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Is Biogas a Good Deal for Surry County?

Executive Summary

Biogas is produced during the anaerobic digestion process when organic matter decomposes. Biogas is collected from three main sources: landfills, wastewater treatment plants, and animal manure. Concentrated Animal Feeding Operations (CAFOs) are the primary source of biogas when sourced from animal manure. CAFOs are responsible for negatively impacting the environment, human health, and the animals' quality of life. Thus, CAFOs and biogas are directly related. After biogas is collected from its source, it is treated and upgraded to become renewable natural gas (RNG) which can be used in the same way as natural gas. Additionally, there are many state and federal programs that provide economic and educational support to promote biogas adoption in the United States. Biogas producers rely on economic support to profit from this technology.

Overall, biogas has advantages and disadvantages as a technology used to generate renewable electricity. In this paper we analyze these advantages and disadvantages through a case study of Align RNG's (the joint venture between Dominion Energy and Smithfield Foods, Inc.) plan to build a gas upgrading facility in Surry County, Virginia. This facility would be the first of its kind in Virginia. It would collect the biogas from 20 hog farms within the state and convert it into RNG to generate electricity. We conducted interviews and contacted relevant stakeholders to learn more about how community members, industry, and environmental groups all view this proposed biogas project in Surry County. Throughout this paper we include several analysis points that we have **bolded** in order to add our own thoughts and highlight key ideas. We conclude our paper with our recommendations for Surry County and Virginia.

The following are our key analysis points:

- Despite general state and federal support for biogas, it still represents an extremely small portion of the United States' electricity production. We do not see it ever fully replacing natural gas.
- Although biogas is a renewable energy source, it should not be confused with a greenhouse gas emissions free/carbon free source, as CO₂ is emitted.
- Biogas is a promising technology for mitigating the release of methane, but also perpetuates a reliance on natural gas infrastructure and CAFOs.
- Despite Virginia's sparse CAFO concentration, Align RNG has identified several economic benefits of this project.
- The lack of comparable projects in other states prevents accurate predictions of impacts on communities.
- Biogas is not financially viable without government subsidies or drastically improving technological efficiency.
- Biogas and RNG allow politicians of both political parties and oil and gas industry groups to maintain the status quo and pander to their bases.
- Biogas stakeholder groups have conflicting priorities within their specific group, as well as between other stakeholders.

Objective: research and analyze the advantages and disadvantages of extracting gas from hog lagoons (current federal and state laws identify biogas as renewable energy).

Your research should examine:

- (1) funding/financing and any other support (education, promotion) provided by federal or state governments
- (2) cost-benefit analysis of this energy source
- (3) current state of technology and future technology prospects
- (4) stakeholder groups
- (5) alternatives for treating animal waste

Table of Contents

INTRODUCTION.....	4
BIOGAS ADVANTAGES AND DISADVANTAGES	4
DEFINING BIOGAS.....	4
DEFINING CAFOs.....	6
ENVIRONMENTAL JUSTICE CONSIDERATIONS	7
STATE AND FEDERAL SUPPORT FOR BIOGAS.....	9
RENEWABLE NATURAL GAS EMISSIONS SAVINGS.....	10
THE FUTURE OF BIOGAS AND BIOGAS TECHNOLOGIES.....	11
SURRY COUNTY CASE STUDY	13
VIRGINIA SUPPORT FOR BIOGAS.....	13
SURRY COUNTY DEMOGRAPHICS.....	13
PLANS	14
COSTS	18
METHODOLOGY.....	20
INTERVIEWS OF KEY STAKEHOLDER GROUPS	21
COMMUNITY MEMBERS	21
INDUSTRY	23
ENVIRONMENTAL GROUPS.....	27
STAKEHOLDER CONFLICTS.....	29
BIOGAS RECOMMENDATIONS FOR VIRGINIA AND SURRY COUNTY.....	30
APPENDICES.....	31
APPENDIX A. ADDITIONAL FEDERAL PROGRAMS.....	31
APPENDIX B. LIFESTYLE CHANGES	31
APPENDIX C. BIOGAS SOURCE FROM FISH WASTE	32
APPENDIX D. FACEBOOK MESSAGE SCREENSHOTS.....	32
APPENDIX E. COMMUNITY MEMBER QUOTES	34
APPENDIX F. MAXIMIZING BIOGAS BENEFITS	35
APPENDIX G. TRADEOFFS BETWEEN BIOGAS AND HOG FARM EFFICIENCIES.....	36
REFERENCES	38

Introduction

Biogas Advantages and Disadvantages

Table 1. The following chart provides a short overview of some commonly identified advantages and disadvantages of biogas implementation that we will explore in greater detail throughout this paper.

Advantages	Disadvantages
Nationally accepted “renewable energy”	Production and consumption of biogas release toxic and flammable air contaminants
Offers local jobs and increases tax revenue	Limited efficiency despite high cost
Reliable alternative to coal/natural gas because it is stored and available on demand	Methane released from leaks would lead to a net increase in fossil fuel emissions
Diverts methane that would otherwise be released to the atmosphere	Undesirable odor associated with biogas sources
The slurry produced is rich in N, K, and P, making it a readily available organic crop fertilizer	Reduced property value for surrounding community
Diversifies farmer income, resiliency, and independence	Environmental justice concern as disadvantages primarily impact impoverished communities and people of color

Defining Biogas

Biogas is produced when organic matter, such as animal manure, municipal waste, plant material, food waste, or sewage, is broken down during anaerobic digestion (National Grid, 2022). Anaerobic digestion or decomposition occurs naturally in swamps and lakes and under controlled conditions in anaerobic digester tanks (Image 1). Digestate is the material remaining after the anaerobic digestion process, which is typically recycled and used as fertilizer. Biogas is usually collected from three main sources: municipal solid waste landfills, sewage and industrial wastewater treatment (WWTP), and animal waste (U.S. EIA, 2021). After being collected, biogas can be utilized for heating, automobile fuel, or electricity generation. When biogas is

treated to remove gasses like carbon dioxide, it is upgraded to renewable natural gas (RNG), also called biomethane. Once upgraded to RNG, biogas is used in the same manner as natural gas (Korbag et al., 2020).



Anaerobic digesters at the Lincoln, Nebraska wastewater-treatment facility

Source: Lincoln, Nebraska government (copyrighted)



An anaerobic digester at a dairy farm

Source: Michigan State University (copyrighted)

Image 1. (U.S. EIA, 2021)

The biogas production yield depends on the source. The highest yielding feedstock is from municipal and solid waste, followed by crop residues, and animal manure as the least efficient. For example, industrial waste can provide about 0.40 ton of oil equivalent of energy per ton, while poultry and pig manure can provide only about 0.039 ton of oil equivalent of energy per ton (IEA, 2020b) (Figure 1). Landfills represent over 90% of RNG production in the United States, meaning that other RNG sources are relatively low. This is because landfills already have methane collection technologies and produce high volumes of gas in a concentrated area (Cyrs & Feldmann, 2020). Biogas' current contribution to national electricity production is very low. Biogas collected from landfills generated about 0.3% of the U.S.' utility scale electricity generation in 2020, while biogas collected from sewage and industrial wastewater treatment and from animal waste sources generated even less (U.S. EIA, 2021).

