Power or Fuel: Renewable
Natural Gas a Feasible
Alternative

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Gas Utilization
WWTP Industry Snapshot

- 14,780 WRRF
- 1,238 WRRF Anaerobic Digestion
- 1,054 WRRF Beneficial Reuse

Biogas Utilization:
- Building Heating 27%
- Power Generation 16%
- Process Machinery 8%
- Digester Heating 48%
- Pipeline Injection 1%

Biogas Utilization Graph:
- Building Heating 27%
- Power Generation 16%
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Renewable Fuel Standard
RNG and RINS

- The Renewable Fuel Standard requires RINS to offset Transportation Fuel, Heating Oil, or Jet Fuel used in the Market
- Digester Gas Qualifies as
  - D-3 Cellulosic Biofuel
  - D-5 Advance Biofuel
- Viable Revenue for RNG
  - 1 RIN = 77,000 BTUs
  - 1 Therm = 1.3 RINS
  - Purchased NG = $0.80/Therm
  - Ave. Value of D3 = $1.89/Therm
- Requires a 3rd Party Contract to be used to offset Transportation Fuel
The City of South Bend, Indiana WWTP

- 48.0 MGD Class IV activated sludge plant
- 4 anaerobic digesters (2 primary, 2 secondary)
  - Built in 1954
  - Digester No. 2 and 4 upgraded in 1988
- Gas boiler system

![Diagram of the WWTP process]

- Primary Sludge
  - No Data gal/d
  - No Data lb/d
- WAS
  - 285,100 gal/d
  - 0.7%
  - 16,893 lb/d
- Gravity Thickener
  - 33,200 gal/d
  - 1.3%
- Dissolved Air Floatation
  - 48,500 gal/d
  - 4.1%
  - 16,437 lb/d
- Blend Tank
  - 81,800 gal/d
  - 4.1%
  - 27,837 lb/d
- Digestor No. 1
  - 170,000 cf/d
  - 50% Volatile Solids Reduction
  - 94,400 gal/d
  - 2.9%
  - 19,742 lb/d
- Sludge Storage No. 1
- Sludge Storage No. 2
- Sludge Storage No. 3
- Sludge Storage No. 4
- Belt Filter Presses
  - 18%
  - 10 DT/day
- Organic Resource Facility
  - Land Application

- Supernatant
  - 15,600 gal/d
Long-term Biosolids Planning

- Digester Gas Utilization (2015)
- Preliminary Design Report (2012)
- Biosolids Master Plan (2011)
- Digester Upgrade Evaluation (2009)
- Digester No.2 and 4 Interior Inspection (2009)
- Digester Operations Memo (2009)
- Digester Condition Assessment (2009)
- Digester Use Improvements (2008)
Vision and Project Goals

• **Initial Digester Goals**
  – Long Term Strategy for Maintaining Digesters

• **Gas Utilization Goals**
  – Maximize Energy Recovery
  – Minimize Flaring of Digester Gas
  – Demonstrate City Efforts for Sustainability and Environmental Stewardship
Phased Approach

1. Digester Upgrade Phase
   – Digester Upgrade Evaluation -> BMP 2011
   – Preliminary Design Report
   – Upgrades to Digester No. 2

2. Gas Utilization Phase
   – Digester Gas Utilization Report
   – Digester cleaning skid to clean raw digester gas to natural gas pipeline quality.
   – Gas distribution infrastructure

3. Final Digester Upgrades
Evaluation Process

- Digesters – Mixing
  - Gas Injection
  - Gas Cannons
  - Vertical Linear Motion
  - Pump Recirculation
  - Draft Tube Mixers
  - Jet Mixing

- Digesters – Covers
  - Fixed Covers
  - Floating Covers
  - Gas Holding Covers
  - Gas Holding Membranes

Digesters – Process Configurations

- 1 Thermophilic / 2 Mesophilic
- 2 Thermophilic / 2 Mesophilic
Digester No. 2 Upgrades

