Sustainable Conversion of Waste to Energy

Existing and Emerging Technologies: Successes and Challenges

3rd Annual Sustainability Symposium and Expo

March 22, 2013

Presenters:
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What is Energy?

The Ability to do Work

- Chemical
- Thermal
- Radiant
- Electrical
Radiant Energy
Electrical Energy
“Potential” Energy
Renewable Energy by Type in NC

Excluding Hydro, Geothermal, and Solar (quadrillion Btu in 2011)

- Wood = 2.0
- Biofuels = 1.9
- Wind = 1.2
- Waste = 0.5

U.S. Energy Information Administration / Annual Energy Review 2011
U.S. Renewable Energy Supply

Source: Short-Term Energy Outlook, March 2013

- Petroleum-Fired
- Natural Gas-Fired
- Coal-Fired
- Nuclear
- Hydroelectric
- Other Renewables

Source: Energy Information Administration, Electric Power Monthly
## Emissions by Fuel Type (lbs/MWh)

<table>
<thead>
<tr>
<th>Fuel Type</th>
<th>Coal</th>
<th>Natural Gas</th>
<th>Oil</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon Dioxide</td>
<td>2,249</td>
<td>1,135</td>
<td>1,672</td>
</tr>
<tr>
<td>Nitrogen Oxides</td>
<td>6</td>
<td>0.1</td>
<td>4</td>
</tr>
<tr>
<td>Sulfur Dioxide</td>
<td>13</td>
<td>1.7</td>
<td>12</td>
</tr>
</tbody>
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Waste Conversion is Carbon Neutral

- Carbon from waste combustion/conversion is part of the natural carbon cycle

- Some positive carbon emissions from combustion of inorganics (plastic)

- Avoids or destroys methane

- Avoids coal/fossil fuel combustion for energy generation

http://www.epa.gov/cleanenergy/energy-and-you/affect/air-emissions.html
Trash to Tank Process

MSW Processing → Thermal Treatment

Refuse Derived Fuel (RDF)

CO + CO₂ + CH₄ + H₂ → CO + H₂

Fischer-Tropsch Process

Syngas Refinement
Small-Scale Gasifier System Example

SOURCE: Southern Research Institute
Working Definition

A process whose primary purpose is to convert solid waste (or more specifically MSW) to one or more of the following:

- Energy (e.g. heat, electricity)
- Biofuels (e.g. methane, hydrogen, biodiesel, CNG/LNG, ‘bio’-coal)
- Useful Chemicals (e.g. organic acids)
Waste to Energy Technologies

- Incineration
- Pyrolysis (Polymer to Energy)
- Waste Gasification
- Landfill Gas to Energy
Incineration
Incineration (Mass Burn, WTE)

- Proven Technology
- Bottom Ash requires landfill for disposal. Flyash may have beneficial uses.
- High capital/operating costs (~$20M + ~$70/ton)
- Difficult permitting process
- Many facilities have had financial difficulty
Waste to Energy in North Carolina

New Hanover County WASTEC, Monthly

megawatthours

Source: U.S. Energy Information Administration
Emissions controls on pyrolysis facility in Burgau, Germany
Pyrolysis

- Process decomposes organic material in absence of oxygen
- Temperatures at or below 1,000°F
- Produces synthetic gas (syngas)
- Requires landfill for non-organic materials and ash waste
- 70% waste reduction
- High capital costs ($39M to $95M)
Gasification

- Similar to Pyrolysis, but oxygen is present in combustion
- Is common in the U.S. with traditional fuels (coal, coke, wood)
- Waste is difficult to gasify
- Requires mechanical and thermal processing
- High capital/operating costs expected
- Requires landfill for ash waste
Refuse Derived Fuel (RDF)

• Removes unburnable materials  
  – e.g. glass, rocks, metals
• Shreds remaining material
• Process into uniform pellets
• May contain paper, organics, and recyclables
Gasification

- **Zone 3**: Freeboard (Gas reforming zone)
- **Zone 2**: Gasifying Layer (Drying and Pyrolysis zone)
- **Zone 1**: Coke Layer (High temperature melting zone)
- Molten Slag Basin
- Coke & Limestone (Submaterials)
- Third Tuyere
- Secondary Tuyere
- Main Tuyere
- Slag and Metal
Gasification: Domestic vs. International

- Compare >$370/ton in Japan to <$75 in US
- Limited scale in US (~10-15 tons/day)
- Military/DOD: net-zero waste goals
  - Air Force SOC (FL, 4/2011): 4,200 tons/year
  - Army Garrison (Monterey, CA)
- More prevalent, larger scale in Japan
  - Constrained by limited land
  - “Proximity Principle”
Capture of methane generated by the decomposition of waste
Landfill Gas to Energy

- Combustion in an engine or turbine to generate electricity
Landfill Gas to Energy

With the RFS 2010 amendments, LFG to CNG projects are being developed

Small-scale vehicle fuel project, St. Landry Parish, LA (16th Annual LMOP Conference/Project Expo)

[Image of a natural gas fuel pump and a vehicle with a sticker saying "Fueled With CNG From Landfill Gas"]
Renewable Energy Benefits NC

Landfill Gas-to-Energy Projects in North Carolina

3 Current EPA—LMOP Landfill and LFG Energy Project Database: North Carolina. 4 Based on typical construction cost of approximately $1 million per Megawatt.
Our LFGTE Work in NC

- Sampson County 8 MW
- Durham County 3 MW
- Wayne County 3 MW
- Davidson County 1.6 MW
- Orange County 1 MW
- Johnston County 1.6 MW Under Construction

Over 18 MW of capacity in NC
Renewable Energy Threatened in NC

N.C. renewable energy program would end under state House bill

John Murawski | The News & Observer (March 14, 2013)

Read more here:

http://www.mcclatchydc.com/2013/03/14/185808/nc-renewable-energy-program-would.html#storylink=cpy
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