THE EFFECTIVENESS OF BIOGAS UTILIZATION AND OTHER HEAT RECOVERY PROCESSES AT WASTEWATER TREATMENT PLANTS

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The Effectiveness of Biogas Consumption at Wastewater Treatment Plants

What is Biogas?

•*bi·o·gas/*'bīō,gas/Noun: Gaseous fuel, esp. methane, produced by the fermentation of organic matter.



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Biogas is generated through anaerobic process in which organic material is consumed by anaerobic microorganisms and generate methane and carbon dioxide and can be used as fuel.

- 60 % Methane
- 40% Carbon Monoxide
- Plus trace amounts of other compounds

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Two main sources of biogas generation:

- Landfills
- Anaerobic digestion of sewage sludge at sewage treatment plants
- Others may include food processing waste like whey digestion

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Landfills

- Gas can be recovered based on size of landfill
- Gas is limited especially after landfill is closed
- About 25 30 years useful life
- Landfill gases have been combusted for heat and power at the facility

Anaerobic Digestion – Purpose

- Reduce sludge generated at sewage treatment plant
- Biogas as a byproduct
- Unlike landfills biogas generated is the gift that keeps on giving!

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Anaerobic Digestion



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- Originally the only safe way to dispose the biogas generated was to flare it off.
- Flared gas provides unnecessary increase in air pollution (i.e. VOC, NOx, CO, SO2, etc.)
- Flared gas provides unnecessary increase in greenhouse gases (i.e. CO2 and unburned methane)

WASTED ENERGY!!!











Biogas can provide an energy source at no cost!

- However optimal consumption of biogas is extremely important.
- Throughout the years facilities have experimented in use of biogas.
- Biogas usage is still a work in progress.

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Biogas Use: A Historical Perspective

In the beginning, biogas generated from anaerobic digesters needed to flared then it was discovered another use...



The Effectiveness of Biogas Consumption at Wastewater Treatment Plants Burning biogas in small boilers for localized heat seemed very ideal. However, the lower energy content caused a problem Natural Gas - 1020 BTU per cubic foot Biogas ~ 600 BTU per cubic foot

Combining both gases increases BTU content providing more stable use of the boilers

- For every gallon of sludge processed in the digester about 2 cubic feet of biogas is generated or 1200 BTU of energy.
- For a 1.2 MMBTU per hour boiler will burn 2,000 cubic feet of biogas per hour generated from 1,000 gallons of sludge digested.
- 24,000 gallons of sludge digested per day for that boiler.

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- Based on 0.005 gallons sludge generated from 1 gallon wastewater , the boiler will need 200,000 gallons of wastewater processed per hour or which translates to a 2.4 MGD plant.
- Boilers may be one aspect but there is a better use.





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- The engines were breaking down with constant need of repair!
- NOx and CO concentrations were exceeding permitted concentrations!
- PSE&G was taking notice and were about withdraw the Standard Offer...looks like biogas use for engines was

DOA

The Effectiveness of Biogas Consumption at Wastewater Treatment Plants What was the problem?????



- What is this white substance that is fouling up the engines?
- Gas impurities generated from the sludge
- A trace substance is causing this.

What is it?

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- Siloxanes which are contained in hair care products end up in the sludge
- During anaerobic digestion they evaporate and enter the biogas
- Because siloxanes contain silicon the product of combustion is $\ensuremath{\mathsf{SiO2}}$ or sand
- The sand generated caused the pistons to foul and stop working and caused the increased NOx and CO concentrations
- Solution???

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Solution!

- The BCUA installed a carbon absorption system to remove siloxanes and other impurities in the biogas.
- Once installed and put to use, the operated better and no longer had problems.
- NOx and CO concentrations were in compliance with the permit.
- In conclusion the BCUA was able to continue to operate with the Standard Agreement with PSE&G.....SUCCESS!!!!

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With the BCUA's success to burn biogas in an engine, other facilities in the state wanted to take biogas combustion to the next level.

COMBINED HEAT AND POWER

- The objective is to use biogas generated in the plant and burn it in the engine to generate electricity for the plant as well as heat recovered for the plant as well.
- It will save costs for the facility by using biogas instead of purchased natural gas and electricity.

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- In 2002, the first New Jersey facility to installed a CHP plant to utilize biogas was the Rahway Valley Sewerage Authority.
- There were major problems...



