Financing CHP Projects at Wastewater Treatment Facilities with Clean Water State Revolving Funds

Combined heat and power (CHP), also known as cogeneration, can be a reliable, cost-effective solution for managing energy costs at wastewater treatment facilities (WWTFs). [1] The wastewater treatment process can be energy-intensive, using pumps, motors, and solid handling and aeration equipment day and night. Energy is also consumed for building ventilation and lighting. Energy costs account for approximately 25 to 35 percent[2,3,4] of total operating costs at conventional WWTFs.[5] By capturing waste heat from electricity generation, CHP systems improve fuel efficiency, and when sized appropriately, they improve power availability and thermal energy supplies and provide energy cost savings.

Depending on the local weather conditions at the WWTF, the specific anaerobic digestion treatment process employed, and other factors, a CHP system might be able to provide all the heat required to operate the anaerobic digestion process. In the event that the CHP system does not provide adequate heat, the shortfall is typically met by backup natural-gas-fired boilers. Should a CHP system provide heat in excess of the anaerobic digestion heating requirements, the additional heat can be used to heat water for treatment processes, and/or can provide space heating or space cooling (via an absorption chiller) for onsite facilities.

Obtaining capital with a suitable return on investment is often the primary challenge to installing a CHP system at a WWTF. Public funds such as EPA's Clean Water State Revolving Fund (CWSRF) program, which provides low-interest loans for publicly owned WWTFs,[6] can help overcome this financing challenge.

This fact sheet:

- Describes the CWSRF, how it works, and how it applies to CHP project development.
- Provides examples of CHP projects that have been funded through the program.
- Presents a case study that highlights how a publicly owned WWTF in Michigan used a CWSRF loan to develop CHP.

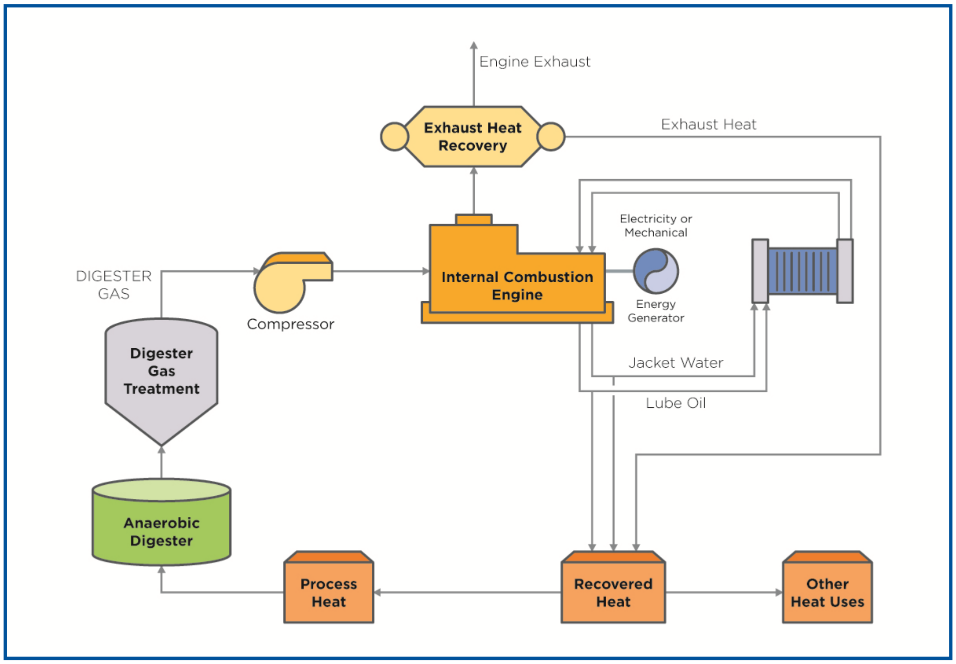
Financial Challenges to CHP Development

A WWTF typically has a backup power or emergency generation system to ensure temporary power availability when there is interruption in the grid power. With on-site energy production using CHP, a WWTF will be able to ensure that power is available at all times—even during grid outages. As is the case with other equipment installed at a facility, initial capital, installation, and permitting costs will be incurred, as well as periodic operating costs. The average initial capital costs for a CHP system are between $700 and $3,000 per kilowatt (kW),[7] depending on the specific CHP technology employed.[8] These costs are recovered through energy savings from the CHP system over the life of the equipment.

