Overview of Wood Biomass & Systems
An Excellent Renewable Resource

Presentation By:
Stephen Bearss –
Sales Representative
What is Wood?

<table>
<thead>
<tr>
<th>Chemical Content</th>
<th>Natural Wood % By Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon (C)</td>
<td>49</td>
</tr>
<tr>
<td>Hydrogen (H)</td>
<td>6</td>
</tr>
<tr>
<td>Oxygen (O)</td>
<td>44</td>
</tr>
<tr>
<td>Ash (Potassium, Sodium, Calcium, Phosphorus, Silicon, ...)</td>
<td>0.8 (trunk wood spruce incl. bark)</td>
</tr>
</tbody>
</table>

Woody Biomass is stored solar energy through photosynthesis.

Trees sequester the elements of CO2 over its life time.

Once harvested, wood waste is converted into useful energy.
Do We Have Enough?

• 402,000,000 ha or 41% of Canada is Forest
• 66% of BC’s – 60,000,000 ha - is forest.
• < 1% of BC Forests are harvested annually.
• BC Pellet Mills produced 1,950,000 Tonne in 2012
• Canada estimates 20,000,000 Tonne SUSTAINABLE potential.
How Much Do I Need?

Typical Biomass Consumption by Usage

- Pellet Plant: 12,000 Truck Loads
- Power Plant: 5,000 Truck Loads

10X Magnification

- 5 MW Community Electricity: 1,000 Truck Loads
- Enderby DH: 20 Truck Loads

WOOD WASTE 2 RURAL HEAT
Notes on Wood Pellets

- Uniform in shape & energy content 5000 kWh/Tonne
- Lower capital cost of installation
- Higher fuel cost per tonne
- Quantity per m³ = 650kg/m³
Chips need to be very clean and consistent.

Moisture below 35% is **IDEAL** but as high as 55%.

kWh / kg – Does not vary much between wood species.

Higher Capital Cost for Storage and Transport of Chips, Shavings, Grindings, Mix vs. Pellets.

Quantity m³ = 160 – 300 kg/m³
On a Scale of 0% to 65%

<table>
<thead>
<tr>
<th>Moisture content (%)</th>
<th>Wood energy (kWh / tonne)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0%</td>
<td>5280</td>
</tr>
<tr>
<td>5%</td>
<td>4980</td>
</tr>
<tr>
<td>10%</td>
<td>4680</td>
</tr>
<tr>
<td>15%</td>
<td>4380</td>
</tr>
<tr>
<td>20%</td>
<td>4080</td>
</tr>
<tr>
<td>25%</td>
<td>3780</td>
</tr>
<tr>
<td>30%</td>
<td>3480</td>
</tr>
<tr>
<td>35%</td>
<td>3180</td>
</tr>
<tr>
<td>40%</td>
<td>2880</td>
</tr>
<tr>
<td>45%</td>
<td>2580</td>
</tr>
<tr>
<td>50%</td>
<td>2280</td>
</tr>
<tr>
<td>55%</td>
<td>1980</td>
</tr>
<tr>
<td>60%</td>
<td>1680</td>
</tr>
<tr>
<td>65%</td>
<td>1380</td>
</tr>
</tbody>
</table>

Kiln Dry Chips
Outside Pile of Dry Chips
Wood Pellets
Dimensional Waste – Pallets, 2x4 etc.
Road Side Trimmings

Highland Birchwolds web site
www.highlandbirchwolds.co.uk/
How Much for Biomass?

• How much can you pay and how much do you need?
• cost is VERY local market driven
• need to understand local market
  – What goes where?
  – How much do they pay?
  – How long is the contract?
• from -$30 to $120 per tonne
## Cost and Emissions

<table>
<thead>
<tr>
<th>Fuel Types</th>
<th>Cents / kWh</th>
<th>Fuel Types</th>
<th>kg of CO2e / kWh</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wood Chips 50% MC</td>
<td>1.0 – 2.25</td>
<td>Wood Chips</td>
<td>.008 up to .039</td>
</tr>
<tr>
<td>Wood Pellets 5% MC</td>
<td>2.25 – 3.5</td>
<td>Wood Pellets</td>
<td>.050</td>
</tr>
<tr>
<td>Natural Gas</td>
<td>3.0 – 6.0</td>
<td>Natural Gas</td>
<td>.1773</td>
</tr>
<tr>
<td>BC Hydro</td>
<td>6.8 &amp; 10.19</td>
<td>BC Hydro</td>
<td>.0000171</td>
</tr>
<tr>
<td>Heating Oil</td>
<td>7.0 – 9.0</td>
<td>Heating Oil</td>
<td>.266</td>
</tr>
<tr>
<td>Propane</td>
<td>8.5 – 11.0 (25)*</td>
<td>Propane</td>
<td>.214</td>
</tr>
</tbody>
</table>

