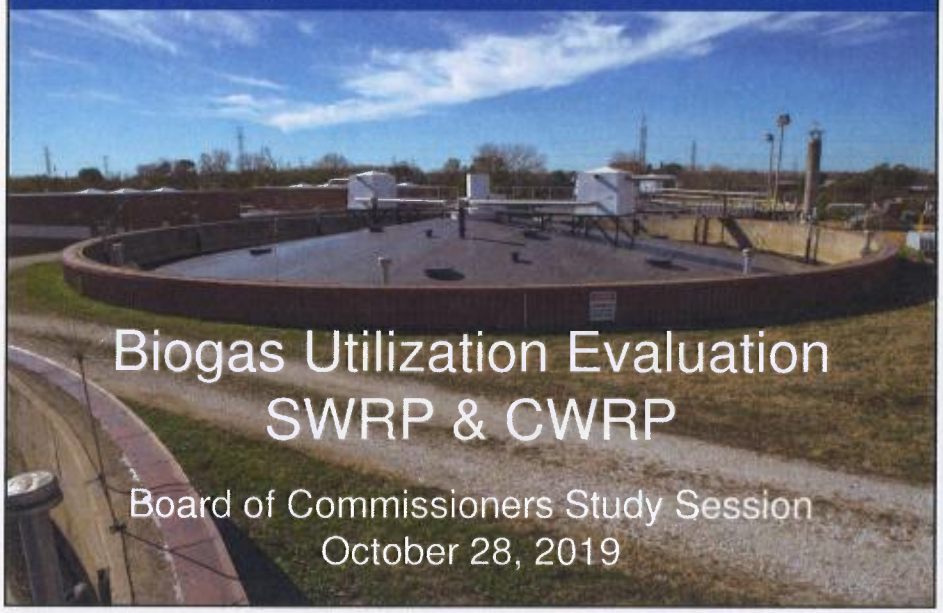
Metropolitan Water Reclamation District of Greater Chicago



Biogas Utilization Evaluation SWRP & CWRP

Board of Commissioners Study Session
October 28, 2019

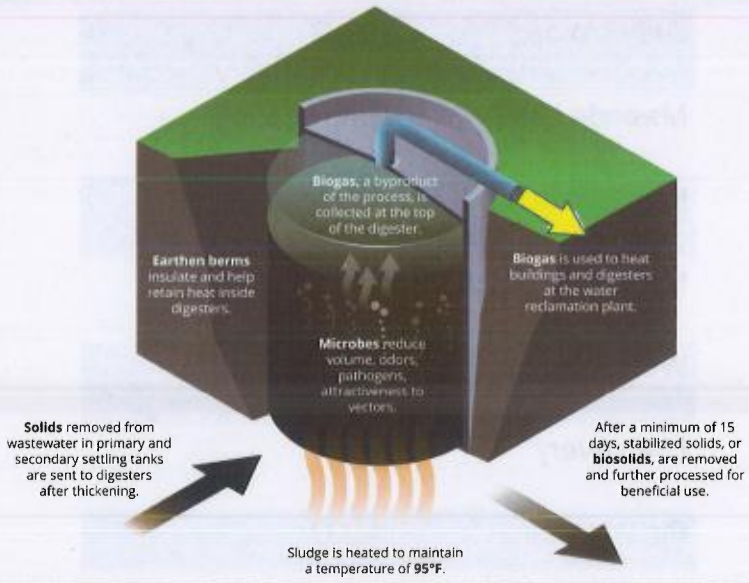
Biogas Utilization Evaluation Team

Judy Moran	M&R
Mwende Lefler	Engineering
Matt Schiltz	Engineering
Michael Goldrich	M&R
Wendy Sin	Treasury
Ellen Avery	Law
Pinakin Desai	M&O

