Evaluating Biogas to Energy Options
Northwest Regional Water Reclamation Facility
Fox Lake, IL

NWRWRF

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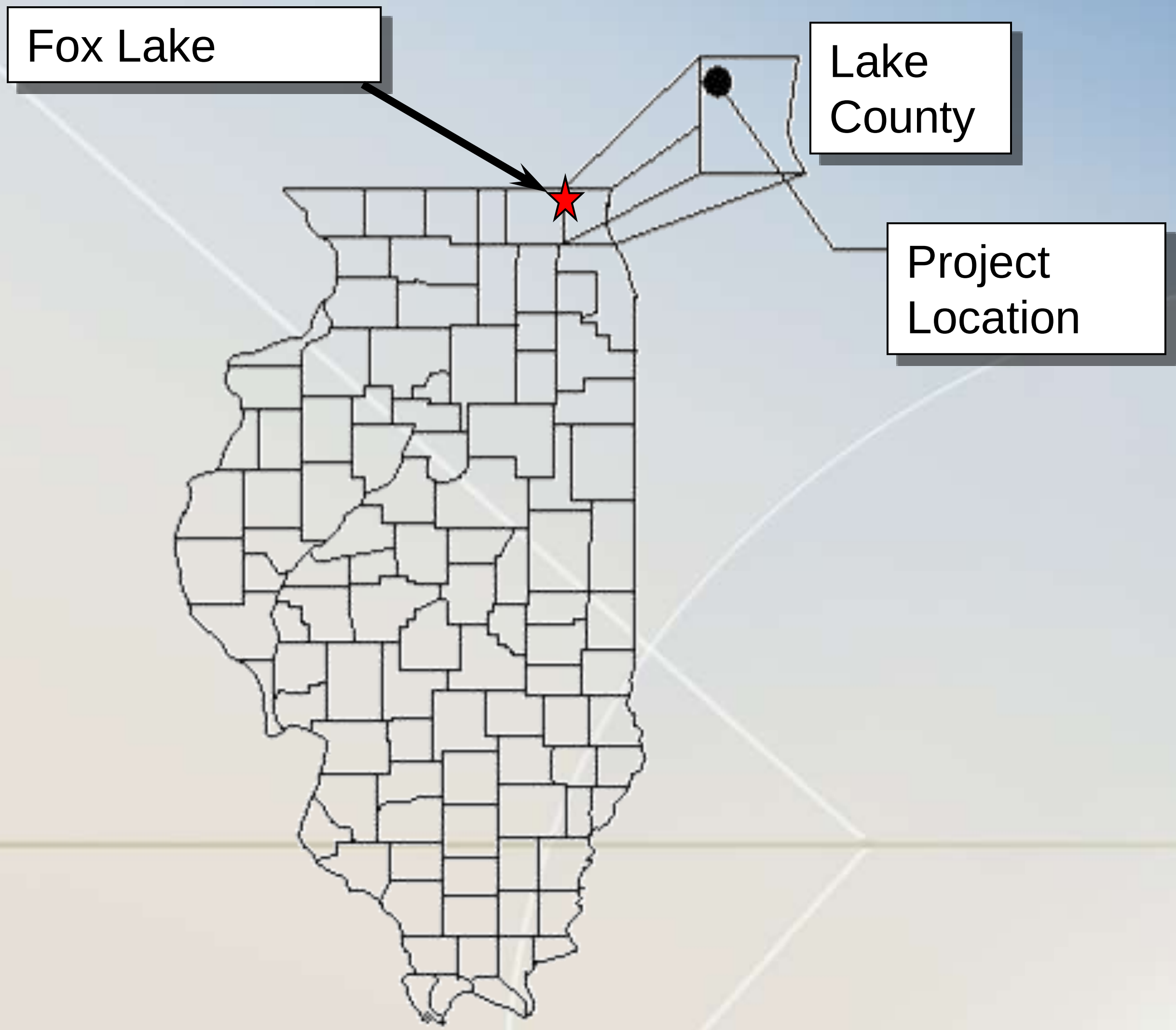
ENGINEERS