The structure of financing will impact project costs, management, and flexibility, as well as affect a WWTF's long-term return on investment. In some cases, WWTFs have been able to pay for CHP projects through their operating budget; however, CHP financing typically comes from local or state bonds, partnerships with local utilities or third-party owner/operators, or state/federal loans and grants.

HOW IS CHP USED AT WWTF?

CHP is the production of both power and heat from a single fuel source. It can be an effective solution at WWTFs that have or are planning to install anaerobic digesters to stabilize sewage sludge. The biogas from the anaerobic digester is used as "free" fuel to generate electricity for the facility using a turbine, microturbine, fuel cell, or reciprocating engine. Excess electricity can be sold to the grid. Exhaust gas (i.e., the "waste heat") is captured in a heat recovery unit where it used for digester heat loads and space heating. A typical internal combustion (IC) CHP system at a WWTF is shown in the figure below. Depending on the facility configuration, CHP can also be used for sewage sludge incineration. When effectively installed, CHP systems can offset a significant portion of a WWTF's electric power demand.



Process Flow Diagram of a Typical IC Engine CHP System at a WWTF

Source: Evaluation of Combined Heat and Power Technologies for Wastewater Treatment Facilities. September 2012.

Internal Combustion Engine CHP System at Bergen County Utility Authority, Little Ferry, New Jersey

Source: Evaluation of Combined Heat and Power Technologies for Wastewater Treatment Facilities. September 2012.

The Clean Water State Revolving Fund (CWSRF)

Authorized under the 1987 Clean Water Act Amendments (Title VI), the CWSRF program funds water quality improvement projects such as the construction of publicly owned WWTFs and the implementation of nonpoint source pollution control and estuary protection projects. The program has assisted a range of borrowers, including municipalities, communities of all sizes, farmers, homeowners, small businesses, and nonprofit organizations. Each state and Puerto Rico operates a CWSRF. As of June 2014, the CWSRF has provided over $100 billion, funding more than 33,000 low-interest loans for wastewater treatment, including CHP, nonpoint **source pollution control, and estuary management** projects.

How the CWSRF Works

Under the CWSRF program, the U.S. Environmental Protection Agency (EPA) provides grants to states to capitalize their own CWSRF programs. States are required to match 20 percent of the federal funding they receive. To meet higher demand for funds, some states increase their available funds in some years by selling bonds. CWSRF monies are then loaned to communities, and loan repayments are recycled back into the program to fund additional water quality protection projects. The revolving nature of these programs provides for an ongoing, long-term funding source.

In addition, each state is required to provide a portion of its grant to subsidize the cost of projects, generally in the form of principle forgiveness on some loans. The percentages for these two requirements change from year to year based on the annual Appropriations Act; the dollar amount varies significantly from state to state.[9]

Each state is responsible for operating its own CWSRF program. States can structure their programs based on their specific environmental needs and use a variety of assistance options, including loans; refinancing, purchasing, or guaranteeing local debt; and purchasing bond insurance. Each state CWSRF program establishes its own interest rate, ranging from 0 percent to just below the market rate. Some states set their rates at 75 percent of the market rate. The loan repayment period is for 30 years or the useful life of the project, whichever comes first. Also, many states offer preferred loan terms to disadvantaged communities and priority projects. The national average for CWSRF interest rates is currently 1.7 percent.

Each state is required to provide a portion of its annual capitalization grant to further subsidize the cost of projects from fiscal years 2010 – 2014. Additional subsidization generally takes the form of grants or principle forgiveness on loans. The authority to provide additional subsidization was made permanent by the 2014 Water Resources Reform and Development Act, which also stipulates that states are no longer required to provide a minimum amount of additional subsidization.

