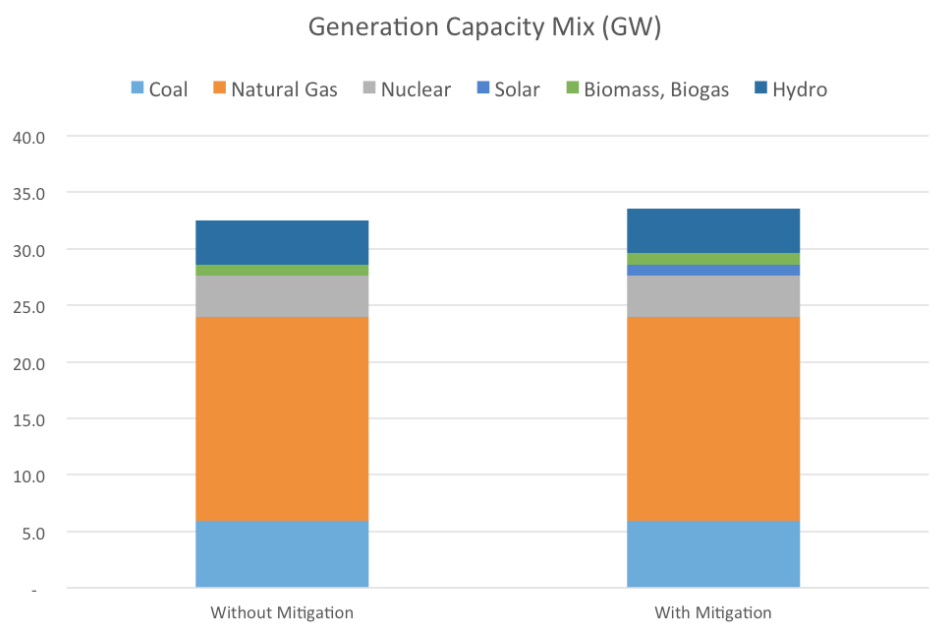


Figure 5. Scenario A: Statewide Generation Under Least-Cost 2030 CPP Compliance

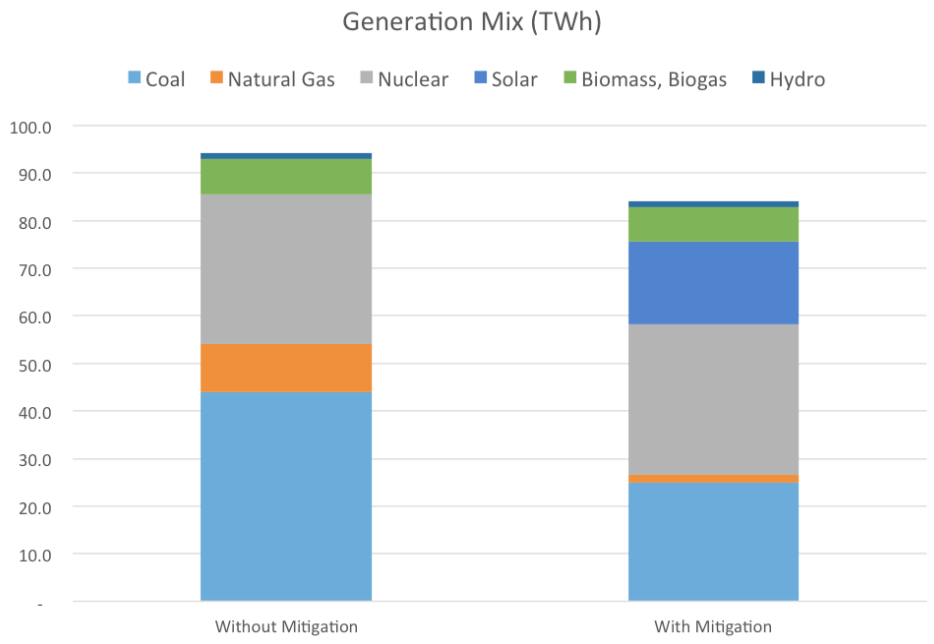


Figure 6. Scenario B: Statewide Generation Under Least-Cost 2030 CPP Compliance

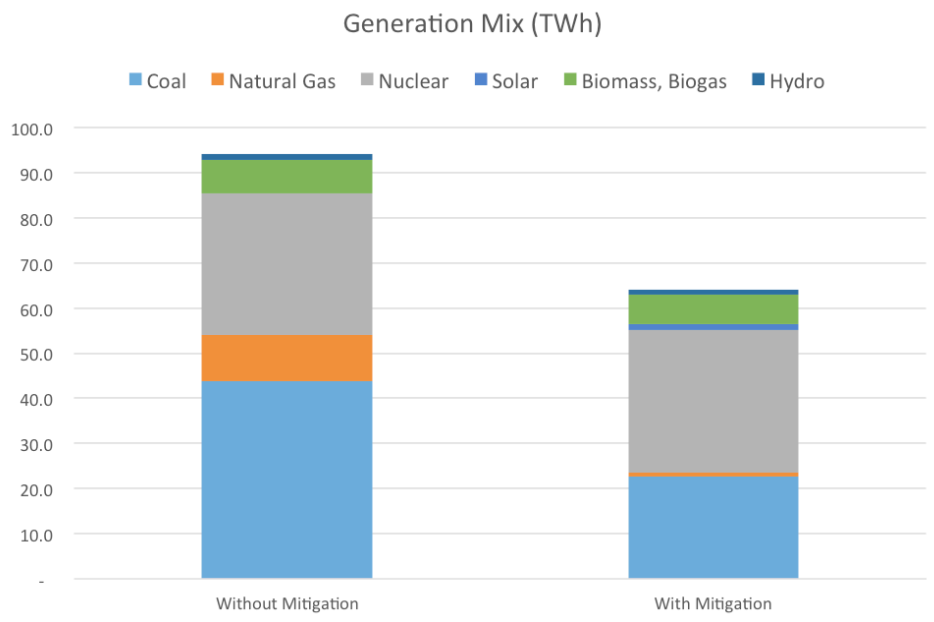


Figure 7. Scenario A: Percent of Mitigation Achieved by Measure for Least-Cost 2030 CPP Compliance

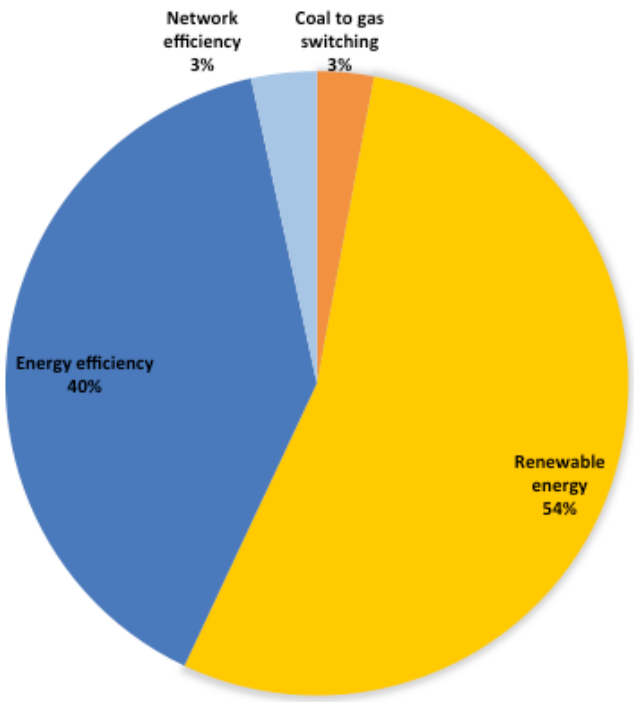
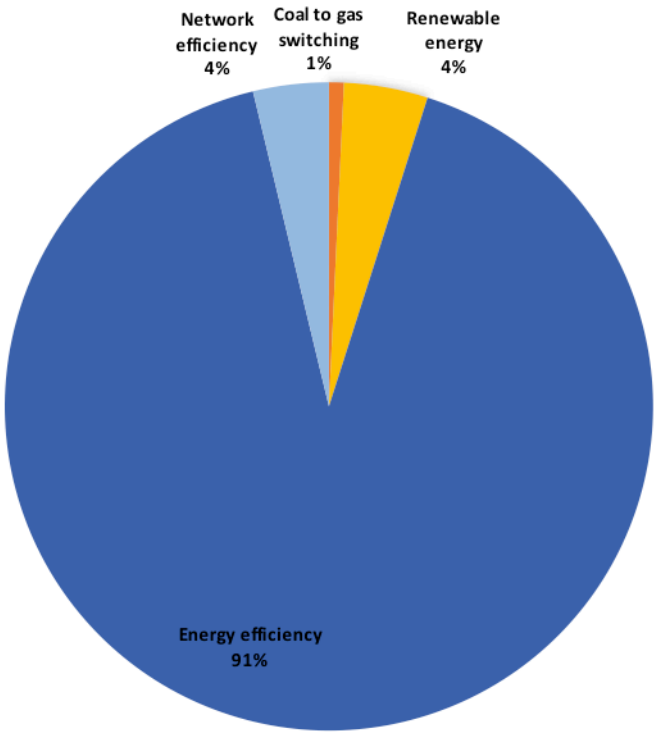


Figure 8. Scenario B: Percent of Mitigation Achieved by Measure for Least-Cost 2030 CPP Compliance



Conclusion

When developing a least-cost compliance plan for meeting the Clean Power Plan, Virginia can take advantage of a wide array of commercially available, innovative new technologies, including renewable energy, energy efficiency, combined heat and power, and heat rate improvements at existing coal generation facilities. Based on the scenarios examined in this paper, it is clear that carbon mitigation need not impose significant costs to ratepayers. In fact, under some scenarios, there is likely to be a decline in rates compared to business-as-usual.

"The Clean Power Plan is recognition of the need for action and creates a pathway for clean energy initiatives that will grow jobs and help diversify Virginia's economy," said Governor Terry McAuliffe, upon the finalization of the Clean Power Plan.[4] By using STEER as a resource to examine the different policy and market scenarios the state may face in the next 15 years, Virginia can balance these considerations to develop a cost-effective plan that meets Clean Power Plan requirements and satisfies the state's energy needs and economic ambitions at the same time.

[4] "McAuliffe: Clean Power Plan in Virginia," Richmond Times-Dispatch, October 5, 2015. http://www.richmond.com/opinion/their-opinion/guest-columnists/article_0ed2e6bc-a48f-522f-90d0-444d8b7f40b7.html