COMMERCE DEPARTMENT
ENERGY RESOURCES

Welcome

Conservation Applied Research & Development (CARD) Webinar

December 1, 2020

Reconsidering Cooling Loads in Minnesota

Reconsidering Cooling Loads in Minnesota



Mary Sue Lobenstein
R&D Program Administrator
MN Department of Commerce
marysue.Lobenstein@state.mn.us



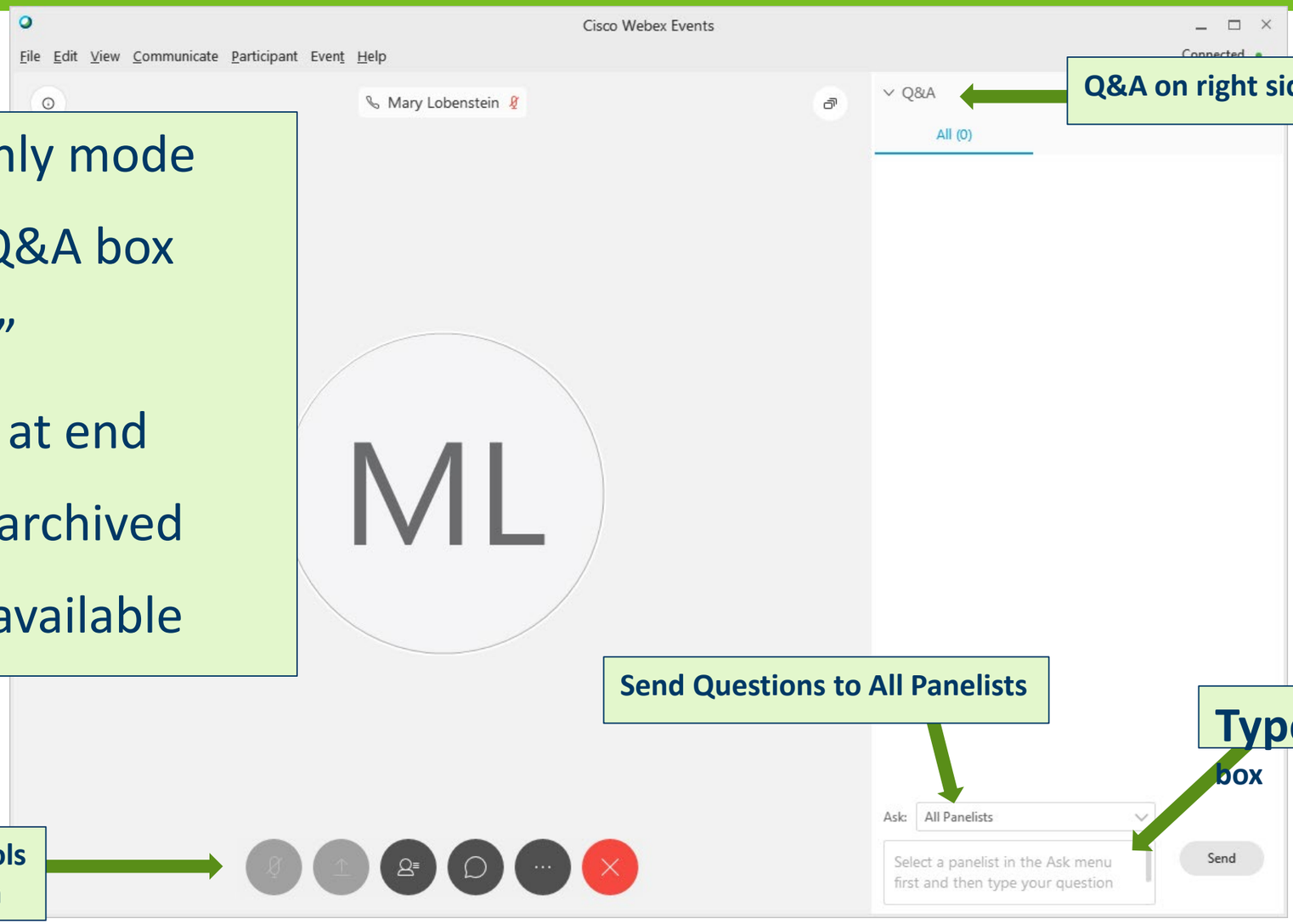
Adway De, PhD.
Energy Planner Principal
Mn Department of Commerce
adway.de@state.mn.us



Ben Schoenbauer
Senior Research Engineer
Center for Energy and Environment
bschoenbauer@mncee.org

Webinar Basics

- Attendees in listen-only mode
- Type questions into Q&A box
- Send to “All Panelists”
- Questions addressed at end
- Webinar recorded & archived
- Slide set will also be available



