

Is It Really Cost-Effective to Use My Digester Gas? (Should I Be Co-Digesting?)

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Acknowledgements

- Terry Goss
- Ralph Eschborn
- Simon Baker

Outline

- Current Industry Trend
- Impact of Co-Digestion
- Case Histories
- Summary
- Conclusions and Recommendations

Current Industry Trend

Digester Gas Utilization – Past

- Historically Primarily Just Boilers for Digester Heating
- Often Included Building Heating
- Occasionally Used Engine/Generators
- Some Engine/Generators Used Recovered Heat (Combined Heat and Power or CHP - <https://www.epa.gov/chp>)
- Rarely Cleaned Gas for Other Uses
 - Pipeline
 - Vehicle Fueling

Digester Gas Utilization – Current

- Many Systems Using Engines, Microturbines, and Turbines
- Many, Newer Gas Cleaning Technologies
- Electricity Generation Often Primary Benefit
- CHP Common
- Cleaning for Pipeline and Vehicle Fueling Practiced
- Sophisticated Controls and Dashboards



Real-Time Display Client - Main

File Edit View Window Options Help

EnergyVIEW Dashboard

Main CB

KW	995
KW Max	1030
KW Average	958
Phase A Amps	566
Phase A Amps	530
Phase A Amps	578

MCC No. 1

KW	450
KW Max	450
KW Average	429
Phase A Amps	266
Phase A Amps	238
Phase A Amps	277


MCC No. 2

KW	387
KW Max	418
KW Average	390
Phase A Amps	207
Phase A Amps	203
Phase A Amps	206


MCC No. 3

KW	158
KW Max	161
KW Average	140
Phase A Amps	91
Phase A Amps	91
Phase A Amps	93

Wire or Wireless



Power Cost \$/Hour		KW
Current \$/Hr	\$ 61.71	995
Daily Max	\$ 63.85	1030
Daily Min	\$ 36.65	0



Real-time Power Use Trend

Real-time Power Cost Trend

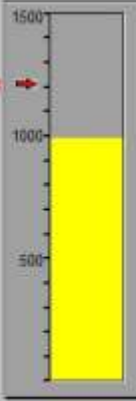
Daily KWH Pump Report

Monthly KWH Pump Report

Yearly KWH Pump Report

KWH Trend Historical

Alarm Setpoint →



1. Track and Trend Energy Real-time
2. Record 15 minute and daily peak demand
3. Report hourly, daily and monthly usage
4. Monthly Audit Report

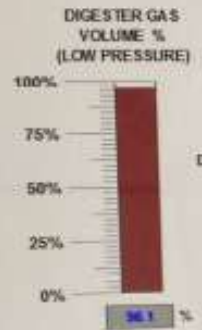
From <http://www.intellisys-is.com/> web site

