Dominion Energy

Applied Policy Project:
Renewable Natural Gas

A new energy for Virginia's future.

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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 entity.

Honor Statement

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

Lucy T. Smith

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EXECUTIVE SUMMARY

The market for renewable energy has been in a continuous state of change as new technologies have emerged, and the demand for these technologies has continued to grow as government agencies increase goals for carbon reduction. Tradition fossil fuels like carbon and natural gas will not be viable as future energy sources if these market and government trends are to continue. That desire for carbon neutral or carbon negative fuels has changed the business model for utilities (Charles, 2019). However, there is an energy solution for Virginia's future: renewable natural gas. Renewable natural gas is essentially a zero-carbon fuel, and can even actively reduce the carbon footprint of methane-producing industries and utilities alike (Charles, 2019).

To address this issue, first this report will complete a background and literature review in order to provide information on what renewable natural gas is, how to capture and produce it, and how it may be used to provide carbon-free energy for Virginia homeowners and businesses on the Dominion Energy grid. The report will address relevant impacted parties and potential challenges as well as reviewing examples of successful renewable natural gas programs and the lessons learned from research.

To address the issue of renewable natural gas expansion in Virginia, this report offers the following five alternatives as potential courses of action by Dominion Energy:

1) Let Present Trends Continue
2) Advise Governor Northam to add Renewable Natural Gas to Executive Order
3) Information Campaign on the Benefits of Methane Capture
4) Develop a Tax-Subsidy Program Similar to the Solar Investment Tax Credit
5) Develop a Digester Development Grant Program

This report evaluated the alternatives on the criteria of *cost, political feasibility, administrative feasibility,* and *effectiveness in production of renewable natural gas.* Ultimately, it is recommended by this paper that Dominion Energy follow **Option 5: Develop a Digester Development Grant Program.**

IN AN ERA OF INCREASING GLOBAL TEMPERATURES, VIRGINIA IS NOT DOING ENOUGH TO EXPAND ADOPTION OF RENEWABLE NATURAL GAS.

Problem Statement

INTRODUCTION

Our planet is experiencing the devastating effects brought on by global warming caused by increasing carbon in the atmosphere. In fact, climate change has forever altered the way energy is perceived, and changed the expectations that energy customers now have for electric service and energy companies. There is a strong push from energy customers, interest groups, and elected representatives toward creating additional sources of renewable energy to mitigate the negative effects of carbon and methane producing industries and energy sources, which contribute to climate change, rising temperatures, and water levels.

Multiple kinds of renewable energy have hit the general market in recent years, but none come without challenges: solar energy faces land space hurdles; nuclear sites rely on the continuous importation of uranium, and offshore wind is just developing. Many renewable sources can only effectively generate energy when the environmental conditions are just right. So, there is still market space to be filled by more types of green energy sources that can more effectively replace coal and natural gas. Renewable natural gas is unique in that it actively turns an environmentally harmful substance we are producing every day into a carbon neutral energy source, and would be beneficial for Virginians to encourage the production of this energy.

 Virginians and climate scientists are demanding that new options for renewable energy be supported and developed. Renewable natural gas is one of these alternative energy options, ideal because of its ability to produce energy independent of weather patterns as well as actively reduce methane emissions. It is imperative for Dominion Energy to do its part in this changing energy landscape by aiding the transition to and adoption of renewable natural gas.

BACKGROUND AND LITERATURE REVIEW

Renewable Natural Gas Definition and Production
Renewable natural gas (RNG), also known as biogas or biomethane, is a methane-based fuel (90% methane) that is derived from the anaerobic decomposition of organic matter such as food and animal waste. This gas can be used as a transportation fuel or burned to heat homes and provide electricity, much like fossil fuels and natural gas (Methane Capture, 2011). Renewable natural gas presents an opportunity for the energy industry, as it can be a carbon neutral or carbon reducing way to produce energy (Elger, 2017).

Methane is a harmful byproduct of many common industries, including landfills, wastewater treatment plants, livestock farms, and other agriculture like rice farms and bogs that is 21 times more dangerous to the atmosphere than carbon dioxide (Methane Capture, 2011). In these industries, organic matter that is left to decompose in landfill cells or animal waste lagoons does so anaerobically, meaning without oxygen (Methane Capture and Use, 2017). This solid matter digestion process creates methane gas. To capture the methane gas, some farms and landfills have built methane capture facilities or digesters, which places a thick plastic cover over the landfill cells and manure lagoons which lifts and balloons as it fills with the captured methane gas generated below (Charles, 2019). Figure 1 below shows these thick plastic covers, which incidentally also keep rainfall from falling on the waste cells and lagoons, which in heavy downpours like hurricanes will keep waste from spilling into the surrounding land and water supply (Mufson, 2018).

Figure 1: Methane digester in operation (Juergens, 2020).

