North American Perspective on Integrated Solid Waste Management and Applicability in Brazil

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October 2, 2013

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October 2, 2013
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Gershman, Brickner & Bratton, Inc.

GBB -- Quality – Value – Ethics – Results

- Established in 1980
- Solid Waste Management and Technology Consultants
- Helping Clients Turn Problems into Opportunities

GBB Waste Technology Services

- Economic, technical, and environmental reviews
- Markets development
- Process planning and design
- Waste characterization and sourcing
- Procurement and negotiation assistance
- Independent feasibility consultant
- Technology due diligence
- Acceptance testing and operations monitoring
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History of the MSW Management in the US
Policy History

• The first U.S. federal solid waste management law: Solid Waste Disposal Act (SWDA) of 1965
• First Earth Day April in 1970
• The Resource Conservation and Recovery Act (RCRA) of 1976
• 1984 through 1998 RCRA Amendments for policy shift from landfilling to waste reduction, and recovery of materials and energy
• 1990 Clear Air Act Amendment
Historical Waste Generation & Management, 1960 - 2011

- Recognized value for materials and energy from waste
- Waste reduction and product stewardship efforts
- Reduce the environmental impact of products
- Implementation of integrated waste management related policy with recycling goals
- Increased interest in Zero waste and food recycling
- Public and financial support for better waste management

Management Practices
What are we doing today with our waste?

Disposition of MSW in the U.S.

EPA Estimate:
250 million tons (2011)

- Discarded: 53.60%
- Recovery: 34.70%
- Combustion with Energy Recovery: 11.70%

Biocycle Estimate:
389 million tons (2008)

- Discarded: 69.30%
- Recovery: 24.10%
- Combustion with Energy Recovery: 6.70%
Generation and Recovery of Material Types (EPA, 2011)

<table>
<thead>
<tr>
<th>Material</th>
<th>Weight Generated (million tons)</th>
<th>Weight Recovered (million tons)</th>
<th>Recovery as Percent of Generation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paper and paperboard</td>
<td>71.31</td>
<td>44.57</td>
<td>62.5%</td>
</tr>
<tr>
<td>Glass</td>
<td>11.53</td>
<td>3.13</td>
<td>27.1%</td>
</tr>
<tr>
<td>Metals</td>
<td>22.41</td>
<td>7.87</td>
<td>35.1%</td>
</tr>
<tr>
<td>Plastics</td>
<td>31.04</td>
<td>2.55</td>
<td>8.2%</td>
</tr>
<tr>
<td>Rubber and leather</td>
<td>7.78</td>
<td>1.17</td>
<td>15.0%</td>
</tr>
<tr>
<td>Textiles</td>
<td>13.12</td>
<td>1.97</td>
<td>15.0%</td>
</tr>
<tr>
<td>Wood</td>
<td>15.88</td>
<td>2.30</td>
<td>14.5%</td>
</tr>
<tr>
<td>Food</td>
<td>34.76</td>
<td>0.97</td>
<td>2.8%</td>
</tr>
<tr>
<td>Yard trimmings</td>
<td>33.40</td>
<td>19.20</td>
<td>57.5%</td>
</tr>
<tr>
<td>Total other wastes</td>
<td>80.63</td>
<td>21.58</td>
<td>26.8%</td>
</tr>
<tr>
<td>Total MSW</td>
<td>249.86</td>
<td>85.14</td>
<td>34.1%</td>
</tr>
</tbody>
</table>

Recycling and Material Recovery Facilities

- In 1970, US relied on local scrap yards and waste paper dealers to receive and prepare materials for recycling
- Now, US also has MRFs:

<table>
<thead>
<tr>
<th>MRF Type</th>
<th>Number of MRFs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year</td>
<td>2006</td>
</tr>
<tr>
<td>Single Stream</td>
<td>144</td>
</tr>
<tr>
<td>Dual Stream</td>
<td>227</td>
</tr>
<tr>
<td>Source Separated, Other Programs</td>
<td>127</td>
</tr>
<tr>
<td>All MRFs</td>
<td>437</td>
</tr>
</tbody>
</table>

Materials Recycling and Processing in the United States (Berenyi, 2012)
Cost of Collection and Disposal

- Costs and revenues affected by:
  - community size
  - government structure
  - politics
  - facilities used
  - waste supply agreements
  - Revenue sharing back to customer
- Collection
  - Residential solid waste: $10 - $40 USD per month per household
  - Residential recycling $2 - $4 per month per household
- Commercial waste
  - charged on a per month per box basis, and may include a separate pass-through cost for disposal charges:
  - 2 cubic yard box serviced once per week = $60 - $140 per month
  - 6 cubic yard box serviced once per week = $130 - $280 per month
- WTE tipping fee = $68/ton (2010 data)