### CARBON NEUTRAL?

- Some studies wood biomass is worse than coal
- In other studies it produces 75% more CO2 than Natural Gas
- **Good News →** BC M.O.E. Best Practices for GHG Emissions along with U.K. & EU countries, woody biomass used from wood waste streams or landfills is CO2 neutral. **NOTE:** are to Record Bio CO2 = 93.33 kg/GJ
### How Much for Biomass?

<table>
<thead>
<tr>
<th>Metric - Heating Values and Cost Comparisons for Various Fuel Types</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Type of Fuel</strong></td>
</tr>
<tr>
<td>------------------</td>
</tr>
<tr>
<td><strong>Heating Value</strong></td>
</tr>
<tr>
<td><strong>$ per kWh</strong></td>
</tr>
<tr>
<td><strong>$ per tonne</strong></td>
</tr>
</tbody>
</table>

*Source Information compiled by Fink Machine Inc. with template from EPA, US EPA, and US Carbon Trust Values incorporated into chart.*
Challenge of Biomass Heating

• Retrofit to Hydronic Heating
• Capital vs. Operating Cost

• Education!

Biomass heat system scrapped

The city has abandoned its plan to power an innovative district heat system for its Olympic Village site by burning wood waste, because people just couldn’t believe it was a good environmental choice.

Vancouver Sun April 18, 2007
Old is New

Viessmann - KOB Pyrot Biomass Boiler

10,000 KOB systems worldwide principles of gasification with modern technology
low emission, 85+% efficient

By 1945, end of WW2 – 9,000,000 vehicles were travelling on syn gas all over the world.
Hot Model

- Inception 1995
- Areal Burn Chamber
- Awards for Innovation
- 540kW – 540kW
- Feed Design
- Efficient burn. 85-90%
- Efficient
- Wet Content Fuel
Get A Wood Stove

- Feed auger and Grate
- Recirculation Gas – 7 to 10% O2
- Primary Air - 800 Deg C
- Secondary Air – 1100 Deg C
- (Low Nox & Low Clinker)
- Complete Combustion – CO2)
- De-ashing system
- Ignition
- Triple pass heat exchanger
- Induced draft fan
- High Density Insulation
Heatingtec Model

- Inception 1987
- 1000 units worldwide
- 100kW to 1250kW
- Automatic feed / Grate Design
- Efficient burn. 85-
  thermal efficient
- Wet Content Fuel
Emission Control – GVRD 1190

- Flue Gas Cyclone PM 10
- Metal Mesh Filtration PM 2.5 < 18 mg/Nm3
- Electrostatic Precipitator PM 2.5 < 18 mg/Nm3
Out this System

1st of it’s Kind in Canada:
• Privately Funded
• Owner / Operator Model
• <1MW in size
• In Natural Gas Territory

Built Entire Ourselves
• Retrofitted Clients facilities
• Installed Line ourselves for $400 L/M (Line, Labour, Trench)
• Present: 275 TPY (50% Capacity)
• Winter: 20T truck load/week
• Approximately 225t GHG year
• Fuel: wood chips 25 - 60 minutes away.
• Fuel options in region.
• Price $35 - $60 BDT
• Viessmann Gas Boiler Back-up (have not used back-up once!)
• Estimated Payback 15 years (10 Years with IHA & Senior Complex)

• OPERATIONAL IN 8 MONTHS
el to Energy

Hold 50 Tonne
2 Weeks Winter
2 Months Summer
Boiler  Water Mgmt Tanks  Manifold  Clients
Customer Enderby Pool

Installed 250 metres operational in 3 Weeks
Seasonal Heat Load at Demand - 85kW
District Layout in 2014...

Present Customers
1. Tony's Tire (35 kW)
2. Edwin D. (15 kW)
3. Enderby Autobody (35 kW)
4. Enderby Lions Pool (80 kW)
5. Royal Inn (DHW) (15 kW)
6. Cedar Solution (60 kW)
7. Fink Machine (85 kW)
8. Boiler House (Pyrot 540)
9. ENFAB (90kW)

Future Customers
1. Parkview Place (120 kW)
2. Marvin's Mechanical (20 kW)
3. CNC (45 kW)
- 950 metres of new district lines
- No Internal Redundancy Heating Systems
80 kW Energy Transfer Station
Clients have found 10-15% direct decrease in Heating Costs:

- Improved Efficiencies (OLD units)
- Transfer of Maintenance Costs
BRITISH COLUMBIA
• Size: 30,000 sq ft plant

• Boiler: Pyrot 540 kW
• Fuel: Chips and Sawdust

• Owner physically removed gas line from property!

