Current Progress in US Dairy Farm Biogas Development - A Five Article Report

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Contents

Contents

Preface

I wrote this short ebook in March 2009 for professionals and students seeking information about biogas digesters on US Dairy Farms, and I very much hope you will find it a useful general introduction to this subject.

If you would like to contact me or comment to the readers of our blog, email me at the address below or you are welcome to comment on the forum at our sister site www.forum.anaerobic-digestion.com .

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Cover illustration: A Biogas Digester

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1. Biogas Digester Development and Increasing Adoption

Anaerobic digestion is a series of processes in which microorganisms break down biodegradable material in the absence of oxygen. It is widely used to treat wastewater sludges and organic waste because it provides volume and mass reduction of the input material.

As part of an integrated waste management system, anaerobic digestion can also reduce the emission of landfill and incidental farm methane gas emissions into the atmosphere.

Anaerobic digestion is a renewable energy source because the process produces a methane and carbon dioxide rich biogas suitable for energy production helping replace fossil fuels. Also, the nutrient-rich solids left after digestion can be used as fertiliser.

Scientific interest in the gasses produced by the natural decomposition of organic matter goes back a long way. Biogas was first reported in the seventeenth century by Robert Boyle and Stephen Hale, who noted that flammable gas was released by disturbing the sediment of streams and lakes. In 1808, Sir Humphry Davy determined that methane was present in the gasses produced by cattle manure.

It has been reported on the web that the first anaerobic digester was built by a leper colony in Bombay, India in 1859. In 1895 the technology was developed in Exeter, England, where a septic tank was used to generate gas for street lighting. Also, web sources report that in England, in 1904, the first dual purpose tank for both sedimentation and sludge treatment was installed in Hampton. In 1907, in Germany, a patent was issued for the Imhoff tank, an early form of digester.

The biogas digester (anaerobic digestion plant - AD plant) also, of course, has a big part to play in farming – especially dairy. An AD plant captures naturally occurring gas from manure and converts it into electricity. One recently published US News item declares that with one new AD system, they are generating up to 300,000 kilowatt-hours per year for their farm. That is a value in saved power costs of about $40,000 a year!

The farming industry is developing a variety of AD Plant systems using different technologies.

For example, placing a tarpaulin over manure ponds can provide a very basic biogas digester. Doing it eliminates the release of methane (a natural byproduct of manure) into the air which would cause greenhouse gas global warming.

The amount that can be removed is small in overall emissions terms but could be significant.

According to the 2003 U.S. Department of Energy Report on Greenhouse Gases, agricultural sources, primarily animal waste, account for approximately three percent of greenhouse gas emissions. The same source reports that a dairy cow can generate 120 lbs. of waste each day, totaling about 40,000 lbs. per year.

Furthermore, using a digester wastes nothing as the solids separated from the waste are

composted and reused as fertilizer, providing additional, and highly sustainable benefits.

2. Anaerobic Digestion Use Rises in the United States

Thanks to two pieces of recent legislation, at least 13 additional methane systems are now under construction in the US, and renewable-energy advocates are predicting that scores more are sure to follow.

The Straus project is the first of 14 methane projects to receive matching funds from the California Energy Commission, one result of incentives following the rolling blackouts that plagued the state during the summer of 2001.

With net metering, small producers like Straus can reduce or erase their energy bills by pumping their excess energy into the grid. Net metering has been available to owners of home solar systems for several years, but it can also be used for digester power delivered into the grid in many areas.

It may also be advantageous to clean and compress the biogas and deliver it into the gas local supply grid, instead of generating electricity from it. However, not many natural gas grid distribution companies will so far allow grid supplies from biogas plants, and the calorific value for biogas (usually called “biomethane” when purified and compressed in the grid) is lower than for natural gas. However, the current reluctance will soon change in many nations anxious to utilise their renewable resources in the most efficient manner.

For Anaerobic Digestion (biogas digestion) to really take off economically it is essential that the liquid and solid products – compost and liquid digestate fertilsier – can be marketed and sold. There has been recent success in this area as well.

Garick has recently trademarked “Moo Moss” for example. This is there product made from the fibrous solids (solid digestate) processed in the Tillamook Bay Port's digester and then pressed from the liquid fraction after anaerobic digestion. It is stable enough to be used directly in nursery potting mixes. This trademarked product has been recognised as an ideal alternative or amendment to peat moss in nursery media.

The story of this digester goes back to 2003, when the Port of Tillamook Bay, Oregon constructed a centralized methane digester to biologically process the manure from 4000 of the county's 30,000 dairy cows. The project was 14 years in development as MEAD (Methane Energy and Agricultural Development). The facility, owned and managed by the Port, utilizes simple, proven cost-effective digester, solids separation and biogas-to-electricity technology also now currently being employed at over a dozen sites nationally.

