BIOGAS & ANAEROBIC DIGESTERS

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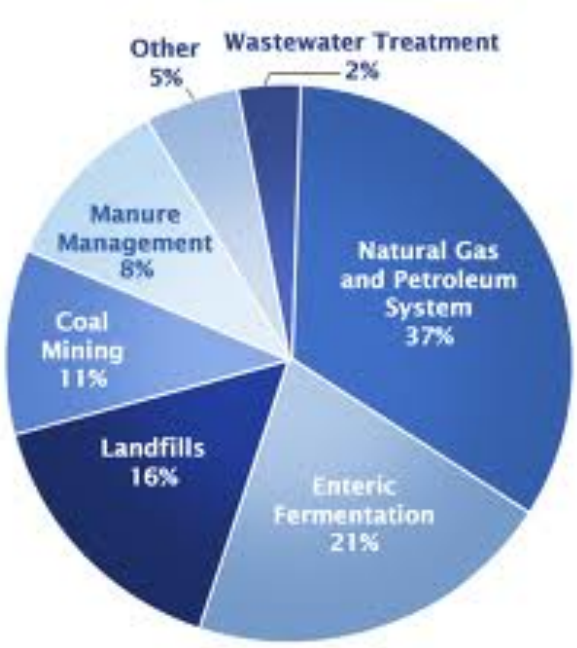
Source: www.biocycle.net

Methane

- **Methane is the second most prevalent greenhouse gas emitted in the US from human activity.**
  - Methane accounts for 9% of greenhouse gases.
  - Methane is one of the most potent greenhouse gases with over 20 times the heat-retaining capacity as CO_2.
- **Methane occurs from decomposition, manure, landfills, and leaky natural gas facilities.**
  - It can also be produced naturally by wetlands, oceans, volcanoes, and other sources.
- **Natural gas and petroleum production account for the greatest human-caused methane emissions (30%)**
  - Ruminant animals and their waste account for 23% of methane emissions.
  - Landfills generate the third-most methane at 17% of US emissions.

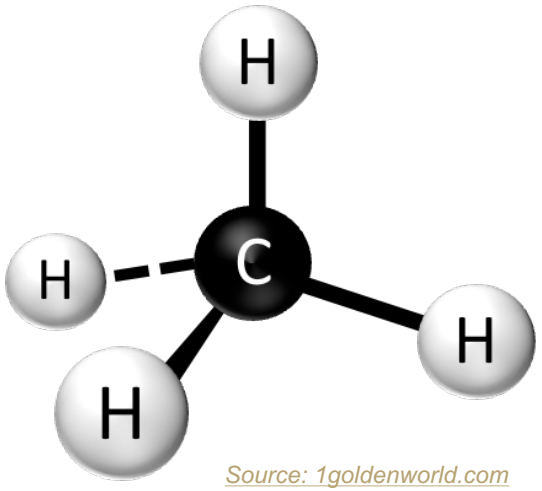


Source: www.epa.gov

Methane & Biogas

- **While methane is a potent greenhouse gas, it can be used to produce energy as a biogas.**
  - When methane is burned to produce energy (such as in an electrical generator or an automobile engine), it is released as CO_2 and H_2O.

- **While CO_2 is also a greenhouse gas, it is far less potent than methane.**
  - The use of anaerobic digesters on farms could drastically reduce the second-leading cause of anthropogenic methane emissions.
    - *Anthropogenic = human-activity related.*
  - This could also provide distinct economic and energy-security benefits to the US.



Source: 1goldenworld.com

Biogas

- **Biogas is a gaseous fuel (usually methane) that is produced through fermentation of organic matter.**
  - Biogas is produced through a process known as anaerobic digestion, which is decomposition without oxygen.

- **Biogas can be used to produce electricity or heat or it can be used as a transportation fuel if it is compressed.**
  - Biogas is usually 50-80% methane; the remaining percentage is mostly carbon dioxide with a mixture of trace gases.
  - Biogas is different from natural gas, which is 70%+ methane with the remainder being other petroleum products (such as propane and butane).

