Co-Digestion: The Path to Net-Zero Energy Consumption

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What is Bioenergy?

Biomass

Carbon Dioxide

Renewable Energy
Co-Digestion = Energy Self-Sufficiency?

Current: 30% Power Demand Met by Renewable Energy

Future: 80% to 100% Self Sufficient

- Energy Recovered from Wastewater Solids
- Energy Recovered from Food Waste
- Solar
- Grid Power
- Other Bioenergy Sources
Why Codigestion?

- Increase biogas energy production
- Reduce fossil fuel consumption
- Reduce operating / energy costs
- Minimize carbon footprint
- Increase the plant’s value to the community by recycling challenging liquid “wastes”
- Can improve digester performance & biosolids quality
- Be a true Water Resource Recovery Facility (WRRF)
It’s THE NEW HOT TOPIC...

DRIVEN BY...

- Water sector focus on energy consumption
- Renewable energy initiatives
- Energy prices (If it wasn’t for cheap natural gas, the drive would be even greater.)
- States’ focus on diversion of organics from disposal
  - MA 2014 ban on landfill disposal of organics
  - VT ~ 2015 ban on landfill disposal of organics

*Organics are becoming a hot commodity!*
Options for Organic Waste Management

From Parry et al., 2009
Food Waste Is A Key Component to Meeting Landfill Diversion Goals

Photograph from EBMUD Presentation at www.bacwa.org
Food Waste → Digester → Compost
WWRFs & Co-Digestion

- Pilot studies: Boston (MWRA), Metro Vancouver, Orange County Sanitation District, Dallas Water Utilities, San Francisco Public Utilities Commission, City of Los Angeles

- Whey receiving: Gloversville-Johnstown, NY

- Multiple feedstocks: Des Moines, IA; Essex Junction, VT

- FOG receiving: Austin Water Utility, City of Tacoma

- Deicing fluid receiving: Philadelphia Southwest Plant,

- Active food waste / FOG / organics receiving: East Bay Municipal Utility District (EBMUD) – NET ENERGY PRODUCTION
Overview: EBMUD food waste digestion

- EBMUD treats wastewater from 7 cities
- Food waste, FOG, and other high-strength wastes are trucked in and co-digested with primary & secondary wastewater solids
- In 2010, at the EBMUD wastewater facility
  - 90% of electricity needs provided from EBMUD biogas
  - Almost $3 million saved in electric power demand
- Winter 2012: EBMUD wastewater facility became a net electricity producer, (new turbine went online).
- EBMUD also has solar & hydropower installations

Food Waste Digestion at East Bay Municipal Utility District, Oakland, CA
EBMUD Pretreatment Process

*Patented Process*
Photographs from EBMUD Presentation at www.bacwa.org
Key for rapid, thorough digestion: consistent pulped waste
EPA-Funded Research on Food Waste Digestion at East Bay MUD

- Evaluation of food waste digestion vs. municipal ww solids digestion
- Bench scale
- Evaluated:
  - Minimum MCRT
  - VS & COD loading
  - VS destruction
  - CH$_4$ production rates
  - Process Stability
  - Meso & thermo AD operating temperatures
Turning Food Waste into Energy at the East Bay Municipal Utility District (EBMUD)

EBMUD Helps Mitigate Climate Change Through Anaerobic Digestion

Fact: Food Waste Contributes to Climate Change
Food waste is one of the least recovered materials in the municipal solid waste stream and is one of the most important materials to divert from landfills. Food that is disposed of in landfills decomposes to create methane, a potent greenhouse gas that contributes to climate change.

• More about the importance of diverting food waste from landfills

Fact: Food Waste Can Be Transformed Into A Natural Fertilizer
Of the less than 3% of food waste recovered from the waste stream, composting is the prominent diversion method. Composting, either in your backyard or in a commercial facility, creates a natural fertilizer with many beneficial qualities.