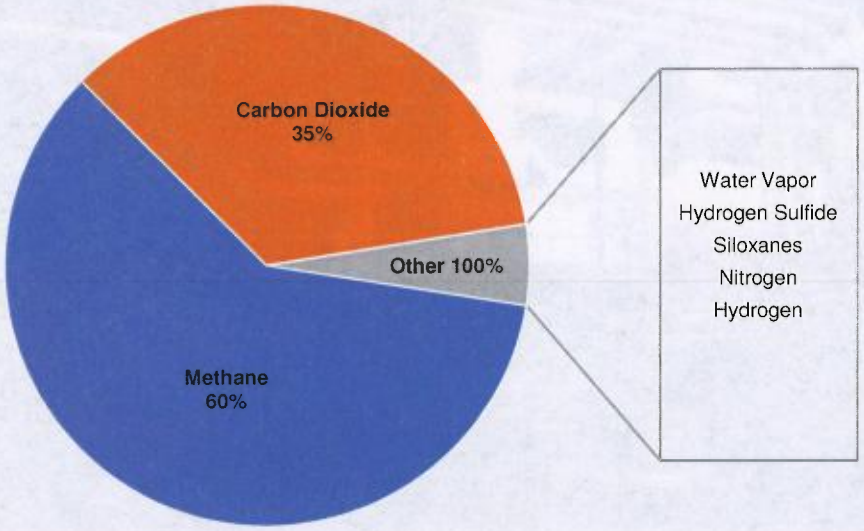
Evaluation Criteria

- Energy security
- Environmental benefits
- Economics
- Risk

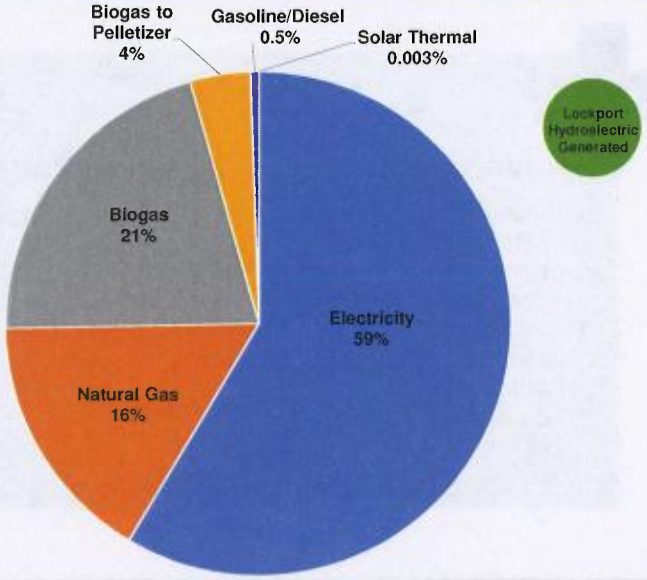
Biogas Production



Biogas Characteristics



Energy Use at District



Current Utilization - Boilers

Used for heating digesters and heating/cooling buildings.

Current Utilization - Boilers

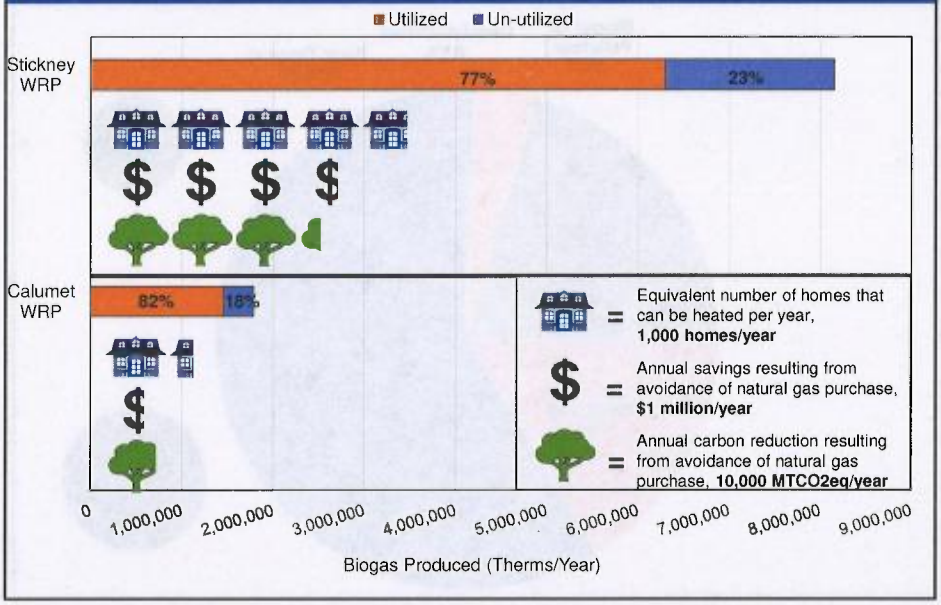
Advantages

- Readily adaptable to existing equipment
- No additional personnel
- Relatively low capital and O&M costs
- Low level of biogas treatment required
- Offsets need for natural gas

