Agricultural Innovation: From Idea to Reality
About AURI

• To foster long-term economic benefit through development of new value-added uses for agricultural products
AURI Locations

Crookston
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Crookston, MN 56716
800.279.5010

Marshall
1501 State St.
Marshall, MN 56258
507.537.7440

St. Paul
1475 Gortner Ave.
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651.624.6055

Waseca
PO Box 251
Waseca, MN 56093
507.835.8990
Focus Areas

- Renewable Energy
- Coproducts
- Biobased Products
- Food
AURI’s Services

- Applied Research and Development
- Hands-on Scientific Assistance
- Innovation Networking
AURI’s Labs

Waseca Lab

• Co-Product Utilization
  o Grinding
  o Milling
  o Size reduction
  o Blending
  o Pelleting
  o Drying
  o Product characterization
  o Particle size analysis
Biomass for Cooling System Technologies: A Feasibility Guide

Co-Authors:
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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
Biomass for Cooling System Technologies: A Feasibility Guide

• 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)
  - Yazaki Energy Systems
  - Trane Systems (Thermax)
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Analysis of Wood Pellets as the Primary Source of Energy (per month) VS Analysis of Electricity of Conventional Air Conditioning Unit (per month)
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• Estimate based on average electricity consumption of 911 kWh
  – Average wood pellet cost per month: $40.18
  VS
  – Average electrical cost per month: $51.70/month (COP=1:2) to $25.85/month (COP= 1:4)
  • Coefficient of Performance (COP) for electrical cooling (range 1:2 to 1:4)
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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>TOTAL</td>
<td>$152,418</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
  – 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
  – 3-4 single family houses together
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• **Conclusions**
  – Worth consideration if:
    • Constructing a new building
    • Retrofitting a current system where piping is in place
Questions?

Full copies of the report are available at:
AURI.ORG
Or
At our Booth