Draft

Combined Heat and Power

Energy Savings and Energy Reliability for Wastewater Treatment Facilities

Combined heat and power (CHP), also known as cogeneration, can be an excellent solution for controlling energy costs while improving the reliability of power and thermal energy supplies for your wastewater treatment facility (WWTF). With a well-designed CHP system, your facility can:

- Produce power at a cost below retail electricity.
- Reduce operating costs by displacing purchased fuels for thermal needs.
- Ensure the availability of reliable heat and electricity supply.
- Increase energy efficiency, reduce greenhouse gas emissions, and generate renewable power.

How Is CHP Used at WWTFs?

CHP is the production of both power and heat from a single fuel source. CHP is a reliable, cost-effective option for WWTFs that have, or are planning to install, anaerobic digesters. The biogas flow from the digester can be used as "free" fuel to generate electricity and power in a CHP system using a turbine, microturbine, fuel cell, or reciprocating engine. The thermal energy produced by the CHP system is then typically used to meet digester heat loads and for space heating. By making use of the waste heat from onsite electricity production, CHP increases fuel efficiency and decreases energy costs.

Engineering Rules of Thumb for Considering CHP at a WWTF

- A typical WWTF processes 100 gallons per day of wastewater for every person served.
- Approximately 1.0 cubic foot (ft^3) of digester gas can be produced by an anaerobic digester per person per day. This volume of gas can provide approximately 2.2 watts of power generation.
- The heating value of the biogas produced by anaerobic digesters is approximately 600 British thermal units per cubic foot (Btu/ft^3).
- For each 4.5 million gallons per day processed by a WWTF with anaerobic digestion, the generated biogas can produce approximately 100 kilowatts (kW) of electricity and 12.5 million Btu (MMBtu) of thermal energy.

For detailed information on the opportunities for CHP at WWTFs, see the CHP Partnership's report, *The Opportunities for and Benefits of Combined Heat and Power at Wastewater Treatment Facilities*.[1]

[1] Available at *http://www.epa.gov/chp/markets/wastewater.html*.

Where Does CHP Have the Best Technical and Economic Fit?

CHP has the greatest technical and economic potential at WWTFs that have anaerobic digesters and influent flow rates greater than 5 million gallons per day (MGD). Anaerobic digestion continuously produces biogas that contains approximately 60 percent methane. The biogas generated from each 4.5 MGD of influent flow generates approximately 100 kW of electricity and 12.5 MMBtu of thermal energy in a CHP system. The electricity and heat can be used for a variety of purposes:

- To sell back to the grid as green power.
- To operate pumps and blowers used throughout the treatment process.
- To maintain optimal digester temperatures, dry the biosolids, and provide space heating for the WWTF.

A variety of CHP technologies can be used at WWTFs. Reciprocating engines are the most widely used CHP systems and can be employed at facilities with any influent flow rate. Microturbine and fuel cell CHP systems up to approximately 1 megawatt (MW) can be employed at facilities with influent flow rates less than 50 MGD. Combustion turbine CHP systems greater than 1 MW are an option for facilities with influent flow rates greater than 50 MGD.

What Can CHP Do for You?

Reduce Energy Costs

A well-designed CHP system can be an attractive investment for your WWTF. A CHP system allows your facility to generate both electric and thermal energy on site, offsetting the costs of grid power and purchased fuel.

