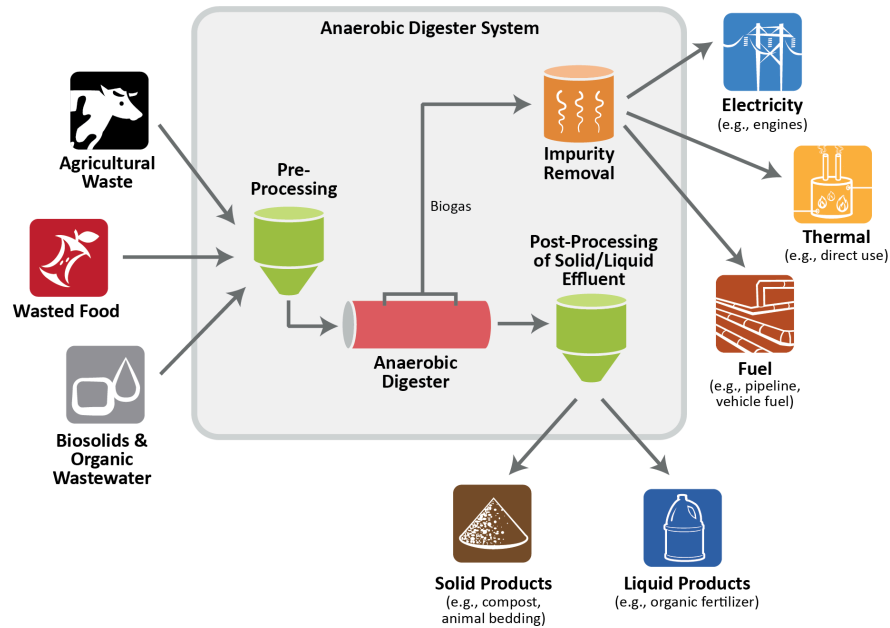


ANAEROBIC DIGESTER & BIOGAS MYTH VS. FACT SHEET ¹

Companies are quickly pushing digester proposals without allowing neighbors to learn about the associated public health and environmental risks. **Proponents of digesters typically use the same talking points.** Below, I outline several of the most common talking points to support digesters and pair them with research that challenges these points.



Section 1: Digester 101

What is the difference between a digester and a co-digester?

- On-farm digesters typically only take manure (manure-only digesters), but can also be used as a “catch-all” term for both types of digesters.
- On-farm co-digesters mix manure with a number of inputs from outside the farm including food waste (which can include various types of industrial food manufacturing waste), yard waste, and biosolids (human sewage).

What is digestate?

The output or by-product of digesters is called digestate, which is typically separated into solid and liquid forms using technology called a screw press. During the digestion process, most of the phosphorus is shifted into the dry portion and the nitrogen is shifted into the liquid portion.²

- **Dry digestate**= spread on fields as fertilizer or used for animal bedding

¹ For any questions or inquiries related to this fact sheet, please contact Dr. Sarah D’Onofrio at sdonofr1@vols.utk.edu

² Penn State Extension. 2023a. <https://extension.psu.edu/anaerobic-digestion-biogas-production-and-odor-reduction>

- **Liquid digestate**=spread on fields as fertilizer or kept in a lagoon or closed containers to be used later as irrigation water

Section 2: Public Health and Environmental Myths Around Digesters

***Myth:** Digesters make it easier for farmers to manage their manure and reduce water pollution associated with agricultural runoff.*

REALITY: Digestate can make nutrient management more difficult and increase agricultural runoff & water pollution because digestate does not act like raw manure.