In another example, we are told that by summer, a new methane digester will handle the fresh manure generated by Fiscalini's Californian 1,500 Holstein, Jersey and Brown Swiss herd. In addition, whey from their cheese making facility plus any feed waste is to be pumped into the digester tanks and composted at 100 degrees. The digester itself is kept warm by radiant heating using simple plastic tubing.

The methane will power a generator located near the cheese plant producing sufficient

electricity to power the dairy barn (which holds 54 cows at one time) plus the 88,000 sq ft cheese plant. The heat from the system will also help pre-warm the water for the plant's heat exchangers.

The Dennis Haubenschild dairy farm near Princeton, Minnesota reports that it has added another "one of the first" distinguished honors to its list of accomplishments, after previous honors included the first methane digester to be built in Minnesota and that is said to be the first digester in the world to run a hydrogen fuel cell from biogas.

When the Haubenschilds began trading carbon credits from methane captured by their anaerobic digester in November, they were only one of two farms in the nation to do so. Now there are a reported dozen plus farms trading carbon credits from captured methane. The credits provide an additional source of revenue for the farm and address a growing, serious concern: global warming.

Perham, Minnesota. Reports that dairy farm wastes could someday heat homes and dry clothes for residents of a northern Minnesota town as well.

One company has designed a city-rural co-operation scheme where, besides dairy manure, a digester would convert waste from one of the city's biggest employers, Barrel O' Fun, into energy. Primera Foods, another Perham business, has also expressed interest. Another benefit cited is that waste diverted to the digester would ease burdens on the city's wastewater handling system, reportedly allowing local industry to expand. Perham could sustain more jobs without increasing its wastewater treatment capacity.

3. US Anaerobic Digestion Capacity Increases Slowly

There are two state programs designed to encourage farmers to install methane digesters, which capture methane gas that can be converted into electricity. In spite of these efforts, Minnesota farmers have been slow to adopt this technology.

This hesitancy may be due in large part to the significant upfront costs and low electricity purchase rates offered by utilities. Technical limitations of biogas production may also be a factor. Studies have indicated that profitable biogas production in Minnesota using current digester technology may be limited to large dairy operations (at least 300 cows) that collect manure by scraping rather than flushing.

Profitable methane production requires a significant amount of manure to be gernated on-farm, and cows have been shown to have greater gas production potential than swine or poultry (measured in ft.3/animal unit/day).

A methane digester is reported to be the newest project at Green Meadow Farms. They produce methane and sell the methane gas to a company called North American Biofuels L.L.C. They take the gas and convert it to electricity. The manure will now be diverted into the digester before it goes into the treatment plant. By doing this they should also be able to cut down on the cost of the ferric chloride that they use in the treatment process.

Straus Creamery expects to generate up to 600,000-kilowatt hours per year, saving an

estimated $6,000 in monthly energy costs. A digester is an airtight container that uses bacteria to break down manure. As part of that process, methane gas is produced and used to power electrical generators.

It is reported that progress is taking place, but more momentum is needed if the sector is going to make a significant contribution to greenhouse gas emissions in the next 10 years.

Biogas digesters, however, are not going to appeal to all to some. Biogas is one of those matters where results do not come immediately. It can take a few weeks for process changes to take effect, so the changes will be harder to control than in other process plant, but they do come.

One great and as yet hardly tapped opportunity in the US, is the use for biogas is as a replacement for natural gas in our gas systems worldwide. Biogas must be very clean before it can be pumped into that system, to reach exacting natural gas distribution pipeline quality standards. It must be of the correct calorific composition for the local distribution network to accept. Carbon dioxide, water, hydrogen sulfide and particulates must all be removed if present.

Production of biogas is a mature technology, well established in many European countries. Experience in Sweden has shown that upgrading biogas for use as a transportation fuel, while a relatively new technology, can be done with high reliability and at reasonable cost.

In the US concerns still exist about the production of biogas during the winter, costly dung collection arrangements, inadequate slurry handling systems and lack of outside financial help. These are even so just some of the constraints reported in the promotion of the program and with the introduction of the new US government administration hopes are high that biogas incentives will soon be reviewd and given additional fiscal encouragement.

4. The Importance of Biogas Digesters for Our Future

Biogas digesters hold a high level of importance for all our futures as the only way to turn the tide on global emissions from a huge range of waste organic materials.

Society is blinded by the opportunities of solar energy, wave and wind power, but so far has failed to see that unless the rising quantities of argnic waste we produce are disposed of without decomposing to produce methane, a huge problem remains.

As a result of that failure of vision a very large and growing greenhouse gas emission load will remain and we can never become truly sustainable, as things are now, and future generations are in grave danger.

We are now using our natural gas (carbonaceous fuel) resources up at a huge rate. These were formed from the fossilized remains of plants and animals in a process that took millions of years.

Such resources do not "grow back" in a time scale that is meaningful for humans. Natural

gas is a fossil fuel that was created eons ago by the anaerobic decomposition of organic materials. It is often found in association with oil and coal. It will deplete without an adequate replacement other than biogas, so we had better get on with it and improve our ability to produce biogas and syngas (from gasification) – these are its only real replacements other than converting other carbonaceous fuels into gas fuels!

