Landfill Biogas to CNG – The Future is Now

LMOP 2013 Annual Conference
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LFG Energy – A Brief Look Back

• Primary biogas uses - electricity, direct use
  o Limited pipeline, vehicle fuel, etc.
  o Driven heavily by Section 29, 45 and 1603
  o Higher NG prices allowed growth of medium-Btu

• Incredible success story – U.S. is the world leader!
However, maybe time for a course correction...

Cheap and abundant natural gas

Rising petroleum prices

Increased focus on climate and GHG
The CNG Revolution has begun!

- CNG (compressed natural gas)
- 15,000,000 NGVs running worldwide
- Fleets (especially refuse) are converting to CNG for cost savings and environmental sustainability.
  - Vehicle emissions contribute to air pollution, climate change, and health concerns.
- Citizens want energy security and independence.
- Vast majority of CNG to date has come from fossil sources.
A new opportunity is before us – biogas to CNG!
Why Biogas-CNG?

- “…renewable natural gas and fossil gas are the only vehicle fuels that can displace significant amounts of oil while safeguarding U.S. national security and strengthening the economy.”
- “The U.S. economy is sapped of almost $845 million a day that is sent abroad to buy 45% of the oil to meet our needs. Some $110 million of this goes daily for the oil needed in diesel production.”
  - Fluctuating price destabilizes U.S. economy and upsets local community budgets
- “The 10 million trucks and buses on U.S. roadways provide essential services to every American community, and they transport goods worth nearly 70% of the GDP.”
  - Buses and trucks make up just 4% of all vehicles, but they use 23% of all highway fuel – almost entirely high-carbon diesel from foreign oil.

*Renewable Natural Gas (RNG) - The Solution to a Major Transportation Challenge A Clean, Secure, Commercially Viable Replacement for Diesel Fuel Today* (Energy Vision, 2012)
Biogas-CNG Benefits

• Significant savings over gasoline and diesel
  – 50-75% savings over current gas/diesel cost
  – Cost-competitive to fossil-based CNG
• Local, green, renewable fuel source
  – Up to 90% GHG reductions v. gas and diesel
  – Renewable fuel and GHG credits
• Control your future!
  – Cost locked in for 15-20 years
  – Hedge against rising NG prices
Successful Projects

Biogas Source

Vehicle Fuel Demand

Project Enabler/Developer
The Biogas Resource
(Energy Vision 2012)

**Wastes**
All organic wastes contain energy.

**Biogas**
Anaerobic digestion of wastes at landfills or in digester plants produces energy-rich biogas.

**RNG Fuel**
Biogas upgrading removes carbon dioxide & impurities to make renewable natural gas (RNG).

**Fuel Stations**
RNG goes to on-site fueling stations, or by truck or pipeline to off-site pumps.

**Vehicles**
RNG works just like regular natural gas to power vehicles.

*Figure 2. The Pathway from Organic Waste to RNG*
Best Vehicles for ‘CNG – ROI’

- High fuel use vehicles with return-to-base operations or repetitive route or pre-set geographic operating areas.
  - Regional freight truck – 16-20K GGE
  - Transit buses – 12.5-15K GGE
  - Refuse trucks – 7.5-10K GGE
  - Municipal sweeper – 5-6K GGE
  - Airport shuttle service – 5.5-7.5K GGE
  - Taxi - 4.5-5.5K GGE
  - School Bus – 2-3K GGE
# Current Biogas to RNG Projects

