Welcome

Conservation Applied Research & Development (CARD) Webinar

September 25, 2019
Emerging Technologies in Energy Efficiency
Emerging Technologies in Energy Efficiency

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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

Additional WebEx Controls at Bottom of Your Screen

Send Questions to All Panelists

Type Questions in Q&A box
• 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 CO₂ 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
CARD RFP Spending by Sector thru FY2019

RFP Summary

- 10 Funding Cycles
- 472 proposals
- 121 projects funded
- $27.4 million in research
Project Overview: The 120 Second Trailer

- Minnesota does a great job with its R&D efforts to further energy efficiency technologies.
• Minnesota does a great job with its R&D efforts to further energy efficiency technologies.
• But, Minnesota is a land of 10,000 lakes, not an island.
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This project screened six years of California publicly funded R&D work for MN applicability.
Project Overview 4: The 120 Second Trailer

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- But, Minnesota is a land of 10,000 lakes, not an island.
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- We found several technologies worth noting.
• Minnesota does a great job with its R&D efforts to further energy efficiency technologies.
• But, Minnesota is a land of 10,000 lakes, not an island.
• This project screened six years of California publicly funded R&D work for MN applicability.
• We found several technologies worth noting.
• We developed fact sheets and technology summaries for MN utilities, Commerce, and researchers to use. These will be posted on the CARD website and [here](https://eeaps.evergreenecon.com/card-emerging-technology).
Minnesota does a great job with its R&D efforts to further energy efficiency technologies.

But, Minnesota is a land of 10,000 lakes, not an island.

This project screened six years of California publicly funded R&D work for MN applicability.

We found several technologies worth noting.

We developed fact sheets and technology summaries for MN utilities, Commerce, and researchers to use.

It’s worth keeping an continuous eye on the other R&D programs to screen for applicable insights.
Out-of-State R&D Context

Beyond Minnesota…

• California, New York, and the US Department of Energy have large, active R&D efforts on energy efficiency.
  ➢ We focused on California.

• California administers EPIC – the Electric Program Investment Charge.
  • 296 projects in first two investment triennia (2012-2017)
  • $874,099,034 in authorized spending
  • Four administrators with California Energy Commission in charge of 80% of funds
  • Develops new technology, identifies new uses of existing technology, and demonstrates lightly used technology
  • Includes end-user efficiency and grid-oriented efficiency
  • Obviously designed to support aggressive California energy goals, but a fair bit is applicable elsewhere
• First step: Screening technologies for applicability

• Second step: Describing the technologies
• Most of the screened studies are in progress => imperfect information
• Climate was a disqualifier for very few technologies
• End-use fit was more likely to throw a technology out of consideration
• Excluded supply-side studies for this effort
Technology Fact Sheet Topic Areas

• Commercial HVAC Technologies and Controls (3 fact sheets)
• New Wastewater Treatment Technologies (4 fact sheets)
• Emerging Technologies in Food Services and Grocery (1 fact sheet)
• Program Adoption Insights from Consumer Studies (1 fact sheet)
• Assorted Commercial Building Technologies (supplemental information, did not lead to full fact sheets)
## Commercial HVAC Technologies and Controls

### Optimized Hybrid Cooling Controls

The Electric Power Research Institute is testing the use of an intelligent HVAC controller that processes signals from building sensors and system feedback to maximize system efficiency. This particular study is applying the controller to the optimization of variable refrigerant flow and indirect evaporative cooling for the optimal mix. The control system utilizes cloud-based optimization using weather, grid conditions, and occupancy (CO2) as inputs to optimally operate the hybrid system. (For Midwestern applications, such a controller would need to be configured to optimize hybrid cooling solutions for humid climates.)

### Problem Addressed:
Lack of control technology to effectively integrate multiple cooling approaches optimized based on existing conditions.

### Status
As of the end of 2018, baseline conditions were being measured at three project sites in California where this system will be tested. The study is scheduled to be completed in 2020.