That collected gas is then pumped out and processed to remove water vapor and CO2 (Charles, 2019). As seen in Figure 2 below, the leftover methane gas can be used to fuel transportation vehicles, natural gas-powered homes, or burned at power plants to provide electricity to the grid. In addition to biogas, there is another byproduct called digestate, which consists of the matter that does not become biogas in the process. This digestate is a nutrient-rich fertilizer that can be used to enrich home gardens or other agricultural plots, both small and large scale (*Methane Digesters,* 2020).
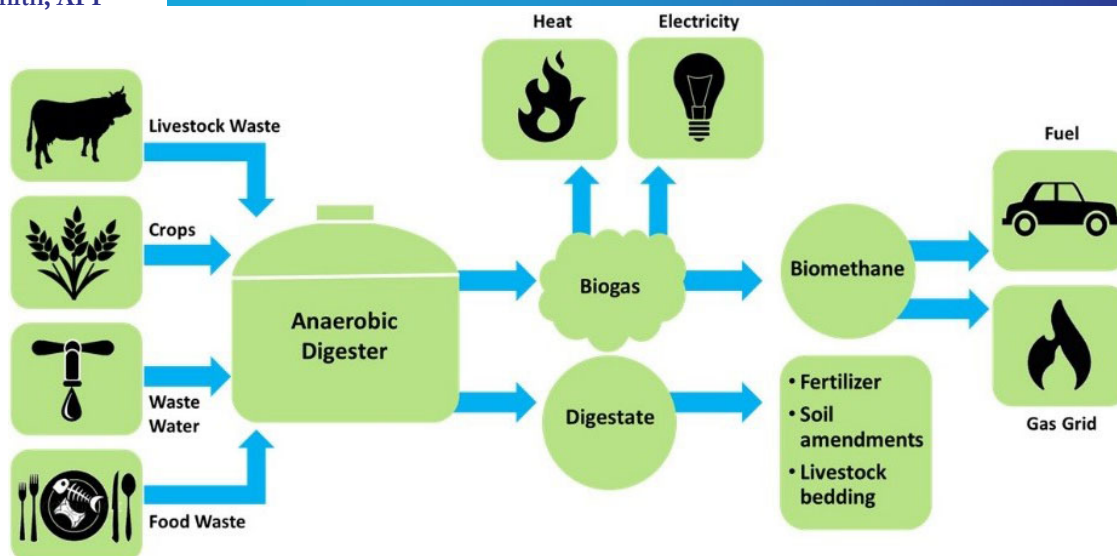
Figure 2: The Methane Gas Collection Cycle (Tanigawa, 2017).

Without a collection system in place, methane produced in this process simply leaks into the atmosphere. This is a problem because these kinds of methane producing activities are ubiquitous. In Virginia alone, there are roughly 60 landfills (Landfills in Virginia. (n.d.), 500 dairy farms (Lee, 2019), and many other businesses that produce methane gas as a by-product of their industry. Despite the usefulness of methane as a renewable energy source and benefits to the environment from reducing the amount of methane released into the atmosphere, there are no current regulations or laws that encourage these industries to capture methane at the federal level or broadly at the state level (Methane Capture, 2011). This is possible because of a lack of familiarity with the potential of this energy source, or because of a fear that it will incentivize these industries to increase instead of reduce their methane emissions overall if methane capture becomes profitable for them (Methane Capture, 2011). As a state, Virginia could be harnessing this byproduct to power its homes, cars, and industry with renewable energy. However, these methane-producing industries either do not have the information, infrastructure, or interest in doing so.

Challenges to Renewable Natural Gas Systems
One of the major challenges to the widespread use of RNG as a renewable energy source is the issue of getting the power to homeowners and businesses, who often do not live in close proximity to industries like landfills and livestock farms. The two methods of moving the processed RNG to populated areas is by truck or by pipeline. There are challenges to both of these methods, namely: creating an efficient method to truck tanks of RNG or obtaining the approval and funding necessary for building miles of pipelines across Virginia to transport renewable natural gas to energy facilities.

The other challenge is that electric energy in Virginia is provided by a one of two utility companies, Dominion Energy or Appalachian Power. These companies form a monopoly over energy distribution and generation. Therefore, new energy

technologies cannot be widely adopted in Virginia unless done so by either utility. As it stands currently, there is no partnership or connection in Virginia between these named utilities and the facilities whose waste produces methane. This missing link will need to be addressed in order for a partnership to be successful to introduce RNG into Virginia.

Impacted Parties

Residents of Virginia will certainly be impacted, as addressing this problem statement will require changes to the current energy production system, incurring costs on the incumbent utility that may pass on to customer energy bills. Managers and owners of methane-producing industries will also be affected. It is unclear if they will view this issue as a positive (additional avenue to earn income) or a negative (additional regulations, procedures, and third parties accessing their land and buildings to create the necessary collection infrastructure). Finally, individuals living directly around the methane producing centers will experience cleaner air as the methane becomes trapped in digesters and kept free from the air.

Other groups that will be focusing on this issue include the State Corporation Commission, who authorizes major building projects and billing practices for Dominion Energy; various state agencies; Delegates and Senators in the Virginia State Government who support climate initiatives; and special interest groups such as the Sierra Club and the Virginia League of Conservation Voters.

Dominion Clean Energy Goals

Dominion Energy has made a commitment to reduce their emissions to a net zero goal by 2050. To accomplish this mission, Dominion will need to drastically expand their renewable energy portfolio. Their current renewable energy portfolio has given them a great start. As of 2020 in Virginia, Dominion has the 4th largest solar fleet in the country, powering over 450,000 homes (Dominion Energy, 2020). Also, a part of their renewable energy team is off-shore wind, which will power 650,000 homes at the completion of its construction in 2026 (Dominion Energy, 2020). Finally, Dominion Energy has nuclear energy facilities in Virginia, North Carolina, and the Northeast which together power 1.5 million homes at a zero-carbon rate (Dominion Energy, 2020). But as is known, renewable energy comes with shortcomings that hinder our full transition. Many, like solar and wind, can only operate when the conditions are right. They also are not always powerful enough to feed the grid during the coldest winter months and hottest summer days. That is why both Virginia and Dominion Energy need to invest in bringing Renewable natural gas into the state's portfolio.