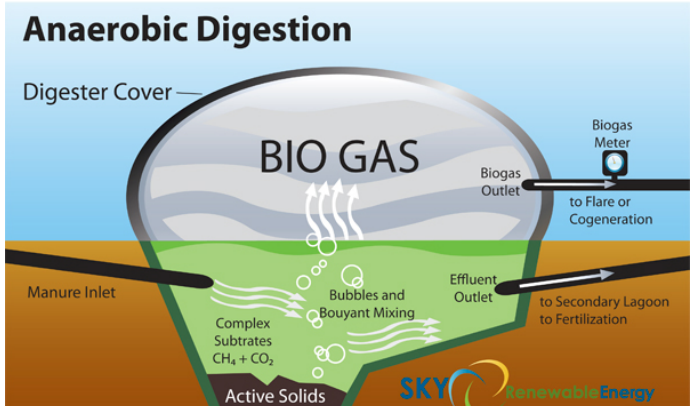
- **Biogas can be made from sewage, animal byproducts, and from agricultural, industrial, and municipal solid waste.**
  - Agricultural anaerobic digesters hold strong economic potential as a source of biogas.

Source: www.biocycle.net

Anaerobic Digesters

- **<u>Anaerobic digesters</u> (or <u>methane digesters</u>) collect manure and convert the organic molecules in the manure into methane.**
  - This methane can then be used to produce electricity, for heating or cooling processes, or as a transportation fuel (if compressed).
  - Digesters are usually used to produce electricity due to the near-constant demand (as opposed to heating oil, for example, which has fluctuations in demand).

- **The biological mechanisms of an anaerobic digester is as follows:**
  1. Organic matter (such as manure) is consumed by acid-forming bacteria.
  2. The bacteria break the organic matter into simple organic acids (such as acetic acid, proprionic acid, etc.).
  3. Methane-forming bacteria then consume the organic acids and convert them into methane/biogas.
  4. The biogas is then used to produce electricity (which can be used or sold), to power on-farm needs (such as refrigeration of milk or heating a water heater), or it can be compressed and stored to be used as transportation fuel.



Source: www.skyrenewableenergy.com

Statistics

- **A 100 cow dairy farm would need a round tank 18 ft wide and 19 feet tall to process the manure produced by these cows.**
  - A pig farm with 200 sows would need a 24 x 25 tank.
- **A 1400 lb. dairy cow can produce over 46 cubic feet of biogas per day, resulting in 28,000 BTU's of energy.**
  - In a digester, this could produce 18,000 BTU's of net energy (after subtracting the amount of energy needed to power the digester).
  - This could produce $15.45 per cow per year, or $7725 of additional gross income to a 500-cow dairy farm.
    - If the biogas were converted into L.P. Gas (for transportation fuel), the average dairy cow could add $41.60 of additional gross income per year to a farm (at $0.58 a gallon).
    - This equates to $20,800 of additional gross income for a 500 cow farm.

Source: www1.extension.umn.edu

Digester Benefits

- **Besides additional income, a anaerobic digester provides the following benefits:**
  - **On-farm source of energy** independent of rising fuel costs, allowing for more constant and predictable energy costs.
  - **Reduced odors** – the aspects of manure that cause odor are what are also used to produce methane. When burned, this methane will be odorless, reducing odors from the farm.
  - **High Quality Fertilizer** – during anaerobic digestion, organic nitrogen is converted into a more-valuable fertilizer, ammonium.
  - **Reduced Surface and Groundwater Contamination** – because it produces a more valuable, more easily-absorbed fertilizer, it reduces the likelihood of water pollution (more nutrients are absorbed by the crop).
  - **Pathogen Reduction** – dangerous bacteria is killed off in the manure during the digester process.
  - **Source of bedding** – anaerobic digesters produce a solid byproduct that can be used for bedding for cattle.