Q&A on right side of WebEx panel

Send Questions to All Panelists

Type Questions in Q&A box

Additional WebEx Controls at Bottom of Your Screen

Minnesota Applied Research & Development Fund

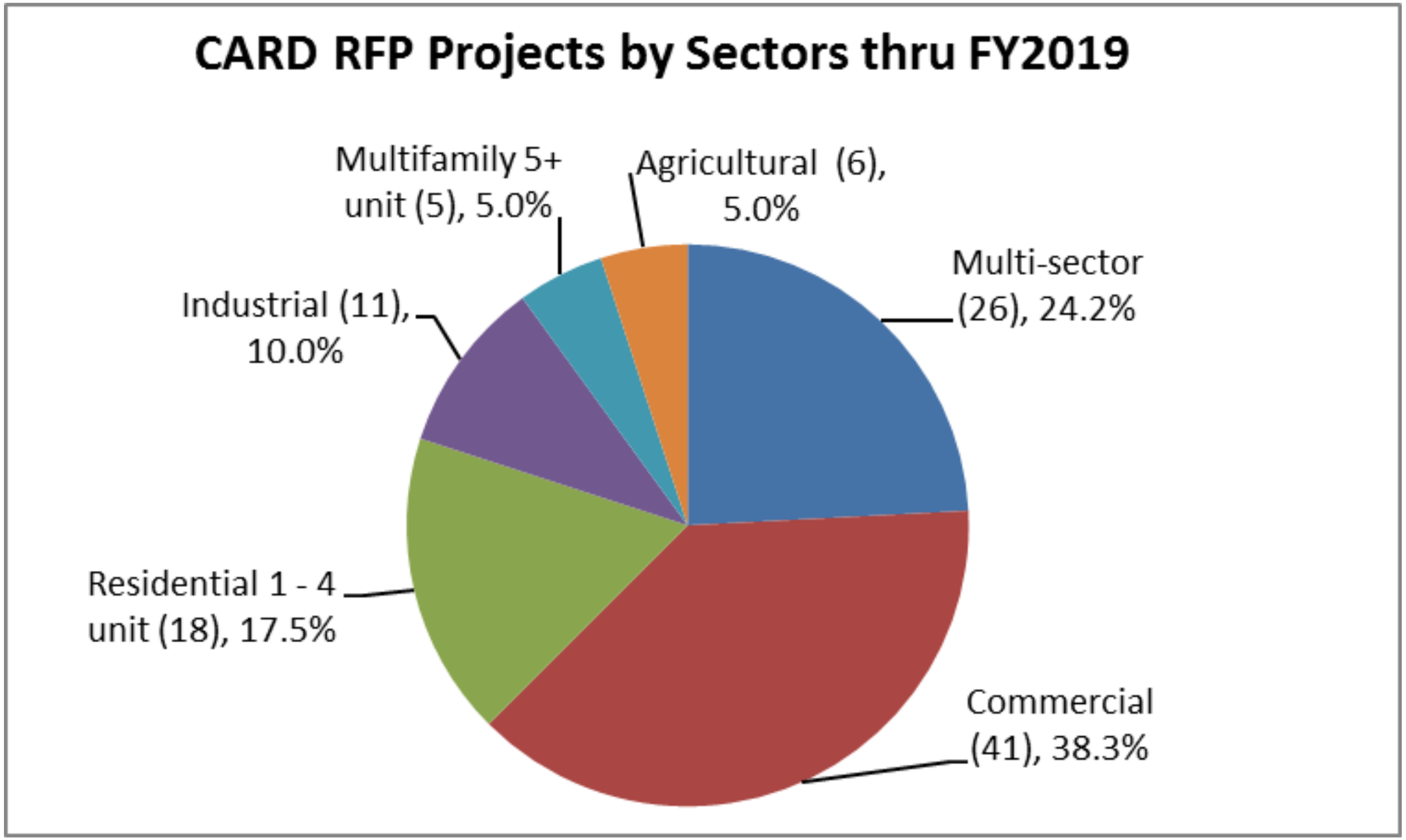
- **Purpose to help Minnesota utilities achieve 1.5% energy savings goal by:**
  - ***Identifying new technologies or strategies to maximize energy savings;***
  - ***Improving effectiveness of energy conservation programs;***
  - ***Documenting CO_2 reductions from energy conservation programs.***

Minnesota Statutes §216B.241, Subd. 1e

- **Utility may reach its energy savings goal**
  - **Directly through its Conservation Improvement Program (CIP)**
  - **Indirectly through energy codes, appliance standards, behavior, and other market transformation programs**

State Capitol Image: Courtesy Minnesota Department of Administration

CARD RFP Spending by Sector thru FY2019



RFP Summary

- 10 Funding Cycles
- 472 proposals
- 121 projects funded
- $27.4 million in research

Agenda

- Why should we care about cooling in cold climates?
- Residential loads in Minnesota
- Types of cooling systems
- Recent Innovations
- Opportunities for Energy Savings
- Assessment for Minnesota Homes
- Tool Overview
- Key results

Why should we care about cooling in cold climates?

Increasing applications

- Globally
- Nationally
- Locally
  - As of 2015, 75% of MN single family homes have central A/C