Examples of Successful Renewable Natural Gas Programs

When looking at how Dominion Energy can best productively introduce renewable natural gas in its Virginia market, it is extremely useful to look at which states have successfully accomplished this goal. In this section, this report will focus first on

California, which has been an industry leader, then North Carolina, a Dominion Energy electric state.
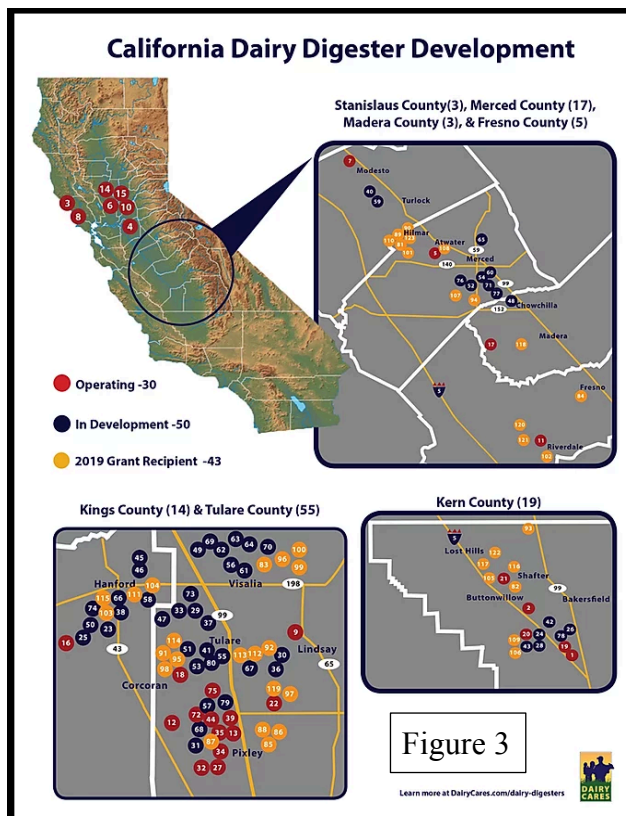
California

California has led the charge for adoption of RNG not only in the United States but around the world. The state is exemplary in the way it has encouraged two methane producing industries, dairy farms and landfills, to create methane capture and processing systems.

Dairy

California produces more milk and dairy products than any other state, accounting for nearly 20% of milk production in the U.S. (Matthews and Sumner, 2019). California's dairy farms are concentrated in internal parts of the state, in particular the Fresno region. This dairy region is the first in the world to set a goal of reducing methane emissions from cow manure by 40%, which they are on track to achieve in a decade (by 2030) because of the widespread adoption and use of digesters/methane collection and processing facilities (*Dairy Digester Development in California,* 2020). In fact, in the Fresno region alone there are 30 digesters already in operation, with 123 total facilities operating, under construction, or planned (*Dairy Digester Development in California,* 2020). In Figure 3 below, the rapid growth of digesters in California can be seen, with distinct colors to indicate established digesters, those in development, and those that are popping up as a result of the new California Grant program.

The reason California has seen such widespread adoption of RNG and have been able to build the necessary facilities at dairy operations is because of that statewide grant. In 2018, California passed Senate Bill 856, also known as the Dairy Digester Research and Development Program (DDRDP), which awards $99 million in state grant funds to California dairy farms and operations for the purpose of building digesters to process organic waste into biogas and reduce methane emissions (*2019 Dairy Digester Research and Development Program*, 2018). These funds were appropriated from the Greenhouse Gas Reduction Fund (GGRF). The GGRF is funded by proceeds from the state of California's Cap and

Figure 3

Trade program for greenhouse gas emissions. (California Climate Investments, 2020).

California Landfills
In addition to the digester program, California is also experiencing success with RNG in its landfill systems. State agency CalRecycle runs a program called the Landfill Methane Capture Strategy. This program aims to 1) identify landfill systems currently without methane capture systems, and work to install them at those locations; 2) maximize efficiency of methane capture at landfills by optimizing landfill design, operation policies, and studying best practices; 3) increase the recoverable amount of landfill gas by as much as possible in order to move California's energy portfolio further away from fossil fuels (State of California, 2019).

North Carolina
With the recent partnership between Smithfield Foods and Dominion Energy, North Carolina is quickly becoming another leading force for renewable natural gas in the United States. This partnership, facilitated under the named Align RNG, will capture the methane produced by hog waste lagoons at Smithfield farms and use it to power homes across the Tar Heel state. The partnership began in late 2018, when Dominion Energy announced a $500 million-dollar investment into infrastructure in North Carolina to build hundreds of miles of underground pipes in order to collect and transport methane gas (Dominion Energy and Smithfield Foods Invest, 2020). The project is sizable, and is projected to be able to collect at a minimum 105,000 metric tons of methane each calendar year from participating methane producers (Charles, 2019). The collection of that amount of methane for use as natural gas reduces greenhouse gas emissions by the equivalent of 500,000 cars coming off the road each year (Charles, 2019). The climate impact of these reductions over 20 years would be equivalent to eliminating carbon dioxide emissions from more than 700,000 homes, EDF said." (Mufson, 2018).

