Lessons Learned, Progress, and Development Needs for Processing and Handling Herbaceous Biomass

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Presentation Overview

• Company background (brief)
• Background on lessons learned (to date)
• Key challenges related to commercialization of feed handling concepts
• Approaches to overcome these challenges
• U.S. DOE’s role in supporting industry needs in order to overcome these challenges
Supporting Clean Energy Sectors

Bio-Fuels

Biomass Power

Biomass R&D

Solar

Energy Efficiency

Wind

Relatively “plug-and-play,” known, off-the-shelf equipment, tangible examples abundant, bankable policies, market pull.
Original Lessons

• Ottumwa Generating Station
  – Alliant Energy / Mid-American
  – 726 MW, PRB Coal, 1982 startup
  – Twin furnace T-fired PC boiler
  – 2.5 to 5% heat input from switchgrass, 12.5 to 25 ton/hr
  – Up to 200,000 ton/yr capacity
  – Separate biomass injection, 2 - 4 ports

• Fuel
  – 3’ x 4’ x 8’ switchgrass bales
  – 2-step milling process to 1/8” minus

• Project ended in 2006
• Chariton Valley Biomass Project
2000+ Hour Continuous Demo
New additions to allow full truck unloading, automated de-stacking

Already Demonstrated / Documented (Chariton Valley)
Key Lessons Learned

• Entire supply chain is important for facilitating reliable and efficient at-plant operations
  – Lower Quality Biomass = More Processing Problems

• More efficient loading / unloading needed

• Biomass is variable, guaranteed
  – Deal with it (robust handling system is critical)

• Predictive maintenance control systems needed

• Improved biomass quality diagnostics needed

• Demonstration-scale process facility(s) are needed
  – Regularly operating--the more the better
  – Need a processed material off-taker
Automated Square Bale Infeed
Bale Handling System
Feedstock Logistics Linkages
Concluding Remarks

• Innovation investments are stymied in a market with little “pull”
  – DOE investments will continue to be very important
• Additional development needed on consistently delivering the desired spec material size with variable incoming material properties
• Suggestion: Public/private partnership(s) to establish one or more demonstration-scale biomass processing and handling “depot(s)”
  – With high potential for regular/frequent operation
  – Needs one or more material off-takers (paying)
High-volume Unloading Systems

Cotton Gin

Log Trailers

Wood Chips

Sugar Mill
Example High-volume Infeed Systems
Exhibit 48 Long Term Test Burn Daily Tons Processed

Switchgrass Processed (tons)

Avg. Moisture Content

Switchgrass Processed
Ave. Moisture Content
Exhibit 51 Long Term Test Burn Weekly Processing System Availability

<table>
<thead>
<tr>
<th>Week of Test Burn</th>
<th>Percent Operating Hours / 24 hr/day x 7 day/wk</th>
</tr>
</thead>
<tbody>
<tr>
<td>2/16 to 2/22</td>
<td>21.1%</td>
</tr>
<tr>
<td>2/23 to 3/1</td>
<td>76.5%</td>
</tr>
<tr>
<td>3/2 to 3/8</td>
<td>84.0%</td>
</tr>
<tr>
<td>3/9 to 3/15</td>
<td>92.4%</td>
</tr>
<tr>
<td>3/16 to 3/22</td>
<td>83.9%</td>
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<tr>
<td>3/23 to 3/29</td>
<td>45.7%</td>
</tr>
<tr>
<td>3/30 to 4/5</td>
<td>61.2%</td>
</tr>
<tr>
<td>4/6 to 4/12</td>
<td>80.1%</td>
</tr>
<tr>
<td>4/13 to 4/19</td>
<td>90.1%</td>
</tr>
<tr>
<td>4/20 to 4/26</td>
<td>86.3%</td>
</tr>
<tr>
<td>4/27 to 5/3</td>
<td>95.6%</td>
</tr>
<tr>
<td>5/4 to 5/10</td>
<td>96.2%</td>
</tr>
</tbody>
</table>
Exhibit 52 Long Term Test Burn Average Biomass Feed Rates (During Run Time)
**Exhibit 79 Feed Rate and Milling Power Versus Moisture Content**

**NOTE:** This graph only includes power consumption from the milling equipment (Debaler and “Eliminator”). It does NOT reflect total facility power consumption.