# Meeting—and Exceeding—the Clean Power Plan in Virginia

*A Robust Plan for Securing a Clean Energy Future*

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The Clean Power Plan (CPP), finalized in August 2015, sets the nation's first-ever limit on carbon dioxide ($CO_2$) emissions—the primary contributor to global warming—from power plants (see Box 1). Nationwide, Virginia has one of the more moderate CPP state targets, with a goal of reducing emissions by 7.9 million tons,[1] or approximately 22 percent below 2012 levels as calculated by the EPA[2] (OAR 2015a). The Commonwealth is well-positioned to meet—and even exceed—this goal because of its existing lower-carbon generating fleet and small, but growing, investments in renewable energy and energy efficiency. New analysis by the Union of Concerned Scientists shows that a combination of strong renewable energy and energy efficiency policies and a robust carbon emissions–trading program would provide a cost-effective pathway for the Commonwealth to cut carbon emissions, charting a course toward a clean energy future that delivers significant health and economic benefits for *all* Virginians.

## Virginia's Clean Energy Transition

Virginia's power sector is already dominated by lower-carbon energy resources; in 2014, a majority of the state's electricity generation came from nuclear power (40 percent) and natural gas (28 percent). Most of the state's remaining generation (27 percent) comes from coal, but its contribution is on the decline. Twelve coal generating units in the state, totaling more than 1,700 megawatts (MW) of power capacity, have been shut down since 2012 (SNL Financial 2015; Fleischman et al. 2013). This mirrors a nationwide trend, as aging and polluting coal power plants are replaced by cleaner, more cost-competitive energy resources such as natural gas, wind, and solar (Cassar 2015).

Virginia lags behind many states in realizing its renewable energy potential. Non-hydro renewable energy resources made up just 2.8 percent of Virginia's electricity generation in 2014[3] (EIA 2015a). According to a recent U.S. Department of Energy analysis, the economic potential of renewable energy in Virginia—led primarily by utility-scale solar and wind—ranges from 48 to 118 percent of the state's electricity sales in 2014 (Brown et al. 2015). However, Virginia currently has a mere 15 MW of installed solar (SEIA 2015), while neighboring North Carolina has more than 1,000 MW.[4] Virginia's Renewable Energy Portfolio Goal sets a voluntary target of 15 percent of electricity sales to come from qualified renewable energy sources by 2025[5] (Virginia General Assembly 2007), but in-state renewable energy development has been slow to materialize due to a lack of clear policy support (Serota 2015).

Virginia has also done little to promote energy efficiency, ranking near the bottom of all states in terms of its overall efficiency efforts (Serota 2015) and receiving the lowest possible score by the American Council for an Energy-Efficient Economy for utility and public benefits programs and policies (Gilleo et al. 2015). The Commonwealth established a voluntary energy efficiency goal of 10 percent electricity savings relative to 2006 levels by 2022, and in 2014 Governor Terry McAuliffe proposed achieving this goal by 2020—two years ahead of schedule (DMME 2014). But Virginia could go much further. One study estimated that the state could achieve a 23 percent reduction in electricity consumption in 2030 relative to 2012 by implementing a mandatory energy efficiency savings target combined with investments in combined heat and power systems (which uses leftover heat from electricity generation for heating) and building and equipment efficiency standards (Hayes et al. 2014). Another study found that a 7.5 percent reduction in energy consumption (including both electricity and natural gas) would save the average household $325 in annual energy costs (Brown et al. 2010).

Virginia's utilities have been slow to recognize the value of renewable energy and energy efficiency (Piatt 2014). For example, Dominion Power, Virginia's largest investor-owned utility, is investing heavily in natural gas in the near term (Meek, Gasper, and Kaufman 2015). But strong evidence suggests that becoming too reliant on natural gas poses numerous complex risks, including price volatility, climate-changing emissions from combustion and leakage of methane, and water and air pollution from natural gas production (Deyette et al. 2015). A recent analysis rates Virginia's risk of overreliance on natural gas as moderate to high due to its rapid shift toward natural gas generation in

BOX 1. **The Clean Power Plan**

The CPP was developed under the authority of Clean Air Act, an act of Congress that requires the U.S. Environmental Protection Agency (EPA) to take steps to reduce air pollution that harms the public's health. The CPP aims to reduce $CO_2$ emissions from the nation's electricity sector—the largest contributor to U.S. global warming emissions—by an estimated 32 percent below 2005 levels by 2030. The EPA set differing targets among states because of each state's unique mix of electricity generation resources—and also because of technological feasibilities, costs, and emissions reduction potentials, all of which vary across the country.

