Increasing Renewable Sources for Electricity Generation in the Commonwealth of Virginia

Applied Policy Project Prepared for The Nature Conservancy, Virginia

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May 2022

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Disclaimer

The author conducted this study as part of the program of professional education at the Frank Batten School of Leadership and Public Policy, University of Virginia. This paper is submitted in partial fulfillment of the course requirements for the Master of Public Policy degree. The judgments and conclusions are solely those of the author, and are not necessarily endorsed by the Batten School, by the University of Virginia, or by any other agency.

Acknowledgements

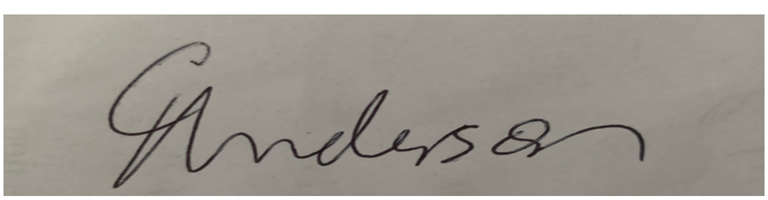
This Applied Policy Project (APP) would not have been possible without the consistent support and guidance from numerous people. Firstly, I would like to thank my APP advisor, Dr. Raymond Scheppach, for his invaluable guidance, constructive criticism, and light-hearted good spirits throughout the process. The wealth of knowledge that Dr. Scheppach has with regards to the Virginia legislative system in general, and with regards to utilities and in-state electricity generation was fundamental to my research.

Many thanks to Judy Dunscomb, Senior Conservation Scientist, The Nature Conservancy, Virginia, for allowing me to take on this challenge, providing me with the relevant questions to frame my research in a way that is most beneficial to her organization, and granting me the freedom to explore the intersection between policy and science. Her enthusiasm for her work and her willingness to explore different disciplines and mechanisms to achieve a common goal motivated and inspired me through this process. I would also like to thank Mark Lambridges, Global Director, Low Carbon Future, The Nature Conservancy for gauging my preliminary thought for an APP project- and connecting me with Judy.

Finally, I would not have been able to complete this report without my family, friends and classmates. To my parents and my sister, thank you for always being role models for me, and inspiring me to continue my education and pursue my goals. To my classmates, thank you for always being in high spirits and marinating positivity even through the difficult times. I had a pleasure sharing the classroom with you all and am grateful for the genuine insights and critiques you provided me with.

Honor Pledge

On my honor as a student, I have neither given nor received unauthorized aid on this assignment.



Cameron Anderson

Acronyms

AC—Alternating Current
APCo—Appalachian Power Company
CAA—Clean Air Act
CO_2—Carbon Dioxide
DEQ—Department of Environmental Quality
DOE—Department of Energy
Dominion—Dominion Energy Virginia
EIA—Energy Information Administration
EPA—Environmental Protection Agency
E3—Energy & Environmental Economics
GHGs—Greenhouse Gasses
ITC—Solar Investment Tax Credit
kW—kilowatt
kWh—kilowatt hour
M&T—Machine and Tax
MW—megawatt
NCUC—North Carolina Utility Commission
NEM—Net Metering Nevada Energy
NPUC—Nevada Public Utility Commission
NREL—National Renewable Energy Laboratory
PM—Particulate Matter
PPAs—Power Purchasing Agreements
PV-- Photovoltaic
RACs—Rate Adjustment Clauses
RGGI—Regional Greenhouse Gas Initiative
RPS—Renewable Portfolio Standard
SC[1]-- Social Cost of Carbon
SCC—State Corporation Commission
SREC—Solar Renewable Energy Credit
VCEA—Virginia Clean Economy Act
VCN—Virginia Conservation Network

[1] Please note that the social cost of carbon is typically abbreviated to SCC. To avoid confusion with the State Corporation Commission in this report, SC will be used as the substitute abbreviation.

Client Overview

The Nature Conservancy (TNC) is one of the largest and farthest-reaching environmental nonprofits in the world. The mission of TNC is to conserve the lands and waters on which all life depends. TNC's strategy plans to boldly address biodiversity and climate issues by 2030. TNC has been particularly interested in the role of solar energy and renewables in the Commonwealth of Virginia particularly in the face of new legislation calling for increased take up of renewables. In response to the changing political context, TNC conducted a study that determined that the Commonwealth had approximately 6.48 million acres of potentially suitable solar land. Virginia seemed to be poised to transition to cleaner energy. However, despite having an abundance of suitable land for solar development, there seems to be unique challenges facing Virginians, namely: the limitations and shortcomings of energy providers such as Dominion; an unwillingness from landowners and localities for solar development; as well as changes in land use and cultural values. TNC has been trying to determine what policy measures can be implemented to increase the rate of solar energy take up in Virginia in order to remain on track to meet the state's goals with regards to energy generation and fossil fuel emissions.

Executive Summary

Currently, private investor-owned utility companies in the Commonwealth of Virginia rely too heavily on fossil fuels, such as coal and natural gas, to generate electricity in state. Over reliance on fossil fuels increases the concentration of GHGs into the atmosphere, ultimately contributing to climate change. GHG emissions pose health and safety risks to Virginia citizens and ultimately impose significant costs to society. Currently, renewable alternatives to fossil fuels are being underutilized and distributed too slowly to Virginia residents and businesses to counteract the harmful anthropogenic effects of climate change.

The Virginia General Assembly passed the Virginia Clean Economy Act in 2020 with the intention of transitioning the Commonwealth to a green economy. Currently, only 7% of the electricity generated in state annually comes from renewable sources (EIA, 2019). Virginia ranks 35th nationally for electricity generated from renewables. The VCEA has protection. Namely, Virginia ranked fifth nationally in 2021 for new solar systems installed. This statistic is misleading for two reasons; firstly, many states have existing systems that with greater capacity than Virginia, and thus have no need to install new systems, and secondly, the new solar installations to not result in enough carbon emission offsets to meet Virginia's climate change goals.

There are various policy alternatives aimed at increasing renewable development, including increasing the RPS set by the VCEA to 12.5%, permitting community solar with a net metering billing mechanism, and increasing competition among utility providers in state. Based on the evaluative criteria—cost effectiveness, political feasibility, ability to implement, and equity—this analysis recommends Policy Alternative #2 Increasing the RPS to 12.5 % of total electricity generated state. This alternative is the most cost-effective way to reduce carbon emissions and is feasibly to implement both politically and technically.

Problem Overview

Carbon Dioxide emissions in the Commonwealth of Virginia are too high. Private investor owned utility companies in the Commonwealth of Virginia still rely too heavily on the burning of fossil fuels to generate electricity. Furthermore, the rate at which renewable energy alternatives is distributed to Virginia residents is too slow. Renewable energy alternatives will be quintessential to combatting climate change and advancing efforts to reduce carbon emissions. Over the past five years roughly 70% of the electricity generated in Virginia comes from fossil fuels (EIA, 2019). Nationally, about 60% of all electricity generated comes from burning fossil fuels (Jacobs, 2021). Despite being more reliant on fossil fuels to generate electricity than the national average, there is great disparity among surrounding states and the primary sources used to generate electricity within them. In West Virginia, 88% of the net electricity generated comes from coal power plants (EIA, 2019). Conversely, North Carolina has emerged as one of the nation's leaders in nuclear and solar energy sources. About 17% of the total electricity generated in North Carolina comes from renewable sources, with 7% coming directly from solar energy (EIA, 2020). In Virginia only about 7% of the states total electricity generated comes from renewable resources, ranking Virginia 35th nationally. (EIA, 2019).

Global Climate Change

Since the Industrial Revolution began in 1750 the concentration of greenhouse gasses (GHGs) has increased by over 50% (Herring, 2020). The atmospheric concentration of Carbon Dioxide (CO_2), a GHG of particular concern to humans, has increased from 280-420ppm (parts per million) since the start of the Industrial Revolution in 1750 (Herring, 2020). Greenhouse gasses make up about 0.5% of the Earth's atmosphere. The other 99.5% of the atmosphere is composed of nitrogen, oxygen and argon (National Geographic Society, 2019). Despite the levels of GHGs being comparably lower than other gasses, GHGs play a unique role in the Earth's climate. GHGs have the ability to trap infrared radiation emitted, therefore contributing to a warming climate. (NOAA). As the concentration of GHGs continues to increase in the atmosphere, more infrared radiation is absorbed and trapped on Earth, resulting in an amplified warming referred to as the Enhanced Greenhouse Effect (NOAA). Presently, over 90% of scientists agree that the earth is warming, and that human activity is the primary cause of this warming (Rosen, 2021). The Environmental Protection Agency (EPA) provides the following changes in the weather, oceans, and ecosystems as evidence that the climate is changing: changes in temperature and precipitation pattern; increases in ocean levels, acidity and temperature; glaciers and sea ice melting; increased frequency of extreme weather events; and changes in ecosystem patterns, such as seasonal blooming and animal migration patterns (EPA, 2021). The United Nations Environment Programme suggests that only 20 of the world's nations (G20), including the United States, are responsible for emitting roughly 80% of the GHGs annually (UNEP). Current estimates charge burning fossil fuels with releasing approximately 9.5 billion metric tons of CO_2 into the atmosphere annually (Herring, 2020).

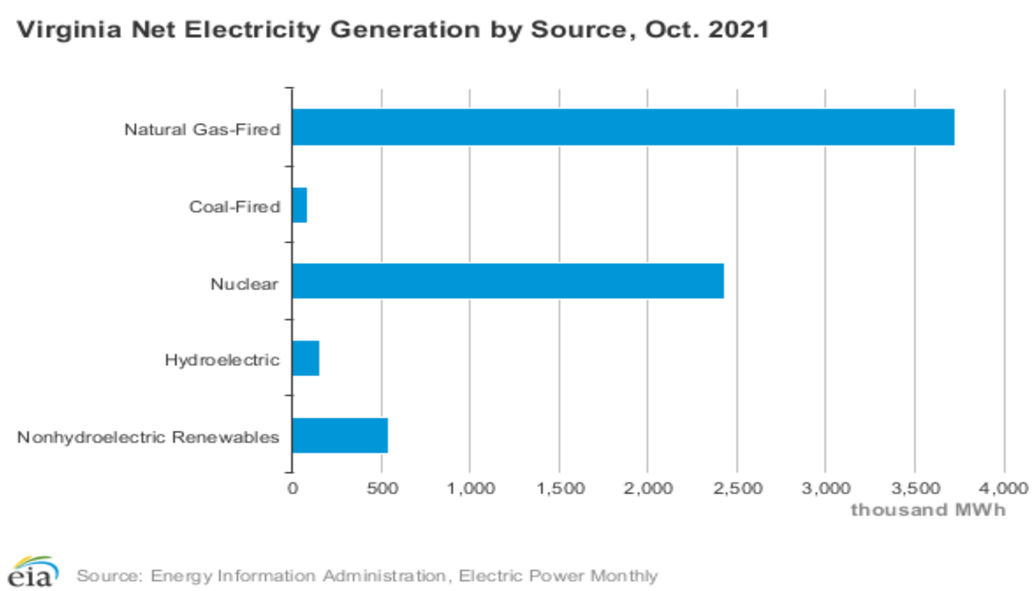
Climate Change in Virginia

Global efforts are in place to reduce the anthropogenic impacts on the climate. Virginia's effort to combat climate change are in congruence with global efforts to bring global carbon emissions to achieve net zero carbon by 2050 and limit the average global temperature increase to below 1.5 °C (EIA, 2021). In the past 100 years, Virginia has experienced an average increase in annual temperature of over 1°F (EIA, 2016). Currently Virginia experiences approximately 10 "Hot Days" when daily temperatures exceed 95ºF. Under the current status quo, Virginia could experience between 20-40 "Hot Days" annually within 70 years (EPA, 2016). More "Hot Days" will increase the rate of air conditioner usage, thus increasing electricity consumption, and continuing the cycle of warming. The EPA also suggests that consistent rising temperatures in Virginia will make it increasingly difficult to regulate and maintain progress made towards clean air (EPA, 2016).

