Biogas Upgrading for Vehicle Fuel and Pipeline Injection

Kim Murdock-Timmerman
Capture your biogas....

**Midwest Digesters**

- **Downers Grove, IL**
- **Wausau, WI**
- **Glenbard, IL**
- **Kenosha, WI**
- **Green Bay, WI**
- **St. Cloud, MN**
- **Beaver Dam, WI**
- **Winona, MN**
and put it to work!

- Boiler Fuel
- Electricity Production
- Heat Recovery
- Fuel for Vehicles
Driving Factors for RNG

- High fuel costs
- Rising utility costs
- Dependence on grid

- Revenue from D3 and D5 RIN’s
- LCFS credits
- Reduce fossil fuel usage
- Lower greenhouse gas emissions

Current operations vs. Renewable fuel with a low carbon content
# RIN Details

<table>
<thead>
<tr>
<th>RIN Type</th>
<th>Description</th>
<th>GHG Reduction Requirement</th>
<th>Price 5/1/19</th>
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</thead>
<tbody>
<tr>
<td>Cellulosic Biofuel (D3)</td>
<td>Municipal wastewater plants and landfill biogas qualify (Cellulose, hemicellulose, or lignin)</td>
<td>60%</td>
<td>$1.55/RIN</td>
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<td>$2.33/GGE</td>
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<tr>
<td>Advanced Biofuel (D5)</td>
<td>Produced from non-corn starch, renewable biomass</td>
<td>50%</td>
<td>$0.34/RIN</td>
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<td></td>
<td></td>
<td></td>
<td>$0.51/GGE</td>
</tr>
</tbody>
</table>

- [https://www.biocycle.net/2017/11/13/101-for-rins/](https://www.biocycle.net/2017/11/13/101-for-rins/)
Getting Started: RIN Basic Information

- A RIN credit is a serial number assigned to each gallon of renewable fuel as it is introduced into U.S. commerce
- Fossil fuel suppliers must have a percentage of their fuel be renewable and achieve some of these levels through RIN
- Federally mandated volumes are in place until 2022
- Only biogas used as renewable transportation fuel can generate RINs
- RIN Agents - similar to Carbon Credit Exchange Brokers
Why RNG as Vehicle Fuel?

- Current Natural Gas Price: $2.55/MMBTU
- Average CNG Price (US): $2.11/GGE
- 8.8GGE = 1MMBTU
  - Equals $18.57/MMBTU, (CNG)
  - RINS are above and beyond the sale price of the fuel
- Current D3 RIN Price is $1.55/RIN ($2.32/GGE)
  - Each RIN is 77,000 Btu
  - This equates to approximately 1.5 RINS/GGE
  - This equals an additional $20.42 per MMBTU
bi-o-gas, ˈbī-ə-gas/, noun, gaseous fuel, especially methane, produced by the fermentation of organic matter.

- Methane, CH$_4$
- Carbon Dioxide, CO$_2$
- Nitrogen, N$_2$
- Oxygen, O$_2$
- Hydrogen Sulfide, H$_2$S
- Moisture
- Particulates
- Siloxanes
- Volatile Organic Compounds
Biogas Conditioning System: Process Flow Diagram

- Digester or Landfill
- Hydrogen Sulfide Removal
- Gas Compression/Moisture Removal
- Siloxane/VOC Removal

Biogas Conditioning System

- MicroTurbines
- IC Engines
- Boilers
Why Hydrogen Sulfide Removal?

- Equipment damage from corrosion (Hydrosulfuric Acid)
- SO$_x$ Emissions
- Health and safety issues (1,000 ppm will cause an individual to lose consciousness)
- Odor control
- Causes fouling of siloxane removal media
- Measure levels with either lab testing, Draeger tubes, or onsite meter
Hydrogen Sulfide Removal Systems

Ferric Oxide, $\text{Fe}_2\text{O}_3$ coated (reaction)
- Wood based
- Clay based

Ferric hydroxide pellet (adsorption)

Wausau WWTP, WI
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Biogas Conditioning System
Moisture & Particulate Removal: Major Components

- Gas Blower Inlet
- Moisture/Particulate Filter
- Compressor
- Heat Exchanger
- Glycol Chiller
Biogas Conditioning System: Process Flow Diagram

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- Biogas Conditioning System
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What is a Siloxane?