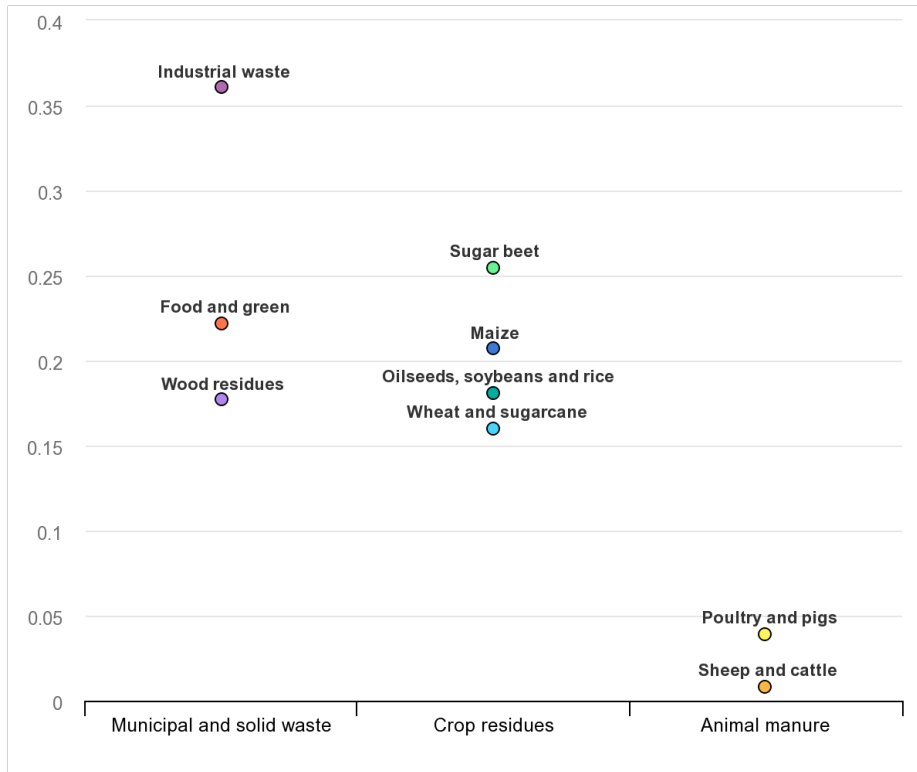


Figure 1. This chart depicts the efficiency of different biogas sources; the y-axis represents toe/ton of feedstock (IEA, 2020b).

Defining CAFOs

The U.S. is home to an estimated 1.2 million livestock and poultry farms (CRS, 2010). The EPA defines Animal Feeding Operations, AFOs, as facilities in which cattle, hogs, and poultry are raised in confinement (CRS, 2010). Concentrated Animal Feeding Operations, abbreviated to CAFOs, are a subset of AFOs (Image 2, Image 3). The distinguishing factor in CAFOs is their size. Less than 5% of AFOs qualify as CAFOs, yet CAFOs account for more than 40% of U.S. livestock raised in confinement (CRS, 2010). The number of confined livestock operations regularly falls year to year. However, the overall number of animals raised in feedlots continues to rise as CAFOs increase their output (CRS, 2010). Virginia is home to 139 large CAFOs (Bowles, 2015). All AFOs in Virginia require a Virginia Pollution Abatement Permit (VPA). CAFOs are regulated under the Clean Water Act and require National Pollutant

Discharge Elimination System (NPDES) permits and the Virginia Pollution Discharge Elimination Permit (VPDES) within the state (Bowles, 2015).



Image 2. Above is an example of a poultry CAFO (RAHU, 2018).



Image 3. Above is a picture of a swine CAFO (NRDC, 2019).

Environmental Justice Considerations

The CAFOs are regularly constructed in rural and impoverished areas. Their construction has come into conflict with civil rights organizations, including the NAACP and the North Carolina's Poor People Campaign (Azhar, 2021). The discharges from CAFOs that degrade groundwater, surface water, and air quality disproportionately harm the surrounding Black and Latinx communities as exemplified by the Smithfield plants in North Carolina (Hribar, 2010). There are ongoing debates as to whether or not current meat production involves humane

practices. Leaked photos from Smithfield farms support the argument that hog farms are not following best practices for the animals (The Humane League, 2021).

CAFOs negatively impact human health by degrading both surface and groundwater, as well as air quality. These large feeding operations release pollutants including: “Nitrogen, Phosphorus, pathogens such as E. coli, growth hormones, antibiotics, chemicals used as additives to the manure or to clean equipment, animal blood, silage leachate from corn feed, or copper sulfate used in footbaths for cows” (Hribar, 2010). The incidence of lung disease and asthmatic symptoms in community members is linked to the nearby CAFOs impact on air (Hribar, 2010). Particulate matter and ammonia, in particular, cause asthma, bronchitis, interstitial lung disease, and scarring of the airways in severe cases (Hribar, 2010). The incidence of respiratory disease is heightened in children and agricultural workers near CAFOs due to greater air intake and exposure. The odor associated with biogas comes from the microorganisms in the waste input. In our case study, the odor is from the bacteria in the hog feces and the process of decomposition in the hog lagoon (Audrey, 2018). The renewable natural gas upgrading facility receives the biogas from the hog lagoons, but does not smell because the system is entirely sealed. Placing caps over the hog lagoons is proven to reduce the smell that is emitted (Audrey, 2018). However, covering the hog lagoons does not address the environmental concerns of runoff from the site and spray fields. In some cases, the covers can amplify the environmental impacts because the nitrogen and other pollutants cannot vent and therefore become more concentrated before they are sprayed onto the surrounding fields (Oglesby, 2021). Communities in North Carolina have requested that Smithfield use advanced nitrification/denitrification techniques to reduce the nitrogen and ammonia released from hog lagoons (Oglesby, 2021). Smithfield is within compliance and has

no intentions of implementing these strategies to address the odor and health concerns related to the hog lagoons (Oglesby, 2021).

State and Federal Support for Biogas

At the federal level, the U.S. Renewable Fuel Standard (RFS) program requires a specific volume of renewable fuel to replace petroleum-based fuels in the U.S. transportation fuel supply. In 2014, biogas was approved by the EPA to qualify as an “advanced or cellulosic biofuel” if the fuel is 60% less greenhouse gas intensive than gasoline (Environmental and Energy Study Institute, 2017; U.S. EIA, 2021). In order to achieve program compliance, RFS program refiners or importers must obtain Renewable Identification Numbers (RINs), which are credits that meet a renewable volume obligation calculated and established each year by the EPA. RIN types (in four categories: cellulosic biofuel, biomass-based diesel, advanced biofuel, and total renewable fuel) correspond with D-codes (D3 RIN through D7 RIN) (U.S. EPA, 2022a). The advanced biofuel category corresponds with D5 RIN and the cellulosic biofuel category corresponds with D3 RIN (U.S. EPA, 2022b). Biogas or RNG generally fall under D3 RIN or D5 RIN, and the EPA has approved RNG sourced from agricultural digesters including agricultural residues and manures to fall under the D3 RIN category (Pleima, 2019). This means that waste from hog lagoons is regulated under the RFS program, through D3 RINs. Other federal programs that support biogas stem from the 2014 Farm Bill (Appendix A).