Electricity Generation in Virginia and Statistics

Between 2010-2020 Virginia's in-state electricity generation increased by approximately 40% (EIA, 2020). There are 162 power plants used to generate electricity in the Commonwealth with a total capacity of 29.9 GW (DOE, 2021). Virginia power plants rely on a variety of sources to generate electricity, namely: natural gas, nuclear fission, coal, petroleum, and renewable sources. 61% of the electricity generated in Virginia is from natural gas. (EIA, 2019). There are 29 power plants in Virginia that produce 14.9 GW of the state's total electricity capacity from natural gas (DOE, 2021). Virginia relies on nuclear sources to generate approximately 29% of the state's electricity (EIA, 2020). The majority of the electricity generated from renewable sources comes from biomass in Virginia (EIA, 2020). Consequently, wind and solar plants generate less than 2% of the state's net electricity (DOE, 2021). Figure 1 breaks down current generation trends in Virginia, highlighting the overreliance on Natural Gas.

Figure 1: Electricity Generation in the Commonwealth of Virginia by Source, Via: EIA



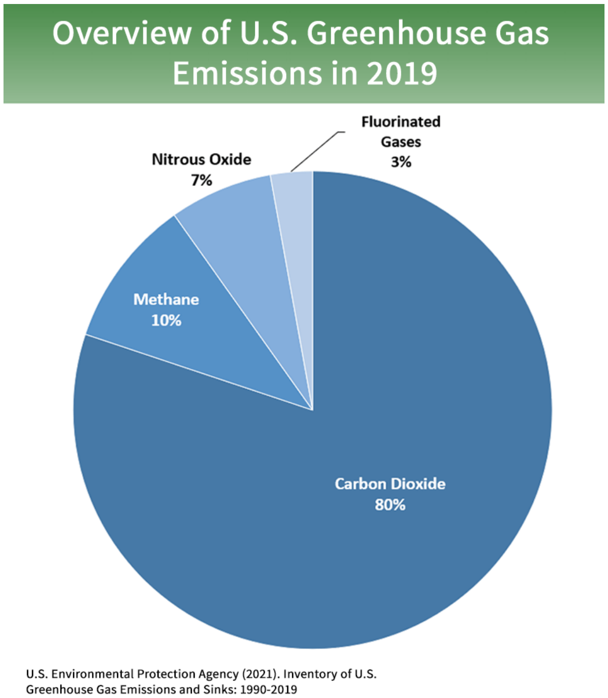
Despite the increase in in-state electricity generation, Virginia still consumes more electricity than it produces, ranking it 10th nationally in terms electricity consumption (EIA, 2020). In 2015, Virginia was estimated to import 40 percent of its electricity needs from out of state power plants (MCG, 2015). Additional estimates suggest that Virginia's true energy imports could actually range from 37% to over 50% (Virginia Tech). The residential sector consumes approximately 23% of the total electricity consumed in Virginia, compared to 33% consumption from the transportation sector, 26% from the commercial sector, and 18% from the industrial sector (EIA, 2020).

Virginia produces roughly 28,000 MW of usable energy each year. Despite having approximately 7 million acres of land suitable for solar development, biomass remains Virginia's primary source of renewable energy for electricity generation. The Solar Energy Industries Association reports that to date, Virginia has installed approximately 2,600 MW of solar, which is sufficient solar energy installed to generate power for 280,000 homes (SEIA, 2021). This number is considerably small when considering the fact that there are approximately 3.5 million households in Virginia that receive monthly electricity bills (EIA) and the fact that less than 3% of Virginia's electricity is currently generated by solar (SEIA, 2021).

Outcome

Due to the role carbon emissions play in climate change, the primary outcome will be a reduction in the amount of carbon dioxide emitted by utility companies and producers in Virginia. There are currently systems and practices in place to monitor and measure the concentrations of carbon that are emitted. Additionally, the proposed recommendation should also seek to directly increase the number of renewable energy projects in Virginia, especially at the residential and community level. Carbon is the outcome being targeted because of the role it plays in warming, its relationship to electricity generation, and its relative abundance compared to other GHGs. Approximately 80% of GHG emissions in the United States come in the form of CO_2 (EPA, 2019). Methane and Nitrous Oxide are the next most abundant GHGs in the atmospheres with concentration levels of 10% and 7% respectively (EPA, 2019). Methane and Nitrous Oxide are closely related to agricultural practices as well as electricity generation. In order to distinguish between the source emitter for GHGs, we will use CO_2 emissions to incorporate all GHG emissions from electricity generation. Therefore, when considering carbon emissions from fossil fuels and electricity generation, we are also considering reductions in other atmospheric GHGs. Furthermore, electricity generation is responsible for 31% of the total annual carbon emissions in the United States (EPA, 2019). Figure 2 shows what percentage of all GHGs emitted is carbon dioxide. CO_2 is the most abundant GHG and has the most heat trapping potential, and therefore will serve as the main outcome and emitted gas of concern in this report.

Figure 2: Overview of US Greenhouse Gas Emissions, 2019, Via: [EPA]



Costs to Society

Direct Costs

Recent studies and techniques aimed at increasing climate legislation have turned to health care costs as a new way to financially quantify the effects fossil fuel emissions and climate change more broadly. Heath has previously been ignored when considering climate change due to the relative difficulty to estimate the costs and benefits. However, the existing science and literature has progressed and reached a consensus linking air pollution from fossil fuel emissions to health problems and in severe instances, death. To analyze the direct costs of the overreliance of fossil fuels, this analysis examines the costs associated with the heath costs of air pollution and increased weather extremes. The health costs of air pollution are still relatively new and scare. Therefore, leading estimates are for national statics, not exclusive Virginia estimates. However, since the concentration of air pollutants is equally distributed, this analysis assumes that the health impacts are also uniformly distributed. Therefore, population assumptions for Virginia are proportional and based on national statistics and population densities. There are approximately 329 million people in the United States and 8.5 million people in Virginia (US Census Bureau, 2020). Consequently, all national air pollution statistics will be divided by 38.7 to generate estimates for Virginia.

Air Pollution

The main forms of air pollution that emerge from fossil fuel consumption are soot air pollution, smog ozone pollution and allergenic pollens (Thompson, 2021). All three forms of pollution are dangerous and have extreme health risk. To analyze the direct cost of air pollution, this paper relies primarily on the cost of hospitalizations and ER visits caused by smog and allergens. Soot air pollution typically leads to premature death and therefore will be addressed in the coming Opportunity Cost section. The report, *"The Costs of Inaction: The Economic Burden of Fossil Fuels and Climate Change on Health in the United States,"* published by the Natural Resources Defense Council estimates that smog leads to 4,150 respiratory-related hospitalizations, 485 asthma related hospitalizations, and 365,468 "other outpatient encounters" which include the need for future care or medication (De Alwis & Limaye, 2021). These numbers convert to approximately 107, 13 and 9,444 respectively in Virginia. Respiratory-related hospitalizations cost approximately $45,659 (Birnbaum et Al., 2020). The average cost of asthma-related ER visits is $235 (Stanford, McLaughlin, Okamoto, 1998). Finally, the average cost of "other outpatient encounters" is $22, 621 (Birnbaum et Al., 2020). Therefore, the cost of respiratory-related hospitalization in Virginia is found as follows:

(107*45,659) + (13*235) +(9444*22,621) = 4,885,513+3,055+213,632,724

Virginia residents spend $**218,491,292** annually on health-related costs that arise from an over-reliance on fossil fuel consumption.

Externalities: Carbon Emissions

Over the past 100 years, the state of Virginia has warmed by over 1-degree Fahrenheit (EPA, 2016). Warmer temperatures are associated with an increase in air-conditioner usage which ultimately increases electricity consumption (EPA, 2016). As a result of increasing temperatures, Virginians are consuming approximately 118.5 million MWh annually (EIA, 2020). This usage is related with average annual carbon emissions in Virginia, approximation 30 million metric tons of Carbon. The social cost of carbon (SC) translates future harm inflicted by emitting each additional ton of carbon dioxide into a present monetary value (Erb, 2020). The current SC is estimated to be $51 (Erb, 2020). The cost Virginia residents are faced with due to carbon pollution and emissions from electricity consumption can be found by multiplying the SC and the level of carbon emission from electricity generation.

29,965,000*51

Electricity consumption costs **$1,528,215,000** to Virginia residents through carbon emissions.

Opportunity Cost

Opportunity Costs present themselves primarily in the form of lost wages. Wages are primarily lost either in the form of missed working days due to illness or due to a premature death.

Wages Lost due to illness

Higher levels of Particulate matter (pm) in the atmosphere are associated with increased risk for illness and health complications, such as asthma. Global estimates suggest that asthma caused by air pollution and particulate matter result in approximately 1.8 billion days taken off work globally (Farrow, Miller, & Myllyvirta, 2020). Although the effects of air pollution are uniformly dispersed, there are different standards for air quality across the globe. Therefore, the number of workdays missed due to asthma is not equally distributed across nations. The United States has comparably stricter regulations with regards to air quality. However, the reliance on fossil fuels to generate electricity nationally results in approximately 14.2 million lost workdays for American adults (ACAII). When factored down to consider the population of Virginia, asthma related illness caused by particulate matter in the atmosphere results in approximately 366,944 lost workdays annually for Virginia residents. To keep estimates conservative, this analysis assumes that the average workday for Virginia adults is 8 hours. Additionally, this analysis uses the new minimum wage of $11 per hour to produce an estimate for the opportunity cost of missed wages for Virginia residents. By using the minimum wage, the analysis attempts to counteract higher salaries with lost workdays that are included in sick leave. Therefore, to calculate the average lost wages due to lost workdays in Virginia, multiply the average number of lost workdays due to asthma in Virginia, by the length of the average workday, as well the minimum wage.

(366,944) (8)(11)

Workdays lost due to asthma and other air pollution related illness cost Virginia residents approximately **$32,291,072** annually.

Wages lost due to premature death

On the severe end of the spectrum, air pollution resulting from burning fossil fuels can lead to a premature death. Nationally air pollution is associated with approximately 107,000 deaths each year (De Alwis & Limaye, 2021). This number translates to roughly 2,765 when it is appropriately scaled for Virginia. Air pollution affects everyone. However, the negative health effects can be particularly detrimental for the elderly, and for young children, particularly those with asthma or other respiratory issues. To account for this age range, this analysis uses the average age of premature death as 30. The Government of Virginia reports that the average of retirement in Virginia in 2010 was 62 (Virginia Gov, 2010). It will be important to use a per capita personal income rather than a median household income here. In 2016, the average per capita personal income was $57,723 in Virginia (Virginia.gov, 2016). Therefore, to calculate the average loss in wages due to premature death in Virginia, multiply the average annual per capita personal income by the number of people affected and by the number of years that they are affected.

(57723) *(2765)*(62-30)

Residents of the Commonwealth of Virginia lose approximately **$5,107,331,040** in wages due to premature death caused by air pollution.

Overall, the societal costs borne by the consumption of fossil fuels to generate electricity in the Commonwealth of Virginia costs approximately **$6,886,328,404** annually.

Governance

The transition to renewable energy and a reduction in fossil fuel usage is governed at all three levels of government in the United States, namely: the federal level, the state level, and the local level. The most important levels of governance with regards to fossil fuel consumption and the transition to renewable energy sources in Virginia will be a combination of state and federal policies. However, local governments will play an important role in the actualization of renewable development through determining the appropriate sites for renewable development, determining zoning and ensuring that State regulations are being adhered to.

Federal Legislation

The federal government is responsible setting a national standard for carbon emissions and air quality associated with fossil fuels. The Environmental Protection Agency (EPA) notes that their role as a federal organization is to set national standards for emissions and performance (EPA, 2021). Notably, the EPA avoids mandating the use of a particular technology, thus delegating the responsibility of how to achieve these national standards to State governments. The EPA is responsible for legislating and regulating national emissions and air quality standards thought the Clean Air Act, initially enacted in 1963.

