CleanTech Biofuels

Garbage In
Energy Out
Presentation Objectives

Present Game Changing Technology for:

• Sustainable Biomass Feedstock
• Accomplish Single Stream Recycling
• Impact Waste Management Industry
• Benefit the Environment
• Provide Industrial Growth & Jobs
• Benefit both Rural & Urban Communities
Biorefining Industry

- Industrial & Municipal Combined Heat and Power (CHP)
- Fuels and Chemicals

The future of the Biorefining Industry depends on establishing a sustainable and predictable supply of affordable biomass feedstock.
Biomass Feedstock Sources

- Dedicated Agricultural Crops
- Forest Resources
- MSW Resources
DOE Goals for Biomass By 2030

• Replace 30% of Imported Oil

• Establish a 1 Billion Ton/yr Biomass Supply

• Produce 5% of Electric Power Demand

• Provide 20% of Transportation Fuels

• Produce 25% of Chemicals
Why Biomass from MSW?

- Exploits Existing, Mature Infrastructure
- Available for Immediate Deployment
- Contains all Essential Qualities for a Biomass Feedstock
- Provides Game Changing Options for a Sustainable Waste Management Industry
- Reduces Waste Management Costs
- Provides Substantial Environmental Benefits
Today’s MSW Challenges

• Landfill Limitations
  – Tipping fees: Soaring Costs
  – Closing landfills
  – Mega-landfills
  – Transportation costs
  – Environmental Impacts

Chicago has seven years worth of landfill space available.
Illinois EPA, 21st Annual Landfill Capacity Report
MSW–The Biomass “Backbone”

- Widely Distributed Availability
- Available 24/7, 365 at Predictable Pricing
- Mature Infrastructure for Collection & Distribution
- Suitable Feedstock for Most Conversion Technologies
- Can Supply Biorefineries in Urban & Rural Locations
- No Food vs Fuel or Indirect Land Use Change Issues
CleanTech Biofuels’ Vision

• Provide a Sustainable Biomass Feedstock Infrastructure
• Stimulate Development of All Biomass Feedstocks
• Provide Predictable Costs for Biorefinery Profitability
• Reduce Dependency on Petroleum
• Stimulate Development of Renewable Power, Fuels and Chemicals from Biomass
• Accelerate the Growth of Jobs in the Biorefining Industry
• Maximize Recycling
• Generate Significant Environmental Benefits
• Extend Landfill Life
Today: Consumption vs. Resources

- Energy Demand
- Consumption
- Waste
- Commodity Prices
- Municipal Budgets
- Land Availability
- Natural Resources
Today’s Challenges

• Energy Crisis
  – Increasing demand
  – Increasing costs
  – Increasing regulation
  – Increasing Carbon emissions
  – Alternative energy mandate
  – Need for biomass feedstock

Electrical demand is projected to increase 26 percent by 2030.
U.S. Government Energy Information Administration, 2009
Tomorrow: Sustainability

- Renewable Energy
- Renewable Biomass Resources
- Increased Recycling
- Decreasing Waste Disposal
- Increasing Consumption
- Increasing Energy Demand

Increasing Consumption

Decreasing Waste Disposal

Increased Recycling

Renewable Biomass Resources

Renewable Energy
MSW Volume and Implications

Estimated MSW Volume

• 260 to 500 million tons annually
• 50+% cellulosic

Assume 100 gal liquid fuel/ton

• MSW could produce 13 – 25 billion gal/yr
• ~ 20% of imports from OPEC
### Typical MSW Composition

<table>
<thead>
<tr>
<th>Material</th>
<th>Percentage</th>
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</thead>
<tbody>
<tr>
<td>Ferrous Metals</td>
<td>5.6%</td>
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<tr>
<td>Non-Ferrous Metals</td>
<td>2.0%</td>
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<tr>
<td>Plastics</td>
<td>11.8%</td>
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<tr>
<td>Glass</td>
<td>5.2%</td>
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<tr>
<td>Misc. Inorganics</td>
<td>10.6%</td>
</tr>
<tr>
<td>Biomass Bone Dry</td>
<td>48.6%</td>
</tr>
<tr>
<td>Water</td>
<td>16.2%</td>
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<tr>
<td><strong>Total</strong></td>
<td><strong>100.0%</strong></td>
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Energy & Environmental Benefits