• More information on composting

Fact: Food Waste Can Be Used to Generate Renewable Energy

Municipal Solid Waste Sent to Landfill, 2007

Join the Discussion
Greenversations Question:

http://www.epa.gov/region9/waste/features/foodtoenergy/index.html
Findings

Compared to wastewater solids, food waste...

- produces as much or more energy / ton of processed material fed into digesters

- Food waste digestion happens at a quicker rate

- VSD = 70 to 80% (compared to ~50 – 60% for wastewater solids)

- Food waste AD produces ~1/2 the residuals (by weight)

- MCRT of 15 days for food waste maximizes CH$_4$ concentration (65 – 70%), but 10 days is OK too

- In short: food waste is more readily biodegradable
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Food Waste Pulp</th>
<th>Wastewater Solids</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volatile Solids in Feed (%)</td>
<td>85–90</td>
<td>70–80</td>
</tr>
<tr>
<td>Volatile Solids Loading (lbs/ft³-day)</td>
<td>0.60 +</td>
<td>0.20 max</td>
</tr>
<tr>
<td>COD Loading (lbs/ft³-day)</td>
<td>1.25 +</td>
<td>0.06–0.30</td>
</tr>
<tr>
<td>Total Solid Fed (%)</td>
<td>10 +</td>
<td>4</td>
</tr>
<tr>
<td>Volatile Solids Reduction (%)</td>
<td>80</td>
<td>56</td>
</tr>
<tr>
<td>Hydraulic Detention Time (days)</td>
<td>10</td>
<td>15</td>
</tr>
<tr>
<td>Methane Gas Produced (m³/ton)</td>
<td>367</td>
<td>120</td>
</tr>
<tr>
<td>Gas Produced (liters/liter of digested volume)</td>
<td>58</td>
<td>17</td>
</tr>
<tr>
<td>Biosolids Produced (lbs/lbs fed)</td>
<td>0.28</td>
<td>0.55</td>
</tr>
<tr>
<td>Description</td>
<td>Amount</td>
<td></td>
</tr>
<tr>
<td>--------------------------------------------------</td>
<td>----------</td>
<td></td>
</tr>
<tr>
<td>Hydropower generated</td>
<td>144,818 MWh</td>
<td></td>
</tr>
<tr>
<td>Solar power generated</td>
<td>640 MWh</td>
<td></td>
</tr>
<tr>
<td>Biogas power generated</td>
<td>36,900 MWh</td>
<td></td>
</tr>
<tr>
<td>Total renewable energy produced by EBMUD</td>
<td>182,358 MWh</td>
<td></td>
</tr>
<tr>
<td>Power purchased from the grid by EBMUD</td>
<td>81,500 MWh</td>
<td></td>
</tr>
<tr>
<td>Net renewable energy produced by EBMUD</td>
<td>100,858 MWh</td>
<td></td>
</tr>
</tbody>
</table>
The Problem with FOG – Fats, Oil, and Grease
What is Brown Grease?

- Fats, Oils, and Grease (FOG) that have come into contact with graywater
- High free fatty acid (FFA) Content: 50-100%
- Found in restaurant grease traps and interceptors
FOG Control Ordinances

• Most require installation of some kind of grease trap with basic BMPs

• More cutting edge:
  • Restaurants must install/upgrade to Automatic Grease Recovery Devices (AGRDs) within 3 years
  • AGRDs ensure daily recovery, dewatered grease, easy collection
  • AGRDs must be serviced & inspected every 90 days
  • All recovered FOG must be beneficially reused
THE SOLUTION:
LAWPCA digesters have ~ 15% excess capacity
Benefits of Codigestion to a Municipality

- All types of organic waste can be treated in one plant
- Efficient recovery of biogas, a renewable energy source
- Closed system with a minimum of smell/odor
- Energy can be recovered as electrical power, combined heat & power, compressed biogas (CBG) upgraded to vehicle fuel
- Revenue from tip fees (SF Bay agencies $0.03-$0.15/gallon)
Codigestion Impacts on a WRRF