At the state level, biogas qualifies in at least 22 states as a renewable fuel source for electricity generation under renewable portfolio standards (Weiss et al., 2020; U.S. EIA, 2021). This can promote its use in the electricity sector, as states are trying to transition away from fossil fuels. Additionally, the two main carbon cap and trade systems in the U.S. (California and the Regional Greenhouse Gas Initiative) permit farms to install anaerobic digesters for carbon

offset credits (Weiss et al., 2020). Several states, including California, Maryland, and Minnesota, operate financial assistance programs similar to the federal Rural Energy for America Program (Weiss et al., 2020). States also utilize tax incentives to promote biogas collection and use in the agricultural sector. States can exempt farms from property taxes if they generate methane from animal waste (such as in Iowa), exempt sales tax on products used to construct and implement anaerobic digester technologies (such as in Wisconsin and Colorado), or implement production tax credit programs that provide a credit for each kWh of energy generated from biogas (such as in Utah and Maryland) (Weiss et al., 2020).

Despite general state and federal support for biogas, it still represents an extremely small portion of the United States' electricity production. We do not see it ever fully replacing natural gas. At only 0.3% of the United States' total primary energy, biogas accounts for an almost negligible portion of energy production (IEA, 2020b). As expressed in Figure 1, animal waste is a far less productive input than waste from WWTPs. Additionally, WWTPs represent a concentrated source of biogas while hog farms require building additional pipelines to connect farms to a central GUS. Capturing biogas from WWTPs should be prioritized for more successful energy production. However, even if all farms and other potential sources of biogas were developed, RNG would only replace 16% of the current natural gas used nationwide (Feinstein & de Place, 2021). This presents a massive obstacle to scaling biogas to become a primary energy source in the U.S. energy mix.

Renewable Natural Gas Emissions Savings

Livestock operations are responsible for approximately 18% of greenhouse gas production globally, and over 7% of U.S. greenhouse gas emissions (Massey & Ulmer, 2008; Hribar, 2010). The greenhouse gas emissions are especially potent because the main components, methane and nitrous oxide, have global warming potentials 23 and 300 times

greater than carbon dioxide (Hribar, 2010). These gasses are captured and used as the primary input in biogas production. The greenhouse gas (GHG) emission savings of RNG stem from avoiding the GHG emissions that would occur during typical waste management. The highest GHG emissions savings occur when the source is actual waste that cannot be utilized for other purposes and when production and use result in a net reduction of methane. In most cases, RNG generates a net-negative carbon intensity through avoiding carbon dioxide emissions per quantity of fuel consumed (Cyrs & Feldmann, 2020). RNG is comprised of mostly methane and releases carbon dioxide when burned. The carbon dioxide released is less harmful to the atmosphere than the methane that would have been released without biogas capture. However, methane leaks throughout the RNG life cycle reduce the GHG emissions savings (Cyrs & Feldmann, 2020).

Although biogas is a renewable energy source, it should not be confused with a greenhouse gas emissions free/carbon free source, as CO₂ is emitted. We want to make it clear that biogas does emit greenhouse gasses to produce electricity, unlike alternatives such as solar, wind, and nuclear. When producing electricity, biogas emits carbon dioxide instead of emitting the more potent greenhouse gas, methane, that would have been emitted if the biogas was not collected. Biogas is a net-negative or GHG emissions savings electricity source, but it is not more environmentally beneficial than true carbon free electricity sources. We believe that although collecting biogas is a better option than allowing methane from waste to be released, it would be most effective to reduce or eliminate the waste source. Additionally, it is crucial that this distinction is communicated to the general public because it can be easily misunderstood.

The Future of Biogas and Biogas Technologies

The International Energy Agency (IEA) has described RNG as “indistinguishable from natural gas” (IEA, 2020a). The IEA predicts that globally RNG has the potential to replace natural gas. This is due to the fact that natural gas transmission and distribution infrastructure

and end-user equipment do not need to be changed for RNG use (IEA, 2020a). This incentivizes expanding fossil fuel infrastructure and encourages continued fossil fuel use (Cyrus & Feldmann, 2020).

Biogas is a promising technology for mitigating the release of methane, but also perpetuates a reliance on natural gas infrastructure and CAFOs. Reducing waste streams is preferable to relying on biogas. Ultimately, biogas encourages the continuation of CAFOs and meat consumption (Appendix B) by providing a financial incentive for CAFOs. Additionally, increasing biogas production leads to expanding fossil fuel infrastructure and hinders the transformation to carbon free energy sources.

The future of biogas relies on alternative sources, such as fish waste (Appendix C). Another alternative biogas source is from wastewater treatment plants. Wastewater treatment plants do not contribute to the unethical farming practices that are criticized of other biogas sources like livestock waste. It is estimated that electricity generated from wastewater treatment plants in the United States could supply about 12% of the U.S.'s national electricity demand. However, of the 16,000 U.S. wastewater treatment plants, only 1,300 (about 8%) have anaerobic digesters on site, and only 860 have equipment to use their biogas (U.S. DOE, 2021). Wastewater treatment plants are a biogas source with untapped potential.

The technologies used for biogas cleaning and upgrading represent the future of the biogas industry. New technologies can yield RNG containing 95-99% methane with only 1-3% carbon dioxide (Korbag et al., 2020). This expands the number of applications for biogas use and allows biogas to be utilized just like natural gas, therefore replacing it in all its applications. However, there are still some challenges associated with current biogas technology. The biogas pollutants (including hydrogen sulfide, volatile organic compounds, siloxanes, carbon monoxide,

and ammonia) are not only harmful to human health, but also have corrosive or damaging properties that cause issues and malfunctions in the machines and infrastructure used throughout the biogas production process. Anaerobic digestion requires additional heat (and therefore increased energy consumption) during cold weather, and there are also no current technologies that can simplify the biogas cleaning/upgrading process, as these treatment steps require significant energy consumption after initial anaerobic digestion (Korbag et al., 2020). Solving these technical limitations through technological innovation would help increase biogas use through increasing efficiency, lowering costs, and addressing harmful pollutants.

Surry County Case Study

Virginia Support for Biogas

In March 2022, Senate Bill 565 (SB 565) and House Bill 558 (HB 558) both passed in Virginia (Virginia's LIS, 2022a; Virginia's LIS, 2022b). This legislation encourages Virginia's natural gas utilities to invest in biogas infrastructure to capture methane (Vogelsong, 2022). The bills specify that natural gas utilities can recover “eligible infrastructure costs” for biogas supply infrastructure projects through the gas component of the utility's rate structure or other economic recovery mechanisms (Virginia's LIS, 2022a; Virginia's LIS, 2022b). The bills represent a unique situation where both Democrats and Republicans are in support of environmental legislation that targets renewable energy technology (Vogelsong, 2022).

Surry County Demographics

Surry County is a historic town in Southern Virginia (Figure 2). Even at the time of the settlers, a portion of the land they settled along was called Hog Island where the settlers raised hogs (Surry County Virginia, n.d.). The town has remained a rural location throughout its 370 year history. According to the 2020 U.S. Census, the population of Surry County totals 6,561 people, a 7% decline from the 2010 population of 7,058 (U.S. Census Bureau, 2021). The

median household income is \$56,525 which is \$8,469 below the national average. Additionally, the percentage of poverty is 11.6%, which is slightly higher than the national average of 11.4% (U.S. Census Bureau, 2021). Surry County is racially made up of 55.2% White citizens and 41.5% Black or African American citizens (U.S. Census Bureau, 2021). All other racial groups are underrepresented. Despite the small presence of Hispanic or Latino representation, the population of people identifying as Black or African American is significantly higher than the national average of 13.4%. The population breakdown adds weight to the argument that Black and Latino communities are often unfairly targeted in the siting of undesirable projects.