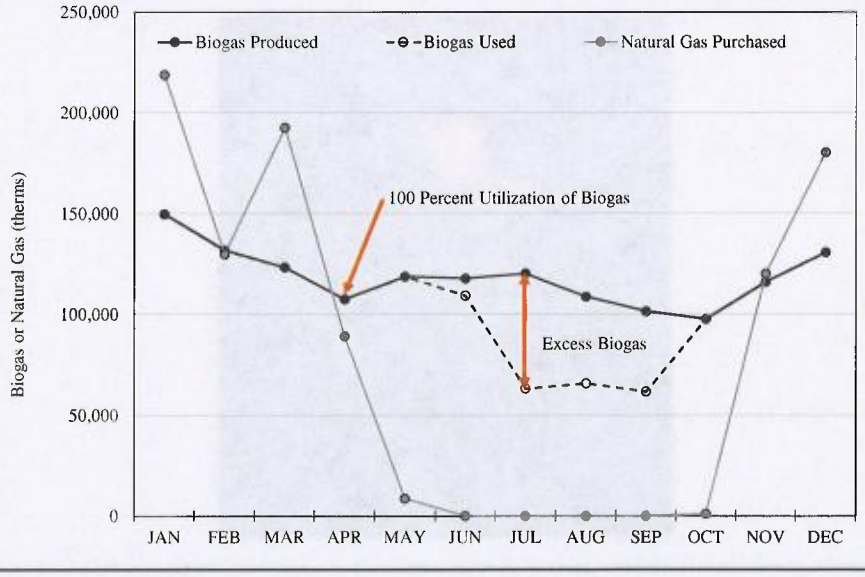
Disadvantages

- Excess biogas goes unused when there is no demand for heat (i.e. in warmer months)

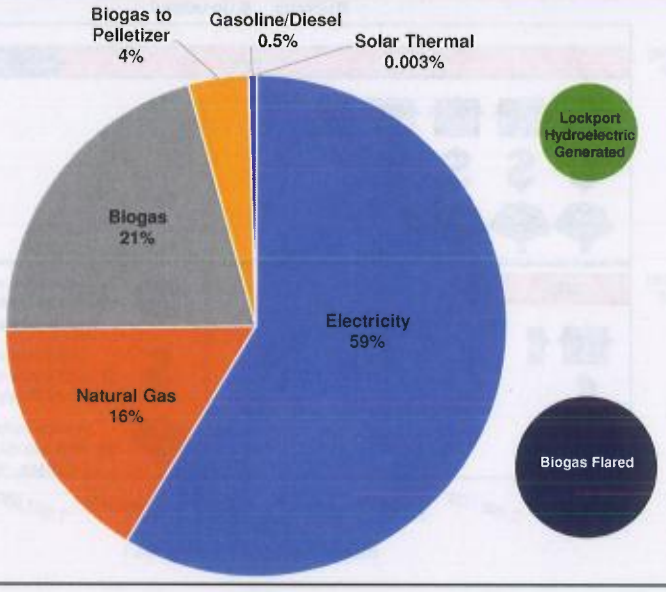
Current Utilization - Boilers



Seasonal Variation of Utilization



Energy Use at District



Flaring

Utilization Options

- Steam
- Combined Heat and Power (CHP)
  - Engines
  - Gas Turbines
  - Steam Turbines
- Renewable Natural Gas (RNG) to Pipeline
- Renewable Compressed Natural Gas (CNG) to Vehicle Fueling Stations

Other Utilization Options Combined Heat and Power (CHP)

Engines

Gas Turbines

Steam Turbines

Electricity

Hot Water

Other Utilization Options Combined Heat and Power (CHP)