The plan provides a number of options for cutting carbon emissions so that each state can develop a plan most suited to its own electricity mix, resource availability, and policy objectives. These options include investing in renewable energy, energy efficiency, natural gas, and nuclear power; and shifting away from coal-fired power. States are free to combine these carbon-reduction options in a flexible manner to meet their targets. States can also join together in multistate or regional compacts to find the lowest-cost options for reducing their $CO_2$ emissions, including through emissions-trading programs.

The EPA has given states the option of choosing between a rate-based emissions target (measured in pounds of $CO_2$ per megawatt-hour of electricity generated) or a mass-based target (measured in short tons of $CO_2$ emitted by generating units). To avoid undermining the environmental integrity of the standard, states must also address the potential for "leakage," or emissions that might arise due to a shift from existing to new fossil fuel–fired power plants (which are not covered under the CPP). One way EPA suggests addressing leakage is the adoption of the "new source complement," which represents an increase in a state's emission target based on an estimate of new power plants required to meet additional electricity demand after 2012. A mass-based target that includes $CO_2$ emissions from both new and existing power plants is the most straightforward way of ensuring an accurate accounting of the emissions that contribute to climate change. States that choose a mass-based emissions-trading program would issue carbon allowances (based on that state's target) and could then auction those allowances to generate revenues for public use.

States must submit a final compliance plan, or an initial plan with a request for an extension of up to two years, by September 6, 2016. The compliance plan must outline how the state will meet not only its final 2030 target, but also an interim target that covers the period from 2022 to 2029.

recent years and near-term plans to build additional natural gas power plants (UCS 2015a).

However, there are signs that Virginia's utilities are beginning to change. A subsidiary of Dominion has recently acquired a planned 80 MW solar facility located in Accomack County—the Amazon Solar Farm U.S. East—which will break ground in late 2015 and produce electricity in the fall of 2016 (Lundin 2015). Dominion is planning to develop a total of 400 MW of utility-scale solar by 2020, though that amounts to only about 2 percent of the company's expected capacity in 2020 (Dominion Power 2015). And while Virginia's electric utilities spent only a tiny fraction of their electricity revenues on energy efficiency programs from 2008 to 2012 (Serota 2015), energy legislation passed in 2015 requires both Dominion and Appalachian Power Company (the two largest investor-owned utilities serving Virginia) to fund energy efficiency programs, in particular those supporting low-income, elderly, and disabled residents, and to improve financing of clean energy projects (Meek, Gasper, and Kaufman 2015).

## How Virginia Can Meet and Exceed Its Clean Power Plan Goals

Under the CPP, Virginia's mass-based targets (including emissions from new power plants) are 30 million tons, on average, in the interim period from 2022 through 2029 and 28 million tons in 2030 (EPA 2015). While this is a decrease from the EPA's adjusted baseline, Virginia's 2030 target is 2 percent *higher* than the state's actual power sector emissions in 2012 (EPA 2015).[6]

Virginia is well-positioned to take advantage of the CPP's many options for cutting carbon emissions (as described in Box 1). But the Commonwealth can easily exceed its modest CPP targets by participating in a well-designed mass-based emissions-trading program and implementing strong complementary policies that support renewable energy and energy efficiency. Virginia has already set voluntary renewable energy and energy efficiency goals;

by turning these voluntary goals into mandatory targets, and strengthening them, the Commonwealth can drive real investments in clean energy. And a mass-based emissions-trading program with auctioned allowances would allow Virginia to generate revenues that can be used to benefit all its citizens (see "Carbon Revenue Opportunities," below).