- Digesters **do not decrease the volume or nutrients of the contents added to it.** If more inputs are added besides manure (such as water, food waste, or biosolids), it increases the amount farmers need to manage.³
- The dry digestate is still routinely applied to fields that already have high levels of phosphorus, which increases the risk of phosphorus run-off.⁴
 - For all the treatments, the concentration of dissolved inorganic (DRP) and total dissolved P (TDP) in the runoff waters was higher than the threshold level to prevent the eutrophication of freshwater (0.05 mg Pt L⁻¹, Golterman & Oude, 1991). Although the soil of all treatments was over fertilized with P (phosphorus), the sources of P seem to affect its losses to runoff waters.⁵
- Much of the nitrogen in raw manure is converted from its organic form to ammonium. Ammonium can be transformed to either ammonia or nitrate... Nitrate can be leached through the soil and may eventually reach groundwater. Field application and management to reduce nitrogen losses may be more demanding for digester effluent than for untreated liquid manure.⁶
- If food waste is added to the digester, this further increases the amount of waste that the farm will have to manage.
 - “Attorney General Dave Yost today filed for a contempt motion against Renergy Inc. and others for illegally accepting and storing excessive amounts of food waste and other organic waste at its Morrow County treatment facility...The motion...states that Renergy’s Emerald Facility in Morrow County is improperly storing nearly 1.5 million gallons of untreated organic waste in 83 mobile containers known as frac tanks.” [Ohio Attorney General 2022](#)

REALITY: Discharging treated digestate into creeks and streams, even when it is treated to drinking water standards, still causes water pollution.

³ Penn State Extension. 2023b.

<https://extension.psu.edu/fate-of-nutrients-and-pathogens-during-anaerobic-digestion-of-dairy-manure>

⁴ Horta, Carmo, and João Paulo Carneiro. 2021. “Phosphorus Losses to Surface Runoff Waters After Application of Digestate to a Soil Over Fertilised with Phosphorus.” *Water, Air, & Soil Pollution* 232(10):439. doi: 10.1007/s11270-021-05382-y.

⁵ Ibid.

⁶ Penn State Extension. 2023a. <https://extension.psu.edu/anaerobic-digestion-biogas-production-and-odor-reduction>

- Treated effluent may have more nutrients, such as phosphorus and nitrogen, than many streams can handle and can become a source of nitrogen and phosphorus pollution. The contamination of creeks and streams with even minimum allowable nutrient loads can create an environment susceptible to damaging algae blooms that degrade water quality and limit access to streams for humans and other wildlife.⁷
- Dilution is not the Solution to Pollution- While some rivers and streams have the capacity to some degree for “self-cleaning” due to adequate water flow throughout the year and a riparian environment that is capable of processing nutrients, many others do not. Streams and rivers do not have the capacity for “cleaning” non-organic pollutants like heavy metals, pharmaceuticals, and microplastics especially when discharges are occurring on a daily basis. Existing research indicates that these contaminants pose threats to aquatic flora and fauna and can pass to humans and other animals through the food chain.⁸

REALITY: Food waste contains microplastics that integrate into the soil when used on fields even when plastic is separated from food before digestion.

- “Despite efforts to separate packaging from food waste streams, early evidence suggests that macro- (>5 mm) and micro- (<5 mm) plastics may be present in many food waste derived composts and digestates and could be transferred to agricultural soils when these amendments are land-applied.”⁹
- “...relatively little is known about the abundance of microplastics in composts, digestates, and food wastes and their downstream effects in the environment...It was not until 2012 that the presence of microplastics in terrestrial environments began to receive attention (Rillig, 2012), and studies focusing on terrestrial environments still represent a small fraction of all microplastic publications (i.e., 5% as of 2019) (R. Qi et al., 2020).”¹⁰
- “In addition to the potential risks posed to human and ecosystem health, there is early evidence to suggest that some microplastics have an inhibitory effect on the composting and anaerobic digestion processes (J. Zhang et al., 2020a; Y. Zhou et al., 2022), thereby possibly reducing the intended benefits of food waste diversion initiatives.”¹¹
- Due to their highly stable chemical structure, most conventional petroleum-based plastics are resistant to total degradation and may persist in the environment for centuries (Ali et al., 2021). Through time, plastics may accumulate in soils (Y. Yu &

⁷ EPA 2023- <https://www.epa.gov/nutrientpollution/sources-and-solutions-wastewater>

⁸ Rani, Lata, Arun Lal Srivastav, Jyotsna Kaushal, Ajmer S. Grewal, and Sughosh Madhav. 2022. "Heavy metal contamination in the river ecosystem." In *Ecological Significance of River Ecosystems*, pp. 37-50 in Ecological Significance of River Ecosystems. Edited by Madhav, Sughosh, Shyam Kanhaiya, Arun Lal Srivastav, Virendra Bahadur Singh, and Pardeep Singh. Elsevier.