This is not Smithfield Foods' first foray into renewable natural gas. In 2005, the company experienced a failed attempt at methane capture due to equipment failures and unforeseen effects of new pig feed, where the company lost nearly $30 million dollars (Mufson, 2018). In this new partnership with Dominion, Smithfield now has what it lacked before- a partner with energy industry knowledge and experience. The pig producer will cover all lagoons with digesters and other facilities. The captured methane from Smithfield farms will be sent via pipeline or driven over land to Dominion facilities to be processed and fed into the grid (Mufson, 2018).

Lessons Learned About the Importance of State and Federal Support
Support from state legislatures is important to the adoption of renewable natural gas facilities. For example, in 2006 California passed Assembly Bill 32: California Global Warming Solutions Act of 2006 (Assembly Bill 32 Overview, 2014). This bill mandated the adoption of clean energy technologies, and so placed the state on the forefront of testing new ways to harvest renewable energy (Assembly Bill 32 Overview, 2014). Then in 2018, California established an incentives program (SB 100)

called the Renewables Portfolio Standard which declared that 60% of all retail electricity sales should be sourced from renewable energy sources by 2030 (Renewables Portfolio Standard, 2018). In this incentive program, the state directly names municipal solid waste, landfill gas, biomass, and anaerobic digestion under eligible technologies. Finally, in 2019, California created the California Dairy Digester Research and Development Program (DDRDP), which has awarded $99 million dollars in state grant funds to California dairy farms and operations for the purpose of building digesters to process organic waste into biogas and reduce methane emissions (2019 Dairy Digester Research and Development Program, 2018).

The money for these funds is appropriated from the Greenhouse Gas Reduction Fund (GGRF), designed to hold the proceeds from California's Cap and Trade (greenhouse gas emissions) auction program as those funds are redistributed to fund programs that support the objectives of the California Global Warming Solutions Act of 2006 (California Climate Investments, 2020). As of 2020, this program has appropriated over $11 billion dollars to state agencies implementing greenhouse gas emission reduction programs and projects such as the DDRDP.

As a result, California is home to a wide variety of renewable natural gas facilities notable for their early success in this kind of energy collection: the Altamont Landfill and the Hillarides Dairy Digester (*Renewable Natural Gas: Landfill Methane Outreach Program,* n.d.) as well as over 120 dairy digesters (*Climate-Smart Dairy Digesters,* 2020). The Altamont Landfill is the world's largest landfill gas to RNG facility in the world (We Are Oakland, 2011). Through an intricate system of over 175 collection wells, transmission pipes, and a vacuum extraction system, Altamont successfully captures 90% of methane gas following anaerobic decomposition of municipal solid waste (We Are Oakland, 2011). This is 15 percentage points higher than the national average capture rate for landfill RNG systems, whose capture rate is identified by the EPA as 75% (We Are Oakland, 2011). Hillarides Dairy, located in Lindsay, California, added methane capture technology to their farm in 2004. The methane capture system at the dairy produces enough RNG through its covered lagoon digester to power all dairy fleet vehicles, which in total is equivalent to 230,000 gallons of diesel fuel per year (Elger, 2017).

In comparison, Virginia has not encouraged the adoption of RNG in environmental initiatives. On September 17, 2019 Governor Ralph Northam of Virginia issued Executive Order Forty-Three, which sets two major goals for the Commonwealth: 1) By 2030, 30% of Virginia's electric use will be powered by energy from renewable sources, and 2) By 2050, Virginia's energy will come 100% from renewable sources (Exec. Order No. 43, 2019). In these documents, the Governor specifically refers to renewable sources such as solar, wind, and nuclear energy. Renewable natural gas is not named in this Executive Order as a renewable source of energy for Virginia to incentivize. It is critical to consider the potential value add of including renewable

natural gas on that list of focused energy alternatives, and how that might encourage quick and successful adoption of the technology as seen in California.

On the federal level, adoption of novel renewable energy technologies has been spurred on through the use of tax credits, for example solar panels though the Solar Investment Tax Credit (SITC). This federal tax relief program allows owners of both residential or commercial properties to receive a credit toward their income taxes for up to 26% of the costs of solar panels and their installation (SEIA, 2019). Due to the widespread use of this tax credit since its passage into law in 2006, the solar industry has seen growth of close to 10,000%, including an average annual growth of 52% from 2009-2019 (SEIA, 2019). By creating a financial safety net for first movers in the solar energy field, adoption of the technology was encouraged by the government, making it more familiar, reputable, and cheaper for others to adopt the technology. Without the intervention and support of the federal government on behalf of solar energy, it is fair to assert that adoption of the technology would not have grown at that rate nor become so widespread.

Lessons Learned About Type of Renewable Natural Gas Generation Facility
When considering the potential power generation of different livestock farms, the literature shows that dairy farms top swine and poultry in terms of overall gas production per animal. The biogas yield per animal per day for dairy cows is 66 cubic feet, with beef cattle at 24 cubic feet, swine yield at around 5 cubic feet, and poultry .34 cubic feet per animal per day (Ogejo, Ignosh, and Bendfeldt, 2018). However, Virginia is not known for large dairy productions, unlike other regions in the U.S. such as the Midwest. Instead, the commonwealth is connected to the poultry and swine industries, as it is home to both Perdue and Tyson Chicken farms and processing plants on the Eastern Shore of Virginia, and Smithfield Foods production and hog farms in Smithfield, Virginia. Both of these animal industries create the kind of waste which will produce methane gas through decomposition, and would be likely candidates for renewable natural gas facilities.

