

Adverse impact notification sent to Joint Commission on Administrative Rules, House Committee on Appropriations, and Senate Committee on Finance (COV § 2.2-4007.04.C): Yes  Not Needed

If/when this economic impact analysis (EIA) is published in the *Virginia Register of Regulations*, notification will be sent to each member of the General Assembly (COV § 2.2-4007.04.B).



## Virginia Department of Planning and Budget Economic Impact Analysis

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**9 VAC 5-140 Regulation for Emissions Trading**  
**Department of Environmental Quality**  
**Town Hall Action/Stage: 4818 / 8130**  
December 13, 2017

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### Summary of the Proposed Amendments to Regulation

The Air Pollution Control Board (Board) proposes to establish the CO<sub>2</sub> Budget Trading Program in regulation.

### Estimated Economic Impact

#### *Background*

Governor McAuliffe's Executive Directive 11 (2017)<sup>1</sup> directed the Director of the Department of Environmental Quality (DEQ), in coordination with the Secretary of Natural Resources, to:

*Develop a proposed regulation for the State Air Pollution Control Board's consideration to abate, control, or limit carbon dioxide emissions from electric power facilities that:*

- a. Includes provisions to ensure that Virginia's regulation is "trading-ready" to allow for the use of market-based mechanisms and the trading of carbon dioxide allowances through a multi-state trading program; and*
- b. Establishes abatement mechanisms providing for a corresponding level of stringency to limits on carbon dioxide emissions imposed in other states with such limits.*

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<sup>1</sup> See <https://governor.virginia.gov/media/9155/ed-11-reducing-carbon-dioxide-emissions-from-electric-power-facilities-and-growing-virginias-clean-energy-economy.pdf>

The Board's proposed CO<sub>2</sub> Budget Trading Program is designed to meet the requirements of Executive Directive 11.

Further, the Work Group established by Governor McAuliffe's Executive Order 57<sup>2</sup> to study and recommend methods to reduce carbon emissions from electric power generation facilities concluded in their final report "that it is important and necessary that Virginia work through a regional model, like the established and successful [Regional Greenhouse Gas Initiative], in order to achieve lower compliance costs and address the interstate nature of the electric grid." Thus the proposed regulation specifies participation in the Regional Greenhouse Gas Initiative (RGGI).

#### *Regional Greenhouse Gas Initiative*

RGGI is a cooperative effort among the states of Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New York, Rhode Island, and Vermont to cap and reduce power sector carbon dioxide (CO<sub>2</sub>) emissions. RGGI is composed of individual CO<sub>2</sub> Budget Trading Programs in each participating state. Through independent regulations, each state's CO<sub>2</sub> Budget Trading Program limits emissions of CO<sub>2</sub> from electric power plants, issues CO<sub>2</sub> allowances and establishes participation in regional CO<sub>2</sub> allowance auctions. Regulated power plants can use a CO<sub>2</sub> allowance issued by any participating state to demonstrate compliance with an individual state program. In this manner, the state programs, in aggregate, function as a single regional compliance market for CO<sub>2</sub> emissions.

#### *Virginia's CO<sub>2</sub> Budget Trading Program*

Under the proposed regulation, fossil fuel-fired stationary boilers, combustion turbines, or combined cycle systems that serve an electricity generator with a nameplate capacity equal to or greater than 25 electrical megawatts are considered CO<sub>2</sub> budget units. Any source<sup>3</sup> that includes one or more such units is a CO<sub>2</sub> budget source, subject to the requirements of the regulation. The owners and operators of each CO<sub>2</sub> budget source and

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<sup>2</sup> See <https://governor.virginia.gov/media/6396/eo-57-development-of-carbon-reduction-strategies-for-electric-power-generation-facilities.pdf>

<sup>3</sup> The proposed regulation defines source as "any governmental, institutional, commercial, or industrial structure, installation, plant, building, or facility that emits or has the potential to emit any air pollutant. A source, including a source with multiple units, shall be considered a single facility."

each CO<sub>2</sub> budget unit at the source must hold CO<sub>2</sub> allowances for at least the amount of CO<sub>2</sub> emitted for the relevant time period. Fossil fuel power generating units owned by an individual facility and located at that individual facility that generates electricity and heat from fossil fuel for the primary use of operation of the facility are exempt from the requirements.

For the first year of Virginia's CO<sub>2</sub> Budget Trading Program, 2020, the intent is to allocate to each source conditional allowances approximately equal to the number of tons of CO<sub>2</sub> emitted by their units. The allowances are called "conditional" because the sources cannot just hold on to and use the allowances; the allowances must be sent to the consignment auction. The consignment auction is the quarterly RGGI regional CO<sub>2</sub> allowance auction where anyone can bid for the allowances. The allowances can be used by any regulated power plant (source) in any of the RGGI states. Similarly, Virginia sources can use allowances that either originated in Virginia or any other RGGI state.