Advantages

- Generates electricity and heat
- Well established
- High reliability
- Produces electricity year-round

Disadvantages

- Medium level of biogas cleaning
- Recovered heat may go unused
- Significant infrastructure to connect heat recovery to plant
- Major maintenance requires shipping offsite
- Periodic overhauls required
- Electrical standby charges may be significant
- Additional operations and maintenance personnel required

Renewable Natural Gas to Pipeline

Biogas treatment process

Other Utilization Options
Renewable Natural Gas to Pipeline

Advantages

- Potential for high revenue from sale of gas and environmental attributes (RIN)
- Provides greenhouse gas reduction benefits by offsetting gasoline and diesel fuel

Disadvantages

- Requires significant amount of gas cleaning
- High electricity demand for cleaning and compressing
- Profitability subject to market fluctuations and regulatory discretion
- Significant infrastructure required, including supply pipeline
- Natural gas must be purchased to make up for the biogas no longer available
- Need natural gas pipeline nearby

Renewable Fuel Standards

USEPA Renewable Fuel Standards Program (2005)

- Establishes minimum volumes of renewable fuels that must be used for transportation fuel
- Volumes set by USEPA each year through Renewable Volume Obligations (RVO) for transportation fuel suppliers
- RVO compliance is measured by a unit called a Renewable Identification Number (RIN). 11.727 RINS = 1 mmBTU
- Transportation fuel refiners can meet the RVO by purchasing credits (or RINS) for renewable fuels

Renewable Fuel Standards

Four categories of renewable fuel:

- Conventional Biofuels
- Cellulosic Biofuels (D3)
- Biomass-based Diesel
- Advanced Biofuels (D5)

Cellulosic Biofuels (D3) and Advanced Biofuels (D5) are applicable to biogas.

USEPA sets RVO for each category each year.

Biogas used as vehicle fuel (either as RNG or CNG) counts towards earning RIN.

19

Historic RIN Values (D3 Cellulosic)

Compressed Natural Gas Fueling Station

Biogas → Cleaned to CNG quality → Compression → Transported to fueling station → District gets revenue

On-site compression

Tube truck transportation

CNG fueling station

Other Utilization Options
Compressed Natural Gas Fueling Station

Advantages

- Potential for high revenue from sale of gas and environmental attributes (RIN)
- Requires less cleaning than RNG to pipeline (but more than CHP)
- Provides greenhouse gas reduction benefits by offsetting gasoline and diesel fuel

Disadvantages

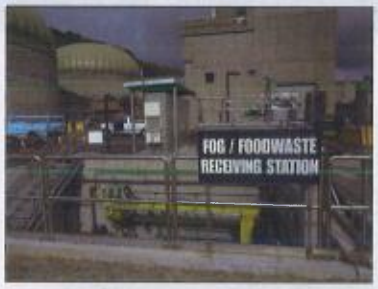
- Additional electricity demand for compressing gas
- Profitability subject to market fluctuations and regulatory discretion
- Conversion of gasoline/diesel engines to CNG
- Must have committed offtake
- Significant infrastructure

Increasing Biogas Production: Co-digestion with High Strength Organic Material (HSOM)

High Strength Organic Material (HSOM)

Fats, Oils, and Greases (FOG)

High Strength Waste Receiving Station



Central Marin Sanitation Agency

Digester Upset

SUBURBS

Stench plaguing residents ends after Glenbard plant stops using outside food waste

By ALICIA FABBRE CHICAGO TRIBUNE |SEP 28, 2017 |

Co-digestion of High Strength Organic Material (HSOM)