Cooling contributes to peak loads

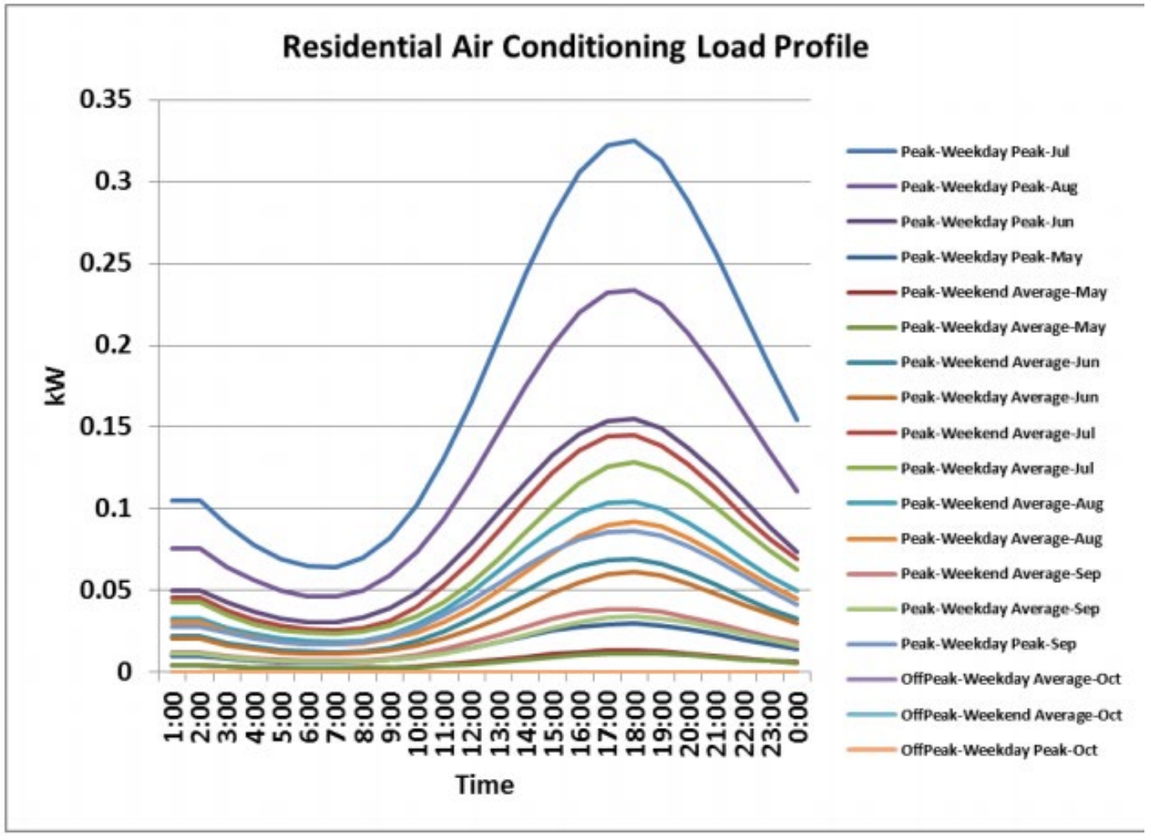
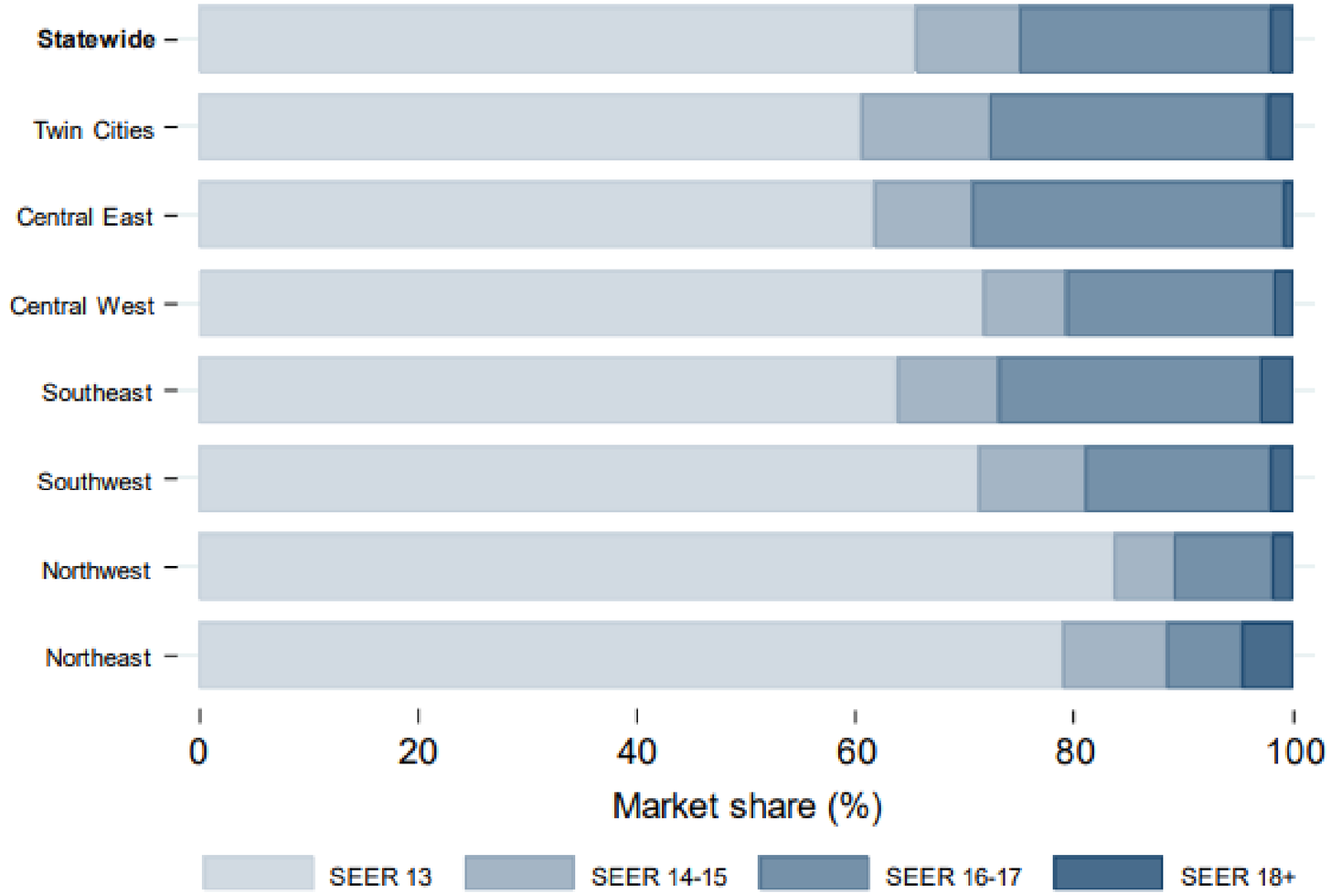


