Crumbles® Technology

Reactor-ready Feedstocks

2017 AE50 Award for Innovation In Biomass Feedstock Processing

BioEconomy 2017

Mike Perry
CEO

Since 1998...

forestconcepts™
Industry Agnostic...

The new bio-economy needs cost-effective, quality optimized feedstocks...

<table>
<thead>
<tr>
<th>Bio-Intermediates</th>
<th>Solid Bio-Fuels</th>
<th>Bio-Materials</th>
<th>Liquid &amp; Gaseous Fuels</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reactor-ready Feedstocks</td>
<td>Wood chips</td>
<td>Industrial fiber</td>
<td>Cellulosic ethanol</td>
</tr>
<tr>
<td>Precision Feedstocks®</td>
<td>Processed wood chips</td>
<td>Absorbents</td>
<td>Butanol</td>
</tr>
<tr>
<td>Biomass-derived sugars</td>
<td>Residential pellets</td>
<td>Carriers (coated/infused)</td>
<td>Aviation Fuel (Jet A)</td>
</tr>
<tr>
<td>Aromatics</td>
<td>Industrial pellets</td>
<td>Erosion control materials</td>
<td>Methanol</td>
</tr>
<tr>
<td>Hydrolysate</td>
<td>Torrefied fuels</td>
<td>Filter media</td>
<td>Naptha</td>
</tr>
<tr>
<td>AFEX fiber feedstock</td>
<td>Biochar</td>
<td>Animal bedding</td>
<td>Renewable Diesel</td>
</tr>
<tr>
<td>Biocrude (pyoil)</td>
<td>Semi-activated carbon</td>
<td>Pet litter</td>
<td>Renewable Marine Fuel</td>
</tr>
<tr>
<td>Biocrude (HTL)</td>
<td>Activated carbon</td>
<td></td>
<td>Renewable Natural Gas</td>
</tr>
<tr>
<td>Syngas (gasification)</td>
<td></td>
<td></td>
<td>Green Gas (RNG)</td>
</tr>
<tr>
<td>Pyrolytic acid</td>
<td></td>
<td></td>
<td>Bio-based heating oil (No.2)</td>
</tr>
<tr>
<td>Acetic Acid</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Furfural</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lignin</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

More than 40 prospective customers waiting...
The Problem

The current standard of drying wood chips and hammermilling consumes an average of 70% of the total energy used in a pellet plant.

The Opportunity:
Reduce the upfront energy cost by 50% = $ millions in savings

Forest Concepts’ Crumbles® Technology can...
and is about to go commercial!
Market Potential

Future Market Insights predicts:

Bio-plastic market $43.8B by 2020 at a CAGR of 28.8%

Build-out of the bio-economy industry between now and 2025 will require more than $180 billion of capital.

Our feedstock processing innovations apply to at least $10 billion of equipment.
What are Crumbles®?

- Flows like grain
- Crumble at Field Moisture
- Don’t dry unless needed
- Dry After milling = more than 50% savings
- 1/3 the energy of hammer milling
• Precision particles
• Physical properties are optimized for specific conversion processes
  – Length
  – Thickness
  – Moisture
  – Uniformity of size
  – Flowability
• Two pathways
  – From veneer
  – From chips
• Cascading processing of chip - particle size converges on cutter thickness
  – Minimal production of fines
The Economics

<table>
<thead>
<tr>
<th>Process</th>
<th>Particle Size (Xgm, mm)</th>
<th>Moisture (%wb)</th>
<th>Specific Energy (MJ/odMg)</th>
<th>Total Energy (MJ/odMg)</th>
<th>Total Energy (Kwh/odUS Ton)</th>
<th>Electricity Use ($/odUS Ton)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crumbler®, cascading</td>
<td>1.0</td>
<td>55%</td>
<td>240</td>
<td>550</td>
<td>139</td>
<td>$7.80</td>
</tr>
<tr>
<td>Hammermill, 2.18mm</td>
<td>1.6</td>
<td>45%</td>
<td>690</td>
<td>2350</td>
<td>592</td>
<td>$33.32</td>
</tr>
<tr>
<td>Corn Stalks</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Crumbler®, cascading</td>
<td>1.5</td>
<td>82%</td>
<td>180</td>
<td>680</td>
<td>171</td>
<td>$9.64</td>
</tr>
<tr>
<td>Hammermill, 12.5mm</td>
<td>1.5</td>
<td>46%</td>
<td>730</td>
<td>4530</td>
<td>1096</td>
<td>$61.68</td>
</tr>
</tbody>
</table>

Results of testing at the Washington State University Wood Science and Bioproducts lab

- For poplar chips, savings of $25.52 per U.S. dry ton (-77%) translates to multi-million dollars per year in electricity savings for biorefiners.

- Processing green corn stalks through the two comminution systems yielded an energy savings of more than -84%.
We will compete for market share and revenues as:

- a direct equipment seller
- a toll processor of feedstocks
- a licensor of technology
### Estimated Market Size at Saturation and First Five Years - Penetration

<table>
<thead>
<tr>
<th>Revenues by Product Type</th>
<th>Estimated Market Size at Saturation</th>
<th>First Five Years - Penetration</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Qty</td>
<td>Price / Unit</td>
</tr>
<tr>
<td>CrumblesMuncher - 1 TPH</td>
<td>200</td>
<td>$125,000</td>
</tr>
<tr>
<td>CrumblesMuncher - 10 TPH</td>
<td>1,500</td>
<td>$700,000</td>
</tr>
<tr>
<td>Screen System - 1 TPH</td>
<td>200</td>
<td>$20,000</td>
</tr>
<tr>
<td>Screen System - 5 TPH</td>
<td>200</td>
<td>$45,000</td>
</tr>
<tr>
<td>Screen System - 10 TPH</td>
<td>1,500</td>
<td>$75,000</td>
</tr>
<tr>
<td><strong>Total Products Revenues</strong></td>
<td>3,600</td>
<td></td>
</tr>
</tbody>
</table>
Success Factors

• 2017 3rd party evaluations critical
  – Refine commercial prototype Crumbler®
  – Real-time proof of benefits to costs and savings

• Prepare for demand for commercial scale machines
  – Build inventory (contract manufacturing)
  – Build parts inventory & support
  – Add marketing & business development
  – Contract field service
  – Funding required

• Complete development of dryer control systems
An Experienced Team

Combining structural plant biology with engineering...
Ask = $10 Million

Commercialization

• Build machines, heads & parts inventory (contract manufacturing)
• Add support system for installation, training & service
• Add staff in business development and engineering

Expand our development efforts and commercialize our novel drying systems for small particle feedstocks.

IP development and maintenance
Why Invest?

“Every bio-company needs quality feedstocks”

• Commercial scale (10 tph) Crumbler® evaluations set

• 14 U.S. Patents issued on the processes and the feedstock particles (more pending)

• $180 billion market with $10 billion potential

• Experienced team: Dr. James Dooley, Tom Broderick, and an excellent staff of engineers.

• The opportunity for an ROI within 3-5 years
Crumbles® Technology

www.forestconcepts.com

Winner of the 2017 AE50 Award for Innovation In Biomass Feedstock Processing