Biomass Fuel for Power Generation
Implications for Railroads

Sandhouse Gang
February 22, 2010
Agenda

✔ Why biomass is coming

✔ Biomass sourcing challenges

✔ Economics challenges

✔ Implications for railroads

Wood pellet extrusion process
To date, biomass has not been a major factor for power generation.

### 2007 U.S. Power Generation

- **Coal**: Largest share
- **Nuclear**: Second in size
- **Hydro**: Smaller share compared to coal and nuclear
- **Natural Gas**: Smaller than hydro but more than biomass
- **Biomass**: Smallest share
- **Wind**: Smaller than natural gas but more than biomass
- **Petroleum**: Smaller than wind but more than biomass

### Fuel Type % of Generation

<table>
<thead>
<tr>
<th>Fuel Type</th>
<th>% of Generation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Renewables</td>
<td>8.5%</td>
</tr>
<tr>
<td>Biomass</td>
<td>1.3%</td>
</tr>
</tbody>
</table>
But state/federal renewable energy standards will change how utilities source power

- 34 states have enacted RPS (typical range 15-25% by 2020)
- Congress considering federal RPS (25% by 2025)
- Cap and Trade bill could require 20%

State RPS commitments (2009)

Source: Database of State Incentives for Renewable Energy (DSIRE).
Note: North Dakota, South Dakota, Utah, Virginia, and Florida, have nonbinding goals for adoption of renewable energy.
Biomass is the only viable renewable source for many utilities

- Cost trade-offs still favor traditional fuel sources
- Current use of renewables
  - **Hydro**: Used where possible
  - **Wind**: High cost, location dependent
  - **Solar/Geothermal**: Minimal use to-date

Source: EIA
U.S. utility interest in biomass is high, based upon a recent Norbridge study

Drivers of Interest

- Government mandates, court rulings
- Government incentives
- Scarcity of other renewables
- Fuel diversification

Interest in an Increased Role for Biomass in Power Generation

Scale: 1 = No Interest; 10 = Very Interested

Median = 7.5
Mean = 6.3
Our study also indicated that many utilities are not waiting for final regulatory requirements

- Some utilities are “in a holding pattern”
- Some utilities already have RPS obligations
- Some utilities are not waiting - even given that biomass economics not competitive with traditional fuels
Based on our study, the utilities that are moving forward are mostly looking at 50-100 MW plants.

- Most plants will have <100MW capacity
- One utility expects 5-10 million tons of annual biomass consumption by 2015
- A 100 MW unit would require an estimated 500,000 – 750,000 tons of dry biomass annually

* Potential Plant Sizes*

*Average of range given by each interviewee who provided plant size estimates.*
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Biomass includes purpose-grown/primary sources and residual/secondary sources

<table>
<thead>
<tr>
<th>Purpose-Grown/Primary Sources</th>
<th>Byproducts/Residual Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Miscanthus grass</td>
<td>• Corn stover</td>
</tr>
<tr>
<td>• Switchgrass</td>
<td>• Straw</td>
</tr>
<tr>
<td>• Algae</td>
<td>• Sawdust</td>
</tr>
<tr>
<td></td>
<td>• Mill residue</td>
</tr>
<tr>
<td></td>
<td>• Slash/hog fuel</td>
</tr>
<tr>
<td></td>
<td>• Roundwood</td>
</tr>
</tbody>
</table>
Raw biomass suppliers are likely to be the land owners or primary product users

<table>
<thead>
<tr>
<th>Raw Biomass</th>
<th>Potential Suppliers</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Agricultural Products</td>
</tr>
<tr>
<td></td>
<td>Wood</td>
</tr>
<tr>
<td></td>
<td>Farm cooperatives</td>
</tr>
<tr>
<td></td>
<td>Agricultural productions companies</td>
</tr>
<tr>
<td></td>
<td></td>
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Wood-based biomass options can differ widely by geography

Roundwood Production by State

- Roundwood is prevalent in some states, but relatively low in others
- Hardwood (in orange) is typically more expensive than softwood (in green)
Agricultural products biomass options can also differ geographically.