Figure 5 Average Residential Air Conditioning Load Profile

https://mn.gov/commerce-stat/pdfs/mn-load-profile-memo.pdf

Opportunity for efficiency



Residential Loads in Minnesota

Center for Energy and Environment

Anatomy of Cooling Loads



Sensible

External

- U-value
- Infiltration
- Solar radiation

Internal

- Occupants
- Lighting
- Appliances
- Electronics

Latent

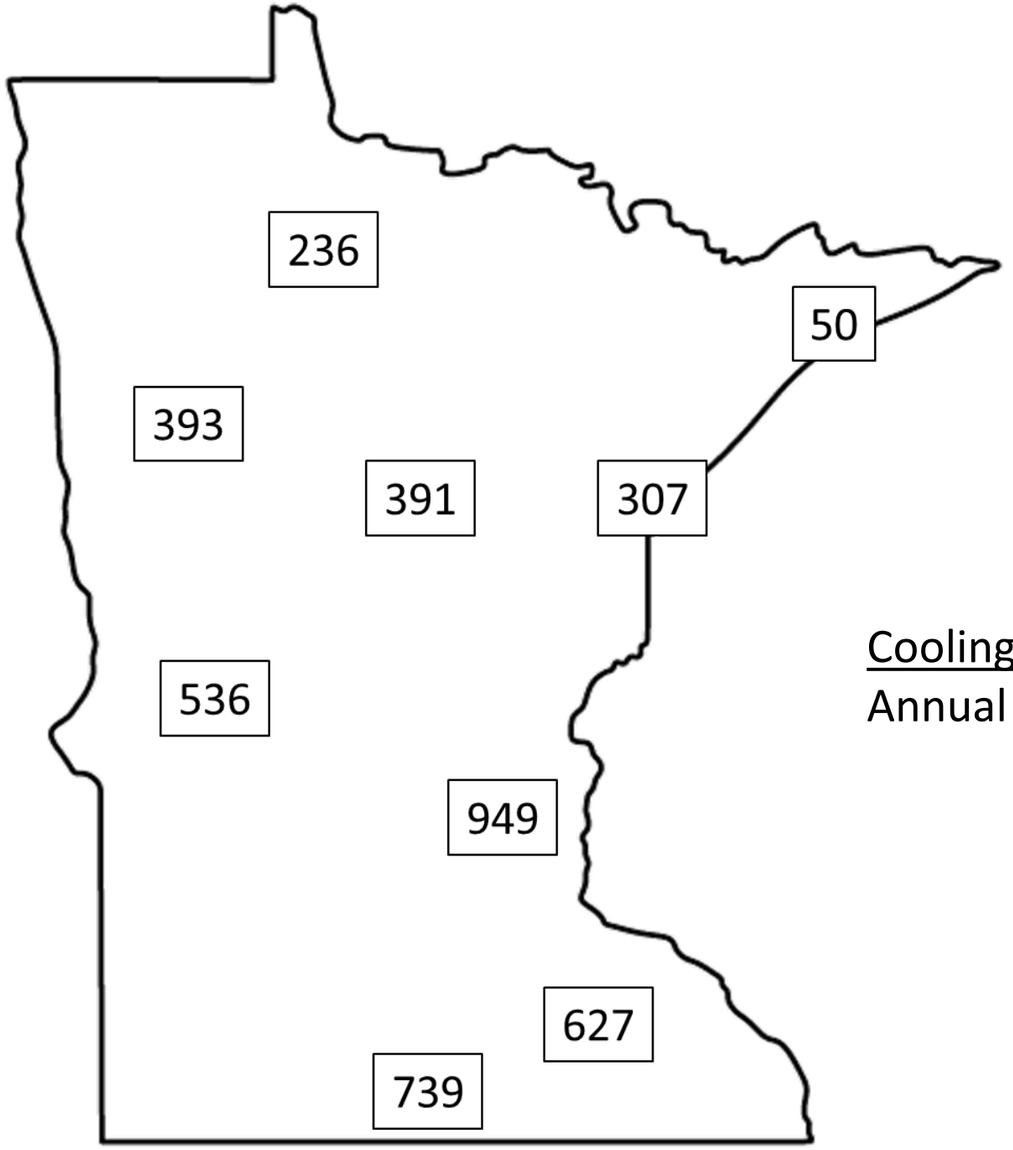
- Infiltration

- Occupants
- Equipment
- Appliances



Center for Energy and Environment

Location and Weather



Cooling degree days
Annual sum of (Daily Temp – 65°F)

Energy Use in MN

- Limited measured data
- Several sources:
  - Minnesota Technical Reference Manual
  - Previous CARD work: Improving Installation and Maintenance Practices for Minnesota HVAC
  - Various Annual Use Estimates

TRM – Min. Efficiency Central System (SEER 13)				
Climate Zone	$EFLH_{cool}$	Annual House Cooling Use, kWhr/year		
		2.5 Ton System	3 Ton System	4 Ton System
Northern MN	213	492	590	786
Central MN	379	875	1,050	1,399
Southern MN/ Twin Cities	520	1,200	1,440	1,920

Climate Zone	**$EFLH_{cool}$**	**Annual House Cooling Load, kWhr/year**		
		2.5 Ton System	3 Ton System	4 Ton System
Northern MN	161 (-24%)	354	425	566
Central MN	234 (-38%)	543	651	867
Southern MN/ Twin Cities	309 (-41%)	708	850	1,133