The Union of Concerned Scientists examined the economic and environmental impacts of Virginia complying with the CPP using these robust policy solutions. We found this approach, called the Clean Energy Compliance Pathway—or "Clean Path"—Case, provides significant environmental, economic, and health benefits for the state, compared with a Reference Case that excludes the CPP and in which no new state or federal policies are implemented beyond those in place as of October 2015. (See Box 2 for our methodology and assumptions.) Benefits include:

- **Generating $251 million in average annual revenue from 2022 to 2030,** from the sale of carbon allowances, for investments in Virginia's economy;
- **Investing $3.4 billion in energy efficiency improvements** to benefit Virginia consumers;
- **Reducing the typical Virginia resident's electricity bills by 4 percent in 2030,** for an annual savings of $62;
- **Developing 6,252 MW of new wind and solar** capacity in Virginia by 2030, generating $3.7 billion in new capital investments;
- **Avoiding 78 million tons of $CO_2$ through 2030;** and
- **Providing health and economic benefits worth an estimated $2.7 billion cumulatively through 2030** by avoiding $CO_2$, sulfur dioxide ($SO_2$), and nitrogen oxides ($NO_x$) pollution.

## BOX 2. **Methodology**

We used a revised version of the Regional Energy Development System (ReEDS), a power sector model developed by the National Renewable Energy Laboratory, to analyze Virginia's compliance pathway. ReEDS simulates the electricity supply mix that would meet electricity demand in the future (through 2050) throughout the contiguous United States at the lowest overall system cost while meeting reliability, environmental, legal, and other requirements. The assumptions in our version of the model are based on information used by the Energy Information Administration for the Annual Energy Outlook 2015 (EIA 2015b) supplemented with data from the recent Wind Vision and SunShot Vision studies (DOE 2015; DOE 2012). We also updated the model's data for existing power plants to include recent retirements and plants under construction (see the technical appendix, online at *http://www.ucsusa.org/cleanpowerplanVirginia*, for more information).

For this analysis, we first modeled a Reference Case with no new state or federal policies beyond those in place as of October 2015. Our Reference Case does not include CPP compliance. We then compared the Reference Case with a policy case with nationwide CPP compliance, and focused on the Virginia-specific results. While the CPP offers flexible compliance options for each state (see Box 1), for our analysis we investigated one set of options for CPP compliance; our policy case, the Clean Energy Compliance Pathway (or "Clean Path") Case, uses the following assumptions:

- We modeled the CPP mass-based targets with the new source complement, which includes both new and existing fossil fuel–fired power plants.
- Each state has the option to meet its CPP target by trading carbon allowances with any other state.
- For Virginia we assumed that the state implements a mandatory Energy Efficiency Resource Standard (EERS) and Renewable Portfolio Standard (RPS) in 2018 with
    - energy efficiency savings equivalent to 9 percent of statewide electricity sales in 2022 and continuing at this level through 2030, and
    - renewable energy generation (including hydro) meeting 8 percent of sales in 2025 and growing to 16 percent of sales in 2030.
    - We assume that other states with policies to support renewable energy and energy efficiency will continue these and a few states will add policies or expand their existing requirements.