Figure 2. Above shows the map of Virginia with Surry County highlighted in red (Location with the U.S. state of Virginia, 2006).

Plans

Align RNG is the joint venture between Dominion Energy and Smithfield Foods, Inc. Biogas sourced from hog farms is Align RNG's focus (Align RNG, 2020). Align RNG already has a fully operational RNG plant in Utah (Image 4) and is constructing a RNG plant in North Carolina. Now they are planning to add a new project in Surry County, Virginia, which would be Virginia's first biogas project sourced from hog farms. This project is referred to as the Surry County project or the Waverly project. Align RNG intends to complete the project by Fall 2022

and will be responsible for the construction, operation, and maintenance of the project (Align RNG, 2022).



Image 4. Above is a picture of an anaerobic digester in Milford, Utah (Surry County Planning Commission, 2021).

This project plans to construct a central conditioning facility, also called a gas upgrading system (GUS) in Surry County that would be about 5 acres in size (with a 3.9 acre facility site and a 1.1 acre access road) (Image 5). This facility would be the only above ground facility included in the project. Twenty farms owned by Smithfield located in Surry, Sussex, Isle of Wight, and Southampton counties would be connected to the GUS through an underground pipe system. From our research, it appears that at least 7 of the 20 farms included in the Waverly project are considered to be CAFOs (GoogleMaps, 2015) (Align RNG, 2022). Two maps are shown in Figures 3 and 4. Biogas from the farms' anaerobic digesters would be sent to the GUS where the biogas will be processed to meet pipeline quality standards and become renewable natural gas for delivery to end users through the natural gas pipeline system. The estimated

annual RNG production is 201,556 dekatherms or enough to heat over 2,500 homes and the estimated annual emissions reduction is 103,000 metric tons of CO2 equivalent (Surry County Planning Commission, 2021).



Image 5. Above is an image of an Align RNG central conditioning facility currently in operation (Surry County Planning Commission, 2021).



Figure 3. Above is a map of the proposed Waverly project (Surry County Planning Commission, 2021).

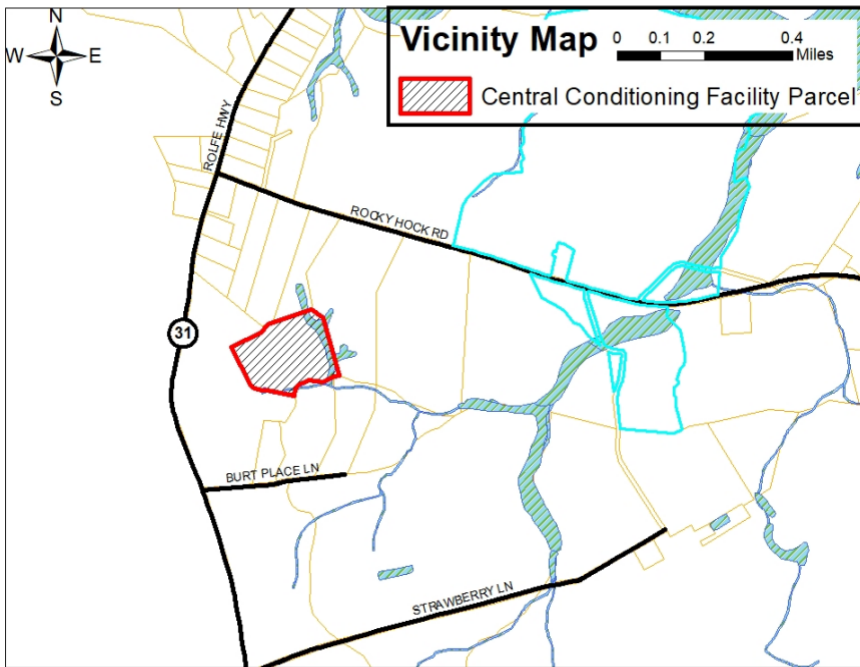


Figure 4. Above is a map of the proposed Central Conditioning Facility location (Surry County Planning Commission, 2021).

A Conditional Use Permit was submitted by TRC Environmental Corporation on behalf of Align RNG in 2021 to build the central conditioning facility in Surry County, so that they could receive a zoning exception. TRC Environmental Corporation is the environmental and engineering consulting firm that prepared and submitted the Conditional Use Permit, in addition to conducting a natural and cultural resources investigation at the proposed central conditioning facility location. The Conditional Use Permit proposal and application included evaluating the adverse impacts during the construction and operation of the facility. The evaluated impacts included: traffic congestion, noise, lights, dust, drainage, water quality, air quality, odor/fumes, vibrations, as well as more general historic and cultural resources and environmental concerns (Surry County Planning Commission, 2021). The main strengths and weaknesses of the project included in the Conditional Use Permit proposal and application are shown in Figures 5 and 6.

Strengths

- Setbacks and buffers proffered are greater than the M-1 Zoning Standards
- The subject property accessed via a private drive by a major thoroughfare.
- Unlikely to smell gas on site
- Provides a diverse means for renewable energy
- Use of the subject property will expand the County's tax base.

Figure 5. Above is a list of project strengths identified by Align RNG(Surry County Planning Commission, 2021).

Weaknesses

- Emergency Hazards for incidents are unknown.
- No projects for comparison within the state of Virginia

Figure 6. Above is a list of project weaknesses identified by Align RNG (Surry County Planning Commission, 2021).

After submitting the Conditional Use Permit proposal and application, Surry's Planning Commission voted in September 2021 to delay their decision for 60 days. This was likely influenced by Surry residents voicing their opposition to the project at the September public hearing (Faleski, 2021a). In November 2021 Surry's Planning Commission voted to approve the project. Surry's Board of Supervisors must vote on the final decision (Faleski, 2021b). In January 2022, Surry's Board of Supervisors decided to postpone their vote and announced at their April 7, 2022 meeting that they are further postponing the vote until June (Faleski, 2022; Staff Reports, 2022).

Costs

One of the main barriers to biogas production in the United States is the high initial anaerobic digester capital costs. The majority of the anaerobic digester systems that have been built in the United States have received aid from government programs to reduce high upfront

costs (Lisowyj & Wright, 2018). In fact, the EPA has identified that the typical size of profitable biogas recovery systems for swine operations is a minimum of 2,000 swine (U.S. EPA, 2018). Increased biogas production will only be possible with continued financial support from government programs. Specific to biogas sourced from swine and dairy operations, the EPA estimated that these farms could generate about 16 million MWh of electricity per year. The EPA has also identified Iowa, North Carolina, Minnesota, Illinois, and Indiana to be the top five states with electricity production potential from swine manure. These states offer the best potential for expanding biogas. Virginia is not an optimal location due to its low number of swine and dairy farms compared to other states (U.S. EPA, 2018).