RECS –MN,IW,SD,ND: 601 kWh/yr

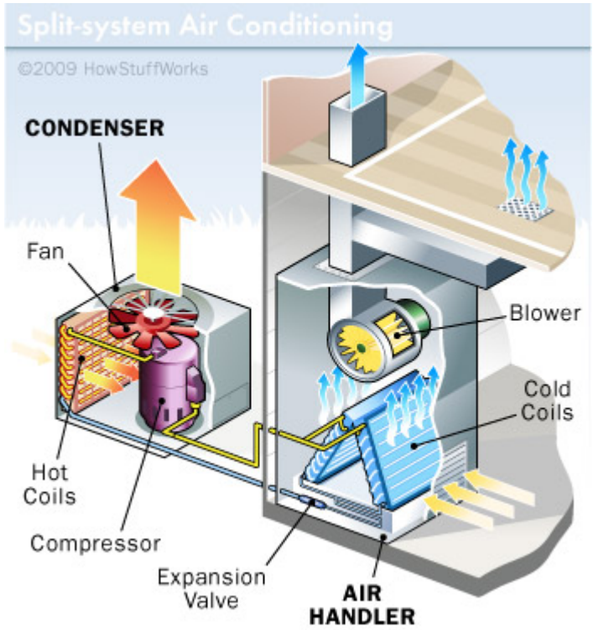
MN TRM load profiles: 641 kWh/yr

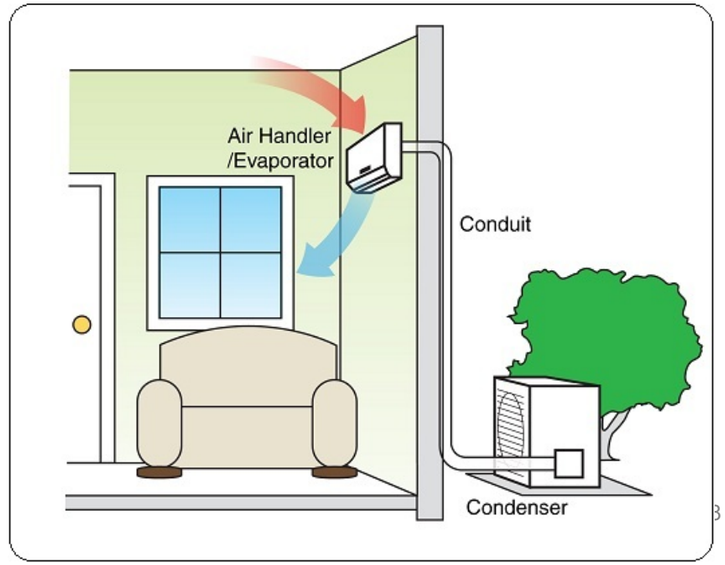
Cooling System Types

Systems Considered

- Central Split Systems
  - SEER ratings from 13 to 26
  - Capacity ranges: 1.5 tons and up
  - Similar to a centrally ducted air source heat pump
    - Same cooling performance and options
    - Added heating performance

- Mini-splits or Ductless Air Conditioners
  - SEER ratings from 13 to 26
  - Capacity ranges: 1 tons and up
  - Many indoor options
  - Similar to a ductless air source heat pump

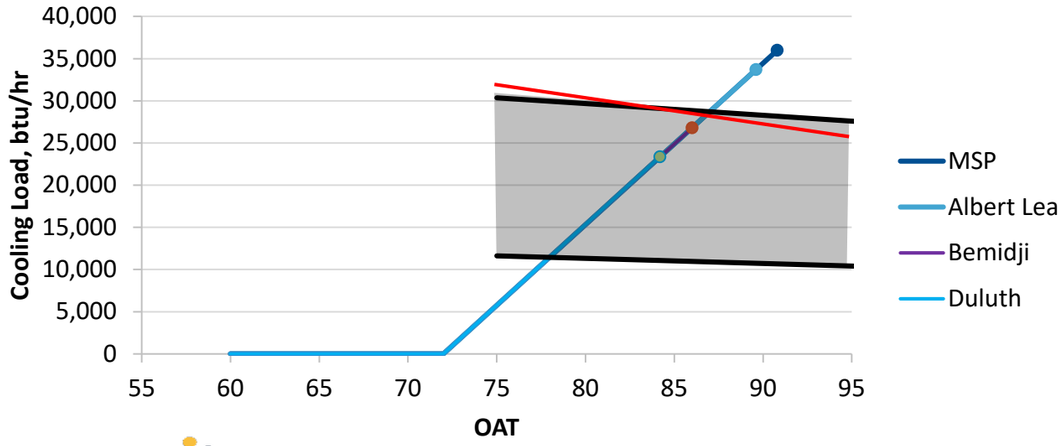


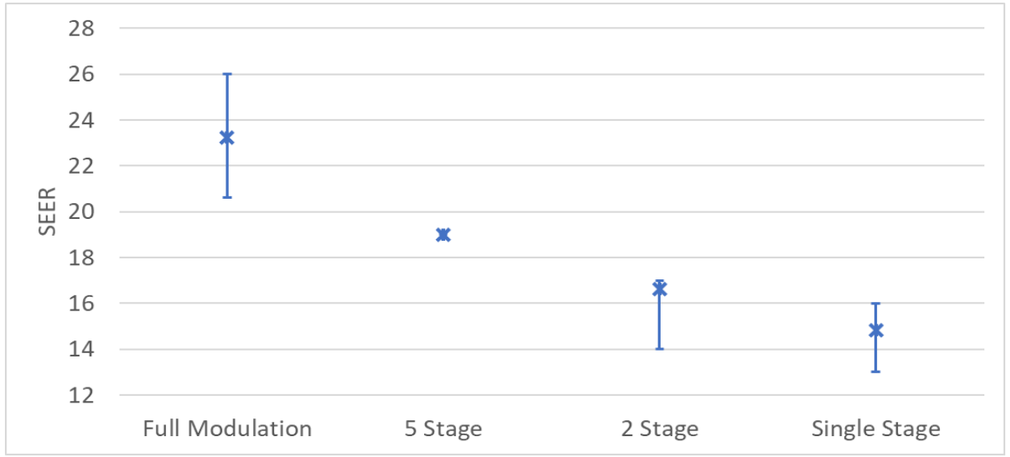


Opportunities for Energy Savings

Improvements to Equipment

- Efficiency improvements
  - New systems with SEER 26
    - Uses half the energy of a baseline model
  - Reduced costs for mid tier efficiency systems
- Operational improvements
  - Variable stage performance



