METHANE DIGESTERS

Methane digesters, also called anaerobic digesters, are devices that promote microbial digestion of feedlot manure or human sewage into biogas products that can be used to power electrical generators or vehicles. This process also produces digestate, a nutrient-rich substance that can be used as fertilizer. Small methane digesters may be placed on farms, where they harness power from decomposing manure to generate electricity for on-farm use. There are also standalone commercial methane digesters that accept organic waste (such as waste from the food and beverage industry) in exchange for a tipping fee. Large methane digesters located at wastewater treatment facilities either flare off the biogas they produce or recapture it and use it to power the operations of the treatment facility.

Methane digestion is a mature energy technology that has been in use for centuries, and adoption of methane digesters is increasing in the U.S.[1] Although this technology will never represent a major source of electricity generation in the U.S., there is substantial room for it to expand. The U.S. presently has 317 manure-based methane digestion systems, which collectively generate 1.73 million MWh of electricity.[2] The EPA estimates that 8,100 U.S. dairy and swine operations could support biogas recovery systems, collectively representing just over 2 GW in capacity.[3] Locations of candidate operations are shown in Figure 1 and Figure 2. A 2016 report stated that at the time of publication, there were 16,000 publicly owned wastewater treatment plants in the U.S., but only 544 were using anaerobic digestion to produce energy from biogas.[4]

As with landfill methane, methane digesters do not produce zero-emissions electricity, but they have a net positive climate benefit relative to simply storing manure and sewage as-is. As with landfill gas, combustion of biogas converts methane that would otherwise be leaked into the atmosphere into carbon dioxide. Although methane combustion releases CO_2, this CO_2 has 34 times less global warming potential over a hundred-year time period as methane.[5] As a result, even if it was not used to generate electricity, burning off biogas would make a net contribution to GHG emission reductions. However, when this combustion is used to generate electricity, it can make an even bigger contribution by displacing some combustion of fossil fuels.

Among its downsides, combustion of biogas releases carbon monoxide, nitrogen oxides, sulfur dioxide, and other hazardous air pollutants into the air.[6] Anaerobic digesters also have lifecycle environmental impacts that occur during the storage and use of digestate. If digestate is stored

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[1] Project Drawdown. “Methane digesters.” https://drawdown.org/solutions/methane-digesters

[2] EPA. “AgSTAR data and trends.” https://www.epa.gov/agstar/agstar-data-and-trends

[3] EPA. “AgSTAR data and trends.” https://www.epa.gov/agstar/agstar-data-and-trends

[4] Vutai, Vincent et al. 2016. The role of anaerobic digestion in wastewater management. *EM: The Magazine for Environmental Managers.* https://pubs.awma.org/flip/EM-Sept-2016/vutai.pdf

[5] Project Drawdown. “Landfill methane capture.” https://drawdown.org/solutions/landfill-methane-capture

[6] McKenzie, Jessica (December 3, 2019). “The misbegotten promise of anaerobic digesters.” *The Counter.* https://thecounter.org/misbegotten-promise-anaerobic-digesters-cafo/

in open tanks, it emits methane into the atmosphere while it sits (this does not occur in closed tanks).[7] Spreading digestate as biofertilizer on agricultural soils can release methane, nitrous oxide, ammonia, and volatile hydrocarbons into the atmosphere,[8] but the amounts produced vary widely and appear to be less than emissions from the spreading of undigested manure slurries.[9] To a certain extent, these side effects can be remedied by banning open digestate storage to prevent methane emissions and regulating digestate spreading onto land to minimize emissions of ammonia and related environmental impacts.[10]

Because methane digesters are expensive to install and therefore do best with significant public investment, opponents claim that these investment dollars would be better spent on even cleaner energy sources, at least in the case of manure-based systems.[11] Since animal manure only produces methane when it is concentrated in anaerobic conditions, such as in the pits and lagoons associated with concentrated animal feeding operations (CAFOs) and not when on open fields, methane digesters may only provide a net positive in industrial operations. Some experts say that the best solution would be to convert more broadly to sustainable farming methods that do not store methane in anaerobic conditions in the first place.[12]

Tradeoffs may be slightly different in the case of wastewater systems. In the absence of production of biogas from anaerobic digesters, sewage sludge is typically incinerated or sent to landfills -- practices that produce GHG emissions. Harnessing biogas from sewage sludge and using it to generate electricity can achieve overall system efficiency with both economic and environmental benefits.[13]

- Fishery friendliness: Impacts of methane digesters to fishery resources vary by location, feedstock, and the practices associated with storage and secondary use of digestate. Digesters using sewage appear to have little in the way of fishery impacts, but those that rely on the concentrated manure pits produced by industrial agriculture raise more questions. Impacts can occur not only at the combustion stage (through GHG emissions and air pollution) but also during the storage and use of digestate as a fertilizer.