Village of Fox Lake



Village of Fox Lake

Northwest Regional Water Reclamation Facility

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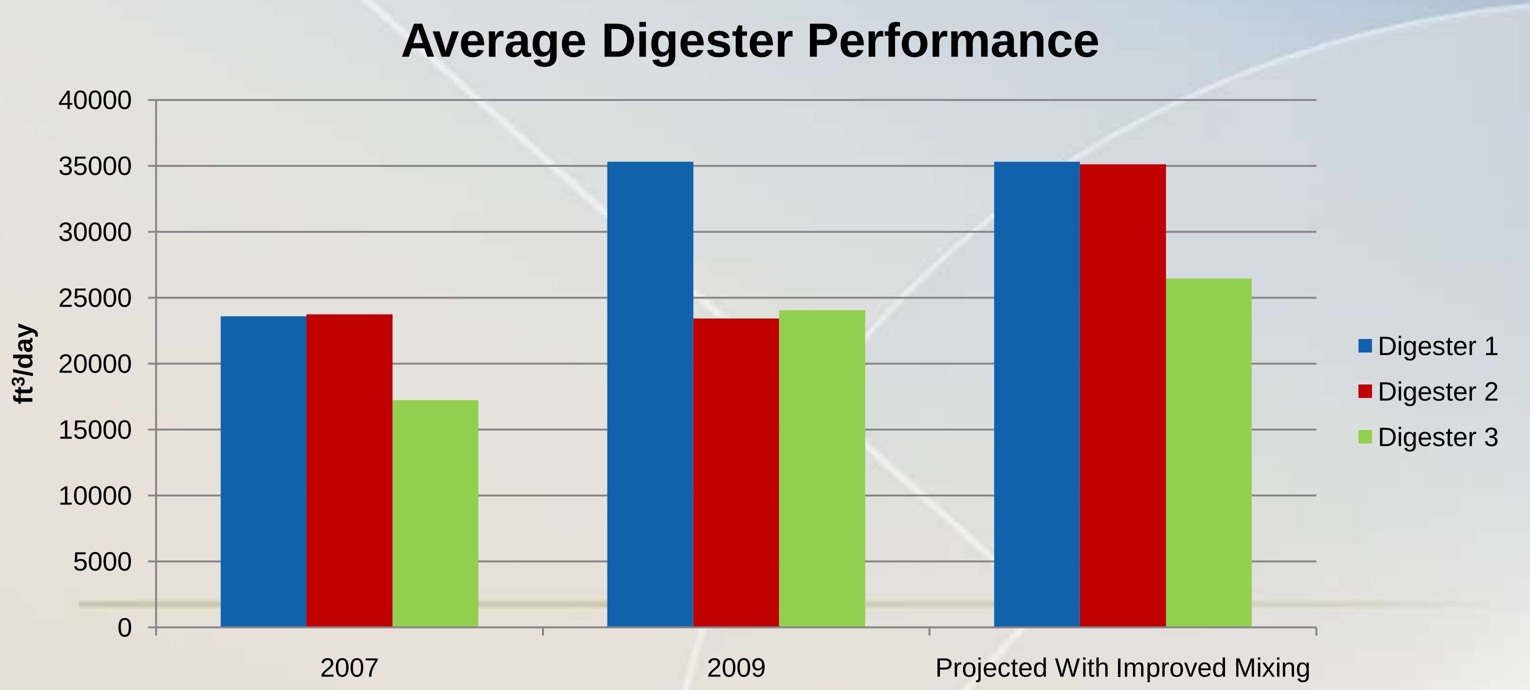
ENGINEERS