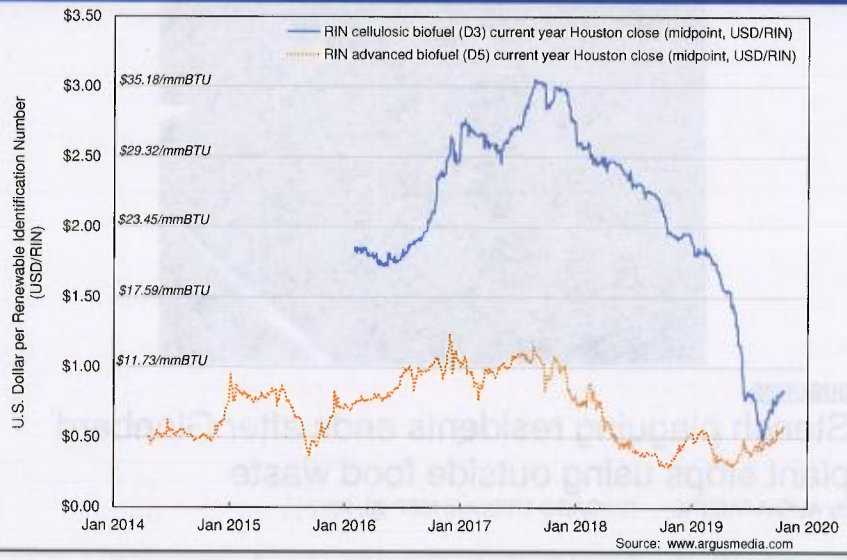
Advantages

- Increases the amount of biogas produced
- Potential revenue from tipping fees

Disadvantages

- Robust infrastructure required for receiving, screening, processing, and storing HSOM
- Digester upgrades required
- D5 RIN applies (lesser value than D3)
- Additional personnel for operations, monitoring, maintenance, program administration
- Increases biosolids volume which increases costs for handling
- Can lead to digester upset (foaming) and odors

Addition of High Strength Organic Material (HSOM)



Third Party Approach to Financing

- Third party finances, owns, designs, builds, operates, and maintains entire project
- For electricity generation via CHP:
  - Power Purchase Agreement (PPA)
  - Third party sells electricity to District under long-term contract for a pre-determined price.
- For RNG or CNG production:
  - Offtake Agreement
  - Third party buys biogas from District under a long-term contract based a formula that references a market index for RIN and natural gas

Third Party Approach

Advantages

- No District capital—frees up capital for other needs
- Revenue (if selling biogas)
- Stable electricity prices (if buying electricity)
- No O&M required of District
- Equipment removed at end of contract

Disadvantages

- Lower financial benefit compared to District financing and owning
- Terms of agreement must be thoroughly negotiated to protect District
- Ownership of infrastructure boundaries
- Private enterprise operating on public land

Evaluation Criteria

- **Energy security**
- **Environmental benefits**
- **Economics**
- **Risk**

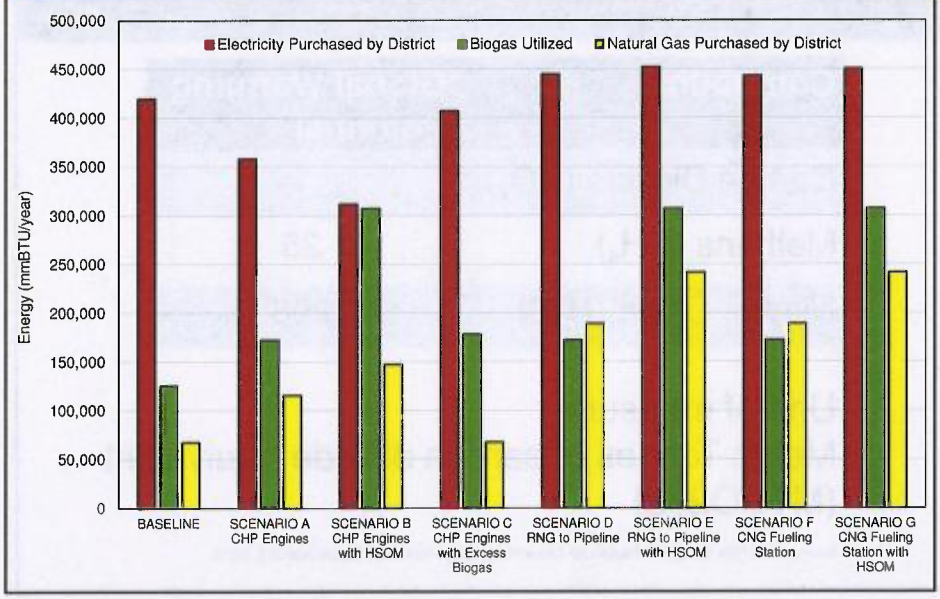
Evaluation Scenarios: Calumet WRP

Scenario	Utilization
A	CHP Engines
B	CHP Engines with HSOM
C	CHP Engines, Excess Biogas Only
D	RNG to Pipeline
E	RNG to Pipeline with HSOM
F	CNG Fueling Station
G	CNG Fueling Station with HSOM