Despite Virginia's sparse CAFO concentration, Align RNG has identified several economic benefits of this project. The project invests in innovative technologies, diversifies local economies, makes hog farming more sustainable, and strengthens local tax bases. The total project cost is approximately \$40.2 million for construction in Surry County (Surry County Planning Commission, 2021). The financial strengths and weaknesses identified are included in Figure 7. Additionally it is estimated that the project will generate an annual tax revenue for Surry County of about \$243,309 (Figure 8). Surry County collects a local option sales tax which is a tax implemented at the county level meant to be utilized for funding local projects. When calculating the average monthly local option sales tax of Surry County from January 2021 to February 2022, Surry County generated on average \$71,307.54 per month (University of Virginia, 2022). The biogas project would be generating about three months worth of the local option sales tax, contributing a significant amount of revenue for Surry County. However, it is unclear whether the Surry community would reap any of the financial benefits. Additionally, it is

uncertain whether the community members in the counties where the hog farms are sited will receive any tax benefits, as only the farmers are likely to benefit.

Strengths

- Increased Direct, Indirect and Induced Economic Impact on Surry County for 2021 – 2022
- Increased Direct, Indirect and Induced Economic Impact on Surry County for 2023 and ongoing
- Possibility of spurred clean energy clusters developing in Surry County
- Partnerships with local farmers

Weaknesses

- Low job creation

Figure 7. Above is a list of financial strengths and weaknesses identified by Align RNG (Surry County Planning Commission, 2021).

Table 3.1: Tax Revenue for the County Government from the Waverly Project

	Tax Category	Surry County
Construction (2021-2022)	BPOL	\$964
	Total Construction	\$964
Annual Operations (2023 Onward)	Real Estate	\$171,039
	Machinery and Tools	\$72,270
	Total Operations	\$243,309

Source: Chmura Economics & Analytics

Figure 8. Above shows the estimated annual tax revenue for Surry County (Surry County Planning Commission, 2021).

Methodology

In March 2022 and April 2022, we conducted three formal interviews over Zoom and one informal virtual Q&A session. To represent industry, we interviewed an employee of both Smithfield and Align RNG (Smithfield employee with name redacted, personal communication, March 18, 2022), as well as a Business Development Manager focused on RNG at Dominion Energy (Dominion employee with name redacted, personal communication, April 4, 2022). Both sources are working on the Surry County project. To represent environmental groups, we interviewed a Senior Program Manager working at the Water Environment Federation (WEF) (WEF employee with name redacted, personal communication, March 18, 2022). WEF is a “a

not-for-profit technical and educational organization” based in Alexandria, Virginia “representing water quality professionals around the world” (WEF, 2022). We also asked relevant questions about biogas to a staff attorney for Food and Water Watch through an informal Q&A session (Food and Water Watch employee with name redacted, personal communication, March 29, 2022). Food and Water Watch is an organization that works “to protect people’s health, communities, and democracy from the growing destructive power of the most powerful economic interests” (Food and Water Watch, 2021).

The data for community member opinion was collected through interviews recounted in articles and through Facebook posts and messages. On March 6th, 2022 we created a Facebook post to inquire about the opinions of people in the Facebook Group: What’s REALLY happening in Surry. The post received 23 comments and responses, excluding our responses. In order to protect the privacy of community members all names are redacted from the Facebook post figures (Appendix D). The names of community members are available in the articles, but are removed for the sake of space, with the exception of Michael Drewry who is the Dendron District Supervisor.

Interviews of Key Stakeholder Groups

Community Members

Community member opinions on the construction of the biogas facility have tended to have more negative outlooks. The concerns of odor, heavier traffic and machinery passing through neighborhoods, environmental damage, and devaluation of property have been consistent throughout many of their comments. The comments below express some of the key concerns and opinions from community members. For a full list of the collected quotations regarding the Waverly project (Appendix E).

One community member who commented in the Facebook post said, “We’ll be the county with views of solar panels and pipes. Stinky Surry worse than the paper mill in Hopewell. These people that want to do this to our countryside do not live here and don’t care.” Her comment expresses her concern for smell and feeling exploited by decision-makers who are siting undesirable projects. The selected site has raised concerns. One community member said, “They are trying to put a gas processing plant right smack in the middle of a bunch of houses on 31 just south of 604.” A different interviewee in the Staff Reports article shared that, “I counted 75 homes in a half-mile radius of this site... once that’s built, we have no way to get out of it.” Their comments reveal their concern for the siting of this project and whether the intended location is fair to those who live in Surry. Vice-Chair of Dendron District, Michael Drewry, said “Landowners have called me with concerns... I’ve had no one call in support, none.”

These quotes express the different concerns regarding the project and the varying levels of information that the citizens have obtained about the Waverly project and its impacts. The siting of the biogas processing facility is viewed by some citizens as yet another way in which they are being taken advantage of. It is important to note that there is some selection bias in this sample because people who are disappointed with the project are more likely to comment on the Facebook post, reach out to their officials, and attend town halls.

During the town hall hearing that took place on April 7th, 2022, Align requested delaying the public comment period prior to the start of the meeting. The head of the board approved this delay without putting it to a vote, violating standard practice. We corresponded with one contact via Facebook who said: “Research the other facilities across the country. They are all in wide open fields with no homes for miles. [The public hearing and vote] was removed from the Board of Supervisors meeting last minute illegally. Align found out we had enough votes to stop them

so they asked for it to be continued.” While his quote is speculation, he has been a well-informed constituent throughout the process and is concerned about the impact of the project on his neighborhood.

The lack of comparable projects in other states prevents accurate predictions of impacts on communities. As our Surry County contact expressed in his statement, there are no projects currently in the U.S. that mirror the scale and location characteristics of the Waverly project. Both of the already approved Align projects in Milford, Utah and Sampson and Duplin, North Carolina are located in remote locations away from housing developments (Align RNG, 2022). Regardless of the assessments that Align conducts to address the concerns of locals, there is inherent risk in being the first biogas project this close to residents’ homes. We agree with the concerned community members that long term impacts of biogas processing facilities cannot yet be determined and may include unforeseen consequences that wealthier communities are not being subjected to.

Industry

When asked how the biogas project will impact current hog waste management practices, our Smithfield source explained that without biogas collection, the hog farms have open air anaerobic lagoons where the manure is collected and treated and the liquid effluent with nutrients is land applied as a fertilizer. The gas portion of the manure is currently emitted into the atmosphere. If the biogas project is successful, a cover will be applied to the lagoons and the biogas will be captured and sent to a central gas upgrading system that will collect biogas from multiple farms (Smithfield employee with name redacted, personal communication, March 18, 2022).

One concern is that biogas production will encourage the continuation and expansion of CAFOs. When our Smithfield and Dominion sources were asked if the Surry County project

would lead to increasing the number or size of CAFOs to create more electricity, both had similar responses. Our Smithfield contact verified that the farms they hope to use in the Surry County project have “remained the same size for over three decades”. This source stated that there are currently no plans to change the sizes of these farms and that the goal of the project is to construct the GUS. Our contact noted that the farms are each too small on their own to produce biogas that would be profitable. Continuing on the topic of economic benefits, our Smithfield source noted that this project qualifies under the U.S. Renewable Fuel Standard under the D3 RIN category (Smithfield employee with name redacted, personal communication, March 18, 2022). Our Dominion contact explained that Dominion would love to expand their RNG production, but are utilizing the farms that already exist and do not have plans to expand the number or size of hog farms. Dominion is currently working on RNG projects sourced from hog and dairy farms, but this source anticipates that Dominion will expand to new biogas sources and into new renewable projects in the future (Dominion employee with name redacted, personal communication, April 4, 2022).