• Gas Displaced 5850GJ
• GHG Reduction 119 Tonne
• Payback was < 5 Years
Project Aquatic Centre

opened 2011 – Pyrot 400
Wood Pellets

Funding Source: UBCM (Union BC Municipalities)
Strategic Priorities & Innovation Fund $467,000

30% over Propane

$467,000

Table 5 - Rate of Return

<table>
<thead>
<tr>
<th></th>
<th>Boiler System Only Actual</th>
<th>Entire BEP Actual</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Project Capital</td>
<td>$411,000</td>
<td>$705,000</td>
</tr>
<tr>
<td>Investment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DoL Investment</td>
<td>$140,000</td>
<td>$238,000</td>
</tr>
<tr>
<td>Savings</td>
<td>$26,000</td>
<td>$26,000</td>
</tr>
<tr>
<td>Simple Payback</td>
<td>5.4 Years</td>
<td>9.2 Years</td>
</tr>
<tr>
<td>Net present Value</td>
<td>$96,806</td>
<td>$152,000</td>
</tr>
<tr>
<td>(15 years and 7%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Internal Rate of Return</td>
<td>17%</td>
<td>7%</td>
</tr>
</tbody>
</table>

Source: UBCM (Union BC Municipalities)
Scenario

Boilers Averaged 67,500 litres of Oil

Cowichan Secondary School consumed 60% of the Fuel in the School District
<table>
<thead>
<tr>
<th>OPTIONS</th>
<th>Propane Fired Condensing Boiler</th>
<th>Air Source Heat Pumps</th>
<th>Ground Source Heat Pumps</th>
<th>Biomass Boiler</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project Cost</td>
<td>$250,000</td>
<td>$490,000</td>
<td>$870,000</td>
<td>$490,000</td>
</tr>
<tr>
<td>Energy Efficiency Increase</td>
<td>23.3%</td>
<td>67%</td>
<td>75.2%</td>
<td>23.3%</td>
</tr>
<tr>
<td>Electrical Cost Savings</td>
<td>($20,000)</td>
<td>$22,750</td>
<td>$31,000</td>
<td>$37,000 - $55,000</td>
</tr>
<tr>
<td>Electrical Increase kWh</td>
<td>None</td>
<td>171,000</td>
<td>182,000</td>
<td>None</td>
</tr>
<tr>
<td>GHG Reduction tCO2e</td>
<td>83.3</td>
<td>194</td>
<td>211</td>
<td>168</td>
</tr>
</tbody>
</table>
School District #79
Cowichan Secondary School

Installation: February 2014

Neutral Funding (CNCP) $217,375

District Funding $272,625

Payback 4.6 – 6.5 Years

Reduction 75% or 160 Tonne

Lonnie Schemerhorn: Capital Coordinator
ALBERTA
Madsen Cabinets

Cabinets


50 sq/ft production plant

Make-up spray booth

540 Boiler

150mm Briquettes & Mill Waste

Displacement 6860 GJ

Reduction: 336 Tonne

Payback 5.5 Years
*Administration Office*

*Maro County Sustainable Wood Energy Project*

- Area: 2365 sq/m
- Gas: 120 tonne of chips per annum
- Envisaged 55% efficient gas for 85% efficient woody biomass

*2011 Award for Innovation*
Waste Solutions

2003rd Ave. Landfill, Calgary

Customer: Installed 2 - 540kW Pyrot

Installing Coverall Building 2008

MRF Building in 2011

Hazardous Construction Waste (Pallets, etc.)
Fuel Oil as of November 30th: 93.7 cents/Litre
Atlantic Bio Heat:

Supply Contract Heat to Total 7 Buildings

Westisle Composite School

Pyrotec 720, installed 2010
Size: 180,000 sq/ft

Dick Arsenault: Atlantic Bio-Heat

Fuel: Wood Chips – New Brunswick & PEI – Forest Mgmt Programs

Oil Displacement 210,000 L/year
GHG Reduction 660 Tonnes
Payback <6 years
NORTHWEST TERRITORIES
06 - 2013 → 16 Systems in GNWT (KOB - Viessmann / Fink Machine Inc.)