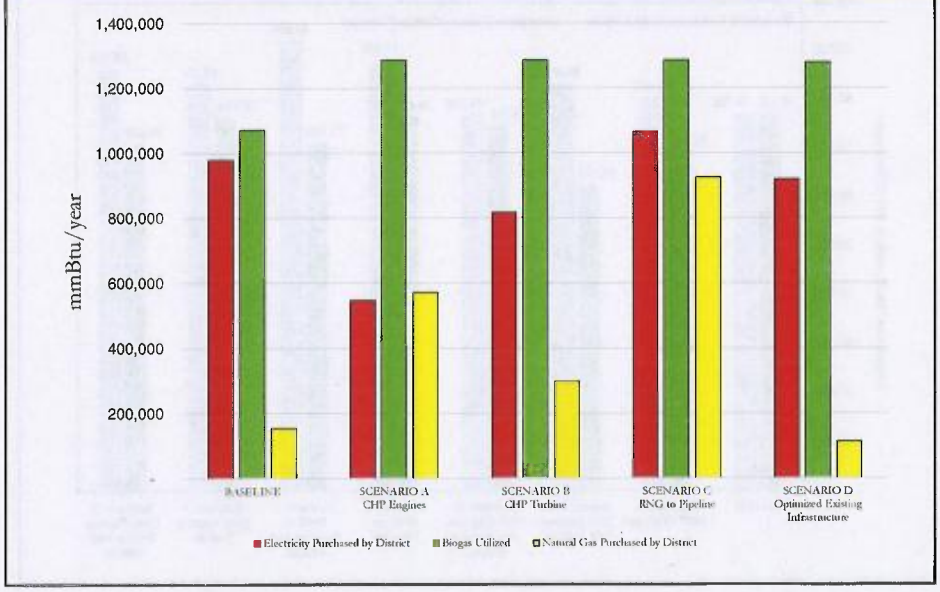
Evaluation Scenarios: Stickney WRP

Scenario	Utilization
A	CHP Engines
B	CHP Steam Turbine
C	RNG to Pipeline
D	Optimize Existing Infrastructure

Calumet WRP: Energy Security



Stickney WRP: Energy Security



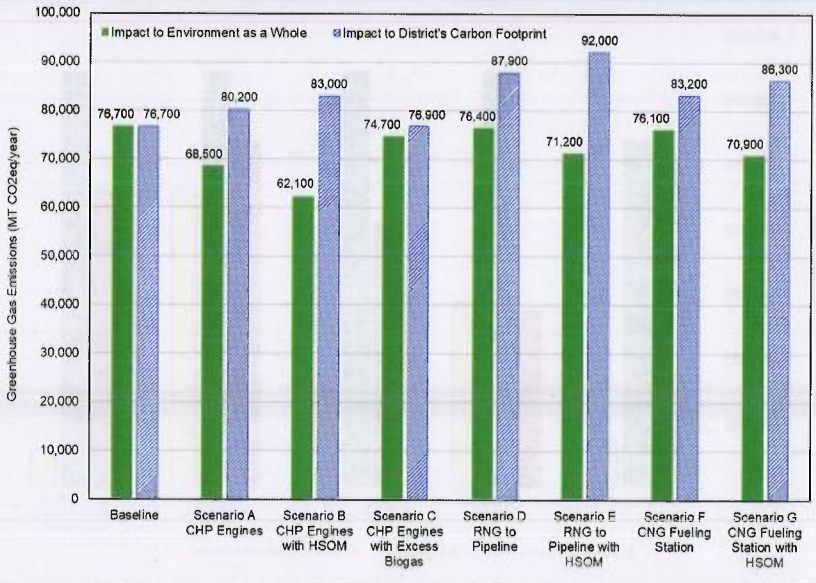
Greenhouse Gas Global Warming Potential

Compound	Global Warming Potential
Carbon Dioxide (CO_2)	1
Methane (CH_4)	25
Nitrous Oxide (N_2O)	298

