

IS ONE COW'S WASTE ANOTHER (HU)MAN'S TREASURE? EXPLORING THE ENVIRONMENTAL AND ENERGY IMPACTS OF MANURE BIOGAS

By
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There is no question that manure biogas, a form of natural gas derived from animal waste, is quickly becoming the most valuable product supplied by factory farms, known also as concentrated animal feeding operations (CAFOs). Manure biogas can be used to produce heat, electricity, or transportation fuel, but its greatest profit stream rests in the myriad government credits and subsidies it can garner. Although turning trash into treasure by giving waste a new life may appear laudable and worthy of such investment, this Article argues that manure biogas is far from a sustainable solution to the United States' environmental and energy obstacles.

Indeed, this Article contends that its harms—from increasing enteric emissions to worsening air quality ten times more than natural gas—far outweigh its benefits—all of which are subject to criticism. Importantly, only CAFOs, not any regular farm, can produce manure biogas such that supporting manure biogas, in turn, is to support a system of violence and abuse. Still, in just the past few years, manure biogas has earned hundreds of millions of dollars in government support, detracting from investment in clean, renewable energy like solar and wind. Moreover, given that countless studies show the need to electrify everything to meet climate goals, this Article argues that natural gas has no future in the United States, and even still, far superior alternatives to manure biogas, like landfill biogas, exist to bridge the gap until we reach a truly renewable system.

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I. INTRODUCTION

Rolling pastures, industrial prisons, or merely means to an end—what you picture when you think of agriculture in America likely depends on your knowledge of concentrated animal feeding operations (CAFOs). Regardless of whether CAFOs are warming your heart, they just might be warming your home through the use of manure biogas, a form of biogas created when bacteria breaks down manure in an oxygen-free environment.¹ Thanks to encouragement and financial support from the government, hundreds of CAFOs now produce manure biogas, commodifying livestock waste by turning it into an energy source that can generate heat, transportation fuel, and electricity.² While turning waste into treasure may sound like a win-win, reality tells a different tale. Ultimately, this Article will argue that any benefits of manure biogas pale in comparison to its negative impacts on the environment and energy system, rendering manure biogas a false promise.

Part II will discuss global goals to combat climate change, the need to recognize methane as an immense driver of global warming, and the role of fossil fuels in contributing to climate change. Part III will address the unique ability of CAFOs, and only CAFOs, to produce manure biogas, explain what manure gas is and how CAFOs can generate it, and its potential end uses. Part IV will discuss the purported benefits of manure biogas while simultaneously addressing the flawed logic of each, especially the benefits connected to the harms of CAFOs. Then, Part IV will explore the numerous avenues to receive government assistance and incentives to produce manure biogas.

While Part IV touches upon the false promise of manure biogas, Parts V and VI further drive home these inescapable negatives. Revolving around methane, Part V suggests manure biogas may increase, not decrease, methane emissions because of methane leakages and growing livestock herd sizes at CAFOs. Centered around manure biogas as an energy source, Part VI will argue manure biogas is an extremely expensive source of energy, could never produce enough energy to replace alternative sources, and is ultimately futile in a 1.5°C world that must move away from natural gas. In addition, Part VI will focus on the harmful effects of manure biogas and argues that if natural gas must persist, manure biogas is still unnecessary thanks to superior biogas sources like landfills and wastewater treatment plants. Finally, Part VII will offer potential solutions to halt manure biogas, ranging from phasing out natural gas entirely to paying farmers to reduce herd sizes.

¹ *How Does Anaerobic Digestion Work?*, EPA (Jan. 20, 2024), <https://www.epa.gov/agstar/how-does-anaerobic-digestion-work> (accessed Sept. 8, 2024).

² See *infra* Part III, Section C (describing end uses of manure biogas).

II. CLIMATE CHANGE: HUMANITY'S GREATEST CHALLENGE AND OPPORTUNITY

“Climate change is the single greatest threat to a sustainable future [b]ut . . . [it] presents a golden opportunity to promote prosperity, security and a brighter future for all,” proclaimed Ban Ki-moon, then-Secretary-General of the United Nations at a Climate Leaders Summit in 2014.³ Nearly a decade later, this sentiment still rings true: climate change persists, but so too does the opportunity to stop it. To combat climate change, humanity’s greatest challenge, we must alter our way of thinking. Rather than view climate change as an expensive, daunting undertaking riddled with sacrifices and losses, we must view it as an opportunity to transform the world for the better. Nevertheless, though positive paths to produce a thriving climate exist, not all solutions are created equal. Fittingly, this Article will discuss the ill-fated promise of manure biogas, offered as a solution to the climate crisis. Before doing so, however, it remains important to understand how the world has reached dangerous levels of atmospheric warming.

A. METHANE MATTERS TO COMBAT CLIMATE CHANGE

On December 12, 2015, 196 parties to the United Nations Framework Convention on Climate Change unanimously adopted the Paris Agreement and committed to a long-term temperature goal of holding global temperatures to “well below 2°C above pre-industrial levels” while trying to limit the increase to “1.5°C.”⁴ Unfortunately, in 2023, Simon Stiell, Executive-Secretary of the UN Climate Change, shared, “[W]e are severely off track.”⁵ In part, this is due to the blind eye historically given to methane emissions.⁶ Since 1950, most human-caused global warming has stemmed from greenhouse gas emissions.⁷ Thus, reducing global temperatures requires reducing greenhouse gases.⁸ At the forefront, carbon dioxide is the “primary” greenhouse gas causing

³ U.N. Secretary-General, *Secretary-General’s Remarks at Climate Leaders Summit*, UNITED NATIONS (Apr. 11, 2014), <https://www.un.org/sg/en/content/sg/statement/2014-04-11/secretary-generals-remarks-climate-leaders-summit> (accessed Sept. 8, 2024).

⁴ Maria Ivanova, *Politics, Economics, and Society, in THE PARIS AGREEMENT ON CLIMATE CHANGE: ANALYSIS AND COMMENTARY* 17, 17 (Daniel Klein et al. eds., 1st ed. 2017); Paris Agreement art. 2(1)(a), Dec. 12, 2015, T.I.A.S. No. 16-1104.

⁵ Press Release, UNFCCC, *New Analysis of National Climate Plans: Insufficient Progress Made, COP28 Must Set Stage for Immediate Action* (Nov. 14, 2023), <https://unfccc.int/news/new-analysis-of-national-climate-plans-insufficient-progress-made-cop28-must-set-stage-for-immediate>.

⁶ *Methane: A Crucial Opportunity in the Climate Fight*, ENV’T DEF. FUND, <https://www.edf.org/climate/methane-crucial-opportunity-climate-fight> (accessed Sept. 8, 2024).

⁷ *Basics of Climate Change*, EPA (Apr. 2, 2024), <https://www.epa.gov/climatechange-science/basics-climate-change#keygases> (accessed Sept. 6, 2024).

⁸ David Herring & Rebecca Lindsey, *Can We Slow or Even Reverse Global Warming?*, NAT’L OCEANIC & ATMOSPHERIC ADMIN. CLIMATE.GOV (Oct. 12, 2022), <https://www.climate>.

climate change.⁹ Accordingly, climate change solutions have largely focused on carbon dioxide.¹⁰ Yet, lurking in the shadows is methane.¹¹ Extremely potent, methane boasts an atmospheric warming potential twenty-eight times more powerful than that of carbon dioxide.¹² In simpler terms, methane traps the sun's heat twenty-eight times better than carbon dioxide.¹³ Therefore, methane can drastically warm the planet, which poses risks to all life on Earth through climate change.¹⁴

Despite being more potent than carbon dioxide, methane is also far more short-lived.¹⁵ Methane has an atmospheric lifetime of around twelve years; carbon dioxide, centuries.¹⁶ Moreover, methane is far less abundant than carbon dioxide: carbon dioxide accounts for 79.7% of greenhouse gas emissions in the United States, while methane accounts for merely 11.1%.¹⁷ Because of these mitigating factors, methane has flown largely under the radar, with carbon dioxide receiving more bad press.¹⁸

However, the Intergovernmental Panel on Climate Change (IPCC)—established with the goal of crafting comprehensive, scientific assessments regarding the current state of climate change, including future strategies to allay its social and economic impacts—spurns the notion that methane is unimportant to climate change.¹⁹ Instead, the IPCC urges that the world cannot achieve Paris Agreement's long-term temperature goal of 1.5°C above pre-industrial levels²⁰ without

gov/news-features/climate-qa/can-we-slow-or-even-reverse-global-warming (accessed Sept. 6, 2024).

⁹ *Basics of Climate Change*, *supra* note 7.

¹⁰ John M. Reilly et al., *Multi-gas Contributors to Global Climate Change*, PEW CTR. ON GLOBAL CLIMATE CHANGE (Feb. 2003), <https://www.c2es.org/wp-content/uploads/2003/02/multi-gas-contributors-global-climate-change.pdf> (accessed Sept. 11, 2024).

¹¹ See Rebecca Leber, *It's Time to Freak Out About Methane Emissions*, VOX (Nov. 3, 2021), <https://www.vox.com/22613532/climate-change-methane-emissions> (accessed Sept. 6, 2024) (discussing the largely unrecognized influence of methane on climate change).

¹² *Importance of Methane*, EPA (Nov. 1, 2023), <https://www.epa.gov/gmi/importance-methane> (accessed Sept. 6, 2024).

¹³ *Id.*

¹⁴ *Causes and Effects of Climate Change*, UNITED NATIONS, <https://www.un.org/en/climatechange/science/causes-effects-climate-change> (accessed Sept. 6, 2024).

¹⁵ *Importance of Methane*, *supra* note 12.

¹⁶ *Methane and Climate Change*, INT'L ENERGY AGENCY, <https://www.iea.org/reports/methane-tracker-2021/methane-and-climate-change> (accessed Sept. 6, 2024).

¹⁷ *Overview of Greenhouse Gases*, EPA (Apr. 11, 2024), <https://www.epa.gov/ghgemissions/overview-greenhouse-gases> (accessed Sept. 6, 2024).

¹⁸ Leber, *supra* note 11.

¹⁹ *History of the IPCC*, IPCC, <https://www.ipcc.ch/about/history/> (accessed Sept. 6, 2024); *Climate Change Widespread, Rapid, and Intensifying*, IPCC (Aug. 9, 2021), <https://www.ipcc.ch/2021/08/09/ar6-wg1-20210809-pr/> (accessed Sept. 13, 2024).

²⁰ Paris Agreement art. 2(1)(a), Dec. 12, 2015, T.I.A.S. No. 16-1104; *The Evidence Is Clear: The Time for Action Is Now. We Can Halve Emissions by 2030*, IPCC (Apr. 4, 2022), <https://www.ipcc.ch/2022/04/04/ipcc-ar6-wgiii-pressrelease/> (accessed Sept. 13, 2024).

reducing carbon dioxide *and* methane.²¹ In fact, Durwood Zaelke, lead reviewer for the IPCC, said, “Cutting methane is the biggest opportunity to slow warming between now and 2040.”²² Hearing this, President Biden and the European Union spearheaded the Global Methane Pledge to reduce methane emission 30% below 2020 levels by the end of the decade.²³ Moving forward, successful paths toward defeating climate change must consider both carbon dioxide and methane.²⁴

B. CUT CARBON DIOXIDE AND METHANE EMISSIONS WITH ALTERNATIVE ENERGY SOURCES

Burning fossil fuels remains the overwhelming cause of climate change.²⁵ More specifically, in the United States, fossil fuels account for around 93% of total anthropogenic carbon dioxide emissions;²⁶ fossil fuels, specifically natural gas and oil, also account for 30% of methane emissions.²⁷ Coal remains the dirtiest fossil fuel, responsible for 30% of the increase in global average temperatures.²⁸ Following coal, oil remains the second dirtiest fossil fuel, responsible for around one third of global carbon emissions.²⁹ Fortunately, supply and demand for coal is declining in the United States, largely due to the growth of natural gas.³⁰

Seen as a “good stepping stone” to reduce the impacts of climate change by replacing dirtier fossil fuels,³¹ natural gas emits less carbon

²¹ See IPCC, GLOBAL WARMING OF 1.5°C 42 (Valérie Masson-Delmotte et al. eds., 2018), https://www.ipcc.ch/site/assets/uploads/sites/2/2022/06/SR15_Full_Report_HR.pdf (“Though CO2 dominates long-term warming, the reduction of warming short-lived climate forcers (SLCFs), such as methane . . . can in the short term contribute significantly to limiting warming to 1.5°C above pre-industrial levels.”).

²² Fiona Harvey, *Reduce Methane or Face Climate Catastrophe, Scientists Warn*, THE GUARDIAN (Aug. 6, 2021), <https://www.theguardian.com/environment/2021/aug/06/reduce-methane-or-face-climate-catastrophe-scientists-warn> (accessed Sept. 6, 2024).

²³ WHITE H. OFF. OF DOMESTIC CLIMATE POL’Y, U.S. METHANE EMISSIONS REDUCTION ACTION PLAN 1 (2021) [hereinafter BIDEN METHANE ACTION PLAN].

²⁴ See IPCC, *supra* note 21, at 42 (“Though CO2 dominates long-term warming, the reduction of warming short-lived climate forcers (SLCFs), such as methane . . . can in the short term contribute significantly to limiting warming to 1.5°C above pre-industrial levels.”).

²⁵ *Fossil Fuels and Climate Change: The Facts*, CLIENTEARTH (Feb. 18, 2022), <https://www.clientearth.org/latest/news/fossil-fuels-and-climate-change-the-facts> (accessed Sept. 8, 2024).

²⁶ *Energy and the Environment Explained: Where Greenhouse Gases Come From*, EIA (June 18, 2024), <https://www.eia.gov/energyexplained/energy-and-the-environment/where-greenhouse-gases-come-from.php> (accessed Sept. 8, 2024).

²⁷ BIDEN METHANE ACTION PLAN, *supra* note 23, at 6.

²⁸ *Fossil Fuels and Climate Change: The Facts*, *supra* note 25.

²⁹ *Id.*

³⁰ Dan Gearino, *Coal Power Plunged Again in 2023 and Is Fading Away in the U.S. So What Replaces It?*, INSIDE CLIMATE NEWS (Mar. 14, 2024), <https://insideclimatenews.org/news/14032024/inside-clean-energy-coal-power-decline> (accessed Sept. 8, 2024).

³¹ *Is Natural Gas Really the Bridge Fuel the World Needs?*, U.N. ENV’T PROGRAMME (Jan. 12, 2023), <https://www.unep.org/news-and-stories/story/natural-gas-really-bridge-fuel-world-needs> (accessed Sept. 8, 2024).

dioxide than coal or oil.³² Nevertheless, natural gas is far from the perfect solution. For one, natural gas, just like coal and oil, still draws upon fossil fuels and is a finite resource.³³ Additionally, natural gas presents a more concentrated climate danger. Though each releases carbon dioxide when burned,³⁴ coal and crude oil respectively contain carbon and hydrocarbon, while natural gas is predominantly composed of methane, the more potent greenhouse gas.³⁵ Moreover, the extraction of conventional and unconventional natural gas poses environmental risks beyond warming the planet. Conventional natural gas is extracted through drilling into subsurface rock formations, often as a byproduct of drilling for oil.³⁶ Unconventional (yet growing in popularity thanks to emerging technologies) natural gas is extracted through hydraulic fracturing—the process of injecting water, sand, and/or chemicals into a deep, underground well, causing shale to crack and release large volumes of natural gas.³⁷ Both practices pose numerous dangers. For one, drilling for gas disrupts wildlife by destroying habitats and disrupting migration.³⁸ Additionally, unconventional natural gas leads to water depletion because fracking consumes an abundance of water.³⁹ For instance, one fracking operation used nearly sixteen million gallons of water.⁴⁰ Moreover, by design, fracking causes small earthquakes

³² *Natural Gas Explained: Natural Gas and the Environment*, EIA (Apr. 16, 2024), <https://www.eia.gov/energyexplained/natural-gas/natural-gas-and-the-environment.php> (accessed Sept. 8, 2024).

³³ *Is Natural Gas Renewable?*, INSPIRE CLEAN ENERGY, <https://www.inspirecleanenergy.com/blog/clean-energy-101/is-natural-gas-renewable> (accessed Sept. 8, 2024).

³⁴ *Hydrocarbons*, UCAR CTR. FOR SCI. EDUC. (2006), <https://scied.ucar.edu/learning-zone/air-quality/hydrocarbons> (accessed Sept. 8, 2024); Tom Cyrs, *7 Things to Know About Renewable Natural Gas*, TRELLIS (July 24, 2024), <https://trellis.net/article/7-things-know-about-renewable-natural-gas/> (accessed Sept. 18, 2024).

³⁵ *Petroleum and Coal*, PURDUE UNIV., <https://chemed.chem.purdue.edu/genchem/topi-creview/bp/1organic/coal.html> (accessed Sept. 8, 2024); *Importance of Methane*, *supra* note 12.

³⁶ Paul Kane, *Renewable Natural Gas (RNG) vs Natural Gas: What's the Difference?*, ENTECH SOLS. (Feb. 3, 2022), <https://energybyentech.com/blog/renewable-natural-gas-rng-vs-natural-gas-whats-the-difference> (accessed Sept. 2, 2024) (site no longer available); *Natural Gas Production*, U.S. DEP'T OF ENERGY, ALT. FUELS DATA CTR., https://afdc.energy.gov/fuels/natural_gas_production.html (accessed Sept. 2, 2024).

³⁷ Water Resources Mission Area, *Hydraulic Fracturing*, USGS (Mar. 2, 2019), <https://www.usgs.gov/mission-areas/water-resources/science/hydraulic-fracturing#overview> (accessed Sept. 2, 2024).

³⁸ Nick Kohomban, *4 Ways Oil and Gas Drilling Is Bad for Wildlife*, THE WILDERNESS Soc'y (Dec. 21, 2023), <https://www.wilderness.org/articles/blog/4-ways-oil-and-gas-drilling-bad-wildlife> (accessed Sept. 2, 2024).

³⁹ Melissa Denchak, *Fracking 101*, NRDC (Apr. 19, 2019), <https://www.nrdc.org/stories/fracking-101> (accessed Sept. 2, 2024).