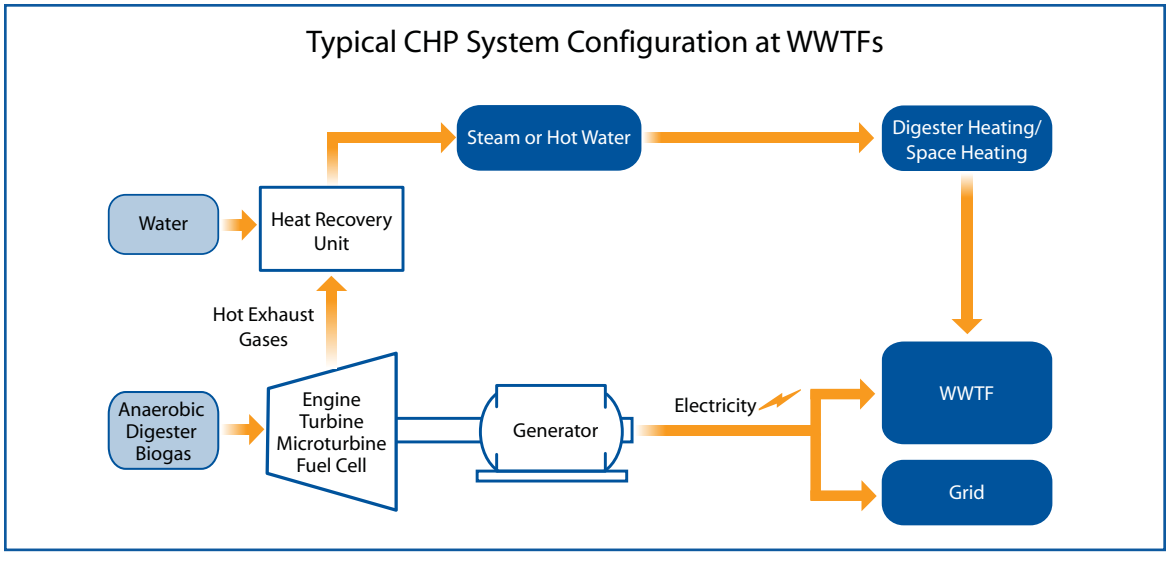
A market analysis developed by EPA's CHP Partnership[2] estimates the net cost to generate power for three representative CHP systems at a WWTF. Depending on the WWTF, costs can range from:

- 3 cents per kilowatt-hour (kWh) to 6.5 cents/kWh for a 126 kW microturbine.
- 9.1 cents/kWh to 10.2 cents/kWh for a 300 kW fuel cell.
- 0.1 cents/kWh to 3.8 cents/kWh for a 1 MW reciprocating engine.

Although the economics of CHP at WWTFs are often attractive, in states where electricity prices are low, burning biogas directly in boilers for onsite heating needs might be more economical.

Ensure the Availability of Heat and Electricity Supply

CHP systems provide critical power and thermal reliability for WWTFs by producing power and heat 24 hours per day, 7 days per week. CHP integrates seamlessly into existing heating and electrical systems and provides a steady supply of hot water or steam. A CHP system can also be configured to provide backup power in the event of a utility outage so operations can continue during a blackout or catastrophic event.



[2] available at *http://www.epa.gov/chp/markets/wastewater.html*

Increase Energy Efficiency, Reduce Greenhouse Gas Emissions, and Generate Renewable Power

With CHP, improved efficiency means that your facility uses less fuel; therefore, operating and maintenance costs are reduced, while environmental performance is improved. The power and heat produced on site by the CHP system displaces purchases of electricity and fuel for boilers. The same reductions in purchased electricity that result in energy cost savings also reduce the environmental impact of WWTF operations by reducing air pollution.

On a national scale, if all WWTFs that operate anaerobic digesters and have influent flow rates greater than 5 MGD were to install CHP, approximately 340 MW of clean electricity could be generated, offsetting 2.3 million metric tons of carbon dioxide (CO_2) emissions annually. These emission reductions are equivalent to removing approximately 430,000 cars from the road.

Additionally, because the biogas produced by WWTFs is considered renewable by most state renewable portfolio standards and third-party green power certification programs, the environmental attributes of electricity generated by CHP systems at WWTFs can be sold as renewable energy certificates (RECs). The monetary value of the REC sale may be used to defray the capital costs of the CHP system to further improve project economics.

How Is CHP Being Used at U.S. WWTFs?

As of September 2007, wastewater treatment CHP systems were in place at 79 sites in 24 states, representing 223 MW of electric capacity. Of the existing CHP systems in the wastewater treatment sector, the majority use reciprocating engines. The mix of technologies used for CHP also includes microturbines, fuel cells, and turbine installations.

The following case studies provide examples of recent successful CHP installations at WWTFs.

