Biomass for Cooling System Technologies: A Feasibility Guide

Heating the Midwest – Minneapolis, MN
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Agricultural Innovation: From Idea to Reality
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- Coproduct Utilization
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  - Milling
  - Size reduction
  - Blending
  - Pelleting
  - Drying
  - Product characterization
  - Particle size analysis
Biomass for Cooling System Technologies: A Feasibility Guide

Coauthors:
Roopesh Pushpala Graduate Research Assistant University of Minnesota, CURA
Agricultural Utilization Research Institute
Biomass for Cooling System Technologies: A Feasibility Guide

• **Project Partners:**
  - University of Minnesota, Center for Urban and Regional Affairs (CURA)
  - University of Minnesota, Northwest Regional Sustainable Development Partnership (NWRSDP)
  - Western Illinois University, Illinois Institute for Rural Affairs (IIRA)
  - Northwest Minnesota Multi-County Housing & Redevelopment Authority (NWMNHRA)
  - Greater Minnesota Management (GMM)
  - Northwest Manufacturing, Inc. / WoodMaster, Minnesota
  - Pinecrest Medical Care Facility, Michigan
  - Heating the Midwest Biomass Resources & Demographics Action Team
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• **Project Intent**
  – Identify innovations that utilize biomass as the energy source for cooling systems
  – Small to medium sized applications
  – Assess basic economic analysis of various energy sources
  – Assess basic economic installation cost on a multi-housing unit
# Biomass for Cooling System Technologies: A Feasibility Guide

## Different Types of Biomass Fuel

<table>
<thead>
<tr>
<th>Fuel Type</th>
<th>Retail Cost (Minnesota)</th>
<th>Btu/lb</th>
<th>Cost/Mbtu</th>
<th>Cost/kWh</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wood Chips*</td>
<td>$60/ton</td>
<td>4,300</td>
<td>$9.30</td>
<td>$0.03</td>
</tr>
<tr>
<td>Wood Pellets*</td>
<td>$160/ton</td>
<td>8,250</td>
<td>$12.93</td>
<td>$0.04</td>
</tr>
<tr>
<td>Natural Gas</td>
<td>$13.21/Mcf**</td>
<td>19,000</td>
<td>$15.73</td>
<td>$0.05</td>
</tr>
<tr>
<td>Propane</td>
<td>$2.60/gal</td>
<td>21,500</td>
<td>$33.49</td>
<td>$0.10</td>
</tr>
<tr>
<td>Corn Cobs</td>
<td>$60/ton</td>
<td>7,461</td>
<td>$5.74</td>
<td>$0.02</td>
</tr>
<tr>
<td>Heating Oil</td>
<td>$3/gal</td>
<td>18,104</td>
<td>$30.90</td>
<td>$0.11</td>
</tr>
<tr>
<td>Electricity</td>
<td>$.1135/kWh</td>
<td>3,412/kWh</td>
<td>$34.28</td>
<td>$0.14</td>
</tr>
</tbody>
</table>

*Note. *Bulk; ** Mcf=Thousand cubic feet; **Peak summer average price.
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• **Technologies Identified**

  – Absorption chiller generates the air cooling effect from the heat generated
  
  – The heat from the biomass is used to operate the absorption chiller to cool the air
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• Absorption Chiller Manufacturers (capable of utilizing biomass thermal and Lithium Bromide as a refrigerant)
  – Yazaki Energy Systems, Japan
  – Trane Systems (Thermax), U.S.A.
  – BSH Innovative Heating & Cooling Solutions, N. Ireland
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Analysis of **Wood Pellets as the Primary Source of Energy** (per month) using absorptive chilling VS

Analysis of **Electricity of Conventional Air Conditioning Unit** (per month)
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• **Estimate based on average household electricity consumption of 911 kWh**
  
  – Average wood pellet cost per month: $40.18 (absorption chiller)
  
  – Average electrical cost per month: $47/month (COP=2.2) to $30.29/month (COP= 3.4)
    
    • COP is defined as the ratio of heat removal to the energy input to the compressor.
    
    • Coefficient of Performance (COP) for electrical cooling (range 2.2 to 2.5)

• Source:
  
  
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- **Economics of the Technology**

## Capital Costs of 30 Ton Cooling System

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biomass boiler</td>
<td>$ 68,378*</td>
</tr>
<tr>
<td>Absorption chiller</td>
<td>$ 65,000**</td>
</tr>
<tr>
<td>Control system</td>
<td>$  14,000</td>
</tr>
<tr>
<td>Cooling tower</td>
<td>$  5,040***</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>$152,418</strong></td>
</tr>
</tbody>
</table>

*Note.* *(G. Gagner, personal communication, June 8, 2016)  **(M. Spresser, personal communication, June 6, 2016)  ***(HVAC Brain, Inc., 2016)*
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- Economics of the Technology – 30 ton cooling system
  - Estimated Installation and Pipelining Cost: $173,391

- Total Cost
  - Capital/Product Costs: $152,418
  - Pipelining & Installation Costs: $173,391

GRAND TOTAL: $325,890
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• Potential Application of a Cooling System
  – Small scale industries
  – Strip malls
  – Quad homes
  – Townhomes
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• Conclusions

  – Worth consideration if:

    • Constructing a new building
    • Retrofitting a current system where piping is in place
    • Potential utilization of a hybrid biomass system
Questions?

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