⁹ Porterfield, Katherine K., Sarah A. Hobson, Deborah A. Neher, Meredith T. Niles, and Eric D. Roy. 2023. “Microplastics in Composts, Digestates, and Food Wastes: A Review.” *Journal of Environmental Quality* 52(2):225–40. doi: 10.1002/jeq2.20450.

¹⁰ Ibid.

¹¹ Ibid.

Flury, 2021), with macroplastics fragmenting into microplastics or even nanoplastics due to physicochemical and biological degradation (Ali et al., 2021). This partial degradation can release additives and impurities that may be harmful to human and ecosystem health (Rillig et al., 2021).¹²

- Food itself is also a source of microplastic particles...Plastic contamination rates in purely food waste streams may be higher, as available evidence indicates plastic contamination levels in food waste streams may be higher than that of other organics waste streams, such as yard waste.¹³
- Much remains uncharacterized about the environmental fate of and exposure to plastic particles in composts and digestates generated from food waste and used as soil amendments, making it challenging to evaluate risks to human health and the environment.¹⁴

REALITY: Farmers and scientists still don't understand how digestate impacts various aspects of soil health despite claiming that it can be used as a high quality soil amendment.

- The National Organic Standards Board (NOSB), a Federal Advisory Board made up of 15 dedicated public volunteers from across the organic community, decided that digestate failed to meet the standards to be added to the National List to be used in organic production.
 - “Because of the potential for negative effects on human health through food-borne pathogens, the unproven safety of digestate fiber, and the many alternative practices and materials already in use in organic production, the NOSB has determined that anaerobic digestate as petitioned, without pre-harvest application intervals, is not compatible with a system of sustainable agriculture.”¹⁵
- The liquid fraction only slightly benefits bacteria and negatively affects mycorrhizal and saprophytic fungi. Digestate in its whole form negatively affects litter surface dwelling springtails, nematodes and earthworms, though these effects are reduced for organisms that inhabit deeper layers of soil. The negative effects of digestate on soil organisms are due to a combination of factors including, but not limited to; (i) lack of carbon supplied to support growth, (ii) toxicity due to ammonia and contaminant content, and (iii) changes to habitat conditions caused by shifting soil pH.¹⁶
- Mismanagement of digestate can have serious consequences in terms of environmental tradeoffs: “...if improperly applied, digestate can harm plant growth

¹² Ibid.

¹³ EPA. 2021. Emerging Issues in Food Waste Management: Plastic Contamination. https://cfpub.epa.gov/si/si_public_record_Report.cfm?dirEntryId=352658&Lab=OSAPE

¹⁴ Ibid.

¹⁵ National Organic Standards Board. 2017. Updated in 2023. <https://www.ams.usda.gov/sites/default/files/media/CSAnaerobicDigestateFinalRec.pdf>

¹⁶ van Midden, Christina, Jim Harris, Liz Shaw, Tom Sizmur, and Mark Pawlett. 2023. “The Impact of Anaerobic Digestate on Soil Life: A Review.” *Applied Soil Ecology* 191:105066. doi: 10.1016/j.apsoil.2023.105066.

and the soil (Rigby and Smith, 2013), and due to its chemical composition, it can lead to problems for its sustainable disposal.”¹⁷