If a Virginia source intended to emit fewer tons of CO<sub>2</sub> than it received in conditional allowances, then the source would purchase fewer allowances (through the auction) than it had auctioned off, and would earn the auction price per ton times the net number of tons it sells (minus a small fee kept by RGGI for administrative costs). A Virginia source that intended to emit exactly the number of tons of CO<sub>2</sub> it was allotted would buy back the same number of allowances it brought to the auction and would break even (minus the administrative fee). A source that planned to emit more CO<sub>2</sub> than it received in conditional allowances would purchase the number of allowances it needed and pay the auction price times the number of tons beyond its allotted number.

For 2020, the proposed regulation specifies a Virginia base budget of either 33 million or 34 million tons of CO<sub>2</sub> allowances. (The proposed text at the Proposed Stage of this regulatory action includes the following: "Editor's Note: Two versions ... are provided for comment. The board seeks comment on whether the base budget should be 33 million tons or 34 million tons, with corresponding 3% per year reductions.") The base budget declines by about 1 million tons of CO<sub>2</sub> allowances per year thereafter until 2030. Of the base budget, 95% is allocated to CO<sub>2</sub> budget sources and the remaining 5%

is allocated to the Department of Mines, Minerals and Energy (DMME) to assist DEQ in the abatement and control of air pollution, specifically CO<sub>2</sub>.

The proposed Virginia CO<sub>2</sub> Budget Trading Program includes mechanisms designed to ensure that the allowance price remains within a set range. Details concerning those mechanisms can be found in Appendix I.

*Impact: Benefit of CO<sub>2</sub> Emission Reduction*

The Report of the Executive Order 57 Work Group<sup>4</sup> identifies several Virginia-specific environmental and economic harms that result from CO<sub>2</sub> emissions:

- According to data compiled by the Georgetown Climate Center and Old Dominion University's Mitigation and Adaptation Research Institute, the Commonwealth has already seen a 33 percent increase in heavy rainstorms and snowstorms in the last sixty years, as well as an 11 percent increase in precipitation from the largest storms.<sup>5</sup> The same report found that as many as 400,000 Virginia homes are at risk of damage from increased storm surges.
- Climate change also has the potential to endanger the agricultural sector. Half of Virginia's counties face increased risk of water shortages by 2050 as the result of climate-related shifts in precipitation and weather.<sup>6</sup>
- Other business sectors are similarly feeling the impacts of climate change as warmer temperatures affect worker productivity and the health of the workforce.<sup>7</sup>

Thus, reducing CO<sub>2</sub> emissions has the potential to benefit the Commonwealth.

The U.S. Environmental Protection Agency (EPA) and other federal agencies use estimates of the social cost of carbon (SC-CO<sub>2</sub>) to value the climate impacts of regulatory rulemakings.<sup>8</sup> The SC-CO<sub>2</sub> is a measure, in dollars, of the long-term damage done by a ton of CO<sub>2</sub> emissions in a given year. This dollar figure also represents the value of damages avoided for a reduction of a ton of CO<sub>2</sub> emissions in a given year (i.e. the

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<sup>4</sup> See <https://naturalresources.virginia.gov/media/9156/eo57-report-final-5-12-17.pdf>

<sup>5</sup> Georgetown Climate Center and Old Dominion University Mitigation and Adaptation Research Institute, Understanding Virginia's Vulnerability to Climate Change, February 17, 2017, available at <http://www.georgetownclimate.org/files/report/understanding-virginias-vulnerability-to-climate-change.pdf>

<sup>6</sup> Ibid.

<sup>7</sup> U.S. Global Change Research Program. Impacts of Climate Change on Human Health in the United States: A Scientific Assessment, April 2016, available at <https://health2016.globalchange.gov/>

<sup>8</sup> Interagency Working Group on Social Cost of Greenhouse Gases, United States Government; *Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis* [https://19january2017snapshot.epa.gov/sites/production/files/2016-12/documents/sc\\_co2\\_tsd\\_august\\_2016.pdf](https://19january2017snapshot.epa.gov/sites/production/files/2016-12/documents/sc_co2_tsd_august_2016.pdf)

benefit of a CO<sub>2</sub> reduction). It should be noted that the federal model estimates of the social cost of carbon are for the world overall.<sup>9</sup> Thus it is not possible to quantify the Virginia-specific benefits.