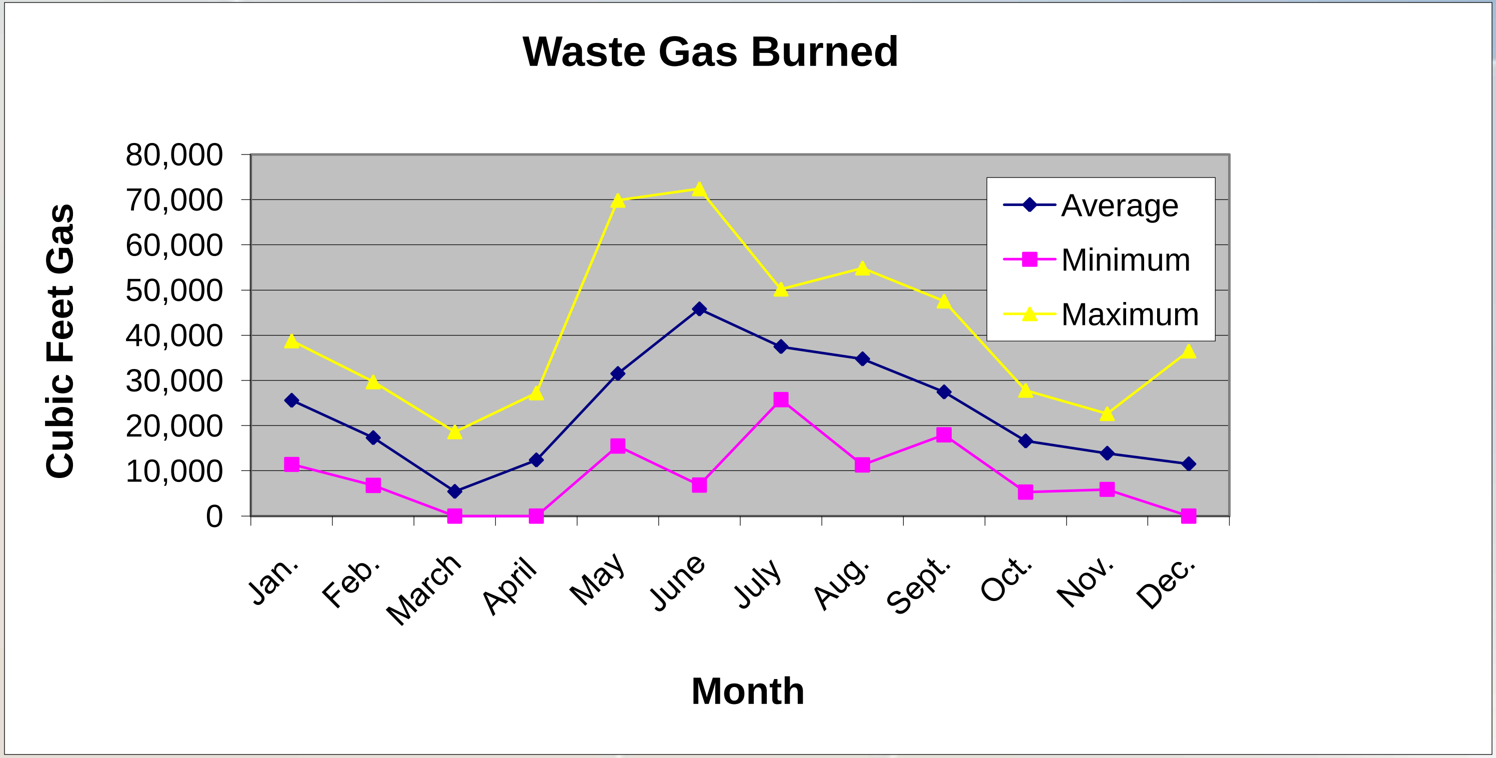
Step #1 – Evaluate gas volume produced

- How much is produced? (cfm and cfd)
- How much is used? (cfm and cfd)
  - How much extra gas do you have?



Step #1 – Evaluate Gas production

- How much gas is used?
- How much gas is wasted?



Goal: Put the wasted gas to use!

Step #2 – Determine the gas quality (sampling)

- BTU / CF (methane concentration)
- Siloxane concentrations
- H_2S levels
- VOC levels

Major Component Table

Major Component –

Sample ID:	Conc. Unit	K0113b01
	Description:	Bio Gas, Fox Lake, IL, WWTP, 1/11/10
Methane	%	59.7
Carbon dioxide	%	39.4
Nitrogen	%	0.75
Oxygen	%	0.183
GHV, dry (14.73 psi) *	Btu/scf	606
Relative density *		0.941

* Calculation based on major components listed.

Note: All major component concentrations were reported as a moisture and C_2 plus free basis and were normalized to 100%. Oxygen and Argon cannot be separated; therefore, the oxygen result includes a small amount of Argon. Some results may be reported with additional significance for reference.

Compound Speciation - Siloxanes

Compound Speciation – Siloxanes

Organic Silicon (siloxanes)	K0113b01	
	Bio Gas, Fox Lake, IL, WWTP, 1/11/10	
	ppmv as Si	ppmv
Tetramethyl silane	<0.05	<0.05
Trimethyl silanol	<0.05	<0.05
Hexamethyldisiloxane (L2)	0.82	0.41
Hexamethylcyclotrisiloxane (D3)	0.28	0.094
Octamethyltrisiloxane (L3)	<0.05	<0.02
Octamethylcyclotetrasiloxane (D4)	0.59	0.147
Decamethyltetrasiloxane (L4)	<0.05	<0.01
Decamethylcyclopentasiloxane (D5)	11.41	2.28
Dodecamethylpentasiloxane (L5)	<0.05	<0.01
Dodecamethylcyclohexasiloxane (D6)	1.21	0.202
Others. as L2	0.24	0.12
Total:	14.55	
Total (Si, mg /M^3):	17.25	

Note: Others may include traces (BDL) of 10 target compounds. Some results may be reported with additional significance for reference. Tedlar bag often contributes a background level of <0.2 ppmv siloxanes due probably to the use of silicone-based lubricant on the valve stem.