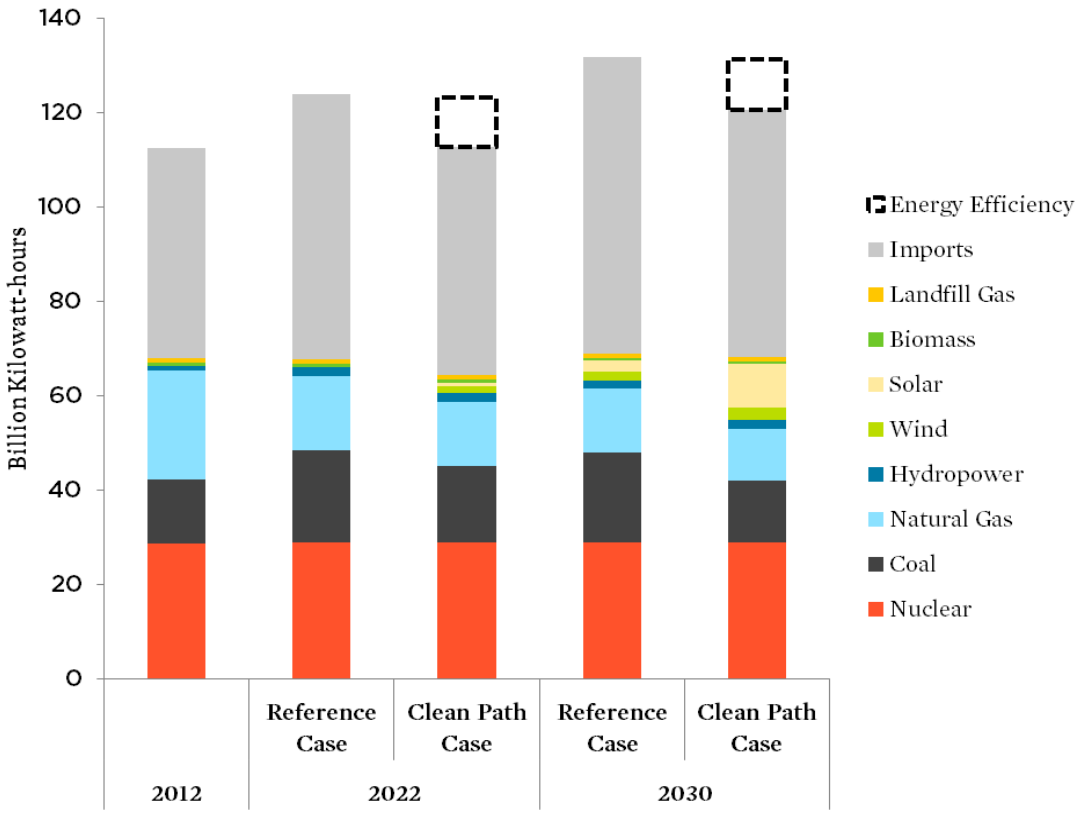
The CPP also includes a Clean Energy Incentive Program (CEIP), which offers states incentives for early development of renewable energy and energy efficiency. A portion of the generation that meets the RPS and EERS requirements we modeled may qualify for the CEIP, but we did not model the impact of the program, or the benefits that early crediting would have on the cost-effectiveness of qualifying clean energy projects.

## Clean Energy Policies Drive Virginia's Transition to Low-carbon Electricity

Without strong policies, Virginia is not likely to shift away from higher-carbon energy resources. Indeed, in the Reference Case in 2022 and 2030, Virginia's coal-fired power generation is greater than in 2012 (a low year for coal generation nationally due to low natural gas prices) while natural gas–fired power generation decreases due to reduced use of less-competitive natural gas plants. Solar and wind power generation combined increase to just 6 percent of generation by 2030 in the Reference Case, while electricity imports increase from 40 percent in 2012 to 50 percent in 2030.[7]

In contrast, the Clean Path Case shows a more diversified generation mix. By 2030, the EERS leads Virginia to achieve 8 percent[8] energy efficiency savings, relative to total electricity sales in that year. The RPS drives up wind power generation to reach 4 percent of Virginia's generation in 2030 and solar generation to 14 percent.[9] Relative to the Reference Case, generation from coal and natural gas plants are lower.[10] In 2030, natural gas comprises 16 percent of total generation, while coal generation accounts for 19 percent. Further, Virginia will be able to cut its electricity imports 17 percent by 2030 relative to Reference Case projections.