When asked if biogas and RNG have any safety or human health risks associated with them, our Dominion contact answered no, stating that once the biogas is upgraded to RNG it “becomes natural gas” and that it is “not flammable” and “not hazardous” (Dominion employee with name redacted, personal communication, April 4, 2022). This source also stressed that Dominion is always concerned with safety first and that they have emergency response plans in place for all biogas projects (Dominion employee with name redacted, personal communication, April 4, 2022). Both contacts were also asked about issues with siting biogas facilities due to communities not wanting them in their backyards. Our Smithfield contact believes gas upgrading systems do not negatively impact communities, as both odor and noise concerns are typically

addressed during planning and construction. This source noted that biogas reduces odors on farms, as the biogas is collected and sent to the GUS instead of being emitted into the air (Smithfield employee with name redacted, personal communication, March 18, 2022). Our Dominion contact noted that the main challenge with siting biogas facilities is the lack of education and the public perception. This source noted that industry gets pushback from the public and throughout all steps of the biogas siting process. Part of the Dominion employee's job is to answer the public's questions and educate people about biogas to reduce fears and misconceptions. This is accomplished through public comment periods, public hearings and meetings, and open houses (Dominion employee with name redacted, personal communication, April 4, 2022).

Despite our source's comment, after researching Dominion's public interaction, we found no record of open house events. Align RNG does promote answering community questions at Q&A sessions typically at the end of both in person and virtual county public meetings. However, in their North Carolina project, they have been criticized for not providing all of the information to residents. In February 2021, the Southern Environmental Law Center (SELC) challenged the four air permits granted to Smithfield and Dominion allowing them to build a biogas facility in Sampson and Duplin counties. SELC specifically challenged the North Carolina DEQ's decision to grant the air permits stating that key details about the project, including potential environmental impacts were not provided (Johnson, 2021; Southern Environmental Law Center, 2021).

Our Dominion source stated that the approval of the Conditional Use Permit is the largest barrier to the Surry County project. Dominion is hoping that this permit will get approved, as locating a new site for the GUS would be time intensive. This source explained that the Surry

County location was chosen for several reasons including access to a main road, limited environmental concerns, and an existing tree buffer area that would help to hide the facility. Our Dominion contact pointed out that although the project will utilize 5 acres of land, the equipment itself will only take up “a third of a half of an acre” of land. This source also noted how they have observed different concerns from the public when comparing Align RNG’s North Carolina project (under construction) and Align RNG’s Surry County Virginia project (still awaiting the Conditional Use Permit approval). With the North Carolina project, most public comments in opposition to biogas were against hog lagoons and CAFOs. This source stated that the public uses “biogas as a scapegoat for farming” practices. In contrast to these concerns, the Surry County community seems to be more concerned with noise and visual pollution. Our Dominion source explained how they have addressed these concerns. Dominion subcontracted a noise reduction company to conduct sound modeling and have subsequently added sound walls to their equipment plans. Additionally, the proposed site has many trees to hide the facility and reduce noise impact. Our source stated that this project would not impact property values (Dominion employee with name redacted, personal communication, April 4, 2022).

When our Dominion contact was asked if biogas is profitable today without subsidies or financial help from government agencies, they stated that more subsidies would continue to make it easier for biogas siting. This source mentioned that “the more subsidies that anyone could get obviously would make it more profitable”. When asked if biogas/RNG will be the new natural gas in the future, our source responded, “I definitely see it as being a good addition to natural gas”, but “I wouldn't say that it would totally take the place of natural gas”. This contact predicts that the U.S.’ future energy mix will be a combination of mainly solar, wind, and hydrogen (Dominion employee with name redacted, personal communication, April 4, 2022).

Biogas is not financially viable without government subsidies or drastically improving technological efficiency. Biogas produced from animal manure is more profitable for larger farms. Animal manure produces the least biogas per ton of waste compared to other potential sources. Due to the high cost and low efficiency of biogas, it would be more cost effective to invest in wind and solar. If the United States plans to invest in biogas as an electricity source, we recommend wastewater treatment plants. WWTPs are more energy efficient than animal manure, and there are minimal negative social consequences.

Environmental Groups

WEF has shown support for biogas and is also a member of the American Biogas Council, the trade association representing the biogas industry (American Biogas Council, 2022). Our WEF contact expressed that biogas production helps to avoid manure land application that can lead to nutrient runoff into water sources and eutrophication which results in plant and animal life dying from a lack of oxygen. This explanation establishes the relationship between biogas and water quality protection. When asked why WEF supports biogas, our source's main two reasons were cost benefits (revenue source for farmers and cost savings due to using a waste material for energy) and the reuse of a waste product (viewing waste as a valuable and recyclable resource) (WEF employee with name redacted, personal communication, March 18, 2022).

WEF is unique in their support for biogas, as several other environmental groups have expressed opposition, mainly due to environmental justice concerns. Some of these groups include the Sierra Club, the Southern Environmental Law Center, and the Natural Resources Defense Council (Vogelsong, 2022). The Sierra Club Virginia Chapter and Virginia Conservation Network have provided reasons for residents to oppose Virginia's SB 565 and HB 558. Some reasons include the lack of consumer and environmental protections in the bills, more

gas infrastructure, lack of enforced environmental benefit, and the overall promotion of CAFOs (Virginia Conservation Network, 2022).

Our Food and Water Watch source stated that “you are going to have to convert a lot of land over to animal agricultural practices which have their own water consumption issues to produce enough gas to support that.” When asked about Food and Water Watch’s stance, our contact said that “Food & Water Watch is really opposed to these biogas projects because essentially they’re a joint project between fossil fuel companies and CAFO operators to consolidate the animal agricultural industry under subsidies and greenwash their practices into being a green fuel... we feel it’s a false solution” (Food and Water Watch employee with name redacted, personal communication, March 29, 2022).

When asked how WEF views other environmental organizations that oppose biogas production, our WEF contact responded that there is a “lack of understanding” and that many people “fear the unknown”. This source explained that concerns about biogas facilities producing an odor or noise were invalid as there are technologies to mitigate issues (WEF employee with name redacted, personal communication, March 18, 2022). We brought up environmental justice to address the unfair concentration of these concerns in low income communities. Environmental justice seemed to be our contact’s last priority. Our discussion established that WEF’s priorities were not as holistic as other environmental organizations that incorporate environmental justice and community well-being into their missions.

Biogas and RNG allow politicians of both political parties and oil and gas industry groups to maintain the status quo and pander to their bases. The minimal infrastructure development required for biogas is both a benefit and detriment. By using pre-existing pipelines, RNG is a renewable energy that does not require the same transformational overhaul of other

renewables. Because it requires less drastic change, it is more palatable for voters to understand. However, it also further entrenches the U.S. in its reliance on natural gas. Politicians from both parties have the opportunity to spin biogas as a positive investment (i.e. good for the environment or positive for small farmers). Meanwhile, the statistics support that biogas only accounts for a miniscule fraction of the energy mix and is unlikely to increase drastically enough to become a major energy source. At present, investments in biogas are investments in fossil fuel infrastructure.

