BIOMASS ENERGY FOR NEW BELGIUM BREWERY

New Belgium Brewing
Fort Collins, CO
June 14, 2017
OUTLINE

• Project background
• Why biomass?
• Study findings
  – Proposed system
  – Fuel use
  – Fuel supply
  – Emissions
  – Costs
  – Variants
ABOUT WISEWOOD ENERGY

Our Mission
We outfit communities and businesses with state-of-the-art biomass energy systems that strengthen local economies, lower heating costs and promote environmental stewardship

Technology in Service of Community and Environment
PROJECT BACKGROUND

• CSFS and Dan Bihn met with Wisewood to discuss CO biomass opportunities
• New Belgium Brewing was identified as a compelling process heat project
• CSFS retained Wisewood Energy to conduct a feasibility assessment of biomass process heat at the Fort Collins facility
• Feasibility study completed in May 2017
Biomass Energy for New Belgium Brewery

WHY BIOMASS?
Biomass is efficient...
Development of emissions of Austrian Biomass Boilers, measured by the federal agency for agricultural engineering Wieselburg (BLT)

... AND CLEAN
LOCAL FUEL SUPPLY

• New Belgium has its own spent grain supply
• The City of Fort Collins is concerned about Emerald Ash Borer (EAB) impacts in the area
• 15% trees in Fort Collins are ash; entire population expected to die within 5-10 years of initial EAB detection
• New Belgium still uses ~88,000 MMBtu/yr of natural gas for the steam brewing process
• Natural gas is cheap, but is not renewable and has environmental costs that are not reflected in the price
A LEADER IN SUSTAINABILITY

Reduce electricity and natural gas demand with efficient equipment and waste heat capture.

Biogas to CHP (15%)
Solar PV (4.5%)

Per-kWh internal tax

2-way feedback for Smart electricity use

On-Site Power Generation

Demand Management
- Smart Grid Technology -

Energy Conservation
- Harvesting & Usage Reduction -

I.E.T.
- Internal Usage Tax -
Biomass Energy for New Belgium Brewery

WHY BIOMASS?

RENEWABLE STEAM!
Biomass Energy for New Belgium Brewery

STUDY FINDINGS
EXISTING NATURAL GAS SYSTEM

- 24/7, 5-7 days/wk operations
- Medium pressure steam
- Steam load primarily met by 1 modulating Clayton boiler
- Supplemented by 3 binary output Miura LX-200 boilers
- Consumption of approx. 88,000 MMBtu/yr
- >30,000 tons/yr spent grain produced, sold to cattle farmers for nominal price
PROPOSED BIOMASS SYSTEM

• 25%:75% spent grain to wood
• Displace 100% natural gas steam use with a 13.6 MMBtu/hr boiler
• 2,200 tons of spent grain per yr, 6,600 tons of wood per yr
• Target 35% combined spent grain and wood moisture content for max fueling flexibility
BIOMASS ENERGY MODEL

Estimated Heat Load Coverage by New Biomass-Fired Boiler

- Calculated Heat Load (MBH)
- Estimated Biomass Boiler Load Coverage (MBH)
## Target Fuel Moisture Content

<table>
<thead>
<tr>
<th></th>
<th>Scenario A</th>
<th>Scenario B</th>
<th>Scenario C</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Grain Drying</strong></td>
<td>Dewatering Screw + Active Drying</td>
<td>Dewatering Screw</td>
<td>None</td>
</tr>
<tr>
<td><strong>Target Spent Grain Moisture Content</strong></td>
<td>20%</td>
<td>50%</td>
<td>84%</td>
</tr>
<tr>
<td><strong>Target Wood Moisture Content</strong></td>
<td>40%</td>
<td>30%</td>
<td>19%</td>
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</tbody>
</table>

- **Steam Tube Bundle Dryer**
- **Dewatering Screw**
WOOD SUPPLY OPTIONS

• **Commercial arborists**
  • Expected to be challenged by influx of wood from Emerald Ash Borer
  • Currently paying to dispose of wood
  • 1,000 – 5,000 tons/yr available

• **Morgan Timber**
  • Currently supplying wood chips to existing biomass systems
  • Reliable, steady, plentiful supply

• **Hageman’s Earth Cycle**
  • Additional market for wood waste
  • 15,000 – 20,000 GT/yr woody material
  • More expensive to access

• **Larimer County Landfill**
  • 87,000 – 100,000 tons/yr woody material
  • More expensive to access
EMISSION CONTROLS

- Dynamic feedback from oxygen and temperature sensors in the combustion chamber and flue gas stream to optimize combustion
- Multi-cyclone array
- Electrostatic precipitator
- Other options if needed/desired for specific criteria pollutants (NOx)
Stabilized year operating costs compared to existing natural gas system.