The SC-CO<sub>2</sub> is meant to be a comprehensive estimate of climate change damages and includes, among other things, changes in human health, property damages from increased flood risk, net agricultural productivity, and changes in energy system costs, such as reduced costs for heating and increased costs for air conditioning. However, according to the EPA, the federal SC-CO<sub>2</sub> estimates omit various impacts that likely would increase damages. The models used to develop SC-CO<sub>2</sub> estimates do not currently include all of the physical, ecological, and economic impacts of climate change recognized in the literature because of a lack of precise information on the nature of damages and because the science incorporated into these models naturally lags behind the most recent research. Nonetheless, current estimates of the SC-CO<sub>2</sub> are a useful measure to assess the climate impacts of CO<sub>2</sub> emission changes. Details about the federal model SC-CO<sub>2</sub> estimates and their development can be found in Appendix II of this report.

By design, under Virginia's proposed CO<sub>2</sub> Budget Trading Program, CO<sub>2</sub> emissions are reduced by about 1 million tons per year from 2020 to 2030. If a 3% discount rate is assumed,<sup>10</sup> then the benefit of a CO<sub>2</sub> reduction by about 1 million tons in 2021 versus 2020 would be about \$42 million, while the benefit of a CO<sub>2</sub> reduction by about 1 million tons in 2030<sup>11</sup> would be about \$50 million.<sup>12</sup> The estimated cumulative benefit for the ten years of CO<sub>2</sub> reduction would be about \$460 million. The assumed discount rate makes a large difference in the estimated benefit. If a discount rate of 2.5% a year is used rather than 3%, then the estimated cumulative benefit for the ten years of CO<sub>2</sub> reduction would be about \$680 million. On the other hand, using a discount rate of 5% a year rather than 3% results in an estimated cumulative benefit for the ten years of CO<sub>2</sub> reduction of about \$140 million.<sup>13</sup>

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<sup>9</sup> Ibid, p.17.

<sup>10</sup> See Appendix II for a discussion of discount rates and how the SC-CO<sub>2</sub> estimates vary with use of different discount rates.

<sup>11</sup> The last year specified in the proposed regulation is 2030.

<sup>12</sup> See the table in Appendix II for estimated SC-CO<sub>2</sub> figures, and the text of Appendix II for discussion on how the figures are determined.

<sup>13</sup> All calculations use the federal government's SC-CO<sub>2</sub> estimates shown in Appendix II.

*Impact: Benefit of Incidental Reductions in SO<sub>2</sub> and NO<sub>x</sub>*

Air pollutants such as sulfur dioxide (SO<sub>2</sub>) and nitrogen oxides (NO<sub>x</sub>) are co-produced along with CO<sub>2</sub> emissions from fossil-fuel power plants. SO<sub>2</sub> and NO<sub>x</sub> can form particulate matter. Exposure to particulate matter can adversely affect the lungs and heart, leading to premature death in people with heart or lung disease, nonfatal heart attacks, aggravated asthma, decreased lung function, and increased respiratory symptoms, such as irritation of the airways, coughing or difficulty breathing.<sup>14</sup> In meeting CO<sub>2</sub> reduction requirements, there would also be reductions in SO<sub>2</sub> and NO<sub>x</sub> emissions.

EPA developed the Co-Benefits Risk Assessment (COBRA) model,<sup>15</sup> to estimate the health co-benefits from the incidental reductions in SO<sub>2</sub> and NO<sub>x</sub> emissions. EPA ran the COBRA model to analyze the effects if Virginia linked to RGGI and established its CO<sub>2</sub> Budget Trading Program. The EPA used two sets of assumptions: the RGGI Scenario and the Virginia (VA) Scenario. Table 1a compares the two scenarios.

Table 1a: Comparison of Assumptions in RGGI and VA Scenarios

	<b>RGGI Scenario</b>	<b>Virginia Scenario</b>
<i>Natural Gas (NG) Prices</i>	NG price assumptions obtained from the Energy Information Agency's 2017 Annual Energy Outlook report. <sup>16</sup>	NG price assumptions based on Dominion Energy's Integrated Resource Plan. <sup>17</sup> (NG prices are slightly higher under the VA scenario.)
<i>Future Electricity Demand</i>	Future electricity demand projections for Virginia come from the PJM Interconnection <sup>18</sup> which is the Regional Transmission Organization that covers Virginia and other eastern states.	Future electricity demand projections based on Dominion Energy's Integrated Resource Plan. (Future electricity demand projections are substantially higher under the VA scenario.)
<i>Future Renewable Power Generation</i>	Because Virginia is not presently linked to RGGI, it does not include any future Virginia renewable power generation.	Based on Dominion Energy's Integrated Resource Plan. (Includes future Virginia renewable power generation such as solar).

