THE STATE OF VERMONT
Harvesting Methane to Protect the Planet

Project Snapshot

PROJECTS
Research and development of digesters on Vermont dairy farms and related education and outreach

TECHNOLOGY
Anaerobic digestion of cow manure and use of the methane produced

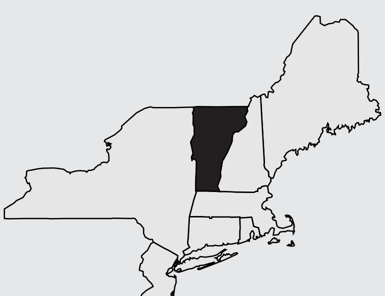
CO_2 EMISSION REDUCTIONS
1,325-ton-a-year potential from an average dairy farm

INVESTMENT
$695,000 total in 2000 and 2001

LESSONS LEARNED

- The ability to sell renewable energy at a premium would greatly benefit the economics of anaerobic digestion on farms.
- In addition to lower energy costs, digestion offers a wide variety of benefits to dairy farmers. Too often energy savings are the only benefits considered.
- Other synergies can make manure digestion even more attractive, such as co-location of a digester and a greenhouse.

FUNDING SOURCES
Budget allocations from the U.S. Department of Energy



INTRODUCTION

Methane is a potent greenhouse gas. Scientists estimate that it is 21 times more powerful than carbon dioxide. Even small sources of methane are significant, and collectively they play an important role in how climate change strategy is designed. Cow manure – which as fertilizer releases harmful nutrients into groundwater, lakes and streams – is a significant source of methane. On a national basis, EPA estimates that livestock account for nine percent of all methane emissions. For its part, methane constitutes ten percent of all U.S. greenhouse gas emissions.[1] Two state agencies in Vermont, along with the Coalition of Northeastern Governors (CONEG), have launched a project designed to refine manure treatment technologies and test them on working farms. The program focuses on the storage of manure in anaerobic digesters.[2] The digesters accelerate methane production and permit it to be captured for use.

THE PROJECT

Nearly all dairy farms use cow manure to fertilize the fields that produce the feedstock for their dairy herd. But farmers face major environmental challenges in managing the nutrients in cow manure. For instance, if manure is applied to frozen ground, the result often is excessive runoff and high nutrient loadings to local rivers and lakes. On the other hand, if manure must be stored for long periods in pits or lagoons, decomposition causes the release of sizable quantities of methane – in addition to sizeable odors and consequent complaints from the neighbors. Large farms, which often sell manure for use as fertilizer, face an additional challenge: the high cost of transportation. They are constantly on the lookout for better ways to separate the liquid and solid components of the waste, since only the lighter, solid portion is sold.

The first efforts to commercialize anaerobic digester technology on Vermont farms date back to the 1970's and focused primarily on heat and electricity production. The digester is a closed, heated container. Inside it manure decomposes faster than in an open lagoon, generating more methane. The methane is captured and burned. As a new energy source, however, manure digestion proved expensive. Digestion offers other benefits, though, and their value is increasing as environmental consciousness grows and the economics of farming tighten. Digested manure is less odiferous, more easily separated for transportation, and – because nutrients are more available to plants – a better fertilizer. A Resource Assessment published in July 2000 by the Vermont Departments of Public Service and Agriculture, which worked with CONEG on this initiative, predicted that manure digestion and its attendant benefits could become commonplace at Vermont dairy farms, if technological improvements were to lower digestion costs and the means found to resolve issues like nutrient loading and wayward odors. This also would cut emissions of a powerful agent of climate change – a significant plus.

Vermont's Farm Methane Project is focusing on anaerobic digestion technology that would be cost-effective at dairy farms of all sizes. "The goal is to develop techniques and technologies that will speed digestion and reduce maintenance costs, making anaerobic digestion more affordable for a variety of farm sizes and management styles," explains Jeff Forward of Richmond Energy Associates, an energy consulting firm providing technical support to the project. The most promising innovations rely on steam to preheat incoming manure and speed digestion. With faster digestion, a smaller digester is needed, lowering capital costs. Beyond technology testing, the project is:

- Working with experts in manure management and water quality protection to further reduce the environmental impacts of the dairy cycle.
- Assessing statewide potential for

digestion of manure and other organic wastes like whey, garbage and beer.

- Establishing working demonstration sites.

- Publicizing progress to stimulate demand for digesters at farms and for the organic fertilizers they produce.

In the July 2000 Resource Assessment, the Farm Methane Project identified cow manure as the category of organic waste that offers Vermont the largest potential source of new energy, by far.

THE RESULTS

Technical research for the project currently is taking place at Foster Brothers dairy farm in Middlebury, Vermont. Foster Brothers, with 350 cows, has operated a digester for almost a decade. This experience provides valuable baseline data against which to measure the performance of new systems and procedures. The results to date have been promising. For example, by preheating the manure, a digester can reach methane-production temperatures in a week. Without preheating, it takes three months. Design changes in the digester also have reduced cleaning and maintenance time considerably. The project consultant is optimistic that these changes will lead to digester systems small and fast enough to be attractive investments for most large dairy farms. In addition, smaller farms – those with fewer than 300 cows – may find that benefits like odor reduction, nutrient management and more effective manure separation make digesters desirable additions.

