

Biomass for Cooling System Technologies: A Feasibility Guide

Heating the Midwest – Minneapolis, MN

April 10, 2017

Agricultural Innovation: From Idea to Reality

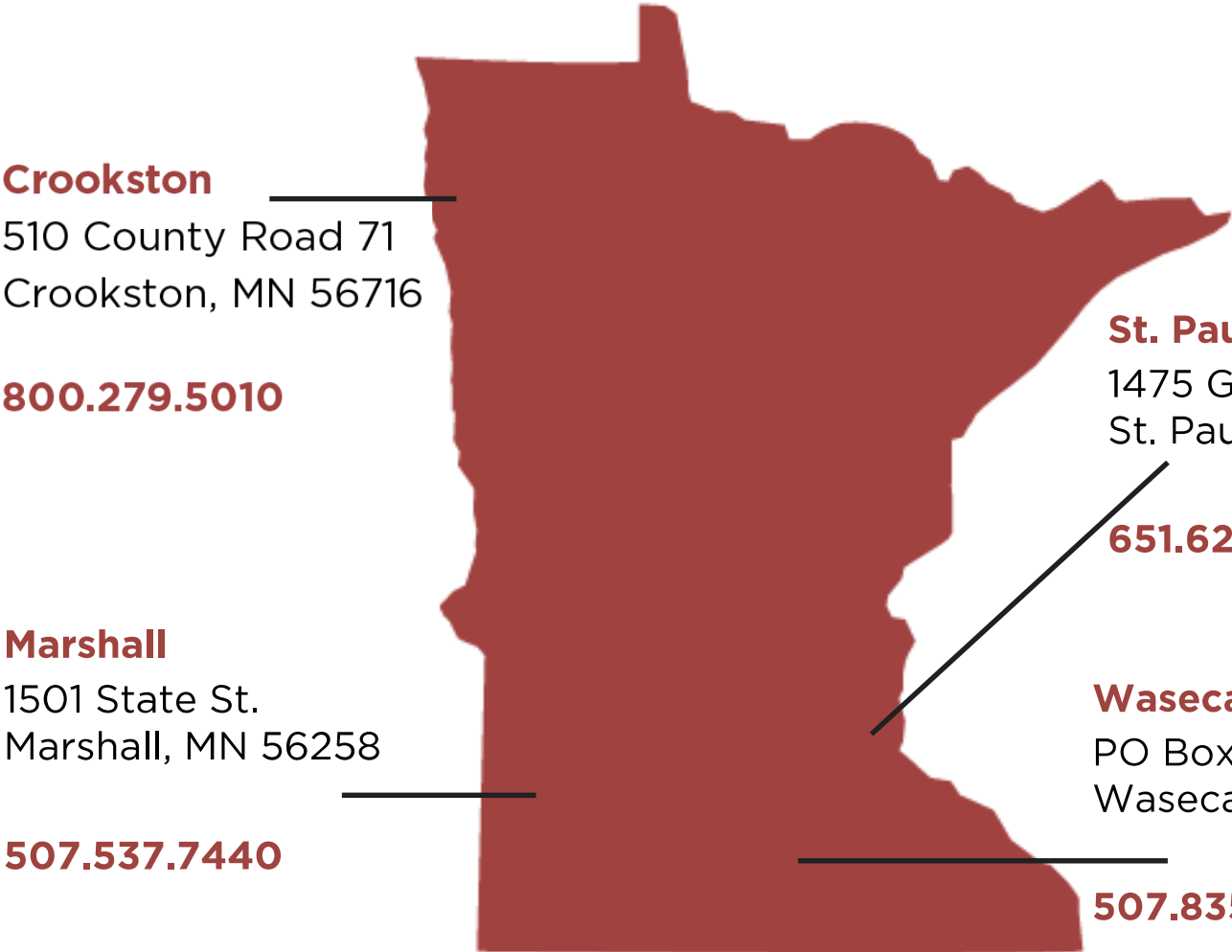


About AURI

- AURI helps discover new uses for agricultural commodities
- AURI was created by the MN Legislature, and its mission is to foster long-term economic benefit through value-added agricultural products.