- Max
- Call
- Last

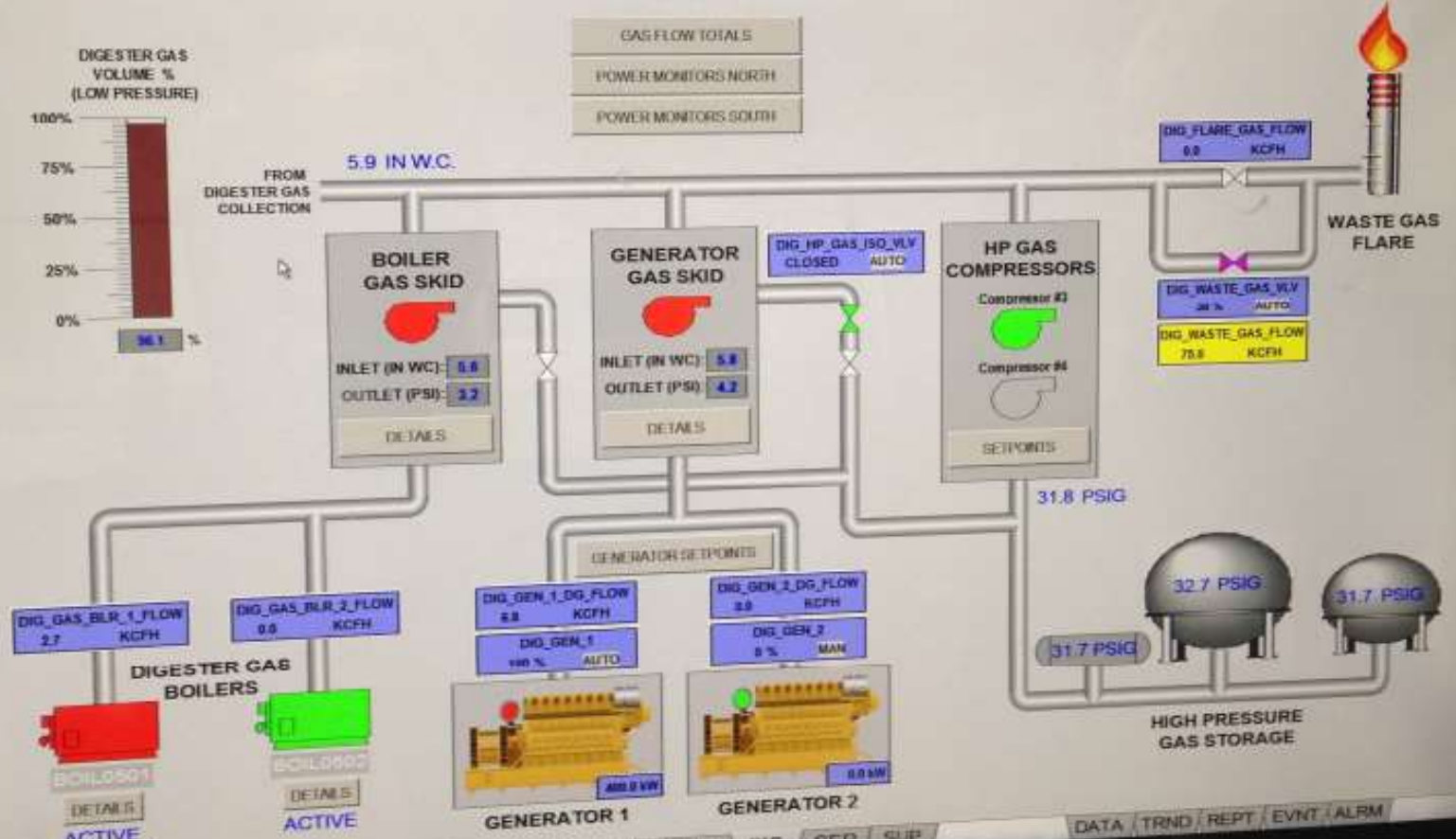
GAS SYSTEM OVERVIEW

Interceptor Sewer Level **3.1 FT** CSO Pump(s) **OFF** **ALARM** TUE 10/18/201 11:35:31 AM
 Well Inlet Area Level **14.9 FT** Influent Flow **32.1 MGD**

GAS FLOW TOTALS
 POWER MONITORS NORTH
 POWER MONITORS SOUTH



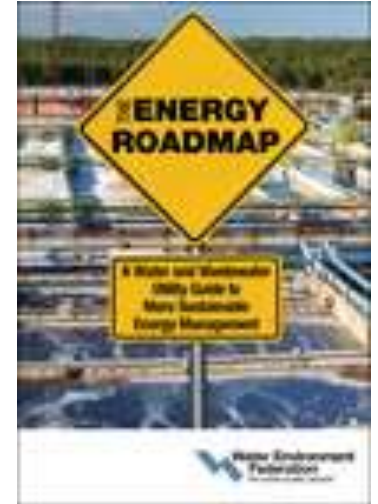
- Overview
- Digester 1
- Digester 2
- Digester 3
- Digester 4
- Digester 5
- Digester 6
- Digester Feed
- Digester Withdrawal
- DS Pumps
- Heating System
- Gas Production
- Digester Building
- Log In