- Four 20 Hp external draft tube mixers (0.025-0.04 Hp/1,000 gal)
- Gas holder cover
- Centrifuge Flygt N-technology pump
- Flex type boiler
- New sludge and digester gas piping, valves and gas appurtenances
Phased Approach

1. Digester Upgrade Phase
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   – Preliminary Design Report
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   – Digester Gas Utilization Report
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   – Gas distribution infrastructure

3. Final Digester Upgrades
<table>
<thead>
<tr>
<th></th>
<th>Capital</th>
<th>O &amp; M</th>
<th>20 Year LCCA</th>
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<tbody>
<tr>
<td>$</td>
<td>714,000</td>
<td>$ 40,000</td>
<td>$ 1,183,000</td>
</tr>
<tr>
<td></td>
<td>$ 565,000</td>
<td>$ 130,000</td>
<td>$ 1,940,000</td>
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<tr>
<td></td>
<td>$ 2,702,000</td>
<td>$ 60,000</td>
<td>$ 3,310,640</td>
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<tr>
<td>Technology</td>
<td>Pressure Swing Adsorption and Physical</td>
<td>Membrane and Physical</td>
<td>Scrubber, chemical, physical</td>
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<tr>
<td>Removal</td>
<td>CO2, N2, Siloxanes, H2S, and VOCs</td>
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<tr>
<td>Advantages</td>
<td>Regenerable Media Operational Flexibility Low O&amp;M Cost</td>
<td>Low Equipment Cost Smaller Footprint</td>
<td>10 year gas Quality Guarantee Low O&amp;M</td>
</tr>
<tr>
<td>Disadvantages</td>
<td>Higher Capital Cost</td>
<td>High O&amp;M Limited Warranty Non-regenerable Filters Short media and membrane life</td>
<td>High Capital Cost Media non-regenerable Short Media Life</td>
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</tbody>
</table>
Guild’s Gas Cleaning Process

DIGESTER GAS
82 CFM

MOLECULAR GATE
Guild Pressure Swing Adsorption

METHANE RECYCLE

RNG
43 CFM
N₂ <4%
CO₂ <2%

TAIL GAS
N₂ and CO₂
Lost Natural Gas

FLARE
Gas Utilization Options

1. Supply RNG to two natural gas engines
2. RNG to the fleet vehicle fueling station
3. Sell natural gas to utility and take advantage of RINs
Options for Clean Digester Gas Utilization

Uses for Clean Digester Gas

- **Option 1 - Boiler Only**
- **Option 2 - Boiler and Engines**
- **Option 3 - Boiler, Engines and VFS**
- **Option 4 - Boiler, Engines, VFS and Storage**

Legend:
- **Flared**
- **VFS**
- **CAT**
- **Waukesha**
- **Boiler**

Figure 3.1
South Bend WWTP Digester Gas Utilization System

DIGESTER
200,000 CFD

CLEAN GAS BUFFER TANK
0 – 35 PSIG

GAS SHUT-OFF VALVES
FLOW INSTRUMENTS FOR ENERGY MEASUREMENT

UTILITY GAS
NG

CNG FUELING STATION
(0 – 60 CFM)

ENGINE-DRIVEN PROCESS EQUIPMENT
(0 – 200 CFM)

DIGESTER BOILER
(14 – 75 CFM)

TAIL GAS TANK

GAS PROCESSING EQUIPMENT

RNG

FIT

PIT

FLARE

FLOW INSTRUMENTS FOR ENERGY MEASUREMENT
## Implementation

### Phase 1 – Digester No. 2 Upgrade and Digester Gas Cleaning

<table>
<thead>
<tr>
<th>Description of Improvements</th>
<th></th>
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</thead>
<tbody>
<tr>
<td>Upgraded Digester No. 2 Cover to Floating Gas Holder Cover</td>
<td></td>
</tr>
<tr>
<td>Rehabilitated Digester No. 2 Piping, Exterior, Electrical Equipment</td>
<td></td>
</tr>
<tr>
<td>Installed EDT Mixers in Digester No. 2</td>
<td></td>
</tr>
<tr>
<td>Replaced Digester No. 2 Boiler</td>
<td></td>
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<tr>
<td>Installed New Gas Cleaning Skid</td>
<td></td>
</tr>
<tr>
<td>Constructed Clean Gas and Natural Gas Piping to Digester No. 2 Boiler</td>
<td></td>
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<tr>
<td>Other Miscellaneous Improvements</td>
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**Total Construction Cost** = **$5.93 M**
Gas Payback Period