Digester Drawbacks

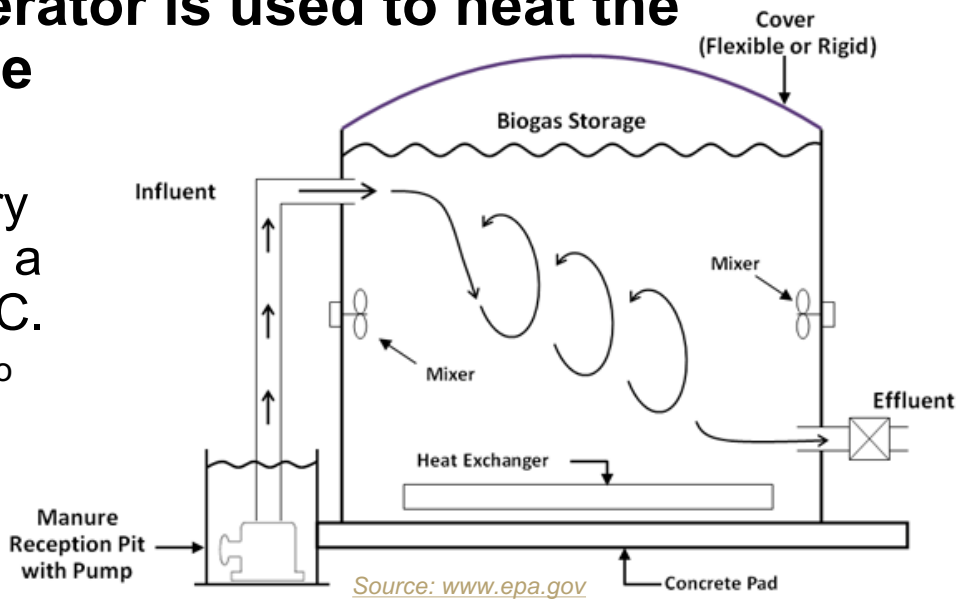
- **Anaerobic digesters can also have drawbacks –**
  - Anaerobic digesters require additional skills and access to skilled experts and consultants.
  - The manure from a farm must be compatible with the digester system (appropriate moisture content, etc.).
  - Typically farms must have 500 cows or more to have enough waste to feasibly accommodate a digester.
  - Methane can become explosive if it mixes with air.
  - Methane leaks are difficult to detect because it is odorless, colorless, and lighter than air.
  - Logistical considerations – anaerobic digesters require additional work to secure the needs and concerns related to insurance, electrical exchanges, etc. such as licenses, electrical connecting costs, consulting fees, etc.

Source: pinkhamwayincinerator.blogspot.

How a Digester Works

- **Digesters are covered waste storage areas that are air-tight.**
  - They are typically constructed from concrete or steel.
  - Most digesters require 20-30 days for the bacteria to convert the organic wastes into acids and then methane gas.

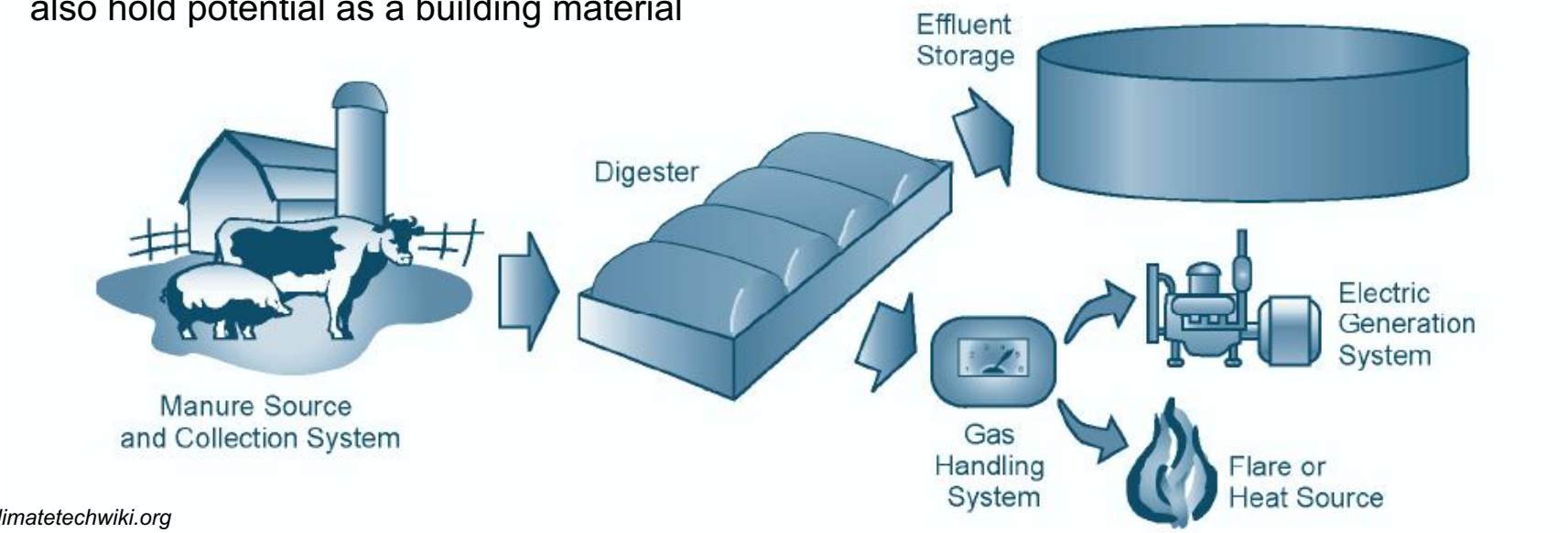
- **Most digesters utilize cogeneration, in which the heat produced by an electric generator is used to heat the digester itself to speed up the reaction time.**
  - The bacteria in a digester are very sensitive, requiring a pH of 7 and a consistent temperature near 35^{o} C.
  - Every 11 degree change from 35^{o} causes the gas production to be cut in half.