<sup>14</sup> See <https://www.epa.gov/pm-pollution/health-and-environmental-effects-particulate-matter-pm>

<sup>15</sup> See <https://www.epa.gov/statelocalenergy/co-benefits-risk-assessment-cobra-health-impacts-screening-and-mapping-tool>

<sup>16</sup> See <https://www.eia.gov/outlooks/aeo/>

<sup>17</sup> See <http://dominionenergy.mediaroom.com/2017-05-01-Dominion-Virginia-Power-Plan-Sees-More-Clean-Energy>

<sup>18</sup> See <http://www.pjm.com/>

Table 1b displays the COBRA model’s estimates of the reduction in mortality from the reductions in SO<sub>2</sub> and NO<sub>x</sub> emissions that would result from Virginia linking to RGGI and establishing the rules and requirements of Virginia’s CO<sub>2</sub> Budget Trading Program..<sup>19</sup>

Table 1b: Health Benefits<sup>20</sup> of Incidental Reductions in SO<sub>2</sub> and NO<sub>x</sub>

Year	Scenario	Tons NO <sub>x</sub> Reduction	Tons SO <sub>2</sub> Reduction	Mortality (low estimate)	Mortality (high estimate)
2026	RGGI	11,169	2,424	5.2	11.9
2026	VA	6,317	1,636	3.2	7.3
2029	RGGI	10,851	2,551	5.3	12
2029	VA	8,140	2,310	4.4	10

#### *Impact: Electricity Consumers*

According to recent presentations by DEQ, the “revenue received by CO<sub>2</sub> Budget Sources owned by regulated electric utilities flow to rate payers pursuant to State Corporation Commission (SCC) requirements.”<sup>21</sup> While not described in the regulation, this action is predicated upon anticipated actions of the SCC which it may or may not take. This assumed action was incorporated in estimates DEQ provided the Board, which indicate the impact that the proposed Virginia CO<sub>2</sub> Budget Trading Program<sup>22</sup> would have on the average monthly electricity bills for residential, commercial, and industrial consumers (Table 2).<sup>23</sup>

<sup>19</sup> The model estimates health benefits through reduced: mortality, various cardiovascular and respiratory ailments, and loss of work days. These estimates could not be verified by DPB staff within the timeframe for this review

<sup>20</sup> See page F-1 of the *User’s Manual for the Co-Benefits Risk Assessment Health Impacts Screening and Mapping Tool (COBRA)* to see EPA’s assigned dollar values for various health conditions, including mortality.

[https://www.epa.gov/sites/production/files/2017-10/documents/cobra\\_user\\_manual\\_september2017\\_508\\_v2.pdf](https://www.epa.gov/sites/production/files/2017-10/documents/cobra_user_manual_september2017_508_v2.pdf)

<sup>21</sup> DEQ November 16, 2017 presentation before the Board, p. 24:

<http://www.deq.virginia.gov/Portals/0/DEQ/Air/GHG/C17-pro.pdf?ver=2017-11-20-153710-670>

DEQ December 4, 2017 presentation to the Commission on Electric Utility Regulation, p. 15.

[http://leg5.state.va.us/User\\_db/firmView.aspx?ViewId=5094&s=7](http://leg5.state.va.us/User_db/firmView.aspx?ViewId=5094&s=7)

<sup>22</sup> That is, participation in RGGI and reductions in CO<sub>2</sub> emissions, as stipulated in the proposed regulation.

<sup>23</sup> DEQ November 16, 2017 presentation before the Board, p. 43.

Table 2: Virginia Average Monthly Bill Impact for Years 2017-2031 (\$2015)

	Reference Case Bill (\$ 2015)		Policy Scenario			
	RGGI Assumptions	Virginia Assumptions	RGGI Assumptions		Virginia Assumptions	
			Monthly Difference (\$ 2015)	Percent Difference	Monthly Difference (\$ 2015)	Percent Difference
Residential	\$181.42	\$181.82	\$1.19	0.7%	\$0.53	0.3%
Commercial	\$1,019.44	\$1,022.67	\$9.59	0.9%	\$4.24	0.4%
Industrial	\$33,934.27	\$34,065.64	\$370.20	1.1%	\$154.55	0.5%
Note: The estimates in Table 2 were produced by the Analysis Group, using the Integrated Planning Model developed by ICF. This was the only model available to DPB during the time period for this review, and DPB lacked the resources to verify the model or its assumptions. If the SCC resumes rate reviews, these assumptions should be reconsidered.						