Landfill Pricing (Tip Fees) for MSW by Region and Year (in $ per ton)

WTE Evolution in the US

- 150 WTE projects in development in the U.S. in the late 1990s
- 2 US Supreme Court cases and the 1990 Clear Air Act Amendment affected the WTE development
- Today, there are 85 WTE plants operating in 23 states, handling approximately 12% of MSW
### WTE Plants in the US

<table>
<thead>
<tr>
<th>Technology</th>
<th>Number of Facilities</th>
<th>Average Tons Per Day</th>
<th>Total Tons Per Day</th>
</tr>
</thead>
<tbody>
<tr>
<td>All Facilities</td>
<td>85</td>
<td>975</td>
<td>82,893</td>
</tr>
<tr>
<td>Mass Burn</td>
<td>65</td>
<td>1,023</td>
<td>64,452</td>
</tr>
<tr>
<td>RDF</td>
<td>15</td>
<td>1,128</td>
<td>16,926</td>
</tr>
<tr>
<td>Modular</td>
<td>7</td>
<td>216</td>
<td>1,515</td>
</tr>
</tbody>
</table>

Facilities and Tons Processed by Technology Type (BERENYI, 2012)

### Technology and Project Developers – 579 and Counting

- 34 Aerobic Composting
- 100 Anaerobic Digestion
- 30 Ethanol Fermentation
- 174 Gasification
- 49 Plasma Gasification
- 69 Pyrolysis
- 59 WTE: mass burn, modular, dedicated boilers, and RDF
- 64 Others (agglomeration, autoclave, depolymerization, thermal cracking, steam reforming, hydrolysis)

Source: Gershman, Brickner & Bratton, Inc., June 2013
Gasification Technology Offerors

Technologies Processing Mixed Non-recyclable Plastics
### Technologies Processing Organic Waste

<table>
<thead>
<tr>
<th>Developer</th>
<th>Technology</th>
<th>Location</th>
<th>Throughput (TPD)</th>
<th>Energy Products</th>
<th>Cost (M)</th>
<th>Federal Grants/Loan Guarantees (M)</th>
<th>Start Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enerkem</td>
<td>Gasification/ Catal.Conv. of Syngas</td>
<td>Edmonton, Alberta, CA</td>
<td>300</td>
<td>Methanol; Ethanol</td>
<td>$80M</td>
<td>$23.5M</td>
<td>2014</td>
</tr>
<tr>
<td>INEOS Bio</td>
<td>Gasification/ Ferment. of Syngas</td>
<td>Vero Beach, FL</td>
<td>450</td>
<td>Ethanol</td>
<td>$130M</td>
<td>$125M</td>
<td>June 2012</td>
</tr>
<tr>
<td>Fulcrum Bioenergy</td>
<td>Gasification/ Catalytic Conv. of Syngas</td>
<td>Storey, NV</td>
<td>400</td>
<td>Ethanol; Propanol</td>
<td>$120M</td>
<td>--</td>
<td>2015</td>
</tr>
<tr>
<td>Zero Waste Energy</td>
<td>Anaerobic Digestion</td>
<td>Monterey, CA</td>
<td>15</td>
<td>Biogas; Electricity</td>
<td>$1.6M</td>
<td>--</td>
<td>Jan 2013</td>
</tr>
<tr>
<td>Clean World Partners</td>
<td>Anaerobic Digestion</td>
<td>Sacramento, CA</td>
<td>100</td>
<td>Biogas; Electricity</td>
<td>$12M</td>
<td>$1.8M</td>
<td>2014</td>
</tr>
</tbody>
</table>
Locations Advancing “Proven” Technologies

- Mass burn WTE expansions completed
  - Hillsborough County, FL - Covanta
  - Lee County, FL - Covanta
  - Olmsted County, MN - Olmsted County
  - Honolulu, HI – Covanta

- Mass burn WTE facilities under construction
  - Durham York (Ontario CN) - Covanta
  - Palm Beach County, FL (SWAPBC) – B&W

- Example of Locations advancing new facilities with ‘proven’ technologies:
  - Baltimore, MD – Energy Answers
  - Frederick County, MD (NMWDA) - Wheelabrator
  - City of Los Angeles, CA – Green Conversion Systems
  - Region of Peel, Ontario, CN - Covanta
  - Puerto Rico – Energy Answers
  - Metro Vancouver, CN – To be determined

Locations Advancing “Proven” Technologies (cont’d)

- Anaerobic digestion specific RFPs issued:
  - Humboldt Waste Management Authority, Eureka, CA
  - Montgomery, AL- under construction w/Zero Waste Energy