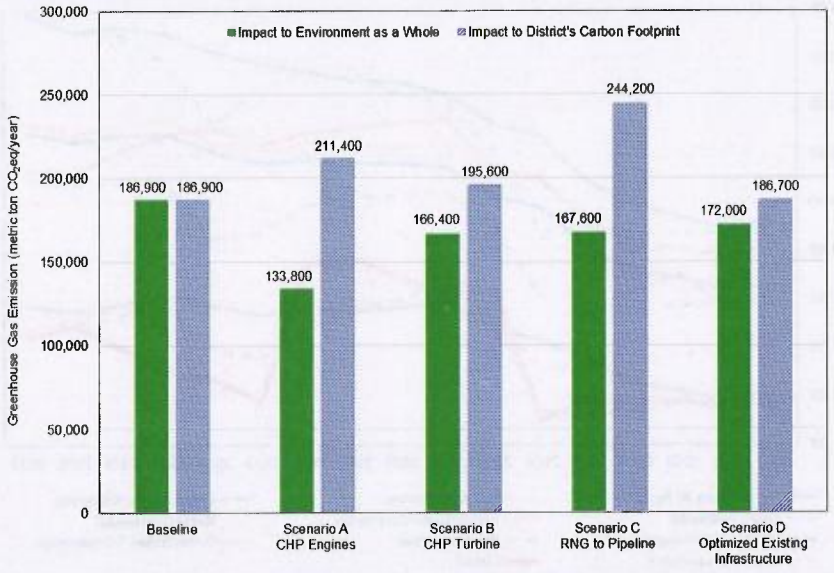
Unit of measure:
Metric Tonnes of carbon dioxide equivalent (MTCO2eq)

Source: USEPA's "Emission Factors for Greenhouse Gas Inventories" dated March 9, 2018.

Calumet WRP: Environmental Benefits



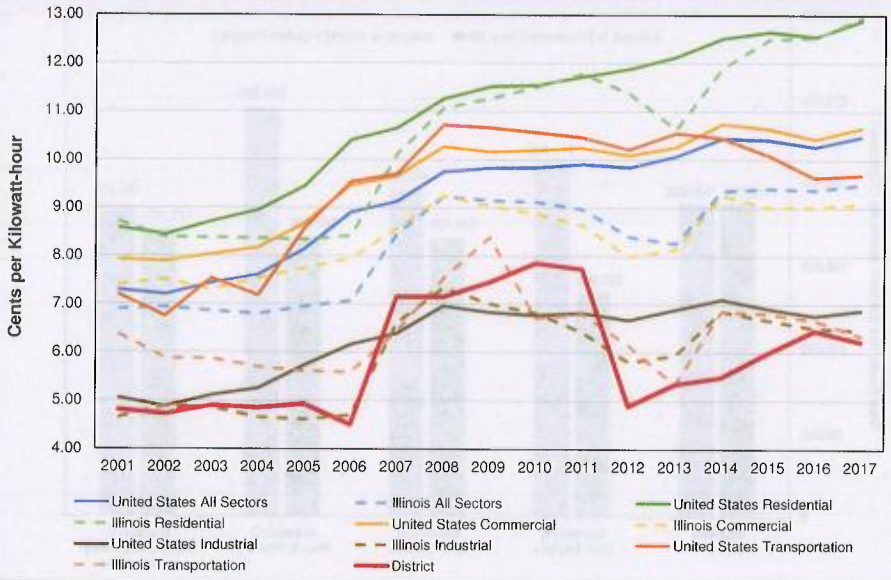
Stickney WRP: Environmental Benefits



Calumet WRP Evaluation Results

Scenario:	CHP Engines		
	Existing Biogas	With HSOM	Excess Biogas Only
Economics			
20-Year Net Present Value ($1,000s)	(31,560)	(29,850)	(19,110)
Discounted Payback Period (years)	>Estimated Useful Life	> Estimated Useful Life	> Estimated Useful Life
Energy Security (Change in Purchased Energy)			
Electricity (%)	-15	-26	-3
Natural Gas (%)	70	120	0
Change in Greenhouse Gas Emissions (Impact to...)			
Environment (%)	-11	-19	-3
District's Emissions (%)	5	8	0.3
Risk			
Risk	Low	Low	Low