CHP PROJECT DEVELOPMENT RESOURCES

Project Development Handbook

The CHP Project Development Handbook provides information, tools, and insights on project development, CHP technologies, and the resources of the CHP Partnership. Available at: http://www.epa.gov/chp/project-development/index.html.

***d*CHPP (CHP Policies and Incentives Database)**

To assist project developers, policy makers, and others find financial incentives and state/federal policies that support CHP project development, the CHP Partnership maintains *d*CHPP, an online database that allows users to search for CHP policies and incentives by state or at the federal level. Available at: http://www.epa.gov/chp/policies/database.html.

How the CWSRF Is Applied to CHP

Publicly owned WWTFs are eligible to receive CWSRF loans for the planning, design, and construction or improvement of their facilities,

MORE INFORMATION ABOUT THE CLEAN WATER STATE REVOLVING FUND

- EPA's CWSRF Webpage: http://water.epa.gov/grants_funding/cwsrf/cwsrf_index.cfm.
- How the CWSRF Program Works: http://water.epa.gov/grants_funding/cwsrf/basics.cfm.
- Fact Sheets and Other Publications: http://water.epa.gov/grants_funding/cwsrf/factsheets.cfm.
- Green Project Reserve: http://water.epa.gov/grants_funding/cwsrf/Green-Project-Reserve.cfm.
- Regional and State Contacts (provides access to details about each state's CWSRF): http://water.epa.gov/grants_funding/cwsrf/contacts.cfm.

To apply for a CWSRF loan, contact the applicable state CWSRF program. Details about each state's CWSRF program can be accessed at: http://water.epa.gov/grants_funding/cwsrf/contacts.cfm.

including the capital costs associated with installing CHP systems, digester gas pretreatment equipment, other retrofits, process improvements, and upgrades. Projects addressing the energy needs of a WWTF have always been eligible for CWSRF loans.

Created by the American Recovery and Reinvestment Act of 2009 and perpetuated through annual appropriation acts from FY 2010 to 2014, the Green Project Reserve (GPR) requires every state's CWSRF program to use a portion of each year's capitalization grant for green infrastructure, water efficiency, energy efficiency, or other environmentally innovative activities. The GPR has contributed to the number of CHP projects that have been funded at WWTFs.

CWSRF loans have been used to finance the installation of a single CHP system as well as larger facility upgrades, in combination with the construction of new or upgraded anaerobic digesters that include new CHP projects or retrofits. Table 1 lists examples of CHP projects that have been funded by CWSRF loans, and it provides a cross-section of the size and type of these projects. A facility could apply for funding for the CHP system alone or it could be a part of a larger application package. The state makes its own determination of the number of projects that can be funded in a year. Most project funding is a combination of public and private funding, but projects can be fully funded through the CWSRF. The state determines whether the CHP project is fully or partially funded by the CWSRF, based on the applicant's need.

The loan application process is straightforward and can be completed with guidance from the state environmental agency. Typically, an

Table 1: CHP Examples at Wastewater Treatment Facilities Installed Through CWSRF Funding