- Anaerobic Digestion plants under development based on private companies initiatives:
  - City of Newport News, VA- quasar
  - Town of Bourne, MA- Harvest Power
  - Town of Brunswick, ME-quasar and Village Green Ventures
  - City of Columbia, SC- w/W2E
  - City of Portland, OR- w/Columbia Biogas
  - Monticello, IN- w/ Waste No Energy LLC
  - City of Charlotte, NC- w/Blue Sphere
Featured Ongoing Projects in North America

- City of Cleveland - Long-Term Waste Recycling and Disposal Project
- City of Houston - One Bin for all
- Prince William County - Demonstration plant of an emerging MSW WTE conversion technology
- County of Maui - Integrated Waste Conversion and Energy Project
- Iowa City - Conversion technology as part of the solid waste management system

Opinion: Trends for the Future

- Many conversion projects advancing
- Will need 4-6 years to learn what works and their economics
- Continuation of public sector taking "Low Risk" attitude until "proven"
- Demand for more recyclables expected to continue at attractive pricing
- More mixed waste processing systems...again!
  - Many conversion technologies require MSW pre-processing... for feedstock sizing and inerts removal
  - Electric utilities may become a player for RDF
- ‘Environmentalists’ and ‘Zero Waste’ proponents will continue to fight WTE and Waste Conversion Technologies calling them all “incineration”
Applicability to Brazil

What are the solutions and what can be expected to happen?

Brazil Current Situation

Waste Composition

- Organic Material: 51%
- Paper, Paperboard: 13%
- Other Material: 17%
- Plastics: 15%
- Metals: 3%
- Glass: 2%

Final Disposal of MSW in 2012

- Sanitary landfills: 58%
- Controlled landfills and dumpsites: 32%
- Not collected: 10%

Source: ABRELPE, 2012
Brazil National Policy and Goals

- National Solid Waste Policy - PNRS
- National goals for 2021 within the region include:
  - Prevention of illegal dumping and remediation of dump sites
  - Control of existing landfills and developing sanitary landfill
  - Improve solid waste collection services
  - Increase recycling
  - Increase capacity for waste processing
  - Reduce exportation of wastes for treatment and/or disposal
  - Reduce the greenhouse gas impacts of the treatment of organic waste through capture and use of gases produced

Sources: Universidad Estadual Paulista, Abrelpe, IPT, Ministry of Science and Technology, Brazil; CETESB, CPLEA, Plastivida, Abiplast.

Brazil Recycling and Composting

- Few formal MRFs
- 643 informal recycling and sorting centers in 2011
- 44 composting facilities processing MSW as a feedstock in 2011
- Northeast (Belem, Sao Luis) and Southeast regions of Brazil have highest number of collection programs for MSW and recyclables
  - In 2001, fewer than 8.2% of municipalities with garbage collection also collected recyclables separately
  - In 2010, the percentage that have separate collection had reached 57.6%
- Initiated WTE projects:
  - Rio de Janiero,
  - Belo Horizonte,
  - Campo Grande,
  - Ferraz de Vasconce-los,
  - Sao Bernardo do Campo, Sao Sebastiao,
  - Santos

Sources: Universidad Estadual Paulista, Abrelpe, IPT, Ministry of Science and Technology, Brazil; CETESB, CPLEA, Plastivida, Abiplast.
Brazil’s Biggest Potential...

- Organic waste makes 51% of the MSW
- Anaerobic digestion to BioCNG as a fuel and compost

<table>
<thead>
<tr>
<th>2021 Facilities Prediction</th>
</tr>
</thead>
<tbody>
<tr>
<td>WTE/RDF</td>
</tr>
<tr>
<td>14/1</td>
</tr>
</tbody>
</table>

* Indicates number of composting facilities that specify MSW as feedstock
Indicates total existing facilities, including those that are not currently operating

Source: Gershman, Brickner & Bratton, Inc., 2011

Anaerobic Digestion Facility Examples

Sacramento, CA - Clean World Partners
Capacity: 35,000 TPY
Feedstock: Commercial food waste
Anaerobic Digestion Facility Examples

Monterey, CA - Zero Waste Energy

Capacity: 5,000 TPY
Feedstock: MSW food & yard waste

Brazil’s Challenges to Achieve Sustainable Solid Waste Management

- Public education
- Integrate informal recycling into a formal integrated waste management system
- Develop efficient collection systems to create flows for more recycling and waste conversion
- Develop financing mechanisms to minimize the burden on the citizens and develop processing capacity
- Energy/fuel revenues for the waste processing facilities need to be high to compete with landfilling
- Encourage landfill bans and waste diversion through landfill taxes as in EU and UK
A Realistic & Ultimate Goal:
Fully Sustainable and Efficient Waste Management System with Significant Diversion (Recycling) and WTE-WCT
...in a 50-50 partnership!
...for more jobs, better environment, and energy independence!

Questions and comments?

Thank you!!
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