Is It Really Cost-Effective to Use My Digester Gas? (Should I Be Co-Digesting?)
Rusty Schroedel, P.E., BCEE, WEF Fellow
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
Is It Really Cost-Effective to Use My Digester Gas

From [http://www.intellisys-is.com/](http://www.intellisys-is.com/) web site
Is It Really Cost Effective to Use My Digester Gas?
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
Co-Digestion

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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

Co-Digestion of Organic Waste
Addressing Operational Side Effects

Co-published by
NEW YORK STATE OF OPPORTUNITY
NYSERDA

Final Report

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

Gallons

$-

$50,000

$100,000

$150,000

$200,000

$250,000

$300,000

$350,000

0

5,000,000

10,000,000

15,000,000

20,000,000

25,000,000

$50,000

$100,000

$150,000

$200,000

$250,000

$300,000

$350,000

$50,000

$100,000

$150,000

$200,000

$250,000

$300,000

$350,000

2010

2011

2012

2013

2014

2015

2016

Entered - VOLUME (GAL)

Metered - VOLUME (GAL)

REVENUE ($)
Plant B

- **Baseline Alternative**: $6,037,547
- **Eliminate HSW Alternative**: $2,413,430
- **Refined HSW Receiving Alternative**: $4,009,657

Legend:
- Red: Digester upgrade capital costs
- Blue: Receiving station capital costs
- Green: Microturbine Costs
- Pink: Class A Dried Biosolids Application Revenue
- Orange: HSW Tipping Fee Revenue
- Brown: Liquid land application annual expense
- Purple: Thickening polymer annual expense
- Cyan: Sludge dewatering polymer annual expense
- Gray: Electrical production annual revenue
- Olive: Electrical, Maintenance & Labor Expenses
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
    o $\geq 32\%$ electrical efficiency
    o $\geq 44\%$ 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
    – NOx: 150 ppm
    – CO: 2,000 ppm
Plant C – Gas Cleaning

- Gas cleaning originally designed based on carbon media scrubbers
- Later data indicated that $\text{H}_2\text{S}$ were very high (up to 3,000 ppmv).
- High $\text{H}_2\text{S}$ 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

<table>
<thead>
<tr>
<th>Alternative</th>
<th>Type</th>
<th>Capital</th>
<th>O &amp; M</th>
<th>Total</th>
<th>Payback Period</th>
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<td>Alternative A</td>
<td>IC Engine</td>
<td>$16,800,000</td>
<td>$-9,700,000</td>
<td>$7,100,000</td>
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<td>Alternative B</td>
<td>Microturbine</td>
<td>$15,800,000</td>
<td>$-9,600,000</td>
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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