The reference case refers to the model's forecasts of electric bills without the adoption of the regulation and implementation of the Virginia CO<sub>2</sub> Budget Trading Program. In contrast, by 2031 the model's forecasts of electric bills resulting from adoption of the regulation increase by 0.7% to 1.1% using the RGGI assumptions, and by 0.3% to 0.5% using VA assumptions (in real dollars).

*Impact: Electricity Producers*

The proposed regulations restrict CO<sub>2</sub> emissions by electricity producers. Electricity producers who find the restrictions binding, i.e. they would have emitted more than their allotted allowances without the restrictions, would need to combine finding alternative methods of producing electricity and purchasing additional allowances. The alternative methods would presumably be more expensive, otherwise the restrictions would not have been binding. Firms in this position would encounter increased costs due to the proposed regulation.

Electricity producers who do not find the restrictions binding can potentially profit by selling allowances that they do not need. Firms that had planned to emit fewer tons of CO<sub>2</sub> than they were allotted would fall into this category.

Assuming that all revenues raised from the auction by regulated utilities are returned to ratepayers, then these producers will not profit, because they cannot keep their sales revenue. Table 3 lists forecasted prices per ton of allowances in nominal dollars for specified years using both the RGGI and VA scenario assumptions.

Table 3: ICF Model's Forecasts of Allowance Prices with Virginia Participation in RGGI

<b>Year</b>	<b>RGGI: Nominal\$/Ton</b>	<b>VA: Nominal\$/Ton</b>
2020	\$6.48	\$6.08
2023	\$7.71	\$7.24
2026	\$ 9.60	\$9.02
2029	\$11.44	\$10.74
2031	\$13.35	\$12.53

Given the proposal to limit CO<sub>2</sub> emissions to 33 million tons in 2020, and that 5 percent of the emissions are allotted to DMME, 31.35 million tons of emissions would be allotted to sources in 2020. Based on the forecasted prices of \$6.08 and \$6.48 per ton, sources would spend approximately \$191 million to \$203 million for CO<sub>2</sub> emission allowances for the year 2020. Since the 2020 base budget is intended to be close to the amount of emissions actually being generated at that time, in net sources would not initially face significant additional costs from finding alternative lower-emitting but higher cost means of generating electricity.

Taking into account the annual reduction in the Virginia base budget in the proposed regulation and DMME's share of the base budget, 28.53 million tons of emissions would be allotted to sources in 2023. Based on the forecasted prices of \$7.24 and \$7.71 per ton, sources would spend approximately \$207 million to \$220 million for CO<sub>2</sub> emission allowances for the year 2023. Since the 2023 base budget is smaller than the 2020 base budget, and the demand for electricity is unlikely to fall, sources likely would need to find alternative, lower-emitting means of generating electricity.

Following the same reasoning, the source allotments for 2026 and 2029 would be 25.71 million tons and 22.89 million tons, respectively; and based on the forecasted prices of \$9.02 to \$ 9.60 and \$10.74 to \$11.44 per ton, sources would spend approximately \$232 million to \$247 million in 2026 and \$246 million to \$262 million in 2029 on CO<sub>2</sub> emission allowances. Given the further contraction in the base budget of allowances, sources would need to find alternative, lower-emitting means of generating electricity.

*Impact: Fiscal*

The Joint Legislative Audit and Review Commission (JLARC) estimates that the fiscal impact (negative and positive) of the proposed regulation (in 2017 dollars) will be “approximately – \$1.3 million in 2020, when the regulation would take effect, and [will] be \$1.9 million in 2031, the last year in which information is available to develop an estimate.”<sup>24</sup> JLARC notes that the latter cost equates to approximately one percent of projected state electricity costs in 2031, and that the majority of this impact would be due to an increase in electricity costs for public higher education institutions, which represented 70 percent of total electricity costs for state entities in FY17. Impacts are estimated as the difference between electricity costs under the proposed regulation pursuant and electricity costs if the regulation was not adopted.