Compound Speciation – Sulfer Components

Compound Speciation – Sulfur Components

Sulfur Compounds, ppmv as S	K0113b01
	Bio Gas, Fox Lake, IL, WWTP, 1/11/10
Hydrogen sulfide	62.6
Carbonyl sulfide	0.31
Methyl mercaptan	<0.05
Ethyl mercaptan	0.04
Dimethyl sulfide	<0.05
Carbon disulfide *	<0.05
i-Propyl mercaptan	0.08
t-Butyl mercaptan	0.06
n-Propyl mercaptan	0.07
Ethylmethyl sulfide	<0.05
Thiophene	<0.05
Diethyl sulfide	<0.05
Dimethyl disulfide *	<0.05
Ethyl methyl disulfide *	<0.05
Diethyl disulfide *	<0.05
Others (as S)	0.19
Total S: (ppmv)	63.4
(mg/M3)	85.8

Note: Some results were reported with additional significance for reference. The normal detection limit of each sulfur compound is 0.05-0.1 ppmv.

* 1.0 ppmv as sulfur = 0.50 ppmv sulfur compound

Gas Conditioning

Will biogas conditioning be required?

YES – If you want the equipment to last more than 1 year!

- Siloxane removal
  - < 5 ppb for microturbine
  - < 50 ppb for ICE generators
- H_2S removal
  - < 5 ppm for microturbine
  - < 500 ppm for ICE generators
- Moisture removal

Step #3 – Options for biogas use

- Dual-feed boilers
  - Digester heating
  - Building heat
- Engine generators
- Microturbines
- Others (air conditioning, vehicle fueling, synthetic natural gas production, etc.)

Microturbines vs. Engine Generators

	Advantages	Disadvantages
Microturbines	• Cost effective • Low install costs • Pre-packaged systems	• May require service assistance • Requires a very clean gas • Newer technology that is rapidly updating
Engine Generators	• Familiar technology – has been used for at least 50 years • Requires low pressure gas feed (typically less than 1 psi) • Tolerates dirtier gas - higher H_2S and siloxane levels • Lots of options for size • Less parasitic costs	• Requires a larger footprint • More expensive to install • Slightly higher operating costs • Slightly less fuel efficient

Recommendation – Engine generator

Step #4 – Determine Costs

- Capital costs
  - Equipment
  - Installation
- Annual O&M costs
- Other parasitic costs
  - Power for gas compression, conditioning, etc.
- Value of the power and heat produced