LST C50 PRE PRI AER SEC DIS PND THK DIG SEP SUP DATA TRND REPT EVNT ALRM

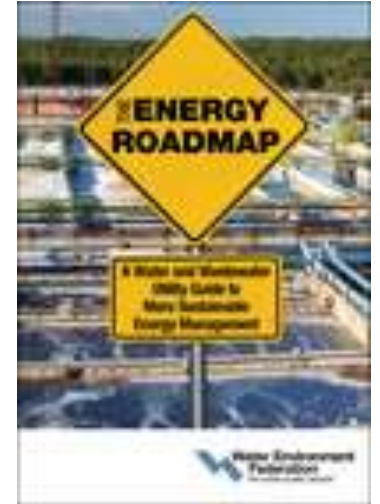
Co-Digestion

- Identified as a Means to Become Energy Neutral – Use of High Strength Waste (HSW)
- Wisconsin Has Been a Leader
 - Sheboygan
 - Stevens Point
 - Plymouth
- Numerous Articles and References
- “The wastewater sector is beginning the transition from wastewater treatment to resource recovery, including becoming a source of distributed energy generation”. WEF “The Energy Roadmap



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Impact of Co-Digestion

Recent Publications

- Encourage Co-Digestion
- Recommend Identifying Impacts
- Recommend Careful Evaluation
- WE&RF Reports (2017)
- NSF/WE&RF Workshop October 25-26



Final Report

Understanding Impacts of Co-Digestion:

Digester Chemistry, Gas Production, Dewaterability,
Solids Production, Cake Quality, and Economics





Final Report

Co-Digestion of Organic Waste
Addressing Operational Side Effects

Co-published by



NYSERDA



Final Report

Lessons Learned: Developing Solutions for
Operational Side Effects Associated with Co-Digestion
of High Strength Organic Wastes



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Co-Digestion Impacts

– Positive

- Reduced Energy Costs (Electricity, Natural Gas, Fuel)
- Reduced Sewer Maintenance
- Support for Local Industry

– Negative

- Additional Solids
- Toxic or Inhibitory Compounds
- Increased Recycle Streams – Flows and Loads
- Thickening and Dewatering
 - Concentrations
 - Polymer