### Energy Savings Potential

**Lifetime Energy Savings**
- Point estimate: 0.3 TWh
- Range: 0.1-0.9 TWh

Note: High uncertainty. A Midwest-specific analysis would be needed to determine savings potential for hybrid systems for humid climates.

**Assumptions and Inputs**
- Annual commercial cooling consumption: 1.2 TWh
- Tech. applicability: 30% of buildings (range: 20%-50%)
- Cooling energy use reduction: 12.5% (range: 10%-15%)
- Adoption rate: 30% (range: 20%-50%)
- Measure life: 20 years

### For More Information
**EPRI grant project:** Climate appropriate HVAC Systems for Commercial Buildings to Reduce Energy Use and Demand
- (Search for project by name.)

**Contacts**
- Bradley Meister, brad.meister@energy.ca.gov, 916-327-1722
- EPRI research project manager: Ram Narayanmurthy, ramnarayanmurthy@epri.com, (650) 855-2418

### Next Steps and What to Watch
Key items to watch are the in-field performance of the controller at producing cooling energy savings during testing. A separate analysis for the Midwest may be required to assess its potential to optimize hybrid cooling in humid climates.
Commercial HVAC Technologies and Controls

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<tr>
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<tbody>
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Assumptions and Inputs
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- Peak cooling capacity: 50% of buildings (range: 20%-50%)
- Cooling energy use reduction: 12.5% (range: 10%-15%)
- Adoption rate: 30% (range: 20%-50%)
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Commercial HVAC Technologies and Controls

3 fact sheets based on EPIC studies
• Ultrasonic Anemometer
• Integrated Building Control Retrofit Package
• Optimized Hybrid Cooling Controls

Additional references
• 8 CARD studies on relevant topics
Ultrasonic Anenometer

- Center for the Built Environment developing low-cost communicating anemometer for commercial building ducts and occupant spaces
- Allows elimination of excess airflow and greater setbacks
- Estimated to save 10% to 15% of building HVAC usage
- Cost estimated at $20 to $100
- Tested in 2018; report expected this year
- Project partners included Price Industries and Vigilent
Integrated Building Control Retrofit Package

- California Lighting Technology Center is developing a retrofit package to allow for integrated control of lighting, fenestration, and space-conditioning
- Involves sensors, a master controller, and control logic
- Allows coordination of HVAC, lighting, and fenestration controls (when they exist)
- Computer simulations estimate savings up to 37% of HVAC and lighting energy usage
- Laboratory tested; installed in UC Davis building in 2019 for monitoring; results in 2020; report in 2020 or 2021
- Control algorithms will be public; unclear market path
Optimized Hybrid Cooling Controls

- Electric Power Research Institute is testing the use of an intelligent controller to maximize efficiency from hybrid cooling systems
- EPRI applying to hybrids of variable refrigerant flow and indirect evaporative cooling
- Includes weather, grid conditions, and occupancy as inputs
- Any Midwest application would need to employ other hybrid systems
- Estimated to save 10% to 15% of building cooling usage
- Installing and testing at three California project sites; report scheduled for 2020
New Wastewater Treatment Technologies

4 fact sheets based on EPIC studies
• Raw Wastewater Filtration Cloth Depth Filters
• Novel Staged Anaerobic Fluidized Bed Membrane Bioreactor
• Biofiltration as an Advanced Primary Treatment Method
• Biological Double-Efficiency Process (BDP)

Additional references
• 2 other EPIC studies
• 1 CARD white paper on a related topic
Raw Wastewater Filtration Cloth Depth Filters

- The cloth depth filter adds a filtering process to the primary stage for wastewater treatment processes to remove more biosolids than ordinarily occurs from settling and standard filtering.
- Doing so reduces the aeration and biosludge processing needed, thereby cutting the electricity for aeration.
- The project team from Kennedy/Jenks estimates electricity savings of about a third in the secondary aeration stage.
- This process was demonstrated and measured in three POTWs in California and one in Rockford, Illinois.
- As of this summer, a final report was being written; Kennedy/Jenks was creating a website to introduce CDFs to the market.
Novel Staged Anaerobic Fluidized Bed Membrane Bioreactor

