COGENERATION IMPLEMENTATION GUIDE

for Wastewater Treatment Plants

By Wessler Engineering

INTRODUCTION

It takes a lot of energy and money to treat wastewater.

The electrical cost of wastewater treatment often accounts for more that 25 percent of the total costs associated with operating wastewater treatment plants (WWTP). With rising costs of electricity inevitable in the Midwest, there's a growing interest and need for investing in sustainable energy sources in these facilities.

One such source is dual electrical and thermal energy production known as cogeneration. This method has been used for many years in Europe, and on the East and West Coasts of the United States.

Currently, only three municipal facilities in Indiana have cogeneration systems in operation or under construction: West Lafayette, Fort Wayne, and Evansville.

Perhaps your facility is interested in a cogeneration project to save costs and invest in sustainable energy. We hope this document provides you with information to begin advocating for, exploring, and implementing a successful cogeneration system.

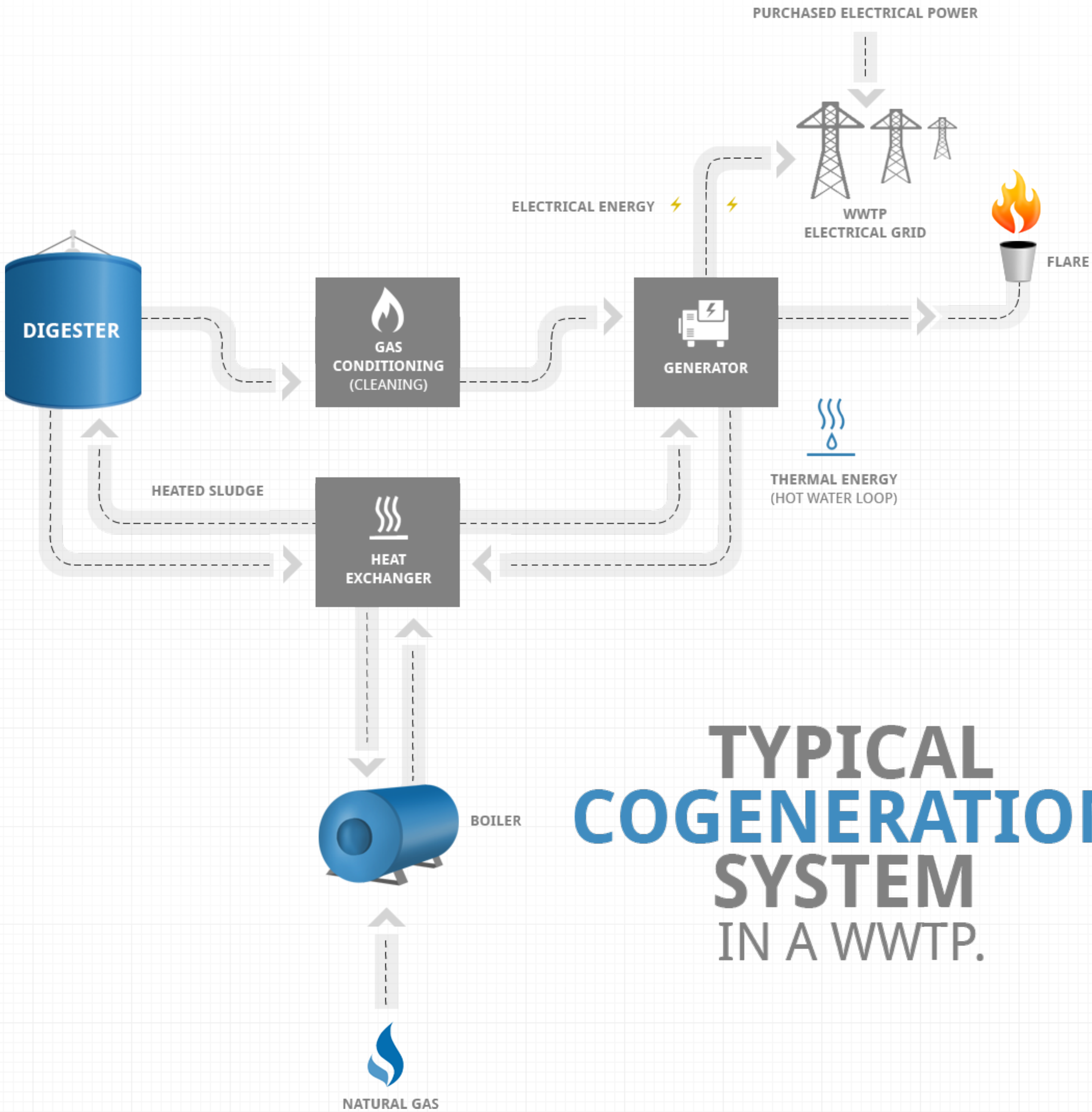
What Is Cogeneration

Let's break down the definition of cogeneration.

Cogen (as it is commonly referred to) is:

- the use of a single fuel source, in this case digester gas
- to produce both electrical and thermal energy
- using a single generator, such as an internal combustion engine or micro-turbine.

By definition, a cogeneration system is more efficient than a utility operated central power plant. This is because thermal energy that would otherwise be wasted is captured for use at the facility. The resulting decrease in the need for purchased electrical power and natural gas can generate substantial savings for the WWTP.



TYPICAL COGENERATION SYSTEM IN A WWTP.

The electricity produced by the digester gas-driven generators is most commonly fed to the WWTP's electrical grid. It can then be used where demanded and displace the power brought in from the local electric utility grid.