JLARC estimates that the cost to DEQ for administering the regulation and the cap and trade program would be approximately \$95,000 per year to cover the salary and benefits for one staff position.<sup>25</sup> According to JLARC, DEQ staff indicated that the anticipated responsibilities of this staff person would include collecting and analyzing information necessary to allocate allowances to electricity generators, participating in RGGI meetings and webinars, and managing all correspondence with RGGI. While monitoring and compliance should be handled automatically by the RGGI carbon dioxide allowance tracking system, this staff person would have responsibility for managing DEQ

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<sup>24</sup> JLARC’s analysis, which was published on December 4, 2017, could not be verified by DPB staff within the timeframe for this review. JLARC notes that, “the fiscal impact is estimated to be negative in 2020 because it is expected that compliance will be easier in earlier years and electricity generators may hold or bank allowances that they do not need to reduce compliance costs in later years when the emissions cap decreases.” Source: [http://jlarc.virginia.gov/pdfs/fiscal\\_analysis/FIR/2017\\_ED11\\_review.pdf](http://jlarc.virginia.gov/pdfs/fiscal_analysis/FIR/2017_ED11_review.pdf)

<sup>25</sup> Source: <http://leg1.state.va.us/cgi-bin/legp504.exe?171+oth+HB2018F122+PDF>

compliance actions for electricity generators that are substantially and consistently out of compliance. Additional resources could be necessary if there is frequent need for compliance action by DEQ.

JLARC also estimates that the cost to DMME for administering the allowances it receives each year is approximately \$105,000 to cover the salary and benefits for one staff position. This position would be an upper-level program manager responsible for establishing a program inventory that would maximize emission reductions. This position would manage a contract with a third-party administrator to sell the allowances allotted to DMME and make the funding available for use in a variety of programs to help reduce carbon dioxide emissions.

### **Businesses and Entities Affected**

The proposed amendments particularly affect the 12 companies that operate the 32 electric power facilities with a capacity of >25 MW in the Commonwealth. All entities that use electricity, including industrial and commercial firms, farms, residences, government offices, schools and colleges, etc., are affected as well. All entities and people in Virginia would also likely experience the impact of environmental improvement.

### **Localities Particularly Affected**

As CO<sub>2</sub> emissions are reduced over time, the regulation is likely to have a positive impact on all localities.

### **Projected Impact on Employment**

The proposed reduction in allowed emissions of CO<sub>2</sub> over time may reduce employment associated with electricity production that is high in CO<sub>2</sub> emission such as coal, and may increase employment in electricity production that is low in CO<sub>2</sub> emission such as wind and solar.

### **Effects on the Use and Value of Private Property**

It is difficult to estimate the effects of this regulation on the value of property. To the extent that the proposed amendments decrease flooding risk, and thus limit loss of use, the value of private property near bodies of water and other low-lying properties could become more valuable, or they could decline since it could cause the inventory of usable land to increase. Further, land values could increase in some areas as the demand for solar farms increases.

**Real Estate Development Costs**

The proposed amendments do not appear to significantly affect real estate development costs.

**Small Businesses:****Definition**

Pursuant to § 2.2-4007.04 of the Code of Virginia, small business is defined as “a business entity, including its affiliates, that (i) is independently owned and operated and (ii) employs fewer than 500 full-time employees or has gross annual sales of less than \$6 million.”

**Costs and Other Effects**

The proposed amendments likely would increase electricity costs for small businesses, but environmental improvements may lower other costs. Based upon the assumptions used for the model results displayed in Table 2, monthly electric bills should not increase by more than 1.1% (\$2015) by 2031 due to the proposed program.

**Alternative Method that Minimizes Adverse Impact**

There is no clear alternative method that would minimize the adverse impact for small businesses, while still achieving the intended policy goals.

**Adverse Impacts:****Businesses:**

The proposed amendments likely would increase electricity costs for businesses. Based upon the assumptions used for the model results displayed in Table 2, monthly electric bills should not increase by more than 1.1% (\$2015) by 2031 due to the proposed program. The proposed limitations on CO<sub>2</sub> emissions for sources would increase electricity production costs for at least some electric power producing firms.

**Localities:**

The proposed amendments likely would increase electricity costs for local governments. Based upon the assumptions used for the model results displayed in Table 2, monthly electric bills should not increase by more than 1.1% (\$2015) by 2031 due to the proposed program.

**Other Entities:**

The proposed amendments likely would increase electricity costs for homeowners, farms, state government, schools, colleges, and other entities. Based upon the assumptions used for the model results displayed in Table 2, monthly electric bills should not increase by more than 1.1% (\$2015) by 2031 due to the proposed program.

**Legal Mandates**

**General:** The Department of Planning and Budget has analyzed the economic impact of this proposed regulation in accordance with § 2.2-4007.04 of the Code of Virginia (Code) and Executive Order Number 17 (2014). Code § 2.2-4007.04 requires that such economic impact analyses determine the public benefits and costs of the proposed amendments. Further the report should include but not be limited to: (1) the projected number of businesses or other entities to whom the proposed regulatory action would apply, (2) the identity of any localities and types of businesses or other entities particularly affected, (3) the projected number of persons and employment positions to be affected, (4) the projected costs to affected businesses or entities to implement or comply with the regulation, and (5) the impact on the use and value of private property.