Virginia also has an abundance of landfills, an ideal source for generation of renewable natural gas. In 2018, Virginia landfills collected 13.9 million tons of municipal solid waste (Annual Solid Waste Report for CY2018, 2019). The majority of this trash is deposited at the seven Virginia "mega-landfills" accepting at least 3,500 tons of municipal solid waste per day, who could be candidates for a system similar to the Altamont plant: county landfills in Amelia, Brunswick, Gloucester, King and Queen, King George, Sussex, and a developing landfill project in Cumberland (Vogelsong, 2018).

Therefore, in developing renewable natural gas facilities it is recommended that Dominion Energy focus its efforts on these 7 "mega-landfills" as well as the livestock industries present in Virginia, like Smithfield Foods (with whom Dominion has a pre-existing relationship) and poultry plants.

Lessons Learned About Infrastructure

The Altamont landfill is located in Livermore, California and serves the cities of Oakland and San Francisco, California (Altamont Landfill, 2019). The proximity of Altamont to the San Francisco and Oakland areas is beneficial to the success of the landfill, because it has a steady influx of municipal solid waste from the urban areas. These cities benefit from having a large landfill open at all hours close enough to the city to make convenient trips, yet far enough away to keep residents free from unpleasant side effects of landfills, such as odor. At Altamont, enough methane is generated each day to power the entire facility as well as enough to power the equivalent of 6,500 homes (We Are Oakland, 2011). However, the renewable natural gas collected from this landfill is used as a transportation fuel for facility owner Waste Management's trash collection vehicles rather than residential power, because the pipelines or other infrastructure needed to transport the gas from the out-of-town landfill into urban areas is not built (We Are Oakland, 2011). This is a problem that Dominion Energy would need to consider, as Virginia also does not have the pipeline infrastructure already in place. It would require a large financial investment from Dominion and permission from the Commonwealth to build the necessary pipelines, similar to the investment made in North Carolina.

Lessons Learned About Partnerships

Through examination of the literature, we see that methane or biogas collection facilities are typically borne of partnerships. To build, design, and operate the Altamont Landfill renewable natural gas conversion center, Waste Management partnered with Linde North America (We Are Oakland, 2011). This partnership created an opportunity for a methane producing facility to work together with a company that has all the tools to capture the gas and create usable energy.

The AgStar program is also an important public sector partnership to consider. This decades-old program is a partnership between the EPA and the United States Department of Agriculture which promotes the adoption of anaerobic digesters on agricultural land, and offers support and guidance to organizations entering this renewable energy field (Elger, 2017). This program actively searches for potential partners to achieve its goal of realizing the U.S.'s potential for 8,000 new agricultural anaerobic digesters, which would create enough power for over 1 million homes (Elger, 2017). This program represents an untapped resource for Dominion Energy as they look to bring renewable natural gas to Virginia electric generation.

Dominion has already seen the value of partnerships in their work in other states. In August of 2019, Dominion Energy and Smithfield Foods broke ground on Align RNG, the largest renewable natural gas project in North Carolina to capture methane emissions from hog waste (Dominion Energy and Smithfield Foods Break Ground, 2019). In Virginia, other companies are already taking advantage of these partnership opportunities. For example, the Atlantic Waste Disposal landfill in Hopewell, Virginia partnered with DTE Biomass Energy and Waste Management to provide renewable

natural gas created from landfill gas to power Honeywell Specialty Chemicals plant (Landfill Gas Energy Project Data, 2010). Creating partnerships like these will be crucial to the long-term success of any new methane capture program.

Next Steps Forward

As we look to Virginia, there exist multiple opportunities to create partnerships with different sources of methane gas to renewable natural gas production, particularly in the landfill, swine, and poultry farm sectors. It is necessary to move quickly on entering this market, as partnerships have already sprung up between existing methane-producers and companies. Based on the data gathered from this literature review, it is recommended that Dominion Energy consider identifying a potential landfill partner, such as the developing landfill project in Cumberland. It is also recommended that Dominion Energy consider appealing to the Governor to add language supporting renewable natural gas to Executive Order Forty-Three, or to create another avenue of state support for the emerging technology.

EVALUATIVE CRITERIA

Criteria #1: Cost
This criterion will measure the overall financial cost of the alternative. Any proposed action must fall within the operating budget of Dominion Energy and, where applicable, the budget of the State of Virginia for energy and environmental programs. Costs borne by Dominion Energy would be projects such as the building renewable natural gas facilities, improvements to the electrical grid and energy delivery system, updates to consumer information, and salaries for lobbyists to pass necessary legislation. Costs incurred by Dominion may be distributed to ratepayers, so this criterion must also consider the amount of additional cost for each customer, as measured by a "rider," or an addition to a customer's bill for a specific program. Costs borne by the State would include subsidies, grants, tax credits, and related programs.

This criterion will be evaluated using the best projected financial cost, in dollars. An ideal alternative will be as low as possible while meeting the other criteria, both for Dominion and for the State. A low-cost alternative would allow Dominion to keep rates down for consumers, and allow any state government actions to be more politically attractive and feasible to pass.