Facility Name	Location	Year of CWSRF Funding	CHP System Size	CHP Prime Mover	Year CHP Became Operational
Beaver Dam Municipal Water Treatment Plant	Beaver Dam, WI	2009	788 kW	Reciprocating engine	2011
City of Covington Wastewater Treatment Plant	Covington, VA	2009	43 kW	Stirling engine	2010
Delhi Charter Township Wastewater Treatment Plant	Delhi Charter Township, MI	2007	60 kW	Microturbine	2009
Hampton Roads Sanitation District Atlantic Treatment Plant	Hampton Roads, VA	2012	1.6 MW	Reciprocating engine	2013
Johnstown-Gloversville Joint Wastewater Treatment Facility	Johnsonville, NY	2010	400 kW	Reciprocating engine	2010
Lewiston Auburn Water Pollution Control Authority Wastewater Treatment Plant	Lewiston, ME	2011	460 kW	Reciprocating engine	2013
Medina Wastewater Treatment Plant	Medina, NY	2010	60 kW	Reciprocating engine	2012
Metropolitan Wastewater Treatment Plant	St. Paul, MN	2011	830 kW	Boiler-Steam turbine	2012
Pittsfield Wastewater Treatment Facility	Pittsfield, MA	2010	200 kW	Microturbine	2012
R.M. Clayton Wastewater Treatment Plant	Atlanta, GA	2011	1.6 MW	Reciprocating engine	2012
West Lafayette Wastewater Treatment Facility	West Lafayette, IN	2006	130 kW	Microturbine	2009
Wolf Creek Water Reclamation Facility	Abingdon, VA	2009	60 kW	Microturbine	2010

applicant works with the state CWSRF contact to develop the application. The application processing time depends on the nature of the CHP funding request, on its own or as part of a larger request that includes other improvements.

CWSRF in Action: Delhi Charter Wastewater Treatment Plant

Delhi Charter Township is located south of the city of Lansing, the state capital, in Ingham County, Michigan. The Township's wastewater treatment plant was built in 1962, with upgrades made in 1982 and 2007.[10] Prior to the 2007 upgrade, the plant capacity was estimated to be severely overloaded due to population growth in the Township during the previous decade. The Township started exploring alternatives in 2005 and decided to upgrade to an integrated biomass-to-energy (IBES) system. This was the first IBES system in Michigan, and its design secured local, regional, and national awards. The upgrade was achieved using a CWSRF loan combined with state funding and cash the Township had on hand. The new system, completed in 2009, consists of new replacement digesters, a 60 kilowatt (kW) microturbine CHP system to produce electricity and heat for the plant, gas mixers and sludge recirculation pumps, process piping, a building to house the sludge pumps, and other components. The project also replaced a leaking junction chamber on the nitrification pipeline, rehabilitated additional digesters located onsite, and installed a sludge grinder.

The CHP System. The plant serves a population of 25,000 and is designed to treat a wastewater flow of 2.5 million gallons per day (MGD), with a design flow of 4.0 MGD. The project uses a two-phase (i.e., thermophilic-mesophilic) anaerobic digestion process that yields "Class A" biosolids suitable for direct land application. The Township estimates that the reduction in the plant's demand for natural gas and electricity attributable to the CHP system yields an estimated annual cost savings of $60,000.

Prior to the digester upgrade and CHP system installation, the plant flared the biogas produced in its digesters. The IBES system allows the plant to capture and use the biogas produced in its

Aerial view of the Delhi Charter Township IBES System

anaerobic digesters to fire two 30 kW micro-turbines. These are designed to operate with a turndown of up to 50 percent, which allows the two turbines to operate in the range of 25 to 100 percent of the combined operable capacity and produce 15 to 60 kWh of electricity on demand. The electricity generated is used to operate pumps, compressors, and other equipment related to the operation of the two-phase anaerobic digestion system. Electricity generated by the microturbines reduces the amount of electricity the facility must purchase from the utility by more than 40 percent.

The majority of the energy generated from the CHP system is in the form of heat. Approximately 43 percent of the available heat from the CHP system is recovered and used by the facility to heat the digesters in lieu of natural gas. The temperature of the microturbine exhaust gas exiting the system is around 500^{o} F, and the exhaust is captured using a tube-in-shell gas-to-liquid heat exchanger. The heat is used to heat the thermophilic and mesophilic digester anaerobic digester tanks, thus significantly reducing the amount of natural gas needed to heat the digester tanks.

CWSRF Funding and Application Process. In September 2007, Delhi Township received a $9.85 million CWSRF low-interest loan to finance the entire IBES system. A small component of this loan covered the equipment and installation costs of the CHP system.[11] The Michigan

Department of Environmental Quality (DEQ) provided the loan, in conjunction with the Michigan Municipal Bond Authority (Department of Treasury). The CWSRF loan has an interest rate of 1.625 percent with a 20-year term. The Township also received approximately $500,000 through a Michigan state grant and used approximately $840,000 in cash it had on hand to cover the remaining cost of the project.