• Corn and rice have the most residuals per ton of primary crop.
Biomass can be used in its natural state or pelletized

<table>
<thead>
<tr>
<th>Why Pelletize?</th>
<th>Why Raw Biomass?</th>
</tr>
</thead>
<tbody>
<tr>
<td>■ Increased density</td>
<td>■ Avoid cost of drying and pelletizing</td>
</tr>
<tr>
<td>■ Lower moisture content (higher BTU content)</td>
<td>■ Avoid additional cost of handling</td>
</tr>
<tr>
<td>■ Added durability</td>
<td>■ Avoid CapEx of pellet plants</td>
</tr>
<tr>
<td>■ Standardized size</td>
<td></td>
</tr>
<tr>
<td>■ Lower transportation cost over long distances</td>
<td></td>
</tr>
<tr>
<td>■ Boiler requirements</td>
<td></td>
</tr>
</tbody>
</table>
While there are emerging biomass pellet manufacturers, there are few major facilities.
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Biomass primarily competes against other renewables – not against coal

**Economics Challenges**

<table>
<thead>
<tr>
<th>Traditional</th>
<th>Under RPS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coal $</td>
<td>Biomass $$$?</td>
</tr>
<tr>
<td>Biomass $$$?</td>
<td>Wind $$$-$$$$?</td>
</tr>
<tr>
<td></td>
<td>Solar $$$-$$$$?</td>
</tr>
</tbody>
</table>
Biomass economics will depend on a large number of variables

**Capital Costs**
- Boiler conversion
- Storage
- Conveying & crushing system
- Dust & combustion control systems
- Unloading system
- Transportation equipment/infrastructure

**Operating Costs**
- Biomass fuel
- Transportation (multi-mode)
- Terminal/handling
- Materials handling
- Plant operations
- Inventory carrying
Capital Costs: Boiler modifications can be a major component of conversion capital costs

Boiler Conversion

- Costs can vary widely
  - Existing infrastructure/designs
  - Firing system
  - Type of biomass fuel
  - Permitting
- Change in boiler capacity?
Operating Costs: Fuel costs will likely be the major component of operating costs

Fuel Costs
- Pellets currently cost $100 - $200/ton
- Raw biomass makes up about 25-50% of cost
- Cost to dry fuel?
- Long-term price?
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✔ Biomass opportunity

✔ Impact on coal business

Wood pellet extrusion process
**Biomass transportation**
...very different from traditional fuels

<table>
<thead>
<tr>
<th></th>
<th>Coal</th>
<th>Biomass</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Origins</strong></td>
<td>Limited, well known</td>
<td>Unknown, likely high number</td>
</tr>
<tr>
<td><strong>Rail equipment</strong></td>
<td>Open hoppers or gondolas</td>
<td>Covered hoppers</td>
</tr>
<tr>
<td><strong>Rail unloading</strong></td>
<td>Roll-over, or bottom dump with doors</td>
<td>Bottom dump through gates</td>
</tr>
<tr>
<td><strong>Ash disposal</strong></td>
<td>Higher ash content; Sell to cement?</td>
<td>Lower ash content; Sell to farms?</td>
</tr>
</tbody>
</table>
Biomass origins are not well defined

- Origins TBD – likely numerous
- No service exists today
- No rates exist today
- New routes
- Smaller blocks
- Rail-influenced sites?
And will require new equipment

- Wood pellets require covered equipment
  - Grain cars?
  - Purpose build cars?

- Raw biomass requirements vary

- Equipment ownership?

- Existing coal car fleet?
Logistics will be vastly different

- **Unloading**
  - Railcar bottom dump through gates
  - Covered unloading

- **Storage**
  - Indoor storage for pellets

- **Ash disposal**
  - Lower ash content
  - Not for cement?
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Biomass will displace some coal

- US coal generation expect to grow marginally to 2020, even with RES*
- Biomass mainly displacing coal growth
- May frequently be co-fired

*EIA: Renewable Energy Standards as Proposed in the American Clean Energy and Security Act Discussion Draft, April, 2009
PRB coal could be a beneficiary

- Biomass replacing high-cost, higher emissions Eastern coal?

- Opens door for more low sulfur PRB coal to serve Eastern utilities?
  - Longer length of haul
Thank You

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