Integrating Anaerobic Digestion and Aerobic Composting

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WHICH IS BETTER,

ANAEROBIC DIGESTION OR AEROBIC COMPOSTING?
What’s Better, AD or Aerobic Composting?

• Which is more expensive?
• What do we mean by expensive?
  – Input costs (capital and O&M)
  – Net costs after revenues
  – Life cycle costs
• Which one will work best at our site?
• Which one can we get permitted easier?
• Are there better incentives like subsidies for one vs the other?
• Which one is the more proven technology?
Anaerobic Digestion vs. Composting
Start with Feedstocks

- AD or Composting: Which is better suited to the feedstocks we have?

- **Leaf and yard wastes** generally not as well-suited for AD
  - Low biogas yield
  - Lignocellulosic materials – resistant to digestion
  - Investment too high to justify returns, but depends on digester technology and project specifics

- **Food wastes** well-suited for AD
  - Higher biogas yields
  - More rapid and complete digestion
• What if we have various feedstocks
  – AD has better results for some feedstocks
  – Composting better for others

• HOW ABOUT COMBINING THE TWO IN ONE PLANT?
How do we decide?
Let’s look at inputs and outputs

Compost inputs and outputs:
Inputs and outputs for AD

- **Feedstocks**
- **Energy**
- **Water**

Digester

- **Biomass Utilization**
- **Biomass**
- **Energy**
- **Effluent**
- **Wastewater Treatment**
- **Digestate**
Integrated AD/Compost Inputs and Outputs
Advantages of Integrated Systems

- Elimination of effluent treatment
- Thermophilic composting treats effluent from mesophilic digestion – pathogen destruction
- Direct use of biogas energy in composting system (avoiding grid costs)
- Conservation of effluent nutrients – nutrients go into compost
- Increases overall plant capacity with minimal footprint increase
- Minimizes odor from food waste processing – food waste receiving and digestion is completely enclosed
- Relatively small amounts of food waste can be handled in the same plant as larger leaf/yard waste quantities.
- During startup and shutdown periods of the AD system, food waste can be diverted to the compost system.
Is this being done anywhere?

- Several plants in Europe employing *partial stream digestion*.
  - Hengelo, Netherlands – Dranco System by OWS
    - 44,000 tpy biowaste (combined yard/food waste), 11,000 tpy pre-consumer food waste
  - Tenneville, Belgium
    - 43,000 tpy food waste, 14,000 tpy yard waste, 1,400 tpy liquid organic waste
  - Up to 70% of waste goes into anaerobic digestion
  - Generate electricity from biogas

- In North America,
  - Harvest Power’s Energy Garden and Composting Facility in Richmond, BC
    - 20,000 tpy commercial food waste
    - 200,000 tpy combined food and yard waste
  - JC Biomethane in Eugene, Oregon
    - 12,000 tpy commercial food waste
    - 16,000 tpy food processing waste and manure
  - San Jose HSAD Facility – Zero Waste Energy
    - 90,000 tpy organics from “wet/dry” ICI waste collection system
Partial stream digestion: Hengelo (NL)

Aerobic composting: 4 acres

Anaerobic digestion: 0.5 acres

Courtesy Organic Waste Systems
Partial stream digestion: Hengelo (NL)
Harvest Power's Energy Garden and Composting Facility (Richmond, BC)
How do we analyze a system to decide?

Many factors to consider – take it ONE STEP AT TIME

1. Define feedstocks and project quantities
2. Define the scenarios (compost, AD, combined) for your site.
3. Develop process flow diagrams for each scenario
4. Develop site layouts for each scenario – make sure it fits
5. Compute mass and energy balances for each scenario
6. Economic evaluation – Net Present Value over project life
Step 5: Mass and Energy Balance (example)

SCENARIO 2

Inputs

Feedstock Preparation: 450,000 kWh/year (e)
Heat digester: 770,000 kWh/year (t)
Pumps etc: 790,000 kWh/year (e)

Final Products

144,447,600 kWh/year SCF Biogas (e)
419,208 kWh/year CHP & Biogas treatment (e)
315,000 kWh/year Digestate handling (e)
365,000 kWh/year Compost (e)

Net Energy:
4,836,417 kWh/year (e)
7,123,188 kWh/year (t)
STEP 6: COMPARE NET PRESENT VALUE OVER 20 YEARS

COSTS
- Capital Costs
- O&M by Year Over Project Life
- Equipment Replacement Costs

REVENUES
- Tipping fee
- Compost sales
- Energy sales
- Grants, interest free loans, other incentives
- Cost savings
  - Displace existing fuels with biogas
  - Reduced composting time
NPV RESULT (example)

- Membrane covered ASP Composting
- Dry Stackable Anaerobic Digestion
- CNG system for biogas use
- $10 million initial grant
- 20 year project life

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<thead>
<tr>
<th></th>
<th>Scenario 1 40K tpy compost</th>
<th>Scenario 2 30k compost 10k AD</th>
<th>Scenario 3 30k compost 20k AD</th>
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</thead>
<tbody>
<tr>
<td>20-year Project Life</td>
<td></td>
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<tr>
<td>Total Initial Capital Spending</td>
<td>($12,818,848)</td>
<td>($18,064,370)</td>
<td>($23,168,419)</td>
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<tr>
<td>Total Equipment Replacement</td>
<td>($5,210,000)</td>
<td>($5,320,000)</td>
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<td>Total Operating and Maintenance</td>
<td>($22,041,857)</td>
<td>($27,263,214)</td>
<td>($33,273,080)</td>
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<td>Total Grants and Revenue</td>
<td>$47,307,323</td>
<td>$57,049,597</td>
<td>$84,055,659</td>
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<tr>
<td>Net Present Value</td>
<td>$1,895,081</td>
<td>($1,012,888)</td>
<td>$11,068,631</td>
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Thank you!

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