The Effectiveness of Biogas Consumption at Wastewater Treatment Plants The CHP facility has been deemed inoperable and costs to retrofit are very high This resulted in lawsuits not to mention local taxpayers pay more What was supposed to be a cost saving measure turned out to be a money pit Lesson learned....plan ahead and determine the most feasible facility Know what your plant generates in biogas and design a CHP facility accordingly.

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The failure at RVSA did not stop other New Jersey

Wastewater Treatment Plants from installing CHP plants The next was Ocean County Utilities Authority who installed two small scale CHP units at their North and Central Plants.

Both facilities are 32 MGD which are mid size facilities

With smaller scale and potential for expansion, the CHP plants installed without problems and became a major success.

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In 2003 Joint Meeting of Essex and Union Counties proposed to install a CHP facility at their wastewater treatment plant in Elizabeth.

The facility is a 75 MGD plant.

The design originally was to install six Caterpillar engines (reduced to four).

Reviewed and installed gas pretreatment for siloxanes. Revised Title V air permit to accommodate this.

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It took several years due to change of deals and revised plans but CHP plant finally commenced operation in 2009.

Cost savings have been immediate and beneficial.

The Effectiveness of Biogas Consumption at Wastewater Treatment Plants South Monmouth Regional Sewerage Authority has a 9 MGD plant that has anaerobic digestion Originally installed a 30 kW microturbine for CHP processing of biogas After several years of studies, SMRSA installed 2 - 140 kW Caterpillar Engines - Commenced operation in 2010. Based on information the facility saved about \$240,000 in

2011.

Which brings us back to ...

Bergen County Utilities Authority

- With the success of the blower engine operation, the BCUA decided to construct a CHP plant for their 109 MGD facility in Little Ferry, NJ.
- With the lessons learned from the blower engine operation, the BCUA was able to design a plant with appropriate pretreatment, air permitting considerations and operational details.
- Two 1.4 MW GE Jenbacher engines were installed which specialized in low BTU combustion...this resulted in...

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The CHP plant at the BCUA commenced operation in 2008

Plant was able to save over \$6 million to date in what would have cost for natural gas and electricity

The BCUA facility was deemed a great success and won awards from AEA, NJDEP and BPU for the plant operations

But there is always room to improve....

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Other facilities throughout the state want to install new equipment for CHP facilities. There is a problem however....



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- State Budget cuts that are funding municipalities combined with a recent recession and lower tax revenue due to higher unemployment results in lack of funding!
- Facilities need money for capital investment but cannot raise rates to do this.

What money is there available?

- There are loans and grants provided from the federal and state government
- NJBPU has the Renewable Energy Incentive Program for Biopower
- Facilities can apply for a rebate on certain projects that will result in the proper utilization of renewable energy sources including biogas utilization
- Must complete an application which includes the design of the proposed biopower application.

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Enhancements of biogas production

- Greater generation of biogas
- Fats, Oils and Grease (FOG) application in anaerobic digestion
- Food waste application in sludge (i.e. whey)
- If facilities charge tipping fees and generators can save money on travel costs
- With facilities that have CHP plants, increased generation may result in the plant expansion (i.e. additional engines)

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Biogas Storage

- Many facilities still need to burn off biogas in flares even with a CHP facility due to overabundance
- Biogas storage tanks allow the gas to be stored and used at a later date
- This results in pollution and cost savings

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Other Energy Recovery Issues for Sludge Treatment

- Sludge Incineration Many facilities in New Jersey that incinerate sludge do have heat recovery.
- None have CHP capabilities but can be considered.
- Some facilities need to evaluate costs and feasibility installing anaerobic digestion and CHP vs. CHP installation from sludge incineration.
- Sludge composting heat is generation but can it be captured?

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Environmental Benefits

- Overall lowering of ozone generating pollutants (i.e. VOC and NOx)
- Overall lowering of greenhouse gases (i.e. CO2 and methane)
- Please note that the reductions are not just for the plant but for power plants that would have generated the electricity used from the CHP facility.

Lessons Learned

- Due to trial and error and experimentation biogas production and consumption is now commonplace.
- Combined Heat and Power at Wastewater Treatment Plants with Anaerobic Digestion of Sludge provides cost, energy and pollution savings
- Promote...promote If you have such a facility SHOW IT OFF! Provide tours and present this at conferences.

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