



Beneficial Use of Biogas

Part A: Review of Uses and Issues

July 18, 2016

Webinar Overview

- ▶ Project Goals and Objectives
- ▶ Biogas Beneficial Use Benefits and Goals
- ▶ Options
 - Onsite Thermal Uses
 - CHP
 - Renewable Gas
 - Offsite User
- ▶ Project Implementation Co



Benefits of Beneficial Use of Biogas

- ▶ Reduce Flaring
- ▶ Maximize the Energy Potential of Biogas Source
- ▶ Demonstrate Long-term Economic Benefit
- ▶ Affordable Project Delivery



Typical Goals

- ▶ Assuming Digester in Place and Biogas Being Produced
- ▶ Goals Could Include
 - Maximize Energy Potential of the Biosolids
 - Reduce Energy Consumption
 - Reduce Trucking of Wastes
 - Limit Greenhouse Gas Emissions
 - Increase sustainability
 - Enhance environmental stewardship

Biogas Beneficial Use Options

- ▶ Purify Biogas to Higher Quality
 - Sell to Gas Utility/Pipeline
 - Vehicle fuel
- ▶ Combust Biogas to Produce Energy/Heat
 - Boiler for digester/space heat
 - CHP for power and heat
- ▶ Sell to nearby, larger energy user
 - Schools
 - Manufacturing sites

Beneficial Use Considerations

- ▶ Economic Analysis
 - Construction/Operational Costs
 - Energy Off-set/Savings (CHP)
 - Gas Sales (Purification Option)
 - Net Present Worth Analysis or Return on Investment (Payback)
- ▶ Other Considerations
 - Operation and Maintenance
 - Control of Assets and Contractual Arrangements


Barriers to Beneficial Use

- ▶ Inadequate payback/economics – can't justify the investment for beneficial use of biogas.
- ▶ Lack of available capital – there are more pressing needs.
- ▶ Operations and maintenance complications and concerns – concern over a lack of expertise on staff or on call to operate a new system.
- ▶ Issues with utilities/public – “we could not work with our power and gas utilities or the public to implement beneficial use project.”
- ▶ Lack of community and utility leadership or interest in green energy – the environmental benefit provides inadequate justification for the project.
- ▶ Difficulties with air regulations or obtaining air permit – air and greenhouse gas (GHG) regulations make it too difficult to get a CHP air permit or CHP will require a Title V permit.
- ▶ Plant too small – “our facility and/or biogas production is too small to justify a project.”

(Source: NYSERDA/WERF 2012)



Volume Considerations

- ▶ How much is being produced by anaerobic digestion process?
 - ▶ Are there anticipated future increase in production?
 - ▶ How much is currently consumed for process heating at boilers?
 - ▶ How much is flared?
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Site Considerations

- ▶ Proximity to critical infrastructure
 - Pipeline for gas sales
 - Electric distribution/transmission for electricity export
 - Weak system may prioritize CHP
 - Strong system may support power export
 - Nearby energy users that could purchase biogas
 - Condition of on-site boilers

CHP Considerations with Biogas

- ▶ There are unique issues in the WWT sector that result in biogas-based CHP systems being operated less efficiently than in other sectors, and sometimes less efficiently than grid-provided electricity.
- ▶ **WWTPs can't use all of the heat.** Most sectors size their CHP system to meet the thermal load. WWTPs often size CHP based on the volume of biogas or their electrical needs, which is typically larger than sizing on thermal load. Their plants use some of the CHP heat but have seasonal thermal loads, leading to excess thermal output that is not needed. Plants in cold climates can make relatively greater use of the heat.
- ▶ **Biogas needs to be “conditioned” or cleaned for CHP use,** which creates an energy penalty of about 7–10% of electricity generated.
- ▶ **The input fuel is free,** which removes some incentive from installing the most efficient CHP system

Quality Considerations

- ▶ Inherent biogas characteristics from municipal WWTPs:
 - Corrosivity (H_2S)
 - Water content
 - Low energy content
 - Siloxanes compounds and other impurities

Comparison of Gas Quality

(Source: Philadelphia Water Department)

Constituent	Raw Biogas Samples		Pipeline Gas Requirements
	Plant 1	Plant 2	
Methane	58%	61%	97% min
CO2	40%	39%	1% max
Nitrogen	1.5%	0.35%	2% max
Water	NA	Saturated	7 lbs/MMcf max
H2S	200 ppmv	Up to 14 ppmv	4ppmv

Note: Raw biogas leaving the digester can have hydrogen sulfide concentrations of 3,000 ppm or higher, the values above appear to be after partial water removal

Digester Gas Pretreatment

- ▶ **Boiler (less stringent requirements)**
 - May be able to use raw biogas and increase boiler maintenance
 - Otherwise remove contaminants, may including water vapor, sulfur and siloxanes
- ▶ **CHP (more stringent requirements)**
 - Moisture removal: coalescing filter/chiller to condense water
 - Siloxanes removal: carbon-based medias are common
 - H₂S Removal: iron oxide-based media is typical
- ▶ **Pipeline/Vehicle Fuel (most stringent treatment)**
 - Remove moisture, sulfur and siloxanes
 - Scrub CO₂ to reach natural gas quality

Example CHP Cost/Benefit Analysis

(Source: Philadelphia Water Department)

- ▶ 20 Year Life Cycle Cost Analysis
- ▶ \$28.5 M Capital Cost
- ▶ \$24M Net Present Value
- ▶ 11% Return Rate
- ▶ \$4.3M offset in electricity costs annually
 - Including O&M costs (5% of capital)
 - Does not include additional incentives
 - Based on \$0.07/kWh

Evaluate Options

- ▶ Economics: cost vs benefits
- ▶ Weigh regulatory and public influence
- ▶ Look short term and long term



ITHACA AREA WWTF BIOGAS UTILIZATION

BACKGROUND

- ▶ Codigestion facility with cogeneration system since 1987
- ▶ During last four years upgrades to digester mixing, biogas cleaning, biogas storage and new cogeneration equipment have been implemented
- ▶ New Trucked Residuals Receiving Center Constructed
- ▶ Plant receives a wide variety of codigestion substrates to supplement in plant residuals.





COGENERATION UPGRADE

Completed upgrade from reciprocating engines to microturbines in 2013

260 Kilowatts of installed capacity

Average 120,000 kilowatt hours per month

Replaced Reciprocating Engines with over 100,000 hours of operation



Biogas Conditioning Skid

Due to the presence of siloxanes
All municipally derived biogas requires a
Cleaning process.

Siloxanes can foul combustion surfaces
and shorten the useful life of generation
Equipment.

Unison skid dehumidifies, compresses and
Scrubs gas using carbon

Gas samples are taken to determine
Carbon change out.

CHALLENGES

- ▶ Cogeneration was not new to Ithaca. Switching from reciprocating engine to microturbines has been successful
- ▶ Biogas cleaning is new and so far has operated reliably. Sacrificial load due to electric motors on skid cost a significant amount of electricity. Equivalent to half of one cogen.
- ▶ Luckily our gas is a high quality biogas with >65% methane