Case Histories

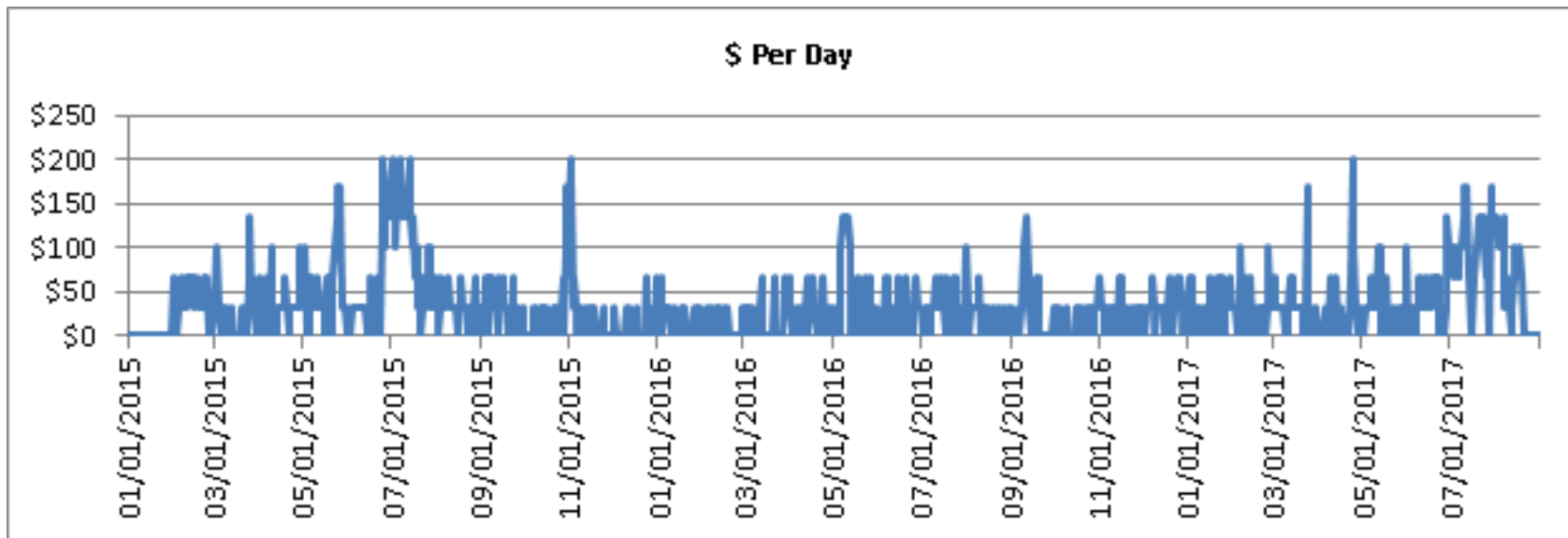
Plant Information

- Plant A – Small Midwest
- Plant B – Medium Midwest
- Plant C – Medium West
- Plant D – Large East
- Plant E – Large Midwest

Plant A – Small Midwest

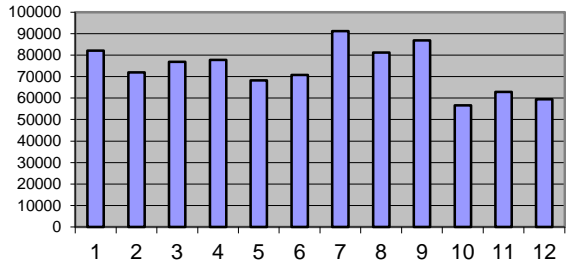
- Added Co-Digestion Including Microturbines
- Fed Directly Into Existing Digesters
- No Tipping Fee
- Peak Demand Fee Reduction
- Significant Electricity Cost Reduction