Stakeholder Conflicts

Biogas stakeholder groups have conflicting priorities within their specific group, as well as between other stakeholders. The community member stakeholder group is split between farmers generally supporting biogas as it will increase their profits, and residents near CAFOs or biogas upgrading facilities generally opposing biogas due to fears that it will influence their quality of life through odor, noise, and property value impacts. The energy industry and farming industry have a unique relationship with biogas sourced from animal waste, as they can work together to generate profits. Environmental groups overwhelmingly oppose biogas, with exceptions like WEF. Amongst politicians biogas is a unique case where Democrats and Republicans are both in support of a renewable energy technology, but for different reasons. Democrats in Virginia promote biogas as a climate change solution, while Republicans promote biogas as a revenue source for farmers and a technology that can be easily transitioned to as the infrastructure already exists. These stakeholder conflicts make the biogas issue very complicated as there are so many priorities involved, even within groups.

Biogas Recommendations for Virginia and Surry County

We do not see biogas becoming the new natural gas and think that biogas captured from hog farms is not worth the financial investment and additional infrastructure in Virginia. The continued reliance on pipelines allows oil and gas proponents to argue that biogas is an easy transition to renewable energy while still mainly relying on oil and natural gas. If Virginia does want to increase biogas production, the focus should be on wastewater treatment plants, which do not have the same social consequences as landfills and CAFOs. Landfills promote single use waste and CAFOs promote overconsumption of meat products. The disposal of trash and large meat consumption are behavior-related, making solutions of minimizing trash and altering diets a more environmentally-conscious route than maintaining these systems with the added investment of biogas. Biogas collected from wastewater treatment facilities is approximately three times more efficient than that from animal waste (IEA, 2020b). Ultimately, investing in renewables like solar and wind will be more profitable. These technologies do not emit any greenhouse gasses to produce electricity rather than being carbon negative, like biogas.

In the case of Surry County, Dominion and Smithfield are taking actions to address community concerns by making changes to proposed plans and interacting with community members. However, this case perpetuates unfairly siting undesirable projects in low income communities of color. Although the tax revenue for the Surry County project is viewed as a benefit, there are no public plans that ensure that this money benefits the community. **We do not support the approval of this project.**

Appendices

Appendix A. Additional Federal Programs

Key federal programs stemming from the 2014 Farm Bill include the following:

- The Bioenergy Program for Advanced Biofuels: providing payments to producers of advanced biofuels refined from sources excluding corn starch
- The Rural Energy for America Program: providing grants and loans of up to \$20,000 to agricultural producers and rural small business for implementation of renewable energy systems and equipment, as well as energy efficiency improvements
- The Biomass Research and Development Initiative: providing awards, grants, contracts, and financial assistance to research and development of biofuels and bio-based projects
- The AgSTAR Program: led by the EPA, USDA, and DOE that provides technical and regulatory assistance and planning guidance for the implementation of anaerobic digesters
 - (Environmental and Energy Study Institute, 2017; Weiss et al., 2020; U.S. EPA, 2021)

Appendix B. Lifestyle Changes

The practice of raising animals on a massive scale for slaughter is perpetuated by individual consumption. The market for meat in the United States has continued to grow. As of 2017, the average American consumed 144 pounds of meat annually (The Humane League, 2021). Pork is the third largest meat product behind beef and chicken, with an average consumption of 51 pounds per person annually (Davis & Lin, 2005). There are ongoing debates as to whether or not current meat production involves humane practices. Leaked photos from Smithfield farms support the argument that hog farms are not following best practices for the animals. For example the use of gestation crates and inhumane slaughter are still practiced throughout the U.S. (The Humane League, 2021).

Veganism, vegetarianism, and plant-based or other meat-limiting diets are often healthier for individuals and the environment. Most medical professionals, as well as numerous studies support primarily plant-based diets (Zimlich, 2021). The benefits of vegetarianism include reduced risk for major chronic diseases, cardiovascular diseases, obesity, and various cancers

(Craig, 2018). Ultimately, reducing the amount of meat each person consumes will reduce the demand for pork and send a market signal that the value of meat is declining. Downsizing farms will also decrease the profitability of renewable natural gas. This effort may be difficult to implement on a large scale, but does give consumers a voice on the matter of biogas proliferation.

Appendix C. Biogas Source from Fish Waste

One alternative and relatively new biogas source is fish waste. In 2019, the first full-scale biogas plant from fish sludge became operational at the Cermaq hatchery in Norway. At this location, the salmon waste generates about 500,000 kWh of energy per year used to heat the facility. This plant is unique because it only utilizes fish waste as the raw material to generate biogas (Salmon Business, 2019). Using fish waste rather than livestock waste, also helps address the fact that aquaculture and marine fisheries have lower emissions intensities and freshwater use when compared to that of terrestrial livestock. The emissions intensity of fish from aquaculture or marine fisheries are less than half of the emissions intensity of pork (MacLeod et al., 2020).

Appendix D. Facebook Message Screenshots

What's REALLY happening in Surry
Kathryn Weisbrodt · Mar 6 · 🌐

Kathryn Most of us just have issues with the location they have chosen to build it
4w Like Reply 1

Write a reply...

We are hoping to get them to choose a new location. If enough people can attend there may be a town meeting tuesday night. If anyone would like to attend and ask question/learn, let me know ASAP. Meeting would be in Dendron
4w Like Reply 1

we will be there.
4w Like Reply 1

Do you know if there will be an option to attend virtually? Will the meeting will be recorded?

They are trying to put a gas processing plant right smack in the middle of a bunch of houses on 31 just south of 604. There has been 3 planning commission meetings and 1 BOS meeting about it so far.

have no idea. I just heard about it when I saw this post and started looking into it
5w Like Reply 1

it is scheduled to be discussed again at the April Board Meeting. Any assistance from the community against this project would be greatly appreciated.
5w Like Reply 3

Write a reply...

Write a comment... 📷 🗨️ 🎬 😊

during construction and afterwards.
5w Like Reply 3

And increased truck traffic that will damage/destroy roads. Back roads + 18 wheelers = no bueno
5w Like Reply 3

Write a reply...

Did not know about this but I'm not surprised. It seems like those in charge are doing what they can to dissuade people from living here. Turning it into a county with scenic views of solar panels and now a biogas plant. Who wants to live somewhere in the country with solar panel views in their backyard?
5w Like Reply 3

Following
5w Like Reply

Pipeline that doesn't even supply oil to the US, at that.
5w Like Reply 3

Write a reply...

Is this that project that will pipe the pig farm waste to a centralized processing station?
5w Like Reply