<table>
<thead>
<tr>
<th>Description</th>
<th>Quantity</th>
<th>Unit</th>
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<tbody>
<tr>
<td>Qty of MSW = 260 Million Tons/yr</td>
<td></td>
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</tr>
<tr>
<td>Biomass Feedstock (10% Water)</td>
<td>140,400,000</td>
<td>Ton/yr</td>
</tr>
<tr>
<td>Crude Oil Equivalent</td>
<td>322,436,000</td>
<td>bbl/yr</td>
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<tr>
<td>Equivalent Diesel Fuel</td>
<td>14,490</td>
<td>Billion gal/yr</td>
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<tr>
<td>Ethanol Equivalent</td>
<td>24,500</td>
<td>Billion gal/yr</td>
</tr>
<tr>
<td>Electricity Equivalent</td>
<td>164,300,000</td>
<td>MW/yr</td>
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<tr>
<td>Electricity Equivalent</td>
<td>19,600</td>
<td>MW/hr</td>
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## Energy & Environmental Benefits

<table>
<thead>
<tr>
<th>Category</th>
<th>Tons/Day</th>
<th>Energy (MMBtu/yr)</th>
<th>Avoided GHG (MTCE/yr)</th>
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</thead>
<tbody>
<tr>
<td><strong>MSW=1 Million Tons/Day</strong></td>
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</tr>
<tr>
<td>Ferrous Metals</td>
<td>56,000</td>
<td>291,200,000</td>
<td>7,134,400</td>
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<tr>
<td>Non-Ferrous Metals</td>
<td>20,000</td>
<td>1,076,400,000</td>
<td>19,240,000</td>
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<tr>
<td>Plastics</td>
<td>118,000</td>
<td>1,626,040,000</td>
<td>12,885,600</td>
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<tr>
<td>Glass</td>
<td>52,000</td>
<td>36,504,000</td>
<td>1,081,600</td>
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<tr>
<td>Misc. Inorganics</td>
<td>106,000</td>
<td>0</td>
<td>0</td>
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<tr>
<td><strong>Biomass Bone Dry</strong></td>
<td>486,000</td>
<td>1,870,128,000</td>
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</tr>
<tr>
<td><strong>Water</strong></td>
<td>162,000</td>
<td></td>
<td></td>
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<tr>
<td><strong>Total</strong></td>
<td>1,000,000</td>
<td>4,900,272,000</td>
<td>40,341,600</td>
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</table>

*The table above illustrates the energy and environmental benefits of managing one million tons of municipal solid waste (MSW) per day.*
CleanTech Innovative Solution

Garbage In ➔ Processing ➔ Biomass Out

Recyclables Out
Process Details

From this ......
Process Details

To this ... in three easy steps!
MSW is delivered to a tipping floor and over-sized items are removed.
MSW is processed with steam in a cylindrical vessel that separates garbage into its component parts.
Biomass feedstock is stored for transport to biorefineries, CHP and power companies.
Coff’s Harbor Commercial Facility, Australia
Coff’s Harbor Commercial Facility, Australia
Costs

Capital Costs:
~ $25 to 30 million for a 1,000 ton/day Facility

Production costs
~ $25/ton
Economics depend largely on tipping fee:

- Tipping fees range from $24/ton to $100/ton
- National average tipping fee is ~ $34/ton
- CleanTech biomass production costs: ~ $25/ton

With no government subsidies!
Costs of Other Feedstocks

Wood chips: $40+/ton

Agricultural crops: $65+/ton

Corn: > $200/ton
Commercial Strategy

• Develop Multiple Revenue Streams:
  – Tipping fees
  – Biomass Sales
  – Electricity/Steam Sales
  – Project Development/Licensing Fees
  – Development Rights
  – Equipment Sales
• Develop Biomass Plants via Public-Private Partnerships
• Develop Integrated Business w/Fuels or Chemicals Technology
• Promote Future Global Expansion
Summary

- Game-changing, patented proprietary technology
- **Sustainable Backbone for Biorefining Industry**
  - Economic Biomass Feedstock Supplies
  - Significant Environmental Benefits
  - Stimulates Growth of Biorefining Industries
- Reduces Dependency on Foreign Oil
- Maximizes Recycling
- **Job and Industry Growth for Rural & Urban Areas**