Source: www.epa.gov

Digester Requirements

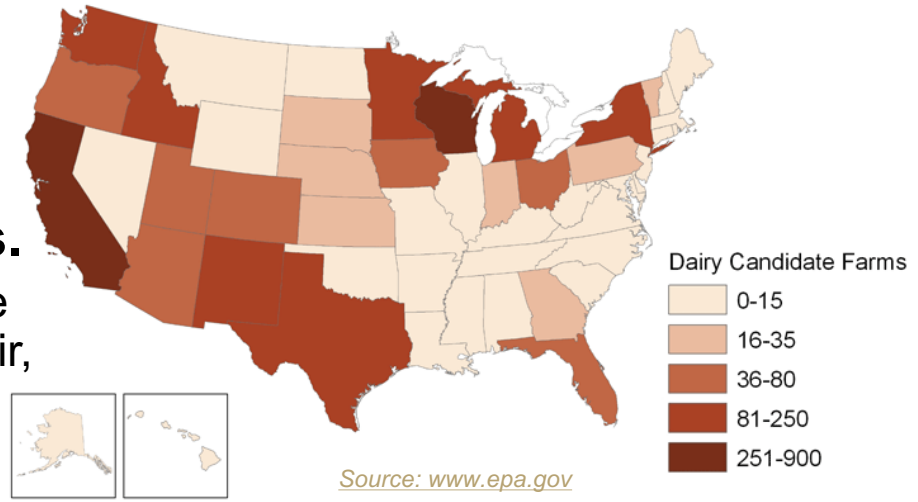
- **Farm anaerobic digesters require the following:**
  1. **Manure Collection**: waste must be delivered to the digester itself.
  2. **Anaerobic Digestion**: in an air-tight lagoon or tank, bacteria convert the organic waste into acids and then methane.
  3. **Biogas Handling**: the gas that results from anaerobic digestion is collected from the digester.
  4. **Gas-use Device**: a device utilizes the gas in order to convert it into a source of power or energy (water heater, refrigeration, electrical generation, or compressed gas for transportation fuel).
  5. **Digester Byproduct Removal**: the following byproducts must be handled after digestion is completed:
     - Liquid effluent (sewage) can be used as a high-quality fertilizer
     - Digested solids: can be used as bedding for cattle or for biodegradable planting pots; it may also hold potential as a building material



Source: climatetechwiki.org

Potential Impact

- **The US Environmental Protection Agency (EPA) estimates that there are 8200 dairy and swine operations in the United States that could support a methane digester.**
  - Altogether, these farms could generate more than 13 million megawatt-hours of energy.
  - They could and displace about 1,670 megawatts of fossil fuel-fired generation collectively per year.
    - A typical coal-fired power plant produces 600-700 megawatts per year, so US agricultural biogas production could eliminate 2-3 coal-fired power plants.
    - Use of landfill biogas could eliminate even more coal-fired power plants!
- **Biogas production would reduce dependence on foreign oil and heavily-polluting coal power plants.**
  - Use of anaerobic digestion would provide more income to farmers while reducing air, soil, and water pollution.



Source: www.epa.gov

Sources

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