⁴⁰ *Id.*

in order to extract more natural gas.⁴¹ However, fracking can induce larger earthquakes, like a 4.9 magnitude earthquake in Texas.⁴²

Because coal and oil heavily emit greenhouse gases and conventional and unconventional natural gas pose additional environmental risks, the world requires a superior energy source.⁴³ While renewable energy, like wind and solar, is on the rise,⁴⁴ manure biogas is also gaining traction as an alternative fuel source for Americans because it possesses the advantage of natural gas—emitting less carbon dioxide than coal and oil—without the same disadvantages, like disrupting wildlife migration and causing earthquakes.⁴⁵ Moreover, on top of reducing greenhouse gases, manure biogas claims to usher in additional benefits, disguising itself as an optimal energy source.⁴⁶

III. THE RISE OF MANURE BIOGAS: CAFOS ANSWERING THE CALL

Touted to mitigate the negative impacts of CAFOs, support jobs in agriculture, turn waste into a valuable commodity, and emit less greenhouse gas than fossil fuels, manure biogas boasts its fair share of praise, even from the President of the United States.⁴⁷ However, not just any farm can produce these positives and harness the power of manure biogas. According to AgSTAR, a program sponsored by the EPA and USDA specifically to promote manure biogas,⁴⁸ the ideal farms to produce and profit from manure biogas host over 500 cows or at least 2,000 animals total.⁴⁹ In other words, the only farms that can feasibly produce manure

⁴¹ *Does the Production of Oil and Gas from Shales Cause Earthquakes? If So, How Are the Earthquakes Related to These Operations?*, USGS, <https://www.usgs.gov/faqs/does-production-oil-and-gas-shales-cause-earthquakes-if-so-how-are-earthquakes-related-these> (accessed Sept. 2, 2024).

⁴² *Id.*; Elizabeth Weise, *Rash of Earthquakes Blamed on Oil Production, Including a Magnitude 4.9 in Texas*, USA TODAY (July 23, 2024), <https://www.usatoday.com/story/news/2024/07/23/4-9-earthquake-west-texas-dallas-monday-map-usgs-rotan-scurry-county-magnitude/74508675007/> (accessed Oct. 11, 2024).

⁴³ *Fossil Fuels and Climate Change: The Facts*, *supra* note 25.

⁴⁴ *Solar and Wind to Lead Growth of U.S. Power Generation for the Next Two Years*, EIA (Jan. 16, 2024), <https://www.eia.gov/todayinenergy/detail.php?id=61242> (accessed Sept. 2, 2024).

⁴⁵ Kane, *supra* note 36; Kohomban, *supra* note 38; *Does the Production of Oil and Gas from Shales Cause Earthquakes? If So, How Are the Earthquakes Related to These Operations?*, *supra* note 41.

⁴⁶ See *infra* Part IV, Section A (explaining the alleged benefits of manure biogas).

⁴⁷ See BIDEN METHANE ACTION PLAN, *supra* note 23, at 12 (citing the production of on-farm renewable energy from methane as a solution to reduce methane emissions).

⁴⁸ *AgSTAR: Biogas Recovery in the Agriculture Sector*, EPA (updated Aug. 5, 2024), <https://www.epa.gov/agstar> (accessed Sept. 7, 2024).

⁴⁹ *Market Opportunities for Biogas Recovery Systems at U.S. Livestock Facilities*, EPA (June 2018), <https://19january2021snapshot.epa.gov/sites/static/files/201806/documents/epa430r18006agstarmarketreport2018.pdf> (accessed Sept. 7, 2024) [hereinafter *AgSTAR Biogas Market Report*].

biogas are not small-scale family farms, but factory farms, which churn out animals, pollution, suffering, and now, manure biogas.⁵⁰

A. CAFOS

Under the EPA's National Pollutant Discharge Elimination System (NPDES) program, an animal feeding operation (AFO) is facility where (1) "animals have been, are, or will be stabled or confined and fed or maintained for a total of 45 days or more in a 12-month period," and (2) "crops, vegetation, forage growth, or postharvest residues are not sustained in the normal growing season over any portion of the lot or facility."⁵¹ For an AFO to become a CAFO, the facility must either meet a threshold number of a type of animal,⁵² discharge waste a specific way,⁵³ or be designated a significant contributor of pollutants to waters of the United States by a State Director and/or Regional Administrator.⁵⁴

According to the EPA's most recent CAFO permitting report, 21,179 CAFOs exist in the United States, each of which is brimming with both animals and manure.⁵⁵ CAFOs produce an estimated 99% of livestock—ten billion animals—in the United States.⁵⁶ With their abundance of animals, some CAFOs produce more waste than entire cities.⁵⁷ A CAFO with 10,000 pigs can create as much waste as 50,000 humans;⁵⁸ a CAFO with 800,000 pigs, over one and a half times as much waste as Philadelphia.⁵⁹ Although this abundance of manure can be seen as a burden, many CAFO operators now see it as an opportunity thanks to the "gold rush" of manure biogas.⁶⁰

⁵⁰ *Regulatory Definitions of Large CAFOs, Medium CAFOs, and Small CAFOs*, EPA, https://www.epa.gov/sites/default/files/2015-08/documents/sector_table.pdf (accessed Sept. 7, 2024) (noting the size threshold for CAFOs).

⁵¹ 40 C.F.R. § 122.23(b)(i)-(ii).

⁵² To be deemed a CAFO based on size threshold alone, a facility could, for example, contain at least 125,000 chickens other than laying hens, 1,000 cattle, or 2,500 swine. *Regulatory Definitions of Large CAFOs, Medium CAFOs, and Small CAFOs*, *supra* note 50.

⁵³ To be deemed a CAFO based on waste discharge, a facility must either have a man-made ditch or pipe carrying waste to surface water or animals who come into contact with surface water passing through the facility. *Id.*

⁵⁴ 40 C.F.R. § 122.23(c).

⁵⁵ *NPDES CAFO Permitting Status Report: National Summary, Endyear 2023*, EPA (May 14, 2024), <https://www.epa.gov/system/files/documents/2024-06/cafo-status-report-2023.pdf> (accessed Nov. 4, 2024).

⁵⁶ HANNAH RITCHIE, *How Many Animals Are Factory-Farmed?*, OUR WORLD IN DATA (Sept. 25, 2023), <https://ourworldindata.org/how-many-animals-are-factory-farmed> (accessed Sept. 7, 2024).

⁵⁷ CARRIE HRIBAR, UNDERSTANDING CONCENTRATED ANIMAL FEEDING OPERATIONS AND THEIR IMPACT ON COMMUNITIES 7 (Mark Schultz ed., 2010), <https://stacks.cdc.gov/view/cdc/59792> (accessed Sept. 7, 2024).

⁵⁸ *Concentrated Animal Feeding Operations (CAFOs): Assessment of Impacts on Health, Local Economies, and the Environment with Suggested Alternatives*, INST. OF SCI., TECH., & PUBLIC POL'Y, https://istpp.org/pdf/istpp_cafo.pdf (accessed Sept. 7, 2024).

⁵⁹ HRIBAR, *supra* note 57.

⁶⁰ CHLOE WATERMAN & MOLLY ARMUS, BIOGAS OR BULL****? THE DECEPTIVE PROMISE OF MANURE BIOGAS AS A METHANE SOLUTION 31 (Friends of the Earth 2024), <https://foe.org/>

B. MANURE BIOGAS 101

Unlike natural gas, manure biogas is not a fossil fuel because it does not come from fossilized plants and animals millions of years old, but instead, from the manure of animals living today.⁶¹ Nevertheless, manure biogas and natural gas share a chemical makeup: both are predominantly composed of methane.⁶² Decomposed naturally, like in a pasture, manure does not emit significant amounts of methane.⁶³ However, manure can emit methane and thus produce manure biogas through anaerobic digestion, whereby bacteria break down organic matter—like manure—without the presence of oxygen.⁶⁴ In the case of manure biogas, anaerobic digesters offer this closed, oxygen-free environment.⁶⁵ Thus, for a CAFO to be able to capture and produce manure biogas, it must first install an anaerobic digester.⁶⁶

Primarily, CAFOs use one of three anaerobic digesters systems to produce manure biogas: a covered lagoon system, a complete-mix system, or a plug flow system.⁶⁷ The way in which CAFOs store their manure—liquid, slurry, or semi-solid—affects which anaerobic digester system to install.⁶⁸ In a covered lagoon system, a “glorified tarp[]”⁶⁹ covers lagoons full of liquid manure, urine, and chemicals, sealing the manure in and keeping oxygen out.⁷⁰ Being passive, covered lagoons require low maintenance and remain the cheapest and most commonly used option.⁷¹ Moreover, because they use ambient air temperatures to

wp-content/uploads/2024/03/Factory-Farm-Gas-Brief_final-0312.pdf (accessed Sept. 7, 2024).

⁶¹ Melissa Denchak, *Fossil Fuels: The Dirty Facts*, NRDC (June 1, 2022), <https://www.nrdc.org/stories/fossil-fuels-dirty-facts#sec-what-is> (accessed Sept. 8, 2024); *Biomass Explained: Landfill Gas and Biogas*, EIA (Dec. 15, 2023), <https://www.eia.gov/energyexplained/biomass/landfill-gas-and-biogas.php> (accessed Sept. 8, 2024).

⁶² *Natural Gas Explained*, EIA (Dec. 27, 2022), <https://www.eia.gov/energyexplained/natural-gas/> (accessed Oct. 5, 2024); *Biomass Explained: Landfill Gas and Biogas*, *supra* note 61.

⁶³ *Factory Farm Biogas*, ANIMAL LEGAL DEF. FUND, <https://aldf.org/issue/factory-farm-biogas/> (accessed Sept. 9, 2024).

⁶⁴ *How Does Anaerobic Digestion Work?*, *supra* note 1.

⁶⁵ WATERMAN & ARMUS, *supra* note 60, at 13.

⁶⁶ *Factory Farm Biogas*, *supra* note 63.

⁶⁷ HYUNOK LEE & DANIEL SUMNER, GREENHOUSE GAS MITIGATION OPPORTUNITIES IN CALIFORNIA AGRICULTURE: REVIEW OF THE ECONOMICS 17 (Nicholas Inst. 2014), https://nicholasinstitute.duke.edu/sites/default/files/publications/ni_ggmoca_r_7.pdf (accessed Sept. 8, 2024).

⁶⁸ *Id.*

⁶⁹ *Factory Farm Biogas*, *supra* note 63.

⁷⁰ *Id.*; Iriaghomo et al., *How Does Nitrogen Move Through a Swine Farm with a Lagoon-Sprayfield System?*, NC STATE EXTENSION (June 13, 2022), https://content.ces.ncsu.edu/how-does-nitrogen-move-through-a-swine-farm-with-a-lagoon-sprayfield-system#section_heading_16903 (accessed Sept. 15, 2024).

⁷¹ Douglas W. Hamilton, *Anaerobic Digestion of Animal Manures: Types of Digesters*, OKLA. STATE UNIV. (Mar. 2017), <https://extension.okstate.edu/fact-sheets/anaerobic-digestion-of-animal-manures-types-of-digesters.html> (accessed Sept. 8, 2024); LEE &

heat the manure naturally, they thrive in warmer climates.⁷² Continuing, in a complete-mix system, a heated tank holds and mixes slurry, the combination of manure and water.⁷³ Because this system requires energy to heat the tanks, it is the most expensive option.⁷⁴ Finally, in a plug-flow system, fresh semi-solid manure enters a long-lined tank and pushes older manure through the digester, which decomposes and makes biogas along the way.⁷⁵

C. END USES OF MANURE BIOGAS

Depending on the level of processing, manure biogas has a range of end uses. Without much processing, manure biogas can be used to generate heat or electricity on-site or for the electric grid;⁷⁶ electricity generation remains the most common use of manure biogas.⁷⁷ Conversely, manure biogas can be processed into renewable natural gas by removing carbon dioxide, water vapor, and other gases.⁷⁸ After processing, manure biogas made into renewable natural gas becomes interchangeable with conventional natural gas.⁷⁹ Accordingly, it can be injected into gas pipelines to produce electricity, heat, or cooking fuel.⁸⁰ In the alternative, this renewable natural gas can be further converted into compressed natural gas or liquefied natural gas to be used as a transportation fuel.⁸¹ For example, Fair Oaks Dairy, an Indiana CAFO, powers its milk delivery trucks with compressed natural gas produced from its manure biogas.⁸² Generally, CAFOs can use manure biogas to lower their operational costs by using it themselves, like Fair Oaks Dairy, and/or boost profits by selling it to others.⁸³

SUMNER, *supra* note 67, at 17; *AgSTAR Data and Trends*, EPA, <https://www.epa.gov/agstar/agstar-data-and-trends#adfacts> (accessed Sept. 8, 2024).

⁷² Roxanne Pillars, *Farm-Based Anaerobic Digesters*, MICH. STATE UNIV., https://www.agmrc.org/media/cms/FinalAnaerobicDigestionFactsheet_2E11FAB524961.pdf (accessed Sept. 8, 2024).

⁷³ LEE & SUMNER, *supra* note 67, at 17.

⁷⁴ Pillars, *supra* note 72.

⁷⁵ LEE & SUMNER, *supra* note 67, at 17; Pillars, *supra* note 72.

⁷⁶ Sara Tanigawa, *Biogas: Converting Waste to Energy*, ENV'T & ENERGY STUDY INST. (Oct. 3, 2017), <https://www.eesi.org/papers/view/fact-sheet-biogasconverting-waste-to-energy> (accessed Sept. 8, 2024); WATERMAN & ARMUS, *supra* note 60, at 13.

⁷⁷ *AgSTAR Biogas Market Report*, *supra* note 49, at 8.

⁷⁸ Tanigawa, *supra* note 76.

⁷⁹ *Renewable Natural Gas Production*, U.S. DEP'T OF ENERGY, https://afdc.energy.gov/fuels/natural_gas_renewable.html (accessed Sept. 3, 2024).

⁸⁰ Tanigawa, *supra* note 76.

⁸¹ *Id.*

⁸² *Fair Oaks Dairy Digester – Fair Oaks, IN*, EPA (updated July 18, 2016), https://www.epa.gov/sites/default/files/2016-07/documents/fair_oaks_-_rev_7-18-16.pdf (accessed Sept. 3, 2024).

⁸³ *Id.*; *The Benefits of Anaerobic Digestion*, EPA (updated Sept. 20, 2023), <https://www.epa.gov/agstar/benefits-anaerobic-digestion> (accessed Sept. 18, 2024).

IV. AMERICA IS BUYING THE BENEFITS OF MANURE BIOGAS

“Only if one accepts the status quo model for industrial animal production . . . can it be argued that manure biogas has any benefits,” declared Friends of the Earth in a 2023 manure biogas exposé.⁸⁴ Unfortunately, this is the ugly truth given CAFOs and manure biogas are so interconnected; manure biogas cannot and would not exist if not for CAFOs.⁸⁵ Yet, advocates of manure biogas do not refute manure biogas comes from CAFOs, even suggesting manure biogas can mitigate certain threats of CAFOs.⁸⁶ Above all, however, manure biogas advocates espouse its advantages from energy and environmental standpoints, concluding its benefits outweigh any harms.⁸⁷

A. PURPORTED AND OFT-OVERSTATED BENEFITS OF MANURE BIOGAS

To begin, anaerobic digesters significantly reduce CAFO odors—even up to 97%⁸⁸—because manure biogas is an odorless gas (methane) far preferable to the “rotten egg” smell of untreated manure on CAFOs.⁸⁹ Notably, the odor from a typical CAFO can be “so overpowering that [neighbors of the CAFO] cannot tend their gardens, hang their laundry, or invite relatives over for cookouts.”⁹⁰ By contrast, a Smithsonian writer visiting a farm with an anaerobic digester claimed the air “smell[ed] like . . . nothing” because “[t]he digester had turned all the manure into money.”⁹¹ CAFOs are infamously poor neighbors not known to respect concerns of nearby communities, so it is far-fetched to imagine that they would reduce odors just to better others.⁹²

⁸⁴ WATERMAN & ARMUS, *supra* note 60, at 19.

⁸⁵ *See id.* at 13 (explaining that manure biogas is inseparable from CAFOs because of the quantity of animals needed to create it).

⁸⁶ *See infra* Part IV, Section A (highlighting various detriments of CAFOs, like odor and water quality issues, that manure biogas advocates argue that manure biogas mitigates).

⁸⁷ AgSTAR Biogas Market Report, *supra* note 49, at 5–6.

⁸⁸ Nathanael Greene, *Manure: The Smell of Money*, NRDC (Sept. 26, 2006), <https://www.nrdc.org/bio/nathanael-greene/manure-smell-money> (accessed Sept. 13, 2024).

⁸⁹ AgSTAR Biogas Market Report, *supra* note 49, at 5.

⁹⁰ Barry Yeoman, *Here Are the Rural Residents Who Sued the World’s Largest Hog Producer over Waste and Odors – and Won*, FOOD & ENV’T REPORTING NETWORK (Dec. 20, 2019), <https://thefern.org/2019/12/rural-north-carolinians-won-multimillion-dollar-judgments-against-the-worlds-largest-hog-producer-will-those-cases-now-be-overtuned/> (accessed Sept. 13, 2024).

⁹¹ Rachael Moeller Gorman, *How Dairy Farmers Are Turning Manure into Money*, SMITHSONIAN MAG. (Apr./May 2023), <https://www.smithsonianmag.com/innovation/dairy-farmers-turning-manure-into-money-180981809/> (accessed Sept. 13, 2024).

⁹² *See, e.g.,* McKiver v. Murphy-Brown, LLC, 980 F.3d 937, 946 (4th Cir. 2020) (revolving around the neighbors of Kinlaw Farms, a CAFO contracted by a subsidiary of Smithfield, the largest pork producer in the world, seeking relief under state nuisance law from odors, pests, and noises emanating from Kinlaw Farms).