Plant A – Electricity Cost per Day

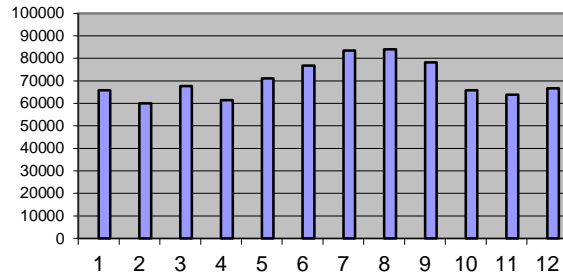


Plant A – kWh/month

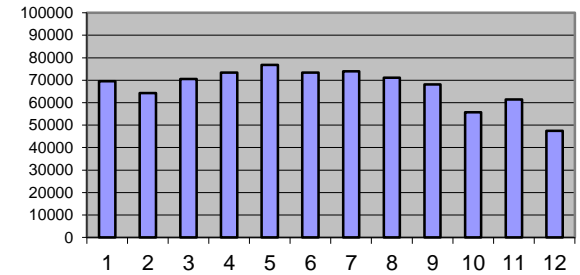
WWTP 2012



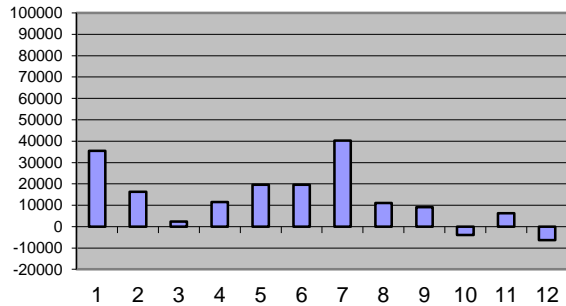
2013



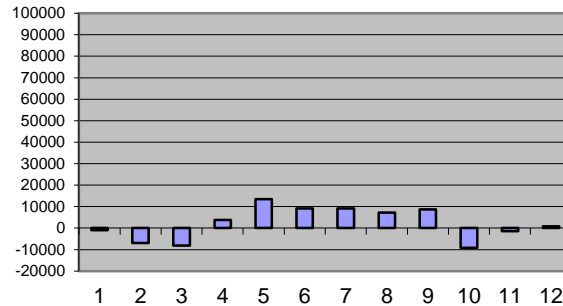
2014



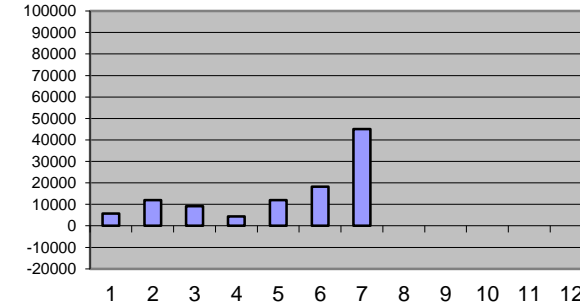
2015



2016



2017



Plant A - Issues

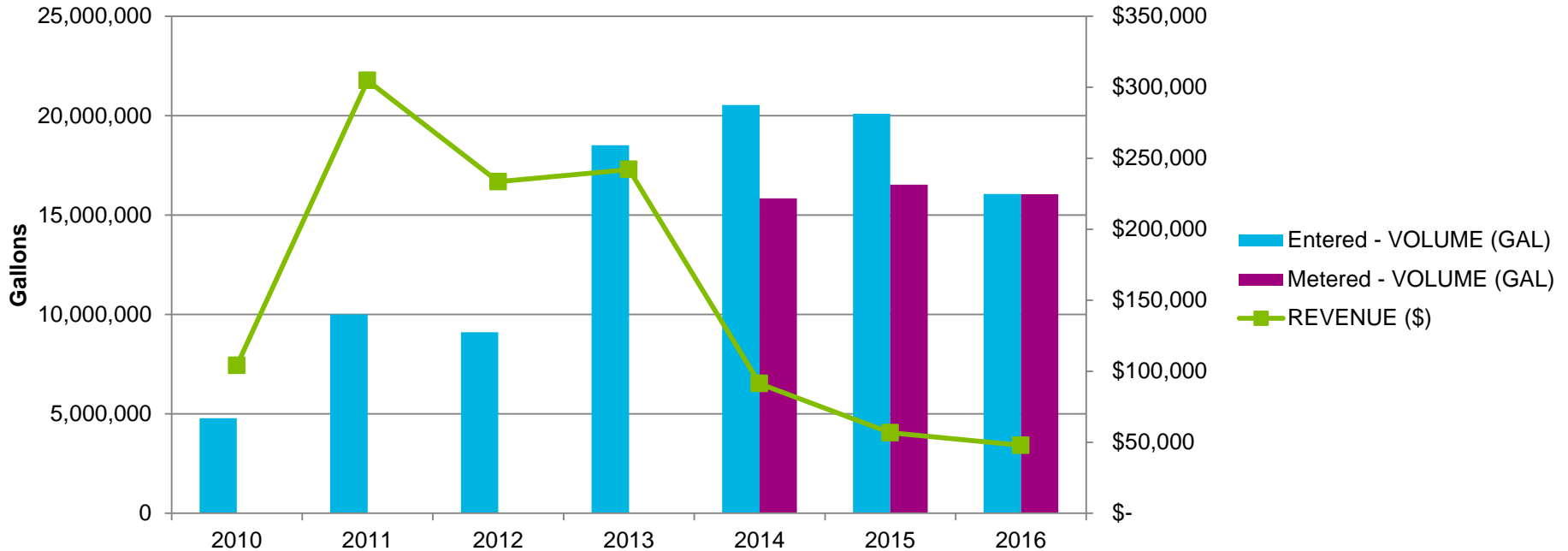
- Mechanical Problems Shut Down Microturbines
 - Poor Quality Gas After Feeding Large Volume of HSW
 - No Screening
 - Lower Electricity Production During Warmer Weather
 - Increased Mechanical Maintenance
 - Increased Recycle from Secondary Digester – Plant Solids Inventory
 - Doubled Sludge Hauling – Biggest Headache
- Management Has Questioned Cost-Effectiveness**