Criteria #2 and #3: Feasibility: Political and Administrative
Feasibility will be measured in two terms, political and administrative. Political feasibility indicates that the issue is ripe for the current political climate in the state of Virginia and any government-related measures would be passed by the general assembly. Administrative feasibility is measured in this policy analysis is the degree to which it is in the power and interest of Dominion Energy to enact that change either legally, structurally, or financially. Feasibility will be measured as either high, medium, or low.

Criteria #4: Effectiveness in Production of Renewable Natural Gas
This criterion will evaluate how effective each alternative is in producing quantities of renewable natural gas. In this evaluation, it will be important to consider how many new collection systems for renewable natural gas production will be generated by each alternative, and how much energy will be collected at these locations for use in Virginia's energy grid. This criterion will be measured in gallons of renewable natural gas produced, and when possible in terms of homes powered.

ALTERNATIVES

Option 1: Let Present Trends Continue

This alternative recommends continuing with the current course of action. Currently, the adoption of renewable natural gas technology across Virginia is dependent on market forces alone. Dominion Energy has acted on their own in North Carolina to create a system of renewable natural gas collection and use through a partnership with Smithfield Foods, called Align RNG. Following this recommendation would likely see Dominion Energy moving to create similar private partnerships with industry in Virginia without the assistance or involvement of Virginia state government.

This alternative would be the easiest alternative to implement, as it plays into status-quo bias and market forces, and would require no new legislation or program creation. This is why this alternative scored highly in both administrative and political feasibility, as well as will have a very low cost. However, if the let present trends continue option is chosen, it is likely that renewable energy technologies such as solar, offshore wind, and nuclear energy will continue to be the main focus of Virginia's goal to have 100% of energy created from renewable sources by 2050, which is why this option did not score high in its potential to contribute to the growth of Virginia's renewable natural gas industry (Exec. Order No. 43, 2019).

Option 2: Advise Governor Northam to add Renewable Natural Gas to Executive Order 43

This alternative recommends that Dominion Energy advise Governor Northam to add renewable natural gas to his Executive Order 43. This order set two major goals for the Commonwealth: 1) By 2030, 30% of Virginia's electric use will be powered by energy from renewable sources, and 2) By 2050, Virginia's energy will come 100% from renewable sources (Exec. Order No. 43, 2019). In these documents, the Governor specifically refers to renewable sources such as solar, wind, and nuclear energy. Renewable natural gas is not specifically named in this Executive Order as a renewable source of energy for Virginia to incentivize. By naming renewable natural gas specifically in this order, state funds and program priorities will be updated to include this energy source, as seen in California's Assembly Bill 32: California Global Warming Solutions Act of 2006 and the Renewables Portfolio Standard (SB 100), which can be read about in more depth in the Lessons Learned About the Importance of State and Federal Support section of the Background and Literature Review.

This achieved a score of medium for its potential to contribute to the growth of Virginia's renewable natural gas industry because it would give this energy source recognition from state government, moving it from a fringe or new energy source to a mainstream source actively encouraged by state leaders. However, this designation would not provide any new programs to support that new interest. This option would

be effective because support from State Legislatures is important to the adoption of renewable natural gas facilities. For example, in 2006 California passed Assembly Bill 32: California Global Warming Solutions Act of 2006 (*Assembly Bill 32 Overview,* 2014). This bill mandated the adoption of clean energy technologies, and so placed the state on the forefront of testing new ways to harvest renewable energy (*Assembly Bill 32 Overview,* 2014). Then in 2018, California established an incentives program (SB 100) called the Renewables Portfolio Standard which declared that 60% of all retail electricity sales should be sourced from renewable energy sources by 2030 (*Renewables Portfolio Standard,* 2018). In this incentive program, the state directly names municipal solid waste, landfill gas, biomass, and anaerobic digestion under eligible technologies. As a result, California is home to two RNG production facilities notable for their success in this kind of energy collection: the Altamont Landfill and the Hillarides Dairy Digester (*Renewable Natural Gas: Landfill Methane Outreach Program,* n.d.) as well as over 120 dairy digesters (*Climate-Smart Dairy Digesters,* 2020). Because this option simply requires modification of language on an existing executive order, it is low cost and both politically and administratively feasible.

Option 3: Information Campaign on the Benefits of Methane Capture
In this alternative, Dominion Energy would create a campaign to inform methane producers about the potential benefits and financial incentives of partnering with utilities to capture methane for use as renewable natural gas. As renewable natural gas is an emerging technology, it is probable that the lack of quick adoption is due to a lack of information about what it is, who can participate, what is required, and what the benefits are of methane capture. This alternative would close that knowledge gap, and eligible industries would look to partner with Dominion Energy both to benefit financially from the capture of this otherwise unused byproduct as well as to reduce their carbon footprint.

Option 3 scored medium for its potential to contribute to the growth of Virginia's renewable natural gas industry because it will share information on the benefits for industries and for the environment of developing methane capture facilities, as this renewable energy source is relatively new and unknown. It did not score a high for this criterion because it provides no direct support or mandate to participate. This alternative would not require funding from the state, as this would be an initiative run by Dominion Energy to solicit private partners for renewable natural gas production. The cost would be equivalent to other Dominion Energy campaigns, and could be scaled to budget. Therefore, it is both politically and administratively feasible, as Dominion Energy has a media department who has institutional knowledge on how to successfully create and manage such a campaign as well as develop partnerships.