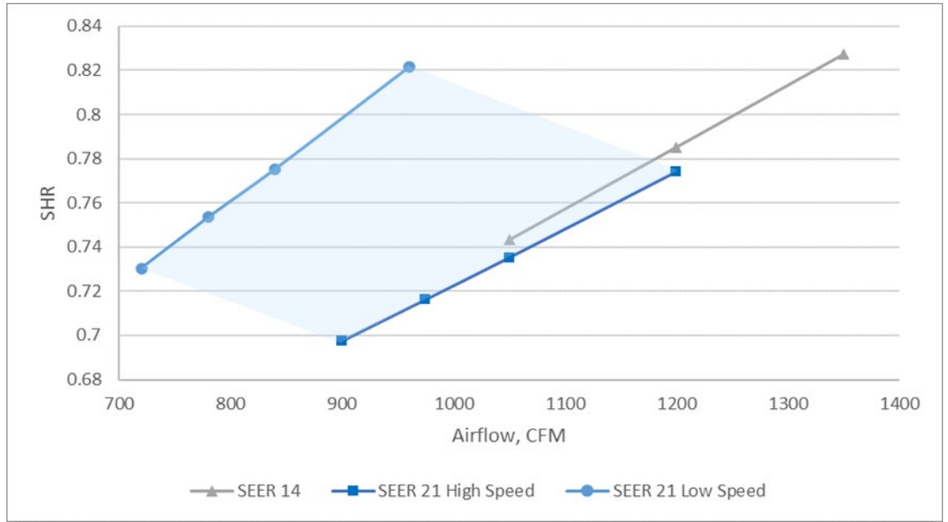


Center for Energy and Environment

Controls Innovations

- Smart and communicating thermostats
  - Pathway to ensure reliable program or schedule-based savings

- Controlling for humidity control (AKA dry-cool mode)
  - Dehumidification address latent load
  - Increased importance in low load homes
    - Reduced AC runtime
    - Internal loads are larger fraction of the heating load
  - Variable capacity increases runtime and improves the sensible heat ratio
  - Dry-cool mode attempts address directly
    - Humidity sensor
    - Runtime controlled



Center for Energy and Environment

Operation and Behavior

- How is the cooling system operated?
  - Always or nearly always off
  - Set it and forget it (AKA: HOLD)
  - Daily schedule
  - Manual switching
- Thermostat setpoint
  - Occupied
  - Unoccupied/Sleep
- Balance point

Applications

- Traditional Quality Installation programs
  - Sizing
  - Proper charge
- Zoned approached
  - Install a smaller higher efficiency system in a high load portion of the home
  - 33% savings from a small Florida pilot
  - Very occupant behavior dependent
- Combined heating and cooling with ASHPs
  - Same high efficiency cooling performance
  - Incremental costs between ASHP and CAC with similar specs is minimal
  - Additional savings potential in shoulder heating seasons
    - For homes with electrical or propane heat savings over the majority of the heating season

Barriers to Implementation: Cost and payback

- High efficiency systems are expensive and have limited penetration
  - NREL Residential Efficiency Measures Database: Central Split System AC

SEER	Variable cost, $/kBtuh	Set Cost	Total for 3 Ton System
13	$42	$2,600	$4,112
16	$42	$3,000	$4,512
18	$42	$3,250	$4,762
20	$42	$3,500	$5,012
24.5	$42	$4,000	$5,512

- Cooling loads are small and inexpensive
  - 500 to 1,500 kWhs for central systems across the state
  - 30% savings is $16 to $50/year at $0.11/kwh
  - Highest savings would be ~10 year payback

Barriers to Implementation

- Availability and interest
- Quality Installation programs have been successful
  - But increased program options and complexities leads to higher requirements
- Rebates
  - Many programs offer tiered rebates based on SEER
    - Max values at SEER 16 or 18
  - ASHP technology rebates are replacing or demising AC rebates
- Efficiency Metrics, Deemed Savings, and Other Calculations

