Cellullosic Ethanol and Project Liberty: Looking Toward the Future

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POET-DSM Advanced Biofuels

two innovative companies – one shared vision
The Value of Cellulosic Ethanol

Economic
● A single plant brings:
  - $200+ million investment.
  - 45 full-time jobs and hundreds of construction jobs.
  - Over $2 million into the community per year before add-on effects.
  - Over $20 million for biomass acquisition a year.

Energy Security
● A single plant replaces:
  - About 1 million barrels of imported oil per year.
  - $50 million in annual foreign spending with US jobs.

Environmental Sustainability
● Cellulosic ethanol must be 60% better than gasoline’s 2005 greenhouse gas emission levels.
● A single plant will reduce over 210,000 tons of CO₂ per year.
● We gather about 25% of the corn stover from the field which has been demonstrated to be long term sustainable.
Cellulosic Ethanol

Corn Crop Residue

Pre-treatment
softens the rigid structure of cellulose

Hydrolysis & Fermentation
breaks down the cellulose to sugars which are converted to ethanol

Distillation
collects ethanol by means of evaporation & condensation

Solid Fuel Boiler
converts residual solid materials, producing steam energy

Solids

Lignin (non-fermentable)

Separation

Liquids

Anaerobic Digestion
breaks down biodegradable materials producing a methane-rich biogas

Steam & Biogas
to power cellulose & grain ethanol plants
Our Biomass History

- POET researched how to collect and store cobs

2009
- Single-Pass Baling was trialed, along with cobs

2010
- First Commercial Harvest of Biomass Ever for Cellulosic Ethanol with 2nd Pass Cob bales being the new feedstock
- The Stackyard at Project Liberty was built

2011
- Second Biomass Harvest with Expanded Acres

2012
- Material from the Fourth harvest will be used to make cellulosic ethanol

2013
- Third Commercial Harvest
- Role-out of the Custom Model

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Growth Platform

Biomass Resources Available in the United States
Normalized by County Area

Tonnes/sqkm/Year
- Above 250
- 200 - 250
- 150 - 200
- 100 - 150
- 50 - 100
- Less than 50

This study estimates the technical biomass resources currently available in the United States by county. It includes the following feedstock categories:
- Agricultural residues (crops and animal manure)
- Wood residues (forest, primary mill, secondary mill, and urban wood)
- Municipal discards (municipal and landfill, and urban and domestic wastewater treatment)
- Dedicated energy crops (on Conservation Reserve Program and Abandoned Mine Lands)

September 2005
Manage residue AND keep consistent organic matter levels

ISU Recommendations:
- 10-15 lbs of Potassium/acre (based on 1BDT/acre removal rate)
- No additional Nitrogen or Phosphorus needed
- No change in OM seen with EZ Bale removal
Boost your Corn Yields on C/C

Residue removal allows for:
- Darker, faster-warming soils
- Better seed-to-soil contact
- Improved germination
- Better potential = Better yield

### Average grain yield at research site 2008-2012

<table>
<thead>
<tr>
<th>Treatment</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
<th>Average</th>
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<tbody>
<tr>
<td>Conventional</td>
<td>180.1</td>
<td>156.5</td>
<td>151.8</td>
<td>157.6</td>
<td>173.0</td>
<td>162.4</td>
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<tr>
<td>Cob Only</td>
<td>178.0</td>
<td>153.5</td>
<td>150.9</td>
<td>158.5</td>
<td>185.0</td>
<td>162.1</td>
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<tr>
<td>2nd Pass Cob Bale</td>
<td>185.8</td>
<td>152.8</td>
<td>152.6</td>
<td>157.1</td>
<td>176.5</td>
<td>164.1</td>
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<tr>
<td>Rake &amp; Bale</td>
<td>174.6</td>
<td>170.0</td>
<td>150.2</td>
<td>146.1</td>
<td>181.0</td>
<td>160.1</td>
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<tr>
<td>Average</td>
<td>181.8</td>
<td>161.8</td>
<td>155.0</td>
<td>151.1</td>
<td>179.5</td>
<td>163.4</td>
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</table>

### Stover Yield (dry ton/ac)

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<th>2010</th>
<th>2011</th>
<th>2012</th>
<th>Average</th>
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</thead>
<tbody>
<tr>
<td>Cobs only</td>
<td>0.5</td>
<td>0.7</td>
<td>0.5</td>
<td>0.2</td>
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<td>0.5</td>
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<tr>
<td>2nd Pass Cob Bale</td>
<td>1.0</td>
<td>1.1</td>
<td>0.9</td>
<td>0.9</td>
<td>0.8</td>
<td>0.9</td>
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<tr>
<td>Rake and Bale</td>
<td>2.3</td>
<td>1.5</td>
<td>1.4</td>
<td>2.9</td>
<td>1.2</td>
<td>1.9</td>
</tr>
</tbody>
</table>
On Site Manufacturing of enzymes

- Organism producing enzymes is grown on local C-source and produces the required enzyme cocktail based on local inducers (e.g. the plant’s cellulosic feedstock)

- OSM process fully integrated with the cellulosic ethanol plant maximizing cost-effectiveness

- Enzymes produced as whole broth, directly applicable in hydrolysis

* Picture on slide is skid-mounted OSM pilot plant vessel

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Value Proposition — A full-service package

**Upfront**
- Site Selection and Regulatory support
- Biomass development
- Financing

**Building**
- Process design, Engineering and Construction
- Enzymes including On-Site Manufacturing
- Yeast

**Operation**
- Startup and ongoing technical support.
- Can provide full plant management and ethanol marketing