Option 4: Develop a Tax-Subsidy Program Similar to the Solar Investment Tax Credit

This alternative would operate in a similar fashion to the federal tax credit for private residents that install residential solar on their homes as well as for industries that install commercial solar. This tax credit program allows participants to deduct 30% of the overall cost of installing the solar system with no cap on the total value eligible (Smith, 2019). This program made achieving a solar home or business possible for many. In fact, since the creation of the federal solar tax credit in 2006, the U.S. solar industry has experienced annual growth of 52% (SEIA, 2019).

It scored medium-high for the potential resulting growth of Virginia's renewable natural gas industry because while it dramatically lowers the cost of installing methane capture systems to individuals, they will still have to cover the upfront cost before receiving the tax relief. This option would model its program after a federal tax relief program called the Solar Investment Tax Credit (SITC) which was passed in 2006, and has since been renewed until 2024 (Renewable Energy Extension Act, HR 3961 and S 2289). Since the introduction of the tax credit program, solar energy in the United States has grown by 52% annually (Solar Investment Tax Credit, 2020).

A tax subsidy clearly was effective in the rapid expansion of residential solar nation-wide, but it is undetermined as to whether it will be as successful for the renewable natural gas industry. The cost will be high for Virginia, as program administrators will need to be hired and there will be a loss of tax revenue to equal the number of capture facilities built. Dominion faces the costs of their lobbyists' time in order to have the program adopted by Virginia legislators. This alternative will face political opposition because of its cost to taxpayers, but will also receive support as a new green energy source in an increasingly green-friendly Virginia and Democratic-majority government.

Option 5: Develop a Digester Development Grant Program

This alternative would mimic the California Dairy Digester Research and Development Program (DDRDP), which awards $99 million in state grant funds to California dairy farms and operations for the purpose of building digesters to process organic waste into biogas and reduce methane emissions. These funds were appropriated from the Greenhouse Gas Reduction Fund (GGRF). The GGRF is funded by proceeds from the state of California's Cap and Trade program for greenhouse gas emissions. Because Virginia does not have a similar state program to tap into to fund this program, the state will need to look for assistance from federal programs and supporting biogas industry nonprofits and organizations. These include 1) the United States Department of Agriculture's (USDA) 2014 Farm Bill, which receives roughly $35 million per year to award to support producers of biofuels; 2) the Rural Energy for America Program, which makes $150 million available for loans and grants to small rural businesses and farms to support their efforts to promote

renewable energy production; and 3) Biomass Research and Development Initiative (a joint program between the USDA and the Department of Energy) which provides up to $20 million to projects that stimulate the research and development of biofuels (Tanigawa, 2017).

This option scores the highest in likelihood to expand the renewable natural gas industry in Virginia. This is because it provides immediate financial support to industries who would like to build methane capture facilities on their land. The success of a grant program was seen in the California Dairy region, where such a program caused the explosion in growth of methane collection facilities, with 123 new facilities under construction to join the 30 already in existence (*Climate-Smart Dairy Digesters,* 2020). The cost will be high to the state of Virginia, as this program will require the immediate availability of funds to be distributed to grant participants. The cost will also be the highest for Dominion, as this will be a more difficult program to be implemented because of the higher cost to the state.

This program and its associated costs may face political opposition because of its connection to Dominion Energy, and the potential for the program to be seen as Dominion arguing for the state to pay for a program that benefits the company. However, for an energy-conscious Virginia electorate, the financial costs will be worth the investment, as this type of grant program has been effective in expanding environmentally friendly energy sources. In California, for every $9 received by the grant program participants, one ton of greenhouse gas emissions were eliminated from the atmosphere (*Climate-Smart Dairy Digesters,* 2020). This is an excellent return on investment, as abatement costs for renewable fuel typically average about $100 per ton of CO_2 eliminated (Gillingham and Stock, 2018). In fact, the costs associated with different types climate and carbon reduction interventions, including wind and solar energy, gasoline taxes, CAFE standards, Energy Efficiency Programs, Renewable Portfolio Standards, and reforestation range from $10-over $1,000 per ton, making this program extremely cost-effective in comparison (Gillingham and Stock, 2018).

RECOMMENDATION

As indicated in the Outcomes Matrix on the next page, the recommended course of action for the client, Dominion Energy, is Option 5: encourage and work with Virginia lawmakers to create a Grant Program for facilities to build methane capture facilities to produce renewable natural gas in Virginia. This option scored highest of all 5 options on the most important criteria, which was the degree to which the alternative would expand the renewable natural gas capacity of Virginia.