Nevertheless, reducing odors can benefit CAFOs as much as it benefits their neighbors: reducing odors can also reduce nuisance lawsuits.⁹³ In fact, the University of Missouri listed a decrease in nuisance lawsuits as two of the top five reasons to install anaerobic digesters.⁹⁴ Illustrating the potential danger of nuisance lawsuits, the University of Missouri summarized ten nuisance suits with awards ranging from \$12,100 to \$50,000,000.⁹⁵ Additionally, AgSTAR notes fostering this good relationship with local communities “can make farm expansions more palatable,” another win for CAFOs.⁹⁶ Nevertheless, considering three anaerobic digesters have reported shutting down due to odor issues, manure biogas does not eradicate odors completely.⁹⁷

Continuing, through anaerobic digesters, manure biogas can aid in protecting water quality by destroying “more than 90% of disease-causing bacteria that might otherwise enter surface waters” from manure.⁹⁸ Because CAFO manure contains countless contaminants—including nitrogen, phosphorus, *E. coli*, animal blood, and copper sulfate⁹⁹—CAFOs present significant threats to those who live nearby, especially when manure contaminants enter water from lagoon leakages, overflows, or runoffs.¹⁰⁰ Moreover, despite the Clean Water Act requiring NPDES permits for any discharge of a pollutant from a point source into navigable waters,¹⁰¹ in *Waterkeeper Alliance v. EPA*, the Second Circuit vacated an EPA rule that all CAFOs must apply for NPDES permits or demonstrate they have no potential to discharge.¹⁰² Consequently, only 6,174 of the 21,279 CAFOs in the United States have these permits, leaving the remainder to operate without federal or state waste regulation.¹⁰³ Thus, if we accept CAFOs can and will continue to manage manure poorly,

⁹³ UNIV. OF MO. EXTENSION, E³A: ANAEROBIC DIGESTER APPLICATIONS FOR THE FARM OR RANCH: UNDERSTANDING ANAEROBIC DIGESTERS 2 (Dec. 2014), <https://extension.missouri.edu/media/wysiwyg/Extensiondata/Pub/pdf/energymgmt/em0701.pdf>.

⁹⁴ *Id.*

⁹⁵ *Id.* at 3.

⁹⁶ AgSTAR *Biogas Market Report*, *supra* note 49, at 6.

⁹⁷ See AgSTAR, LIVESTOCK ANAEROBIC DIGESTER DATABASE (updated June 2024), <https://www.epa.gov/sites/default/files/2020-10/agstar-livestock-ad-database.xlsx> [hereinafter AGSTAR AD DATABASE] (listing the Lowell Energy AD Facility Digester, Napoleon Biogas Digester, and Heartland Biogas Digester as the three digesters with odor control issues).

⁹⁸ AgSTAR *Biogas Market Report*, *supra* note 49, at 5.

⁹⁹ HRIBAR, *supra* note 57, at 2.

¹⁰⁰ See JoAnn Burkholder et al., *Impacts of Waste from Concentrated Animal Feeding Operations on Water Quality*, 115 ENV'T HEALTH PERSPS. 308, 308 (2007) (discussing how the growth of CAFOs poses an increased risk to water quality and public health due to inadequate livestock waste management practices that fail to protect water resources from excessive nutrients, pathogens, and pharmaceuticals, necessitating rigorous ecosystem monitoring and the enforcement of best practices to minimize environmental contamination).

¹⁰¹ Clean Water Act, 33 U.S.C §§ 1342(a)(1) & 1362(12).

¹⁰² *Waterkeeper Alliance, et al. v. EPA*, 399 F.3d 486, 504 (2d Cir. 2005).

¹⁰³ NPDES CAFO Permitting Status Report: National Summary, *Endyear 2023*, *supra* note 55.

the ability of anaerobic digesters to counteract this danger is a benefit. However, we need not accept CAFOs' poor manure management practices or offer CAFOs with anaerobic digesters a get-out-of-jail-free card. Rather, the government should regulate CAFOs and require NPDES permits, thereby strengthening manure management practices from the front end.

In addition, manure biogas can bring jobs and keep CAFO owners financially afloat. Manure biogas could bring 335,000 temporary jobs and 23,000 permanent jobs through the construction of anaerobic digesters.¹⁰⁴ Bear in mind, however, cleaner and renewable alternatives to manure biogas, like wind and solar, could employ 42 million people by 2050, far exceeding the employment opportunities of manure biogas.¹⁰⁵ To continue, not only does manure biogas create jobs, but it also gives CAFOs a second revenue stream.¹⁰⁶ Because the demand for certain CAFO products continues to decrease—e.g., dairy milk, which has steadily decreased, falling at a faster than ever rate since the 2010s¹⁰⁷—the ability to turn poop into profit may become vital to stay in business. In fact, CAFOs' profits from manure biogas may even eclipse that of animal products.¹⁰⁸ The manager of Threemile Canyon Farms, an Oregon CAFO and Tillamook supplier,¹⁰⁹ admitted, “The most valuable product that we have is natural gas.”¹¹⁰ Continued another CAFO operator, “We used to joke about how funny it would be if we could make more money off the poop than the milk . . . And now we're essentially here.”¹¹¹ Predominantly, this new revenue stream comes not from selling manure biogas, but from receiving government subsidies for it.¹¹² To the government, the value in manure biogas lies in prevented greenhouse gas emissions.¹¹³ However, as will be discussed later, subsidizing

¹⁰⁴ Tanigawa, *supra* note 76.

¹⁰⁵ INT'L RENEWABLE ENERGY AGENCY, MEASURING THE SOCIO-ECONOMICS OF TRANSITION: FOCUS ON JOBS 14 (2020), https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2020/Feb/IRENA_Transition_jobs_2020.pdf (accessed Sept. 9, 2024).

¹⁰⁶ *The Benefits of Anaerobic Digestion*, *supra* note 83.

¹⁰⁷ Hayden Stewart & Fred Kuchler, *Fluid Milk Consumption Continues Downward Trend, Proving Difficult to Reverse*, USDA ERS (June 21, 2022), <https://www.ers.usda.gov/amber-waves/2022/june/fluid-milk-consumption-continues-downward-trend-proving-difficult-to-reverse/> (accessed Sept. 3, 2024).

¹⁰⁸ See WATERMAN & ARMUS, *supra* note 60, at 31 (showcasing CAFO managers explaining the value of manure biogas); Aaron Smith, *What's Worth More: A Cow's Milk or its Poop?*, UC DAVIS (Feb. 3, 2021), <https://asmith.ucdavis.edu/news/cow-power-rising> (accessed Sept. 9, 2024) (noting that as of 2021, subsidies from manure biogas make it half as valuable as cow's milk).

¹⁰⁹ *Growing with Great Partners*, TILLAMOOK, <https://www.tillamook.com/news/growing-with-great-partners> (accessed Sept. 9, 2024).

¹¹⁰ WATERMAN & ARMUS, *supra* note 60, at 31.

¹¹¹ *Id.*

¹¹² See Smith, *supra* note 108 (calculating that it costs more to maintain an anaerobic digester than revenue earned from selling manure biogas, yet subsidies yield a net profit).

¹¹³ *Id.*

manure biogas may increase, not decrease, emissions.¹¹⁴ Usurping all other benefits, the ability of manure biogas to lower greenhouse gas emissions and replace alternative fossil fuels—to produce electricity, heat, or transportation fuel—remains at the forefront of the argument for manure biogas.¹¹⁵ By design, manure biogas helps to capture and thus reduce methane emissions from manure.¹¹⁶ Indeed, the National Renewable Energy Lab posits that installing anaerobic digesters could capture 1.9 million metric tons of methane per year from manure.¹¹⁷ However, a 2023 paper found that California CAFOs with covered lagoons—a type of anaerobic digester—failed to emit significantly less methane per animal than CAFOs with uncovered lagoons/no digesters, besmirching one of the principal arguments for manure biogas.¹¹⁸

Additionally, on top of capturing methane, manure biogas may reduce carbon dioxide emissions.¹¹⁹ Chemically similar to natural gas,¹²⁰ manure biogas results in less carbon dioxide emissions when burned compared to coal or oil.¹²¹ Whereas coal and distillate fuel oil respectively produce 200 and 160 pounds of carbon dioxide per million British thermal units (MMBtu), natural gas produces 117 pounds.¹²² As such, switching from coal to natural gas from 2010 to 2018 avoided more than 500 million tons of carbon dioxide emissions globally and 18% of carbon emissions savings in the United States.¹²³ Also, despite still emitting carbon dioxide like natural gas, manure biogas may be environmentally preferable because it is carbon-neutral in the sense that it does not add new greenhouse gas emissions, unlike natural gas.¹²⁴ Rather, manure

¹¹⁴ See *infra* Parts V & VI (revealing that manure biogas can increase both methane and carbon dioxide emissions, especially compared to renewable alternatives).

¹¹⁵ *AgSTAR Biogas Market Report*, *supra* note 49, at 5–6.

¹¹⁶ *Learning About Biogas Recovery*, EPA (updated May 22, 2024), <https://www.epa.gov/agstar/learning-about-biogas-recovery> (accessed Sept. 8, 2024).

¹¹⁷ ROBERT BONNIE ET AL., CLIMATE 21 PROJECT 12, https://climate21.org/documents/C21_USDA.pdf (accessed Sept. 8, 2024).

¹¹⁸ WATERMAN & ARMUS, *supra* note 60, at 34. Of course, one could argue that a single study cannot topple USDA's claims. However, the growth of manure biogas fad is relatively new, so few studies have been conducted on either side. Moreover, the USDA's claims are premised on hypotheticals and projections, while the 2023 study is rooted in reality. Ultimately, even though one study may not topple the entire claim, it does, at least, suggest that the USDA's claims may be unsound.

¹¹⁹ PETER ZENIEWSKI ET AL., THE ROLE OF GAS IN TODAY'S ENERGY TRANSITIONS 8, 56 (Adam Majoe ed., 2019), <https://iea.blob.core.windows.net/assets/cc35f20f-7a94-44dc-a750-41c117517e93/TheRoleofGas.pdf> (accessed Sept. 8, 2024).

¹²⁰ *Natural Gas Explained: Natural Gas and the Environment*, *supra* note 32; *Biomass Explained: Landfill Gas and Biogas*, *supra* note 61.

¹²¹ *Natural Gas Explained: Natural Gas and the Environment*, *supra* note 32.

¹²² *Nonrenewable Natural Gas*, EIA, <https://www.eia.gov/kids/energy-sources/naturalgas/#:~:text=About%20117%20pounds%20of%20carbon,MMBtu%20of%20distillate%20fuel%20oil> (accessed Sept. 8, 2024).

¹²³ ZENIEWSKI ET AL., *supra* note 119, at 8, 49.

¹²⁴ *Biogas: A Renewable Biofuel*, UNIV. OF FLA., <https://biogas.ifas.ufl.edu/FAQ.asp> (accessed Sept. 19, 2024).

biogas emits existing greenhouse gases from manure.¹²⁵ However, manure biogas is less abundant than natural gas and thus cannot usher in the same emissions reductions.¹²⁶ Per AgSTAR's accounting, the average operational anaerobic digester generates around 124 million cubic feet of manure biogas a year.¹²⁷ Currently, 400 anaerobic digesters operate on CAFOs, so CAFOs can generate approximately 50 billion cubic feet of manure biogas a year.¹²⁸ By contrast, there exists 7,299 trillion cubic feet of natural gas reserves, over 132,709 times more abundant than annual manure biogas productions.¹²⁹ Further, as will be discussed later in this Article, manure biogas might actually cause more harm than natural gas.¹³⁰

Regarding heating and transportation fuel potential, manure biogas converted into renewable or compressed natural gas could potentially heat over 2.7 million homes or fuel nearly 150,000 refuse trucks.¹³¹ However, this only covers about 4.7% of the 58 million homes in the United States that use natural gas for space heating.¹³² Regarding energy potential, the EPA estimates manure biogas could generate nearly 16 million megawatt-hours (MWh) of energy each year if each of the 8,113 potential livestock biogas systems came online in the United States.¹³³ However, due to the electricity demand, this Article will later explain just how little manure biogas could contribute to America's electricity system—covering 0.4% of demand at best.¹³⁴ Nevertheless, the government opts to see the glass half full, taking all these purported benefits and awarding them with taxpayer dollars.¹³⁵

¹²⁵ *Id.*

¹²⁶ See *infra* Part VI, Section B (noting that manure biogas cannot supplant natural gas).

¹²⁷ See AGSTAR AD DATABASE, *supra* note 97 (calculating this number by finding the average reported generation of biogas per CAFO per day, around 341,000, and multiplying by 365 days).

¹²⁸ See *id.* (calculating this number by multiplying the average above with the number of operational anaerobic digesters on CAFOs).

¹²⁹ *What Is the Volume of World Natural Gas Reserves?*, EIA (updated June 10, 2024), <https://www.eia.gov/tools/faqs/faq.php?id=52&t=8> (accessed Sept. 8, 2024).

¹³⁰ See *infra* Part VI, Section C (delineating manure biogas's harm to the environment, humans, and nonhuman animals).

¹³¹ AgSTAR *Biogas Market Report*, *supra* note 49, at 9.

¹³² Susan Phillips, *For the First Time, Electricity Beat Out Natural Gas to Heat Homes Nationwide*, WHYY (June 9, 2022), <https://whyy.org/articles/electric-heat-natural-gas/#:~:> (accessed Sept. 8, 2024).

¹³³ AgSTAR *Biogas Market Report*, *supra* note 49, at 4, 8.

¹³⁴ See *infra* Part VI, Section B (calculating this figure from the consumption habits in the United States and the highest possible electricity that could be generated by manure biogas).

¹³⁵ See *infra* Part IV, Section B (detailing the government subsidies and incentives for manure biogas).

B. GOVERNMENT ASSISTANCE AND INCENTIVES

Even though it cannot effectively fuel the entire United States, manure biogas from CAFOs is receiving substantial government subsidies.¹³⁶ In fact, most, if not all, of CAFOs' profit in selling manure biogas stems from government subsidies.¹³⁷ Moreover, CAFOs can capitalize on multiple programs and subsidies simultaneously.¹³⁸ For constructing an anaerobic digester, CAFOs can receive grants, loans, and tax credits and exemptions;¹³⁹ for producing manure biogas, renewable fuel credits, renewable energy credits, and carbon credits for the associated emissions reductions.¹⁴⁰ At both the federal and state level, manure biogas presents myriad avenues to receive these various government subsidies.¹⁴¹ This Article will only touch upon a select few: at the federal level, the Farm Bill and the Renewable Fuel Standard; at the state level, state renewable portfolio standards and California's Low Carbon Fuel Standard.

i. The Farm Bill: EQIP and REAP

The Farm Bill offers CAFOs financial help for constructing anaerobic digesters that produce manure biogas. The biggest piece of food and agricultural legislation in the United States, the Farm Bill is king to CAFOs.¹⁴² The 2018 Farm Bill—the Agriculture Improvement Act of 2018—subsidizes manure biogas in two places: Title II (Conservation) and Title IX (Energy).¹⁴³ Most relevant, Title II of the Farm Bill hosts the Environmental Quality Incentives Program (EQIP);¹⁴⁴ Title IX,

¹³⁶ AgSTAR proudly displays the various ways to receive government funding. For a look at this, see *Project Planning and Financing*, AgSTAR (June 9, 2024), <https://www.epa.gov/agstar/project-planning-and-financing> (accessed Sept. 15, 2024) (describing the different sources of federal funding including subsidies AgSTAR receives for its biogas work).

¹³⁷ See Smith, *supra* note 108 (“Policy incentives make it profitable for dairy farmers to install digesters.”).

¹³⁸ For example, Brubaker Farms, a Pennsylvania CAFO, receives a premium for producing alternative energy and carbon credits for methane emission reductions. *Project Spotlights; Codigestion - Added Benefits*, AgSTAR (Aug. 9, 2024), <https://www.epa.gov/agstar/project-spotlights> (accessed Sept. 15, 2024).

¹³⁹ EPA, *FUNDING ON-FARM BIOGAS RECOVERY SYSTEMS: A GUIDE TO STATE AND FEDERAL RESOURCES 1* (Kurt Roos et al. eds., 2004).

¹⁴⁰ See *infra* Part IV, Section A, Subsections ii–iv (demonstrating that manure biogas can yield money from the Renewable Fuel Standard, state Renewable Portfolio Standards, and California's Low Carbon Fuel Standard).

¹⁴¹ See generally *FUNDING ON-FARM BIOGAS RECOVERY SYSTEMS*, *supra* note 139 (detailing the plethora of financial resources available to CAFOs).

¹⁴² *Farm Bill*, FEEDING AM., <https://www.feedingamerica.org/take-action/advocate/farm-bill> (accessed Sept. 15, 2024).

¹⁴³ See RENÉE JOHNSON & JIM MONKE, CONG. RSCH. SERV., RS22131, *WHAT IS THE FARM BILL?* 1, 15 (2024) (explaining and analyzing the 2018 Farm Bill).

¹⁴⁴ *Id.* at 12.

the Rural Energy for America Program (REAP).¹⁴⁵ The 2018 Farm Bill reauthorized EQIP,¹⁴⁶ a USDA program which provides farmers (or, in this case, CAFO owners) with financial and technical assistance in implementation of conservation practices.¹⁴⁷ Anaerobic digesters are considered an eligible practice to receive EQIP funds.¹⁴⁸ Not only that, but anaerobic digesters also remain the “single costliest practice eligible for EQIP payments.”¹⁴⁹ In 2022, the average anaerobic digester project received \$283,424.¹⁵⁰ For perspective, helping seven CAFOs each build an anaerobic digester is equivalent to helping 238 farmers plant cover crops.¹⁵¹

Additionally, the 2018 Farm Bill reauthorized REAP,¹⁵² a USDA program which helps agricultural producers (in this case, CAFO owners again) invest in renewable energy.¹⁵³ REAP provides grants for 25% and 50% of a renewable energy project’s cost up to one million dollars.¹⁵⁴ To receive the 50% federal grant, an anaerobic digester/manure biogas project must be located within an energy community defined in § 26 U.S.C. 45 (b)(11)(B) or be proposed by a Tribal entity.¹⁵⁵ On October 31, 2023, the Biden-Harris Administration announced \$145 million to fund 696 projects through REAP, granting eleven anaerobic digester projects nearly \$10 million in total.¹⁵⁶ On January 22, 2024, the Biden-Harris

¹⁴⁵ KELSI BRACMORT, CONG. RSCH. SERV., IF10639, FARM BILL PRIMER: ENERGY TITLE 1 (2022).

¹⁴⁶ MEGAN STUBBS, CONG. RSCH. SERV., IF12024, FARM BILL PRIMER: CONSERVATION TITLE 1 (2024).