Challenges:
- Preprocessing: off-site? Pumpable? Truckable?
- Control of incoming wastes/need to establish permit program
- Pretreatment of wastes to remove debris and protect equipment
- Ensuring sufficient digester capacity
- Potential for process upsets – need to provide uniform feed
- Effect on biosolids and/or organics end use
- Unknown effect on nutrient content in sidestream
- Odor potential at receiving area and during maintenance
- Public outreach
Available wastes in LAWPCA region

1. Fats, Oils, Grease (FOG)
2. Airplane De-icing Fluids (Glycols)
3. Other Glycol Sources
4. Pioneer Plastics / Pionite
5. Waste Oils
6. Machine Coolant (Halogens)
7. Glycerin
8. Landfill and Transfer Station Leachate
9. Dairy Waste (whey, washwater)
10. Brewery Waste
11. Organic Portion of Municipal Solid Waste (mostly consumer food waste)
12. Food Processing Wastes
13. Beverage Bottlers
14. Slaughterhouse Wastes
Landfill leachate
Estimating Financial Benefits (1)

The following only include tipping fees. Additional factors to consider include, but are not limited to:

- Additional revenues or cost offsets from increased biogas production.
- Costs of infrastructure needed to accept, store, and meter in the outside wastes.
- Costs to process the additional solids, including dewatering, polymer, labor, etc.
- Costs to manage the additional biogas, including cleaning, storage, and combustion.
- Feed rate of LAWPCA solids – 58,000 gals/day
Estimating Financial Benefits (2)

Scenario 1. Accept only fats, oils, & grease (FOG) from a variety of transporters:

a. 3,000 gallons/day @ $.06 / gallon = ~$66,000 / year (This pricing matches the lowest-priced current competition, Anson-Madison Sanitary District)

b. 3,000 gallons/day @ $.14 / gallons = ~$155,000 (This pricing matches South Berwick, ME)
Estimating Financial Benefits (3)

Scenario 2. Accept other specialty wastes

- They generate higher tipping fees
- Likely available (subject to review for contamination and feasibility):

  - ~$100,000 / year:
    - *Food processing waste* (B & M Baked Beans): 1,100 gallons / day @ $.14 / gallon = ~$56,000 / year.
    - *Pioneer Plastics / Pionite glycols, etc.*: 1,100 gallons / day * $.14 / gallon = ~$40,000 / year
Co-substrates:
- Restaurant food waste
- Pharmaceutical industry ethanol & methanol (2/3 used for nit/denit)
- Grease
- Airport de-icing fluid

Pretreated:
- Sieve-hammermill
- Ground to 2 mm
- Stored at 60° C

Biogas used for heating digesters, drying solids, and in vehicles

From *biogasmax 2006/2010 the synthesis*. See www.biogasmax.eu
Toronto, Canada

- **Input/material to be treated:**
- Source – separated household waste
- Operating on demonstration scale since 2006
- Processes 25,000 metric tons/year
- Operational issues with organic waste only digesters (ammonia inhibition)
Plant at Lillehammer

- Source – separated household waste and food waste from industrial sector.
- Capacity: 14,000 t/a
- For every 1000 kg input, there is approx. 380 kg reject and 150 kg of digestate. The plant makes about 300 kWh of electricity per 1000 kg of post-reject waste.
- Biogas converted to electrical power; THP steam and digester heat.
- In operation since 2001
Conclusions

- LAWPCA built digesters for solids reduction.
- Taking in outside wastes is optional; not banking on it.
- There is competition for wastes – lots of potential digester & composting projects.
- Generators not interested in long-term contracts
- Municipal AD has benefit of existing infrastructure for managing solids & side stream.
- Phased implementation to taking outside wastes helps operators adjust.
Thank you. Questions?

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