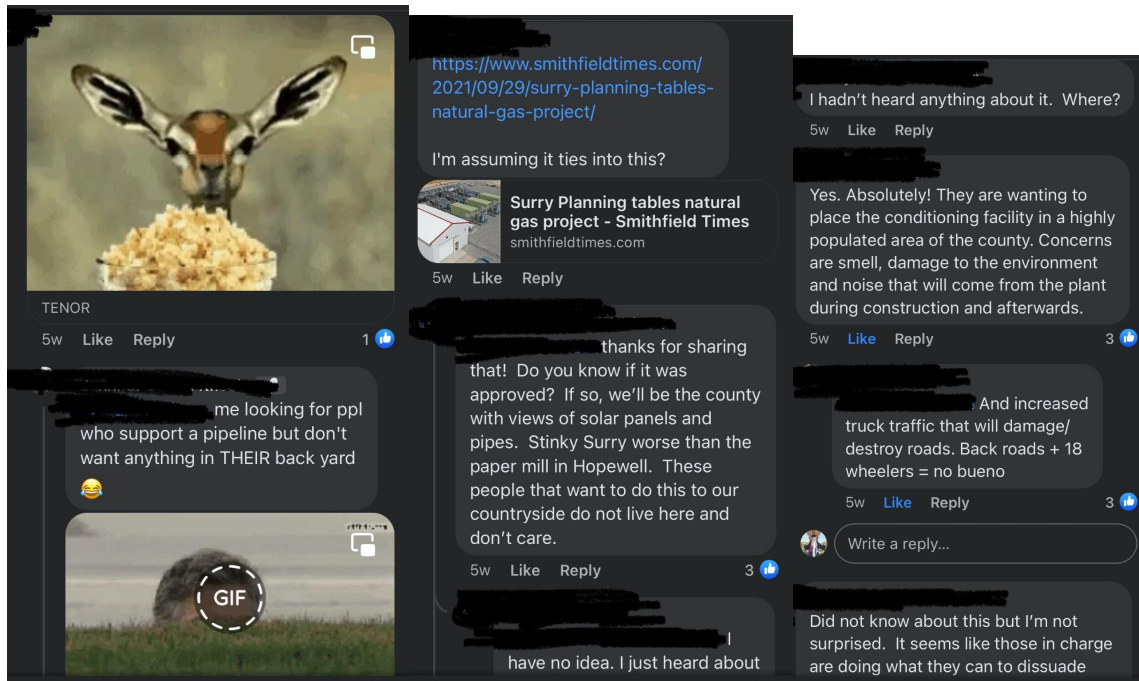
The what?
5w Like Reply

exactly, I hadn't heard anything.
5w Like Reply

Its total BS and all the residents were misled about why they were surveying in the beginning.
5w Like Reply 2

Following.
5w Like Reply

I would imagine the odor would be similar to the open waste lagoons they had years ago in Smithfield that smelled horrendous and later they placed covers on them.
5w Like Reply 2



Appendix E. Community Member Quotes

Table 2. Community member quotes are categorized into concerns/themes

Major Concern or Theme	Surry County Facebook Group: What's REALLY happening in Surry	No decision yet on Surry natural gas project (Staff Reports, 2022)
Odor, Noise and Environmental Concerns	<p>"We'll be the county with views of solar panels and pipes. Stinky Surry worse than the paper mill in Hopewell. These people that want to do this to our countryside do not live here and don't care."</p> <p>"I would imagine the odor would be similar to the open waste lagoons they had years ago in Smithfield that smelled horrendous and later they placed covers on them"</p> <p>"They are wanting to place the conditioning facility in a highly populated area of the county. Concerns are smell, damage to the environment and noise that will comes from the plant during construction and afterwards"</p>	
Degradation of Scenery/ Property Value in Surry	<p>"They are trying to put a gas processing plant right smack in the middle of a bunch of houses on 31 just south of 604."</p>	<p>"I counted 75 homes in a half-mile radius of this site... once that's built, we have no way to get out of it."</p>

	“We are hoping to get them to choose a new location”	“It’s the wrong place, totally the wrong place”
Irritation for/ Expressed to Elected Officials	<p>“Its total BS and all the residents were misled about why they were surveying in the beginning.”</p> <p>“Did not know about this but I’m not surprised. It seems like those in charge are doing what they can to dissuade people from living here. Turning it into a county with scenic views of solar panels and now a biogas plant.”</p> <p>“Research the other facilities across the country. They are all in wide open fields with no homes for miles. [The public hearing and vote] was removed from the Board of Supervisors meeting last minute illegally. Align found out we had enough votes to stop them so they asked for it to be continued. The head Board member approved the continuance without the board voting on allowing the continuance. The board is supposed to vote on allowing continuance or not. The meeting has been rescheduled to June I think.”</p>	“Landowners have called me with concerns... I’ve had no one call in support, none” -Michael Drewry
Support		“I think it’s the right direction to go for renewable energy and for the agricultural production of the county”
First time learning about Waverly Project	<p>“I hadn’t heard anything about it. Where?”</p> <p>“Did not know about this but I’m not surprised...”</p>	

Appendix F. Maximizing Biogas Benefits

It is important to note that when a site is in the process of determining if they should collect and produce biogas, the benefits should be analyzed on a case by case basis. The environmental benefits, and more specifically the GHG emissions benefits of biogas, depend on whether or not the system is complementing other greenhouse gas reduction measures. RNG production should be compared against other waste solutions such as composting, use in animal feed, and converting to soil fertilizer. Depending on the site, these other waste solutions may be

more effective at reducing emissions and environmental impacts, as the main goal is to capture methane emissions (Cyrus & Feldmann, 2020). Maximizing GHG emissions benefits can be achieved through answering “yes” to the following questions:

- “1. Does the production of renewable natural gas capture methane emissions that would otherwise have been emitted into the atmosphere?
2. Does RNG production solve waste management problems, or yield co-benefits alongside emissions benefits?
3. What are competing uses or management practices for the waste streams used, and does renewable natural gas complement solutions such as composting, animal feed or soil fertilizer?
4. Does the project avoid building new fossil fuel-based infrastructure?” (Cyrus & Feldmann, 2020)

Overall, biogas benefits must be evaluated at the site level, as it is possible for a biogas project to do more environmental harm than good.

Appendix G. Tradeoffs Between Biogas and Hog Farm Efficiencies

A major opportunity for improving the environmental outlook of biogas is to reduce the environmental impact of the farms that are generating the biogas. As aforementioned, raising livestock is a resource intensive process that negatively impacts the environment. Animal rights and environmental impact need to be considered in addition to financial optimization. Improving the efficiency of farms would aid and hinder the overall production of biogas in different ways.

Altering the diet of hogs may be one way to optimize the process. Hogs are typically fed grain-based diets of primarily corn for energy and soy for protein. Farmers often add vitamins and minerals as nutritional supplements. The goal in changing the amount of feed or the proportional components of the mix is to maximize the growth of the pig, and minimize the resource consumption and cost of feed components. Our Smithfield contact explained that meat production is the primary goal, but that manure offers an opportunity to capture the wasted energy. As feeding efficiency improves, manure output should decline. This decline would marginally reduce the amount of biogas produced and may be undesirable for stakeholders from

Dominion and other energy companies. Additionally, organic and hormone-free animal rearing practices present similar conflicts of interest. It would benefit the animals and quality of meat, but it hinders the speed of production and may require larger tracts of land and/or a greater environmental impact due to more energy-intensive feed inputs for the animals.

The large CAFO size is synonymous with large environmental impact, but it is also efficient. The land that would be required to produce the same output of meat production is not realistic. This efficiency is why the number of AFOs are shrinking, while overall productivity is increasing. Continuing to expand CAFOs will make biogas more efficient due to the increase in manure and decrease in biogas leaks that occur during transmission. It will also allow for the consolidation of resources and therefore greater focus on large areas rather than smaller fragmented areas. The fewer the pipelines, the less ground disturbed and the less opportunity for leaks.

Technological advances in RNG processing and capture would strictly benefit the production process and are necessary if biogas is going to be profitable without perpetual governmental rebates. Biogas losses range from 5-40% depending on type of cover and other equipment used during gas collection (Cyrus et al., 2020). There is a 1-10% leakage rate of biogas from feedstock conversion, and leakage from transmission is between 0.4-0.9% loss (Cyrus et al., 2020). These losses present opportunities to improve the efficiency of biogas production.

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