Clean Air Act

The Clean Air Act (CAA) was first enacted in 1963, before being further amended in 1970, and revised in 1977 and 1990 (EPA, 2013). The CAA is an overarching federal law that regulates air pollutant emissions from stationary and mobile sources (EPA). Currently, there are pollution standards set for six main pollutants: sulfur dioxide, carbon monoxide, particulate matter, nitrogen dioxide, ozone and lead (EPA, 2013). The policy was designed to protect public health and welfare from different types of air pollution (EPA, 2013). In order to accomplish this goal, the CAA permits the Environmental Protection Agency (EPA) to set and revise national ambient air quality standards (NAAQS) (EPA, 2013). Implementing air quality standards is handled at the state level based on standards established by the EPA (EPA, 2013). The CAA was designed to allow states to choose the best policy options and practices for them in accordance with broader national standard. Since the CAA is ultimately intended to reduce pollution, it is designed to incentivize that by using the frames of human health and welfare impacts to extend the scope and impacts of the act.

Solar Investment Tax Credit

Another role of the federal government will be to facilitate the acceleration a clean, modern energy system (Perciasepe, 2017). There are many federal agencies that are important with regards to transitioning to a clean economy including: The Environmental Protection Agency; The Department of Energy; and The U.S. Energy Information Administration. The Department of Energy has numerous grants, loan and financing programs that can be utilized to fund the transition to clean energy. The primary mechanism for this federal acceleration has been the Solar Investment Tax Credit (ITC). The ITC is a tax credit that can be claimed on federal income taxes for a percentage of the cost of installing a solar photovoltaic (PV) system (DOE). In December 2020, Congress passed an extension of the ITC which provides a 26% tax credit on all solar PV systems installed between 2020-2022, and a 22% tax credit for all systems installed in 2023. There is potential for ITC to be further extended

State Legislation

The Commonwealth of Virginia's State government plays the most crucial role in Virginia's actual transition to clean energy. Climate and environmental policies typically allow states their own freedom to choose and implement policies that best suit them but are also in accordance with national standards. Virginia is one of 34 states that currently has a climate action plan. In December 2007, former Governor Tim Kaine established the Governor's Commission on

Climate Change that set Virginia's initial goal of reducing GHG emissions by 30% by 2025. More recently, the Virginia Clean Economy Act (VCEA) has been used to incentivize transitions to renewables, and a reduction in greenhouse gas emissions. The VCEA provides legislation that mandates a Renewable Portfolio Standard (RPS) and carbon regulations (Li, 2020). The RPS is the mechanism that has been implemented to ensure that Virginia meets its 100% clean electricity standard by 2050, requiring that energy providers Dominion and Appalachian Co. step on the path to diversify their energy portfolios, and transition completely away from fossil fuels by 2050 (PJM). Furthermore, the state has played an important role in prescribing the legislation that dictates current norms and practices within the electricity industry in Virginia.

Virginia Clean Economy Act

In 2020, the Virginia General Assembly passed, and former Governor Ralph Northam signed into law HB 1526/SB 851, more commonly known as the Virginia Clean Economy Act (VCEA) (Byrum Jr., 2021). According to the VCEA's website, the plan is ultimately aimed to eliminate all harmful carbon emissions from Virginia utilities by 2050 and to increase investment in renewable energy alternatives such as solar energy and offshore wind (VCEA, 2020). Additionally, the act seeks create jobs, increase energy efficiency, and ultimately reduce the energy-income burden in Virginia, particularly for low-income residents (VCEA, 2020).

The VCEA establishes that 16,000 megawatts (MW) of solar and onshore wind is in the public interest (Byrum Jr., 2021). Additionally, the act provides that 5,200 MW of offshore wind generation is in the public interest (Byrum Jr., 2021). Currently, Virginia relies on biomass for most of its renewable energy production (EIA, 2020). The VCEA provides tax exemptions for energy storage systems that have an alternating current (AC) storage capacity of more than 5MW and less that 150 MW (Byrum Jr., 2021). Additionally, the VCEA seeks to incentivize smaller, residential solar projects that have an AC storage capacity of less than 1 MW by offering solar renewable energy certificates (SRECs) that can be resold (Thoubboron, 2020). You can generate 1 SREC for every 1,000 kilo Watt hour (kWh) of solar energy generated. The price of SRECs vary, and are determined by supply and demand, but existing SRECs have been sold for approximately $70 and $400 in D.C. and Maryland respectively (Thoubboron, 2020). Furthermore, The Federal Solar Incentive is the Federal Solar Tax Credit that is awarded at 26% of solar investment value to anyone who installs a solar system till the end of 2022 (ElictricRate, 2021).

Virginia Electricity Generation Legislation

The State Corporation Commission (SCC) is the state agency in Virginia that holds the authority to regulate public utilities (SCC, 2021). The SCC was established in 1902 and derives its power from the State constitution and from State Law (SCC, 2021). The SCC has 3 commissioners and 675 full time staff members (SCC, 2021). SCC commissioners are elected by members of the Virginia General Assembly, serving terms that span 6 years (SCC, 2021). The three commissioners of the SCC are Jehmal T. Hudson, Judith Williams Jagdmann, and Angela L. Navaro (SCC, 2021). Under the SCC Virginia's two main utility companies, Dominion Energy Virginia (Dominion) and Appalachian Power Company (APCo)operate as monopolies (GreeneHurlocker, 2018). Additionally, the SCC permits rate adjustment clauses which allow Dominion and APCo to recover certain costs and make a profit outside of base rates through petitioning the Commission for approval of a rate adjustment for recovery from customers of the costs of generating electricity (GreeneHurlocker, 2018).

Shared Solar

The SCC is responsible for regulating utilities. They are also responsible for setting the rate at which Virginians are charged for electricity. The SCC has previously passed regulation with regards to shared solar programs. The SCC does not mandate Virginia utility companies to provide or participate in these programs, rather it provides guidelines and metrics for participation. The SCC defines a "shared solar facility" as one that: Generates electricity through a PV solar device that does not exceed 5,000 kW of alternating current; is located within the service area of an investor-owned utility company; is connected to the electric distribution grid serving the Commonwealth of Virginia; has a minimum of three subscribers; has a subscription rate that covers at least 40% of its capacity, with subscriptions of 25 kW or less; and is located on a single parcel of land. As of fall 2017, BARC was the only utility company in Virginia to offer a shared solar program.

Virginia Electric Utility Regulation Act

Each year the SCC is responsible for providing updates to the Virginia Electric Utility Regulation Act (Regulation Act). The Regulation Act is part of the broader "Code" for Virginia which contains the laws passed by the General Assembly as permitted by the Virginia Constitution. On September 1, 2021 the SCC released its update with regards to the Regulation Act and the requirements that fall within the Commissions purview. Over the past the years the status of the regulation act has expanded to include 17 new or expanded programs that apply to the state's electric utilities and cooperatives. The updates include requirements of the VCEA, which establishes a new Renewable Energy Portfolio Standard (RPS) and Energy Efficiency Resource Standard (EERS) (SCC, 2021).

Dominion Energy Virginia (Dominion)

Between July 1, 2007and July 1, 2021, the average residential electricity bill faced by Dominion customers increased by $30.69 (33.88%) to $121.28 (SCC, 2021). On April 20, 2021 The SCC found Dominion's first annual RPS Plan reasonable and prudent. Dominion has estimated that it may have 48,433 MW of solar resources, 5,112 MW of offshore wind resources, and 316 MW of hydroelectric resources by 2045 (SCC, 2021). Furthermore, Dominion estimates that it will develop 2,730 MW of energy storage through company owned and third-party power purchase agreements (PPAs) by 2035 (SCC, 2021). The SCC approved 498 MW of new renewable generation capacity in Virginia, approved a rate adjustment clause (RAC) for cost recovery associated with approved Dominion-owned solar facilities, and required Dominion to file a least cost plan in accordance with applicable carbon regulations and the mandatory RPS Program requirements under the VCEA in future RPS Plans (SCC, 2021). Dominion applied for approval for 11 new energy efficiency and response programs, and expansion and modification of existing programs (SCC, 2021).

Appalachian Power Company (APCo)

Between July 1, 2007, and July 1, 2021, the average residential electricity bill faced by APCo customers increased by $50.48 (75.79%) to $117.09 (SCC, 2021). In its 2020 RPS Plan APCo estimated adding 3,452 MW of solar resources, 2,200 MW of onshore wind resources, and 400 MW of energy storage capacity by 2050 (SCC, 2021). On April 20, 201 the SCC found APCOs first annual RPS plan to be prudent and reasonable. APCo did not request approval for any generation capacity or recovery of costs (SCC, 2021). The SCC required APCo to file a least cost plan that meets the applicable carbon requirements and RPS Plan regulations under the VCEA (SCC, 2021). Under mandate of the VCEA and the EERS, APCo applied for the approval of five new energy efficiency programs, and one energy efficiency pilot, and for continuance of one demand response program, and one energy efficiency program (SCC, 2021).

Local Governance

Local governments will not be able to influence the issue significantly in terms of what gets passed and implemented. However, they will play a more important in generating community support and buy in for projects that fall under state and federal legislation. The Virginia General Assembly passed the "Small Renewable Energy Act" in 2009 to promote renewable energy in the Commonwealth. The Act directed the Department of Environmental Quality (DEQ) to develop "permits by rule" for development and construction of renewable energy projects in the Commonwealth while maintaining standards to protect Virginia's natural resources (DEQ). Although the DEQ is tasked with regulating renewable energy at the state level, local governments are charged with approving sites for renewable energy projects in their jurisdiction (DEQ).

Regional Cooperation

In 2020 the Virginia General Assembly passed the Virginia Alternative Energy and Coastal Protection Act. Under the Act Virginia became the newest, and first southern state to become a member of the Regional Greenhouse Gas Initiative (RGGI). RGGI is a collaborative, market-based effort to cap and reduce CO_2 emissions from the power sector through a regional cap-and-trade initiative (RGGI). Virginia models its legislation for the program similarly to the other member states including Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Rhode Island, and Vermont (Virginia Governor). It has been reported that Virginia State officials produced a conservative projection of the State's annual revenue from participating in RGGI's carbon auction that ranges from $106-109 million (Vogelsong, 2021). Former Governor Ralph Northam had stated that 45% of the proceeds from participating in RGGI would go to funding community flood protection and coastal resilience programs (Virginia Governor). There is broad consensus that RGGI has been successful both in reducing the amount of carbon pollution in the region and providing quantifiable benefits for those living in participating states. A report created by independent economists at Analysis Group suggests that RGGI has created 45,000 job-years of work[2] and added $4.3 billion in economic value in the region since 2009 (Hibbard et Al., 2018). Another report produced by Abt Associates concluded

[2] 1 job-year equals 1 years' worth of fulltime employment for one person

that by cleaning up the air RGGI has helped prevent asthma attacks, respiratory diseases, and other health benefits totaling $5.7 billion (Manion et Al., 2017).

Anticipated Changes

Technology

On September 23, 2021, the Department of Energy announced $17.9 million in funding for four research and development projects to increase flow battery storage options for renewable energy and long duration storage systems (DOE, 2019). Currently, electricity storage systems are unable to store the total amount of energy generated in the United States because of the current of the reliance on short term, relative cheap storage solutions such as lithium batteries (Laporte, 2019). Flow batteries are seen as an important technology advancement for solar energy storage based on their relatively low energy densities and long-life cycles which makes them better suited for longer energy storage and therefore better suited than lithium batteries for supplying continuous power (Laporte, 2019). A challenge faced by renewable energy, particularly solar and wind options is the question that arises over how they will be able to supply power in unfavorable elements. By increasing the storage capacity and shifting from short term to long term distribution, these challenges can be overcome, and renewable alternatives become more efficient.