Plant B – Medium Midwest

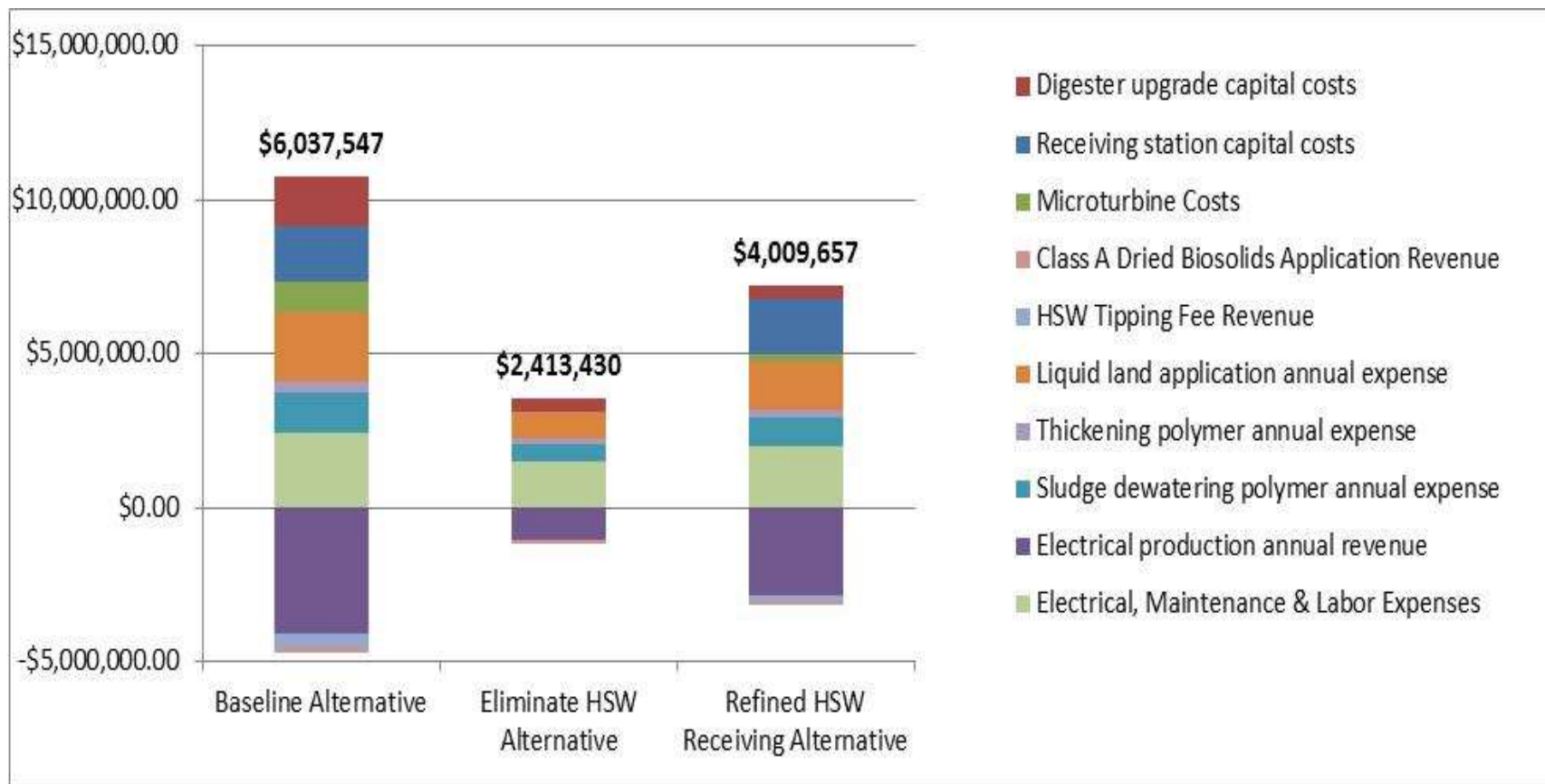
- Microturbines Installed at Two Separate Times
- Maintenance Required on Older Microturbines, Digesters
- New Receiving Station Proposed
- Public Works Director Concerned About Priorities for Available Funds
- Tipping Fees Reduced to Zero to Maintain Supply
- Impacts on the Rest of the Plant Evaluated