**Adverse impacts:** Pursuant to Code § 2.2-4007.04(C): In the event this economic impact analysis reveals that the proposed regulation would have an adverse economic impact on businesses or would impose a significant adverse economic impact on a locality, business, or entity particularly affected, the Department of Planning and Budget shall advise the Joint Commission on Administrative Rules, the House Committee on Appropriations, and the Senate Committee on Finance within the 45-day period.

If the proposed regulatory action may have an adverse effect on small businesses, Code § 2.2-4007.04 requires that such economic impact analyses include: (1) an identification and estimate of the number of small businesses subject to the proposed regulation, (2) the projected reporting, recordkeeping, and other administrative costs required for small businesses to comply with the proposed regulation, including the type of professional skills necessary for preparing required reports and other documents, (3) a statement of the probable effect of the proposed regulation on affected small businesses, and (4) a description of any less intrusive or less costly alternative methods of achieving the purpose of the proposed regulation. Additionally, pursuant to Code § 2.2-4007.1, if there is a finding that a proposed regulation may have an adverse impact on small business, the Joint Commission on Administrative Rules shall be notified.

## Appendix I: CO<sub>2</sub> Allowance Price Ceiling and Floor

In addition to the Virginia base budget, there are CO<sub>2</sub> cost containment reserve allowances (CO<sub>2</sub> CCR allowances). CO<sub>2</sub> CCR allowances are CO<sub>2</sub> allowances that are offered for sale at an auction for the purpose of placing a ceiling on the market auction price (by means of increasing supply, thus providing downward pressure on price). CO<sub>2</sub> CCR allowances offered for sale at an auction are separate from and additional to CO<sub>2</sub> allowances allocated from the Virginia CO<sub>2</sub> Budget Trading Program.

The proposed regulation includes a table of CO<sub>2</sub> cost containment reserve trigger prices (CCR trigger prices) for specified years. The CCR trigger price is the minimum price at which CO<sub>2</sub> CCR allowances are offered for sale at an auction. The following is the proposed CCR Trigger Price table:

Table 4: CO<sub>2</sub> CCR Trigger Prices

2020	\$ 10.77
2021	\$ 13.00
2022	\$ 13.91
2023	\$ 14.88
2024	\$ 15.93
2025	\$ 17.04
2026	\$ 18.23
2027	\$ 19.51
2028	\$ 20.88
2029	\$ 22.34
2030	\$ 23.90

In order to create a price floor, there are the CO<sub>2</sub> emission containment reserve allowances (CO<sub>2</sub> ECR allowances). The CO<sub>2</sub> ECR allowances are CO<sub>2</sub> allowances that are withheld from sale at an auction by DEQ for the purpose of placing a floor on the market auction price (by means of restricting supply, thus providing upward pressure on price).

The proposed regulation includes a table of CO<sub>2</sub> emission containment reserve trigger prices (ECR trigger prices) for specified years. The ECR trigger price is the price below which CO<sub>2</sub> allowances will be withheld from sale by the DEQ or its agent at an auction. The following is the proposed ECR Trigger Price table:

Table 5: CO<sub>2</sub> ECR Trigger Prices

2021	\$ 6.00
2022	\$ 6.42
2023	\$ 6.87
2024	\$ 7.35
2025	\$ 7.86
2026	\$ 8.42
2027	\$ 9.00
2028	\$ 9.63
2029	\$ 10.31
2030	\$ 11.03

## Appendix II: Social Cost of Carbon

In 2009, an interagency working group was convened by the federal Council of Economic Advisers and the Office of Management and Budget to determine how best to monetize the net effects (both positive and negative) of CO<sub>2</sub> emissions and sought to harmonize a range of different SC-CO<sub>2</sub> values across multiple Federal agencies. The purpose of this process was to ensure that agencies were using the best available information and to promote consistency in the way agencies quantify the benefits of reducing CO<sub>2</sub> emissions, or dis-benefits from increasing emissions, in regulatory impact analyses. The interagency group was comprised of scientific and economic experts from the White House and federal agencies, including: Council on Environmental Quality, National Economic Council, Office of Energy and Climate Change, and Office of Science and Technology Policy, EPA, and the Departments of Agriculture, Commerce, Energy, Transportation, and Treasury. The interagency group identified a variety of assumptions, which EPA then used to estimate the SC-CO<sub>2</sub> using three integrated assessment models, which each combine climate processes, economic growth, and interactions between the two in a single modeling framework.<sup>26</sup>