A report produced by the National Renewable Energy Laboratory (NREL) and the Department of energy suggests that up to 45% of the US's total electricity supply in 2050 could be generated by solar, compared to only 4% today (NREL). Furthermore, grid scale storage capacity is expected to increase fivefold by 2050 for an additional 680 GW of storage capacity. This change is due to the declining technology costs and increasing renewable deployment which have resulted in an increased market potential for storage technologies. Estimates suggest that improved storage adds the most value to the grid and therefore, battery storage capacities and technologies are expected to improve over the next few decades. As a result, solar systems will be more efficient and profitable in the future. The potential for increased storage capacity will be a key motivating factor for individuals to buy into certain policies. As a result, it will be important to make calculations with regards to future grid storage capacity so that the benefits of certain policy options may accurately be represented.

Existing Evidence

Appetite for Renewable Energy in the Commonwealth of Virginia

The Commonwealth of Virginia has taken a more active approach to combatting greenhouse gas emissions with emissions policies since the non-binding emission reduction Energy Plan was released in 2007 (Borick & Rabe, 2009). In the United States, State and local governments have traditionally been tasked with implementing policies aimed at combatting climate change. As a result, it has been important to consider local feelings and appetites when considering climate related policy. In Virginia, a telephone survey conducted between September 8 and 24, 2008 revealed that Virginia residents were overwhelming in support for governments to issue policy responses to climate change; residents indicated that regulatory policies, such as renewable energy mandates to be most appealing (Borrick & Rabe, 2009). While it is important to consider Virginian's appetite for solar, it is imperative that this not be taken at face value. Firstly, this study was released in 2009 and under non-binding plan. In 2021, the legislative context has changed, and the question has shifted from "should governments implement policy", to "what is the best, legally binding policy solution". Similarly, telephone surveys have inherent limitations. People may be motivated to lie or be misleading with their responses. Furthermore, responses may be different when residents are presented with the reality of a project, such as the construction of a solar field.

Public opinions can change or be altered during the implementation phase. Whereas many Virginia residents can see the appeal and need for large scale solar projects, resistance and backlash emerge, particularly when considering the location of such projects. Renewable alternatives present unique challenges not faced by the fossil fuel industry due to the amount of land that the require to generate energy, and therefore the overbearing presence in the public eye (Gross, 2020). Gross highlights the Virginia context as part of a broader national trend. However, Gross published her article under the Brookings Institute, which has liberal leaning. Gross introduces an interesting point about the concerns regarding land use. However, the emerging concern should not be the only point against renewables.

Jason Fenston of NPR corroborates Gross's point that renewables face new concerns when they are to be implemented. Fenston notes the resistance of residents in Spotsylvania, Virginia who have opposed the implementation of the largest solar farm east of the Rocky Mountains, citing issues of size, diminishing property value, aesthetic appeal and environmental impact (Fenston, 2019). While Fenston does provide a real example of the issues surrounding public sentiment and solar projects, he also notes that the opposition in Spotsylvania only represents about 26% of the population (Fenston, 2019). Fenston provides real world support to Gross's claim, from a more liberal perspective. When assed simultaneously, it becomes clear that land use will be a major issue for solar projects in Virginia. Moving forward it will be essential to keep this in mind, when evaluating policies and their viability.

Policy Options to increase Solar Development

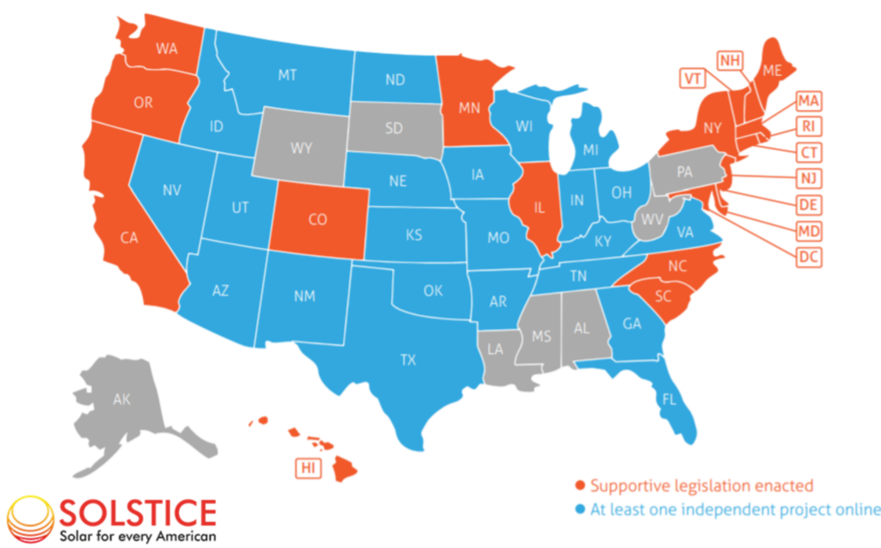
Net Metering and Community Solar

One way to increase interest in solar development is to allow for community solar developments with net metering. As of December 2020, 22 states and Washington D.C. had policies that supported community solar (NREL, 2021). Community solar is paired with net metering. Net Metering is a billing mechanism that credits the owners of solar energy systems for energy generated and supplied to the grid (SEIA). According to the Virginia Conservation Network (VCN), community solar projects leverage economies of scale to reduce the price of solar for individual customers, despite their ability to install residential solar systems (VCN, 2021). Currently there is no law in Virginia that permits net metering for individuals or businesses. A 2014 report prepared for the State of Nevada Public Utilities commission reported that as of December 2013, approximately3,300 individual systems were enrolled in Nevada Energy NEM program with a total installed capacity of over 60MW (Price et. Al, 2014). The report also states that net metering in Nevada provided $36 million in benefits to all Nevada Energy customers, including both solar and non-solar users (Price et. Al, 2014). Furthermore, when also considering savings in the form of infrastructure investment and grid upgrades, net-metering is estimated to generate $166 million in net benefits over the lifetime of solar systems installed prior to 2016 (Price et. Al, 2014). The benefits of the NEM can be seen not only through the direct economic benefits both to those enrolled in the program and those who aren't; but also, through the societal benefits incurred from non-monetized health benefits associated with reduced air emissions.

The report was produced by Energy and Environmental Economics (E3). E3 claim to produce unbiased analysis regarding the provision of energy and electricity. It is useful that they provide a dollar estimate for the benefits of metering in Nevada. However, it may be hard to generalize the results to Virginia because of geographic and political differences. This study is also useful to demonstrate that net metering generates positive spillovers that are enjoyed by all consumers.

The benefits of net metering are dispersed among solar and non-solar users alike. Consequently, a 2013 study conducted by the Public Service Department in Vermont concluded that net-metering systems to not impose any significant net-costs on those who do not participate in the system (PSD, 2013). This finding will work well with the previous study to demonstrate that net metering benefits all utility customers. The success of net-metering in different geographic and political regions provides confidence in the potential success of net-metering policies in Virginia. Figure 3 categorizes the states based on the presence of community solar projects, or even community solar legislation. Virginia has independent community solar projects under consideration, but no formal legislation mandating the practice.

Figure 3: Map of the Community Solar Landscape in the Unites States, Via: [Solstice]



Tax Credits, Subsidies and Solar Incentives

The Virginia Clean Economy Act does not provide any additional tax credits for installing solar systems. Consequently, Virginia residents only qualify for the federal ITC credit that allows for a 26% tax credit on all solar systems installed between 2020-2022, and a 22% tax credit on all systems installed in 2023. Federal incentives alone have proven to be ineffective, especially compared with other states. Studies suggest that states need to provide incentives beyond federal incentives. That is programs that have had the most success have also incorporated legislation to provide local tax exemptions, and recrediting for household solar systems; removing the sales tax from solar systems; and by providing property tax exemptions to properties whose value has increased from installing solar (Hurst, 2021). New York is widely seen as having implemented one of the best solar incentive programs, NY-Sun, in 2011. To date, the NY-Sun program has supported approximately 114,000 solar projects in New York. The major success of NY-Sun program can be seen through the changes in the program's goals; the program has increased its target from 6GW of increased solar capacity by 2025, to 10 GW by 2030 (Penrod, 2021). New York also has the Solar Energy System Equipment Credit that allows residents to deduct up to $5,000 or 25% (whichever is lower) of total solar expenditures from their taxes (Hurst, 2021). To further incentivize solar buyers in New York, solar equipment is not charged with the states 4% sales tax (Hurst, 2021). By combining the evidence presented by Hurt and Penrod, I will be able to provide supporting reasoning and arguments as to why the current solar incentives in Virginia are inadequate.

Tax credits present a unique question of equity primarily caused by systematic differences between homeowners and renters. A study on the distributional effects of tax credits conducted by Energy Institute at HAAS found that the bottom three income quintiles received only 10% of the $18 billion in federal clean energy tax credits while the top quintile received approximately 60% of the credits (Borenstein & Davis, 2015). Solar incentives in the form of tax credits can be critiqued for mainly going to the affluent (Roberts, 2015). Consequently, solar incentives cannot rely exclusively on tax credits and should also include a clean energy subsidy component for low-income households. California's Single-Family Affordable Solar Homes was the first program of its kinds, launched it 2006, and aimed at catalyzing solar adoption in low-income homes and developing a diverse and highly skilled solar work force (Low-income Solar, 2018). Eligible households were those with an income that is 80% below the area median income and own and live in their home that must be classified as "affordable housing" (Low-income Solar, 2018). We know that this plan was popular among those eligible for funding as the majority of the $108.34 million funding was used quickly and that an additional $54 million had to be provided in 2015 (Thoubboron, 2019). SASH programs capped the capacity of solar systems to 5kW. Additionally, California has implemented the MASH program to help low income, multimer person households. Under the SASH and MASH programs California has installed roughly 32.4 MW is solar capacity (Environment California Research and Policy Center, 2015).

One glaring issue with the MASH and SASH programs is that they allow for gap funding. Gap funding is defined as the capital necessary to any remaining costs associated with solar installation beyond the money provided by SASH (Baylis & Copeland, 2014). Gap funding usually comes in the form of roof repairs and electrical upgrades needed to ensure that low-income families are able to install and use the solar system for at least 10 years as prescribed under SASH (Baylis & Copeland, 2014). By finding instances of how equity issues have been overcome with regards to solar, we find a way to combine two policy options often considered to be separate. These sources also help to spread the depth of analysis by providing case study examples from vastly different areas of the country. It is important to note however that California and New York tend to be regarded as liberal states that are more open to progressive environmental policy.

Criteria

Each policy alternative will be analyzed and evaluated across the following criteria: cost-effectiveness, political feasibility, technical feasibility, and equity. They criteria were identified and selected as best suited for evaluating policy alternatives with the following objectives in mind: reducing the amount CO_2 emitted in Virginia when generating electricity in state.; increasing access to renewable energy alternatives for Virginia residents and businesses; protecting the health and safety of Virginia residents; protecting Virginia's natural environment and air quality; and preserving Virginia's climate for the safety of future generations.

Cost-Effectiveness (40%)

Cost-effectiveness provides a ratio of a policy's total costs and its intended outcome.

$$Cost\ Effectiveness = \frac{Present\ Value\ of\ Total\ Costs_{2019-2030}}{Total\ Amount\ of\ \mathrm{CO2}\ Emitted\ During\ Electricity\ Generation_{2019-2030}}$$

This analysis uses cost-effectiveness to assess each alternatives' total costs compared with its projected reduction in Virginia's CO_2 emissions associated with electricity generation, relative to the current status quo. The cost-effectiveness criterion provides a ratio between the total costs and the projected outcome. Since the outcome being measured by policy alternatives is a decrease in the total amount of CO_2 emitted during electricity generation in Virginia, a high cost-effectiveness ratio indicates a more desirable policy. Cost-effectiveness analyses are usually conducted for a 10-year period—2021-2030, in this case. Consequently, to obtain Net present values this analysis uses a discount rate of 3%. Cost-effectiveness is weighted 40% in this analysis. This analysis relies on projections with regards to Virginia's future emissions. 2019 serves as the base year to gather the relevant emissions and cost data for generating electricity in the Commonwealth of Virginia. The relevant government agencies and stakeholders include the Virginia Department of Energy, the SCC, Dominion, and APCo.