FIGURE 1. **The Clean Path Case Diversifies Virginia's Electricity Mix**



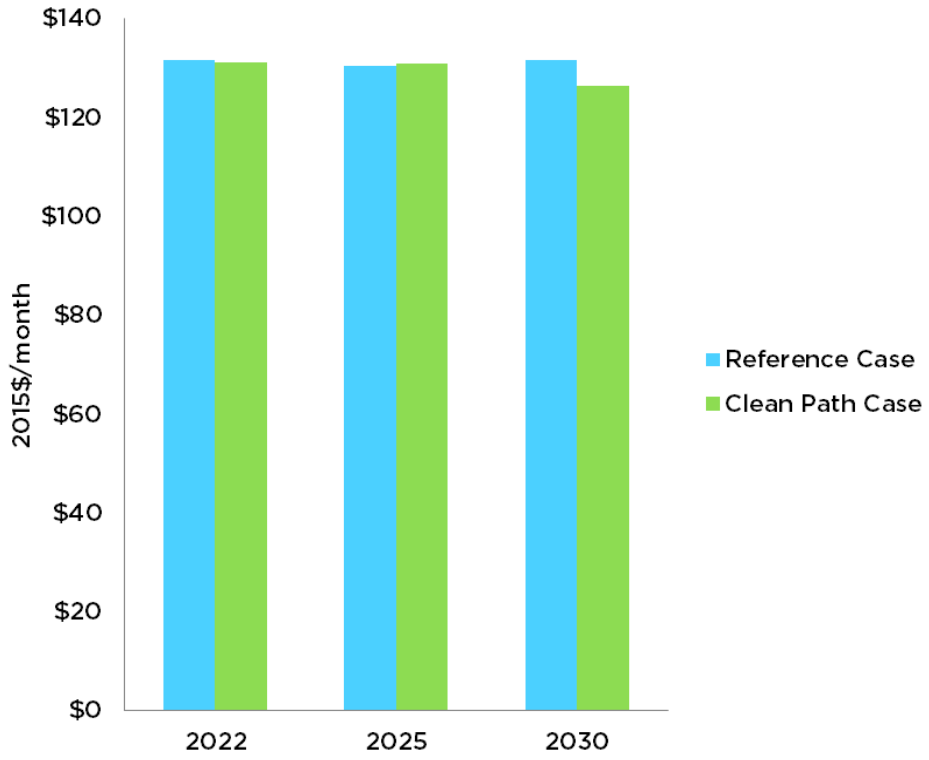

*A pathway to Clean Power Plan compliance that emphasizes renewable energy and energy efficiency policies and participation in a carbon trading program—the Clean Path Case—helps accelerate Virginia's shift away from coal and toward a diversified portfolio of cleaner energy resources. It also helps avoid potential overreliance on natural gas and associated risks such as increased $CO_2$ emissions and vulnerability to volatile fuel prices.*

To provide the increased wind and solar generation projected by the Clean Path Case, Virginia would build an additional 716 MW of wind capacity and almost 5,600 MW of solar capacity in-state, including more than 1,000 MW of rooftop solar on homes and businesses. Overall, **the combined capacity of solar and wind is projected to increase more than 20-fold from 2012 to 2030.** The Clean Path Case would drive $3.7 billion in renewable energy investments in Virginia, and $3.4 billion in energy efficiency improvements.[11] Studies have shown that these types of investments could bring direct benefits to Virginia's economy, including through the creation of jobs in the state (AEEI and VAEIC 2015) and tax revenue to local governments.

#### CLEANER ENERGY LEADS TO LOWER ELECTRICITY BILLS

The clean energy growth in Virginia spurred by the Clean Path Case is not only achievable, but also affordable. The Clean Path Case policies (including investments in new renewable energy projects, energy efficiency programs, and carbon trading) have minimal impact on electricity bills. Compared with the Reference Case, average monthly electricity bills for a typical household are slightly lower in 2022 (0.3 percent decrease, or approximately $5 per year),

FIGURE 2. **Clean Energy Saves Virginia Money**




*The Clean Path Case leads to consumer electricity bills that are, on average, 4 percent lower in 2030 compared with the Reference Case. Energy efficiency helps consumers save electricity, and more renewable energy helps diversify the electricity mix and limit potential impacts from increases in fossil fuel prices.*

Electricity costs in the Reference Case are based on average monthly consumption of 1,132 kilowatt-hours (kWh) for a residential non-electric heating customer (Dominion Power 2015). In the Clean Path Case, average monthly consumption is lower (1,030 kWh) due to the implementation of energy efficiency programs.

but slightly higher in 2025 (0.5 percent increase, or approximately $8 per year). However, these policies ultimately lead to financial savings: the "fuel" used by renewable energy facilities is free, and energy-efficient buildings and appliances cost less to operate. As a result, **in 2030, electricity bills are 4 percent lower for a typical residential customer compared with the Reference Case saving $62 in that year** (see Figure 2).