City of Albert Lea Wastewater Treatment Facility, Minnesota

In the summer of 2003, the city of Albert Lea, Minnesota, installed a 120 kW CHP system at its WWTF. The CHP system integrates four 30 kW microturbines (manufactured by Capstone Turbine Corporation, a CHP Partnership Partner) and utilizes the recovered heat (28 MMBtu per day) from the turbines to maintain proper operating temperature of the anaerobic digester and provide a portion of the facility's space heating requirements.

With funding from the Minnesota Department of Commerce's Conservation Improvement Program and the local utility, the CHP system provides 120 kW of backup power to operate critical systems during a utility power outage. The CHP system also saves the WWTF 800,000 kWh/year, or 25 percent of its energy use. The system has a payback period of approximately 4 to 6 years.

In addition to representing a successful partnership between municipal, utility, and state entities, the project successfully integrates a CHP system utilizing a renewable fuel, generates energy and cost savings for the municipality, and results in reduced air emissions for local citizens.

Palmdale Water Reclamation Plant, California

In 2004, the Los Angeles County Sanitation District (LACSD) began operating a 250 kW fuel cell CHP system at the Palmdale Water Reclamation Plant. The fuel cell was manufactured by FuelCell Energy, a CHP Partnership Partner. With the CHP system, 70 to 80 percent of the digester gas produced by the facility's anaerobic digesters is utilized in the fuel cell. The system produces 225 kW for use on site, while waste heat from the fuel cell exhaust is used to maintain proper temperature for digester operation.

LACSD chose the use of biogas coupled with CHP to conserve fossil fuel, reduce air emissions, and save money. The CHP system reduces annual CO_2 and nitrogen oxide emissions by 778 tons and 0.58 tons, respectively, and saves LACSD approximately $227,000 per year in energy costs.

What Resources Are Available?

Technical Assistance

The CHP Partnership has developed services and tools to assist those considering implementing CHP at their facilities. Visit the Streamlining Project Development pages of the Partnership's Web site at *www.epa.gov/chp/project-development/index.html* to learn more about the CHP project development process, whom to involve on your CHP project team, typical options for system financing, and other services EPA provides.

Project Resources

Take advantage of the Partnership's up-to-date lists of state and federal incentives (e.g., rebates, tax credits, environmental revenue streams) for CHP, along with lists of regulatory rules and rates that are advantageous to clean distributed generation. This information is updated monthly at *www.epa.gov/chp/funding/index.html*.

Public Recognition

Through the ENERGY STAR CHP Awards, EPA recognizes highly efficient CHP projects that achieve fuel and emission savings over comparable state-of-the-art separate heat and power. The Partnership accepts Award applications continuously and presents these awards at key events. For more information on applying for an ENERGY STAR CHP Award for your WWTF, visit *www.epa.gov/chp/public-recognition/index.html*.

Is My Facility a Good Candidate for CHP?

- Do you have an influent flow rate greater than 5 MGD?
- Do you pay more than $0.06/kWh for electricity?
- Is reliable, high-quality power and thermal energy important to you?
- Is it important to reduce energy costs and increase the overall energy efficiency of your wastewater treatment process?
- Do you want to increase your facility's environmental performance?

If the answer is "yes" to two or more of these questions, CHP can benefit your facility.

CHP technologies are flexible, providing a wide range of sizing options. The right CHP system for your WWTF will be determined through consultations and analyses, which will include a site-specific evaluation of your facility's electricity and thermal loads.

What's the Next Step?

EPA is available to answer your questions and provide specific technical support for your project. For information on how EPA can support your evaluation and implementation of CHP, contact Felicia Ruiz at (202) 343-9129 or *ruiz.felicia@epa.gov*.

About the EPA CHP Partnership

The CHP Partnership is a voluntary program designed to foster cost-effective CHP projects. Through the Partnership, EPA engages energy users, the CHP industry, state and local governments, and other stakeholders in cooperative relationships to expand the use of CHP. Information about the Partnership's services and program offerings is available on its Web site: *www.epa.gov/chp*.

EPA CHP COMBINED HEAT AND POWER PARTNERSHIP

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