- CEO of Vanguard Renewables admits this—“We are seeing great crop yields on farms that utilize what we call our “low carbon, high nutrient fertilizer.” **We know the benefits anecdotally, but need to conduct research to quantify them.** Finding ways to commercially sell the digestate is an opportunity that we haven’t yet put our hands around — but it is on the horizon, especially with the cost of conventional fertilizer going through the roof.” [Vanguard CEO Neil Smith \(2022\)](#)

MYTH: *Digesters improve water quality by reducing pathogens in raw manure.*

REALITY: **Digesters do not destroy all pathogens and pathogens reproduce over time after digestate is removed from the digester.**

- After the completion of the digestion process, researchers in Wisconsin found “nearly every microbe we could detect” in the liquid digestate .¹⁸
- “Cryptosporidium parvum, Salmonella spp., norovirus, Streptococcus pyogenes, E. coli enteropathogenic (EPEC), Mycobacterium spp., Salmonella Typhi (followed by S. paratyphi), Clostridium Spp., Listeria monocytogenes and Campylobacter coli were found to be the most relevant (top 10) pathogens in relation to potential risk from spreading anaerobic digestate on agricultural land, specifically in Ireland.”¹⁹

MYTH: *Digesters reduce air pollution.*

REALITY: **Digesters and biogas production produce a wide range of air pollutants that are toxic and deadly for human health.**

- Studies have repeatedly shown that **digestate increases ammonia emissions.**
 - “Digestion often shifts the form of the nitrogen to more ammonium. When digested manure is field applied, much of the ammonium will be released as a gas (ammonia) unless it is incorporated into the soil.”²⁰
 - Holly et al. (2017) found in their study of digestate in Wisconsin that in storage, ammonia emissions increased 81%.²¹
 - Since ammonia has a higher potential for volatilization (to turn into a gas) when spread on fields, this has the potential to dramatically increase the

¹⁷ Lamolinara, Barbara, Amaury Pérez-Martínez, Estela Guardado-Yordi, Christian Guillén Fiallos, Karel Diéguez-Santana, and Gerardo J. Ruiz-Mercado. 2022. “Anaerobic digestate management, environmental impacts, and techno-economic challenges.” *Waste Management* 140 (2022): 14-30. [doi: 10.1016/j.wasman.2021.12.035](https://doi.org/10.1016/j.wasman.2021.12.035).

¹⁸ Burch, Tucker R., Aaron D. Firnstahl, Susan K. Spencer, Rebecca A. Larson, and Mark A. Borchardt. 2022. “Fate and Seasonality of Antimicrobial Resistance Genes during Full-Scale Anaerobic Digestion of Cattle Manure across Seven Livestock Production Facilities.” *Journal of Environmental Quality* 51(3):352–63. [doi: 10.1002/jeq2.20350](https://doi.org/10.1002/jeq2.20350).

¹⁹ Nag, Rajat, Paul Whyte, Bryan K. Markey, Vincent O’Flaherty, Declan Bolton, Owen Fenton, Karl G. Richards, and Enda Cummins. 2020. “Ranking hazards pertaining to human health concerns from land application of anaerobic digestate.” *Science of the Total Environment* 710: 136297. [doi: 10.1016/j.scitotenv.2019.136297](https://doi.org/10.1016/j.scitotenv.2019.136297).

²⁰ Markham, Lynn; Blaha, Karen; Michalesko, Ryan (2022). Wisconsin Anaerobic Digester Operations: Agricultural Industry Case Studies. Stevens Point, Wisconsin: Center for Land Use Education, University of Wisconsin-Stevens Point.

