Turning Biomass Resources into Renewable Energy

Be a leader. Use less energy. Use smart energy.

ALAN KIRN
Director, Renewable Energy Solutions
Utilizing Renewable Energy in Mississippi - Biomass

- What are viable Biomass resources
- Available Biomass conversion technologies
- Electric and thermal output comparison
- Project drivers impacting viability
- Sample projects
- Various contracting structures
- Open discussion

Figure 1. Renewable energy consumption in the nation's energy supply, 2010

Source: U.S. Energy Information Administration
What is Biomass?

“Plant material, vegetation, or agricultural waste used as a fuel or energy source.”

The American Heritage® Dictionary

Most common sources are:

- Wood waste byproducts
- Grasses (Energy Crops)
- Crop wastes
- Animal manures
- Refuse derived fuels (trash)
## Why Woody Biomass is typically the “Fuel of Choice”

Relative Biomass Costs (Ballpark)

<table>
<thead>
<tr>
<th>Biomass Fuel Type</th>
<th>$ / Green Ton</th>
<th>Moisture Content</th>
<th>BTU/LB (As-Delivered)</th>
<th>$ / Dry Ton</th>
<th>$ / MMBTU</th>
<th>Availability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wood Pellets (bulk)</td>
<td>$140</td>
<td>7%</td>
<td>7,905</td>
<td>$151</td>
<td>$8.86</td>
<td>Limited</td>
</tr>
<tr>
<td>Energy Cubes (bulk)</td>
<td>$100</td>
<td>7%</td>
<td>7,905</td>
<td>$108</td>
<td>$6.33</td>
<td>Limited</td>
</tr>
<tr>
<td>Corn Stover (densified)</td>
<td>$80</td>
<td>15%</td>
<td>7,225</td>
<td>$94</td>
<td>$5.54</td>
<td>Corn Belt Only</td>
</tr>
<tr>
<td>Torrefied Wood</td>
<td>$100</td>
<td>3%</td>
<td>10,000</td>
<td>$103</td>
<td>$5.00</td>
<td>Limited</td>
</tr>
<tr>
<td>Switchgrass</td>
<td>$65</td>
<td>15%</td>
<td>7,225</td>
<td>$76</td>
<td>$4.50</td>
<td>Limited</td>
</tr>
<tr>
<td>Corn Cobs</td>
<td>$50</td>
<td>30%</td>
<td>5,950</td>
<td>$71</td>
<td>$4.20</td>
<td>Corn Belt Only</td>
</tr>
<tr>
<td>Green Wood (chipped or ground)</td>
<td>$30</td>
<td>45%</td>
<td>4,675</td>
<td>$55</td>
<td>$3.21</td>
<td>Broad</td>
</tr>
</tbody>
</table>
Why Woody Biomass is typically the “Fuel of Choice”
Other favorable attributes (non-economic)

- Typically the **easiest to permit**
- Most **abundant** in many areas
- Internationally considered **carbon neutral**
- **Proven emission control** technologies
- **Non seasonal** and **sustainable**
- **Proven handling** and **combustion technologies**
Do you have Woody Biomass in Mississippi? - YES
Biomass Fuel Crops

- United States Department of Agriculture (USDA) has just started a strong incentive program to incent biomass crop production; this will have significant impact on fuel cost that can improve project economics
- Targeted for marginal lands that are not productive for food crops
- Has the potential to create jobs for rural America
- Can provide more control over long term fuel cost
- Needs incentives to compete today
Municipal Solid Waste Challenges

Less favorable attributes

- Much more **difficult to permit** today
- Potentially **in conflict with EPA** – Reduce, Reuse, Recycle
- Potentially **dealing with hazardous materials** - VOCs, dioxin, furans and heavy metals
- **New conversion technologies not commercialized**
- **Consider** using a refuse derived fuel (RDF) as shown below that has been sorted (right) and blended for consistency **if you attempt MSW**
## Primary Biomass Conversion Technologies

