

Allentown Wastewater Treatment Plant

360-kW CHP System

Microturbine application using digester gas

Site Description

The City of Allentown's wastewater treatment plant treats an average of 32 million gallons of wastewater every day from more than 200,000 customers. The 33 acre facility was built in 1929 and currently uses a two-stage trickling filter design. Although the facility has changed over the past 8 decades, its goal is still to produce an environmentally-safe effluent and a solid residual (known as biosolids) that is suitable for beneficial reuse as a soil amenity on farm fields.

Reasons for CHP

Purchased electricity is the second largest operating expense for the wastewater plant. The City of Allentown's reason for installing the CHP plant was and always will be to reduce operating costs by generating electricity from very low-cost "opportunity" fuel. Other reasons for the CHP plant are:

- Better utilization of existing fuel sources.
- Desire to reduce grid dependence for electricity.
- State incentives for energy efficiency upgrades allowed low-interest financing for all initial capital costs.
- Performance contracting could share technical and financial risk.

Quick Facts

LOCATION: Allentown, PA
MARKET SECTOR: Wastewater treatment (Municipality)
FACILITY SIZE: 32,000,000 gallons per day
FACILITY PEAK LOAD: ~ 1.5 megawatts (MW)
EQUIPMENT: 13 microturbines and 3 exhaust heat recovery units
FUEL: Digester gas (Biogas)
USE OF THERMAL ENERGY: 34,117 MMBtu per year for digester temperature control
CHP TOTAL EFFICIENCY: 58 %
ENVIRONMENTAL BENEFITS: Reduction in fossil fuel consumption and both VOC and NOx emissions.
FINANCING: PA Guaranteed Energy Savings Act provided low-interest loans for 100% of the capital costs.
TOTAL PROJECT COST: \$1,107,000
YEARLY ENERGY SAVINGS: \$65-125 K
PAYBACK: <15 years
CHP IN OPERATION SINCE: 2001



A view of the rock media trickling filter (foreground) and various settling tanks (background)



The CHP plant is housed under a 1,000 ft² pavilion

CHP Equipment and Operation

The CHP plant consists of (13) 30 kW Capstone microturbines, (3) exhaust heat recovery units, a fuel pre-treatment skid, auxiliary boilers, water and sludge circulation pumps, and various other heat exchangers. The microturbines run as often as possible to produce electricity. When the anaerobic digesters require heating, thermal energy is recovered from the microturbines and the boilers are cycled as needed.

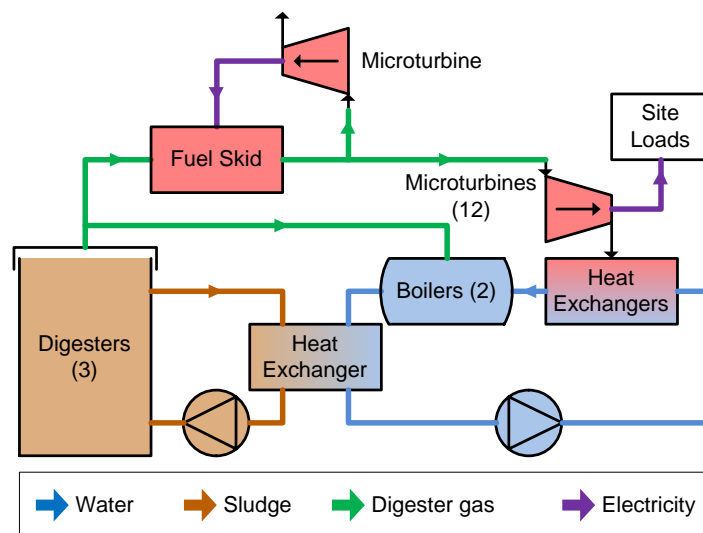
When the CHP is running at full capacity, it has the ability to provide 26% of the wastewater plant's electricity needs. Plant up-time varies year-by-year, but the City of Allentown has experienced 25–51% annual total capacity utilization.

Fuel Systems

Digester gas is a renewable fuel which is produced through the decomposition of wastewater sludge during anaerobic digestion. For the City of Allentown, the wastewater plant produces around 122,000,000 ft³ of digester gas per year. It contains mostly methane and carbon dioxide and has a heat content of around 630 Btu per ft³. The digester gas contains some undesirable compounds for combustion such as water vapor, hydrogen sulfide, and siloxanes. These compounds must be removed and the digester gas must be further treated for effective combustion in the microturbines. This occurs in a collection of equipment called the fuel pre-treatment skid.

Lessons To Share

- Major equipment:
 - The CHP plant's design should emphasize the importance of maintaining high plant up-time.
 - Depending on owner requirements, engines with capacity control are also desirable.
- Fuel systems:
 - Should be addressed early using experienced designers that have worked in a similar locale.
 - Redundancy of treatment systems is critical for continuous operation.
 - Clarify owner requirements for operation under short and long-term fuel supply shortages.
- Contracts:
 - Energy efficiency grants for municipalities can cover all capital costs through low-interest loans.
 - Performance contracting allows owner to share risk if technical experience is limited.



For More Information

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FOR A DETAILED CASE STUDY OF ALLENTOWN'S WASTEWATER TREATMENT PLANT OR MORE PROJECT PROFILES:

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