²¹ Holly, Michael A., Rebecca A. Larson, J. Mark Powell, Matthew D. Ruark, and Horacio Aguirre-Villegas. 2017. “Greenhouse Gas and Ammonia Emissions from Digested and Separated Dairy Manure during Storage and after Land Application.” *Agriculture, Ecosystems & Environment* 239:410–19. [doi: 10.1016/j.agee.2017.02.007](https://doi.org/10.1016/j.agee.2017.02.007).

creation of fine particulate matter (PM2.5) which is already the leading cause of air pollution deaths from agricultural production.²²

- “The most frequently reported health complaints from [ammonia] exposure include eye, nose, and throat irritation, headache, nausea, diarrhea, hoarseness, sore throat, cough, chest tightness, nasal congestion, palpitations, shortness of breath, stress, drowsiness, and alterations in mood (Schiffman and Williams, 2005; Wing and Wolf, 2000).”²³
 - As PM2.5 levels in the air increase, the likelihood of death above the age of 60 increases as well.²⁴
- Digestate and digesters also produce **Volatile Organic Compounds (VOCs)**-hazardous gasses that are emitted from industrial products or processes.
 - When Zheng et al. (2019) studied the VOCs released from digestate during storage, they detected 49 different types of VOCs. **Almost a third (32.77%) of the VOCs emitted from digestate were hazardous to human health:** 8 of the compounds were carcinogenic and 14 were known to cause organ damage in humans.²⁵

MYTH: *Digesters eliminate odors from concentrated animal feeding operations (CAFOs).*

REALITY: **In the real world, there are many examples of digesters failing to control odors.**

- “Nearly two years after going online, an innovative, municipally owned power plant that burns methane from agricultural waste is generating only a fraction of its promised electricity. The \$45 million plant...also is producing something its promoters said it wouldn't — stink. ‘It is like living next to a giant poop plant,’ said Katie Terwedo, the closest neighbor to the Hometown BioEnergy plant.” [Minnesota Star Tribune 2015](#)
- “...it can be overpowering, eye watering and liable to make one feel physically sick...in a rural area one should expect to be subjected to occasional manure smells. The digestate in my view is far worse than manure.” [Comments from a rural community in Murrow UK](#)
- “The digester, which uses mostly cattle manure but also some municipal food waste, had been operating near LaSalle since 2015. The complaints started not long after — and these were from Weld County residents not unfamiliar with run-of-the-mill agricultural smells. This smell was worse, they said. One resident

²² Domingo, Nina G. G., Srinidhi Balasubramanian, Sumil K. Thakrar, Michael A. Clark, Peter J. Adams, Julian D. Marshall, Nicholas Z. Muller, Spyros N. Pandis, Stephen Polasky, Allen L. Robinson, Christopher W. Tessum, David Tilman, Peter Tschofen, and Jason D. Hill. 2021. “Air Quality–Related Health Damages of Food.” *Proceedings of the National Academy of Sciences* 118(20):e2013637118. [doi: 10.1073/pnas.2013637118](https://doi.org/10.1073/pnas.2013637118).

²³ Wyer, Katie E., David B. Kelleghan, Victoria Blanes-Vidal, Günther Schaubberger, and Thomas P. Curran. “Ammonia emissions from agriculture and their contribution to fine particulate matter: A review of implications for human health.” *Journal of Environmental Management* 323 (2022): 116285.

²⁴ Apte, Joshua S., Michael Brauer, Aaron J. Cohen, Majid Ezzati, and C. Arden Pope III. “Ambient PM2.5 reduces global and regional life expectancy.” *Environmental Science & Technology Letters* 5, no. 9 (2018): 546-551.

²⁵ Zhang, Yu, et al. 2019. “Characterization of volatile organic compound (VOC) emissions from swine manure biogas digestate storage.” *Atmosphere* 10.7: 411.

described it as “scorched manure” to Colorado Public Radio.” [The Coloradoan, 2017](#)

- Neighbors of Renergy digester in Morrow County, Ohio complain of obnoxious odors, loud noises, traffic, and spills. On Christmas Eve 2022, Renergy spilled 150,000 gallons of liquid waste onto a neighbors yard which took them 6 months to clean up. [Channel 10 News 2023](#)
- “Facing continuing complaints about raunchy odors stemming from environmental violations, Renergy has agreed to permanently close down its organic waste treatment facility in Greene County – a victory for the facility’s neighbors and the state as a whole.” [Ohio Attorney General 2023](#)

Section 3: Myths from Big Ag/ Big Oil on Benefits of Biogas

MYTH: “By utilizing the trapped biogas as a renewable energy source, digesters displace the need for additional fossil fuels.”