- Uses anaerobic bacteria in place of aerobic bacteria to filter industrial wastewater
- Project tested the replacement of the aeration step in the filtration process at the Silicon Valley Clean Water treatment facility and demonstrated the reuse of the water
- Projected to save space and water as well
- Currently reviewing initial results with study completion slated for winter 2020-21
- Results to be disseminated in a trade journal, the demonstration site’s web page, and offered by vendors such as Suez
Biofiltration as an Advanced Primary Treatment Method

- Replaces conventional wastewater clarifiers in the primary treatment stage with biofiltration that utilizes microorganisms to reduce secondary aeration needs, by breaking down biosolids early in the process
- Expected to reduce energy consumption for aeration by 45 to 60%
- Pilot in progress at one POTW in California
- Final study report expected in winter 2020-21
Biological Double-Efficiency Process (BDP)

- Uses advanced aeration methods, airlift circulation, and an all-in-one bioreactor to do the work of the anoxic and aerobic tanks in one step
- Does so reduces aeration needs in the secondary stage by as much as 50%
- Reduces capital costs, land, and maintenance needs as well
- Final report is expected in early 2020
1 fact sheet based on EPIC studies

- Electric Plug Load Savings Potential of Commercial Foodservice Equipment

Additional references

- 2 other EPIC studies
- 2 CARD studies on relevant topics
Electric Plug Load Savings Potential of Commercial Food Service Equipment

- Fisher-Nickel, Inc. assessed the market and savings potential for emerging kitchen appliance control technologies
- Monitored 10 commercial food service facilities and 52 appliances
- Most promising opportunities
  - Smart conveyor toasters
  - Induction soup warmers
  - Modular insulated hot food holding cabinets
Program Adoption Insights from Consumer Studies

1 fact sheet based on EPIC studies
• Customer-Centric Approach to Scaling IDSM Retrofits

Additional references
• 3 other EPIC studies
Customer-Centric Approach to Scaling IDSM Retrofits

- Seeking to overcome challenges to multifamily efficiency installations from concerns about tenant disruption
  - Specifically testing in low-income buildings
- Testing a set package of advanced HVAC, smart thermostats, plug load controls, LED lighting, and heat pump water heaters
  - Estimated energy savings of 30 to 40 percent
- Installations completed and being monitored for 12 months in Ontario, California; repeating in Fresno
# Scale of Energy Savings Potential

<table>
<thead>
<tr>
<th>Technologies by Topic Area</th>
<th>Lifetime Savings Estimate (tentative)</th>
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<tbody>
<tr>
<td><strong>Commercial HVAC Technologies and Controls</strong></td>
<td></td>
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<tr>
<td>Ultrasonic Anemometer</td>
<td>300-2,800 GWh</td>
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<tr>
<td>Integrated Building Control Retrofit Package</td>
<td>400-11,100 GWh</td>
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<tr>
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<td>Electric Plug Load Savings Potential of Commercial Food Service Equipment</td>
<td>Unclear</td>
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<tr>
<td>Customer-Centric Approach to Scaling IDSM Retrofits</td>
<td>Did not estimate</td>
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</table>
Our screening tool, but might be useful to some of you as well

- List of all EPIC projects from first two triennia
- Overview / description
- Brief descriptions (searchable)
- Our scoring (changeable)
## Overview