The timing of the emission release (or reduction) is key to estimation of the SC-CO<sub>2</sub>, which is based on a present value calculation. The integrated assessment models first estimate damages occurring after the emission release and into the future, often as far out as the year 2300. The models then discount the value of those damages over the entire time span back to present value to arrive at the SC-CO<sub>2</sub>. For example, the SC-CO<sub>2</sub> for the year 2020 represents the present value of climate change damages that occur between the years 2020 and 2300 (assuming 2300 is the final year of the model run); these damages are associated with the release of one ton of carbon dioxide in the year 2020. The SC-CO<sub>2</sub> will vary based on the year of emissions for multiple reasons. In model runs where the last year is fixed (e.g., 2300), the time span covered in the present value calculation will be smaller for later emission years—the SC-CO<sub>2</sub> in 2050 will include 40 fewer years of damages than the 2010 SC-CO<sub>2</sub> estimates. This modeling

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<sup>26</sup> See Technical Support Document: Social Cost of Carbon for Regulatory Impact Analysis, Interagency Working Group on Social Cost of Carbon, United States Government, February 2010. <http://www.bobkopp.net/papers/pubs/Social-Cost-of-Carbon-for-RIA-2010.pdf>

choice—selection of a fixed end year—will place downward pressure on the SC-CO<sub>2</sub> estimates for later emission years. Alternatively, the SC-CO<sub>2</sub> should increase over time because future emissions are expected to produce larger incremental damages as physical and economic systems become more stressed in response to greater levels of climatic change.

One of the most important factors influencing SC-CO<sub>2</sub> estimates is the discount rate. A large portion of climate change damages are expected to occur many decades into the future and the present value of those damages (the value at present of damages that occur in the future) is highly dependent on the discount rate. To understand the effect that the discount rate has on present value calculations, consider the following example. Let's say that you have been promised that in 50 years you will receive \$1 billion. In "present value" terms, that sum of money is worth \$291 million today with a 2.5 percent discount rate. In other words, if you invested \$291 million today at 2.5 percent and let it compound, it would be worth \$1 billion in 50 years. A higher discount rate of 3 percent would decrease the value today to \$228 million, and the value would be even lower—\$87 million-- with a 5 percent rate. This effect is even more pronounced when looking at the present value of damages further out in time. The value of \$1 billion in 100 years is \$85 million, \$52 million, and \$8 million, for discount rates of 2.5 percent, 3 percent, and 5 percent, respectively. Similarly, the selection of a 2.5 percent discount rate would result in higher SC-CO<sub>2</sub> estimates than would the selection of 3 and 5 percent rates, all else equal.

The interagency group recommended a set of four SC-CO<sub>2</sub> estimates for each emissions year for use in regulatory analyses. The first three values are based on the average SC-CO<sub>2</sub> from three integrated assessment models, at discount rates of 5, 3, and 2.5 percent. SC-CO<sub>2</sub> estimates based on several discount rates are included because the literature shows that the SC-CO<sub>2</sub> is highly sensitive to the discount rate and because no consensus exists on the appropriate rate to use for analyses spanning multiple generations. In addition, a discount rate reflecting lower-probability, but higher-impact outcomes from climate change, which would be particularly harmful to society and thus relevant to the public and policymakers, is included as well. The fourth value represents the marginal damages associated with these lower-probability, higher-impact outcomes. Accordingly, this fourth value is selected from further out in the tail of the

distribution of SC-CO<sub>2</sub> estimates; specifically, the fourth value corresponds to the 95th percentile of the frequency distribution of SC-CO<sub>2</sub> estimates based on a 3 percent discount rate.

The following table summarizes the four SC-CO<sub>2</sub> estimates in certain years. For example, the four SC-CO<sub>2</sub> estimates are: \$12, \$42, \$62, and \$123 per metric ton of CO<sub>2</sub> emissions in the year 2020 (2007 dollars).

Table 6: Social Cost of Ton of CO<sub>2</sub> Emitted in Specified Year (in 2007 dollars)<sup>27</sup>

<b>Year/ Discount Rate</b>	<b>5% Average</b>	<b>3% Average</b>	<b>2.5% Average</b>	<b>High Impact (3%, 95th percentile)</b>
2020	\$12	\$42	\$62	\$123
2025	\$14	\$46	\$68	\$138
2030	\$16	\$50	\$73	\$152

<sup>27</sup> Source: EPA Social Cost of Carbon Fact Sheet, page 4:  
[https://19january2017snapshot.epa.gov/sites/production/files/2016-12/documents/social\\_cost\\_of\\_carbon\\_fact\\_sheet.pdf](https://19january2017snapshot.epa.gov/sites/production/files/2016-12/documents/social_cost_of_carbon_fact_sheet.pdf)