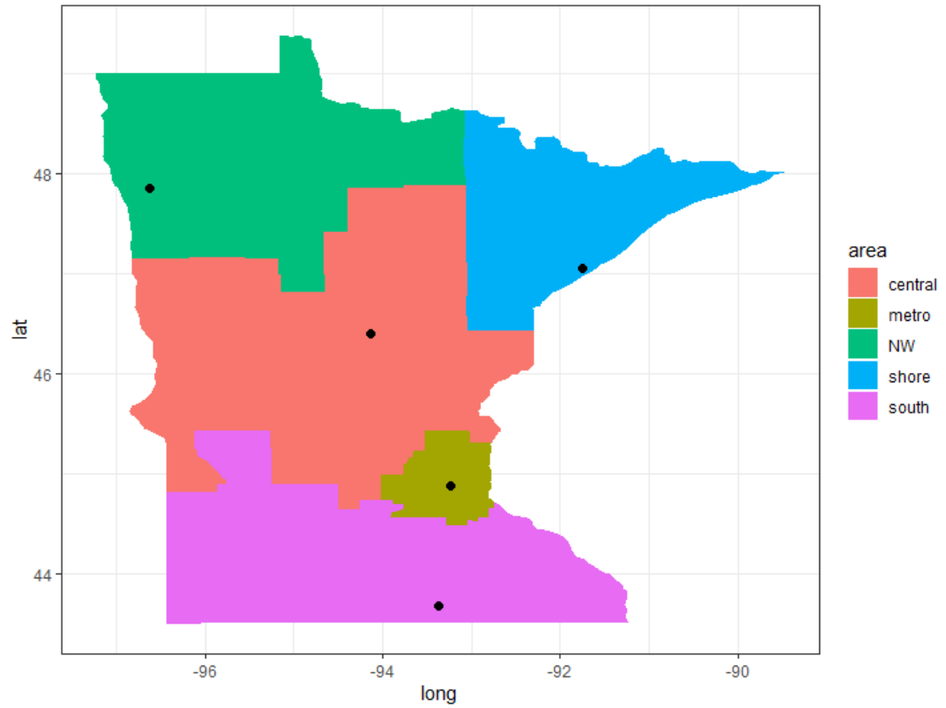
Assessment of Minnesota Homes

Center for Energy and Environment

Calculating performance

- Categories of Inputs
  - House characteristics (size, envelope, etc)
  - Weather
  - Cooling system
  - System operation
  - Occupant comfort criteria
  - Occupant behavior

- Lots of variables and options…



Let’s make a calculator

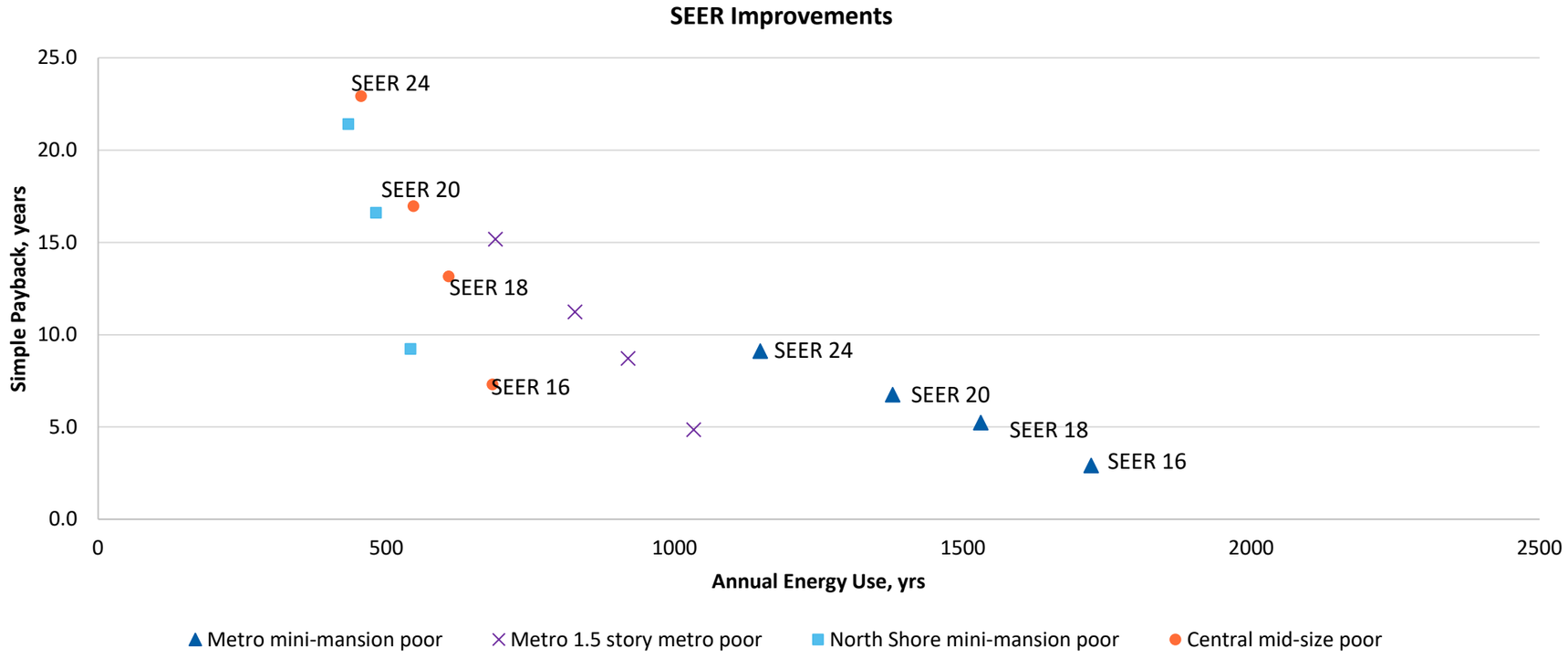
Tool demo



Important Results and Recommendations

Example of Tool Runs

- High load homes are required for reasonable SEER paybacks



Example of Tool Runs Showing Zoned Approaches

- Zoned Approaches have good potential in specific applications
  - Baseline with no central system

Case	Energy Use, kWh	First Cost	Operational Cost, $/yr
Window AC in Master	176	$150	$23
Min. Efficiency Central AC	1219	$4,616	$158
Zoned: Efficient System Living & Min. Efficiency System in Master	607	$4,605	$79
Zoned: Efficient System Living & Window AC in Master	563	$2,543	$73

CIP Recommendations

- Consider a savings calculation that allows for wider approaches
  - Calculation tool
  - Measured savings
  - Adjusted baselines for targeting high use situations
  - Demand savings for customers outside saver switch type programs

- Consider how to address combined systems
  - Heating and cooling savings
    - Shared savings across gas and electric utilities
  - Cooling and dehumidification

High Level Results

- Cooling installations are growing in Minnesota, the region, and the nation
- Individual system loads are small
- Traditional efficiency opportunities (increase the SEER) often have long paybacks
- Occupant behavior and system operation have a large impact on energy use
  - Especially true for a cold climate like MN
- Individual installs have low loads and high first cost, but due to the large number of installs aggregate impacts have a huge impact on energy use and demand.
- Additional work is still needed

Questions?