Plant B – Tipping Fees

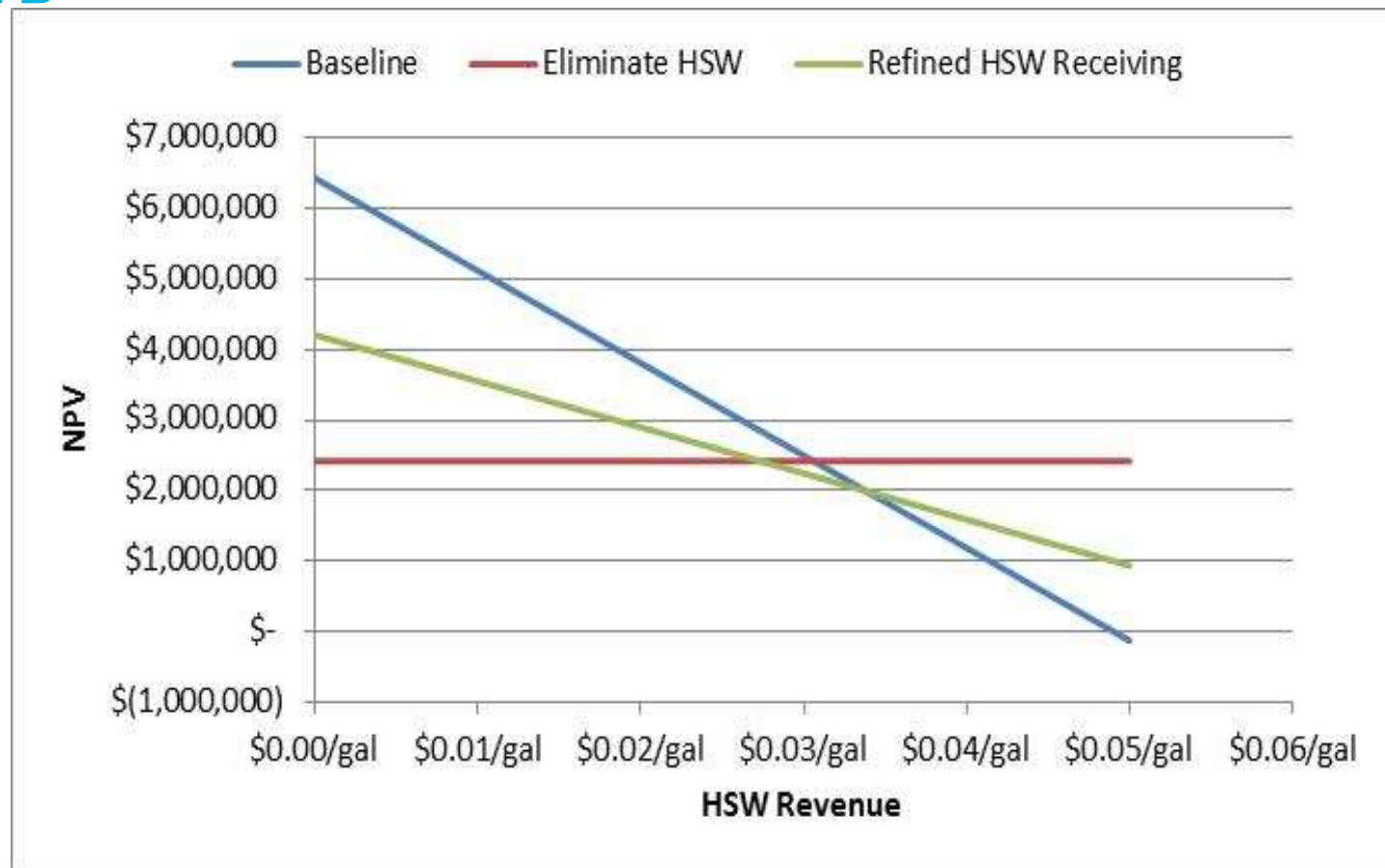
High Strength Waste Volume & Revenue 2010-2016



Plant B



Plant B



Plant C – Medium West

- CHP Originally sized based on 190 kW engine
 - Sized for max 10% gas flaring at projected annual average conditions
 - $\geq 76\%$ total efficiency required
 - $\geq 32\%$ electrical efficiency
 - $\geq 44\%$ thermal efficiency – Hot water for digester and building heat
- Later size reduced to 150 kW based on revised projections



- Gas requires treatment prior to cogeneration (H_2S and Siloxanes)
 - Limited H_2S data provided during bid phase (500 ppmv design basis)
- System must meet strict emission regulations
 - NO_x : 150 ppm
 - CO: 2,000 ppm