- Silica and organic compounds are combined (Organosilicon)
- Used in many consumer and *industrial products (Listed as Silicones as the ingredient on products)
  - Shampoo
  - Conditioner
  - Deodorant
  - Food additives
  - * Dry Cleaning Solutions
  - * Windshield Cleaning Products
  - * RTV Silicone Cleaner
- Siloxanes break down in landfills and digesters, and combine with the methane gas
When methane gas is used as a fuel, the siloxanes form SiO$_2$ Silicon Dioxide, and precipitate to a hard deposit on surfaces.

- Significant impact on electrical generation systems
  - Increased down time for maintaining equipment
  - Increased costs for components, i.e. spark plugs, valve seats
  - Engine rebuild time is more frequent
Siloxane/VOC Removal

- Coal
- Coconut shell
- Wood

Extruded pellets

- Silica gel - spheres
- Silica gel – irregular shaped

4 x 8 mesh chips
Biogas

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- Volatile OrganicCompounds
BioCNG Fueling System

Process Flow Diagram

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

- Traditional System with Addition of CO₂ Removal System
- MicroTurbines
- IC Engines
- Boilers
Janesville WWTP, WI – Fast Fill

- Janesville, WI
- Start-up: November 2010
- Gas Flow: 140 scfm
  - BioCNG 50
- Fast Fill – vehicle fueling
- (4) CR65 micro turbines
- (1) CR 200 micro turbine
Blue Line Transfer – Time Fill

- South San Francisco, CA
- 8 Dry Anaerobic Digesters
  - 11,200 tons of food and green waste diverted per year
- Gas Flow: 100 scfm
- Time Fill – CNG fueled waste haulers
- Fast fill – small amount of high pressure storage on site for emergency fill

In operation since 2015
Persigo WWTP, Grand Junction, CO
Dedicated Pipeline

- Population – Approximately 80,000, Grand Junction and Mesa County
- Located on the Colorado River
- 12.5 MGD municipal plant (Avg. flow 8 MGD)
- 100 scfm of biogas produced
- In operation since April 2015
City of Grand Junction RNG Pipeline

- Dedicated 5.8 mile pipeline
- Located on the Colorado River
- Extends from WWTP to existing fueling stations
Time Fill – Fueling Station

- Time Fill for CNG-Fueled collection trucks and city buses
- Dedicated 5.8 mile pipeline
- 142,000 gallons of gasoline diverted
- CO₂ Reduction of 3 million pounds/year
- 2017 - 62 city and county vehicles total being used
- Saved $179,000 on gasoline
At a Glance

- Previous raw gas use (untreated) was for boilers on site only
- Provides 280 - 300 GGE per day for city vehicles
- Production costs - $1.04/GGE
- RIN payback - $2.30/RIN (3/29/18) $3.45/GGE (1.5 D3 RIN/GGE)
- $1.50/GGE charged to city during payback period
- $3.91/GGE Net profit
- 6 year payback
- $2.9M Total project, ($1.5M for equipment, balance for pipeline)
- Colorado Department of Local Affairs grant - $500,000

Details provided by site, September 2018
St Landry Parish, LA Landfill
Virtual Pipeline

- Washington, LA
- Operational since March 2012
- Gas Flow: 150scfm
  - BioCNG 50 & 100
- Low pressure fuel storage vessel (120 psi)
- Fast Fill – vehicle fueling
St Landry Parish-Opelousa, LA

- Remote station
- Trailer with 9 low pressure storage tubes (2580 psi)
- Fast Fill – vehicle fueling
• Increased methane recovery
• High BTU product (RNG)
• Dual stage membrane technology
• Nitrogen removal may also be needed
Getting Started on a Biogas to Energy or Vehicle Fuel Project

- Cost
  - O & M Costs
  - Capital Cost
- Revenue
  - RECs, RINs, LCFS
  - Energy Offsets
  - Grants
Getting Started

http://www.energenecs.com/

www.unisonsolutions.com