Political Feasibility (30%)

It is important to evaluate the likelihood that a proposed alternative can be enacted or adopted within the current political atmosphere. This analysis focuses on policy alternatives intended to be enacted by the state legislature in Virginia. The Political Feasibility criterion seeks to provide a gauge on the sentiments of the SCC committee chairs on other relevant stakeholders based on what they have previously said, both explicitly though interviews, and implicitly through voting histories on similar issues. Relevant stakeholders with regards to proposed alternatives include Dominion; APCo; and Virginia residents and business owners. The relevant decision makers are: The SCC; Virginia General Assembly members and state legislators; Governor Glenn Youngkin (R). The following are important to consider when assessing the political feasibility of an alternative:

- What have Committee Chairs said in previous interviews?
- How have relevant stakeholders voted on similar issues?
- What press releases have been made about the issue? By whom? In favor or against?
- What is the popular public opinion around the policy alternative? Is there consensus?
- Does the policy alternative have the potential for bi-partisan support?
- Has the policy been successful in other states? What are the similarities and differences in the political landscapes?

Political Feasibility will be used as a qualitative criterion. Policy Alternatives will be given a score between 1 (low Political Feasibility) and 3 (high Political Feasibility). Political Feasibility is weighted 30% in this analysis. A high political feasibility score demonstrates a strong likelihood of a policy to be enacted.

Ability to Implement (20%)

Ability to implement measures a policy alternative's ease and ability to be implemented. That is, ability to implement seeks to measure how much work is required by a proposed policy alternative. The aim of the ability to implement criterion is to evaluate how realistic proposed policy alternatives are. Below is a list of relevant questions to ask when considering ability to implement:

- Who are the main parties responsible for implementing the proposed policy? Do they agree with the policy?
- Do the implementing agencies have the necessary expertise for the policy's success?
- How many different agencies are involved? Who are the relevant stakeholders required to implement the proposed policy? What are the working relationships?
- Does the proposed policy require an additional labor force? How many new jobs is the policy expected to create?
- Does the proposed policy require new infrastructure? To what extent can the policy capitalize on existing systems and infrastructure?
- What is the proposed timeframe for rollout for the proposed policy?

This analysis usess the ability to implement criterion to assess how realistic each policy alternative is, and the ease with which a policy alternative can be implemented. Policy alternatives will receive a score of 1(low ability to implement, difficult to implement)-3(high ability to implement, easy to implement). Ability to implement is weighted 20% in this analysis. Policy alternatives receiving high ability to implement scores can be quickly and easily implemented.

Equity (10%)

A major concern raised by renewable energy development is the question of who has access to these technologies. In the past home solar systems were reserved for wealthier, home owning individuals due to their high upfront cost. Renewable energy is becoming more accessible to all people as advances in technology continue reduce the total cost of home systems. Following this trend, it will be important for policies to be easily accessible and relevant to all Virginia residents, despite their income levels. Special consideration will be given to policies that directly address the gap left due to income disparity, created by renewable energy development projects in the past. Below is a list of relevant questions to ask when considering equity:

- Is the recommended policy readily accessible to most Virginia residents?
- Does the recommended policy do anything to reduce the energy-cost burden of electricity for low-income Virginia residents?
- Does the recommended policy address historical gaps and inequities left by renewable energy development projects in the past?

Policy alternatives will receive a score of 1(Low equity)-3(High equity). Given the urgency of the issue short term equity can be overlooked by immediate, impactful policy. As a result, equity is weighted 10% in this analysis. Higher equity scores demonstrate policies that are more accessible to all Virginia residents and more inclusive.

Policy Alternatives

The following policy alternatives provide steps forward for Virginia legislators and stakeholders concerned with reducing the total amount of fossil fuels used to generate electricity in the Commonwealth of Virginia. Alternatives have been tailored specifically to Virginia, based on the State's geography, climate, political atmosphere, and other regional examples that have been successful in promoting renewable sources.

Alternative #1: Status Quo

The VCEA proves the legislation for the status quo with regards to renewable energy and electricity generation in the Commonwealth of Virginia. Furthermore, the SCC is responsible for regulating the utility companies that provide Virginia with electricity and ensure that they adhere to the standards set forth under the VCEA. The VCEA mandates that utility companies become 100% emission free by 2050. The status quo does meet the goal of the policy with regards to reducing harmful emissions and provides a clear timeline that Dominion and APCo must follow. The VCEA is designed to help facilitate the transition to renewable energy and a clean economy in Virginia. Dominion and APCo are required to submit a RPS to the SCC to ensure compliance. Currently RPS reports are made in terms of total energy created from renewable sources, rather than what percentage of total electricity generated comes from renewable sources. Dominion has estimated that it may have 48,433 MW of solar resources, 5,112 MW of offshore wind resources, and 316 MW of hydroelectric resources by 2045. In its 2020 RPS Plan APCo estimated adding 3,452 MW of solar resources, 2,200 MW of onshore wind resources, and 400 MW of energy storage capacity by 2050. Dominion and APCo currently operate as monopolies in Virginia as permitted by the SCC.

Alternative #2: Updated Renewable Portfolio Standard (RPS)

Virginia established its RPS in 2020 under the VCEA. The Virginia General Assemble passed the VCEA, but the SCC is responsible for setting and regulating Virginia's RPS. As of September 2020, 38 States and the District of Colombia had an established RPS or renewable energy goal (EIA, 2021). North Carolina has been a national leader with regards to establishing RPS. The RPS in North Carolina is legislated by Senate Bill 3, which was adopted in June 2007. Session Law 2007-379 (Senate Bill 3) mandated that investor-owned utilities in North Carolina be required to meet 12.5% of their energy needs through renewable energy sources or energy efficient measures to generate electricity in state (NCUC, 2021). Dominion and APCo are the two major investor-owned utility in Virginia and would therefore be subject to this regulation. Under current legislation, Dominion and APCo are required to submit a RPS to the SCC each year for approval. This policy seeks to address the population growth seen in Virginia and the increased demand, and therefore supply of electricity in the state. Similarly, over the past decade, Virginia electric companies have had to increase the amount of electricity they produce in state to meet the demands of the states growing population. Rather than approve the total amount of electricity generated from renewable sources, this policy determines that a specific percentage of all electricity generated must come from renewable sources. North Carolina currently generates 7% of its total electricity from solar sources. Therefore, this policy builds on the existing legislation requiring a RPS, and instead requires 12.5% of all electricity generated in state to come from renewable sources. This policy alternative upholds the standards of the VCEA that requires Dominion and APCo to be 100% carbon emission free by 2050.

Alternative #3: Permit Community Solar and Net Metering

This policy option is aimed at increasing solar take-up among Virginia residents. One common criticism of the VCEA is that is does not permit community solar or net metering options in Virginia. Community Solar and Net Metering provide Virginia residents with an alternate source to meet their electricity demand. Community Solar and net metering allow both the owner of the solar system to receive renewable electricity in their homes, as well as those without systems who subscribe to the program and therefore receive the excess clean electricity generated by system owners. This alternative requires the legislation to be changed to permit system owners access to State power grids. Moving forward, grid access will refer to the ability for solar system owners to sell excess energy generated into the grid. It is important to note that current technologies in solar technology are increasingly more inefficient with regards to storage and capacity the further they are from the grid. Other recommendations for adjustments are made based on the incentives provided by other states to increase residential solar take-up, mainly through tax credits and subsidies. This alternative calls for the VCEA to mirror the federal tax for solar systems bought and installed in Virginia. In this case the policy establishes an instate 26% tax credit similar to that posed by federal legislation. Policy alternative 2 established that the maximum tax credit Virginia residents can receive is $5,000. The tax credit will be available for all solar systems installed until 2050. The following homes qualify for a state level solar tax credit: house; houseboat; mobile home; cooperative apartment; condominium; manufactured home that meets federal standards for constructed homes. Furthermore, the following equipment is deemed to be energy saving and thus eligible for the state tax credit: Solar powered units that generate heat or electricity; geothermal heat pumps; small wind turbines; fuel cell property (limit $500 for each kW of capacity; solar-electric collecting roofs and roof products; solar power storage equipment; and installation and labor costs. Additionally, this policy alternative removes the sales tax from solar systems bought in Virginia. In Virginia, solar systems are taxed as a machine and tax (M&T) (ES, 2020). In Virginia, local governments determine the M&T tax rate. In Virginia M&T tax rates vary by county, from less than 1% to up to 4% (ESA, 2020). Lastly, this policy alternatives allows home solar owners to be exempt from Virginia's property tax. The SCC will be responsible for setting the rates that Virginia public utilities are required to purchase any excess energy produced. This model borrows on the existing practices in Nevada where the Nevada Public Utilities Commission is responsible for determining the price. The NPCU recently changed the rate at which utilities were required to purchase excess energy from customers from the "retail rate of electricity" in Nevada to the "wholesale rate". Dominion and APCo will purchase excess energy at the retail rate for the first five years of the policy before switching to the wholesale rate in 2027.

Alternative #4: Demonopolize Investor-Owned Utility Companies with Mandated Shared Solar

This alternative represents a bolder, more aggressive policy alternative. The idea is for the SCC to remove the legislation that allow Dominion and APCo to operate as monopolies in Virginia. A major component of this alternative will be lobbying the Virginia legislature and the members of the SCC to mandate shared usage of grids and electricity transmission systems. Virginia is primarily served by two main grid systems, and no additional storage infrastructure would be required to service this alternative. By breaking up the monopolies Dominion and APCo have, other companies may enter the industry. The assumption is that more companies will provide more choice for customers with regards not only to where they chose to supply their electricity demands from as well as the choice of receiving electricity exclusively from renewable resources. This policy alternative is paired with a new mandate that new utility companies looking to break into the market must have a Shared Solar program that Virginia residents can participate in and benefit from. This alternative aims to increase competition and promote innovation and development in the industry. Similarly, by requiring a Shared Solar component rather than permitting one, all new utility companies will already have a renewable energy component if they are to legally enter the market. When Dominion and APCo operate as a monopoly, the SCC permits the companies to have Rate Adjustment Clauses that allows them to pass on extra expenses to the customers. When customers are given a choice of where to get their electricity, Dominion and APCo will be forced to maintain rates that are competitive. Deregulating utilities involves removing the RAC altogether from Virginia utilities.

Cost Effectiveness Methodology

Below gives general context to how estimates were generated to conduct a cost effectiveness estimate for each alternative. A full, detailed worksheet including key assumptions, actual figures, and calculations can be found in **Appendix A.**

The primary outcome being measured in the cost effectiveness estimate is the total amount of CO_2 during electricity generation in the Commonwealth of Virginia. This analysis uses 2019 as the base year and provides cost and outcome projections for the next 11 years, to 2030. Below outlines a general methodology for how estimates for costs and CO_2 emissions were obtained.

This analysis uses historical data from EIA to gather data on total emissions from the electric power industry from 2005-2019. Additionally, this paper relies on projected estimates from the Rocky Mountain Institute to generate estimates for CO_2 emissions in Virginia from 2019-2030 for the status quo. To calculate projected CO_2 emissions under alternative 2, this analysis multiplyies the protected level of CO_2 emissions in each year of the status by 0.875 to estimate the reduction in CO_2 emissions associated with a 12.5% RPS. To project CO_2 emissions under alternative 3, this analysis relies on the impact that the NEM program had in Nevada. Consequently, to estimate the reduction in CO2 emissions, this analysis scales the number of systems installed under the NEM program to Virginia's population and estimates the total amount of carbon emissions reduced by solar projects of that capacity. The reduction in CO_2 emissions associated with alternative 4 is found by estimating the number of new utility providers that will enter the market and calculating the total amount of CO_2 emissions associated with their mandated solar projects.

This analysis uses 3 main cost categories to estimate the total cost of the status quo policy in the baseline year of 2019. The categories used are: the cost of generating electricity in the commonwealth of Virginia; the cost of operating and maintaining the grid storage and distribution systems; and the cost of additional investments in retrofitted solar systems both residentially and commercially. To calculate the projected costs of the status quo until 2030, a projected 10 year inflation rate of 2.2% is used. Alternative 2 has the same costs associated with the status quo and the additional costs of constructing or purchasing new solar developments. Alternative 3 is faced with the costs of purchasing and installing home solar in Virginia. Like alternative 2, alternative 4 faces the same costs as the status quo and the additional costs of constructing solar facilities. This analysis uses a 3% discount recommended by the United States Office of Budget and Management to estimate the net present value of the costs of each alternative. Ultimately, the cost effectiveness ratio is found by dividing the net present value of the cost of each alternative, by the total protected CO_2 emissions from 2019-2030.