OUTCOMES MATRIX

	Contribution to the Expansion of RNG in VA	*Cost (both to Dominion and to the State)*	*Administrative Feasibility*	*Political Feasibility*
Option 1: Let Present Trends Continue	**LOW** No additional incentive/action to encourage RNG.	**LOW** No additional cost associated with maintaining present behavior.	**HIGH** No actions required.	**HIGH** No actions required.
Option 2: Add Renewable Natural Gas to Ex. Order 43	**MEDIUM** RNG will be considered alongside other energy sources.	**LOW** This would incur only the administrative costs of an adjustment to an existing order.	**HIGH** Action requires known procedure.	**HIGH** This option does not change the order, just includes another energy source.
Option 3: Information Campaign on the Benefits of Methane Capture	**MEDIUM** Industries will become aware of RNG.	**MEDIUM/LOW** Cost of a campaign can range depending on range of reach and materials.	**HIGH** Dominion Energy has the staff and institutional knowledge.	**HIGH** No political approval required.
Option 4: Tax-Subsidy Program	**MEDIUM/ HIGH** Cost of installation is lessened, but not eliminated.	**MEDIUM/HIGH** Costs for the state would be on the back-end, after installation of the capture facility; state would have reduced income from taxes. Costs for Dominion would require focus of paid lobbying team.	**MEDIUM** Virginia may lack the structures in place to implement a program modeled after a federal tax-subsidy program.	**MEDIUM** This alternative would receive mixed support from environmental supporters and budget hawks.
Option 5: Grant Program	**HIGH** Eliminated cost reduces the main barrier to building such a facility.	**HIGH** State would need to provide entire cost of methane capture facility installation upfront. Dominion would require entire focus of lobbying team at the cost of other opportunities.	**MEDIUM** Virginia may lack the structures or revenue streams in place to implement a program modeled after a California grant program.	**MEDIUM** This alternative would receive mixed support from environmental supporters and budget hawks.

IMPLEMENTATION

Stakeholders

There are many stakeholders involved in moving my recommendation forward. The largest include Dominion Energy, with all electric energy and business departments; the State Corporation Commission, a Virginia state regulatory agency whose authority encompasses utilities; the Virginia Department of Environmental Quality, who will evaluate how a renewable natural gas system needs to be implemented to benefit the state; Virginia-based environmental groups such as the Sierra Club, Advanced Energy Economy: Virginia, and more; the Appropriations Committee, who will determine if and what amount of funding is shifted to cover this program; the Rules Committee, who will establish the rules that will either facilitate or hinder the adoption of this program; Dairy Digester Grant Program managers in California, who could provide essential learning and advice; the rate payers (who are also the taxpayers) who can advocate for the addition of this new renewable energy source, or might bear the brunt of its cost if it fails in the market; the owners and managers of livestock farms and landfills, who will face upheaval at their facilities to build methane capture facilities; homeowners near these industries, who might be impacted by the building of new infrastructure. It will be essential to engage with all stakeholders to ensure the successful outcome of the chosen alternative.

Next Steps

First, reach out to different environmental focused agencies and state committees to build understanding of renewable natural gas and how it could be beneficial for the state of Virginia to invest in it. Next, Dominion Energy will need to work with lawmakers to draft a bill for the grant program, and begin lobbying efforts to get it passed in the next session of the General Assembly. For this purpose, it is recommended that Dominion Energy consider lawmakers such as Senator Jennifer McClellan (D-Richmond), who recently championed the Virginia Clean Economy Act, which passed and was signed into law by the Governor in the 2020 session. During this process, lobbying should be focused on the stakeholder groups, to ensure that they are on board with supporting the adoption of renewable natural gas by the creation of a grant program.

Preparation for Potential Pitfalls and Scenarios

The perspective of some stakeholders, such as energy consumers, is so far unknown as this is a very new technology that is not yet a major part of the national renewable energy conversation. Environmental companies may show a combination of support and resistance. The same goes for the General Assembly, who may be interested in expanding Virginia's renewable energy portfolio but unsure about their commitment to the cost of such an action. The best way for Dominion Energy to mitigate these concerns is to provide full and complete information to as many of these various stakeholder groups as it can reach through media and in-person channels. They will

need to exercise leadership to influence a movement toward adopting biofuel in Virginia that will outweigh the concerns of opponents.

1) It is possible that environmental groups could push back on this initiative instead of embracing it. There has already been some vocal dissent from environmental groups in North Carolina about the Smithfield Foods/Dominion Energy partnership to capture methane gas for use as biofuel. Their objection centers around the idea that building methane capture facilities creates financial incentives for industries to create more trash or raise more livestock in order to then produce more biogas if it were to become financially lucrative. This would encourage industries to expand, rather than reduce, their methane output. In order to quell these concerns, a cap on the expansion of any methane capture partner facility would need to be included.

2) Proposals to build local pipelines for the distribution of renewable natural gas to power plants, homes, and businesses could be denied or made impossible during the regulatory process.

3) There may be barriers to building the necessary facilities. For instance, landfill companies and livestock farmers may not be interested in building methane capture facilities on their grounds. Additionally, there may not be a sufficient number of farms/landfills near populated areas or there may be environmental or landscape concerns that render interested facilities inaccessible for this kind of a program. Finally, livestock farmers and landfill managers may be interested in building methane capture facilities, but are inclined to use it to power their own facilities as opposed to selling the power to Dominion Energy, and, therefore Dominion customers.

4) Public or company opinion could waver as a result of the novel Coronavirus pandemic. The economy is likely to experience a severe recession as a result of the forced business closures. In that circumstance, the public as well as the company may be risk-averse to investing in new renewable energy technologies that are yet untested in Virginia.

I think it is most important to consider the scenario raised in #4. The successful implementation of a project of this nature and scope will be reliant on perceived surplus funding in the state budget. If the state is recovering from or in the midst of a recession, it is likely to assume there will not be a large policy window open for this particular issue. The issue brought to attention in #3 is the second most likely risk. Because this is a new energy source, barriers are very likely to be present, and there will not already exist solutions in Virginia for these particular barriers. It is recommended that a strategy is created to address these potential issues for the recommended alternative to be successful.

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