Reconsidering Cooling Loads in Minnesota



Ben Schoenbauer
bschoenbauer@mncee.org



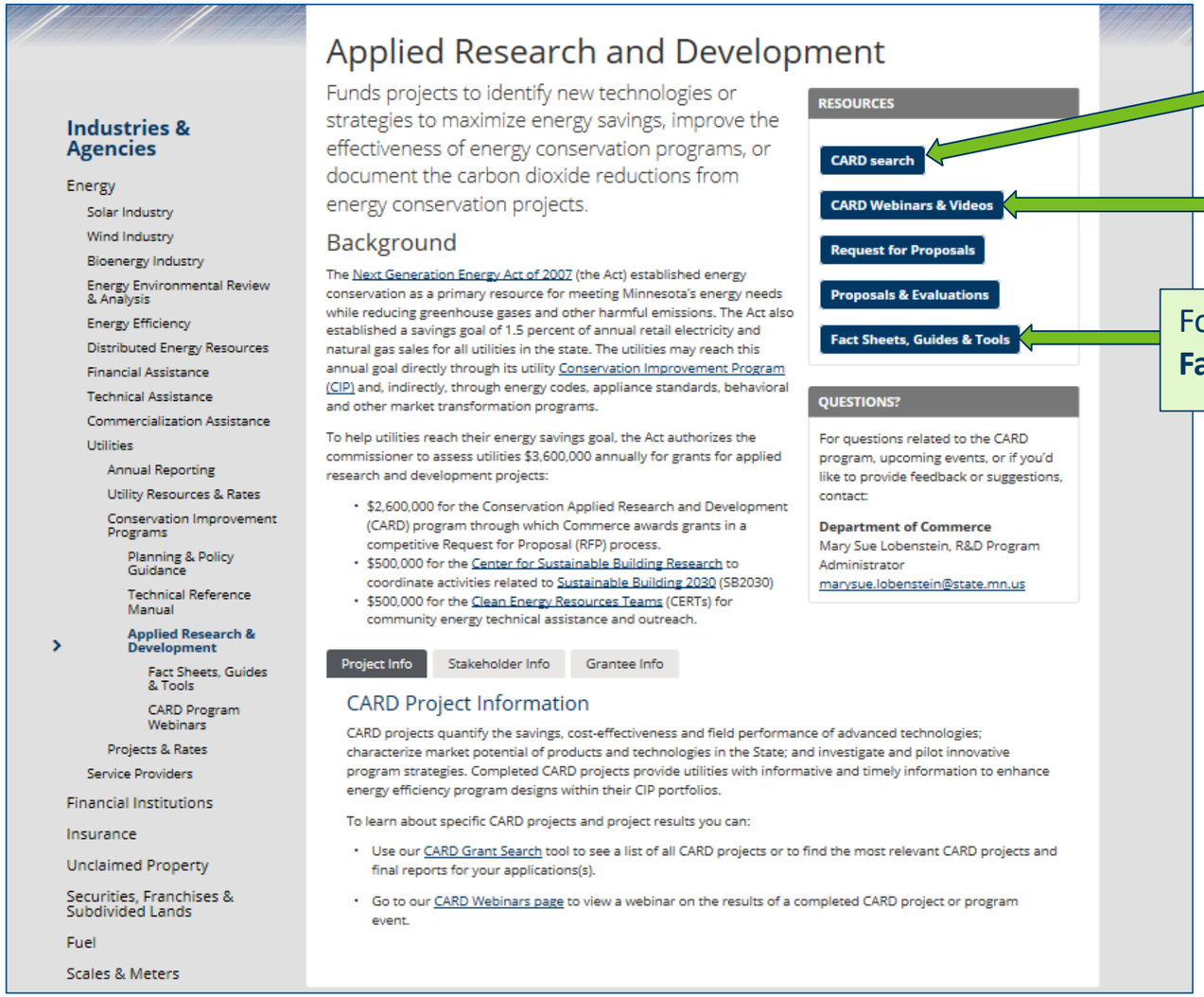
Mary Sue Lobenstein
marysue.Lobenstein@state.mn.us



Adway De, PhD.
adway.de@state.mn.us

Send us your questions using the Q&A panel

CARD Project Resources



For **Reports** use **CARD Search** Quick Link

For **Webinars** use **CARD Webinars & Videos** Quick Link

For **Other** research documents use **CARD Fact Sheets, Guidelines & Tools** Quick Link

Webinar Recording & Final Report available in couple months

R&D Web Page (https://mn.gov/commerce/industries/energy/utilities/cip/applied-research-development/)

Thanks for Participating!

Upcoming CARD Webinars:

- **December 10** – C&I Refrigeration Market Assessment (Center for Energy and Environment)
- **January 21 (New Date)** – Codes and Standards Roadmap (2050 Partners)

Commerce Division of Energy Resources e-mail list sign-up

If you have questions or feedback on the CARD program contact:

Mary Sue Lobenstein
R&D Program Administrator
marysue.Lobenstein@state.mn.us
651-539-1872

COMMERCE DEPARTMENT
ENERGY RESOURCES

Let us know how we did today