We also looked at financial savings in Virginia economy-wide—including net impact on electricity bills for all customer classes, investments by participants in energy efficiency programs, and net costs for power generators and distributors. In 2022, there is a net cost of $336 million, or 3 percent of total electricity system costs, to implement the policies outlined in the Clean Path Case. However, similar to the residential example described above, these policies also generate financial savings over time, and pay for themselves by 2029. In 2030, the net savings are $462 million (in 2015 dollars)—a decrease of 4 percent in total electricity system costs—and these savings will continue to grow in the years that follow.

In addition, under the Clean Path Case a carbon emissions–trading program generates millions of dollars in revenues that could further offset consumer electricity bill impacts or otherwise benefit Virginia residents (see "Carbon Revenue Opportunities," below).

#### CLEANER ENERGY MEANS LESS POLLUTION

Under the Clean Path Case, electricity-related $CO_2$ emissions[12] are projected to be 23 million tons in 2022 and 19 million tons in 2030, or 29 percent below the Reference Case in 2030. That would put Virginia well below both its interim and final CPP targets. Cumulatively from 2016 through 2030, $CO_2$ emissions are 78 million tons lower in the Clean Path Case than in the Reference Case. The lower $CO_2$ emissions directly reflect the cleaner generation mix (see Figure 1) spurred by renewable energy and energy efficiency policies along with the impacts of reduced electricity imports. Our analysis shows how utilities in Virginia have the flexibility to take advantage of both the power market (buying or selling electricity) and the carbon market (buying or selling carbon allowances) to provide electricity at the lowest cost for consumers while meeting the Clean Power Plan.

The Clean Path Case also helps cut other conventional air pollutants including $SO_2$ and $NO_x$. $SO_2$ emissions would be 40 percent lower than in the Reference Case in 2030, while $NO_x$ emissions are projected to be 32 percent lower.

Reducing $NO_x$, $SO_2$, and $CO_2$ emissions will lead to tangible health and economic benefits. $NO_x$ and $SO_2$ are contributors to smog and soot, which can exacerbate asthma and other heart and lung diseases, and can cause premature death (EPA n.d.). $CO_2$ emissions contribute to global warming, which contributes to risks of heat waves, extreme weather, and other climate impacts that can harm human health. Using the same methodology applied by the EPA in its impact assessment for the CPP, we estimated the monetary savings associated with reducing these pollutants.[13] The combined carbon and health benefits of the avoided emissions of $CO_2$, $SO_2$, and $NO_x$ under the Clean Path Case are $347 million (in 2015 dollars) on average each year through 2030. These benefits add up to a total of $2.7 billion[14] for the entire time period, or 3 times more than the total electric system costs of complying with Clean Path Case policies.

## Carbon Revenue Opportunities

Our analysis also shows that a multistate, mass-based emissions-trading program with auctioned allowances would help Virginia generate significant carbon revenues that could be used for the benefit of the Commonwealth's citizens. By participating in such a program, Virginia can raise average annual revenues of $251 million (in 2015 dollars) per year from 2022 to 2030. The amount varies from year to year, ranging from a low of $166 million in 2022 to a high of $321 million in 2024, depending on the level of the cap and carbon allowance price. The table below summarizes possible priorities for the use of auction revenue, along with approximate funding needs; a detailed explanation of each follows.

With a well-designed CPP compliance plan that includes full auctioning of carbon allowances, Virginia would have a range of investment options including:

- **Building resilient infrastructure in coastal areas vulnerable to sea level rise and flooding.** The impacts of global warming–induced sea level rise, including routine tidal flooding and worsening storm surge, are already a reality in places such as Norfolk and Hampton Roads (Spanger-Siegfried, Fitzpatrick, and Dahl 2014). They threaten electricity infrastructure and reliability (McNamara et al. 2015) and also put several nationally important historic landmarks in Virginia at risk (Holtz et al. 2014). Norfolk alone has estimated that

it would need to invest approximately $1 billion over the next few decades to build resilience to sea level rise (Tompkins and Deconcini 2014).

