Converting Biogas into Energy and Vehicle Fuel

October 8, 2015

Tony Schilling
Capture your biogas....

- **Municipal Digesters**
  - Palm Beach, FL
  - South Monmouth, NJ
  - Sheboygan, WI

- **Industrial & Ag Digesters**
  - Sierra Nevada Brewery, NC
  - KB Compost, OH
  - Seneca Foods, MN

- **Landfills**
  - La Crosse, WI
  - Cherry Island, DE
  - Mountain View, CA

Leaders in Biogas Technology
and put it to work!

- Boiler Fuel
- Electricity Production
- Heat Recovery
- Fuel for Vehicles

Leaders in Biogas Technology
Traditional Biogas Conditioning System

Process Flow Diagram

- Digester or Landfill
- Hydrogen Sulfide Removal
- Gas Compression/Moisture Removal
- Siloxane/VOC Removal
- MicroTurbines
- IC Engines
- Boilers

Biogas Conditioning System
Case Study’s Electricity and Heat Production
Sheboygan, WI WWTF

Site Information
- Western Shore of Lake Michigan, serves 7 communities
- 56.8 MGD municipal plant (Avg. flow 18.4 MGD)
- 300 scfm of biogas produced

Project Timeline
- 2006 - Phase 1 Project Installed (10) CR30’s
- 2011 - Phase 2 Project Installed (2) CR200’s
- 2013 - NetZero Energy - 2013 Grand Award

Gas Conditioning Equipment
- Gas Compression/Moisture Removal
- Siloxane Removal

End Use Equipment
- (10) Capstone CR30 Turbines, produce 300 kW of electricity and thermal energy
- (2) Capstone CR200 Turbines, produce 400 kW of electricity and thermal energy

Leaders in Biogas Technology
Danville, IL Sanitary District

Site Information
- 16 MGD municipal plant (Avg. flow 5-8 MGD)
- 50 scfm of biogas produced

Project Timeline
- 2008 - Project Planning Begins
- 2012 - System Start Up

Gas Conditioning Equipment
- Gas Compression/Moisture Removal
- Siloxane Removal

End Use Equipment
- (1) Tech 3 IC Engine, produces 150 kW of electricity and 778,000 BTU/hour of thermal energy

Leaders in Biogas Technology
Dubuque, IA WRRC

**Site Information**
- 40 MGD municipal plant (Avg. flow 14 MGD)
- 350 scfm of biogas produced

**Project Timeline**
- 2012 - Phase 1 Project Installed Boiler Fuel
- 2013 - Phase 2 Project Installed (1) CR600

**Gas Conditioning Equipment**
- Hydrogen Sulfide Removal
- Gas Compression/Moisture Removal
- Siloxane Removal

**End Use Equipment**
- Boiler Fuel for thermal energy
- (1) Capstone CR600 Turbine, produces 600 kW of electricity and thermal energy
Downers Grove, IL Sanitary District

**Site Information**
- 11 MGD municipal plant (Avg. flow 8 MGD)
- 160 scfm of biogas produced

**Project Timeline**
- June 2014 - System Start Up

**Gas Conditioning Equipment**
- Hydrogen Sulfide Removal
- Gas Compression/Moisture Removal
- Siloxane Removal

**End Use Equipment**
- (1) Tech 3 IC Engine, produces 280 kW of electricity and thermal energy

Leaders in Biogas Technology
Plymouth WI Utilities, WI

Site Information
- 1.01 MGD municipal plant
- 50 scfm of biogas produced

Project Timeline
- December 2014 - System Start Up

Gas Conditioning Equipment
- Gas Compression/Moisture Removal
- Siloxane Removal

End Use Equipment
- (2) Capstone CR65-ICHP Turbines, produce 130 kW of electricity and thermal energy

Leaders in Biogas Technology
Lloyd Ray Farms; Yadkinville, NC

Site Information
- Agricultural - Covered Lagoon/Digester
- 50 scfm of biogas produced

Project Timeline
- December 2013 - System Start Up

Gas Conditioning Equipment
- Gas Compression/Moisture Removal

End Use Equipment
- (1) Capstone CR65-ICHP Turbine, produces 65 kW of electricity

Leaders in Biogas Technology
Potawatomi Casino; Milwaukee, WI

Site Information
- Digester - Food waste from Casino and local grocery stores
- 700 scfm of biogas produced

Project Timeline
- October 2013 - System Start Up

Gas Conditioning Equipment
- Gas Compression/Moisture Removal

End Use Equipment
- (2) Waukesha IC Engines, produce 2 MW of electricity and thermal energy

Leaders in Biogas Technology
GreenWhey Energy; Turtle Lake, WI

Site Information
- Food/Industrial Waste Digester
- 1,100 scfm of biogas produced

Project Timeline
- June 2013 - System Start Up

Gas Conditioning Equipment
- Gas Compression/Moisture Removal

End Use Equipment
- (2) Caterpillar 3520 Engines, produces 3.2 MW of electricity

Leaders in Biogas Technology
Grande Cheese; Brownsville, WI

Site Information
- Food/Industrial Waste Digester
- 140 scfm of biogas produced

Project Timeline
- November 2013 - System Start Up

Gas Conditioning Equipment
- Gas Compression/Moisture Removal

End Use Equipment
- (2) Capstone CR200 Turbines, produces 400 kW of electricity

Leaders in Biogas Technology
Sierra Nevada Brewery; Fletcher, NC

<table>
<thead>
<tr>
<th>Site Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Food/Industrial Waste Digester</td>
</tr>
<tr>
<td>- 250 scfm of biogas produced</td>
</tr>
</tbody>
</table>

