Central Washington Biomass Energy Workshop

April 29, 2015

Brent J. Sauder
Director, Strategic Partnerships
University of British Columbia
Welcome to UBC’s Point Grey Campus
Greenhouse Gas Emissions at UBC
Teaching and Research Excellence

Innovation and Commercialization Leader

Independent Municipality

Independent Utilities

Supportive Provincial policies

Enablers of Innovation
Project Drivers:

- Aging infrastructure
- Increasing Energy Need
- GHG Commitment
Combined Heat and Power (CHP) System Operating Modes

1. Biomass Dryer
2. Fuel Storage
3. Gasifier

4. Syngas Conditioning
5. Engine
6. Heat & Power

Syngas → Conditioned Syngas

Thermal Mode

7. Oxidizer
8. Boiler
9. ESP
10. Thermal Energy

Syngas

20,000 lbs/hr steam

Technology Driver
The Team

UBC Operations, Faculty, Students, Researchers; with industry partners: Nexterra, General Electric, BCHydro; and the local community: UNA, SHHS

UBC project partners include:

• BC Bioenergy Network
• BC Ministry of Energy, Mines
• BC Ministry of Forests
• BC Hydro
• Western Economic Diversification

• City of Vancouver
• FP Innovations
• GE Energy
• Natural Resources Canada
• Nexterra Systems Corp.
• Sustainable Development Technology Canada
What were the social licence barriers of the BRDF?

- biomass sourcing
- building siting
- truck traffic
- air emissions
Fuel (Biomass) Sourcing

Fuel is ground & chipped waste wood:

- Sawmill residuals
- Furniture/carpentry offcuts
- Municipal trimmings
- Land clearing operations

Uses 2-4 trucks per day for 12,500 dry tonnes per year.
Social License: BRDF Siting

- The site was chosen to be a first of its kind in BC, for a social license, to demonstrate a biomass/cogeneration facility in a high density urban setting
- Secondary consideration for site was the close proximity to Marine Drive and operational support
Above & beyond: Ambient Air Monitor

- Emission Dispersion Study showed Marine Tower 5 as the most likely residential building for air emission impact
- June 2012, UBC proactively installed a real time Ambient Air Monitor on Marine Tower 5

- Automatic emails alerts if air quality limits are exceeded
  - 24 hour average PM 2.5 < 25 µg/m³ or
  - 1 hour NO₂ < 107 ppb
- Air emissions remain well below Metro Vancouver limits
How has the BRDF performed?
## BRDF Air Emissions (Performance)

<table>
<thead>
<tr>
<th>Permit Requirements</th>
<th>Dryer</th>
<th></th>
<th>Boiler</th>
<th></th>
<th>Engine</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Permit</td>
<td>Test</td>
<td>Permit</td>
<td>Test</td>
<td>Permit</td>
</tr>
<tr>
<td>PM</td>
<td>15</td>
<td>3.9</td>
<td>15</td>
<td>2.1</td>
<td>15</td>
</tr>
<tr>
<td>Particulate Matter</td>
<td>-</td>
<td>-</td>
<td>272</td>
<td>230</td>
<td>249.7</td>
</tr>
<tr>
<td>NO\textsubscript{x}</td>
<td>10.4</td>
<td>9.6</td>
<td>10.5</td>
<td>2.2</td>
<td>40.9</td>
</tr>
<tr>
<td>Nitrogen Oxides</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VOC</td>
<td>5%</td>
<td>&lt;5%</td>
<td>5%</td>
<td>0%</td>
<td>5%</td>
</tr>
<tr>
<td>Volatile Organic Compounds</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Opacity</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Verified by 3rd party testing (Al Franco)
- Unless otherwise noted, all units are in mg/m3
**Enhanced Performance:**