AURI Locations



Crookston

510 County Road 71
Crookston, MN 56716

800.279.5010

Marshall

1501 State St.
Marshall, MN 56258

507.537.7440

St. Paul

1475 Gortner Ave.
St. Paul, MN 55108

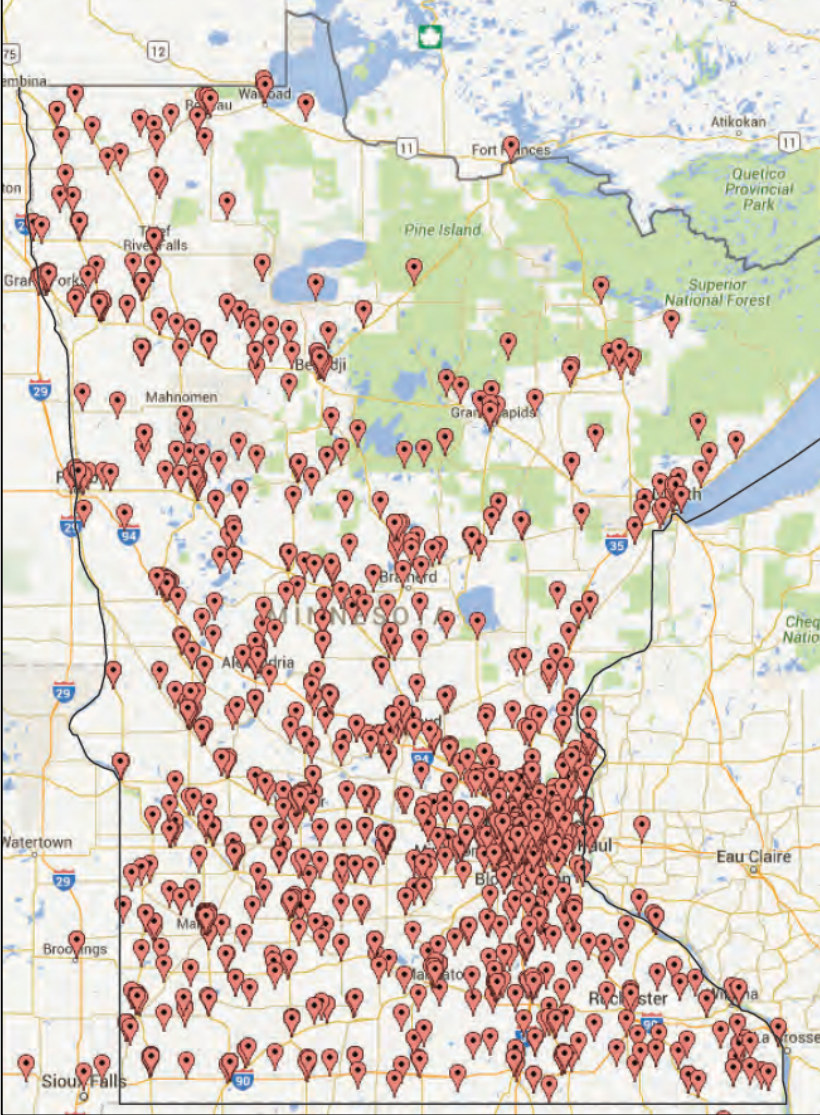
651.624.6055

Waseca

PO Box 251
Waseca, MN 56093

507.835.8990

Offices



Clients

Focus Areas



**Renewable
Energy**



Coproducts

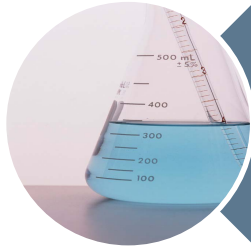


**Biobased
Products**



Food

AURI's Services



Applied Research and
Development



Hands-On Scientific
Assistance



Innovation Networking

AURI Waseca Lab

- **Coproduct Utilization**

- Grinding
- Milling
- Size reduction
- Blending
- Pelleting
- Drying
- Product characterization
- Particle size analysis



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- **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

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Different Types of Biomass Fuel

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

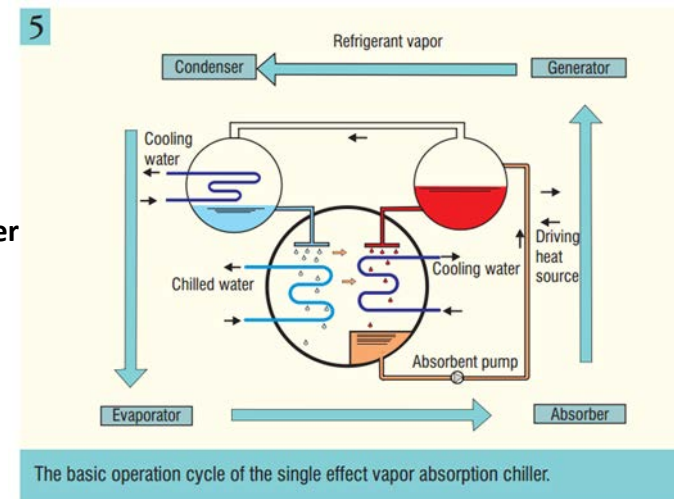
Note. *Bulk; ** Mcf=Thousand cubic feet; **Peak summer average price.

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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

Trane (Thermax) Cooling System – Single Effect Vapor Absorption Chiller



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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:
 - <http://antaresgroupinc.com/how-to-decide-if-an-absorption-chiller-right-for-you/>
 - <http://www.lowenergybuildings.org.uk/leb/technical-information/fuel-usage-coefficients/>

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- **Economics of the Technology**

Capital Costs of 30 Ton Cooling System

Item	Cost
Biomass boiler	\$ 68,378*
Absorption chiller	\$ 65,000**
Control system	\$ 14,000
Cooling tower	\$ 5,040***
TOTAL	\$152,418

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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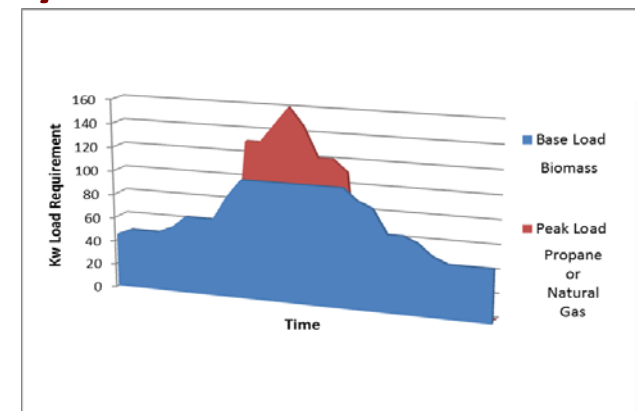
- **Potential Application of a Cooling System**
 - Small scale industries
 - Strip malls
 - Quad homes
 - Townhomes

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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?

Full copies of the report are available at:

auri.org

Or

At our Booth