FOOD WASTE / MANURE

Paul Greene | Chairman – ABC | Vice President – O’Brien & Gere Engineers
Manure and Food Waste Digestion

- Types of food waste
  - (preconsumer, postconsumer, industrial, liquid, solid)

- Types of manure
  - (farm yard slurry, farm yard manure)

- How much of what goes in to a manure or food waste digester comes out the other end and what can you do with that leftover stuff?

- How much food waste and manure is available to digest?
Meet cow...cow eats food...

Cow makes milk...

Milk is pasteurized onsite and sold locally

Cow gets milked...

Cow makes poop...super cool poop scraper collects poop in tank below
Clover Hill Dairy, Wisconsin | 1,250 Cows | 300kW Power
Albany NY | Small Farm Digester
Auburn, NY Community Digester
Various Digester Designs
Mini Digester | 1 Ton /day
People waste food...the waste water is collected in tank and the food is ground up...

Digester is 60 feet deep and covered to collect gases release from the breakdown of foods

Ground food, waste water and poop mix in tank then moves to digester
Substrate Management

- Substrate takeover facility
  - Closed building w/ truck takeover & washing
  - Negative pressure & bio-filters (NO odors)
  - Substrate stream management (blending, mixing, storage, etc.)
  - Trained personnel

- Key requirements:
  - Ability to deal with Multiple Feedstock
  - Removal of impurities
  - Particle size reduction
  - Ability to deal with changing feedstock
  - Substrate preparation for Anaerobic Digestion

- Separation Equipment
  - Automated organics / packaging separation
  - High throughput

- Substrate Processing Equipment
Multi-Feedstocks

- Food Industry Residues (from breweries, diaries, slaughterhouses)
- Organic Waste (e.g. kitchen waste, packaged food waste, OFMSW)
- Biofuel Industry Residues (e.g. ethanol stillage, distillation residues)
- Agricultural Residues and Products (e.g. chicken litter, cow manure)

- Suitable for various, complex and challenging industrial residues
- Conversion into BioGas separately or as a mixture
- Maximum possible efficiency and energy output from any feedstock
Substrate Management

Example

- Transports
- Dosing Bunker
- Crushing
- Centrifugal Separation
- Sand removal
- Maceration
- Pasteurization
Waste Separation Equipment
FEEDSTOCK DRIVERS

- Will there will be significantly more anaerobic digesters developed (both urban & agricultural) in the next 10-20 years?
  - YES!

- Will there be more competition for clean, high energy potential feedstocks over the next 10-20 years?
  - YES!

- What will be the impact on the economics of AD plants only able to handle clean feedstocks?
  - Potential shortages of feedstocks.... Lower energy production....Lower energy revenue
  - Lower tip fees – 50-60% of revenue
FEEDSTOCK PROCUREMENT SUCCESS

- **Price**
  - Lower than local alternatives

- **Location**
  - Lower transportation costs

- **Flexibility**
  - Accept contaminated feedstock
# Feedstock Characterization

<table>
<thead>
<tr>
<th></th>
<th>Clean Solid</th>
<th>Liquid</th>
<th>Contaminated Solid</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Agricultural</strong></td>
<td>Manure (10-12%TS)</td>
<td>Liquid Manure (6-10% TS)</td>
<td>Feedlot Manure</td>
</tr>
<tr>
<td></td>
<td>Energy crops e.g. corn silage</td>
<td></td>
<td>Greenhouse</td>
</tr>
<tr>
<td><strong>Urban</strong></td>
<td>Fruit &amp; Vegetables Distillery/brewery grains</td>
<td>Fats, Oils, Greases DAF (Dissolved Air Floatation) Juice, softdrink</td>
<td>Residential Food Waste Packaged Food Product Destruction e.g. off spec, expired</td>
</tr>
</tbody>
</table>
**Feedstock Segmentation**

- **Clean Solids**
  - Breaded Chicken
  - Fruit Peels

- **Contaminated Solids**
  - “Separated” Grocery
  - Non-separated Restaurant

- **Liquids**
  - Milk & Yogurt
  - Fats Oils Greases

- **Packaged Food**
# Biogas Potential

<table>
<thead>
<tr>
<th>AGRICULTURAL</th>
<th>CLEAN SOLID</th>
<th>LIQUID</th>
<th>CONTAMINATED SOLID*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manure</td>
<td>LOW</td>
<td>Liquid Manure - LOW</td>
<td>Feedlot Manure - LOW</td>
</tr>
<tr>
<td>Energy crops</td>
<td>MED</td>
<td></td>
<td>Greenhouse - LOW</td>
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<th>URBAN</th>
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<th>LIQUID</th>
<th>CONTAMINATED SOLID*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fruit &amp; Veg</td>
<td>LOW</td>
<td>Fats, Oils, Greases - HIGH</td>
<td>Packaged Food - HIGH</td>
</tr>
<tr>
<td>Distillery/brewery</td>
<td>HIGH</td>
<td>DAF (Dissolved Air Floatation) - MED</td>
<td></td>
</tr>
<tr>
<td>Residential Yard &amp; Garden</td>
<td>LOW</td>
<td>Juice, softdrink - HIGH</td>
<td></td>
</tr>
</tbody>
</table>

**Legend:**
- LOW = 10 – 30 m³/ton
- MED = 30 – 100 m³/ton
- HIGH = 100 + m³/ton

*Varies with % Contaminants
# Tipping Fee Revenue

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<td>LOW</td>
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<tr>
<td>Urban</td>
<td>MED</td>
<td>HIGH</td>
<td>HIGH</td>
</tr>
</tbody>
</table>