The plant manager was initially concerned that it would be too much effort to apply for the CWSRF loan and that the money might come with too many strings. However, he quickly became a proponent of the funding program when he discovered that the CWSRF interest rate of 1.625 percent was significantly lower than the market interest rate available to the plant, which was in the 4 to 5 percent range. The lower interest rate made the project much more economical and was critical to its success. In addition, the facility used part of the Michigan state grant it received to pay for development of the 20-year capital improvement plan required by the state's CWSRF program.

Delhi Township reports that the loan application process was straightforward, with helpful guidance provided by the Michigan Department of Environmental Quality (DEQ). For example, DEQ clearly described the steps of the application process and made staff available to help answer the Township's questions. It took approximately 18 months to receive the CWSRF funding from the time Delhi Township started the application process.

Lessons Learned. As part of the CWSRF loan application process in Michigan, facilities must submit a 20-year capital improvement plan that outlines how the loan money will be expended. Delhi Township's original CWSRF plan included only the upgrade of the plant's digesters. When the plant decided to develop its CHP system, it had to submit an amendment to its 20-year plan, and this required additional effort. The plant notes that it is difficult to anticipate everything that might be needed over a 20-year horizon but points out that plants should plan as best as possible from the outset and be prepared that plan amendments may be necessary. Delhi Township believes that developing the plan was well worth the effort, given the successful results, including helping them to be better plant operators.

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1 The CHP Partnership's report *Opportunities for Combined Heat and Power at Wastewater Treatment Facilities: Market Analysis and Lessons from the Field* (available at: http://www.epa.gov/chp/documents/wwtf_opportunities.pdf) provides information about the current state of CHP use at WWTFs, the technical and economic potential for further development of CHP at WWTFs, and operational insights from WWTF operators.

2 California Energy Commission. July 2009. *Combined Heat and Power Potential at California's Wastewater Treatment Plants.* CEC-200-2009-014-SD (Draft Staff Paper). http://www.energy.ca.gov/2009publications/CEC-200-2009-014/CEC-200-2009-014-SD.PDF.

3 Wastewater Management Fact Sheet on Energy Conservation. July 2006. http://water.epa.gov/scitech/wastetech/upload/2008_01_16_mtb_energycon_fasht_final.pdf].

4 Evaluation of Combined Heat and Power Technologies for Wastewater Treatment Facilities. September 2012. http://www.cwwga.org/documentlibrary/300_CHP%20-%20EPA%20(final)%20w-Apps.pdf.

5 In comparison to WWTF systems that employ natural systems such as ponds, land treatment, wetland treatment systems.

6 As defined by 40 CFR 403.3(o), POTWs treat municipal sewage or industrial wastes of a liquid nature. While WWTFs can be owned or operated privately or publicly, POTWs are according to the Federal definition treatment works that are owned by a State or municipality.

7 American Council of Energy Efficient Economy. September 2011. Challenges Facing Combined Heat and Power Today: A State-by-State Assessment. http://www.aceee.org/sites/default/files/publications/researchreports/ie111.pdf.

8 EPA Catalog of CHP Technologies. http://www.epa.gov/chp/technologies.html.

9 A recent amendment to the CWSRF program, based on the 2014 Water Resources Reform and Development Act (WRRDA), provides further subsidization to WWTFs in disadvantaged communities, communities with fewer financing options, and/or to projects that meet the GPR.

10 http://www.degremont-technologies.com/IMG/pdf/tech_infilco_Biogas-Cogeneration.pdf.

11 Microturbine-based CHP systems have an installed cost of $2,500/kW-$4,300/kW according to the EPA's CHP Catalog of Technologies (available at: http://www.epa.gov/chp/technologies.html).