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<tr>
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<th>A</th>
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<tbody>
<tr>
<td>1</td>
<td><strong>MN CARD - Leveraging Public Research for Application in Minnesota</strong></td>
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<td><strong>Scoring Database - version 2019-02-15</strong></td>
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<td>Dear Stakeholder, this database is an interim product of the CARD white paper project &quot;Leveraging Public Research for Application in Minnesota.&quot;</td>
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<td>This project is reviewing nearly 300 clean energy research and development projects funded by California ratepayers to identify which are likely to result in insights or technology of potential use in Minnesota conservation improvement programs. This database is the outcome of our screening.</td>
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<td>5</td>
<td>Some of the higher rated studies will be written up as technology fact sheets and included in an upcoming white paper, but the entirety of California-funded studies may be of value to stakeholders. We present them here.</td>
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<td>Overview</td>
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<td>7</td>
<td>The scoring database (on the tab to the right) lists each project reviewed by the study team as a row. Columns are grouped as follows:</td>
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<td>8</td>
<td>Green (columns A-C) -- lists Evergreen's study ID, EPIC project name, and a brief project description.</td>
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<td>9</td>
<td>Red (columns D-M) -- presents initial (round 1) scoring results, including both the scoring categories and final score, using categories and weights agreed upon by project reviewers. (See also scoring key.)</td>
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<td>10</td>
<td>Orange (columns N-X) -- flags projects with potential relevance for Minnesota policy issues provided by the Department of Commerce. These flags do not factor into project scores.</td>
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<td>11</td>
<td>Blue (columns Y-AK) -- presents revised (round 2) scores, as well as links to longer project descriptions for higher-rated studies, and potential technology fact sheets that higher-rated projects could fit into.</td>
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<td>12</td>
<td>Sorting</td>
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<td>13</td>
<td>This database is protected against accidental changes, but you can sort the data by selecting the named range &quot;SortRange&quot; in the 'Scoring and projects database' tab (just above column A).</td>
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<td>14</td>
<td>Then define your sort as you normally would. If you have any trouble, let Ingo Bensch know. See below for contact information.</td>
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<td>15</td>
<td>For more information</td>
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<tr>
<td>16</td>
<td>Contact Ingo Bensch, principal investigator and a principal consultant at Evergreen Economics</td>
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<td>17</td>
<td>bensch@evergreen econ.com</td>
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</table>
### Scoring and projects database

<table>
<thead>
<tr>
<th>Project Name</th>
<th>Description</th>
<th>Start Date</th>
<th>End Date</th>
<th>Score</th>
<th>Note</th>
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</thead>
<tbody>
<tr>
<td>Project 1</td>
<td>Description 1</td>
<td>01/01/2023</td>
<td>01/31/2023</td>
<td>8.5</td>
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<tr>
<td>Project 2</td>
<td>Description 2</td>
<td>02/01/2023</td>
<td>02/28/2023</td>
<td>9.0</td>
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<tr>
<td>Project 3</td>
<td>Description 3</td>
<td>03/01/2023</td>
<td>03/31/2023</td>
<td>7.5</td>
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</tr>
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</table>

*Note: This is a sample data from the database.*
<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Scoring Variables</td>
<td>Scoring Key</td>
<td>Max Points</td>
<td>Categorical Scoring Options</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Technology Status</td>
<td>Degree to which the technology being investigated and the EPIC study showing promise. In early scoring, most studies will have unclear results based on data available to us. These scores will be refined, as needed, when the study team investigates selected technologies more deeply for technology fact sheets.</td>
<td>20 0 - Research suggests major limitations</td>
<td>1 - Research still in progress / unclear results</td>
<td>2 - Research suggests viability</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>End-Use/Energy Applicability</td>
<td>Degree to which the technology addresses end-uses or circumstances that are applicable in sufficient numbers in Minnesota.</td>
<td>25 0 - None</td>
<td>1 - Limited applicability</td>
<td>2 - Average</td>
<td>3 - Above average</td>
</tr>
<tr>
<td>4</td>
<td>Climate Applicability</td>
<td>Degree to which the technology applies in Minnesota's climate.</td>
<td>20 0 - Not at all / minimal</td>
<td>1 - Somewhat</td>
<td>2 - Fully</td>
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<tr>
<td>5</td>
<td>Supply or Demand Impacts</td>
<td>Indicates whether the technology addresses energy supply or energy demand (or both). Priority is on energy demand.</td>
<td>10 0 - Other</td>
<td>1 - Energy supply only</td>
<td>2 - Energy demand</td>
<td>3 - Both demand and supply</td>
</tr>
<tr>
<td>6</td>
<td>Potential Size of Future Impacts</td>
<td>Educated estimate of the relative size of energy savings if the technology is implemented. Comparing to average CIP measures, refinements will be made, as needed, based on more detailed information for EPIC studies investigated further for fact sheet development.</td>
<td>10 0 - Unable to determine</td>
<td>1 - Less than most CIP measures</td>
<td>2 - Comparable to most CIP measures</td>
<td>3 - Higher than most CIP measures</td>
</tr>
<tr>
<td>7</td>
<td>Possible Implementation</td>
<td>Indication of who may implement or be involved in the furthering of the conference. Priority is technologies that can be promoted through utility CIP programs.</td>
<td>10 0 - Unclear</td>
<td>1 - Private non-utility only</td>
<td>2 - Utility non-CIP</td>
<td>3 - CIP</td>
</tr>
<tr>
<td>8</td>
<td>State of Minnesota Research and Vetting</td>
<td>Degree to which Minnesota implementation of the technology would need to be vetted further for inclusion in the state's TRM.</td>
<td>5 0 - Unclear</td>
<td>1 - Requires more research</td>
<td>2 - Requires moderate vetting</td>
<td>3 - Requires no further research</td>
</tr>
</tbody>
</table>
Already available at our emerging project website: (https://eeaps.evergreenecon.com/card-emerging-technology/)