¹⁴⁷ *Environmental Quality Incentives Program*, NAT’L SUSTAINABLE AGRIC. COAL. (May 2019), <https://sustainableagriculture.net/publications/grassrootsguide/conservation-environment/environmental-quality-incentives-program/#:~:text=The%20Environmental%20Quality%20Incentives%20Program,practices%20on%20working%20agricultural%20land> (accessed Oct. 3, 2024).

¹⁴⁸ MICHAEL HAPP, INST. FOR AGRIC. & TRADE POL’Y, WASTE AND WATER WOES: POPULAR CONSERVATION PROGRAMS SHOULD FOCUS ON SMALL-SCALE AND SUSTAINABLE FARMS, NOT INDUSTRIAL SCALE FARMS 3 (2023).

¹⁴⁹ *Id.*

¹⁵⁰ *Id.*

¹⁵¹ *Id.* at 3–4.

¹⁵² BRACMORT, *supra* note 145.

¹⁵³ *Rural Energy for America Program (REAP): Announcing \$145 Million to Expand Access to Renewable Energy and Lower Energy Costs for Rural Americans*, USDA, <https://www.rd.usda.gov/inflation-reduction-act/rural-energy-america-program-reap> (accessed Sept. 15, 2024).

¹⁵⁴ *Policy Landscape of Anaerobic Digestion*, PENNSTATE EXTENSION (Mar. 19, 2024), <https://extension.psu.edu/policy-landscape-of-anaerobic-digestion> (accessed Sept. 12, 2024).

¹⁵⁵ *Rural Energy for America Program (REAP): Announcing \$145 Million to Expand Access to Renewable Energy and Lower Energy Costs for Rural Americans*, *supra* note 153; 26 U.S.C. § 45.

¹⁵⁶ Press Release, White House, FACT SHEET: President Biden Announces Over \$5 Billion to Support Rural Communities During Investing in Rural American Event Series, (Oct. 31, 2023), <https://www.whitehouse.gov/briefing-room/statements-releases/2023/10/31/fact-sheet-president-biden-announces-over-5-billion-to-support-rural->

Administration granted additional funding of over \$165 million to fund 682 more projects.¹⁵⁷ With that round of funding, they granted twenty-seven anaerobic digester projects nearly \$57 million.¹⁵⁸ And, on March 28, 2024, the Biden-Harris Administration invested \$124 million in an additional 541 projects, granting \$500,000 to one more anaerobic digester project.¹⁵⁹ At the time of writing this Article, REAP has granted thirty-nine anaerobic digester projects nearly \$69 million total.

ii. The Renewable Fuel Standard

The Renewable Fuel Standard (RFS) offers CAFOs an additional profit for producing renewable transportation fuel from manure biogas. Under the Energy Policy Act of 2005, Congress created the Renewable Fuel Standard to decrease greenhouse gas emissions and increase renewable fuels.¹⁶⁰ The RFS achieves this goal by requiring transportation fuel providers to use a minimum volume of renewable fuels each year.¹⁶¹ To demonstrate compliance with the RFS, fuel providers must retire, or use, Renewable Identification Numbers (RINs), with one RIN symbolizing the production of one gallon of renewable fuel.¹⁶² Fuel providers can meet the renewable volume obligations by selling renewable fuel themselves, which earns them RINs, or purchasing RINs from other producers.¹⁶³ For fuel to earn a RIN, it must fall into one of four renewable fuel categories: biomass-based diesel, advanced biofuel, cellulosic biofuel, and total renewable fuel.¹⁶⁴ Since 2014, biogas qualifies

communities-during-investing-in-rural-america-event-series/ (accessed Sept. 12, 2024); USDA, USDA RURAL DEVELOPMENT ENERGY FOR AMERICA PROGRAM, USDA 8, 11, 13, 18, 51, 93–94 (Nov. 1, 2023), <https://www.rd.usda.gov/media/file/download/usda-rd-reap-chart-11-01-2023.pdf> (accessed Sept. 15, 2024).

¹⁵⁷ USDA, USDA RURAL DEVELOPMENT FPEP AND REAP FINAL CHART, USDA 1 (Jan. 22, 2024), <https://www.rd.usda.gov/media/file/download/usda-rd-reap-fpep-chart-01162024.pdf> (accessed Dec. 26, 2024).

¹⁵⁸ *Id.* at 1, 3–5, 39, 44, 63, 66, 69, 72, 73, 86, 87, 92 (Jan. 22, 2024).

¹⁵⁹ Press Release, USDA Press, Biden-Harris Administration Invests in Clean Energy and Fertilizer Production to Strengthen American Farms and Businesses (Mar. 28, 2024), <https://www.usda.gov/article/biden-harris-administration-invests-clean-energy-and-fertilizer-production-strengthen-american-farms> (accessed Dec. 26, 2024); USDA RURAL DEVELOPMENT FERTILIZER PRODUCTION EXPANSION PROGRAM AND RURAL ENERGY FOR AMERICA PROGRAM, USDA 103 (Mar. 28, 2024), <https://www.rd.usda.gov/media/file/download/usda-rd-final-fpep-reap.pdf>.

¹⁶⁰ *Renewable Fuel Standard Program*, EPA (Aug. 30, 2024), <https://www.epa.gov/renewable-fuel-standard-program> (accessed Sept. 15, 2024).

¹⁶¹ *Renewable Fuel Standard*, U.S. DEP'T OF ENERGY, <https://afd.energy.gov/laws/RFS> (accessed Sept. 22, 2024).

¹⁶² *Id.*; *Overview of the Renewable Fuel Standard Program*, EPA (May 16, 2024), <https://www.epa.gov/renewable-fuel-standard-program/overview-renewable-fuel-standard-program> (accessed Sept. 22, 2024).

¹⁶³ *Renewable Fuel Standard*, *supra* note 161.

¹⁶⁴ *Id.*; *Overview of the Renewable Fuel Standard Program*, *supra* note 162.

as a cellulosic biofuel, and manure biogas is a D3 RIN.¹⁶⁵ Accordingly, CAFOs that convert manure biogas into transportation fuel can earn D3 RINs and sell them to other transportation fuel providers.¹⁶⁶ Although it fluctuates, one D3 RIN was worth \$3.12 as of November 18, 2024.¹⁶⁷ Yielding such a large return per gallon of fuel generated, the RFS remains extremely beneficial to CAFOs producing manure biogas.

iii. State Renewable Portfolio Standards

A state renewable portfolio standard (RPS) offers CAFOs an additional profit stream for producing renewable energy from manure biogas. An RPS requires electricity providers in a state to procure a certain amount of energy from renewable energy sources.¹⁶⁸ As of 2023, twenty-eight states and the District of Columbia have adopted renewable portfolio standards.¹⁶⁹ Many states requires utilities to retire a renewable energy credit (REC) to demonstrate compliance with its RPS.¹⁷⁰ In other words, electricity providers in a state must use RECs to “prove” that they are meeting and complying with the state’s renewable goals.¹⁷¹ One REC represents the “environmental, social, and other non-power attributes” of generating one MWh of renewable electricity.¹⁷² Many states deem manure biogas as a renewable energy source satisfying their RPS.¹⁷³ For instance, Oregon considers “biogas produced from . . . anaerobic digesters” as a renewable energy source compliant with its RPS.¹⁷⁴ Accordingly, electricity providers in such states, like Oregon, would earn one REC for every MWh of manure biogas electricity they produce.

Because electric providers must use RECs to comply with state RPSs, CAFOs that produce biogas can sell RECs at a lofty price depending on the market and how ambitious the state’s RPS is (i.e., RECs will likely be pricier in a state with a higher renewable energy target because high demand yields higher prices). Indeed, RECs have reached

¹⁶⁵ Tanigawa, *supra* note 76; *Renewable Natural Gas from Agricultural-Based AD/ Biogas Systems*, EPA (updated Sept. 30, 2024), <https://www.epa.gov/agstar/renewable-natural-gas-agricultural-based-adbiogas-systems> (accessed Dec. 26, 2024).

¹⁶⁶ *Overview of the Renewable Fuel Standard Program*, *supra* note 162.

¹⁶⁷ *RIN Trades and Price Information*, EPA (July 24, 2024), <https://www.epa.gov/fuels-registration-reporting-and-compliance-help/rin-trades-and-price-information> (accessed Sept. 15, 2024).

¹⁶⁸ *Renewable Energy Explained: Portfolio Standards*, U.S. ENERGY INFO. ADMIN. (July 30, 2024), <https://www.eia.gov/energyexplained/renewable-sources/portfolio-standards.php> (accessed Sept. 15, 2024).

¹⁶⁹ *Id.*

¹⁷⁰ *Id.*

¹⁷¹ *Id.*

¹⁷² *Renewable Energy Certificates (RECs)*, EPA (Jan. 15, 2024), <https://www.epa.gov/green-power-markets/renewable-energy-certificates-recs> (accessed Sept. 15, 2024).

¹⁷³ See *AgSTAR Biogas Market Report*, *supra* note 49, at 6 (noting that twenty-nine states consider biogas from an anaerobic digester to be renewable).

¹⁷⁴ OR. REV. STAT. § 469A.025 (2023).

\$60 per REC in some states recently.¹⁷⁵ When the market for RECs is high, CAFOs can make a substantial profit. For example, Farm Power Tillamook, a CAFO selling electricity to Tillamook People's Utility District, produces 8,234,400 kWh, or around 8,234 MWh, of electricity annually.¹⁷⁶ Thus, if the price of a REC were \$60, the CAFO could theoretically earn \$494,040 from RECs each year.

iv. California's Low Carbon Fuel Standard

California's Low Carbon Fuel Standard (LCFS) offers CAFOs an additional profit stream for producing renewable transportation fuel that offsets carbon emissions. Due to its LCFS, California is the largest demand-side driver of manure biogas, and both CAFOs inside and outside of California can participate.¹⁷⁷ Akin to Congress with the RFS, California created the LCFS to decrease carbon intensity of California's transportation fuel and increase renewable fuels.¹⁷⁸ To comply with the LCFS, transportation fuel producers must not exceed carbon intensity maximums, and if they do, they must purchase credits.¹⁷⁹ Every year, the California Air Resource Board sets carbon intensity standards, and fuels below the standard receive credits while fuels above it receive deficits.¹⁸⁰ To illustrate, while gasoline incurs deficits for its high carbon intensity, manure biogas earns credits for its low carbon intensity.¹⁸¹ Moreover, manure biogas receives an unusually high subsidy: its subsidy is ten times that of landfill biogas¹⁸² and, oddly, even better than electric vehicles powered by renewable electricity.¹⁸³ Manure biogas scores so well because it receives points both for reducing methane emissions and for replacing a dirtier fuel.¹⁸⁴ For instance, whereas California mandates that landfills already must curb methane emissions, CAFOs need not;¹⁸⁵ accordingly, CAFOs that do limit methane emissions with manure biogas essentially go above and beyond current legal mandates.

¹⁷⁵ *Green Power Pricing*, EPA, <https://www.epa.gov/green-power-markets/green-power-pricing> (accessed Sept. 15, 2024).

¹⁷⁶ AGSTAR AD DATABASE, *supra* note 97; NW. CHP TECH. ASSISTANCE P'SHIPS, FARM POWER NORTHWEST FIVE SITES IN WA AND OR 1 (2018), https://chptap.ornl.gov/profile/77/Farm_Power_Northwest-Project_Profile.pdf.

¹⁷⁷ WATERMAN & ARMUS, *supra* note 60, at 16.

¹⁷⁸ *Id.*

¹⁷⁹ Phred Dvorak, *California's Green-Energy Subsidies Spur a Gold Rush in Cow Manure*, WALL ST. J. (Feb. 19, 2022, 9:00 AM), <https://www.wsj.com/articles/californias-green-energy-subsidies-spur-a-gold-rush-in-cow-manure-11645279200> (accessed Sept. 15, 2024).

¹⁸⁰ WATERMAN & ARMUS, *supra* note 60, at 16.

¹⁸¹ Smith, *supra* note 108.

¹⁸² *Id.*

¹⁸³ WATERMAN & ARMUS, *supra* note 60, at 16.

¹⁸⁴ *Id.*

¹⁸⁵ Dvorak, *supra* note 179.

In 2021, the LCFS subsidized CAFOs \$12 per diesel-gallon equivalent of manure biogas, or \$86 per MMBtu.¹⁸⁶ Thus, a cow that generated around 22.5 MMBtu per year also generated a \$1,935 subsidy from the LCFS.¹⁸⁷ By design, CAFOs house vast numbers of cows and can thus earn significant subsidies accordingly.¹⁸⁸ For example, Grimmus Cattle Company, a California CAFO with an anaerobic digester, has 79,000 cows.¹⁸⁹ Thus, if Grimmus were to seek LCFS credits for its manure biogas, it could theoretically earn up to \$152,865,000 a year. In sum, CAFOs can receive substantial subsidies for manure biogas. Not only does the government often cover the construction of anaerobic digesters, but it also awards credits for selling a renewable product *and* for reducing carbon dioxide emissions. However, if the true goal of these subsidies is to combat climate change by reducing greenhouse gas emissions, the real impact of manure biogas on the environment and energy system renders these subsidies counterproductive.¹⁹⁰

V. THE REAL IMPACT OF BIOGAS ON THE ENVIRONMENT: MORE METHANE, MORE PROBLEMS

Instead of tackling the issues of CAFOs directly, proponents of manure biogas argue that anaerobic digesters will mitigate the nefarious side effects of CAFOs.¹⁹¹ Prominently, manure biogas advocates champion its ability to curb carbon dioxide and methane emissions by replacing alternative fossil fuels and capturing manure fumes, thereby combatting climate change and bettering the environment.¹⁹² Nevertheless, its connection to methane is both a strength and shortcoming; manure biogas poses the risk of increasing, not decreasing, methane emissions due to pipeline leaks and added enteric emissions from increased herd sizes at expanding CAFOs, thus harming more than helping the environment.¹⁹³

¹⁸⁶ Smith, *supra* note 108.

¹⁸⁷ *Id.*

¹⁸⁸ See *Regulatory Definitions of Large CAFOs, Medium CAFOs, and Small CAFOs*, *supra* note 50 (showing the vast quantity of cows needed for an animal feeding operation to be considered a CAFO).

¹⁸⁹ See AgSTAR AD DATABASE, *supra* note 97 (showing that Grimmus Cattle Company Digester, a California operation with 40,000 cattle and 29,000 dairy cattle, has a covered lagoon); *Covered Lagoon*, PENNSTATE EXTENSION (Mar. 9, 2023), <https://extension.psu.edu/covered-lagoon> (accessed Sept. 29, 2024) (explaining that a covered lagoon digester is a large anaerobic lagoon).

¹⁹⁰ See *infra* Parts V & VI (revealing the true and detrimental impact of manure biogas on the environment and energy system).

¹⁹¹ See *supra* Part IV, Section A (explaining that many of the alleged benefits of manure biogas coincide with the harms of CAFOs, like those relating to odor and water quality).

¹⁹² See *id.* (discussing the ability of manure biogas to reduce methane and carbon dioxide emissions).

¹⁹³ See *supra* Part IV, Section A & *infra* Part V, Section A (referring to the process harming more than helping the environment); WATERMAN & ARMUS *supra* note 60, at 24, 38.

A. BIOGAS GENERALLY: METHANE LEAKS

To combat climate change, it remains vital to transition away from fossil fuels that emit greenhouse gases, like carbon dioxide and methane. However, replacing coal with manure biogas is a deceptive solution. Although biogas releases less carbon dioxide than coal and crude oil when burned,¹⁹⁴ it releases methane, not carbon dioxide, if it escapes before end use.¹⁹⁵ Thus, the risk of biogas is twofold—not only does biogas still emit significant amounts of carbon dioxide, but it also presents the heightened risk of emitting methane through pipeline leaks.¹⁹⁶

The ability of biogas to mitigate climate change depends almost entirely upon the rate at which methane leaks.¹⁹⁷ In fact, if methane leaks so much as a mere 0.2%, the climate impact of burning natural gas equals that of burning coal.¹⁹⁸ For biogas specifically, one study estimates that methane leaks 2–15%,¹⁹⁹ highlighting how fraught and volatile its potential climate benefit is. Unfortunately, the danger of methane gas leakages is already occurring. A 2022 report by U.S. PIRG, Environment America Research & Policy Center, and Frontier Group discovered 2,600 pipeline incidents that release 26.6 billion cubic feet of methane, equal to the emissions of 2.4 million cars driven for a year.²⁰⁰ As evidenced, methane leaks have already proven a danger in real life, not just in theory.

Worse still, the true rate of methane leakages is unknown, so while known leaks have already been proven to harm the climate, the full danger of biogas remains unrealized.²⁰¹ Because leaks are so difficult to quantify, Desirée Plata, Director of the MIT Methane Network, explains that “[n]obody knows” just how harmful methane leaks have been to the

¹⁹⁴ *Natural Gas Explained: Natural Gas and the Environment*, *supra* note 32.

¹⁹⁵ *How Much Does Natural Gas Contribute to Climate Change Through CO₂ Emissions When the Fuel is Burned, and How Much Through Methane Leaks?*, MIT CLIMATE PORTALS (July 17, 2023), <https://climate.mit.edu/ask-mit/how-much-does-natural-gas-contribute-climate-change-through-co2-emissions-when-fuel-burned#:~:text=The%20U.S.%20Environmental%20Protection%20Agency,of%20total%20natural%20gas%20production> (accessed Sept. 10, 2024).

¹⁹⁶ *Id.*; see *How Much Carbon Dioxide Is Produced Per Kilowatt-hour of U.S. Electricity Generation?*, U.S. ENERGY INFO. ADMIN., <https://www.eia.gov/tools/faqs/faq.php?id=74&t=11> (accessed Sept. 10, 2024) (showcasing that natural gas still produces significant carbon dioxide emissions: 743 million metric tons of carbon dioxide in the United States in just one year).

¹⁹⁷ Deborah Gordon et al., *Evaluating Net Life-Cycle Greenhouse Gas Emissions Intensities from Gas and Coal at Varying Methane Leakage Rates*, 18 ENV'T RSCH. LETTERS 1, 1 (2023), <https://doi.org/10.1088/1748-9326/ace3db> (accessed Dec. 30, 2024).