Historic Electricity Rates



Calumet WRP Evaluation Results

Scenario:	RNG-to-Pipeline			RNG-to-Pipeline with HSOM		
	D.1	D.2	D.3	E.1	E.2	E.3
Economics						
20-Year Net Present Value ($1,000s)	(58,200)	(10,370)	45,320	(50,660)	(18,240)	61,160
Discounted Payback Period (years)	> Estimated Useful Life	> Estimated Useful Life	8.2	> Estimated Useful Life	> Estimated Useful Life	8.1
Energy Security (Change in Purchased Energy)						
Electricity (%)	5	5	5	7	7	7
Natural Gas (%)	190	190	190	270	270	270
Change in Greenhouse Gas Emissions (Impact to...)						
Environment (%)	-0.4	-0.4	-0.4	-7	-7	-7
District's Emissions (%)	15	15	15	20	20	20
Risk						
Risk	High	High	High	High	High	High

Calumet WRP Evaluation Results

Scenario:	CNG Fueling Station			CNG Fueling Station with HSOM		
	F.1	F.2	F.3	G.1	G.2	G.3
Economics						
20-Year Net Present Value ($1,000s)	(12,420)	(6,630)	(2,490)	(5,730)	(2,760)	1,690
Discounted Payback Period (years)	> Estimated Useful Life	> Estimated Useful Life	> Estimated Useful Life	> Estimated Useful Life	> Estimated Useful Life	16.9
Energy Security (Change in Purchased Energy)						
Electricity (%)	0	0	0	0.5	0.5	0.5
Natural Gas (%)	180	180	180	260	260	260
Change in Greenhouse Gas Emissions (Impact to...)						
Environment (%)	-1	-1	-1	-8	-8	-8
District's Emissions (%)	8	8	8	13	13	13
Risk						
Risk	Medium	Medium	Medium	Medium	Medium	Medium

Stickney WRP Evaluation Results

Scenario:	CHP Engines (A)	CHP Turbine (B)	RNG-to-Pipeline (C)			Optimize Existing Infrastructure (D)
			C.1	C.2	C.3	
Economics						
20-Year Net Present Value ($ in 1,000s)	(89,070)	(19,930)	(112,600)	205,320	564,810	6,230
Discounted Payback Period (years)	> Estimated Useful Life	> Estimated Useful Life	> Estimated Useful Life	3.2	1.3	8.0
Energy Security: Change in Purchased Energy						
Electricity (%)	-45	-17	9	9	9	-6
Natural Gas (%)	270	90	510	510	510	-27
Environmental Benefits: Change in Greenhouse Gas Emissions (Impact to...)						
Environment (%)	-28	-11	-10	-10	-10	-8
District's Emissions (%)	13	5	31	31	31	-0.1
Risk						
Risk	Low	Low	High	High	High	Low

Calumet WRP Evaluation Results

Risk	CHP Engines			RNG-to-Pipeline		CNG Fueling Station	
	Existing Biogas (A)	With HSOM (B)	Excess Biogas (C)	Existing Biogas (D)	With HSOM (E)	Existing Biogas (F)	With HSOM (G)
Biogas Production							
Permitting & Rights-of-Way							
Environmental Attributes							
Third Party Partnership							
HSOM Quality & Quantity							
Equipment							

High Risk | Medium Risk | Low Risk

Stickney WRP Evaluation Results

Risk	CHP Engine (A)	CHP Turbine (B)	RNG-to-Pipeline (C)	Optimization of Infrastructure (D)
Environmental Attributes				
Biogas Production				
Equipment				

High Risk

Medium Risk

Low Risk

Initial Recommendations for Consideration

Calumet WRP

Continue current practice of utilizing biogas in existing steam boilers (82% utilization), decommission small boilers and connect to Central Boiler Facility.

Stickney WRP

Continue current practice of utilizing biogas in the boilers, increase usage at biogas-fired turbine, and increase usage at the biosolids pelletizer facility.