The Opportunity: Torrefied biomass coal replacement fuel

*TorrB™* torrefied biomass @ 6.9 cents per kwh

*COAL* @ 8.1 cents per kwh with emission control
Power Plants to be Closed

EPA regulations are shutting down nearly 10% of coal energy.
Torrefaction

- The process of roasting biomass at a high temperature (250 to 350 degrees Celsius) in the absence of oxygen.

Juniper waste wood

Torrefied juniper
Torrefied Biomass
Advantages

- Higher BTU per pound than hog fuel or pellets
- Requires less energy to grind than traditional wood pellets
- Heat from burning volatile exhaust gases coming out of torrefaction is used in the process, resulting in a cleaner process which needs less energy
- Is water resistant, unlike wood pellets
Torrefied Biomass as Coal Replacement Fuel

- Transports in open railcars; stored outdoors
- TorrB™ tested at 100% direct replacement
- Is easily pulverized, just like coal
- Burns at similar BTU value to coal
Competition/Competitive Advantage

HM3 Energy appears to be the only company to have:

- Waterless dirt removal and hydrophobic densification technologies.
- Won 3 highly competitive grants: USDA-SBIR Phases I and II and US Endowment for Forestry and Communities.

6 provisional patents filed.

“HM3 Energy appears to be farther along in development than other US torrefaction companies.”

*Biomass Power & Thermal, September 2011*
Awards & Accomplishments

- **USDA SBIR Phase I Grant $90,000 in 2010**
  For development of biomass waterless dirt removal system

- **US Endowment for Forestry and Community Award $241,000 in 2010**
  For construction and operation of pilot plant

- **USDA SBIR Phase II Grant $460,000 in 2011**
  For equipment design and testing for commercialization

- **National Clean Tech Open Competition Award $10,000 in 2011**
  As one of 18 finalists out of over 1,000 applicants nationwide.

- **Oregon BEST Grant $85,000** in 2012 in partnership with Oregon State University.

- **Six Patents Pending**
SUCCESSFUL TEST BURNS performed at Western Research Institute, Laramie, WY with 10 to 50% TorrB biomass/coal blends, then 100% TorrB biomass in place of coal.

LETTER OF ENGAGEMENT received from Portland General Electric to perform major test burns, in their Boardman, OR coal-fired plant.
Present Development Status

- Status of Bench Scale Tests for Process Optimization
  1. Determined torrefaction conditions
  2. Determined densification conditions
  3. Optimizing the pressure drop and temperature distribution across torrefaction reactor –
- Functional design of the demonstration plant layout (6 tons/day) and equipment completed ($2 million needed to complete the plant construction)
- Functional design of the first commercial plant layout (130 tons/day) and equipment design completed
- Target date for first commercial plant: Feb 2013
Torrefaction
Wood is composed of cellulose, hemi-cellulose and lignin. Hemi-cellulose is approx. 30% of wood weight and 10% of wood energy. When wood is heated to torrefaction temperature without air, hemi-cellulose will vaporize and come out of the torrefied wood. The vapor is burned and energy from the burning vapor is used to dry the incoming wood chips and to heat the torrefier.
• Traditional pellets must be kept dry in storage and transit

• Torrefied pellets or briquettes can be stored outside & hauled in open hopper rails cars

• Cost difference for shipment overseas = $50 per ton
Oregon is the #1 timber production state in U.S.

Half of Oregon has forests:

- 60% owned by Federal Government
- 35% privately owned
- 5% owned by tribes
Forest Restoration Efforts

- Less than 10% of growth on federal forest lands, and 75% of growth on private forest lands are harvested each year.
- Overstocked federal forests need thinning to restore forest health.
- Some private timber needs restoration
- HM3 Energy provides a market for residual & low-grade wood.
Suppliers to HM3 Energy

Major biomass collectors in Central Oregon:

- Quicksilver
- Bar 7A
- T-2
- Craig Woodward
- and others
<table>
<thead>
<tr>
<th>Source</th>
<th>2010</th>
<th>2011</th>
<th>Est. Annual</th>
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<tbody>
<tr>
<td><strong>Total available biomass, green tons (40% MC)</strong></td>
<td></td>
<td></td>
<td>Assuming $50/bdt price</td>
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<tr>
<td><strong>Slash from commercial timber harvest</strong></td>
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<tr>
<td>Deschutes NF (40%)</td>
<td>19,900</td>
<td>n.a.</td>
<td>25,000</td>
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<tr>
<td>Ochoco NF (100% of Crook County)</td>
<td>8,000</td>
<td>n.a.</td>
<td>10,000</td>
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<tr>
<td>Private timberland (Crook &amp; Jefferson, 40% of Deschutes)</td>
<td>10,900</td>
<td></td>
<td>11,000</td>
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<tr>
<td><strong>Pre-commercial thinning &amp; fire hazard fuels reduction</strong></td>
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<tr>
<td>Deschutes NF</td>
<td>23,100</td>
<td>29,100</td>
<td>30,000</td>
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<tr>
<td>Ochoco NF</td>
<td>11,050</td>
<td>9,700</td>
<td>12,000</td>
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<td>Private timberland &amp; rangeland</td>
<td>n.a.</td>
<td>n.a.</td>
<td>150,000</td>
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<td><strong>Rangeland restoration</strong></td>
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<td>BLM - Prineville</td>
<td>20,151</td>
<td></td>
<td>25,000</td>
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<tr>
<td>Crooked River Nat’l Grassland</td>
<td>12,500</td>
<td>12,500</td>
<td>18,000</td>
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<td><strong>Residual from sawmills &amp; chip operations</strong></td>
<td></td>
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<tr>
<td><strong>Total biomass (green tons)</strong></td>
<td></td>
<td></td>
<td>281,000</td>
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</tbody>
</table>
• Hiroshi Morihara, Ph.D., ME, president. Co-inventor of process that manufactures purest polysilicon in the world. Past president of 2 Bay Area biotech companies.
• Bill Breneman, MSChE, PE and MBA, process engineering manager. Co-inventor of same polysilicon process. 30+ years experience in chemical plant design, construction and operation.
• David Carter, BSChE, project manager. 20 + years experience in project management, plant operation and maintenance.
• Andrew Green, BSChemE, project engineer. 15 years experience in semiconductor device design and manufacturing. Built pilot torrefaction system.
• Howard Dawson, Ph.D. Chemistry, IP manager. 30+ years experience in wood chemistry. Consults internationally.
• Warren Shoemaker, MBA, business development manager. 20+ years experience in biomass feedstock and contract negotiations.
Transport & Power Plant Feeding

Cost Comparison between Raw Pellets & TorrB Torrefied Briquettes

Raw Pellets (1 Tonne = 17 GJ)

TorrB (0.74 Tonne = 17 GJ)

Covered Storage & Handling

Outdoor Storage & Handling

Shipping Raw Pellets:

North American Port

$35

Asian Port

$26

Build New Feeding System

Covered Storage at Power Plant

Outdoor Storage at Power Plant

Covered Transport

Open Transport

Use Existing Feeding System

Cost per 17 Gigajoule of ENERGY for Feeding and Transport:

Raw Pellets = US $93

TorrB = US $43