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[7] Fusi, Alessandra, et al. 2016. Life cycle environmental impacts of electricity from biogas produced by anaerobic digestion. *Frontiers in Bioengineering and Biotechnology.* 4. DOI:10.3389/fbioe.2016.00026

[8] Paolini, Veronica et al. 2018. Environmental impact of biogas: A short review of current knowledge. *Journal of Environmental Science and Health, Part A: Toxic/Hazardous Substances and Environmental Engineering* 53(10): 899-906. DOI:10.1080/10934529.2018.1459076

[9] Fusi, Alessandra, et al. 2016. Life cycle environmental impacts of electricity from biogas produced by anaerobic digestion. *Frontiers in Bioengineering and Biotechnology.* 4. DOI:10.3389/fbioe.2016.00026

[10] Fusi, Alessandra, et al. 2016. Life cycle environmental impacts of electricity from biogas produced by anaerobic digestion. *Frontiers in Bioengineering and Biotechnology.* 4. DOI:10.3389/fbioe.2016.00026

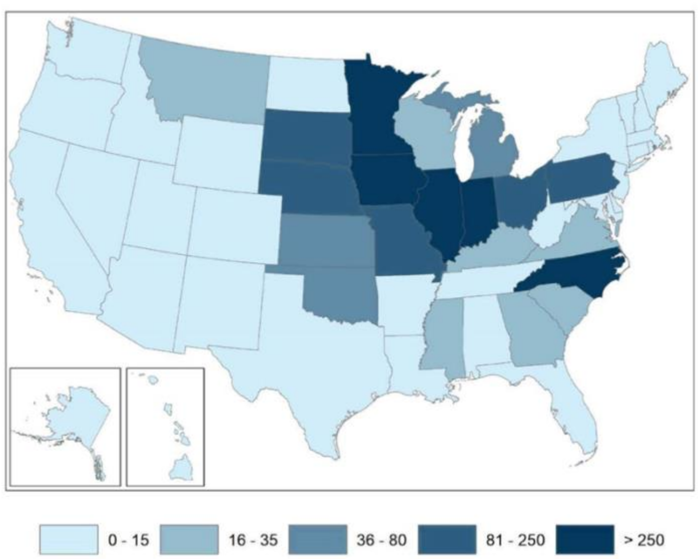
[11] McKenzie, Jessica (December 3, 2019). "The misbegotten promise of anaerobic digesters." *The Counter.* https://thecounter.org/misbegotten-promise-anaerobic-digesters-cafo/

[12] Wozniakca, Gosia (April 24, 2020). "Are dairy digesters the renewable energy answer or a 'false solution' to climate change?" *Civil Eats.* https://civileats.com/2020/04/24/are-dairy-digesters-the-renewable-energy-answer-or-a-false-solution-to-climate-change/

[13] Vutai, Vincent et al. 2016. The role of anaerobic digestion in wastewater management. *EM: The Magazine for Environmental Managers.* https://pubs.awma.org/flip/EM-Sept-2016/vutai.pdf

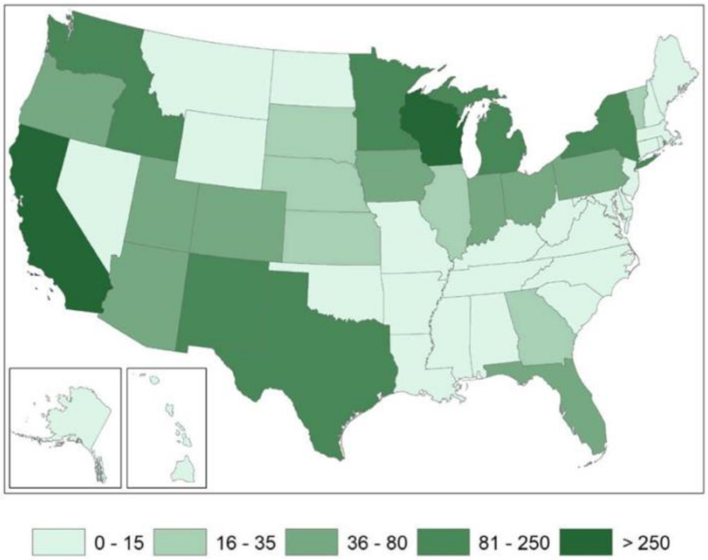
- Co-benefits: Use of anaerobic digesters to generate electricity from biogas can achieve cost savings and new revenue streams for farms and wastewater treatment facilities, as well as the production of low-cost fertilizer as a byproduct.
- Environmental externalities: Combustion of biogas produces GHG emissions, but less than would be produced if wastewater sludge and manure slurries were disposed of in other manners, and the electricity produced is cleaner than some fossil fuel power generation. Combustion also releases carbon monoxide, nitrogen oxides, sulfur dioxide, and other hazardous air pollutants; some experts suggest that a better solution for agricultural wastes would be to replace industrial farming with sustainable methods that do not store manure in anerobic conditions.
- Policy catalysts: Use of anaerobic digesters to generate electricity can be promoted through tax incentives, loans, grants, carbon pricing, renewable energy portfolio standards, and lead-by-example projects.
- More information:
    - Drawdown: Methane digesters
    - EPA: Types of anaerobic digesters
    - McKenzie, Jessica (December 3, 2019). "The misbegotten promise of anaerobic digesters." *The Counter.*
    - Wozniakca, Gosia (April 24, 2020). "Are dairy digesters the renewable energy answer or a 'false solution' to climate change?" *Civil Eats.*

Figure 1. Locations of candidate swine farms for methane digestion energy generation. Source: EPA 2018.[14]



[14] EPA. 2018. *Market opportunities for biogas recovery systems at U.S. livestock facilities.* https://www.epa.gov/sites/default/files/2018-06/documents/epa430r18006agstarmarketreport2018.pdf

Figure 2. Locations of candidate dairy farms for methane digestion energy generation. Source: EPA 2018.[15]



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[15] EPA. 2018. *Market opportunities for biogas recovery systems at U.S. livestock facilities.* https://www.epa.gov/sites/default/files/2018-06/documents/epa430r18006agstarmarketreport2018.pdf