Findings

Each policy alternative is evaluated against the four criteria, cost effectiveness, political feasibility, ability to implement, and equity, below. The results are summarized in an outcome matrix designed to determine the best policy alternative, and ultimately provide the recommended policy alternative. Based on how the criteria are defined, the policy alternative receiving the highest overall weighted score were be selected as the proposed recommendation.

Alternative #1: Status Quo

Cost Effectiveness

This analysis focuses on carbon emissions from electricity generation in the Commonwealth of Virginia as the primary outcome. This analysis uses historic data from the Energy Information Association (EIA) gather data on total emissions from the electric power industry from 2005-2019. EIA reports that Virginia utility companies emitted 29,965,120 metric tons of CO_2 in 2019. 2019 serves as the base year to counteract discrepancies due to the global pandemic. Therefore, the values serving as carbon emissions from 2020-2030 are projected outcomes.

Energy Innovation and the Rocky Mountain Institute developed the Virginia Energy Policy Simulator to provide projections for CO_2 emissions in the Commonwealth. The Simulator can be manipulated to account for various policy outcomes. Energy Innovation previously estimated that emissions from generating electricity would rise from approximately 30 million metric tons in 2019 to about 35 million metric tons by 2050 (Orvis, Subin 2020). The rate of emissions is expected to reach 35 million metric tons by 2030 and plateau at that level until 2050. The total sum of carbon emissions under the status quo between 2020-2030 is expected to be **387,465,120 metric tons.**

This analysis relies on 3 main cost categories to estimate the total cost of the status quo policy in the baseline year of 2019. The categories used are: the cost of generating electricity in the commonwealth of Virginia; the cost of operating and maintaining the grid storage and distribution systems; and the cost of additional investments in retrofitted solar systems both residentially and commercially. The cost of generating electricity in Virginia in 2019 was **8,457,722,659.** The cost of operating the grid systems in Virginia ibn 2019 was **$269.9 million** in 2019. The cost of retrofitting rooftop solar systems was **451,750,000** in 2019. The total cost of the status quo in Virginia in 2019 was **$9,179,372,659.**

Under the status quo the net present value for the projected cost of generating electricity Virginia from 2020-2030 is $**108,578,391,370.65**. Therefore, using the cost-effective formula, the cost effectiveness calculation of the status quo form 2020-203 is as follows:

$$Cost\ Effectiveness = \frac{108{,}578{,}391{,}370.65}{387{,}465{,}120}$$

Under the status quo, the cost effectives ratio is estimated to be approximately **$280.23** per metric ton of carbon.

Political Feasibility

Virginia Clean Economy highlights that 73% of surveyed Virginia residents wanted lawmakers to prioritize the advanced energy installments in the VCEA (VA Clean Economy, 2021). Public sentiment in this case has directly translated into legislative action. That is, the VCEA was passed with overwhelming bipartisan support receiving bipartisan majority votes of 51-45 and 22-17 in the Virginia House of Delegates and the Virginia State Senate Respectively. This policy alternative receives a score of **3 (high)** political feasibility.

Ability to Implement

The status quo may present the policy alternative that requires the least involvement and additional action. The VCEA has already been passed. There is no need for additional planning and coordination from other government agencies. This alternative burdens Dominion and APCo with changing their practices as they are the most responsible for harmful carbon emissions in the Commonwealth. However, the SCC permits Dominion and APCo to shift the cost burden to the consumer, meaning they are not required to make drastic changes or improvements to meet the new regulation. This policy alternative receives a score of **3 (high)** ability to implement.

Equity

The issue of equity can mainly be seen through by analyzing the incentives for home solar development laid out under the VCEA. Virginia homeowners are eligible for a Federal Solar Incentive is the Federal Solar Tax Credit that is awarded at 26% of solar investment value to anyone who installs a solar system till the end of 2022 (ElictricRate, 2021). The department of numbers reports that in 2019, 33.87% of Virginia residents were home renters. Renters do not enjoy the same benefits from installing home solar as homeowners do, so this policy immediately excludes a third of the population. Similarly, the average home solar system in Virginia is $25,000. The low-income level for an individual in Virginia is $12,880 (Virginia Tax). The status quo is also exclusive to low-income individuals in Virginia who may be priced out of installing solar systems, and therefore unable to enjoy the same benefits as others. This policy alternative receives a score of **1 (low)** equity.

Alternative #2: Increased RPS

Cost Effectiveness

North Carolina demonstrates a RPS that is more successful in generating electricity from solar and wind sources than Virginia's current standard. Since this policy is aimed at reducing carbon emissions associated with generating electricity by increasing generation from solar sources, this alternative will draw upon the success of North Carolina. Policy alternative 2 proposes a RPS of 12.5% of the total electricity in Virginia coming from renewable sources rather than approved individual sums currently mandated by the status quo. Under this alternative, projected carbon emissions would be 87.5% that of the total status quo. This policy alternative estimates that a 12.5% RPS will result in **312,812,500 metric tons** of carbon emitted in Virginia between 2020-2030.

Currently only 2% of the total 29,900 MW, 589MW electricity generated in the Commonwealth of Virginia comes from solar and wind sources. If the RPS was 12.5% 3725 MW of electricity generated would have to come from solar. That leaves 3136 MW of new solar energy that must be developed on 1 acre per MW. Estimates suggests that it takes 1 acre of land to develop 1MW of solar generating capacity. Large scale solar development is estimated to cost $500,000 per acre developed. Policy alternative 2 costs an additional **$1,568,000,000** annually compared to the status quo. Alternative 2 is still faced with the original costs of the status quo and additional costs required to meet stricter regulation. The net present value of the costs of policy alternative 2 is $**124,186,629,632.56.** Therefore, using the cost-effective formula, the cost effectiveness calculation of policy alternative 2 form 2020-2030 is as follows:

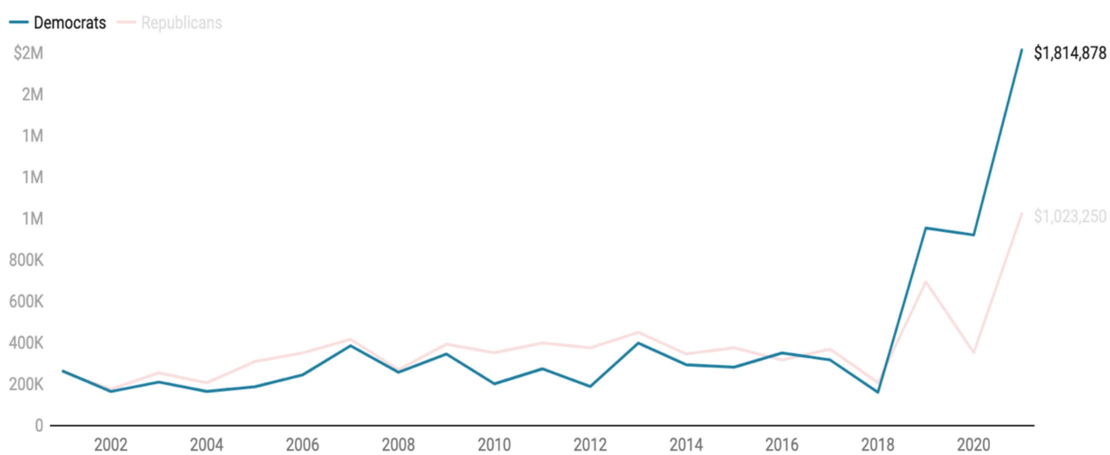
$$Cost\ Effectiveness = \frac{124{,}186{,}629{,}632.56}{312{,}812{,}500}$$

Under policy alternative 2, the cost-effectiveness ratio is estimated to be approximately **$397** per metric ton of carbon.

Political Feasibility

Policy Alternative 2 may seem to be fairly similar to the status quo. That is, Virginia legislators have already passed a RPS that has overwhelming public support. Policy alternative 2 remains feasible to the general public but this increased regulation directly affects investor-owned utility companies operating in the Commonwealth of Virginia. Policy alternative 2 will result in more costs and regulation for Dominion and APCo. Dominion notes on its website that it actively engages in political activism and lobbying in Virginia. Historically, Dominion has made comparably equal political donations to the Republican Party and the Democratic Party. However, recently Dominion has increased the total size of its political contributions as well as beginning to donate more to the Democratic party (Oliver, 2021). Dominion's political contributions have increased from roughly $300,000 annually to both parties, to $1.8 million to Democrats and $1 million to Republicans in 2021 (Oliver, 2021). Figure 4 shows Dominion's historic political contributions to both parties. Recent trends of increased political contributions demonstrate Dominion's changing role and position in policy and advocacy in Virginia.

Figure 4: Dominion's Political Contribution to Virginia State Politics, Via: Virginia Mercury



Dominion has become more active in Virginia politics. Virginia legislators are responsible for selecting the SCC members, who are responsible for regulating utilities in the Commonwealth, and ultimately would be responsible for enacting Policy Alternative 2. It is fair to assume that Virginia representatives and the SCC members could be hesitant to enact more regulation on Dominion, if they continue to receive increased political contributions and campaign funding. Similarly, the VCEA recently passed in 2020, and there can be some political fatigue and burnout, especially with regards to environmental policy. Despite these concerns strong public support for policy alternative 2, and previous voting history in favor of some form of RPS indicate that policy alternative 2 scores a **2 (medium)** for political feasibility.

Ability to Implement

Policy alternative 2 can be seen as a scaled-up version of the status quo. That is, it builds upon existing legislation by increasing the burden placed on utility companies, and the urgency of transitioning to a green economy. It does not however, involve any new government agencies, or private stakeholders. This policy builds upon the expected success of the status quo in the form of job creation and health benefits by increasing the presence of a renewable economy in Virginia. Dominion has already demonstrated its ability to successfully develop and begin to operate renewable energy developments through the Fort Powhattan Power Facility. As outlined in the literature review, there may be some disconnect between Virginia residents desire for renewable energy development, and the location of said development. As a result of increased size and scale, policy alternative option 2 may have issues related to land permits, zoning, and large-scale development required to meet the stricter regulation. As a result, policy alternative 2 receives a score of **2 (medium)** ability to implement.

Equity

Policy alternative 2 is directed at investor-owned utility companies. As a result, it does little to incentivize a transition to renewable energy for Virginia's residential and commercial communities. Policy alternative 2 does not eliminate the rate adjustment clause that Dominion and APCo currently enjoy. It is fair to assume that utility companies will capitalize on these RACs to transfer the costs of transitioning to a green economy onto their customers, Virginia residents and businesses. Policy alternative 2 does not alleviate the current energy burden faced by Virginia Consumers. Policy alternative 2 scores **1 (low)** for equity.

Alternative #3 Permit Community Solar and Net Metering

Cost Effectiveness

Estimates for policy alternative 3 rely on the impact that the NEM program had in Nevada. This analysis uses a direct proportional ratio adjusted for Virginia's population size to estimate the number of residential and commercial solar systems that would be installed under a community solar and net metering program in Virginia. The NEM program resulted in 3,300 new solar systems installed in Nevada. This analysis estimates that a similar program would result in **9,146** new solar systems installed in Virginia. Solstice, an organization that advocates for community solar and net metering programs estimates that the average home solar system installed in America offsets approximately **5 metric tons** of CO_2 annually. Therefore, Virginia's projected emissions would be lowered by **45,792 metric tons** annually compared to the status quo. Under this policy alternative, the projected total volume of carbon emitted from generating electricity between 2020-2030 is **356,996,288 metric tons**.