<table>
<thead>
<tr>
<th>Utilization Option</th>
<th>Life Cycle Present Value</th>
<th>Payback Period (years)</th>
<th>Annual Energy Savings</th>
<th>Average % Clean Digester Gas Utilized</th>
<th>Cumulative % Clean Digester Gas Utilized</th>
<th>Reduction in CO₂ Emissions (metric tons CO₂/yr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural Gas Engines</td>
<td>$270,000-$386,000</td>
<td>8.5-10.3</td>
<td>$27,900-$33,700</td>
<td>17%-21%</td>
<td>71%-75%</td>
<td>235-284</td>
</tr>
<tr>
<td>Vehicle Fueling Station</td>
<td>$53,000-$285,000</td>
<td>6.9-14.8</td>
<td>$10,100-$21,700</td>
<td>6%-12%</td>
<td>77%-87%</td>
<td>79-170</td>
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<tr>
<td>Put Storage Spheres Back in Service</td>
<td>($91,000)-($47,000)</td>
<td>22.1-24.5</td>
<td>$20,200-$22,400</td>
<td>11%-13%</td>
<td>88%-100%</td>
<td>160-178</td>
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</table>
Status of Gas Utilization

South Bend WWTP Digester No. 2 Upgrade and Digester Gas Cleaning
Gas Cleaning Product Analysis

Gas Flow (SCFM)

Date


- Clean Gas
- Digester Gas
- Minimum Specified Digester Gas Feed
- Maximum Specified Digester Gas Feed
Implementation

Lessons Learned

✓ System Selection to Project Goals and Needs
✓ Thoroughly Vet General Contractor and Subcontractors
✓ Invest in O&M Staff
✓ On-site Representation is Key
## Future Considerations

<table>
<thead>
<tr>
<th>Phase</th>
<th>Description of Improvements</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phase 1</td>
<td>Digester No. 2 Upgrade and Digester Gas Cleaning</td>
<td>2013</td>
</tr>
<tr>
<td>Phase 2</td>
<td>WWTP Digester Gas Utilization</td>
<td>2017</td>
</tr>
<tr>
<td>Phase 3</td>
<td>Digester No. 1 and 3 Upgrades (Cover, Boilers, Piping, External Draft Tube Mixers)</td>
<td>TBD</td>
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<tr>
<td>Phase 4</td>
<td>Other Expansions</td>
<td>TBD</td>
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Future of RFS

- Rep. John Shimkus (R-IL), Chair of Subcommittee of Energy and Commerce intends to take up RFS Reform
- Leave Ethanol Volumes at Existing Levels Act (LEVEL Act)
- H.R. 776 and H.R. 777
- Renewable Fuel Standard Elimination & Reform Act
Acknowledgements

City of South Bend
Al Greek, Utilities Director
Jacob Klosinski, PE, Assistant City Engineer
Operations and Maintenance Staff
Questions?

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Next Steps

Phase 2

- Clean Gas Skid
- 2" CG Piping
- 3" CG Piping
- Compressor Building
- CNG Vehicle Fueling Station
Next Steps

• Phase 2
   – Project Awarded December 2016: $754,000
   – Notice to Proceed Issued to Thieneman Construction: January 25, 2017
   – Final Completion: December 21, 2017
Carbon Footprint Reduction

**Vehicle Fuel System**

- Reduction in CO$_2$
  - 170 MT/yr
  - 36

**Natural Gas Engines**

- Reduction in CO$_2$
  - 284 MT/yr
  - 60

**Natural Gas Boiler**

- No additional reduction
Combined Heat and Power Consideration

![Graph showing Microturbine System Payback Period (Years) vs. Energy Cost ($/kWh)]