Although methane reduction from anaerobic digestion has been difficult to quantify, in 1994 the U.S. Department of Energy (DOE) helped alleviate uncertainty by publishing standard methodologies for reporting greenhouse gas reductions.[3] Specifically, DOE provided emission factors for dairy livestock manure, based on storage method and climate. Drawing on these emission factors as well as on average characteristics of dairy cows, we estimate that the digestion of all manure on a 300-cow farm in Vermont would reduce methane emissions by about 63 tons a year – the equivalent of 1,325 tons of CO_2.[4]

LESSONS LEARNED

As electricity markets are deregulated, suppliers are beginning to offer "green" or renewable electricity to consumers. Dan Scruton of Vermont's Department of Agriculture notes that this may afford many dairy farmers the opportunity to improve the economics of digestion by selling their output at a premium.[5] If this proves profitable, Scruton predicts, farmers who use their digesters to produce more electricity than they need could sell the excess as green power – for five to six cents a kilowatt-hour (kWh), compared to a typical market rate of three to four cents/kWh. Most of the Vermont farms likely to opt for digesters are expected to produce enough methane to generate saleable electricity.

Another opportunity to increase the benefits and improve the economics of a digester is to find ways to use the waste heat – for example, as part of the space-heating system. A dairy farm located near a greenhouse would be an especially valuable combination, since high heating costs make it very expensive to operate greenhouses in the Vermont winter. Further economies could be realized if the adjacent digester provided the greenhouse with organic fertilizer.

The overarching lesson is that the economic analysis of a project like this should take into account a broad range of benefits, not just one – energy, for example. Even though some of those benefits – greenhouse gas reduction, nutrient management and odor alleviation – can be difficult to quantify with precision, they may offer sufficiently clear advantages to persuade a Vermont farmer to install a digester.

FUTURE COMMITMENTS

The Vermont Farm Methane Project has secured $395,000 in funding for 2001 from U.S. DOE. The 2001 work will focus on installing and launching digesters at farms identified as promising sites. Lessons learned from tests at the Foster Brothers digesters will be incorporated into these projects.

Estimated Methane Emission Reductions from Manure Digestion (annual)

lbs./Cow	Cows/Farm	lbs. of Cows/Farm	Daily lbs. Manure/lb. Cow	Daily lbs. Manure per Farm	Annual lbs. Manure per Farm	Annual Tons Methane/ Farm
1,200	300	360,000	0.06	21,600	7,884,000	63

THE PARTNERSHIP

The Vermont Farm Methane Project is a collaboration between CONEG and the Vermont Departments of Public Service and Agriculture. Richmond Energy Associates, an energy consulting firm, is providing technical support. The project evolved during the 1990's, as it was becoming clear that earlier efforts to develop anaerobic digester technology for dairy farms had largely been unsuccessful. In 2000, CONEG received $300,000 from the U.S. Department of Energy to study its potential in Vermont, as well as implementation barriers.

The project also has received assistance from U.S. EPA's "AgSTAR" program, which supports livestock farmers who are investigating ways to capture and use methane from manure. Research at AgSTAR estimates that some 3,000 livestock facilities in the U.S. could install cost-effective methane recovery systems having an overall potential to recover about 469,700 tons of methane a year.

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EPA AgSTAR Program
www.epa.gov/agstar/

1 Because methane is 21 times more potent as a greenhouse gas than CO_2, figures for methane emissions are converted to "tons of CO_2 equivalent" in order to asses what percentage of total greenhouse gas emissions they comprise. The 10% figure here is calculated in such CO_2 equivalents.

2 Anaerobic digestion is bacterial decomposition in an oxygen-free environment.

3 Sector-Specific Issues and Reporting Methodologies Supporting the General Guidelines for the Voluntary Reporting of Greenhouse Gases under Section 1605(b) of the Energy Policy Act of 1992, U.S. DOE, Washington, D.C., October 1994, DOE/PO-0028.

4 In this calculation, we have used EPA's figure for methane emissions from 30-day pit storage in a cool climate (16 kilograms (kg) methane per 1,000 kg of volatile solids).

5 Methane from manure is considered to be a renewable electricity fuel because the underlying resource – feedstock – is renewable. In addition, the byproduct, methane – once it is burned to generate electricity – is transformed from a very potent greenhouse gas to one that is much less potent, carbon dioxide. Moreover, much of the CO_2 emitted in burning this methane is offset by the CO_2 sequestered in the growing feedstock, further mitigating the global warming impacts of this practice.

CLEAN AIR-COOL PLANET CASE STUDY RATING

This case study reduces CO_2 emissions equivalent to the following:

Avoiding the consumption of 7 barrels of oil per day.

OR Taking 186 vehicles off the road per year. (1 car = 20 vehicles)

Assumptions: 1,093 lbs of CO_2 per barrel of oil. Vehicles are average passenger cars (approximately 20 lbs CO_2 per gallon of gasoline – 22.5 miles per gallon, averaging 16,000 miles per year)