

## At a glance

### Location

Ravenna, Michigan, USA

### Commissioned

January 2008

### Fuel

Methane gas from manure of 1,000 dairy cows

### Technologies

- Capstone CR 30 MicroTurbine™ produces 30kW of continuous power and 45kW of thermal energy. Biogas from the digester facility also powers an 80kW CHP reciprocating engine.
  - CR30 microturbine is highly reliable – has only one moving part and doesn't require any oil, other lubricants or coolants.
  - CR 30 can accept H<sub>2</sub>S levels as high as 70,000 parts per million.
- 2.8 MMBTU boiler.
- The anaerobic digester at den Dulk Dairy, manufactured by Austria-based Entec Biogas, is the first system of its kind in the United States. It's 47 feet tall and 48 feet wide.

### Putting waste to work with CHP

- The captured methane gas fuels a low-emission Capstone microturbine that creates on-site power.
- Methane-fueled microturbine produces 30 kW of clean, green electricity.
- Waste heat from the microturbine heats the farm's 700-square-foot concrete liquid/solid separator building.

### Results

- Ultra-low emissions from microturbines.
- Methane gas, which has a greenhouse-gas impact on the atmosphere 21 times that of carbon dioxide, is no longer released into the atmosphere.
- Manure is no longer stored on-site, therefore lowering the environmental impact of dairy operations.

## den Dulk Dairy

Seven gallons of milk isn't the only thing an average dairy cow produces each day.

It's the "other output," about 10½ gallons of manure a day that progressive dairy farmers are using to fuel on-site power thanks to Capstone Turbine Corp.

For two years, the den Dulk Dairy in Ravenna, Michigan has converted manure from 1,000 of its cows into 30kW of clean, green electricity produced by microturbines. In addition, heat from the process is reused to heat the farm's 700-square-foot concrete liquid/solid separator building.



*Waste methane gas from the 47 foot tall anaerobic digester fuels a Capstone microturbine that produces 30kW of clean, green electricity and 45kW of thermal energy used for building heat.*

"With this combined heat and power system, we harness energy from the by-product of the dairy operation to fuel low-emission microturbines that create on-site power," said Sarah Jenan, Director of the Renewable Energy Group at Reynolds Inc., which installed the den Dulk manure-to-electricity facility. At den Dulk, the manure first is pumped through an external heat exchanger that heats the material to 100 degrees Fahrenheit, then sends it to a 47 foot tall, 48 foot wide "dairy digester" tank. The external heat exchanger actually runs off a portion of the biogas created by the process.

The dairy digester at den Dulk is an anaerobic digester, which uses no oxygen in the process. The digester features a continuous stir-tank reactor that mixes the heated manure to break it down, thus creating methane gas, which is considered a waste gas.



Many anaerobic-digester sites around the world flare these waste gases; or worse yet, vent them directly into the atmosphere. Methane has a greenhouse-gas impact on the atmosphere 21 times that of carbon dioxide. Flaring methane completely wastes its energy value. So the best environmental solution is to use these waste gases to generate renewable power – something Capstone turbines do cleanly and economically.

The anaerobic digester at den Dulk Dairy, manufactured by Austria-based Entec Biogas, is the first system of its kind in the United States. It has several unique features, including an inline H<sub>2</sub>S scrubber to remove toxic hydrogen sulfide, pumps built in the digester tank foundation so that any sediment buildup can be removed without emptying the tank and separate units for easy operation and maintenance functions.

Because Capstone turbines can run on a variety of fuel types – from liquid natural gas to diesel fuel to methane, microturbines were the natural choice to create electricity from the waste gas. At den Dulk Dairy, the waste methane gas fuels a Capstone CR30 microturbine, which produces 30kW of continuous power. Biogas from the digester facility also powers an 80kW CHP reciprocating engine. The energy system at the dairy also includes a 2.8 MMBTU boiler.

“In addition, heat exhaust from the Capstone microturbine is either pushed directly into the separator building for heating or delivered to a Cain heat exchanger to heat the hot glycol that provides heat throughout the plant, just as the boiler does,” Jenan explains. The Capstone microturbine produces 45kW of thermal power.

Previously waste from den Dulk, which is home to 3,000 cows and produces 155 million pounds of manure a year, was stored onsite and eventually spread on farm fields across West Michigan. Environmentalists and state regulators say such storage practices cause environmental problems with runoff into rivers and streams.

Capstone offers its CR30, CR65 and CR200 (CR for “Capstone Renewable”) line of microturbines and turbines specifically designed to operate on waste-gas fuels. While such waste-gas fuels contain useable energy, they have low energy density and are usually contaminated with other gases, such as hydrogen sulfide.

Capstone’s microturbines make system design easier than using traditional generating technologies because they operate on a wide range of fuel types, automatically adjust to changing energy densities over time, and accept high levels of contaminants such as hydrogen sulfide. The Capstone CR30, which is the unit installed at den Dulk Dairy, can accept H<sub>2</sub>S levels as high as 70,000 parts per million.



*Cain Heat Exchanger for heat recovery from the Capstone microturbine.*

“Being able to clean gas and get the moisture out is a strong niche our company has in the renewables world,” said Jan Scott of Unison Solutions, a distributor of Capstone Turbine to dairy farms, wastewater treatment plants and a range of other users. “The turbines’ resistance to H<sub>2</sub>S allows users to directly use the methane without the added step of removing the sulfur first.”

In addition to being clean burning and efficient, Capstone turbines are known for their reliability since they have only one moving part and the air-bearing technology does not require any lubricants or coolants.

“We plugged the system in almost a year ago and haven’t touched it since except to change the filter,” Reynolds Inc’s Jenan said.

Hundreds of Capstone microturbines are operating on renewable fuels worldwide, providing a reliable and economical solution to what would otherwise be an environmental problem.

The den Dulk Dairy acquired the microturbine from the Michigan Alternative and Renewable Energy Center (MAREC) at Grand Valley State University in Muskegon, Michigan, which it had purchased with a Department of Energy grant for another project.

The project is being conducted with MAREC and is funded with a \$1 million USD grant from the Michigan Public Service Commission. The den Dulk farm contributed \$1.2 million USD for the site preparation required to host the biodigester. The den Dulk Dairy also purchased a reciprocating engine to use the remaining biogas.

Jenan said dairy digestors are the future of the industry.

“I believe systems such as this will become part of the everyday operation of large farms,” she said. “Not only can they become a distributed generator of electric and thermal power from their waste stream, but it also helps them continue to manage their waste stream in an environmentally responsible manner.” ■