**Project Timeline**

- December 2013 - System Start Up

**Gas Conditioning Equipment**

- Gas Compression/Moisture Removal

**End Use Equipment**

- (2) Capstone CR200 Turbines, produces 400 kW of electricity and sends gas to a Boiler
Unison Solutions’ patent pending system to convert biogas to a gaseous vehicle fuel, RNG - Renewable Natural Gas.
BioCNG™ Vehicle Fueling System
Process Flow Diagram

Digester or Landfill → BioCNG™ Gas Conditioning System → CNG Vehicle Fueling Station and Vehicles

- Traditional System with Addition of CO₂ Removal System

Potential Energy Produced
- Vehicle Fuel
- Electricity
- Heat

MicroTurbines → IC Engines → Boilers
## BioCNG™ Models

<table>
<thead>
<tr>
<th>Model</th>
<th>Biogas Inlet Flow (scfm)</th>
<th>Fuel Production (GGE/day)</th>
<th>Fuel Production (DGE/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>BioCNG™ 50</td>
<td>50</td>
<td>185 - 300</td>
<td>160 - 260</td>
</tr>
<tr>
<td>BioCNG™ 100</td>
<td>100</td>
<td>370 - 600</td>
<td>320 - 520</td>
</tr>
<tr>
<td>BioCNG™ 200</td>
<td>200</td>
<td>740 - 1,200</td>
<td>640 - 1,040</td>
</tr>
<tr>
<td>BioCNG™ 400</td>
<td>400</td>
<td>1,480 - 2,400</td>
<td>1,280 - 2,080</td>
</tr>
</tbody>
</table>

*Leaders in Biogas Technology*
# BioCNG™

## Biogas to Vehicle Fuel Systems

<table>
<thead>
<tr>
<th>Model</th>
<th>Ford F-150</th>
<th>Waste Hauler</th>
<th>School Bus</th>
</tr>
</thead>
<tbody>
<tr>
<td>BioCNG™ 50</td>
<td>16</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>BioCNG™ 100</td>
<td>32</td>
<td>10</td>
<td>8</td>
</tr>
<tr>
<td>BioCNG™ 200</td>
<td>64</td>
<td>20</td>
<td>16</td>
</tr>
<tr>
<td>BioCNG™ 400</td>
<td>128</td>
<td>40</td>
<td>32</td>
</tr>
</tbody>
</table>

*Assumes 1 fill per day per vehicle*

---

**Leaders in Biogas Technology**
Compressed Natural Gas Vehicles

Leaders in Biogas Technology
BioCNG™ Projects

Leaders in Biogas Technology
Rodefeld Landfill; Madison, WI

PHASE 1

1,600 scfm Biogas Conditioning System for CAT engines

December 2009

PHASE 2

Prototype BioCNG™

December 2010

PHASE 3

Upgrade to a BioCNG™ 50 Permanent Storage and Fueling Station

2015

Temporary Fueling Station

Upgrading county fleet to CNG vehicles

Leaders in Biogas Technology
St. Landry Parish Landfill; Washington, LA

PHASE 1

Gas Collection and Control System (GCCS)
On-site flare – monitoring for carbon credits

Winter 2008

October 2011
Site work for Vehicle Fueling System

April 2012
BioCNG™ 50

PHASE 2

BioCNG™ 100 Added

Summer 2015

Leaders in Biogas Technology
City of Janesville WWTF; Janesville, WI

**Site Information**

- 19 MGD municipal plant (Avg. flow 13.5 MGD)
- Current Average Flow - 12.5 MGD
- 130,000 cfd of biogas produced

**Project Timeline**

- November 2010 - Phase 1 Project Installed (4) CR65’s
- November 2011 - Phase 2 Project Installed (1) CR200
- April 2012 - Phase 3 Project Installed BioCNG™

**Gas Conditioning Equipment**

- Gas Compression/Moisture Removal
- Siloxane Removal
- Carbon Dioxide Removal

**End Use Equipment**

- (4) Capstone CR65-ICHP Turbines, produces 260 kW of electricity and thermal energy
- (1) Capstone CR200 Turbine, produces 200 kW of electricity and thermal energy
- (1) BioCNG™ System produces vehicle fuel
### Site Information
- 12.5 MGD municipal plant (Avg. flow 8 MGD)
- 100 scfm of biogas produced

### Project Timeline
- April 2015 - System Start Up

### Gas Conditioning Equipment
- Hydrogen Sulfide Removal
- Gas Compression/Moisture Removal
- Siloxane Removal
- Carbon Dioxide Removal

### End Use Equipment
- Time Fill for CNG-Fueled collection trucks and city buses
- 5.8 mile pipeline from the wastewater facility to the fueling facility
- 142,000 gallons of gasoline diverted = CO$_2$ emissions reduction of 3 million pounds/year
Contact Information

Thank You!

Tony Schilling

tony.schilling@unisonsolutions.com

sales@unisonsolutions.com

www.unisonsolutions.com

Leaders in Biogas Technology