Under policy alternative 3 all the original costs associated with generating electricity in the Commonwealth of Virginia are still present. There are additional costs associated with buying and installing residential and commercial solar systems. The average cost of a residential solar system in Virginia is **$25,000.** If a community solar and net metering program in Virginia results in 9,146 programs installed, policy alternative three will cost an additional **$112,500,000** annually, when compared to the status quo. The net present value of policy alternative 3 is **110,854,374,383.78.** Using the cost-effective formula, the cost effectiveness calculation of policy alternative 3 form 2020-2030 is as follows:

$$Cost\ Effectiveness = \frac{110{,}854{,}374{,}383.78}{356{,}996{,}288}$$

The cost-effectiveness ratio for policy alternative 3 is estimated to be **$310** per metric ton of carbon.

Political Feasibility

The National Renewable Energy Laboratory reports that 39 states, and Washington D.C. currently have community solar projects. 22 of the states, and Washington D.C., have policies that actively promote community solar projects. Dominion and APCo have demonstrated interest in establishing larger shared solar programs for customers. It is fair to assume that they would not be strongly opposed to community solar programs. Therefore, this analysis assumes that under policy alternative 3 Dominion maintains its current levels of political contributions. This is one way to demonstrate the favorability of a policy.

Virginia Democrats were influential in convincing Dominion to created shared solar programs in 2021(McGowan, 2021). Following this effort, Virginia Democratic legislators have identified policies aimed at community solar projects to be a top priority ahead of the 2022 legislative session. Based on previous bipartisan support for renewable energy policies, advocated for community solar policies are confident that the recent shift in Virginia legislators will not impede policy alternative 3 from passing (McGowan, 2021). Virginia is behind neighboring states in the region North Carolina and South Carolina, both states already having existing legislation that supports community solar projects. This trend is intensified towards in the Northeast with New York, Maine, New Jersey, Connecticut, Vermont, New Hampshire, Rhode Island, Delaware, Maryland and D.C. all having policies that promote community solar development. Based on public sentiment towards community solar development, as well as local support from legislators, and existing regional policies in nearby states, policy alternative 3 scores a **3 (high)** for political feasibility.

Ability to Implement

Policy alternative 3 may be introduced as an amendment to the status quo. The Virginia General Assembly has demonstrated a commitment to implementing renewable energy legislation. The onus of this policy option mainly falls on Virginia residents and commercial businesses. They will be the ones responsible for either installing solar systems in their homes or businesses or signing up to receive excess energy from their neighbor. Policy alternative 3 has two main components. Firstly, this policy mandates that Virginians be able to resell excess solar energy that they generate at home to the grid system. This does not require any new infrastructure, however changes in Grid storage are expected to increase solar efficiency. The second component of policy alternative 3 would be to establish the billing mechanism through net metering. The SCC will be responsible for setting the rate at which community solar members may buy back energy from the grid systems based on their expertise and role in utility regulation in Virginia. Once an appropriate rate is set, retrofitting solar panels and connecting to the grid is a quick process that has the potential to create new jobs. Policy alternative 3 receives a score of **3(high)** for ability to implement.

Equity

Policy alternative 3 is uniquely accessible to Virginians based on its ability for both owners of solar systems, as well as members of the community solar project who do not own systems, to benefit from access to renewable energy. Policy alternative 3 seeks to address the gap that has been created by the differing incentives to pursue renewable energy alternatives for homeowner's vs home renters. Policy alternative 3 has the potential to reduce the energy burden for Virginia residents if the SCC sets a net metering rate that allows community solar project members to maximize the benefits of their participation. Policy alternative 3 receives a score of **3(high)** for equity.

Policy Alternative #4 Increase Competition Among Investor-Owned Utility Companies

Cost Effectiveness

This alternative assumes that increasing competition will also increase the total amount of electricity generated in state that comes from renewable sources. To combat the potential for an over reliance on fossil fuels these alternative mandates a shared solar program. This analysis assumes that each shared solar program is operating at the mandated levels of generating 5,000 kW of solar energy (5MW). Grid Alternatives estimates that 1MW of solar energy generated offsets 31,500 tons of CO_2 (Grid Alternatives, 2013). Policy alternative 4 relies on Massachusetts's success with multiple utility providers and shared solar programs. Massachusetts currently has 5 shared solar programs offering 7 active projects (Energy Sage). To calculate the reduction in CO_2 emissions by increasing competition this analysis generates a modest estimate for the number of new firms entering based on the existing projects in Massachusetts while adjusting for Virginia's larger population. Increasing competition for utility companies in Virginia will result in the creation of **9** new shared solar projects, lowering annual carbon emissions compared to the status quo by **1,417,500 metric tons.** Under Policy alternative 4, the projected total carbon emission related to electricity generation in the Commonwealth of Virginia is **341,907,500 metric tons.**

It will cost each firm **$2.5 million** to develop the minimum requirements with regards to shared solar projects in Virginia. Therefore, policy alternative 4 will cost an additional **$112,500,000** annually compared to the status quo. The net present value of policy alternative 4 is **$109,698,218,819.93.** Using the cost-effective formula, the cost effectiveness calculation of policy alternative 4 form 2020-2030 is as follows:

$$Cost\ Effectiveness = \frac{109{,}698{,}218{,}819.93}{341{,}907{,}500}$$

The cost-effectiveness ratio for policy alternative 4 is estimated to be **$320.84** per metric ton of carbon.

Political Feasibility

The SCC was established in 1902 and began operating in 1903. Over time, the SCC's responsibilities and regulative authority has changed. For decades the SCC has permitted Dominion and APCo to act as monopolies. These decisions are independent of actions of other legislative committees in other states such as North Carolina and Massachusetts. Despite being an independent legislative body, the SCC members are elected by members of the Virginia General Assembly. Dominion and APCo have only grown in political participation and influence meaning it would seem highly unlikely for the SCC to change a historical policy now in the face of political backlash from utility companies. Policy alternative 4 has the least potential to be passed in the current political atmosphere. Policy alternative 4 scores a **1(low)** for political feasibility.

Ability to Implement

Due to the nature of electricity generation and distribution, policy alternative 4 will benefit from existing grid and power structures in Virginia. Once the law removes monopoly power from Dominion and APCo, they will be forced to share certain resources. There are no additional government agencies involved, and those who decide to enter will be responsible for acquiring the various land and zoning permits. Policy alternative 4 mandates a shared solar component which will ultimately require development. However, these shared solar programs are substantially smaller than the Utility scale solar projects that would be developed under alternative 2. These smaller scale projects may be better suited to appeal to Virginia residents desire for renewable energy alternatives, but the hesitancy for large scale development within their own communities. Policy alternative 4 scores a **3(high)** for ability to implement.

Equity

Policy alternative 4 follows the economic principles of competition that predict that more competition among utility providers will ultimately lower the price faced by customers, in this case Virginia residents. Policy alternative 4 seeks to directly reduce the energy cost burden for Virginia residents by allowing them to have more choice and freedom when it comes to how they receive electricity. Access to the new shared solar projects may be limited to certain Virginia residents based upon where these new developments arise, geographic locations, and relative proximities. Policy alternative 4 receives a score of **2(medium)** for equity.

Outcomes Matrix

Figure 5: Outcomes Matrix Recommending Policy Alternative 2

	Cost Effectiveness (40%)	Political Feasibility (30%)	Ability to Implement (20%)	Equity (10%)	Weighted Total
1: Status Quo	280.23	3	3	1	113.692
2: 12.5% RPS	**397**	**2**	**2**	**1**	**159.9**
3. Community Solar	310	3	3	3	125.8
4: Increase Competition	320.84	1	3	2	129.436

Recommendation

After evaluating the 4 policy alternatives across the relevant criteria this analysis recommends Policy Alternative #2 Increase Renewable Portfolio Standard (RPS) to 12.5%. Policy alternative 2 has the highest weighted total alternative 2, signifying its favorability. Policy alternative 2 is the most cost-effective policy alternative. Cost effectiveness is weighted the highest in this evaluation at 40%. Policy alternative 2 scores a 2 (medium) for and political feasibility. These scores consider political fatigue which may exist from enacting the status quo. Despite this, policy alternative 2 has not received major pushback from Virginia politicians or residents. Policy alternative 2 also receives a score of 2 (medium) for ability to implement, meaning it is still easy and practical to implement. Despite only scoring a 1 for equity, policy alternative 2 can be paired with other alternatives and amendments specifically aimed at improving equity. Equity was rated the lowest out of the criteria in this report due to the urgency created by climate change, and the need for effective, immediate policy to meet State and global goals.

Implementation

The first step of implementation involves integrating a 12.5% RPS into the legislation. The Virginia General Assembly meets annually, convening on the second Wednesday in January, for 60 days in even numbered years and 30 days in odd numbered years (Virginia General Assembly, 2022). There is always an option to extend annual sessions for a maximum of 30 days. The legislative session for 2022 has concluded, meaning that the amendment to the VCEA to define the RPS at 12.5% of all electricity generated in state would have to be signed into legislation in 2023 at the earliest. The SCC holds responsibility for regulating Dominion and APCo. After signing the RPS into legislation, The SCC will be responsible for regulating Dominion and APCo and holding them to the new standard. Currently the SCC should look to hold Dominion and APCo to this new standard ideally by 2024, but with a grace period until December

2025. Failure to comply with new standards will result in fines that are in excess of projected costs of development.

Increasing the RPS to 12.5% does not require any additional State or Federal funding. Instead, Dominion and APCo are responsible for any funding and development. This does not disqualify Dominion and APCo from applying to funding mechanisms such as grant proposals, it just means that Virginia legislators are not responsible for securing funding, and therefore do not need to make and budget adjustments or to reallocate funds to renewable development. One potential issue that arises is that the SCC permits Dominion and APCo to capitalize on RACs. It seems likely that the costs of developing new solar and wind projects could be passed on to Virginia utility customers through these RACs. Similarly, it will be important for new renewable energy alternatives to be integrated in all utility subscriptions. There is potential for having an all-renewable service option to be highly costly. High costs could restrict access for some Virginia citizens and ultimately defeat the goal of increasing the total amount of electricity generated from renewable sources. The SCC is responsible for determining the appropriate rates for electricity annually. Therefore, this policy alternative allows The SCC to make amendments to pricing and structure if need be. It is important that the SCC review and approve Dominion and APCo's plans annually, as fast changes is battery storage and grid energy efficiency could change the costs associated with generating renewable electricity.

Implementing a 12.5% RPS requires leveraging the opinions of relevant stakeholder's, including outreach experts, political liaisons, media experts, technology experts, and policy experts. Outreach experts will play a crucial role in leveraging public support for renewable energy in general and translating that into desire for a RPS percentage. Media and social media will be important for information dissemination and informing public opinion. Decision makers will be able to act in accordance with their own political views, as well as the desires of their constituents. Engaging the public serves to defeat any political fatigue that legislators may be facing. The VCEA is one of the most comprehensive pieces of environmental legislation in the history of the Commonwealth. Legislators should not avoid amending the VCEA due to its recency of passing, but rather seek to improve it while it remains a key issue in the political sphere and maintains bipartisan support. The next steps for implementation are as follows:

1. Public Education and Information Dissemination – May 2022-December 2022
2. Virginia General Assembly signs 12.5% RPS into legislation – January 2023
3. Dominion and APCo submit upcoming RPS plans for 2024 to the SCC
4. SCC review and approve Dominion and APCo by fall 2024
5. SCC evaluate Dominion and APCo on an annual basis
    a. Measuring total emissions, total electricity generated in state, and if the percentage coming from renewable meets standards.

Concluding Takeaways

Investor-owned utility companies are disproportionately responsible for annual carbon emissions in the Commonwealth of Virginia. Historic emissions have left Virginia citizens susceptible to the negative impacts of climate change such as increased health risks, early death, and increased risk for flooding and natural disasters. Renewable sources have been considered a suitable an alternative to fossil fuel for generating electricity. However, the transition to these renewable sources and ultimately a greener economy has been too slow. Virginia has already taken the first step to this transition by passing the VCEA. Upon reflection, the VCEA is not achieving its goals. There is a misrepresentation regarding the amount of new solar systems that have been installed in Virginia, versus the total amount of electricity coming from solar sources. In order to keep on track to meet state and global efforts to reduce emissions and regulate global temperatures amendments to the VCEA must be made. By establishing a total percentage of electricity that must come from renewable resources, policy alternative 2 leverages public and legislative opinions that a RPS is important and necessary and builds upon to establish the percentage figure that will have the most impact on lowering annual carbon emissions.

