

At a glance

Location

Sheboygan, Wisconsin, USA

Commissioned

December 2005

Fuel

Methane gas from an anaerobic digester

Technologies

- 10 Capstone C30 MicroTurbines™, fueled by waste methane gas from the wastewater plant, generate up to 300kW of electrical power (2,300MW per year).
- Capstone Heat Recovery Modules installed on each turbine capture each microturbine's exhaust heat, which is re-used to maintain the digester's 95 degree Fahrenheit temperature and heat buildings.
- Gas-cleaning system removes moisture and siloxanes from raw methane gas.

Out-of-the-Box Agreement

- Alliant Energy-Wisconsin Power & Light purchased the 10 Capstone microturbines, paid for electrical connections from the wastewater plant to the electrical grid, purchased a gas-cleaning system and a gas-compression system.
- The City of Sheboygan purchases all electricity the microturbines produce, installed heat-recovery modules and provides the methane fuel for the microturbines.

Results

- The wastewater plant's electricity bill has not changed in five years, despite utility rates up 105 percent on average.
- In 2007, the system produced, 1,681MW of electricity valued at \$121,000 USD, and 61,000 therms of biogas valued at nearly \$57,000 USD.
- In 2007, the wastewater treatment plant sold 2,076 Renewable Energy Credits for \$6,540 USD because of green energy the Capstone microturbines produced.

Sheboygan Wastewater Plant

When it was time to upgrade the outdated boiler used to heat anaerobic digesters at the City of Sheboygan's wastewater treatment plant in 2003, the facility's superintendent wanted to solve two problems at once.

The Sheboygan Regional Wastewater Treatment Plant, which treats up to 15 million gallons of water each day, had more methane biogas, a by-product of the anaerobic-digestion process, than it knew what to do with.

At the time, methane gas produced onsite in the anaerobic (without oxygen) digestion process had two purposes: to fuel boilers that heat the anaerobic digesters and to fuel an old 500-horsepower Caterpillar engine that drove an influent pump capable of pumping 11,800 gallons of water per minute. However, more than 25 percent of the methane biogas was considered waste and just flared at the plant site. Unfortunately, flared methane gas has a greenhouse-gas impact on the atmosphere 21 times greater than carbon dioxide.

At the same time, the City wanted to reduce ever rising electricity costs.

"We wanted something that made sense for the bottom line and the environment," said Dale Doerr, the plant's superintendent. "We wanted to get the latest, most efficient system available."

Search for solution begins

The process got underway in 2003 when the City completed a study in conjunction with the local utility – Alliant Energy – and Focus on Energy, a state-wide program that offers grants for energy-saving



The Sheboygan Wastewater Treatment Plant has 10 low-emission Capstone microturbines that use methane gas created by solid waste to generate onsite electricity and heat, cutting the plants electric and natural gas bills by 40 percent and earning renewable energy and emissions credits.



projects. Focus on Energy funds projects based on first-year energy savings.

The study looked at having the Sheboygan treatment plant create a cogeneration system with an Alliant Energy-Wisconsin Power & Light power plant directly south of the treatment plant.

“Ultimately that project fell through, but it got us thinking about cogen,” Doerr said.

Cogeneration, or combined heat and power (CHP), creates two forms of energy: electricity and heat. A facility can use the electricity produced onsite or sell it back to the local utility, while the heat generated by the engine or turbine is captured and used to heat water, rooms or to dry products in a manufacturing process. CHP is far more fuel efficient and environmentally beneficial than utility power and boiler heating.

Through research, plant personnel learned that clean-burning, low-emission microturbines are ideally suited to use methane gas as fuel. Microturbines are quiet, don't vibrate, and don't have the constant maintenance issues associated with reciprocating engines. According to Doerr, the treatment plant's old Caterpillar reciprocating engine needed four gallons of oil each day just to keep running.

Eventually, Doerr convinced Sheboygan officials to allocate \$500,000 USD in 2005 to purchase four microturbines.



Innovative Agreement with Alliant

Unison principals Dave Broihahn and Jan Scott are former Alliant executives who have developed systems for wastewater treatment plants and other facilities throughout the Midwest. Working together, Unison and Alliant came up with an out-of-the-box proposal for the City – Alliant would purchase 10 C30 (30kW) microturbines from Capstone Turbine, pay for electrical connections from the wastewater plant to the electrical

grid, purchase a gas-cleaning system that removes moisture and siloxanes from the raw methane gas and purchase a gas-compression system that compresses the clean methane gas fed to the microturbines.

In exchange, the City agreed to purchase from Alliant all electricity the microturbines produce, install a heat-recovery module to capture the waste heat and provide the methane fuel for the microturbines.

In addition, the City will purchase the entire microturbine system in coming years at a reduced price.

A key benefit of the agreement: the city reaps the financial and societal benefits of producing green/renewable energy. For every megawatt of renewable energy the microturbines create, the Sheboygan Regional Wastewater Treatment Plant receives one Renewable Energy Credit, which the plant can then sell and earn money.

The project got the go-ahead in December 2005 and the 10 Capstone C30 microturbines were installed and running in February 2006.

Microturbines Produce Electricity & Heat

Today, the 10 clean-burning microturbines have a dual purpose: they generate up to 300kW of electrical power (2,300MW per year) and produce waste heat that maintains the proper 95 degree Fahrenheit temperature in the digesters. The waste heat also is used to heat the plant buildings in the winter.

The microturbines can recover 1 million BTUs of heat per hour, or about 73,000 therms per year – enough heat to keep 60 Sheboygan homes warm each year.

“In 2007, the system produced, 1,681 megawatts of electricity valued at \$121,000 USD, and 61,000 therms of biogas valued at nearly \$57,000 USD,” Doerr said.

The result is a significant energy savings for the City of Sheboygan and the use of a clean, renewable-energy source to provide electricity that otherwise would be generated at the coal-fueled power plant nearby.

In 2007, the wastewater treatment plant also sold 2,076 Renewable Energy Credits for \$6,540 USD because of the green energy the microturbines produced. In total in 2007, the plant received more than \$33,600 USD in revenues thanks to energy the Capstone microturbines produced.

“I think outside the box,” Doerr said “My electricity bill isn't any higher today than it was five years ago. But utility rates are up 105 percent on average. This CHP system with microturbines is the answer to helping the environment and keeping costs down.” ■