<table>
<thead>
<tr>
<th>Technology</th>
<th>Process</th>
<th>Cost</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Combustion/Incineration</td>
<td>Full Air</td>
<td>Lowest</td>
<td>Proven Technology, Higher Emissions</td>
</tr>
<tr>
<td>Gasification</td>
<td>Starved Air, Produces Syngas</td>
<td>Moderate</td>
<td>Newer Technology, Lower Emissions, Fuel Flexibility</td>
</tr>
<tr>
<td>Pyrolysis</td>
<td>No Air, Batch Process</td>
<td>Higher</td>
<td>Industrial Use, Often Produces 2nd Fuel</td>
</tr>
<tr>
<td>Anaerobic Digestion</td>
<td>No Air</td>
<td>Moderate</td>
<td>Handles Nasty Fuels, Produces Methane, High Waste Level</td>
</tr>
</tbody>
</table>
Recent Combustion Installation: Missouri DOC – Licking, MO  
(Smallest project we have seen with economic justification)

<table>
<thead>
<tr>
<th>Situation</th>
<th>Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 10-yr old state prison</td>
<td>Switch fuel from <strong>propane</strong> (&gt;$12/MMBtu) to waste wood biomass (&lt;$3/MMBtu)</td>
</tr>
<tr>
<td>Built on low first cost basis</td>
<td>Build new 10 MMBtu combustion boiler</td>
</tr>
<tr>
<td>Propane gas fired boiler plant</td>
<td><strong>Baseload</strong> the biomass boiler</td>
</tr>
<tr>
<td>Lots of wood residuals in the area</td>
<td>Utilize gas boilers for peak and backup</td>
</tr>
<tr>
<td>Part of overall state energy project</td>
<td>Cogeneration not economic – low rates</td>
</tr>
<tr>
<td></td>
<td>Under 10-yr payback – $3.3M cost</td>
</tr>
</tbody>
</table>

**Improved Carbon Footprint!**
Recent Combustion Installation: 1
Recent Combustion Installation: 2
Recent Combustion Installation: 3
Recent Combustion Installation: 4
Recent Combustion Installation: 5

- Project completed late 2009 – didn’t have current pictures on file since construction
- Facility exceeding projections on savings – completed a second similar site since
Recent Gasification installation: Oak Ridge National Labs - DOE
(Gasification system in a NOX attainment zone)

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<th>Solution</th>
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<tr>
<td>▪ 60+ year old district steam plant built for the “Manhattan Project”</td>
<td>▪ Energy efficiency work throughout the campus allowed downsizing of the central plant capacity</td>
</tr>
<tr>
<td>▪ Original coal fired, converted to gas</td>
<td>▪ Demo of much of the existing facility keeping plant operational</td>
</tr>
<tr>
<td>▪ New facilities on site required more steam capacity</td>
<td>▪ Build new 60,000#/hr low pressure steam biomass gasification system</td>
</tr>
<tr>
<td>▪ Lots of wood residuals in the area</td>
<td>▪ <strong>Baseload</strong> the biomass boiler</td>
</tr>
<tr>
<td>▪ Part of overall site energy project</td>
<td>▪ Utilize gas boilers for peak and backup</td>
</tr>
<tr>
<td>▪ Commitment by the DOE to reduce carbon footprint</td>
<td>▪ Cogeneration not economic – low rates</td>
</tr>
<tr>
<td></td>
<td>▪ Under 15-yr payback project</td>
</tr>
</tbody>
</table>
Residual woody biomass available locally converted to a low temperature (500 – 700 °F) synthetic gas in 3 identical gasifiers.

Air injected at the single common oxidizer to complete combustion.

