

# Energy Revolution in Massachusetts

Microturbines provide renewable energy and energy efficiencies.

By Joan Fontaine

**M**icroturbines play an important role in the country's "new energy" revolution. "Green," cost effective, and adaptable to a wide array of applications, they are used to provide on-site and self-contained electricity and heat at many locations across the country.

A small city in Western Massachusetts is becoming an important part of this new energy revolution. Pittsfield, MA, recently completed the preliminary design for an upgrade to its wastewater treatment facility, an upgrade that addresses the issues of renewable energy and energy efficiencies. The wastewater treatment facility features an anaerobic digester in which some of the digester gas being produced is flared. With the proposed modifications, a combined heat and power (CHP) system will be installed, using three 65-kW rated, skid-mounted microturbines (Capstone Turbine Corporation, [www.capstone-turbine.com](http://www.capstone-turbine.com)) for a total rating of 195 kW. The microturbines will be fueled by the digester gas.

Pittsfield will reap many benefits from this project. Along with reduced environmental impact, the city will benefit from a reduced utility bill, since the digester gas will be used to generate both electricity and heat for on-site use. In addition, the plant will generate about \$45,000 a year in revenue through the Renewable Energy Credit market.

But just as vital is the example Pittsfield is setting for other cities and towns by demonstrating how individual municipalities can be both economically savvy and environmental stewards at the same time.

The preliminary design for the upgrade to Pittsfield's wastewater treatment facility includes:

- Installing a brick-and-block building to house the entire CHP system.
- Including space provisions to allow for a fourth microturbine should the city decide to expand.
- Furnishing and installing a 400A, 480/277V distribution panel sub-

fed from the main switchboard in the pump and power building to run the CHP system.

Other key recommendations from the preliminary design include:

- Furnishing and installing three proposed double-disc digested sludge transfer pumps to replace the existing pumps.
- Replacing the existing shell and tube sludge heat exchanger with a single 1.2 MMBTU/hr spiral heat exchanger.
- Installing sufficient instrumentation to monitor sludge and hot water temperatures, pressure drops across the sludge heat exchanger in the sludge and water lines, and instrumentation to automate sludge mixing through use of a timer and through interlocking mixing operations with sludge pumping.

## How It Works

The solids processing infrastructure at the wastewater treatment facility includes: primary and waste-activated sludge pumping, gravity belt thickeners, thickened waste activated sludge pumps, secondary and primary anaerobic sludge digesters, belt filter presses, and dewatered sludge pumps. The purpose of this infrastructure is to reduce the overall mass and volume of sludge for disposal.

Anaerobic digestion at the facility is a two-stage process. The first stage facilitates the destruction of volatile solids through active heating and mixing. Heating of the primary digester is accomplished by re-circulating sludge from the primary digester through a heat exchanger located within the

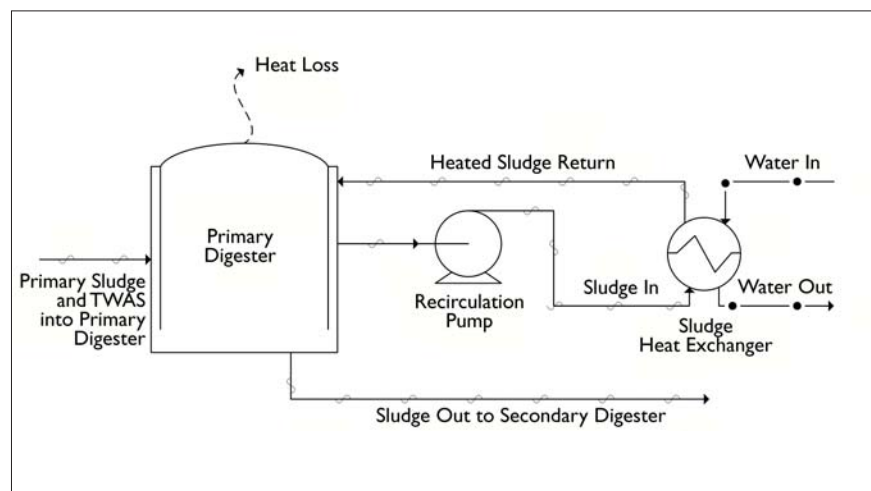


Figure 1. Heat Balance #1—Determine heat requirement of sludge heat exchanger.



*Aerial view of the Pittsfield, MA, wastewater treatment facility.*

digester building, while mixing is accomplished by re-circulating compressed digester gas from the headspace of the primary digester to the bottom of the vessel through lances (see Figure 1). In the second stage of the anaerobic digestion there is no active mixing or heating of the sludge, but solids-liquid separation through quiescent settling of the sludge.

A byproduct of this anaerobic sludge digestion process is digester gas, which is primarily comprised of methane (about 62 percent by volume) and carbon dioxide. Under the current system, this digester gas (which has a heating value of about 620 BTU/SCF) is used as fuel for boilers located in the plant's pump and power building. The boilers are then used to heat a water loop, which heats the sludge in the digesters and maintains it at the optimal temperature for anaerobic digestion.

Any excess digester gas is used to heat the pump and power building in the winter or is flared through a waste gas burner located on the top of the digester building. The amount of digester gas flared would be minimized significantly under the proposed CHP system.


The design calls for diversion of the

digester gas to a fuel gas conditioning system that removes contaminants from the digester gas, including water vapor, hydrogen sulfide, and siloxanes, which are silicone-based compounds contained in many health and beauty care products. The fuel gas conditioning system also boosts the pressure of the gas before it is supplied to the microturbines. There, the digester gas will fuel the microturbines, which will generate electricity and heat to meet the plant's base-load demands.

The waste heat created in the exhaust of the CHP system will be utilized in a heat exchanger to produce hot water, which will then be used for heating the sludge in the primary digester and as building heat in the digester building. Use of the existing boilers in the pump and power building for sludge heating and building heat may still be required, as it is anticipated that there will not be enough heat generated to meet the peak sludge heating requirements under design winter conditions. However, operation of the microturbine system is expected to reduce the need for operation of the boiler system so a reduction in the volume of required diesel fuel is anticipated.

A feasibility study concluded that a CHP system at the Pittsfield wastewater treatment facility will lead to an estimated 30 percent reduction in the plant's electric bill—saving taxpayers over \$200,000 a year—and have a payback period ranging from five to eight years.

But aside from the beneficial financial and environmental outcomes of this project, there is the potential for the Pittsfield project to serve as a template for other municipalities considering microturbine projects for their communities. Currently, only one other community in New England uses microturbines and digester gas to produce electricity for a wastewater treatment plant: Essex Junction, VT, which installed two 30-kW rated microturbines back in 2003.

And what Essex Junction and Pittsfield already know, the rest of this area of the country may soon be learning: that microturbines are a vital part of today's "new energy" revolution. 

*Ms. Fontaine has over 20 years of engineering experience, 12 years of which have been focused in the energy sector performing mechanical and process design, and analysis for numerous utility projects, as well as managing an array of projects, including a recent \$1-million design build project.*