

## Alternative Generation Options for Anaerobic Manure Digesters

IN 2003, THE MINNESOTA DEPARTMENT OF AGRICULTURE was awarded a grant of \$221,000 to conduct fuel cell research using biogas from an anaerobic digester as fuel. Funding for this project was provided by the Minnesota Environment and Natural Resources Trust Fund as recommended by the Legislative Commission on Minnesota Resources (LCMR).

### Project Partners

Dennis Haubenschild, dairy farmer  
 University of Minnesota Biosystems and Agricultural Engineering Department  
 Minnesota Department of Agriculture  
 the Minnesota Project

### Contributing Partners

East Central Energy  
 Great River Energy  
 John Deere, Inc.  
 Electric Power Research Institute  
 Plug Power, Inc.  
 CES-Landtec Engineering  
 Donaldson Corporation

### Background on Alternative Generation Test Site

- Haubenschild Farms, near Princeton, Minnesota
- 800-cow dairy farm, 1000 acres of crop land
- Built plug-flow digester in 1999
- Biogas is being converted to electricity by 130 kW internal combustion engine generator
- Digester is producing excess biogas

### Environment and Economic Benefits

- Reduced reliance on fossil fuels as an energy source
- Reduced odors and emissions
- Nutrient properties of the digested manure are enhanced, reducing the potential for pollution to water and soil
- Distributed energy from a renewable resource supports the rural economy while reducing reliance on fossil fuels and reducing emission of greenhouse gases



View of Haubenschild barn, digester and engine generator room at time of installation in 1999.



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5kW proton exchange membrane (PEM) fuel cell at Haubenschild Dairy Farm

## Project Purpose

Investigate the use of alternative technologies for producing electricity from biogas.

## Project Focus

Test technologies that have the potential to be more environmentally friendly and easier to maintain than conventional engine generator systems. A fuel cell was selected as the technology to research. Throughout the course of this project, the University of Minnesota has looked at a number of aspects of employing a fuel cell with an anaerobic digester, which include: fuel cell type, installation and operation, gas clean up, fuel cell emissions, and economic feasibility.

## Challenges of Using Biogas for a Fuel Cell

- Hydrogen sulfide removal
  - Initial concentration=3000-5000 parts per million volume basis
  - Need concentration < 15 ppmv parts per million volume basis
- Moisture removal
  - Need dry gas

- Carbon dioxide removal
  - Need concentration < 50,000 parts per million volume basis

## Project Execution

A small portion of biogas from the existing plug-flow anaerobic manure digester on the Haubenschild dairy farm was routed into a new research building that housed the fuel cell, gas clean up equipment, and monitoring equipment. A 5kW proton exchange membrane (PEM) fuel cell purchased from Plug Power, Inc. was used for the research project.

University of Minnesota researchers (Dr. Phil Goodrich, Rich Huelskamp,

David Nelson, and David Schmidt) worked on developing and implementing the gas clean-up process and monitoring strategy for the project.

The greatest challenge of this project was cleaning the biogas of impurities (carbon dioxide, hydrogen sulfide, and water vapor) so the biogas could be effectively used in the fuel cell and its reformer.

In January 2005, the fuel cell was operated on compressed natural gas and in February 2005, the fuel cell was operated on biogas for the first time. Since then the gas cleanup system has been continually modified to decrease the contaminants in the fuel and to develop a more reliable gas quality, the fuel cell has been used to test the purified gas intermittently. The fuel cell has operated continuously for periods up to 10 hours at a time. Data has been collected on the performance of the fuel cell and also the emissions given off during operation when using biogas. The emissions from the fuel cell exhaust are essentially non-detectable. The researchers are working to make the cleanup equipment system more reliable to provide a stream of quality methane for the fuel cell, thereby increasing the energy that can be produced with this clean energy converter.