REALITY: Biogas adds to, rather than takes the place of fossil fuels and further ‘locks-in’ CAFOs to our fuel system.

- Technological lock-in describes a scenario where the idea that the more a society adopts a certain technology, the more unlikely users are to switch.
- Digesters deepen lock-in in two respects: 1) they lock CAFOs deeper into our food system by 2) locking CAFOs into our fuel infrastructure. Biogas production requires the buildup of a new network of RNG pipelines and transport systems. Once enough capital investment has been levied to build these pipelines, it becomes more difficult to back away from biogas production. If the US becomes dependent on biogas for things like public transportation, this will ensure that CAFOs become a part of the energy industry. CAFO owners can reap serious money for RNG production in California’s markets which is why they are calling manure “brown gold.” We already see the integration between big oil and big ag all over the US:
 - [Blackrock, a leading investor in oil and gas, purchased Vanguard Renewables which develops infrastructure for biogas plants across the US](#)
 - [Chevron partnered with California Bioenergy to build up biogas production in CA](#)
 - [Duke Energy has partnered with Smithfield to produce biogas in NC](#)
 - [BP purchased Aria Energy \(previously Archaea Energy\) to produce biogas in CA’s Central Valley](#)
 - [BP also created a joint venture with Clean Energy Fuels and Gevo NW Iowa RNG to enable them to buy RNG from CAFOs in Iowa](#)
 - Shell has biogas projects in California, Kansas, Idaho, and Oregon
 - Shell has also purchased Nature Energy, the largest manure biogas company in Europe.

MYTH: *Digesters can meaningfully reduce methane emissions from agriculture.*

REALITY: Digesters are shown to reduce some methane emissions, but not enough.

- Digesters only reduce methane emissions from manure management (9% of US methane emissions), not enteric fermentation from cow burps and farts (27% of US methane emissions).²⁶
 - In 2022, digesters only reduced 1.76% of GHG emissions from agriculture at the same time digesters had their highest rate of on-farm adoption.
- Even if methane digesters were installed on every single US dairy farm and worked at optimal efficiency, this would still fall short of reducing the US dairy industry's total GHG emissions by 25%.²⁷
- Using NASA satellite data, researchers just discovered that over a dozen CAFOs with digesters emitted so much methane into the atmosphere that the plumes could be detected from space.²⁸

REALITY: Any benefits from methane reduction are offset by nitrous oxide (N₂O) emissions.

- Nitrous Oxide (N₂O)- Nitrous oxide is a climate super pollutant that has 300x more global warming potential than carbon dioxide. Methane stays in the atmosphere for about 12 years while nitrous oxide stays in the atmosphere for at least 100 years²⁹.
 - There is evidence that, depending on local weather conditions, spreading digestate on fields can increase nitrous oxide emissions (Holly et al. 2017).
 - Between 16–33% (1st year) and 17–38% (2nd year) of N₂O emissions originated from digestate N, indicating that digestate application triggered N₂O production and release mainly from soil N.³⁰
 - ...N₂O emissions are higher after fertilization with digestate, which we hypothesize is due to the higher organic C content of the digestate. Therefore, we suggest that further studies on the effect of nitrification inhibitors might provide useful information for reducing N₂O emissions from the use of the use of digestate as fertilizer.³¹

²⁶ EPA. 2024. 2022 Inventory of GHG Emissions and Sinks.

<https://www.epa.gov/ghgemissions/inventory-us-greenhouse-gas-emissions-and-sinks-1990-2022>

²⁷Capper, Jude, Roger A. Cady and Dale E. Bauman. 2011. "The Relationship between Cow Production and Environmental Impact." *WCDS Advances in Dairy Technology* Volume 23: 167-179.