Olympic Swimming Pool = 2,500,000L
12,850,000L or 5.1 Olympic Swimming Pools of Oil

Year: 2007 2008 2009 2010 2011 2012 2013 2014
Amount: 568,904 586,590 857,754 1,374,979 2,404,751 2,653,000 2,850,000
Annual Reductions in GHG Emissions (Tonne)

Biomass = 75% of Cumulative GHG Reduction
Biomass = 26,314 Tonne OR 5540 Cars
NWT only has 43,537 people (Stats Can 2013)
Fiscal Year 2013/2014 – 15 Biomass Systems produced $594,000 in Operational Savings

Biomass is 30% cheaper than Heating Oil

$5,800,000 saved since 2007

Fiscal 2014/2015 - 24 Biomass Systems:

-11,500 Tonnes of GHG Annual Reduction
- Reinvest $1,720,000 into Capital Asset Retrofit Fund
Ecole St. Joseph School
Yellowknife, NWT
- 540 kW Pyrot Pellet Boiler
- Fuel Oil reduction 102,000 liters per year

Legislative Assembly Building
- 300kW BINDER Boiler
- Fuel Oil displaced 99,000 liters per year
Biomass Heating Systems for GNWT Buildings

Installed and Planned Wood Pellet Boilers

OCTOBER 2009

Reherron Bone School, Iona
- High-capacity wood pellet boiler
- Expected heat oil reduction of 165,000 litres per year
- Expected GHG reduction of 460 tonnes per year
- Installation completed in 2009

North Slave Correctional Facility, Yellowknife
- Two 150 kW wood pellet boilers
- Expected heat oil reduction of 817,000 litres in 2009
- Expected GHG reduction of 1,168 tonnes in 2009
- Installation completed in November 2009

Legislative Assembly Building, Yellowknife
- One 300 kW wood pellet boiler
- Expected heat oil reduction of 63,000 litres per year
- Expected GHG reduction of 300 tonnes per year
- Installation to be completed in 2009

St. Joas School, Yellowknife
- One 150 kW wood pellet boiler
- Expected heat oil reduction of 107,000 litres per year
- Expected GHG reduction of 400 tonnes per year
- Installation completed in 2009

Sir John Franklin School, Yellowknife
- One 150 kW wood pellet boiler
- Expected heat oil reduction of 143,000 litres per year
- Expected GHG reduction of 580 tonnes per year
- Installation completed in 2009

PVK School & Recreation Complex, Fort Smith
- One 750 kW wood pellet boiler
- Expected heat oil reduction of 300,000 litres per year
- Expected GHG reduction of 900 tonnes per year
- Installation to be completed in 2010

Thebacha College, Fort Smith
- One 150 kW wood pellet boiler
- Expected heat oil reduction of 200,000 litres per year
- Expected GHG reduction of 500 tonnes per year
- Installation to be completed in 2010

Health Centre, Fort Smith
- One 150 kW wood pellet boiler
- Expected heat oil reduction of 200,000 litres per year
- Expected GHG reduction of 500 tonnes per year
- Installation to be completed in 2010

A Brief History

The first wood pellet boilers for a Territorial Government building were installed at the North Slave Correctional Centre in 2006. Arctic Green Energy (AGE) owns and installed the boiler, and sells heat to the Government of the NWT (GNWT). Thanks to the success of that project, the GNWT is now installing its own wood pellet boilers for other facilities, where economically viable. Since the cost to transport wood pellets is higher than that of other fuels, the most viable locations for wood pellet boilers are those closest to the source of wood pellets. Currently, that source is in La Cite in northern Alberta. Therefore, the GNWT is investing in wood pellet boilers in communities on the road network in the South and North Slave regions.
Anderson Thomson Tower

- Thomson-KOB **USED** Pyrotec 720 kW installation: 2013
- 2-year payback
- Wood Pellets  Back-Up: Oil Boilers

Also plans an installation of a Viessmann-
for his 2nd Hotel Tower in Yellowknife.
Variety of Installs

Industrial – ECCO Waste
- Calgary, AB

Residential D.E.
- Pennsylvania

Educational – E.M.E
- N.W.T.

First Nations

Hospitals

Government Facilities
- Vernon, B.C.
- Kelowna, B.C.
- Oregon

http://www.youtube.com/watch?v=EqqSPcphuM#action=share
Thank You for Coming

January 8th, 2015 School District 79 will be hosting a site visit of Lake Cowichan Secondary School. Please see me if you are interested.

http://www.youtube.com/watch?v=EqqSPcpohuM#action=share