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Fact Sheet

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# Anaerobic Digestion: An Alternative Energy Source for Farmers

Anaerobic digestion is a natural process that occurs in a wide variety of ecosystems, but it can also be accelerated in engineered systems called anaerobic digesters. This process creates biogas, a mixture of methane and carbon dioxide that can be used as a renewable source of energy. This factsheet provides an overview of how farmers can use anaerobic digestion to their benefit and the initiatives undertaken by the government to promote its use.

## *How Does Anaerobic Digestion Occur?*

To produce biogas using anaerobic digestion, organic matter, like animal manure or food waste, is collected and placed in an enclosed container called a digester. Inside this controlled environment, bacteria ferment the organic matter, releasing biogas as a byproduct. The design of an anaerobic digester mimics the way bacteria decompose organic waste in a human stomach.

Digesters are typically designed as cylindrical or rectangular containers made from various materials, including concrete, steel, or fiberglass, but their size varies significantly depending on the specific needs of the farm. Smaller farms use digesters with capacities of a few thousand gallons while larger operations may require digesters capable of holding millions of gallons.

For larger scale applications, a digester usually has a mixing system to ensure even distribution of the organic waste. Additionally, a heating system may be used to maintain the optimal temperature range for bacteria activity. Regardless of the digester's shape or size, it must be designed to exclude oxygen, which is essential for anaerobic digestion.

After the anaerobic digestion process is complete, the biogas can then be captured and used as a renewable energy source for heating, generating electricity, or powering vehicles.

## *How is Biogas Utilized by Farmers?*

Generally, the biogas generated by a digester is captured and transported through a multi-component gas collection system. In all systems, the biogas is initially collected in a headspace located above the digester.

Some farms use a pipping system connected to the digester, enabling the collection and transport of biogas from the headspace. In this setup, the biogas may be transported to a gas storage tank, where it is pressurized to prevent escape. The storage tank may also be equipped with purification systems to remove impurities, enabling the biogas to be sold as natural gas. However, due to the cost and time associated with this process, biogas is more commonly used on-site as a fuel source for gas-fired boilers or for electricity generation.

When a biogas-compatible generator is used, the generated electricity can be used for various farm operations. Waste heat emitted by the generator can also be harnessed to maintain the digester's optimal temperature. Alternatively, farmers may opt to sell this surplus electricity back to the grid as an additional source of revenue.

While there are many different ways that biofuel can be used, the difficulty of compressing biogas into liquid makes it an impractical source of fuel for most vehicles. Nevertheless, utilizing biofuel can substantially reduce energy waste and utility costs, particularly when there is a viable market for natural gas or farm-produced electricity.

## *What Happens to the Remaining Material in the Digester?*

After anaerobic digestion is complete, a nutrient-rich residue known as digestate remains in the digester. The exact composition of the digestate can vary based on the type of organic waste that was used as feedstock. It typically contains nitrogen, phosphorus, potassium, and other micronutrients that promote plant growth.

The simplest use for digestate is in its original form. Digestate can be directly applied to soil as a fertilizer. Newer centrifuge technologies have also enabled farmers to separate digestate into liquid and solid fractions, yielding even more nutrient-rich fertilizers for crops. This process typically involves extracting the digestate and storing it in separate tanks for stabilization. Once matured, this fertilizer can effectively enhance soil health on the farm.

Processed or not, digestate offers a cost-effective alternative to synthetic fertilizers, which can have detrimental environmental consequences when overused. In addition to fertilization, digestate can be used as animal bedding or as a feedstock for composting.

### *Is Anerobic Digestion a Practical Energy Source?*

With the continued development of the necessary technology, anaerobic digestion is rapidly gaining recognition as a practical approach to renewable energy generation. According to the International Energy Agency (IEA), sustainable biogas production from processes like anaerobic digestion has the potential to expand by half in 2040.

Currently, anaerobic digestion is most commonly used in Europe and Asia; however, its use has expanded worldwide, addressing the challenges of agricultural and municipal waste management. Many countries, including the United States, have adopted policies and incentives to promote the use of anaerobic digestion for renewable energy production and waste management.

Germany, for example, has over 10,000 biogas plants currently in operation, all benefiting from government-backed tax cuts, feed-in tariffs, and other financial incentives. Other European nations, like Denmark and the United Kingdom, have also established hundreds of biogas plants, taking advantage of similar financial support. China, with over 100,000 biogas plants in operation, stands as one of the world's largest producers of biogas, generating 72,000-terawatt hours (TWh) of energy in 2021, according to the International Energy Agency (IEA).

### *Do U.S. Farmers Utilize Anaerobic Digestion?*

In the United States, farms primarily use anaerobic digestion to treat livestock manure, which can generate biogas for on-farm use or for sale to nearby customers. According to the U.S. Environmental Protection Agency (EPA), there were 343 manure-based anaerobic digestion systems operating in the United States, as of January 2023. The agency also reported that these systems prevented the release of 10.43 million metric tons of carbon dioxide equivalent (MMTCO2e) into the atmosphere.

Despite its significant promise, the potential of anaerobic digestion remains untapped. The U.S. EPA estimates that approximately 8,100 dairy and swine operations have the potential to support anaerobic digestion systems. Looking ahead, the potential for energy generation through anaerobic digestion is significant. The U.S. Environmental Protection Agency (EPA) projects that implementing anaerobic digestion systems on 8,100 farms could contribute roughly 16 million megawatt-hours of electricity per year, amounting to over 2,000 megawatts (MW) for the electrical grid. This would also result in a reduction of about 5.4 million MMBtu in the consumption of fossil fuels.

### *How Does the Government Incentivize and Regulate Anaerobic Digestion?*

The U.S. Department of Agriculture (USDA) has implemented several programs and initiatives to support the development of the necessary technologies, including grants and loans for farm-based renewable energy projects. In March 2023, the USDA promoted a new value-added producer grant program for new and existing digester projects.

Many states have also committed to encouraging the adoption and advancement of anaerobic digestion technology. California, New York, Pennsylvania, Washington, Vermont, and Maryland are a few examples of states that have allocated funding to develop anaerobic digestion technology and install digester systems on farms.

In spite of these initiatives, anaerobic digestion remains a high-cost venture with significant upfront payments. According to the U.S. Environmental Protection Agency (EPA), estimated capital expenditures for a digester range from thousands to hundreds of thousands of dollars, depending on the digester's size. This cost can be a significant barrier for many farmers, especially smaller operations with limited financial resources to support such infrastructure.

### *Conclusion*

The United States' recent interest in funding anaerobic digestion technology reflects a growing belief in its potential to drive large-scale sustainability. This process offers dual benefits, serving as both a source of renewable energy and a method of waste management, making it an

increasingly attractive venture for farmers. As anaerobic digestion technologies continue to decrease in cost and increase in efficiency, it is poised to become much more commonplace on U.S. farms.

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