Will be posted with the white paper, technology fact sheets, and this webinar at the Minnesota Department of Commerce CARD website as well

For a user guide, see the white paper when it is published next month
## Technology Fact Sheet Takeaways

<table>
<thead>
<tr>
<th>Timeframe</th>
<th>Department of Commerce</th>
<th>Minnesota Utilities</th>
<th>Researchers / Others</th>
</tr>
</thead>
<tbody>
<tr>
<td>Near term</td>
<td></td>
<td>Review featured technologies for program applicability</td>
<td>Build on EPIC research; explore Minnesota applications</td>
</tr>
<tr>
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<td>Track study evolution</td>
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<tr>
<td>Mid term</td>
<td>Identify a short list of EPIC-funded technologies of interest and track their progress</td>
<td>Track studies of other EPIC technologies of interest</td>
<td></td>
</tr>
<tr>
<td>Long term</td>
<td>Systematically screen other major R&amp;D programs and track lightly for results</td>
<td>Follow</td>
<td>Build on other major R&amp;D studies; explore Minnesota applications</td>
</tr>
</tbody>
</table>
Questions?

Emerging Technologies in Efficiency

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

Adam Zoet
adam.zoet@state.mn.us

Ingo Bensch
bensch@evergreenecon.com

Jonah Miller
miller@evergreenecon.com

Send us your questions using WebEx Q&A box
Applied Research and Development

Funds projects to identify new technologies or strategies to maximize energy savings, improve the effectiveness of energy conservation programs, or document the carbon dioxide reductions from energy conservation projects.

Background

The Minnesota Energy Act of 2007 (the Act) established energy conservation as a primary resource for meeting Minnesota’s energy needs while reducing greenhouse gases and other harmful emissions. The Act also established a target goal of a 2 percent annual reduction in electricity and natural gas use for all utilities in the state. The utilities may reach this annual goal directly through utility-specific energy conservation improvement programs (ECIPs) and, indirectly, through energy cost, appliance standards, behavioral, and other market transformation programs.

To help utilities reach their energy savings goal, the Act authorized the commission to assess utilities $5,600,000 annually for grants for applied research and development projects:
- $2,600,000 for the Conservation Applied Research and Development (CARD) program through which Commerce awards grants in a competitive Request for Proposal (RFP) process.
- $500,000 for the Center for Sustainable Building Research to coordinate activities related to Sustainable Building 2020 (SBR 2020) and $500,000 for the Clean Energy Resource Teams (CERTs) for community energy projects, assistance and outreach.

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 & White Paper available in couple months

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

Upcoming CARD Webinar:

• No CARD webinars currently scheduled

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