Outline

• Introduction

• Technology Selection
  • Practical Considerations
  • Technical Parameters

• Feedstock Preparation
  • Reception
  • Size Reduction and Separation
  • Removal of Settleables

• AD Technologies
  • Batch High-Solids Anaerobic Digestion
  • Continuous High-Solids Anaerobic Digestion
  • Low-Solids Anaerobic Digestion

• Digestate Handling
Harvest Power’s Business

Harvest finances, builds, owns, and operates state-of-the-art organics recycling centers:

- **Business**: Founded in 2008 as builder, owner and operator of organics processing facilities
- **Investors**: Include Kleiner Perkins, Generation Investment Management, Waste Management, Munich Venture Partners, SAM (part of Rabobank Group)
- **Revenue**: $100 million annualized revenue
- **Capacity**: Handle 1.8 million metric tonnes of waste per year across 15 sites; Sell 29 million bags of soil and mulch and 400,000 cubic yards in bulk
- **Team**: 300 employees; 200+ years experience on management team

Expertise Required in all Three for Success

- Renewable Energy & Fuel
- Organics Procurement & Processing
- Soils, Mulches and Fertilizer
Our Vision for Organics
Factors Affecting Technology Choice

- Feedstock Availability
- Feedstock Economics
- Site Characteristics / Existing Infrastructure
- Wastewater Disposal Options
- Digestate Utilization Options
- Market for end-products

Typical Economically-Justified Technology Applications for Organic Waste

<table>
<thead>
<tr>
<th>Batch High Solids AD</th>
<th>Continuous High Solids AD</th>
<th>Low Solids AD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Combined commercial and residential SSO (food waste and yard waste) are abundantly available year-round, and both feedstocks are associated with favorable tipping fees. This technology is associated with a large amount of solid organic digestate and thus integrates well with composting operations. It generates little or no wastewater. Coarsely shredded MSW can also be used.</td>
<td>Relatively clean commercial food waste is abundantly available (e.g. restaurants, supermarkets and food processing) and associated with a favorable tipping fees. MRF organic residuals are a common feedstock as well. The liquid effluent from this process must be managed, either as an agricultural fertilizer or a high-strength wastewater. Solid digestate can be composted or dried.</td>
<td>Most common digester technology. Wastewater sludge, industrial wastewater (breweries, distilleries, milk processing, etc.) and/or manure is abundantly available. Food waste slurries and FOG may be co-digested. Typically requires some wastewater treatment before final disposal of liquid effluent.</td>
</tr>
</tbody>
</table>
The choice is also dependent on the availability of wastewater reuse options (farms, WWTPs, etc.)
## Promoting AD – Policy & Economic Considerations

*Factors Influencing Developers and Investors to Pursue Large-Scale AD Development in a Particular Jurisdiction*

<table>
<thead>
<tr>
<th>Policy Factors</th>
<th>Economic Factors</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Permitting Pathway</strong></td>
<td><strong>Feedstock</strong></td>
</tr>
<tr>
<td>• Predictability: is it clear <em>how</em> to proceed and <em>what</em> information will be required?</td>
<td>• Availability</td>
</tr>
<tr>
<td>• Speed</td>
<td>• Price</td>
</tr>
<tr>
<td>• Cost and complication: how many different agencies?</td>
<td><strong>Energy Offtake</strong></td>
</tr>
<tr>
<td><strong>Organics Policies</strong></td>
<td></td>
</tr>
<tr>
<td>• Diversion: encouraged or required (note: commercial &amp; institutional more important than residential)</td>
<td>• Price</td>
</tr>
<tr>
<td>• Operating Rules: are standards re: contamination, odor-control, <em>etc.</em> up-to-date and realistic?</td>
<td>• Inter-connection: availability, cost, and timing?</td>
</tr>
<tr>
<td></td>
<td>• Contracting: ease of contracting with off-taker?</td>
</tr>
<tr>
<td></td>
<td><strong>Product Markets</strong></td>
</tr>
<tr>
<td></td>
<td>• Is there an established market for the solid or liquid residuals?</td>
</tr>
</tbody>
</table>
| | • Pricing?
## Contaminant Removal/Feedstock Prep

Feedstock preparation is dependent on the feedstock and the digester technology.

<table>
<thead>
<tr>
<th></th>
<th>Batch High Solids AD</th>
<th>Continuous High Solids AD</th>
<th>Low Solids AD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contaminant removal</td>
<td>Most contaminants (plastic, glass, metal) removed <em>after</em> digestion and composting</td>
<td>Contaminants removed from incoming feedstocks <em>before</em> digestion</td>
<td></td>
</tr>
<tr>
<td>Feedstock Preparation</td>
<td>Mixing with front-end loader – optional coarse shredding</td>
<td>Different types of feedstock are received and handled separately. Contaminated food waste (e.g. supermarkets) is depackaged, macerated and stripped of plastic and metals. Slurry is created for storage and pumping to digester.</td>
<td>Similar to continuous High Solids AD for contaminated feedstocks; Other homogeneous liquid wastes (e.g. FOG) are typically received by direct tanker discharge to storage tanks.</td>
</tr>
</tbody>
</table>
Reception Alternatives

**Clamshell Crane**

Truck tips into a stainless steel pit, shaped to allow a clamshell crane to pick up all material. Clamshell empties into hopper with screw at the bottom, which opens bags and transports material.

**Live Floor with Auger**

Truck tips into a covered stainless steel pit (opened only when the material is loaded), fitted with a transverse auger. Shear action of the screw does the bag opening. Optional crane removes large items and big contaminants.

