Solid Waste Management Technologies

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• Basic description
• Key considerations
• Financial implications
• Examples
• Mayor’s Corner
Sanitary Landfills – The Basics

• Linear
• Leachate management
• Landfill gas collection
• Daily and final cover
## Sanitary Landfills – What to think about?

<table>
<thead>
<tr>
<th>Pre-Construction</th>
<th>Construction/Operations</th>
<th>Closure/Post-Closure</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Landfill capacity</td>
<td>• Liner</td>
<td>• Final cover</td>
</tr>
<tr>
<td>• Siting</td>
<td>• Leachate monitoring, collection, treatment</td>
<td>• Monitoring</td>
</tr>
<tr>
<td>• Recovery of recyclables or reusable materials</td>
<td>• Landfill gas collection</td>
<td>• Post-closure use</td>
</tr>
<tr>
<td></td>
<td>• Storm water management</td>
<td></td>
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<tr>
<td></td>
<td>• Waste compaction</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Cover</td>
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<tr>
<td></td>
<td>• Monitoring</td>
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</tbody>
</table>
Sanitary Landfills – How much will it cost?

**Capital Costs** (25-50%)
- $1M-50M, 20,000-2M t/yr

**Operating Costs** (60-80%)
- $7-30/tonne

**Post-Closure Costs** (10-15%)
- $80,000-500,000/acre
Is your landfill too expensive?

• Regional landfill
• Pool or bundle landfills
• Carbon finance
• Preferred tariffs for renewable energy
• Sale of byproducts or services
• Tipping/gate fess
• Public-private partnerships
Composting – What is it?

• Breaking down of organic matter by microorganisms in the presence of oxygen
• Volume of organic waste can decrease by 60-90% as a result.
## Composting – Selecting Method

<table>
<thead>
<tr>
<th>Scale of operation</th>
<th>Large/ regional/ municipal Windrow/Static Piles</th>
<th>Small/ community In-Vessel</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Processing capacity (tonnes/day)</strong></td>
<td>1 – 1,000</td>
<td>20 – 350</td>
</tr>
<tr>
<td><strong>Time required</strong></td>
<td>Several weeks</td>
<td>Few days to weeks + 2-4 weeks</td>
</tr>
<tr>
<td><strong>Leachate production</strong></td>
<td>Low</td>
<td>Minimal</td>
</tr>
<tr>
<td><strong>Sensitivity to weather</strong></td>
<td>If feedstock freezes, the decomposition process stalls</td>
<td>Functions in all climates</td>
</tr>
<tr>
<td><strong>Capital cost (US$/tonne)</strong></td>
<td>$40-60</td>
<td>$300-500</td>
</tr>
<tr>
<td><strong>Operating cost (US$/tonne)</strong></td>
<td>$12</td>
<td>$130</td>
</tr>
</tbody>
</table>
Composting – What to think about?

- Quality of input
- Types of input
- Siting
- Facility size
- Storm water & leachate management
- Sensitivity to weather
- Speed of composting process
- Market for compost & product certificate
Spending too much on organic waste management?

• Think in total system terms
• Charge a fee for private sector access to your composting facilities
• Offer related services
• Find a partner
• Share a regional facility
• Pool or bundle facilities
• Carbon finance
• Encourage on-site composting
• Try a targeted approach
Anaerobic Digestion – What is it?

- Outputs are semi-solid fertilizer & biogas
- Naturally occurring microorganisms break down waste in the absence of oxygen & emit gases
- Decreases volume by 50-60% while conserving nutrients for soil & killing up to 95% of any disease-causing organisms
- Biogas created can be used to generate electricity or refined & supplied to natural gas utilities
Anaerobic Digestion – What to consider?

• Infrastructure
• Feedstock
• Biogas production
• Biogas uses
• Cleaning of the biogas
## Anaerobic Digestion—Costs & Financing

### Financing
- Think in total system terms
- Tipping fees
- Sale of fertilizer
- Sale of biogas as an energy source
- Preferred tariffs for renewable energy
- Carbon finance
- Public-private partnership

<table>
<thead>
<tr>
<th></th>
<th>Capital Expenditures (US$/annual tonne)</th>
<th>Operational Expenditures (US$/tonne)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Europe</strong></td>
<td>$345-600</td>
<td>$31-57</td>
</tr>
<tr>
<td><strong>United States</strong></td>
<td>$220-660</td>
<td>$22-55</td>
</tr>
</tbody>
</table>
Pyrolysis & Gasification – The Basics

• Advanced Thermal Treatment technologies convert waste primarily into a synthetic gas or fuel

• Heating waste to high temperatures without oxygen, producing (1) a synthetic gas (syngas), (2) tar, & (3) char

PRE-TREATMENT OF WASTE
• Dry
• Sterilize
• Separate out recyclables

HEATING REMAINING WASTE
• Produce syngas, solids

GENERATE ELECTRICITY AND/OR HEAT
• Use ‘scrubbed’ gas to generate electricity and/or heat

‘SCRUBBING’ THE SYNGAS
• Clean syngas to remove particles, soluble substances
• Produce a ‘clean’ gas
Pyrolysis & Gasification – What to think about?

• Energy
• Feedstock
• Controlled facility
• Flexible capacity
• Siting
• Enclosed facility
• Residual waste disposal
• Air pollution control
Pyrolysis & Gasification – Costs & Financing

**Costs**

- Capital
  - $15-80 M for 25,000-100,000 tonnes facility
  - $699/tonne
- Operational
  - $3-6.6M
  - $35/tonne

**Financing**

- Think in total system terms
- Tipping fees
- Sale of electricity and/or heat generated
- Sale of recyclables
- Renewable energy credits
- Carbon finance
- Public-private partnership
Incineration with Energy Recovery – The Basics

• Combustion of waste under controlled conditions to generate electricity and/or heat
• Storage area
• Combustion chamber
• Heat recovery system
• Ash handling system
• Air pollution control system
Incineration with Energy Recovery – What to think about?

- Feedstock requirements
- Siting
- Air pollution control
- Ash disposal
- Electricity & heat generation
- Public perception
- Contract duration
- Contractual requirements for waste quantities & composition
- Informal waste pickers
- Integrated solid waste policy
Incineration with Energy Recovery – Costs & Financing

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<td>$25-30</td>
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<tr>
<td><strong>United States</strong></td>
<td>$600-830</td>
<td>$44-55</td>
</tr>
<tr>
<td><strong>China</strong></td>
<td>$190-400</td>
<td>$12-22</td>
</tr>
</tbody>
</table>

**Financing**
- Think in total system terms
- Tipping fees
- Sale of electricity and/or heat generated
- Generation efficiency
- Preferred tariffs for renewable energy
- Carbon finance
- Materials recovery
Thank you