<table>
<thead>
<tr>
<th>EXISTING HEATING SYSTEM</th>
<th>BIOMASS HEATING SYSTEM</th>
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</thead>
<tbody>
<tr>
<td>NATURAL GAS</td>
<td>WOOD FUEL</td>
</tr>
<tr>
<td>$433,900</td>
<td>$66,100</td>
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<tr>
<td>ELECTRICITY</td>
<td>ELECTRICITY</td>
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<tr>
<td>$2,800</td>
<td>$42,500</td>
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<tr>
<td>OPERATIONS</td>
<td>OPERATIONS</td>
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<tr>
<td>$5,000</td>
<td>$66,200</td>
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<tr>
<td><strong>TOTAL</strong></td>
<td><strong>TOTAL</strong></td>
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<tr>
<td><strong>$441,700</strong></td>
<td><strong>$174,900</strong></td>
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</table>

Summary comparison of lifetime operating costs.

<table>
<thead>
<tr>
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<th>YEAR 1 COST</th>
<th>YEAR 25 COST</th>
<th>CUMULATIVE COST (25 YEARS)</th>
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<tbody>
<tr>
<td>EXISTING SYSTEM</td>
<td>$442,000</td>
<td>$1,125,000</td>
<td>$18,320,000</td>
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<tr>
<td>BIOMASS SYSTEM</td>
<td>$175,000</td>
<td>$281,000</td>
<td>$5,601,000</td>
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<tr>
<td>BIOMASS SYSTEM SAVINGS</td>
<td>$267,000</td>
<td>$843,000</td>
<td>$12,719,000</td>
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# CAPITAL COST OPINION

<table>
<thead>
<tr>
<th>Item Description</th>
<th>Est. Hours</th>
<th>Install Equipment</th>
<th>Install Materials</th>
<th>Install Labor</th>
<th>Line Total</th>
<th>% Total Project</th>
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<tbody>
<tr>
<td><strong>Construction Costs</strong></td>
<td></td>
<td></td>
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<tr>
<td>Civil/Structural</td>
<td>Included</td>
<td>Included</td>
<td>$240,000</td>
<td>Included</td>
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<tr>
<td>Mechanical Installation</td>
<td>3,270</td>
<td>$-</td>
<td>$3,030,000</td>
<td>$490,000</td>
<td>$3,570,000</td>
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<tr>
<td>Electrical</td>
<td>400</td>
<td>$-</td>
<td>$100,000</td>
<td>$50,000</td>
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<td>Permitting</td>
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<td>Miscellaneous</td>
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<tr>
<td>Contingency and Unlisted Items</td>
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<tr>
<td><strong>Subtotal Direct Costs</strong></td>
<td>3,670</td>
<td>$-</td>
<td>$3,360,000</td>
<td>$540,000</td>
<td>$4,740,000</td>
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<tr>
<td>General Contractor Costs</td>
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<td>$950,000</td>
<td>15.4%</td>
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<tr>
<td><strong>Subtotal Construction Costs</strong></td>
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<td>$5,680,000</td>
<td>92.5%</td>
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<td><strong>Engineering, Procurement and Construction Management</strong></td>
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<tr>
<td>Engineering, Procurement and Construction Management</td>
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<td>$460,000</td>
<td>7.5%</td>
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<td>Finance Fees and Management</td>
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<td>$-</td>
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<tr>
<td><strong>Subtotal Development Costs</strong></td>
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<tr>
<td><strong>Total Capital Costs</strong></td>
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<td>$6,140,000</td>
<td>100%</td>
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</tbody>
</table>
BIOMASS SYSTEM VARIANTS

• **Smaller biomass boiler**
  – 8 MMBtu/hr displaces 78% of facility’s demand
  – Avoids federal regulatory compliance
    • System will be equally clean, but less paperwork

• **District steam system**
  – Renewable process steam for breweries in the vicinity
  – Increase boiler size, footprint, and storage system
  – Allows for significant expansion of brewery operations in the “district”