- **Supporting renewable energy development and energy efficiency investment.** Virginia could draw on the experience of the Regional Greenhouse Gas Initiative (RGGI), which caps power sector $CO_2$ emissions in nine Northeast states, and California's cap-and-trade program to use carbon revenue to help drive clean energy investments and save consumers money on their electricity bills. From 2012 to 2014, RGGI states dispersed virtually all of the nearly $1 billion in auction proceeds back into the economy, largely through investments in energy efficiency, renewable energy development, and direct energy bill assistance for low-income residents (Hibbard et al. 2015). Virginia could adopt a similar system and derive economic benefits (AEEI and VAEIC 2015). Revenues could also be used to establish or enhance a "green bank" in Virginia, which would help leverage private capital to fund clean energy projects (UCS 2015b).
- **Assisting low-income and environmental justice communities**. Experience from California could help inform Virginia's policies to address concerns from environmental justice communities—communities that already face disproportionate exposure to pollution and climate impacts. California auctions a portion of the allowances from its cap-and-trade program, raising about $832 million in allowance revenue in the 2014–2015 fiscal year (CARB 2014). At least 25 percent of program funding must benefit environmental justice communities, and at least 10 percent must be allocated to projects located within those communities, such as affordable housing, energy efficiency, and public transit (CARB 2013, California State Legislature 2012). California has demonstrated that well-designed policies can bring clean energy investments into disadvantaged communities, which face a disproportionate burden of pollution and where cost savings and economic development are needed most.
- **Supporting economically distressed coal communities in southwest Virginia**. Existing institutions in the region, such as the Virginia Coalfield Economic Development Authority (VCEDA) and the Virginia Tobacco Region Revitalization Commission (VTRRC), could be funded to support economic development in affected communities. Originally funded from the tobacco settlement agreement in 1998, the VTRRC invested $4.5 million in its Southwest Economic Development Grants program in fiscal year 2014 (TRRC 2014); VCEDA provided $7.8 million in grants and loans in 2014, financed by county

TABLE 1. **Virginia Carbon Auction Revenue Can Generate Millions for Local Communities**

| Investment Category | Approximate Funding Level | Potential Recipients |
|---|---|---|
| **Coastal Infrastructure** | $50 million/year | Coastal communities ($1 billion in grants over 20 years) |
| **Renewable Energy and Energy Efficiency** | $10 million/year | A "green bank" in Virginia, with initial capitalization spread over 10 years |
| **Investments in Environmental Justice Communities** | $25 million/year | State agencies supporting affordable housing, energy efficiency, and public transit |
| **Economic Diversification in Coal Communities** | $25 million/year | Virginia Tobacco Region Revitalization Commission, Virginia Coalfield Economic Development Authority |

income from coal severance taxes and other tax credits (VCEDA 2014; McIlmoil et al. 2012). Carbon revenues could help diversify the economies of coal-dependent counties and help replace lost wages and economic activity from declining coal mining employment.

## Recommendations

To achieve the full benefits of the policies described in the Clean Path Case, policy makers and regulators should work together with utilities, advocates, regional transmission organizations, and other stakeholders to develop a CPP compliance plan that prioritizes renewable energy and energy efficiency and generates benefits for Virginians. The Union of Concerned Scientists offers the following recommendations:

1. **The Virginia Department of Environmental Quality (DEQ) should develop a strong mass-based CPP compliance plan.** The DEQ has already begun a robust stakeholder process to gather comments and information on how to construct a compliance plan that works for the Commonwealth. As part of its final plan, the DEQ should prioritize renewable energy and energy efficiency as a means of compliance, and enact a mass-based emissions-trading program that includes both new and existing sources and allows for trading of carbon allowances.
2. **The Virginia General Assembly should enact strong clean energy and carbon market policies.** The legislature should make existing voluntary renewable energy and energy efficiency programs mandatory and strengthen them. It should also authorize the Commonwealth to auction carbon allowances as part of the emissions-trading program developed by the DEQ, and direct the revenues to specific programs that benefit all residents.
3. **Virginia electric utilities should work to diversify their portfolios, prioritizing low-cost renewables and efficiency.** These steps will help cut consumer electricity bills, shield consumers from the risks of overreliance on natural gas, and cut harmful emissions from power plants.
4. **The PJM Interconnection can show utilities and stakeholders how to ensure reliability and invest in transmission to support low-carbon energy resources.** This regional transmission organization, which coordinates the movement of electricity in the Mid-Atlantic and some Midwest states, including Virginia, has found that adding higher levels of wind and solar to the electricity grid does not affect service reliability, making it feasible to ramp up renewable energy development (PJM 2015; GE Energy Consulting 2014). PJM should work with Virginia stakeholders to make this a reality for the Commonwealth.

With well-designed policies and careful planning and coordination, Virginia can greatly increase its clean energy resources, reducing emissions even further than required by the Clean Power Plan and delivering significant economic benefits in the process. And with a robust emissions-trading program, Virginia could generate large carbon revenues used to make coastal homes and infrastructure more resilient, support quality renewable energy and energy efficiency jobs, strengthen low-income communities, and boost economic development in regions dependent on the fossil fuel economy. These benefits will ensure a clean, prosperous future for *all* Virginians.

**[ENDNOTES]**

[1] "Tons" in this document refers to the U.S. short ton (2,000 pounds).

[2] This calculation is based on adjustments made by the EPA to each state's 2012 emissions in order to account for significant unit-level outages, expected under construction power plants, and other atypical conditions in 2012. The adjusted 2012 emissions for Virginia are 35.7 million short tons and the 2030 goal, including both new and existing sources (OAR 2015b), is 27.8 million short tons of $CO_2$, which represents a 22 percent reduction. Further details are available in OAR 2015a.

[3] This is equal to 1.9 percent of Virginia's electricity sales in 2014.

[4] For comparison, in the past seven years, North Carolina has gone from virtually no solar energy to ranking fourth nationally in terms of solar capacity (Brun, Hamrick, and Daly 2015).

[5] Relative to an adjusted 2007 baseline.

[6] As explained previously, actual 2012 emissions are different from the level the EPA used for the purposes of the CPP. Virginia's 2012 actual $CO_2$ emissions were 27.4 million short tons (Gordon 2015).

[7] The generation mix, including the levels of imported electricity, are the result of the model's calculations for meeting Virginia's electricity demand at least cost, subject to reliability and other constraints, based on assumptions described in our technical appendix, online at *http://www.ucsusa.org/cleanpowerplanVirginia*.

[8] This level of savings is slightly lower than our assumption for 2022 because we assume that energy efficiency savings remain at 11 billion kilowatt-hours over time but this is a declining portion of total sales; see the technical appendix for further detail.

[9] Note that these figures are for generation, not total electricity sales as indicated by the RPS assumption in Box 2.

[10] In 2022, coal generation in the Clean Path Case increases relative to 2012 levels, when low natural gas prices led to very low coal generation. Coal generation in the Clean Path Case is lower than the reference case in 2022 and 2030.

[11] Assuming a 7 percent discount rate, based on recommendations outlined in OMB 2014.

[12] $CO_2$ emissions include emissions from resources that are excluded from the CPP, such as natural gas combustion turbines. Excluded emissions comprise less than 1 percent of total $CO_2$ emissions.

[13] The health benefits are calculated based on Benefit per Ton Estimates for $SO_2$ and $NO_x$, reported in Tables 4-7, 4-8, and 4-9 in OAQPS 2015. See the technical appendix, online at *http://www.ucsusa.org/cleanpowerplanVirginia*, for values and additional information.

[14] This is the net present value from 2015 through 2030 using a 7 percent discount rate, based on recommendations outlined in OMB 2014.

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