1,500 – 1,800 °F heat to Heat Recovery Steam Generator generates 150 PSI steam

SNCR NOX control to meet NOX non-attainment requirements of the site

Dry Electrostatic Percipitator for Particulate control <.03ppm

Completely automated fuel unloading, fuel feed, and ash handling systems

20,000 tons annual carbon reduction
Plant emission levels will be at or below that of a natural gas steam plant

3+ days of on site fuel storage for security

Plant currently in commissioning, start up Q4, 2011, turnover Q1 or Q2 2012
Keys to Biomass Success with “Community Based” Approach
(Summary of What We Have Learned Over Last 10 Years)

- Scale is your friend – Bigger is Better!
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- Thermal is more valuable than electric!
Biomass Energy Value

- Remember – Thermal output value is much higher at today’s prices than electric output!

- 1 Green ton Woody Biomass (@ $28/ton)
  - Thermal Only
  - Offsets 7,567,000 Btu of Natural Gas = $61 (@ $8/MMBtu gas cost)

- 1 Green ton Woody Biomass (@ $28/ton)
  - Electric Only
  - Offsets 377 Kwhr of electricity = $30 (@ $.08/Kwhr electric)

- 1 Green ton Woody Biomass (@ $28/ton)
  - CoGen
  - Offsets natural gas and electricity = $75 (@ above rates)
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- Good thermal load factor (50% or higher) – Most sensitive project variable!
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Supporting Our Local Economy

- **Fuel dollars to be local:** Transportation cost will mandate that biomass fuels are used close to where they are produced.

- **Jobs will be saved:** Timber industry is in decline with paper production reducing and going overseas.

- **Marginal lands to be used and new farm jobs to be created:** Non-food crop based biomass is under developed and has the potential of creating jobs and revenues, supporting rural America.
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- Focus on the markets that are conducive to Biomass Solutions!
# Where the Biomass Solution Fits Best

<table>
<thead>
<tr>
<th>Facility Type</th>
<th>Scale Factor</th>
<th>Load Factor</th>
<th>CHP Factor</th>
<th>Space Factor</th>
<th>Overall Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>K-12 Schools</td>
<td>Poor</td>
<td>Poor</td>
<td>Poor</td>
<td>Fair</td>
<td>Poor</td>
</tr>
<tr>
<td>Higher Ed.</td>
<td>Excellent</td>
<td>Good</td>
<td>Excellent</td>
<td>Good</td>
<td>Very Good</td>
</tr>
<tr>
<td>Industrial</td>
<td>Good</td>
<td>Good</td>
<td>Excellent</td>
<td>Good</td>
<td>Good</td>
</tr>
<tr>
<td>Hospitals</td>
<td>Good</td>
<td>Good</td>
<td>Good</td>
<td>Fair</td>
<td>Fair-Good</td>
</tr>
<tr>
<td>District Systems</td>
<td>Excellent</td>
<td>Good</td>
<td>Good</td>
<td>Good</td>
<td>Good</td>
</tr>
<tr>
<td>Federal Sites</td>
<td>Excellent</td>
<td>Excellent</td>
<td>Good</td>
<td>Good</td>
<td>Excellent</td>
</tr>
<tr>
<td>State/Local Govt</td>
<td>Good</td>
<td>Fair</td>
<td>Fair</td>
<td>Fair</td>
<td>Fair</td>
</tr>
<tr>
<td>Retail/Comm.</td>
<td>Poor</td>
<td>Poor</td>
<td>Poor</td>
<td>Poor</td>
<td>Poor</td>
</tr>
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- Don’t forget about the Carbon offset value!
Don’t Forget the GHG Reduction Value…

Figure 1: Price projections for potential cap-and-trade programmes

Source: New Carbon Finance. Notes: i) prices shown before 2012 indicate allowance cost when programme starts plus cost of carry, ii) prices assume a 2030 time horizon

- @ average of $25/ton the carbon reduction impact of ORNL = $500,000 per year
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Many options to fund Biomass projects –
- Performance Contracting – Long term guarantees
- Design/Build/Own/Operate/Maintain (DBOOM)
- Tax Exempt Municipal Lease/Bond
- Debt/Equity Financing with Tax Benefits
Thank You!

I will be happy to discuss any of this further with you as time did not permit an in depth discussion.

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