**Tipping Trough**

Truck tips into a receiving bunker and the entire bucket tips up. A transverse screw conveyor discharges the bunker.
Size Reduction & Separation Alternatives

Horizontal separator (Hybag)

Vertical chain mill + Piston press (FITEC)

Vertical Bioseparator (Doda)

Hammer Mill Separator (Wackerbauer)
Removal of Settleables

Floor Scraper

Hydrocyclone
Sample Complete Pre-treatment System for Contaminated Feedstocks in LSAD

Truck tips into a covered stainless steel pit (1) (opened only when the material is loaded), fitted with a transverse auger. Shear action of the screw does the bag opening. Optional crane (2) removes large items and big contaminants. Screw conveyor (3) elevates feedstock into horizontal axis paddle separator (4). Paddles and breaker bars create slurry from organics while rejecting metals and plastic (some glass and plastic pass through and are screened post digestion). Rejected plastics and metals are screw conveyed to a dumpster (5), while the organic slurry is pumped (6) into a hydrocyclone (7) to recover the majority of stones, sand, grit and glass (settleables), before being transferred to a reception tank (8).
Sample Complete Pre-treatment System for Contaminated Feedstocks

Supermarket Waste (~10% contamination)

Reception pit

Separator Mill

Hydrocyclone

Shredded Plastic and metal rejects

Settleables (metals, glass, grit, stones, etc.)

Digester
Pre-treatment for Batch HSAD

Optional Shredder/Mixer

Loading Tunnels
1. Hydrolysis Percolators
2. Hydrolysate Buffer Tank
3. Methane Digester
4. Digester Effluent Buffer Tank
5. Covered ASP

Batch High Solids Process Flow
Batch HSAD Facility - Richmond, BC

**Feedstock**
30,000 tons per year of food and yard waste, including municipal SSO and IC&I waste

**Output**
1 MWe

**Technology**
GICON batch, two-stage high solids anaerobic digestion technology

**PPA**
Long-term agreement with BC Hydro

**Compost Product**
~20,000 tons/year

**Footprint**
2 acres
Batch HSAD

- Easily integrates with existing composting operations
- Maximum tolerance for contaminants
- Minimal if any liquid residual
- Requires structural material
Batch HSAD Reference Facilities

- 50+ fully operational batch HSAD plants in Europe
- 30,000 TPY plant under construction at Harvest’s FRSF site
Example Continuous HSAD Technology Overview

<table>
<thead>
<tr>
<th>Feedstock</th>
<th>60,000 tons per year of food waste from supermarkets and dewatered fats, oils and grease (FOG) from grease traps</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output</td>
<td>2.8 MWe</td>
</tr>
<tr>
<td>Technology</td>
<td>Eisenmann / OWS (DRANCO) / Biffa / Others</td>
</tr>
<tr>
<td>End Product</td>
<td>Granular fertilizer</td>
</tr>
<tr>
<td>Footprint</td>
<td>2 acres</td>
</tr>
</tbody>
</table>
Continuous HSAD

- Can run on food waste alone
- Contaminants must be removed before digestion
- Liquid residual must be managed
- Possibility to integrate dryer and produce granular solid product
Continuous HSAD Reference Facilities

- 200+ fully operational biogas plants in Europe
70,000 TPY Low Solids AD Facility - London, ON

<table>
<thead>
<tr>
<th>Feedstock</th>
<th>70,000 tons per year of food processing by-products and commercial SSO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output</td>
<td>2.8 MW of electricity</td>
</tr>
<tr>
<td>Technology</td>
<td>OvivoGWE CSTR low solids anaerobic digestion and fertilizer production</td>
</tr>
<tr>
<td>PPA</td>
<td>Long term agreement with the Ontario Power Authority</td>
</tr>
<tr>
<td>Fertilizer</td>
<td>~5,000 tons/year, granular</td>
</tr>
<tr>
<td>Footprint</td>
<td>5 acres</td>
</tr>
</tbody>
</table>
• Can operate on a range of liquid wastes
• Contaminants must be removed before digestion
• Digester volumes are large
• Large volumes of liquid residual must be managed
• Preferred configuration is integration with WWTP
LSAD Reference Facilities

• Many around the world
• Ideally, we would sell unprocessed digestate for direct agricultural land application owing to its high nutrient content

• Minimal market in the Northeast for liquid effluent as fertilizer. Thus, we have to make provisions to manage the digestate

• Digestate management is different for Batch and Continuous systems
  • Batch-HSAD: There is limited pre-treatment before digestion, therefore majority of the contaminants are taken out post-digestion. Processes and equipment are similar to what you would find at a composting operation, involving shredding, screening and sifting.
  • Continuous HSAD / LSAD: Digestate is wet, and requires some combination of the following:
    • Liquid-solid separation: Screw press; belt filter press; rotary press; centrifuge
    • Further processing of solid digestate: drying to produce granular fertilizer; pelletizing; composting in windrows or in piles
    • Treatment of liquid effluent as a high-strength wastewater: Aeration in an MBR or SBR; UF + RO; etc.
Digestate Management – Batch-HSAD

Drumscreen

Wind sifter

Komptech, Hurrikan, etc.
Liquid-Solid Separation

- **Screw Press**
  - Vetter, Vincent Corp., etc.

- **Decanter Centrifuge**
  - Centrysis, Alfa Laval, etc.

- **Belt Filter Press**
  - Komline, Parkson, Alrick Press Cp., etc.

- **Gravity Belt Thickener**
  - Komline, etc.
Processing Solid Digestate

Dorset, Berlie-Falco Technologies, AVA, Aslan, Fenton, Komline, VOMM, Royal GMF-Gouda, Buss-SMS-Canzler, HUBER, etc.

Harvest’s Proprietary CASP system, Existing or new windrow systems

Dryer

Composting

OR
There’s a better path for organics — help us get there.

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