¹⁹⁸ *Id.*

¹⁹⁹ Emily Grubert, *At Scale, Renewable Natural Gas Systems Could Be Climate Intensive: The Influence of Methane Feedstock and Leakage Rates*, 15 ENV'T RSCH. LETTERS 1, 1 (Aug. 11, 2020), <https://doi.org/10.1088/1748-9326/ab9335> (accessed Sept. 10, 2024).

²⁰⁰ WATERMAN & ARMUS, *supra* note 60, at 24.

²⁰¹ *How Much Does Natural Gas Contribute to Climate Change Through CO₂ Emissions When the Fuel is Burned, and How Much Through Methane Leaks?*, *supra* note 196.

climate.²⁰² To illustrate, while the EPA estimates that 1% of total natural gas production ends up leaking, others have suggested this number could be as high as 9%, and a 2023 study suggests methane emissions were 70% higher than the U.S. government disclosed.²⁰³ As such, these already-staggering statistics may be even worse than anticipated such that the nebulous danger of methane leaks outweighs any benefit of biogas. In the end, adding more biogas to the United States' energy system runs the risk of adding more methane emissions, too.

*B. MANURE BIOGAS SPECIFICALLY: ENTERIC EMISSIONS
AND POLLUTION SWAPPING*

Though biogas from any source may pose an increase in methane emissions, manure biogas poses an even more pronounced methane problem because it perpetuates and incentivizes the existence of CAFOs that emit methane from not only manure, but also from ruminants.²⁰⁴ Astonishingly, agriculture accounts for 37% of methane emissions in America due to the combination of manure *and* enteric fermentation.²⁰⁵ Enteric fermentation occurs when microbes in a ruminant—namely, cows, sheep, and goats—ferment the food the ruminant consumes, creating methane in the process.²⁰⁶ Enteric fermentation occurs inside the ruminant, but she will release this methane into the atmosphere through belching or flatulence.²⁰⁷ And though enteric fermentation is entirely natural, its danger rests in the unnatural number of ruminants living in the world due to intensive factory farming, a food production system which is increasing due to manure biogas.²⁰⁸

Nevertheless, anaerobic digesters—reputed to capture methane and thus lower emissions—only target methane emissions from manure.²⁰⁹ Thus, manure biogas completely fails to address the danger of methane emissions from enteric fermentation, ultimately leading to pollution swapping. Pollution swapping occurs when a decrease of one pollutant leads to an increase of another.²¹⁰ To best showcase how manure biogas leads to pollution swapping, consider then-President

²⁰² *Id.*

²⁰³ *Id.*

²⁰⁴ *Factory Farm Biogas*, *supra* note 63.

²⁰⁵ *Id.*

²⁰⁶ Michael J. Gibbs et al., *CH₄ Emissions from Enteric Fermentation*, GOOD PRACT. GUIDANCE & UNCERTAINTY MGMT. NAT'L GREENHOUSE GAS INVENTORIES 297, 298 (n.d.).

²⁰⁷ *Id.* More specifically, 97% of methane gas from a cow comes from belching rather than flatulence. Dinah Voyles Pulver, *Cow Farts Are Bad for the Earth, But Cow Burps Are Worse. New Plan Could Help Cows Belch Less*, USA TODAY (updated Sept. 27, 2023, 7:41 PM), <https://www.usatoday.com/story/news/nation/2023/09/22/company-plans-to-solve-cow-burps-and-reduce-methane-emissions/70925187007/> (accessed Sept. 11, 2024).

²⁰⁸ WATERMAN & ARMUS, *supra* note 60, at 29, 47.

²⁰⁹ *Id.* at 9, 33–34.

²¹⁰ Carly Stevens & John Quinton, *Policy Implications of Pollution Swapping*, 34 PHYSICS & CHEMISTRY OF THE EARTH 589, 589 (2009).

Biden's *U.S. Methane Emission Reduction Action Plan* (the Plan). According to the Plan, enteric fermentation makes up 27% of methane emissions in the United States; manure management, 10%.²¹¹ Interestingly, the Plan asserts that "natural gas and petroleum systems," responsible for 30% of methane emissions, are the "largest industrial source of methane emissions in the United States."²¹² In reality, though, animal agriculture eclipses that by 7%.²¹³ To hide this truth, the Plan lists enteric fermentation and manure management as two entirely separate sources, failing to treat them as inextricably related products of animal agriculture.²¹⁴ This is not only inaccurate, but also dangerous.

For one, this masks the true methane emission rate of animal agriculture. However, more alarmingly, the Plan presents a solution to reduce methane emissions from manure without addressing that the proffered solution may also increase methane emissions from enteric fermentation. Specifically, to tackle manure methane emissions, the Plan aims to "promot[e] on-farm renewable energy from methane" by fostering the production of manure biogas.²¹⁵ At first blush, it may appear unproblematic to target the 10% of U.S. methane emissions from manure management. Nevertheless, in doing so, the Plan engages in pollution swapping: by scaling up and funding manure biogas on U.S. farms, the Plan might lower methane emissions from manure while inadvertently increasing methane emissions from enteric fermentation.

Admittedly, reducing methane emissions from manure need not inherently increase methane emissions from enteric fermentation.²¹⁶ However, the danger arises when CAFOs can profit off methane emissions reductions by receiving subsidies for producing or selling manure biogas, as this can result in herd growth at CAFOs.²¹⁷ After all, more livestock leads to more manure; more manure leads to more methane; more methane leads to more manure biogas; and, in theory, more manure biogas leads to more methane captured. Thus, manure biogas can yield three profitable products: a credit for avoiding emissions (like with California's LCFS), a credit for creating renewable energy or fuel (like with a state's RPS or the federal RFS, respectively), and an actual commodity to use or sell (electricity, heat, or fuel).²¹⁸ With that in mind, it stands to reason that a rational producer would want to grow their herd to maximize methane and manure biogas production. Indeed, a

²¹¹ BIDEN METHANE ACTION PLAN, *supra* note 23, at 6.

²¹² *Id.*

²¹³ $10\% + 27\% = 37\%$, which is 7% more than 30%.

²¹⁴ BIDEN METHANE ACTION PLAN, *supra* note 23, at 6.

²¹⁵ *Id.* at 12.

²¹⁶ Anaerobic digesters have no connection to enteric fermentation. *Enteric Fermentation*, CLIMATE & CLEAN AIR COAL., <https://www.ccacoalition.org/projects/enteric-fermentation> (accessed Oct. 1, 2024); *Learning About Biogas Recovery*, AgSTAR (May 22, 2024), <https://www.epa.gov/agstar/learning-about-biogas-recovery> (accessed Oct. 1, 2024).

²¹⁷ WATERMAN & ARMUS, *supra* note 60, at 27, 38.

²¹⁸ *Supra* Part IV, Section B, Subsections ii–iv.

2023 study by Friends of the Earth, found that herd sizes at facilities with anaerobic digesters grew 3.7% each year, adding almost 85,000 dairy cows across seventy-three CAFOs.²¹⁹ As a result, new enteric fermentation emissions from increased herd sizes may “partially or fully offset the emissions reductions from manure management.”²²⁰

Ultimately, manure biogas is detrimental to the environment because it poses the risk of increasing, not decreasing, methane emissions. Because manure biogas is composed of methane, it significantly harms the environment if and when it leaks. Additionally, manure biogas likely offsets any environmental benefit by incentivizing the increase of enteric emissions. In the end, transitioning from fuel that emits greenhouse gas is paramount to solving the climate crisis, and manure biogas produces carbon dioxide *and* increases methane emissions.

VI. THE REAL IMPACT OF BIOGAS ON THE ENERGY SYSTEM: A DECEPTIVE DISTRACTION

If biogas is considered a viable solution to produce energy, it may prevent or delay investment in and construction of alternative, truly clean and renewable energy sources. In sum, because it is more expensive, less effective, and ultimately futile in a world that demands the electrification of everything through 100% renewable, zero-emission energy, manure biogas is an imprudent and harmful source of energy.

A. MORE EXPENSIVE ENERGY SOURCE THAN WIND AND SOLAR

Simply put, anaerobic digesters are an extremely expensive way to produce energy due to their construction, operation, and maintenance costs, ultimately yielding a high levelized cost of energy. Studies find that anaerobic digesters are not economically viable without significant subsidies,²²¹ yet anaerobic digesters’ high rate of shutdown, as this Article will explore, suggest that even government subsidies often cannot keep manure biogas afloat.²²² Accordingly, the government could better spend taxpayer dollars on funding alternative sources that are more economically and energy efficient in the long run, like wind and solar.

Because renewables have low levelized costs of energy (LCOE), the lifetime costs of constructing and operating a power system divided by total energy production,²²³ wind and solar are more prudent, economical

²¹⁹ WATERMAN & ARMUS, *supra* note 60, at 6.

²²⁰ *Id.* at 29.

²²¹ LEE & SUMNER, *supra* note 67, at 32.

²²² *Infra* Part VI, Section A.

²²³ See U.S. ENERGY INFO. ADMIN., LEVELIZED COSTS OF NEW GENERATION RESOURCES IN THE ANNUAL ENERGY OUTLOOK 2023, at 2 (2023) (“Levelized cost of electricity (LCOE) . . . represent[s] the estimated cost required to build and operate a generator and diurnal storage, respectively, over a specified cost recovery period.”).

investments for energy producers and the government alike. For the past two decades, the cost of renewable technology has fallen, even becoming cost-competitive with fossil fuels.²²⁴ In fact, wind and solar provide the cheapest power for 67% of the world, including the United States.²²⁵ Looking at 2022 data, in the United States, the LCOE of on-shore wind energy was \$0.039 per kWh²²⁶ and \$0.058 per kWh for solar photovoltaic energy.²²⁷ Conversely, in North America, the LCOE of biogas digester energy was around \$0.065 per kWh.²²⁸ To understand why the LCOE of manure biogas is more expensive than wind and solar, this Article will compare the capital costs and operation and maintenance costs of each energy source.

When considering capital costs per unit of electricity generated annually, renewable alternatives like wind and solar are more economical than manure biogas. First, constructing an anaerobic digester requires substantial upfront capital ranging from \$400,000 to \$5 million, dependent on the size and technology of the digester.²²⁹ However, because AgSTAR has not released the capital cost of every anaerobic digester operating in the United States, it remains difficult to accurately compare the average capital cost per unit of electricity generated. Still, AgSTAR has released the capital costs of a handful of anaerobic digester projects: Tollenaar Holsteins Dairy, Patterson Farms, quasar energy group, Noblehurst Farms, Loyd Ray Farms, Butler Farms, and Fair Oaks Dairy,²³⁰ only the latter four of which are still operational.²³¹ Tollenaar Holsteins Dairy and Patterson Farms have since shut down

²²⁴ *Power Sector Evolution*, EPA (Aug. 28, 2024), <https://www.epa.gov/power-sector/power-sector-evolution> (accessed Sept. 9, 2024).

²²⁵ Susan Tierney & Lori Bird, *Setting the Record Straight About Renewable Energy*, WORLD RES. INST. (May 12, 2020), <https://www.wri.org/insights/setting-record-straight-about-renewable-energy> (accessed Sept. 22, 2024).

²²⁶ TYLER STEHLY ET AL., NAT'L RENEWABLE ENERGY LAB., 2022 COSTS OF WIND ENERGY REVIEW 6 (2023).

²²⁷ MICHAEL TAYLOR ET AL., INT'L RENEWABLE ENERGY AGENCY, RENEWABLE POWER GENERATION: COSTS IN 2022, at 86, 112 (Jonathan Gorvett et al. eds., 2023).

²²⁸ *See id.* at 185. Notably, the International Renewable Energy Agency does not report an exact number for the LCOE of biogas digesters; \$0.065 for manure biogas is an estimation using the given figure.

²²⁹ UNIV. OF MO. EXTENSION, E³A: ANAEROBIC DIGESTER APPLICATIONS FOR THE FARM OR RANCH: ECONOMICS 1 (Dec. 2014), <https://extension.missouri.edu/media/wysiwyg/Extensiondata/Pub/pdf/energymgmt/em0703.pdf>.

²³⁰ *See AgSTAR Project Profiles*, AGSTAR (July 22, 2024), <https://www.epa.gov/agstar/agstar-project-profiles> (accessed Sept. 9, 2024) [hereinafter *AgSTAR Project Profiles*] (hyperlinking to the following sources: AGSTAR, TOLLENAAR HOLSTEINS DAIRY – ELK GROVE (2014) [hereinafter TOLLENAAR HOLSTEINS DAIRY]; AGSTAR, PROJECT PROFILE: PATTERSON FARMS (2021) [hereinafter PATTERSON FARMS]; AGSTAR, QUASAR ENERGY GROUP – WOOSTER, OH (2014) [hereinafter QUASAR ENERGY GROUP]; AGSTAR, PROJECT PROFILE: NOBLEHURST FARMS (n.d.) [hereinafter NOBLEHURST FARMS]; AGSTAR, LOYD RAY FARMS – BOONEVILLE, NC (2014) [hereinafter LOYD RAY FARMS]; AGSTAR, PROJECT PROFILE: BUTLER FARMS (n.d.) [hereinafter BUTLER FARMS]).

²³¹ AGSTAR AD DATABASE, *supra* note 97.

their anaerobic digesters due to economic infeasibility.²³² Tollenaar Holsteins Dairy went bankrupt seven years after installing its digester,²³³ and Patterson Farms received so little compensation for electricity generation that it could no longer afford to run the digester.²³⁴ When operational, though, the Tollenaar Holsteins Dairy anaerobic digester cost \$1.7 million to build and generated just under 1.6 million kWh annually, while the Patterson Farms anaerobic digester cost \$1.5 million and could generate just over 3 million kWh annually.²³⁵ AgSTAR's data does not report whether the Quasar Energy Group's anaerobic digester still operates.²³⁶ However, the lack of information coupled with the fact that the digester exploded and hospitalized three people suggests it no longer operates.²³⁷ Regardless of its operating status, the Quasar Energy Group anaerobic digester cost \$6 million and, at one point, could generate approximately 4.5 million kWh annually.²³⁸ Continuing, the next four anaerobic digesters are still operational. The Noblehurst Farms anaerobic digester cost \$3.5 million and can generate up to around 3.85 million kWh annually;²³⁹ the Loyd Ray Farms anaerobic digester cost \$1.2 million and generates 483,990 kWh annually;²⁴⁰ the Butler Farms anaerobic digester cost \$550,000 to \$650,000 and generates 275,000 kWh annually;²⁴¹ and finally, the Fair Oaks Dairy anaerobic digester cost \$12 million and generates around 7.8 million kWh annually.²⁴²

Hence, of all seven digesters, the average capital cost was \$3.77 million to produce around 3.12 million kWh annually; of the four operational CAFO digesters, the average capital cost was \$4.3 million to produce nearly 3.11 million kWh. By contrast, wind turbines typically cost \$1.3 million per MW to build,²⁴³ and a 1 MW wind turbine would likely

²³² *Id.*; Marc Heller, 'Cow Power' Goes Dark as Manure-to-Electricity Fizzles, E&E NEWS (July 12, 2022, 1:11 PM), <https://www.eenews.net/articles/cow-power-goes-dark-as-manure-to-electricity-fizzles/> (accessed Sept. 9, 2024).

²³³ AGSTAR AD DATABASE, *supra* note 97.

²³⁴ Heller, *supra* note 232.

²³⁵ TOLLENAAR HOLSTEINS DAIRY, *supra* note 230, at 1; PATTERSON FARMS, *supra* note 230, at 1, 3; AGSTAR AD DATABASE, *supra* note 97.

²³⁶ See generally AGSTAR AD DATABASE, *supra* note 97 (omitting the digester from the database entirely).

²³⁷ Bryce Buyakie, *Three Hospitalized After Explosion at Quasar Energy's Wooster Facility*, THE DAILY REC. (June 14, 2022, 2:26 PM), <https://www.the-daily-record.com/story/news/2022/06/14/three-injured-explosion-woosters-quasar-energy-group-facility/7622751001/> (accessed Sept. 9, 2024).

²³⁸ QUASAR ENERGY GROUP, *supra* note 230, at 1–2.

²³⁹ See NOBLEHURST FARMS, *supra* note 230, at 6–7 (converting generation capacity from kW to kWh by multiplying hours in a year).

²⁴⁰ LOYD RAY FARMS, *supra* note 230, at 1; AGSTAR AD DATABASE, *supra* note 97.

²⁴¹ BUTLER FARMS, *supra* note 230, at 3; AGSTAR AD DATABASE, *supra* note 97.

²⁴² AGSTAR, FAIR OAKS DAIRY DIGESTER – FAIR OAKS, IN 1 (2014); see also AGSTAR AD DATABASE, *supra* note 97 (referring to "Fair Oaks Dairy Digester" as "Curtiss Creek Dairy Digester 1" in Fair Oaks).

²⁴³ Dan Blewett, *Wind Turbine Cost: How Much? Are They Worth It In 2024?*, WEATHER GUARD (June 3, 2024), <https://weatherguardwind.com/how-much-does-wind-turbine-cost-worth-it/> (accessed Sept. 13, 2024).

generate over 3.15 million kWh annually.²⁴⁴ Moreover, a 1 MW solar farm costs between \$890,000 and \$1.01 million to build²⁴⁵ and would likely generate 1.5 million kWh annually.²⁴⁶ Thus, for each unit of kWh generated annually, the capital cost of manure biogas remains more expensive than wind and solar. Even if the capital cost of generating manure biogas were similar to or cheaper than wind or solar, one cannot look at capital costs in a vacuum. Instead, one must consider operation and maintenance (O&M) costs, which are far lower for wind and solar energy than for manure biogas. Much like with the capital costs, AgSTAR does not release the O&M costs of each and every anaerobic digester. However, it details O&M costs in select “Project Profiles.”²⁴⁷ For example, the Fair Oaks Dairy anaerobic digester costs \$600,000 to operate and maintain annually, or about \$0.08 per kWh generated.²⁴⁸ Moreover, the Butler Farms anaerobic digester costs about \$25,000 to operate and maintain annually, or about \$0.09 per kWh generated.²⁴⁹ Conversely, each year, a wind turbine costs about \$15,000 to \$27,000 to operate and maintain per MW of capacity, or \$0.005 to \$0.009 per kWh.²⁵⁰ By those numbers, operating a wind turbine is up to eighteen times cheaper than anaerobic digester. Further, a solar farm costs about \$15,000 to operate per MW of capacity, or \$0.01 per kWh generated.²⁵¹ Accordingly, operating a solar farm is up to nine times cheaper than an anaerobic digester. Thus, the O&M costs of wind and solar pale in comparison to manure biogas.