Plant C – Gas Cleaning

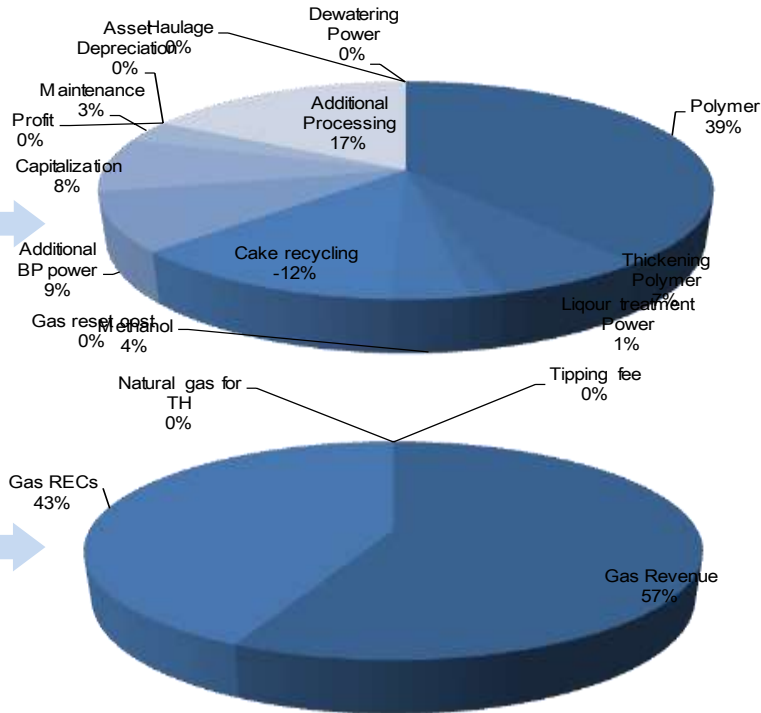
- Gas cleaning originally designed based on carbon media scrubbers
- Later data indicated that H_2S were very high (up to 3,000 ppmv).
- High H_2S not suitable for originally planned system
- Evaluated alternative treatment technologies **but high capital costs**
- Evaluated Ferric Chloride Addition but **high operation costs**
- **No ideal solution was found and CHP was ultimately removed from the project altogether.**



Plant D – Large East

- Developed Mathematical Model to Evaluate Impacts of Co-Digestion
- Calculates economics of co-digestion by difference, i.e. value of additional gas, savings due to difference in sludge production
- Calculates the capacity available for co-digestion based on major unit operations: thickening; anaerobic digestion; gas infrastructure; CHP plant; downstream dewatering
- Numerous technical and financial assumptions
 - On sludge
 - On material added
 - On liquor treatment options
 - On capacity of unit operations
 - On haulage: size of truck (to determine transport movements); optimum transport radius

Plant D – Cost Evaluation



– Estimated Costs - \$966,474 per year

– Estimated Savings - \$316,857 per year

Plant E – Large Midwest

- Developing Preliminary Design
- Business Case Evaluation for CHP
- Very Inexpensive Electricity
- Costly New Gas Cleaning Equipment
- Concerns About Air Emissions

Plant E – Present Worth Costs

		Net Present Value (2016\$)			Payback Period
		Capital	O & M	Total	Years
Alternative A	IC Engine	\$16,800,000	\$ -9,700,000	\$7,100,000	>30
Alternative B	Microturbine	\$15,800,000	\$ -9,600,000	\$6,200,000	>30

Summary

Plant Summaries

- Plant A – Small Midwest – Benefits But Cost Concerns
- Plant B – Medium Midwest
 - Suspended HSW Receiving
 - Retained Digester Gas Utilization
- Plant C – Medium West – Eliminated CHP from Project
- Plant D – Large East
 - Have CHP
 - Decided Against Adding HSW
- Plant E – Large Midwest – Decided Against CHP

Conclusions and Recommendations

Conclusions and Recommendations

- Use of Digester Gas Has Significant Benefits
 - Energy Cost Savings
 - Sustainability
- Use of Digester Gas Has Costs
 - Gas Cleaning
 - O&M
- Co-Digestion Has Benefits and Costs
- Carefully Evaluate Cost and Benefits

Thank You

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