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Appendix A

Cost Effectiveness

1. **The Outcome:** Total amount of fossil fuel emissions resulting from electricity generation in the Commonwealth of Virginia.
2. **Measure of Outcome and Data Series:** Welden Cooper Population Stats Virginia→ Emissions per person → Social Coast of Carbon $50 as valued by EDF. (Alabama case $7 a ton)
3. **Base Year:** 2019 (
4. **Region:** Commonwealth of Virginia, Government Entity: SCC, State Gov Virginia, Department of Energy
5. **Time Horizon:** 10 years, 2029

Seven Steps to Calculating

1. Outcome Projection Baseline, Status Quo

Energy Innovation and the Rocky Mountain Institute developed the Virginia Energy Policy Simulator to provide projections for CO_2 emissions in the Commonwealth. The Simulator can be manipulated to account for various policy outcomes. Energy Innovation previously estimated that emissions from generating electricity would rise from approximately 30 million metric tons in 2019 to about 35 million metric tons by 2050 (Orvis, Subin 2020). The rate of emissions is actually expected to reach 35 million metric tons by 2030 and plateau at that level until 2050. I used historical data from EIA to gather data on total emissions from the electric power industry from 2005-2019. EIA reports that Virginia utility companies emitted 29,965,120 metric tons of CO_2 in 2019. This is concurrent with the data used by Energy Innovation and as a result I will use the Energy Innovation Projected outcomes for emissions under what they refer to as "business as usual". To simplify things I will assume that Virginia utility companies emitted 30 million metric tons of CO_2 in 2020. From there, I will assume that the projected growth rate over the next 10 years is linear, resulting in a 500,000 metric ton increase in CO_2 emissions annually in Virginia. Below is a table to reflect this.

Year	Total CO2 Emissions from Electric Power Industry (Metic Tons)
2005	48,216,112
2006	42,523,462
2007	47,218,350
2008	41,401,705
2009	36,160,554
2010	39,719,081
2011	32,636,730
2012	29,223,189
2013	34,686,454
2014	33,733,804
2015	34,897,976
2016	36,566,152
2017	31,195,217
2018	33,503,951
2019	29,965,120
2020	30,000,000
2021	30,500,000

2022	31,000,000
2023	31,500,000
2024	32,000,000
2025	32,500,000
2026	33,000,000
2027	33,500,000
2028	34,000,000
2029	34,500,000
2030	35,000,000

2. Outcome Projection for Alternatives

Alternative 2: Updated Renewable Portfolio Standard (RPS)

The premise of this policy is centered on the idea that the RPS should represent a total percentage of the total electricity generated that is coming from renewable resources rather than a total sum figure. As a result, to calculate the outcomes for each year I assume that the only changes that are being made is the amount of electricity generated from renewable resources. This alternative is modelled on the success of North Carolina's RPS which is why 12.5% was selected as the proposed number for Virginia's RPS. Consequently, calculations to determine total CO_2 emissions in each year will be made by multiplying the protected level of CO_2 emissions in each year by 0.875.

Alternative 3: Community Solar and Net Metering

To project CO_2 emissions under this alternative, I rely on the impact that the NEM program had in Nevada. To keep my estimates conservative, I have used a directly proportional ratio to adjust for Virginia's population size compared to that of Nevada to estimate the number of home solar systems that would be installed in Virginia under a Community Solar and Net Metering program. Solstice, an organization that advocates for community solar and net metering programs estimates that the average home solar system installed in America offsets approximately 5 metric tons of CO_2 annually. Therefore, to calculate the reduction in CO_2 emissions annually I will adjust the 3,300 systems installed for Nevada's 3.08 million people population for Virginia's 8.536 million people population. I then multiply the total number of anticipated systems installed by 5 to estimate to total reduction of CO_2 emissions. Finally, I will subtract this number from the projected emissions under the status quo.

(8.536*3300)/3.08 = 9,146

9146*5=45,792

Projected Emissions for Alternative = Projected CO_2 emissions Status Quo – 45,792

Alternative 4: Increase Competition and Mandate Shared Solar

This alternative assumes that increasing competition will also increase the total amount of electricity generated in state that comes from renewable sources. If no other amendments to the policy are made besides regulating the monopolies that Dominion and APCo currently operate under it is safe to assume that new firms will differ on the source of the generation with some relying more heavily on renewables, and others on fossil fuels. To combat the potential for an over reliance on fossil fuels this alternative mandates a shared solar program. I assume that each shared solar program is operating at the mandated levels of generating 5,000 kW of solar energy; Massachusetts currently has 5 shared solar programs offering 7 active projects (Energy Sage). Therefore, to calculate the reduction in CO_2 emissions by increasing competition I will generate a modest estimate for the number of new firms entering based on the existing projects in Massachusetts while adjusting for Virginia's larger population. I will assume that each project has a 5,000 kW shared solar program. 5,000 kW is equal to 5 MW. I will multiply the total number of shared solar programs by the 5 MW of solar electricity they generate. Grid Alternatives estimates that 1MW of solar energy generated offsets 31,500 tons of CO_2 (Grid Alternatives, 2013). Therefore, I will multiply the total MW of solar generated by 31,350 and subtract the result from my projected CO_2 emissions.

(8.563*7)/6.893 = 9

9*5=45
45* 31,500= 1,417,500
Projected Emissions for Alternative = Protected Emissions Status Quo- 1,417,500

	Alternative 2: Renewable Portfolio Standard	**Alternative 3: Community Solar and Net Metering**	**Alternative 4: Increase Competition**
2020	26250000	29,954,208	28,582,500
2021	26687500	30,454,208	29,082,500
2022	27125000	30,954,208	29,582,500
2023	27562500	31,454,208	30,082,500
2024	28000000	31,954,208	30,582,500
2025	28437500	32,454,208	31,082,500
2026	28875000	32,954,208	31,582,500
2027	29312500	33,454,208	32,082,500
2028	29750000	33,954,208	32,582,500
2029	30187500	34,454,208	33,082,500
2030	30625000	34,954,208	33,582,500

3. Baseline Costs of Status Quo
I will use 3 main cost categories to estimate the total cost of the status quo policy in the baseline year of 2013. The categories I will use are: the cost of generating electricity in the commonwealth of Virginia; the cost of operating and maintaining the grid storage and distribution systems; and the cost of additional investments in retrofitted solar systems both residentially and commercially.
Cost of Generating Electricity
The main assumption made here is that Dominion and APCo are only operating to break even. In other words, they are not profit generating. As a result, I will be able to use the total cost faced by Virginia residents with regards to their utility bills as representative of the total cost of generating electricity in the Commonwealth of Virginia. In 2019, the average cost of electricity across all sectors in Virginia was 10.54 cents ($0.1054) per kWh (EIA, 2019). In 2019, Virginia utilities had a net generation of electricity of 80,244,048 MWh [3] (EIA, 2019). Therefore, to calculate the total cost of generating electricity in Virginia in 2019 I multiply the average price of electricity faced by Virginia consumers by the total amount of electricity generated by utility companies.
80,244,048,000*0.1054 = 8,457,722,659
The cost of generating electricity in Virginia in 2019 was **8,457,722,659**
Cost of Operating and Maintaining Grid Infrastructure
Virginia receives power from two grids: the PJM Interconnection which supplies most of the state, and the Tennessee Valley Authority, which supplies electricity which provide electricity to four counties in southern Virginia (EIA, 2021). PJM Interconnection is a regional transmission organization (RTO) serving multiple states on the East Coast. Based on the dynamics of the current grid system it is impossible to isolate the costs of operating systems exclusively in Virginia due to the interconnectivity of grid infrastructure. Therefore I use the PJM Interconnection's total operating cost in 2019 which they report to be **$296.9 million** to represent the cost of operating the grid system (PJM, 2020).This

number may seem higher than the actual case may be due to how expansive IJM Interconnection is as a company. To account for this I will not include any additional costs for operating the Tennessee Valley Authority due to the small portion of Virginia residents that it serves.

Cost of Retrofitting Rooftop Solar

Currently, most of the solar generating capacity installed in Virginia has been at the utility scale. These will not be reflected in the costs of retrofitting residential and commercial solar systems. In Virginia, retrofitting solar panels can cost between $3-$5 per watt (Gobler, 2022). The average residential solar system has a 5kW generating capacity. To account for the discrepancies in sizes of commercial solar installations I will use a 5kW system as the average size of all solar systems installed in 2019. To balance this, I will use the $5/W estimate that would total $25,000 per system. In 2019, there were an estimated 18,070 solar systems installed. To calculate the total costs of retrofitting rooftop solar we simply multiply the cost of installing a solar system in Virginia by the total number of installations.

18,070*25,000=451,750,000

The cost of retrofitting rooftop solar systems was **451,750,000** in 2019.

The total cost of the status quo in Virginia in 2019 was **$9,179,372,659**

4. Projected Costs of Status Quo

To calculate the project cost of the status quo I use a projected 10-year inflation rate of 2.2%.

Baseline Costs for Alternative

To Determine the cost for the alternative policy in 2019 I will use the cost of the status quo in 2019 as well as the additional costs of the various policies as outlined below.

Alternative 2: RPS

Currently, only 2% of Virginia's total electricity generation is coming from solar and wind options. Policy alternative requires that12.5% of the electricity generated come from these sources. I assume that to meet this requirement all renewable electricity in Virginia would come in the form of solar electricity at the utility scale. Therefore, this policy would build upon the existing cost of the status quo and add in the cost of constructing new solar fields. Estimates suggests that it takes 1 acre of land to develop 1MW of solar generating capacity. Large scale solar development is estimated to cost $500,000 per acre developed. Virginia currently only generates 2% of its total 29,900 MW from solar for a total of 589MW. If the RPS was 12.5% 3725 MW of electricity generated would have to come from solar. That leaves 3136 MW of new solar energy that must be developed on 1 acre per MW. Therefore, I can multiply the new solar capacity required by this policy alternative by the cost of development.

3136*500000

Policy alternative 2 costs an additional **$1,568,000,000.**

Alternative 3: Community Solar and Net Metering

To calculate the costs of policy alternative three I will multiply the number of proposed installed systems by the average cost of installing a solar system in Virginia. Both these numbers are used previous calculations

9146*25000

Policy alternative 3 costs an additional **$228,650,000**

Alternative 4: Increased competition

To calculate the cost of policy alternative 4 I use previous estimates with regards to the number of new firms entering and the requirement that they have 5MW of solar generating capacity for shared solar. If each firm is required to construct these facilities it will cost each $2.5milion to develop the solar projects.

9*5*2500000= 112,500,000

Policy Alternative 3 will cost an additional **$112,500,000**

Year	**Cost Status Quo**	**Cost Alternative 2**	**Cost Alternative 2**	**Cost Alternative 3**
2019	9179372659	10747372659	9408022659	9291872659
2020	9381318857	10949318857	9609968857	9493818857
2021	9709665018	11277665018	9938315018	9822165018

2022	10049503293	11617503293	10278153293	10162003293
2023	10401235908	11969235908	10629885908	10513735908
2024	10765279165	12333279165	10993929165	10877779165
2025	11142063936	12710063936	11370713936	11254563936
2026	11532036174	13100036174	11760686174	11644536174
2027	11935657440	13503657440	12164307440	12048157440
2028	12353405450	13921405450	12582055450	12465905450
2029	12785774641	14353774641	13014424641	12898274641
2030	13233276753	14801276753	13461926753	13345776753

Net Present Value
Status Quo: $108,578,391,370.65
Alternative 2: $124,186,629,632.56
Alternative 3: $110,854,374383.78
Alternative 4: $109,698,218,819.93

Cost Effectiveness
Status Quo: 280.23
Alternative 2: 397.00
Alternative 3: 310
Alternative 4: 320.84