²⁸ [Food and Water Watch and NASA \(2024\)](#)

²⁹ EPA. 2024. 2022 Inventory of GHG Emissions and Sinks.

<https://www.epa.gov/ghgemissions/inventory-us-greenhouse-gas-emissions-and-sinks-1990-2022>

³⁰ Häfner, Franziska, Reiner Ruser, Ingrid Claß-Mahler, and Kurt Möller. 2021. "Field application of organic fertilizers triggers N₂O emissions from the soil N pool as indicated by 15N-labeled digestates." *Frontiers in Sustainable Food Systems* 4: 614349.

³¹ Verdi, L., P. J. Kuikman, S. Orlandini, M. Mancini, M. Napoli, and A. Dalla Marta. 2019. "Does the Use of Digestate to Replace Mineral Fertilizers Have Less Emissions of N₂O and NH₃?" *Agricultural and Forest Meteorology* 269–270:112–18. doi: 10.1016/j.agrformet.2019.02.004.

REALITY: Methane reduction benefits are also offset by pipeline leakage.

- “In the public discourse, natural gas is often described as a climate-friendly alternative to coal that has a much lower negative climate impact than that of other fossil fuels. In fact, several studies show that this is only true under certain conditions and that the differences in climate impacts are small and depend on various factors...The greenhouse gas (GHG) emissions advantage of natural gas over coal becomes marginal if approximately 3.2% to 3.4% of the gas produced escapes into the atmosphere before being burned. The total global average leakage rate is estimated to be around 2.2%. However, some studies that investigated individual gas fields even found fugitive emission rates of up to 6% of the total amount of natural gas produced. Also, some measurements showed leakage rates of up to 17% for certain regions and circumstances.”³²

MYTH: “Digesters benefit small farmers.”

REALITY: The farms that use digesters are NOT small IN SIZE.

- According to the AgSTAR project development handbook, “Successful farm-based AD/biogas systems typically operate with at least 500 cows in dairy operations or at least 2,000 hogs in swine operations. As economies of scale yield more favorable conditions (e.g., larger number of animals, larger amount of recovered manure, increased amount of salable products produced) the likelihood of successful application and profitability increases. For example, dairy farms having greater than 1,000 animals or hog farms having greater than 5,000 animals increases the likelihood of project success.”³³

REALITY: Most small farmers cannot afford digesters because they are so expensive.

- Farmers need to cover start up costs up front as well as operating costs.³⁴
 - Digester equipment estimates: \$400,000- \$5,000,000 (or more) depending on size and biogas production
 - Operating cost estimates: \$25,000-\$600,000 (or more) depending on size and biogas production

REALITY: The digester and biogas industry is largely being driven by government programs and subsidies on the state and federal levels.

- THE FEDERAL GOVERNMENT:
 - The Inflation Reduction Act (IRA) provided over \$2 billion for USDA’s Rural Energy for America (REAP) program to promote rural or agriculture-related renewable energy.³⁵

³² Kempfert, Claudia, Fabian Präger, Isabell Braunger, Franziska M. Hoffart, and Hanna Brauers. 2022. “The Expansion of Natural Gas Infrastructure Puts Energy Transitions at Risk.” *Nature Energy* 7(7):582–87. doi: 10.1038/s41560-022-01060-3.

³³ [AgSTAR \(2012\)](#)

³⁴ [AgSTAR \(2014\)](#)

³⁵ BioCycle (2022)- <https://www.biocycle.net/the-ira-revolutionizes-ad-tax-credits/>

- CALIFORNIA:
 - Companies are investing in digesters to “offset” their emissions in California markets through their offset program.³⁶
 - Companies are investing in biogas production to financially benefit from the Low Carbon Fuel Standard program led by California by selling renewable natural gas (RNG) to fuel producers in California.³⁷

³⁶SRAP (2020)- <https://sraproject.org/news-and-events/california-cap-and-trade-program-summary/>

³⁷ Smith (2023)- [The Value of Methane from Cow Manure](#)