Cooking is best done with with clean-burning gas, rather than smoky wood. In developing nations and for the poor worldwide, introducing gas cooking improves respiratory health and reduces the pressure on local fuelwood. In contrast, cooking on open fires emits gases that endanger people's health and due to its inefficent use of fuel contributes unnecessarily to global warming.

The German government saw the potential for biogas a number of years ago and intoduced incentives to encourage biogas and biofuel production. German technology companies now have a head-start over the US, and the UK. Based on their experience, acquired over a number of years in partnership with their German customers, they have built a formidable record in biogas digestion plant design and installation.

The US should welcome these experts into the US. They do reportedly say that they want to share their expertise in other markets.

According to reports available on the internet the Germans biogas companies already have numerous projects and installations completed in Russia, Thailand, England, France, Spain and Turkey, and this they consider to be just the beginning.

It is stated in a recent report available on the worldwide web, that biogas even offers the possibility of stepping towards energy security for many rural and even peri-urban communities. However, the converse is certainly also true, and there is no energy security for any nation now which depends upon imports of natural gas, whereas the fact is that biogas is quite literally home-grown and right on our doorstep. How could you imagine a more secure supply than that!.

5. Farm Biogas and Issues Which Arise in Its Production

Biogas production is achieved as the result of the controlled microbial breakdown of organic materials such as animal manures or food scraps in an anaerobic digester.

An anaerobic digester is the name of the plant that makes the gas and is operated at a controlled temperature, pH and loading rate to encourage the growth of microorganisms that eat the organic matter and produce biogas and a more biologically stable liquid effluent.

Biogas is a mixture of about 60-70% methane (natural gas), 30-40% carbon dioxide and other trace gases, such as hydrogen sulfide. The heat content of this gas is based on the amount of methane it contains and is about 600 BTUs per cubic foot.

Anaerobic digesters produce biomethane along with electricity generation and saleable end product biosolids which allows animal production enterprises to become neighborhood

and environment friendly. Important as well of course is the hope that the biogas will provide another source of revenue flow for the digester owners.

Running a biogas plant on a dairy farm works best for farms which hold at least 800 cows. Economically viable systems for dairies under the 800 cow level are possible, but need evaluation on a farm by farm basis to decide whther there will be adequate cost effectiveness. No farm or combinations of farms is ever likely to be too large for such a system.

Whether a particular farm, your farm perhaps, would be suitable for a biogas plant depends on assessing the budget costs of the investment, against the potential earnings from generated electricity sales and from end product bio-solid sales. The economic return period for any farm is an important issue to consider and can be estimated this way. If the return period is short enough and an investor can be found there is a lot to be said for going ahead.

Many people will ask you to demonstrate that the new plant does not have a negative impact on the surrounding environment and see this as an issue for biogas plants. Let us assure you that a well designed and run biogas plant improves the environment significantly and is neither odorous nor dangerous. Such plants can be placed near production facilities which will often be the best customers for the power and heat produced. This can reduce fuel delivery transport movements into and out of the location, and may be a much less polluting form of power than used previously.

Equipment is fitted to the digester plants to suit climate conditions. The bioreactors have thermal insulation and are heated by external heating only at start up, and heat themselves from their own waste heat thereafter. Depending on climate they may also have a cooling system for summer use. In very cold winter conditions a biogas plant may unfortunately consume up to 50% of its produced heat power on parasitic loads like this and this can be an issue to consider.

The liquid that results from the anaerobic digestion process has solids which are separated out, composted, and sold to local gardeners, landscapers and farmers. Some farmers use the solids as bedding for their cows and sell it as bedding to neighbors. The liquids are returned to the farmer as nutrient rich natural fertilizer, which replaces imported nutrients and thereby cuts costs.

There is an issue going around, and it is a fallacy, that Anaerobic Digesters always smell. We would strongly contest this. Anaerobic digesters actually tend to alleviate odor problems when on well run, especially as suburban growth surrounds many farms and introduces neighbors who complain about manure smells most often due to nearby farming activities and not the AD plant at all.

By installing an anaerobic digester, the conscientious farmer can actually solve odor issues to everyone's satisfaction. Since the digesters are airtight, the smell stays within, and the liquids and solids coming out of the digester have only a very slight odor compared to the raw slurry.

Acknowledgements:

This ebook was created using web research, and we acknowledge the use of very short clippings from various sources.

Further Actions:

If you have been spurred on by these articles to give more thought to developing a biogas production facility and need professional advice within the United Kingdom and Ireland on biogas digester feasibility, planning, design and installation we would be pleased to provide a quotation. Email info@ippts.com stating project details.

Interested in more information on anaerobic digestion and biogas information? If so we suggest a visit to www.anaerobic-digestion.com .