## Renewable Natural Gas (RNG)

### 8 Projects in the US

<table>
<thead>
<tr>
<th>Waste site</th>
<th>Location</th>
<th>Vehicles fueled with RNG</th>
</tr>
</thead>
<tbody>
<tr>
<td>Altamont Landfill</td>
<td>CA</td>
<td>300-400 refuse trucks</td>
</tr>
<tr>
<td>Fair Oaks Dairy</td>
<td>IN</td>
<td>42 milk delivery trucks</td>
</tr>
<tr>
<td>Rodefeld Landfill</td>
<td>WI</td>
<td>25-30 vehicles</td>
</tr>
<tr>
<td>Sauk Trail Hills Landfill</td>
<td>MI</td>
<td>NA (RNG leaves site via pipeline)</td>
</tr>
<tr>
<td>Columbus bio-Energy Digester</td>
<td>OH</td>
<td>25+ vehicles</td>
</tr>
<tr>
<td>Janesville Wastewater Plant</td>
<td>WI</td>
<td>40+ vehicles by 2022</td>
</tr>
<tr>
<td>St. Landry Parish Landfill</td>
<td>LA</td>
<td>15+ vehicles</td>
</tr>
<tr>
<td>Rumpke Landfill</td>
<td>OH</td>
<td>10-15 refuse trucks</td>
</tr>
</tbody>
</table>

*Energy Vision, 2012*
Operating Projects
Biogas-CNG System Economics

• Economies of scale will play role
• Biogas quality affects output and O&M
• Fuel demand is critical
• Produce CNG at $0.75-1.50 per DGE (w/RINs)
• Vehicle conversions
  o New HDVs – 10-20% higher (coming down)
  o Retrofits - passenger vehicles/light duty ~$9-15K
• With diesel at $4+ gallon...

  payback expected at between 1 and 5 years
Biogas-CNG 200: Sample Project

• Biogas Input - 200 cfm of landfill gas (54% methane)
  o Assumes ‘typical’ ranges for moisture, siloxanes, VOCs, H2S, and less than 5% N

• Fuel Production
  o 240,000 Diesel Gallon Equivalents (DGEs) per year
  o 775 DGEs/day - enough fuel for 15-20 trash trucks (or 40-50 light duty vehicles)

• Fuel Savings
  o Assuming savings of $2 gallon on diesel costs
  o $480,000 in annual fuel savings

• With Renewable Fuel Credits (RINs)
  o $170,000 per year (assuming $0.72 per DGE)
Environmental Benefit

Direct Greenhouse Gas Emissions (gCO2e/MJ):
Diesel and Alternative Fuels

Derived from C.A. Resources Board LCFS, 2009.
Bio-CNG v. Diesel Emission Reductions
10 garbage trucks converted from diesel to Bio-CNG – reduce 1,000+ tons CO2e annually

![Bar chart showing CO2e emissions for different vehicles driven (x1000) vs. miles driven (x1000). The chart compares Diesel and BioCNG emissions for various vehicle types including Garbage Truck, Municipal Sweeper, Transit Buses, and Regional Freight Truck. The chart indicates significant emission reductions with BioCNG compared to Diesel.]
Local Control of Fuel Cost

• If you could go back 20 years and lock down your fuel costs, wouldn’t you?
  o 1992 - $1.25 gallon gasoline
  o August 2012 - $3.73 gallon gasoline

• Why not control the next 20!

Gasoline Prices – 1992-2011

<table>
<thead>
<tr>
<th>Fuel Type</th>
<th>Price</th>
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<tbody>
<tr>
<td>BioCNG</td>
<td>1.01</td>
</tr>
<tr>
<td>CNG</td>
<td>2.21</td>
</tr>
<tr>
<td>DIESEL</td>
<td>4.19</td>
</tr>
</tbody>
</table>
Biogas-CNG Lessons Learned

• Trucks are quieter and cleaner – great customer service
• Smaller, modular systems allow for growth as:
  o Biogas increases; capital becomes available; fuel demand rises
• Fuel complies with CNG engine warranties
• Bio-CNG vehicle performance comparable to gasoline/diesel
• Biogas quality
  o Higher methane – more fuel
  o Biogas contaminants impact on operating costs - not fuel quality
Biogas-CNG Summary

- Proven technology
- Low cost fuel
- Long-term fixed cost
- Lowest carbon footprint
BioCNG™
Vehicle fuel for a green future
www.biocng.us
See us at Booth 18
chris.voell@biocng.us, 845-695-0240