The waste heat from the generators is captured in a hot water loop which is routed through heat exchangers. This heat is transferred to recirculating sludge in the digesters. Normally, natural gas would be used to fuel boilers to heat the water for the heat exchangers. The captured heat from the generators can also be used to provide heat to buildings at the facility.

A critically important part of the cogeneration process is conditioning the digester gas prior to feeding the generators. Conditioning, or cleaning, the digester gas prevents premature wear or damage of the equipment. This includes removal of moisture, siloxanes (found in beauty products, soaps, and shampoos), and hydrogen sulfide (H2S). The moisture is condensated out of the gas using temperature differentials, and the gas is then passed through a series of media vessels for removal of siloxanes and H2S.

PROS & CONS

There are many benefits to a well-designed cogeneration system fueled by digester gas.

Pros

- Displaces purchased electrical power.
- Displaces purchased fuels (natural gas) for thermal needs.
- May qualify as a renewable fuel source under state renewable portfolio standards and utility green power programs.

- Enhances power reliability for the plant.
- Produces more useful energy than if the WWTP were to use biogas solely to meet digester heat loads.
- Reduces emissions of greenhouse gases and other air pollutants primarily by displacing utility grid power.

As with any complex system, there are also costs and drawbacks to consider.

Cons

- High capital costs.
- Depending on current utility costs, payback periods may be long (this should be determined in Discovery and Analysis phases discussed later).
- Potentially more labor intensive if your facility implements a FOG program. (However, if you are already accepting fats and oils, you are probably wasting gas by flaring it out into the atmosphere when you could be harnessing that extra energy).

STEPS TO IMPLEMENTING A COGENERATION PROJECT

Most municipalities considering a cogen project will partner with an engineering firm at the very beginning of the process. These are the basic steps to implementing a cogen system at a WWTP:

Champion.

Who is involved in the project? This should be a collaborative effort between local government, the utility operators, technology manufacturers, and engineers. It is beneficial to have a champion of the project to help drive it forward. This might be the mayor of a community who has pledged to do more in the way of sustainable energy projects. Or it could be the utility operator who sees their rising electric bills and has heard about cogen as a way to save money.

Discovery.

A few key points must be considered to determine if cogeneration is a potentially good fit for your WWTP:

- Does your facility use anaerobic digestion?
- What are your community's current electric rates, and are they expected to increase?
- Is there reliable historical data available on digester performance and gas production?
- Are there improvements that could be done to the digestion operation to increase gas production such as improved mixing, temperature control, or automation of operations?
- Does your facility have a Fats, Oils, & Grease (FOG) receiving or food receiving operation? If not, does the opportunity exist to create one to help increase gas production?

Analysis.

We look at equipment, costs of engines, gas conditioning, and all of the data compiled during the discovery phase. Then we determine the return on investment (ROI). Cogeneration projects come with high capital costs. We determine how much you will be saving in energy costs and if capital costs will be offset by energy savings, and how long that time period will take. For example, if the analysis determines that in less than seven years the costs of the project will be offset by energy savings, the project is worth pursuing. Each technology is evaluated during this phase to determine the best course of action, and we generate a life cycle analysis report.

Decision.

At this point, the team must make a decision. Does this make economical sense? The life cycle analysis will provide insights about whether or not the project is worth the investment.

Defining the Scope.

Many parts are moving during this stage. Early on in the project, the team will coordinate with the local electric utility. Each utility has their own standards or requirements for how to handle the electricity that your plant will be producing (through cogen). In most municipal cogen projects, the electric utility does not want the electricity you're producing to leak into their grid. Agreements must be negotiated and signed that ensure the appropriate measures are in place to protect the utility. You may also need to start procuring funding at this stage. Governmental agencies like the EPA and state government may provide funding for projects like this. Once you define the scope and coordinate with all parties involved, it's time to move to design.

Design.

Your engineering firm will provide in-depth design by coordinating with technology manufacturers, contractors, operators, and anyone else involved in the project. Cogen projects often lend themselves well to design/build contracts because of the long lead time for equipment. They also lend themselves well to Guaranteed Savings Projects. The engineer and contractor can work together while the equipment is being built to determine how to best implement the cogen system into the existing WWTP.

Construction & Implementation.

This phase is like any other municipal contract and design/build project.

Testing.

Once the project has been implemented, it's important to track electrical usage and generation. This allows you to point back to the life cycle analysis phase to see if ROI lines up with what the analysis predicted. Are we doing as well or better than we thought we would? Are we doing worse, and if so, how can we tweak it to make it better?

CONCLUSION

How can your city or town benefit from cogeneration technology in your wastewater treatment facility? Let's use an example close to home.

Wessler Engineering helped the City of West Lafayette utilize SRF financing to establish a Fats, Oils, and Grease (FOG) receiving facility and a Cogeneration Facility at its wastewater treatment plant. The City saved over $100,000 in 2011 by cogenerating electricity and reducing natural gas consumption. Up to 25% of the plant's power needs are supplied by methane-generated electricity via the use of micro-turbine generation. Direct FOG injection also generates tipping fees, providing the City with a new revenue source.

The City has earned the U.S. EPA's Performance and Innovation in the SRF Creating Environmental Success (PISCES) award. In addition, the city was recognized as a "Green Power Partner" by the EPA in 2009 for reducing the carbon footprint by generating green power on-site.

For more information, contact:

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Interested in learning more about cogeneration?

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Wessler Engineering is a civil and environmental engineering firm, specializing in wastewater, drinking water, and stormwater projects, providing services ranging from master planning and design to construction administration and process energy audits. Founded in 1975 and based in Indianapolis, Indiana, we have branch offices in Evansville, West Lafayette, and Fort Wayne.