**Legend:**
- LOW = $0-$20/ton
- MED = $20-$50/ton
- HIGH = $50-$150/ton
FEEDSTOCK SPECTRUM

Contaminated Solid

- Non-Separated
  - e.g. grocery, restaurant, residential
- Packaged
  - e.g. off-spec, expired

Clean Solid

- Clean ICI
  - e.g. food processors
- Separated
  - e.g. grocery produce

Few Disposal Options
- e.g. Landfill
  - Higher Tip Fees

Many Disposal Options
- e.g. compost, animal feed, farm AD
  - Lower Tip Fees

Clean ICI
- e.g. food processors

Separated
- e.g. grocery produce

Liquid
- e.g. FOGs
FEEDSTOCK SWEET SPOT

*Tip Fee / Ton

Clean ICI
Separated
Liquid
Packaged
Non-Separated

Actual tip fees from large metropolitan market
Contaminants like bones, packaging, dishes, cutlery, light & hard plastic etc.
THE PROBLEM WITH CONTAMINANTS
CONTAMINANTS END UP IN YOUR DIGESTATE OR THE BOTTOM OF YOUR TANK

Sinking Contaminants: bones, metal, glass, shells, rocks, sand

Floating Contaminants: soft & hard plastic, rubber, styrofoam
CONTAMINANT REMOVAL OPTIONS

Chain Shredder & Pump Press

Hammermill

BTA® Hydropulper

Internal Agitator
MULTI-STEP CONTAMINANT REMOVAL SYSTEMS...WHY?

- No conditioning or pre-treatment equipment will be 100% EFFECTIVE... some contaminants always get into the tanks

- 1: Break up organics & contaminants
  - Achieve better particle size reductions

- 2: Screen out organics & heat... 1-2 times
  - Achieve better solid separation

- 3: Remove those contaminants that sink and those that stay in suspension or float
  - Light plastics will float
  - Heavy solids like bones, metals & eggshells will sink
YIELD/FITEC

3 STAGE CONTAMINANT REMOVAL SYSTEM

- 1\textsuperscript{st} : Shredding and pressing removes 95\% of contaminants
- 2\textsuperscript{nd} : Heating and pressing removes 50\% of remaining contaminants
- 3\textsuperscript{rd} : In-tank floor scraper and skimmer removes balance of contaminants
CHAIN SHREDDER
## Example

<table>
<thead>
<tr>
<th>Feedstock</th>
<th>≤ 10 t/hr</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Packaged Food Waste; SSO</td>
</tr>
<tr>
<td>Location</td>
<td>Benet, France</td>
</tr>
<tr>
<td>Customer</td>
<td>SIFDDA / SARIA</td>
</tr>
<tr>
<td>In operation since</td>
<td>2010</td>
</tr>
</tbody>
</table>
Success Stories

- Pamukova, Turkey – Biosun / Hexagon

<table>
<thead>
<tr>
<th>Feedstock</th>
<th>50 000 t/yr</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SSO; OFMSW; Agricultural Residues</td>
</tr>
<tr>
<td>Energy production</td>
<td>~ 1.4 MW&lt;sub&gt;el&lt;/sub&gt;</td>
</tr>
<tr>
<td>Start-up</td>
<td>2011</td>
</tr>
</tbody>
</table>

- Co-Located with composting facility
- Integrated with MRF and RDF facility
- Heat used for local heating applications
- Favorable environment for renewable electricity
- Owner/Operator has large waste collection business
Success Strategies

Example Este (Italy) – Largest Plant in Europe

<table>
<thead>
<tr>
<th>Feedstock</th>
<th>OFMSW, food industry waste, slaughter house waste, biofuel residues</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input</td>
<td>105,000 tons/year</td>
</tr>
<tr>
<td>Fermenter</td>
<td>2 x 2900m³, loading rate &gt; 10 kg COD/m³</td>
</tr>
<tr>
<td>Output</td>
<td>Biogas: 1,450 Nm³/h (59% CH₄)</td>
</tr>
<tr>
<td></td>
<td>Electricity: 3.4 MWₑₑ (27 GWh/y)</td>
</tr>
<tr>
<td></td>
<td>Purified Water &amp; Fertilizer</td>
</tr>
<tr>
<td>Start-up</td>
<td>2006 (original plant), 2011 (expansion)</td>
</tr>
</tbody>
</table>

- Co-Located with composting facility
- Located next to former landfill
- Heat is fed into district heating network, concentrated fertilizer for land appl.
- Owner / operator is major player in waste industry (experience)
- Favorable environment for renewable electricity
Case Study | Food Waste

SARIA ReFood, Marl, Germany

Multi-Feedstock BioGas plant
Customer: SARIA ReFood

- Located within industrial food waste processing complex
- Next to rendering processing company (user of thermal energy)
- Owner / Operator is major player in food residue industry (experience)
- Favorable environment for renewable electricity

<table>
<thead>
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<th>Substrate</th>
<th>Expired food from food retailers, catering waste (87,000 tonnes per year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capacity</td>
<td>6.3 mio Nm³ of BioGas (approx. 3 MW&lt;sub&gt;el&lt;/sub&gt;)</td>
</tr>
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Side Products: Heat, Fertilizer
THANK YOU

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