Perhaps as a result of their high costs, anaerobic digesters have a high rate of failure. In fact, 98 of the 498 once-operational anaerobic digesters on CAFOs, almost 20%, have since shut down.²⁵² Thus,

²⁴⁴ See RYAN WISER ET AL., OFF. ENERGY EFFICIENCY & RENEWABLE ENERGY, DEPT OF ENERGY, LAND-BASED WIND MKT. REP.: 2023 EDITION, at x (2023) (reaching this number by calculating 1 MW x 8,760 hours x 36% = 3,153.6 MWh = 3,153,600 kWh and using a capacity factor of 36%, as that was the average capacity factor of wind turbines in 2022 on a fleetwide basis).

²⁴⁵ *How Much Investment Do You Need for A Solar Farm?*, COLDWELL SOLAR, <https://coldwellsolar.com/commercial-solar-blog/how-much-investment-do-you-need-for-a-solar-farm/> (accessed Sept. 22, 2024).

²⁴⁶ *How Much Money Does a 1 MW Solar Farm Make?*, ZHCSOLAR (May 8, 2023), <https://zhcsolar.com/how-much-money-does-a-1-mw-solar-farm-make/> (accessed Sept. 13, 2024).

²⁴⁷ See *AgSTAR Project Profiles*, *supra* note 230 (providing a list of profiles of livestock farm anaerobic digesters in the United States).

²⁴⁸ See FAIR OAKS DAIRY DIGESTER, *supra* note 242, at 1 (basing this number on Fair Oaks Dairy’s previously mentioned production of 7,818,300 kWh annually).

²⁴⁹ See BUTLER FARMS, *supra* note 230, at 3 (basing this number on Butler Farms’s previously mentioned production of 275,000 kWh annually).

²⁵⁰ ROB HAMMOND & AUBRYN COOPERMAN, NAT. RENEWABLE ENERGY LAB’Y, WINDFARM OPERATIONS AND MAINTENANCE COST-BENEFIT ANALYSIS TOOL (WOMBAT) 1 (2022).

²⁵¹ Leonardo David, *How Much Does a Solar Farm Cost? (2024)*, MARKETWATCH GUIDES (Aug. 29, 2024), <https://www.marketwatch.com/guides/solar/solar-farm-cost> (accessed Sept. 14, 2024).

²⁵² See AgSTAR AD DATABASE, *supra* note 97 (calculating this number by adding the 98 shutdown anaerobic digesters to the 400 currently operating anaerobic digesters).

taxpayer dollars go to constructing projects with a one in five chance of failing. Worse yet, this rate of failure is likely to increase considering 186 anaerobic digesters only became or still have yet to become operational since 2021 and have not yet had ample time to fail.²⁵³ True, government subsidies often cover upfront, capital costs, lowering the financial risk of manure biogas.²⁵⁴ However, this is not always sufficient to maintain financial feasibility because recurring O&M fees for an anaerobic digester can exceed revenue and benefits, even with various government credits and premiums.²⁵⁵ Of the sixty-three farms with shutdown anaerobic digesters that state the reason for closure,²⁵⁶ forty-seven digesters shut down because of economic hardship or operating difficulties, with many specifically listing the difficulty and expense of operating as the cause of economic hardship.²⁵⁷ Thus, even government subsidies cannot always keep these CAFO digesters afloat. In committing to cover capital costs, credits, and premiums on a poor product, the government wastes taxpayer dollars that could be better spent on cleaner, cheaper, and more effective alternatives.

Occasionally, subsidies from producing manure biogas can exceed operating costs and keep manure biogas production profitable.²⁵⁸ For instance, the California Air Resources Board estimated that one 2,000-cow farm would spend \$588,000 each year to operate its anaerobic digester, thus costing \$294 per cow.²⁵⁹ Although the cow would merely generate 22.5 MMBtu of, or \$68 worth, of energy from manure biogas, thanks to government subsidies—in this case, the lucrative California LCFS—the CAFO could earn a subsidy of \$86 per MMBtu.²⁶⁰ Thus, each cow would generate \$1,935 from manure biogas, ample to cover the \$294 per cow operating cost of the anaerobic digester.²⁶¹ Despite benefiting CAFOs, “[t]his fact should make us pause,” warns Aaron Smith, Professor of Agricultural Economics at University of California, Davis.²⁶² Because of the LCFS, taxpayer dollars subsidize CAFOs at a rate twenty-eight times the worth of their product, and that does not even include the government subsidies that fund construction of the anaerobic digester.²⁶³

²⁵³ See *id.* (reaching this number by looking only at digesters that started operating in and after 2021).

²⁵⁴ Smith, *supra* note 108.

²⁵⁵ See AGSTAR AD DATABASE, *supra* note 97 (listing various economic hardships as reasons for closures).

²⁵⁶ See *id.* (displaying thirty-five farms with shutdown digesters that fail to explain the cause).

²⁵⁷ *Id.*

²⁵⁸ Smith, *supra* note 108.

²⁵⁹ *Id.*

²⁶⁰ *Id.*

²⁶¹ *Id.*

²⁶² *Id.*

²⁶³ *Id.*

When anaerobic digesters are not economically viable without significant subsidies,²⁶⁴ manure biogas remains extremely expensive not only to CAFOs, causing nearly 20% of anaerobic digesters to shut down, but also the government, wasting money better spent elsewhere.

B. OVERSTATED, INEFFECTIVE, AND FUTILE ENERGY SOURCE

In addition to being expensive, manure biogas is an overstated, ineffective, and futile source of energy that cannot and should not supplant other sources. To begin, the suggestion echoed by its advocates that manure biogas can supplant other sources of energy and contribute significantly to the United States' electricity system is simply false. For example, the EPA lists 'energy independence' as a benefit of anaerobic digestion, contending that manure biogas could meet on-farm energy needs and provide energy to the local grid.²⁶⁵ Specifically, in a 2018 report espousing the benefits of manure biogas, the EPA proudly predicted that manure biogas could generate nearly 16 billion kWh of electricity annually if each and every of the 8,113 potential livestock biogas systems came online in the United States.²⁶⁶ However, the United States consumed about 4 trillion kWh in 2022, so even at its peak, manure biogas would only account for 0.4% of electricity demand.²⁶⁷ Moreover, because only 400, not 8,113, anaerobic digesters currently operate and only 167 of those generate electricity, manure biogas realistically produces a mere 0.016% of the national electricity demand.²⁶⁸

Manure biogas proponents might argue that they do not expect or intend manure biogas to supply 100% of America's electricity. However, manure biogas cannot even supplant natural gas. According to the American Gas Foundation, at the very most, manure biogas could only meet 3% of America's total demand for natural gas by 2040.²⁶⁹ And still, this is generous. In 2023, natural gas generated 43.1% of electricity in the United States.²⁷⁰ Accordingly, to replace natural gas, manure biogas would have to generate 1.72 trillion kWh annually. Using the same amount of electricity the EPA predicted manure biogas could

²⁶⁴ LEE & SUMNER, *supra* note 67, at 32.

²⁶⁵ *The Benefits of Anaerobic Digestion*, *supra* note 83.

²⁶⁶ *AgSTAR Biogas Market Report*, *supra* note 49, at 4, 8.

²⁶⁷ *Use of Electricity: Electricity Consumption in the United States Was About 4 Trillion Kilowatthours (kWh) in 2022*, EIA (updated Dec. 18, 2023), <https://www.eia.gov/energyexplained/electricity/use-of-electricity.php> (accessed Sept. 23, 2024) (calculating this figure by dividing 16 billion kWh by 4 trillion kWh).

²⁶⁸ See *AGSTAR AD DATABASE*, *supra* note 97 (reporting only 167 anaerobic digesters that generate electricity, totaling 659,092,822 kWh a year); *Use of Electricity: Electricity Consumption in the United States Was About 4 Trillion Kilowatthours (kWh)*, *supra* note 267 (dividing the previous figure by the United States' consumption of about 4 trillion kWh in 2022).

²⁶⁹ Dvorak, *supra* note 179.

²⁷⁰ *What is U.S. Electricity Generation by Energy Source?*, EIA (updated Feb. 29, 2024), <https://www.eia.gov/tools/faqs/faq.php?id=427&t=3> (accessed Sept. 23, 2024).

potentially generate—16 billion kWh—manure biogas could supply only 0.93% of natural gas demand. At the same rate that 167 anaerobic digesters currently produce around 659 million kWh annually, over one million digesters must be online for manure biogas to replace natural gas.²⁷¹ Yet, fewer than 22,000 CAFOs exist in the United States.²⁷²

In addition, for manure biogas to be able to positively contribute to America's electrical grid in the first place, utilities must be willing to buy it. After all, the production of energy does not automatically lead to the consumption of energy. Instead, CAFOs must contract with utilities, some of which “may be unwilling to enter such an agreement.”²⁷³ Because of this, utilities can essentially nullify the entire potential of manure biogas.²⁷⁴

Further, to meet climate goals, the need to electrify everything with clean, renewable energy renders manure biogas useless. To accomplish the Paris Agreement's 1.5°C goal and tackle climate change, studies continue to find that electrifying everything remains the best, if not only, path forward.²⁷⁵ True, manure biogas can be used to generate electricity, a step in the right direction in a world that must electrify everything. However, as discussed previously, manure biogas can produce, at most, only 0.4% of electricity demand in the United States.²⁷⁶ Moreover, manure biogas still emits carbon dioxide when burned and can also leak methane and other air pollutants.²⁷⁷ This is hardly the solution to reach climate goals. And, to electrify everything, the United States requires three times the amount of electricity currently produced.²⁷⁸ At that rate, manure biogas could supply only 0.13% of electricity demand. Additionally, manure biogas processed into renewable, compressed, or liquified natural gas becomes entirely futile if we electrify everything. Currently, fossil fuels burned by machines that already exist—like gas furnaces, cars, and appliances—take us beyond the 1.5°C long-term temperature goal.²⁷⁹ Thus, they must be retired “by everyone, everywhere, whether an individual, a power company, or a corporation.”²⁸⁰

²⁷¹ See AGSTAR AD DATABASE, *supra* note 97 (calculating this number by dividing 719 million by 429 to estimate how much electricity one anaerobic digester produces and dividing by 1.72 trillion).

²⁷² NPDES CAFO Permitting Status Report: National Summary, *Endyear 2023*, *supra* note 55.

²⁷³ UNIV. OF MO. EXTENSION, *supra* note 229, at 1–2.

²⁷⁴ Of course, utilities can and do buy in. However, it is still important to note that this is not a guarantee. A contract with a utility is not required to install a digester, thus making manure biogas risky.

²⁷⁵ See, e.g., SAUL GRIFFITH, *REWIRING AMERICA* 8, 33–43 (2020) (explaining extensively why we must electrify everything).

²⁷⁶ *Supra* Part VI, Section B.

²⁷⁷ Cyrs, *supra* note 34; Grubert, *supra* note 199, at 2; WATERMAN & ARMUS, *supra* note 60, at 24.

²⁷⁸ GRIFFITH, *supra* note 275, at 44.

²⁷⁹ *Id.* at 7.

²⁸⁰ *Id.* at 11.

When these gas-powered machines become obsolete, so does the renewable, compressed, and liquified natural gas produced by manure biogas. Accordingly, we cannot afford to lock in manure biogas infrastructure, as any increased combustion of natural gas fails to provide a long-term pathway to global climate objectives.²⁸¹

C. HARMFUL ENERGY SOURCE

On top of being ineffective and eventually futile, manure biogas also produces a plethora of negative externalities, harming the environment, humans, and nonhuman animals alike. In fact, with its myriad drawbacks, manure biogas causes more harm than other energy sources—from renewables like wind and solar to potentially even natural gas.

Though manure biogas may harm the environment less than coal and crude oil,²⁸² it still causes significant harm. Paradoxically, manure biogas is viewed as carbon-neutral despite emitting carbon dioxide.²⁸³ This is because manure biogas utilizes an existing source of greenhouse gases—manure—instead of adding any new greenhouse gases.²⁸⁴ Just because manure biogas emits less than coal and crude oil does not mean it emits nothing; instead, we can look to wind and solar to accomplish this goal.²⁸⁵ Thus, to argue that manure biogas beats coal and crude oil on environmental grounds is to miss the forest for the trees: reducing absolute emissions relative to what they would be with fossil fuels is not the same as reducing them to what they could be with renewables.²⁸⁶ Additionally, the overproduction of manure biogas causes environmental harm.²⁸⁷ When a CAFO produces too much manure biogas, the CAFO will flare or burn it, releasing carbon monoxide, sulfur dioxide, nitrogen oxides, and particulate matter, which pollute the air and trap heat.²⁸⁸ Because lower emitting alternatives exist, manure biogas is not the solution to end the climate crisis.

Further, manure biogas also harms humans. For instance, just like any other gas pipeline, pipelines needed to deliver manure biogas endanger marginalized communities by threatening their safety.²⁸⁹ Controversially, interstate gas pipelines may assert eminent domain to build on private land, squeezing out landowners who have no power to

²⁸¹ ZENIEWSKI ET AL., *supra* note 119, at 42.

²⁸² *Is Natural Gas Really the Bridge Fuel the World Needs?*, *supra* note 31.

²⁸³ Joe Rudek & Stefan Schwietzke, *Not All Biogas Is Created Equal*, ENV'T DEF. FUND (Apr. 15, 2019), <https://blogs.edf.org/energyexchange/2019/04/15/not-all-biogas-is-created-equal/> (accessed Sept. 20, 2024).

²⁸⁴ *Id.*

²⁸⁵ UNITED NATIONS, *Renewable Energy – Powering a Safer Future*, <https://www.un.org/en/climatechange/raising-ambition/renewable-energy> (accessed Sept. 20, 2024).

²⁸⁶ ZENIEWSKI ET AL., *supra* note 119, at 16.

²⁸⁷ WATERMAN & ARMUS, *supra* note 60, at 24.

²⁸⁸ *Id.*

²⁸⁹ *Id.*

stop them.²⁹⁰ Tragically, those who must surrender their land to pipelines and those living nearby face devastating mental, physical, and economic harms. A 2024 study found that those living near pipelines often face health effects, such as “insomnia, high blood pressure, heart problems, teeth grinding, headaches, tremors, and Atrial fibrillation[.]”²⁹¹ Horrific, the study reports that one person living near a pipeline asserted that five of their friends, all of whom owned land that the pipeline crossed, passed away “in part due to stress or associated with activities related to fighting this MVP pipeline project.”²⁹² Additionally, based on a 2022 report by U.S. Public Interest Research Group, Environment America Research & Policy Center, and Frontier, 2,600 pipeline incidents and 328 explosions occurred from 2010 to 2021, killing 122 people and injuring 603.²⁹³ Moreover, pipelines can reduce property values up to 40%.²⁹⁴ Meanwhile, clean energy, by contrast, yields higher property values.²⁹⁵

Additionally, manure biogas worsens air quality even more than natural gas,²⁹⁶ while clean energy improves it.²⁹⁷ Notably, manure biogas is ten times more toxic to humans than natural gas.²⁹⁸ Manure biogas plants emit more carbon monoxide, sulfur dioxide, nitrogen oxides, non-methane volatile organic compounds, and formaldehyde than wall-fired natural gas boiler plants.²⁹⁹ For example, the digester at Lakeview Dairy, a California CAFO, emits higher levels of nitrogen oxide, volatile organic compounds, and sulfur dioxide than a nearby natural gas plant.³⁰⁰ Each of these air pollutants can seriously damage human health.³⁰¹ Unfortunately, the danger of these air pollutants may be overlooked because CAFOs—and thus manure

²⁹⁰ PIPELINE SAFETY TRUST, PIPELINE BRIEFING PAPER #9: PIPELINE ROUTING AND SITING ISSUES 3 (2015), <https://pstrust.org/wp-content/uploads/2015/09/2015-PST-Briefing-Paper-09-Pipeline-Routing-and-Siting-Issues.pdf>.

²⁹¹ Shannon Elizabeth Bell et al., *Pipelines and Power: Psychological Distress, Political Alienation, and the Breakdown of Environmental Justice in Government Agencies’ Public Participation Processes*, 109 ENERGY RSCH. & SOC. SCI. 1, 9 (2024), <https://doi.org/10.1016/j.erss.2023.103406> (accessed Dec. 31, 2024).

²⁹² *Id.*

²⁹³ WATERMAN & ARMUS, *supra* note 60, at 24.

²⁹⁴ Daniel Walmer, *Pipelines Could Affect Property Values*, LEBANON DAILY NEWS (updated Jan. 4, 2016), <https://www.ldnews.com/story/news/local/2016/01/02/pipelines-could-affect-property-values/77984160/> (accessed Sept. 27, 2024).

²⁹⁵ Melissa Powers, *An Inclusive Energy Transition: Expanding Low-Income Access to Clean Energy Programs*, 18 N.C. J. L. & TECH. 540, 554 (2017).

²⁹⁶ WATERMAN & ARMUS, *supra* note 60, at 23.

²⁹⁷ Powers, *supra* note 295, at 554.

²⁹⁸ WATERMAN & ARMUS, *supra* note 60, at 23.

²⁹⁹ *Id.*

³⁰⁰ *Id.*

³⁰¹ See *Air Pollutants*, QUEENSLAND GOV’T, <https://www.qld.gov.au/environment/management/monitoring/air/air-pollution/pollutants> (accessed Sept. 31, 2024) (listing air pollutants that have negative effects on health).

biogas digesters—are disproportionately sited near low-income and communities of color, causing further environmental injustices.³⁰²

Finally, manure biogas causes extreme suffering to animals, significantly more so than wind or solar energy. Manure biogas requires vast amounts of manure and vast numbers of animals to be economically feasible.³⁰³ Accordingly, CAFOs dominate in producing manure biogas.³⁰⁴ Though seen as a benefit to some, offering CAFOs a second revenue stream further perpetuates a system of animal abuse. A standard CAFO offers little space for its animals, such that animals are “raised like they’re parked cars.”³⁰⁵ Unfortunately, CAFOs are wrought with mistreatment of animals; confinement hardly scratches the surface.³⁰⁶ While it remains true that wind and solar farms harm animals, too, the magnitude is unequal. In the United States, wind turbines kill around one million birds a year;³⁰⁷ solar farms, 37,800 to 138,600 birds.³⁰⁸ By contrast, U.S. CAFOs kill over 9.185 billion birds a year.³⁰⁹ Though advocates of manure biogas may argue that this magnitude of harm occurs even without manure biogas and meaningfully feeds humans, neither argument carries weight. First, because manure biogas leads to an increase in herd sizes,³¹⁰ more animals will suffer due to the poor husbandry and mutilations to which CAFOs subject them. But for

³⁰² Petition from Earthjustice et al., to Environmental Protection Agency Ex.5 (Oct. 2022), https://www.epa.gov/system/files/documents/2023-07/Earth%20Justice%20et%20al._10.2022.pdf (accessed Sept. 28, 2024).