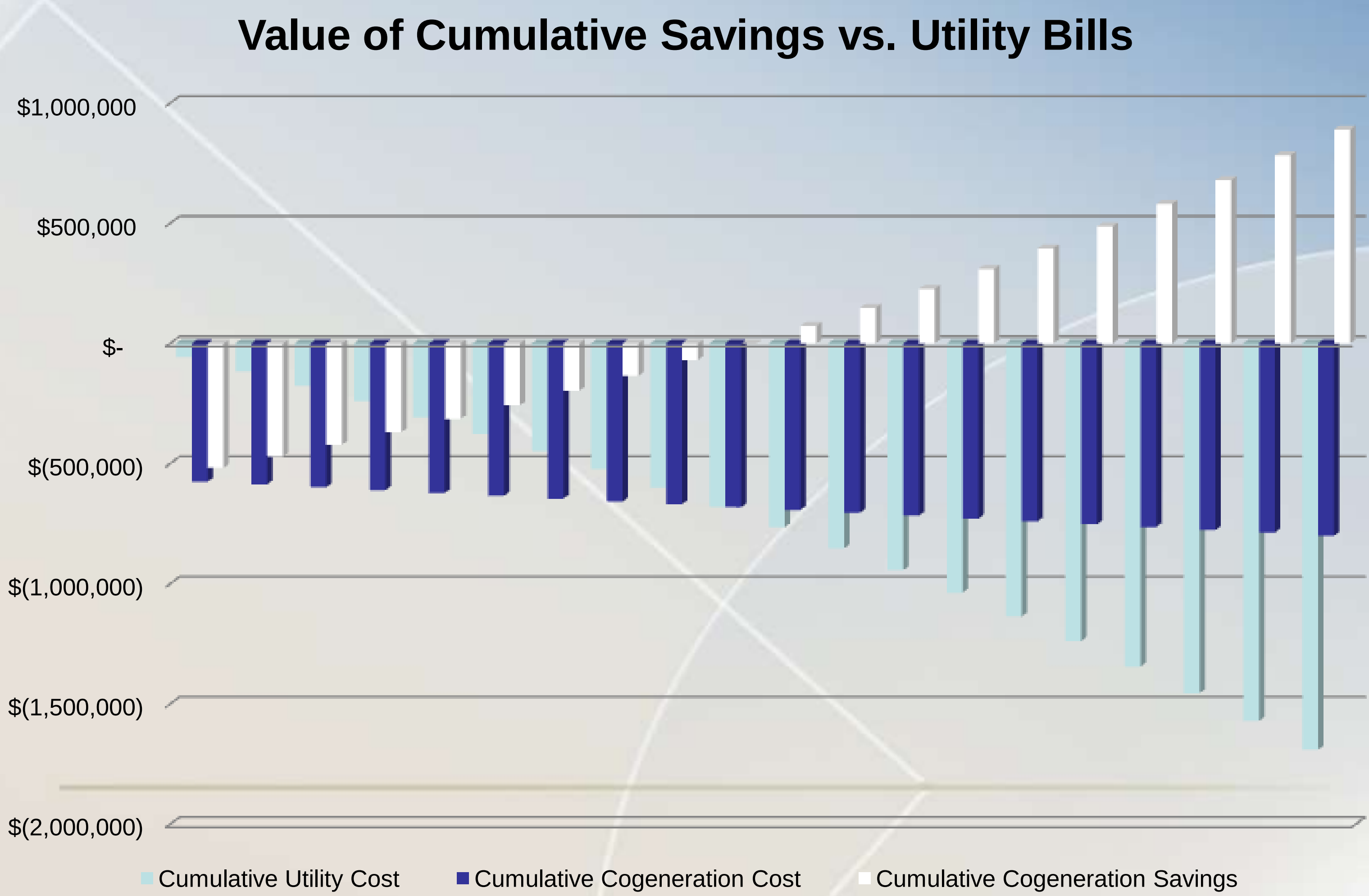
All of these make up the Life Cycle Cost.

Life Cycle Cost Analysis

	Tech-3 Solutions	Martin Machinery	Kraft Power
Planning Period, years	20		20
Discount Rate, %	5.0		5.0
Electricity Cost per KW-Hr	$0.070		$0.070
Heat Recovery Value (per Therm)	$0.65		$0.65
Labor Cost per Hour	$50.00		$50.00
Capital Equipment Cost[1]	$247,555		$173,495
Installation Cost[2]	$100,000		$100,000
Rated Electrical Production (KW)	150		100
No. of Units on Duty	1		1
Annual Hours of Operation, each	6,570		6,570
Annual KW	985,500		657,000
Annual Electric Production Value	$68,985	No Proposal Received	$45,990
Heat Recovery (BTU/Hr)	777,943		499,582
No. of Units on Duty	1		1
Annual Hours of Operation, each	6,570		6,570
Annual Heat Recovery (BTU)	5,111,085,510		3,282,253,740
Annual Heat Recovery (Therms)	51,111		32,823
Annual Heat Recovery Value	$33,222		$21,335
Annual Maintenance Materials Cost	$6,500		$17,600
Annual Maintenance Hours	35		0 [3]
Annual Maintenance Labor Costs	$1,750		0 [3]
Total Capital Cost	$347,555		$273,495
Annual Electric Value	$68,985		$45,990
Annual Heat Recovery Value	$33,222		$21,335
Annual Maintenance Costs	$8,250		$17,600
Total Present Value	**$450,368**		**$492,830**

Notes:
1. Capital equipment costs from Proposals received 7/21/10
2. Installation costs based on an exterior installation on a concrete foundation.
3. Kraft Power included all maintenance costs in a proposal to service the equipment at $2.68 / run hour.

Step #5 – Payback Analysis



10 year payback on the investment!

Questions……?