<table>
<thead>
<tr>
<th>BRDF</th>
<th>Biomass Thermal</th>
<th>Biomass Cogeneration</th>
<th>Biomass Thermal &amp; RNG Cogeneration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steam Boiler</td>
<td>6.0 MWt (20,000lbs)</td>
<td>1.5 MWt (5,000lbs)</td>
<td>6.0 MWt (20,000lbs)</td>
</tr>
<tr>
<td>Heat Recovery Steam Generator (HRSG)</td>
<td>-</td>
<td>1.4 MWt (4,600lbs)</td>
<td>1.4 MWt (4,600lbs)</td>
</tr>
<tr>
<td>Hot Water Engine Heat Recovery</td>
<td>-</td>
<td>1 MWt</td>
<td>1 MWt</td>
</tr>
<tr>
<td>Electrical Energy</td>
<td>-</td>
<td>2 MWe</td>
<td>2 MWe</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>6 MW</strong></td>
<td><strong>5.9 MW</strong></td>
<td><strong>10.4 MW</strong>*</td>
</tr>
</tbody>
</table>

*Note 1MWt = 1 MegaWatt (thermal) = 3,333lbs steam

*75% increase in energy production
## BRDF PERFORMANCE

<table>
<thead>
<tr>
<th>BRDF Project</th>
<th>Original Business Case</th>
<th>The Current Situation FY15 Forecast</th>
<th>FY15 thermal only</th>
</tr>
</thead>
<tbody>
<tr>
<td>Remaining principle ($8.15M loan)</td>
<td>$8.15M</td>
<td>$7.4M</td>
<td></td>
</tr>
<tr>
<td>Annual O&amp;M cost</td>
<td>$1.4M</td>
<td>$1.1M</td>
<td></td>
</tr>
<tr>
<td>Annual fuel input cost$\textsuperscript{1}$</td>
<td>$0.8M</td>
<td>$2.6M</td>
<td></td>
</tr>
<tr>
<td>Revenue generated</td>
<td>$3.2M</td>
<td>$3.9M</td>
<td></td>
</tr>
<tr>
<td>break-even forecast$\textsuperscript{2}$</td>
<td>2026</td>
<td>2028</td>
<td></td>
</tr>
<tr>
<td>Steam Produced (MWh)</td>
<td></td>
<td>34,000</td>
<td></td>
</tr>
<tr>
<td>Portion of Campus Thermal load from the BRDF</td>
<td></td>
<td>18%</td>
<td></td>
</tr>
<tr>
<td>GJ of natural gas offset</td>
<td></td>
<td>146,000 GJ</td>
<td></td>
</tr>
<tr>
<td>Tonnes CO2 offset</td>
<td></td>
<td>6,880</td>
<td></td>
</tr>
<tr>
<td>Electricity Produced (MWh)</td>
<td></td>
<td>9,800</td>
<td></td>
</tr>
</tbody>
</table>

1. Fuel Input costs are considerably higher due to 1) the use of renewable natural gas as the primary fuel for cogen, and 2) the plant is now operating in full thermal and cogen modes simultaneously.

2. The break-even forecast is extended by 2 years due to 1) the delayed completion of the project, and 2) our unsuccessful efforts to reliably produce electricity from syngas.
PERFORMANCE: LESSONS LEARNED

• Requires a higher biomass fuel quality than expected (<30% moisture content)

• Syngas clean up process equipment failures. Requires several system upgrades & yet to be resolved

• Higher operational costs than expected e.g. people, maintenance and materials
Other Outcomes

- Community “Trust”
- Research Asset
- Reference Site
- Culture of Innovation
Drove Marketability of Canadian CLT

- Provided detail imbedded in the Manufacturing Chapter of the CLT Handbook
- Handbook provides Standards to realize:
  - Manufacturing of CLT in Canada
  - Use of Canadian Fibre
  - Construction of CLT structures in Canada
New Technologies

• Thermo-Chemical Processes
  – Gasifiers
  – Pyrolysis

• Ancillary Processes
  – Dryers
  – Char/Ash recovery/utilization
1. Wet biomass is loaded into the top of the dryer

2. It descends inside the dryer — evenly distributed in a turbulence-free environment until discharged at the preset moisture content

3. This is accomplished by pulling heat through the descending biomass via three controlled extraction zones

4. Simple water vapour is vented to atmosphere
NEXT STEPS:

• Continue to work with FortisBC to reduce the cost of renewable natural gas.
• Continuous improvement to operations and efficiency.
• Pre-feasibility study of expanded biomass operation to meet 2020 greenhouse gas reduction target.