³⁰³ See *AgSTAR Biogas Market Report*, *supra* note 49, at 7 (deeming dairy farms with over 500 cows or swine farms with 2,000 to 5,000 animals to be good candidates of manure biogas).

³⁰⁴ WATERMAN & ARMUS, *supra* note 60, at 13 (“This means that the largest and most polluting CAFOs are best positioned to capture the benefits of the many taxpayer-funded subsidies and other policy incentives for producing manure biogas . . .”).

³⁰⁵ Lynne Curry, *After a Decade of Promises, Has the Food Industry Made Progress on Gestation Crates?*, CIVIL EATS (Mar. 21, 2018), <https://civileats.com/2018/03/21/after-a-decade-of-promises-has-the-food-industry-made-progress-on-gestation-crates/> (accessed Sept. 20, 2024).

³⁰⁶ Delineating the extensive harm that CAFOs cause to animals is beyond the scope of this article. However, myriad resources exist which unearth the animal cruelty that occur in CAFOs. See, e.g., SIERRA CLUB GRASSROOTS NETWORK FOOD & AGRIC. TEAM/NAT’L CAFO SUB-TEAM, *CAFOs – Farm Animal Cruelty by Design*, SIERRA CLUB (Aug. 2023), <https://www.sierraclub.org/sites/default/files/2023-08/SC%20CAFOs-Farm%20Animal%20Cruelty%20by%20Design.pdf> (accessed Sept. 20, 2024) (discussing that CAFOs cause high stress, high level of disease transmission, mutilations, forced impregnation, separation of mother and offspring, heat stroke and mass suffocation, injuries due to barn fires and explosions, and suffering during long transportation for the animals).

³⁰⁷ Hannah Ritchie, *How Many Birds Do Wind Farms Kill?*, SUSTAINABILITY BY NOS. (Jan. 31, 2024), <https://www.sustainabilitybynumbers.com/p/wind-power-bird-deaths> (accessed Sept. 20, 2024).

³⁰⁸ Sammy Roth, *How Many Birds Are Killed by Solar Farms?*, DESERT SUN (updated Dec. 17, 2018), <https://www.desertsun.com/story/tech/science/energy/2016/08/17/how-many-birds-killed-solar-farms/88868372> (accessed Sept. 20, 2024).

³⁰⁹ See RITCHIE, *supra* note 56 (listing that 8.9 billion chickens and 285 million are factory-farmed, which totals to 9.185 billion).

³¹⁰ WATERMAN & ARMUS, *supra* note 60, at 29.

manure biogas, harm may never have come to the aforementioned 85,000 dairy cows added by seventy-three CAFOs since installing their anaerobic digesters.³¹¹ Second, the world wastes (i.e., never actually consumes) eighteen billion of the seventy-five billion animals—one in four—raised for food each year.³¹² Specifically, the United States wastes 7.1 animals per person.³¹³ Needless to say, billions of ‘wasted’ animals who die at the hands of the CAFO system do not feed humans or have any meaningful purpose. In perpetuating manure biogas, its advocates must confront, and ultimately condone, this system of abuse.

*D. UNNECESSARY ENERGY SOURCE, EVEN IF
NATURAL GAS MUST PERSIST*

Although we must electrify everything to meet climate goals,³¹⁴ natural gas may persist as a bridge fuel in the meantime.³¹⁵ As it stands, the United States possesses more than enough natural gas, currently boasting enough to last about eighty-six years.³¹⁶ Accordingly, adding more natural gas to the system in the form of manure biogas is unhelpful and unnecessary. To be sure, manure biogas advocates may argue that extracting conventional and unconventional natural gas poses numerous dangers—from wildlife disruption to earthquakes—such that manure biogas is preferable to the eighty-six-year supply of conventional and unconventional natural gas. And while it is true that biogas does not pose identical dangers, the potential allure of biogas need not be tied to *manure* biogas.

Instead, municipal solid waste landfills and wastewater treatment plants can also generate biogas. As previously noted, anaerobic digestion also occurs at landfills and wastewater treatment plants.³¹⁷ Considering that it does not pose the dangers of conventional and unconventional natural gas *and* does not perpetuate unethical institutions like CAFOs, biogas from municipal solid waste landfills and wastewater treatment plants remains the superior form of methane gas. Unlike manure biogas, which requires CAFOs to install anaerobic digesters, landfill biogas occurs naturally in the ground.³¹⁸ After waste decomposes and emits methane, landfills can harness the resulting biogas

³¹¹ *Id.* at 35, 38.

³¹² Kenny Torella, *We Raise 18 Billion Animals a Year to Die—And Then We Don’t Even Eat Them*, Vox (updated Dec. 12, 2023), <https://www.vox.com/future-perfect/22890292/food-waste-meat-dairy-eggs-milk-animal-welfare> (accessed Sept. 20, 2024).

³¹³ *Id.*

³¹⁴ *Supra* Part VI, Section B.

³¹⁵ *Is Natural Gas Really the Bridge Fuel the World Needs?*, *supra* note 31.

³¹⁶ *How Much Natural Gas Does the United States Have, and How Long Will It Last?*, EIA (updated Apr. 29, 2024), <https://www.eia.gov/tools/faqs/faq.php?id=58&t=8> (accessed Sept. 19, 2024).

³¹⁷ *Biomass Explained: Landfill Gas and Biogas*, *supra* note 61.

³¹⁸ *Renewable Natural Gas Production*, *supra* note 79.

by collecting it through buried piping.³¹⁹ More like CAFOs, wastewater treatment plants do not produce biogas naturally, instead relying on anaerobic digesters.³²⁰ Additionally, wastewater treatment plants and CAFOs share similar production processes because they use a similar feedstock—sewage sludge vs. manure, respectively—to create biogas.³²¹

Much like a purported benefit of manure biogas, landfill biogas reduces methane emissions, capturing around 60–90% of methane emitted from landfills.³²² Additionally, in 2023, landfill biogas projects participating in the EPA's Landfill Methane Outreach Program (LMOP) reduced over ninety-five million metric tons of carbon dioxide equivalent³²³ and generated around 12 billion kWh of electricity.³²⁴ This is roughly 0.3% of U.S. electricity demand,³²⁵ compared to manure biogas's 0.016%.³²⁶

Furthermore, 1,269 wastewater treatment plants operate anaerobic digesters in the United States, 860 of which use the biogas produced.³²⁷ In 2022, 102 wastewater treatment plants generated about 1 billion kWh of electricity, or around 0.025% of U.S. electricity demand.³²⁸ However, this biogas could meet upwards of 12% of the national electricity demand.³²⁹

Ultimately, humans make plenty of waste all on their own without bringing farmed animals into the equation. Because of this waste, we

³¹⁹ *Basic Information About Landfill Gas*, EPA (updated Apr. 25, 2024), <https://www.epa.gov/lmop/basic-information-about-landfill-gas> (accessed Sept. 19, 2024).

³²⁰ *Renewable Natural Gas Production*, *supra* note 79.

³²¹ *Id.*; *Sewage*, ANAEROBIC DIGESTION & BIORESOURCES ASS'N, <https://adbioresources.org/about-ad/waste-management/sewage/> (accessed Sept. 30, 2024).

³²² LANDFILL METHANE OUTREACH PROGRAM, LFG ENERGY PROJECT DEVELOPMENT HANDBOOK 1–9 (JAN. 2024), https://www.epa.gov/system/files/documents/2024-01/pdh_full.pdf (accessed Sept. 19, 2024).

³²³ *LMOP Data for 2001 Through 2023*, EPA (updated July 2023), https://www.epa.gov/system/files/other-files/2024-03/national_lmopdata_files_2001-2023.zip (looking at the July 2023 Excel Sheet).

³²⁴ *See id.* (reaching this figure by summing the actual MW generated by every LMOP landfill biogas project in the United States that produced electricity (roughly 1378 MW), converting to kW by multiplying by 1000, and then multiplying by hours in a year (8,760 hours)).

³²⁵ *Electricity Consumption in the United States Was About 4 Trillion Kilowatthours (kWh) in 2022*, *supra* note 267 (dividing the above number by 4 trillion kWh, U.S. electricity demand in 2022).

³²⁶ *See supra* Part VI, Section B (stating that 400 anaerobic digesters exist in the United States, capable of producing only 0.016% of the nation's electricity demand in 2022).

³²⁷ Tanigawa, *supra* note 76.

³²⁸ *Biomass Explained: Landfill Gas and Biogas*, *supra* note 61; *see also Electricity Consumption in the United States Was About 4 Trillion Kilowatthours (kWh) in 2022*, *supra* note 267 (dividing the 1 billion kWh by 4 trillion kWh, U.S. electricity demand in 2022).

³²⁹ NACWA ET AL., THE WATER RESOURCES UTILITY OF THE FUTURE...A BLUEPRINT FOR ACTION 14 (2013), https://www.wef.org/globalassets/assets-wef/direct-download-library/public/03---resources/waterresourcesutilityofthefuture_blueprintforaction_final.pdf.

can create better alternatives to conventional, unconventional, and manure biogas, thus transitioning to renewables without abandoning gas consumers in the process.

VII. SOLUTIONS AND RECOMMENDATIONS

Though climate change may seem insurmountable, it is not impossible to overcome. Thankfully, various solutions to end manure biogas exist, as revolutionary as banning natural gas entirely to as incremental as paying farmers to reduce herd sizes. Nevertheless, each solution shares one common denominator: eliminating funding from manure biogas and shifting it elsewhere. After all, given that manure biogas is utterly unwise and needlessly destructive, any investment in manure biogas is wasting money on a sinking ship.

A. PHASE OUT NATURAL GAS ENTIRELY

Though less likely on a broad scale, one solution to quash manure biogas is to phase out natural gas entirely. Recently and monumentally, Massachusetts became the first state to officially begin phasing out natural gas.³³⁰ On December 6, 2023, the Massachusetts Department of Public Utilities, Massachusetts's regulatory agency for utilities, announced a regulatory framework for shifting away from natural gas and to electricity for heating.³³¹ Matt Rusteika of the Building Decarbonization Coalition announced, “[T]his is the first time a utility has been required to decarbonize To take a step so clear and so deliberate is truly a first.”³³² While clean energy advocates celebrate this ruling, the gas industry is up in arms. Notably, renewable natural gas companies argue that renewable natural gas (including from manure biogas) remains a vital decarbonization tool.³³³ In response, Ezra Hausman, energy policy consultant, asserted that this is “magical thinking,” as renewable natural gas simply cannot replace natural gas.³³⁴ Echoing Hausman’s concern, this Article has demonstrated that manure biogas could, at best, supply 0.4% of electricity demand in the United States.³³⁵ In addition to Massachusetts, eleven other states³³⁶ have recent or ongoing regulatory cases concerning natural gas, so while the end to natural

³³⁰ Dan Gearino, *Massachusetts Just Took a Big Step Away from Natural Gas. Which States Might Follow?*, INSIDE CLIMATE NEWS (Dec. 7, 2023), <https://insideclimatenews.org/news/07122023/massachusetts-natural-gas-ruling/> (accessed Sept. 20, 2024).

³³¹ *Id.*

³³² *Id.*

³³³ *Id.*

³³⁴ *Id.*

³³⁵ See *supra* Part IV, Section B (discussing the amount of kWh the United States consumed in one year and noting that manure biogas would only be able to meet 0.4% of that electricity demand at most).

³³⁶ California, Colorado, Illinois, Maryland, Minnesota, Nevada, New Jersey, New York, Oregon, Rhode Island, and Washington. Gearino, *supra* note 330.

gas seems far off, it may be closer than anticipated.³³⁷ Nevertheless, in Massachusetts, as in anywhere else considering the transition from fossil fuels, valid concerns arise. Though the blow to industry may not evoke sympathy, gas companies are not the only victims of this ruling: so, too, are gas customers. Gas heats 50.5% of Massachusetts homes; electricity, 19.9%.³³⁸ Thus, over half of the households in Massachusetts would need to invest in alternative technologies, which is an expensive endeavor not all can afford. For example, the average cost of switching to electric heating can reach up to \$20,000.³³⁹

Moreover, shifting away from natural gas may disproportionately affect lower-income consumers.³⁴⁰ As this Article has demonstrated, manure biogas is more expensive than renewable energy,³⁴¹ accordingly, customers see these higher prices in their utility bills. For some customers, these high prices effectively signal a reason to switch to electricity and abandon gas completely. However, not everyone can afford to invest in electric heating and appliances, nor does everyone own a home to allow them to make these changes in the first place. As some customers depart from gas utilities, those that remain, like those unable to afford the required investments, are stuck with even higher utility rates.³⁴²

To explain these higher rates, understanding traditional utility rate design is important. In the United States, traditional utility ratemaking is prospective, and rates are spread across the entire customer base.³⁴³ Typically on a three-year timeframe, utilities reach a prospective rate based on the predicted energy supply required for a predicted number of customers.³⁴⁴ Thus, when customers unexpectedly leave, utilities lose some of the profit they anticipated. To recover some of this revenue based on their failed investments, utilities can attempt to increase rates for the remaining customer base.³⁴⁵ However,

³³⁷ *Id.*

³³⁸ *How Massachusetts Households Heat Their Homes*, MASS.GOV, <https://www.mass.gov/info-details/how-massachusetts-households-heat-their-homes> (accessed Sept. 19, 2024).

³³⁹ *How Much Could Electric Heat Really Cost You in MA & CT?*, PAYLESSFOROIL.COM (May 9, 2023), <https://paylessforoil.com/electric-heat-cost/> (accessed Sept. 19, 2024).

³⁴⁰ Powers, *supra* note 295, at 555.

³⁴¹ *Supra* Part VI, Section A.

³⁴² *See* Powers, *supra* note 295, at 555 (discussing how low-income electricity customers often lack the resources to invest in clean energy markets or benefit from the clean energy transition, and because biogas is more expensive than renewable energy, low-income customers will have no choice but to pay comparatively higher rates).

³⁴³ *See* MELISSA POWERS, *Chapter II: Utility Regulation in ENERGY REGULATION IN AN AGE OF TRANSITION* 34–35 (2022) (describing how the traditional ratemaking process is prospective one where public utility commissions must estimate future utility needs).

³⁴⁴ *Id.*

³⁴⁵ *See id.* at 35 (explaining how utilities' profits depend on the fixed rates set by public utility commissions and actual service costs, incentivizing them to improve productivity and reduce expenses, while regulators may intervene if earnings significantly deviate from projected revenue requirements); *Utilities Requesting to Increase Rates: Who, What, How, and Why?*, ELECTRIC CHOICE, <https://www.electricchoice.com/blog/>

adjusting rates after-the-fact conflicts with the general rule prohibiting retroactive (rather than prospective) ratemaking.³⁴⁶ Accordingly, utilities must petition their state regulatory agencies to adjust rates, and because the Massachusetts Department of Public Utilities itself ruled to phase out natural gas, perhaps gas utilities in Massachusetts, not ratepayers, will be stuck paying for departers. Indeed, one solution to the gas death spiral is to do just that: make utilities pay for their failed investments without passing costs on to customers. Though uncommon, doing so is not novel. For example, in *Market Street Railway Co. v. Railroad Commission of State of California*, 324 U.S. 548 (1945), the Market Street Railway Company ran streetcar lines in San Francisco, eventually growing obsolete due to competing municipal street railway lines.³⁴⁷ Attempting to stay online, the Railway petitioned the Railroad Commission to increase its rate from five to seven cents, yet the Commission held that six cents was sufficient.³⁴⁸ In response, the Railway argued that, in refusing to allow the full rate adjustment, the Railroad Commission unconstitutionally took its property by forcing it to operate at a loss.³⁴⁹ Although the Supreme Court had earlier held that valid rates must ensure a return sufficient to maintain a company's financial integrity,³⁵⁰ in *Market Street Railway*, the Court held that increased rates may not prop up a company "whose financial integrity already is hopelessly undermined[.]"³⁵¹

Just like the Market Street Railway Co., gas companies are growing obsolete and financially infeasible due to competition. Accordingly, following the Court in *Market Street Railway*, the Supreme Court and utility regulatory agencies need not and must not bail out these gas companies, "whose financial integrity already is hopelessly undermined."³⁵² In so doing, we can avoid the gas death spiral.

Rather than helping gas utilities stay afloat, the government should help customers make the switch to electricity. For one, the government could spend this money on building electric infrastructure for lower-income communities. Alternatively, it could provide lower-income communities with clean energy through community solar or rooftop solar. For example, California has contracted with GRID Alternatives, a non-profit, to provide rooftop solar in lower-income

utilities-requesting-rate-hikes/ (accessed Sept. 19, 2024) (discussing how utilities often raise rates to cover the costs of repairs, updates, or changes in weather and living expenses).

³⁴⁶ See, e.g., *Phila. Elec. Co. v. Pa. Pub. Util. Comm'n*, 93 Pa. Commw. 410, 421 (Pa. Commw. Ct. 1985) (applying a rule against retroactive ratemaking).

³⁴⁷ *Mkt. St. Ry. Co. v. R.R. Comm'n of Cal.*, 324 U.S. 548, 552, 554–55 (1945).

³⁴⁸ *Id.* at 555, 557.

³⁴⁹ *Id.* at 553–54.

³⁵⁰ See *Fed. Power Comm'n v. Hope Nat. Gas Co.*, 320 U.S. 591, 603 (1944) (determining that return on rates "should be sufficient to assure confidence in the financial integrity of the enterprise").

³⁵¹ *Mkt. St. Ry. Co.*, 324 U.S. at 566.

