

**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

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

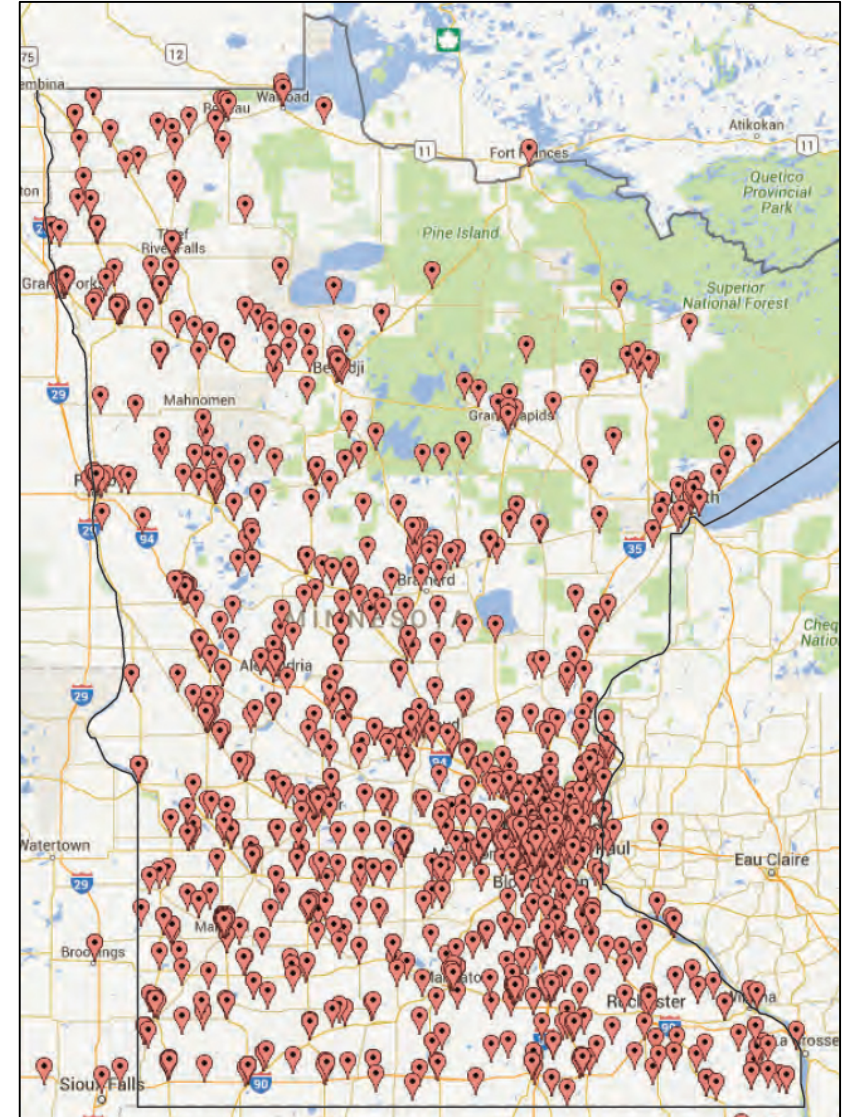
**651.624.6055**

## Waseca

PO Box 251  
Waseca, MN 56093

**507.835.8990**

# Offices



# Clients

# Focus Areas



**Renewable  
Energy**



**Coproducts**

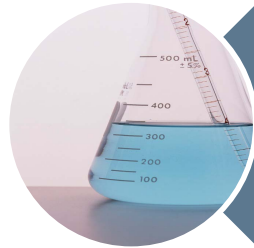


**Biobased  
Products**



**Food**

# AURI's Services



Applied Research and  
Development



Hands-on Scientific  
Assistance



Innovation Networking

# AURI's Labs

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

## Waseca Lab



# Biomass for Cooling System Technologies: A Feasibility Guide

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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

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.

# Biomass for Cooling System Technologies: A Feasibility Guide

- 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

# Biomass for Cooling System Technologies: A Feasibility Guide

- Absorption Chiller Manufacturers (capable of utilizing biomass thermal)
  - Yazaki Energy Systems
  - Trane Systems (Thermax)

# Biomass for Cooling System Technologies: A Feasibility Guide

Analysis of Wood Pellets as the Primary Source of  
Energy (per month)

VS

Analysis of Electricity of Conventional Air  
Conditioning Unit (per month)

# Biomass for Cooling System Technologies: A Feasibility Guide

- 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)

# Biomass for Cooling System Technologies: A Feasibility Guide

- **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)

# Biomass for Cooling System Technologies: A Feasibility Guide

- 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



# Biomass for Cooling System Technologies: A Feasibility Guide

- Potential Application of a Cooling System
  - Small scale industries
  - Strip malls
  - Quad homes
  - Townhomes
  - 3-4 single family houses together

# Biomass for Cooling System Technologies: A Feasibility Guide

- **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**