³⁵² *Id.*

communities, which has lowered participants' monthly electricity bills around 80%.³⁵³ Excitingly, on April 4, 2024, the Biden-Harris Administration pledged \$20 billion to clean energy and climate solutions, especially in lower-income and disadvantaged communities.³⁵⁴ Thus, the government should not contradict its efforts to include lower-income communities in the transition to clean energy by propping up a dying industry: gas. As this Article has and will continue to suggest, any government funding for manure biogas would better serve transitions to clean, renewable energy.

B. IMPLEMENT PRUDENCE REVIEW

Additionally, before investing in the capital costs of manure biogas (e.g., constructing anaerobic digesters), the U.S. government should adopt utility regulators' "prudence review" test for cost recovery. A cornerstone of energy law, "prudence review" requires that a utility's capital investments be prudent, or economically wise, in that the investments will provide necessary service to captive customers.³⁵⁵ Thus, if a capital investment (e.g., construction of a new power plant) is prudent when made, the utility may include and profit from the investment through rates.³⁵⁶ Almost all state utility regulators require an ongoing demonstration of prudence.³⁵⁷ Accordingly, if an investment becomes imprudent, further investments are non-recoverable.³⁵⁸

If a utility proposes to construct an anaerobic digester to deliver gas or electricity to its customers, its capital investment likely will have to be prudent.³⁵⁹ However, CAFOs, not utilities, construct anaerobic digesters, and CAFOs need not satisfy any prudence test to receive government subsidies to cover their capital costs of building an anaerobic digester. However, as this Article discusses, investments in manure biogas remain utterly imprudent. Thus, if the government were to adopt a prudence test before investing in manure biogas, it could then spend

³⁵³ Powers, *supra* note 295, at 562.

³⁵⁴ Press Release, White House, Biden-Harris Administration Announces Historic \$20 Billion in Awards to Expand Access to Clean Energy and Climate Solutions and Lower Energy Costs for Communities Across the Nation (Apr. 4, 2024), <https://www.whitehouse.gov/briefing-room/statements-releases/2024/04/04/biden-harris-administration-announces-historic-20-billion-in-awards-to-expand-access-to-clean-energy-and-climate-solutions-and-lower-energy-costs-for-communities-across-the-nation/> (accessed Sept. 19, 2024).

³⁵⁵ POWERS, *supra* note 343, at 33, 101.

³⁵⁶ *Id.* at 36.

³⁵⁷ Melissa Powers, *Ratemaking and Failed Investments: Hope End Results Implications; Prudent Investment v. Used and Useful* 6 (Sept. 25, 2023) (Energy Regulation Class PowerPoint) (on file with *Animal Law*).

³⁵⁸ *Id.*

³⁵⁹ POWERS, *supra* note 343, at 78 (discussing an alternative to the prudence test as some states only allow cost recovery when an investment becomes used and useful, as in operational and sending power to the grid; some states even require the combination of both).

this money elsewhere, such as transitioning to clean energy or helping lower-income customers invest in electric heating and appliances. In addition, these would-be imprudent government subsidies could be redirected toward building transmission, a major impediment to the successful integration of renewable energy.

C. INVEST IN RENEWABLE ENERGY'S BIGGEST OBSTACLE: TRANSMISSION

Currently, the lack of transmission stands as a colossal obstacle to a meaningful transition to renewable energy. Transmission is simply the process of delivering electricity from place to place, like from the point of generation to the point of consumption.³⁶⁰ In short, high voltage electricity travels across transmission lines, which are tall towers with electrical wires.³⁶¹

From a generation standpoint, renewable energy is both cheaper and more effective in the long-term than manure biogas.³⁶² However, without adequate transmission, even the most optimal energy sources, like renewables, will be useless. To illustrate, a state like Oregon cannot harness optimal wind power from the Great Plains if no transmission line connect the two. Thus, due to insufficient transmission, an energy producer may avoid investing in renewables notwithstanding their viability otherwise. With the current lack of transmission in the United States, this concern remains valid. In fact, on October 30, 2023, the Department of Energy released a Transmission Needs Study³⁶³ which found that the United States requires a 57% increase in transmission by 2035 to support renewable energy.³⁶⁴ Despite being costly and historically slow-going, building transmission infrastructure can ultimately save money, and new policies have eased the process of building transmission infrastructure.

By 2050, the United States must invest \$2.2 trillion in transmission.³⁶⁵ Albeit expensive,³⁶⁶ this investment helps achieve climate goals,

³⁶⁰ *Electrical Transmission*, ENERGY EDUC., https://energyeducation.ca/encyclopedia/Electrical_transmission (accessed Sept. 17, 2024).

³⁶¹ PJM, *HOW TRANSMISSION WORKS 1* (2024), <https://learn.pjm.com/-/media/about-pjm/newsroom/fact-sheets/how-transmission-works-fact-sheet.ash> (accessed Sept. 17, 2024).

³⁶² *See supra* Part VI, Sections A & B (discussing how expensive and ineffective manure biogas is).

³⁶³ Grid Deployment Office, *National Transmission Needs Study*, U.S. DEP'T OF ENERGY, <https://www.energy.gov/gdo/national-transmission-needs-study> (accessed Sept. 17, 2024).

³⁶⁴ *What to Know About DOE's Transmission Needs Study*, AMS. FOR A CLEAN ENERGY GRID (Mar. 14, 2024), <https://cleanenergygrid.org/what-to-know-about-does-transmission-needs-study/> (accessed Sept. 17, 2024).

³⁶⁵ ERIC LARSON ET AL., *NET-ZERO AMERICA: POTENTIAL PATHWAYS, INFRASTRUCTURE, AND IMPACTS 108* (Princeton Univ., 2021), <https://netzeroamerica.princeton.edu/the-report> (accessed Sept. 17, 2024).

³⁶⁶ *See Department of Defense (DOD)*, USASPENDING.GOV (updated July 30, 2024), <https://www.usaspending.gov/agency/department-of-defense?fy=2024/> (accessed Sept. 17, 2024).

creates jobs, and saves money in electricity costs. In the eastern half of the United States alone, transmission can create more than six million jobs and reduce electricity bills by \$300 per household annually by connecting cheaper, renewable energy to the grid.³⁶⁷ Moreover, transmission congestion costs reached \$200 to \$300 million in 2022, so building more transmission could significantly help Americans by lowering the congestion costs reflected in rates.³⁶⁸ Further, recent decisions have breathed new life into transmission. For instance, the 2021 Bipartisan Infrastructure Law gave the Department of Energy and the Federal Energy Regulatory Commission (FERC) more authority in transmission siting, a task otherwise left to states.³⁶⁹ Also, on July 28, 2023, FERC issued Order No. 2023, a final rule that attempts to assuage issues with connecting electricity generators to the transmission grid.³⁷⁰ Additionally, on October 30, 2023, the Biden-Harris Administration even addressed that more transmission is necessary to transition to renewable energy, reduce energy costs, and cut emissions.³⁷¹ Finally, and most notably, on May 13, 2024, FERC issued a landmark transmission planning and cost allocation order: Order No. 1920, the longest procedural record in FERC history.³⁷² Among other requirements, Order No. 1920 directs transmission providers to conduct longer-term planning looking twenty years ahead, consider specific benefits and factors in doing so, and create backstops for allocating the cost of building transmission should state entities avoid cooperation.³⁷³ According to FERC Commissioner Allison Clements, who voted for the order, “Order No. 1920 . . . is

17, 2024) (showing that the United States allocated \$2.1 trillion to the Department of Defense in 2024 alone; at that rate, it could reach the 2050 transmission goal in less than two years).

³⁶⁷ JAY CASPARY ET AL., DISCONNECTED: THE NEED FOR A NEW GENERATOR INTERCONNECTION 4–5 (2021), <https://cleanenergygrid.org/wp-content/uploads/2021/01/Disconnected-The-Need-for-a-New-Generator-Interconnection-Policy-1.pdf> (accessed Sept. 17, 2024).

³⁶⁸ Berkeley Lab, *The Latest Market Data Show that the Potential Savings of New Electric Transmission Was Higher Last Year than at Any Point in the Last Decade*, ENERGY MKTS. & POL’Y (Feb. 7, 2023), <https://emp.lbl.gov/news/latest-market-data-show-potential> (accessed Sept. 17, 2024).

³⁶⁹ MELISSA POWERS, ELECTRICITY LAW AND POLICY 330–331 (2024).

³⁷⁰ Anand Viswanathan, *FERC Order No. 2023: Implications and Unanswered Questions*, 23 PRATT’S ENERGY L. REP. 313, 313 (2023).

³⁷¹ *FACT SHEET: Biden-Harris Administration Announces Historic Investment to Bolster Nation’s Electric Grid Infrastructure, Cut Energy Costs for Families, and Create Good-paying Jobs*, THE WHITE H. (Oct. 30, 2023), <https://www.whitehouse.gov/briefing-room/statements-releases/2023/10/30/fact-sheet-biden-harris-administration-announces-historic-investment-to-bolster-nations-electric-grid-infrastructure-cut-energy-costs-for-families-and-create-good-paying-jobs/> (accessed Sept. 18, 2024).

³⁷² Daniel Hagan et al., *Transmission Planning Reforms Finalized in FERC Order No. 1920*, WHITE & CASE (May 14, 2024), <https://www.whitecase.com/insight-alert/transmission-planning-reforms-finalized-ferc-order-no-1920> (accessed Sept. 18, 2024).

³⁷³ *Fact Sheet | Building for the Future Through Electric Regional Transmission Planning and Cost Allocation*, FED. ENERGY REGUL. COMM’N (May 13, 2024), <https://www.ferc.gov/news-events/news/fact-sheet-building-future-through-electric-regional-transmission-planning-and> (accessed Sept. 18, 2024).

strong step that can considerably enhance grid reliability while making electricity more affordable for consumers.³⁷⁴ As evidenced, new laws and money will continue to support transmission, paving the way for renewable energy and leaving manure biogas in its wake.

Because transmission is becoming less of a barrier to renewable energy, energy producers should invest in renewable energy rather than manure biogas. Moreover, the government should reallocate its various investments in manure biogas to go toward transmission, thus fostering a renewable revolution. Ultimately, though transmission stalls the growth of renewable energy, this is not a permanent hinderance. As transmission continues to expand, so too do the reasons to invest in renewable energy over manure biogas.

D. DISSIPATE INCENTIVES AND POSITIVE PERCEPTION BY CALLING IT WHAT IT IS

Redefining manure biogas and associating it with methane more than renewables could significantly hamper its future financial feasibility. Seemingly insignificant, defining manure biogas as clean, renewable, and carbon-free poses multiple risks in that it allows CAFOs to receive numerous government subsidies and garners public preference. Despite being neither, manure biogas is often considered renewable and carbon-neutral. First, manure biogas is not renewable because manure is not endless and infinite, unlike wind and solar rays. However, the federal RFS and many state RPSs (twenty-nine, according to AgSTAR³⁷⁵) consider manure biogas renewable.³⁷⁶ Accordingly, CAFOs can profit extensively from selling RECs and RINs. Second, despite emitting carbon, manure biogas is often considered carbon-neutral because it emits greenhouse gases that already existed in manure.³⁷⁷ Thus, manure biogas can receive carbon offsets, as illustrated by California's LCFS.³⁷⁸ As a result, this detracts from truly renewable, carbon-neutral energy sources, like wind and solar. To fix this, the RFS, state RPSs, and the LCFS should not list manure biogas as renewable or carbon-neutral, thus ending a significant revenue source of CAFOs.

Continuing, framing manure biogas as methane gas could reduce its public support, thereby stalling the investment in and production of manure biogas. Unlike coal, which many Americans find harmful, 76% of Americans find natural gas favorable, 82% find wind favorable, and

³⁷⁴ Allison Clements, *FERC Order 1920 Is a Big Step Forward on Transmission Planning, But It Is Not the End Game*, UTIL. DIVE (May 15, 2024), <https://www.utilitydive.com/news/ferc-order-1920-transmission-planning-clements/716247/> (accessed Sept. 18, 2024).

³⁷⁵ AgSTAR *Biogas Market Report*, *supra* note 49, at 6.

³⁷⁶ *Id.*; Tanigawa, *supra* note 76.

³⁷⁷ *How Is Biomethane Carbon Neutral?*, CYCLE0 (Nov. 16, 2023), <https://www.cycle0.com/how-is-biomethane-carbon-neutral#:~:text=Biomethane's%20ability%20to%20capture%20methane,of%20methane%20into%20the%20atmosphere> (accessed Nov. 13, 2024),

³⁷⁸ *Supra* Part IV, Section B, Subsection iv.

87% find solar favorable.³⁷⁹ Interestingly, though, the public's perception of natural gas highly depends on its label, as explored in a 2020 study.³⁸⁰ Overall, the study found that Americans react more positively to the term "natural gas" than "methane gas," even though natural gas *is* methane gas.³⁸¹ Specifically, 54% of participants viewed "natural gas" positively, 25% viewed "natural methane gas" positively, and only 14% viewed "methane gas" positively.³⁸² Considering manure biogas, much like natural gas, is methane gas, this study suggests that altering the label of manure biogas could also alter the public's perception of it. In doing so, we can accelerate the transition toward truly renewable, carbon-neutral energy.

E. PAY (FACTORY) FARMS TO REDUCE HERD SIZES

Albeit an imperfect solution, the government could pay CAFOs (and other farms) to reduce herd sizes in order to reduce methane emissions. As it stands, CAFOs possess a perverse incentive to increase, not decrease, herd sizes, as doing so yields more manure biogas. Yet, if the goal is to reduce greenhouse gas emissions, paying dairy producers to reduce herd sizes would be thrice as cost-effective as subsidizing manure biogas.³⁸³ Further, reducing herd sizes would also save the government a portion of the taxpayer dollars it spends subsidizing dairy farmers for the low prices of dairy products caused by oversupply.³⁸⁴ For example, the Dairy Margin Coverage Program, which protects dairy producers when the average cost of milk falls below a certain level,³⁸⁵ spent \$1.2 billion on dairy farmers in 2023.³⁸⁶ However, with less supply, dairy farmers can better compete without the government's assistance, and the avoided subsidies could be spent elsewhere, preferably on mitigating the climate crisis through renewable energy.

VIII. CONCLUSION

"For change to become transformational, our change in mindset must manifest in our actions," said Christiana Figueres, architect of the

³⁷⁹ Karine Lacroix et al., *Different Names for "Natural Gas" Influence Public Perception of It*, 77 J. Env't Psych. 1, at 1 (2021).

³⁸⁰ *Id.* at 1–2.

³⁸¹ *Id.* at 5.

³⁸² *Id.* at 4.

³⁸³ Indeed, whereas manure biogas costs \$30 to reduce one metric ton of carbon dioxide equivalent, reducing herd sizes costs only \$10. WATERMAN & ARMUS, *supra* note 60, at 42.

³⁸⁴ *Id.*

³⁸⁵ *Dairy Margin Coverage Program*, USDA, <https://www.fsa.usda.gov/programs-and-services/dairy-margin-coverage-program/index> (accessed Sept. 22, 2024).

³⁸⁶ *Dairy Margin Coverage Program Provides Critical Support for Dairy Operations*, USDA (Sept. 29, 2023), <https://www.fsa.usda.gov/news-room/news-releases/2023/dairy-margin-coverage-program-provides-critical-support-for-dairy-operations> (accessed Sept. 22, 2024).

Paris Agreement.³⁸⁷ Needless to say, Figueres is right, and we must accept that monumental problems, like climate change, need monumental solutions. Bluntly, manure biogas is far from a monumental solution. Indeed, it can only provide 0.4% of electricity demand and in doing so will be far more expensive than truly optimal energy sources, like wind and solar. Additionally, it poses the dual threat of carbon dioxide and methane emissions, unlike coal and oil—emitting carbon dioxide and a comparatively insignificant amount of methane—and wind and solar—emitting neither. Additionally, while manure biogas does not pose identical threats to conventional and unconventional natural gas, manure biogas poses other threats and harms.

Notably, manure biogas props up CAFOs, evil institutions that harm the environment, humans, and nonhuman animals in spades. Yet, the government advertises its support to CAFOs as a benefit of manure biogas, subsidizing CAFOs to produce a poor product. Only with subsidies can CAFOs maintain manure biogas production, but even still, nearly 20% of anaerobic digesters fail. Accordingly, the government should borrow from traditional utility ratemaking and implement prudence review, whereby each CAFO would have to prove the benefit of its specific project before receiving subsidies. And, because manure biogas is expensive, ineffective, futile, and unnecessary, prudence review would significantly hinder the future of manure biogas.

Additionally, even if manure biogas could reduce carbon dioxide emissions meaningfully, it could eviscerate this benefit to the climate by increasing methane emissions. Because methane is so potent, the risk of any leakages of manure biogas outweighs its minor reduction in carbon dioxide equivalent compared to coal and oil. Moreover, manure biogas incentivizes CAFOs to increase their herd sizes, evidenced already in an increase of 85,000 cows from seventy-three CAFOs. Because more methane emissions come from cow burps than cow poop, reducing methane emissions from manure while increasing those from enteric fermentation is entirely illogical in combatting climate change.

A climate hurtling toward disaster needs a hero, and this comes in the form of wind and solar energy, not manure biogas. As truly renewable forms of energy, wind and solar are not only economically wise, but also environmentally wise. Unlike manure biogas, wind and solar energy emit neither carbon dioxide nor methane. Best of all, we have no shortage of it. For example, the sun produces 85,000 terawatts, while humanity consumes only 19 terawatts.³⁸⁸ Meanwhile, to create enough electricity for just the United States, we would need around one million anaerobic digesters, yet only around 8,000 CAFOs exist to support manure biogas.

³⁸⁷ CHRISTIANA FIGUERES & TOM RIVETT-CARNAC, *THE FUTURE WE CHOOSE: SURVIVING THE CLIMATE CRISIS* 80 (2020).

³⁸⁸ GRIFFITH, *supra* note 275, at 45.

At the end of the day, the future requires clean, renewable energy; this is a need, not a want. At best, investing in manure biogas is simply delaying the inevitable. At worst, investing in manure biogas is harming millions—taxpayers, neighbors of CAFOs, lower-income households, confined animals, even you and me—in the process. To answer the titular question: no; when it comes to manure biogas, one cow's waste is no (hu)man's treasure.