Welcome

Conservation Applied Research & Development (CARD) Webinar

December 10, 2020
CIP Opportunities in the C&I Refrigeration Market
CIP Opportunities in the C&I Refrigeration Market

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KW Engineering
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• 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
• 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
CARD RFP Spending by Sector thru FY2019

RFP Summary
- 10 Funding Cycles
- 472 proposals
- 121 projects funded
- $27.4 million in research
What We’ll Be Discussing Today

• Project Introduction
  • Russ Landry, CEE

• Utility Programs & Facility/Construction Activity Data
  • Melanie Lord, Slipstream

• Results by Sector
  • Grocery
    • Jim Kelsey, kW Engineering
  • Industrial
    • Steve Mulqueen, Cascade Energy
  • Ice Arenas
    • Russ Landry, CEE

• Summary & CIP Program Recommendations
  • Russ Landry, CEE
Market Study Context

• **Why Statewide Study?**
  • Low CIP program refrigeration savings compared to potential
  • Refrigerant and technology changes
  • Local factors (e.g. climate, market conditions, ice arenas)

• **Goal:** To generate information about the medium and large commercial and industrial refrigeration market in Minnesota that will help programs increase the savings realized in this sector.
  • New Measures
  • New Program Approaches

• **Sector:** Large, Refrigeration Dominated Facilities
  • Grocery
  • Industrial refrigeration (food processing and cold storage)
  • Ice arenas
Key Common Characteristics of Refrigeration Dominated Facilities Market

• Technology: Field Assembled Systems
  • Matching of components & system control often has bigger impact than the efficiency of any one component
  • Details of what contractors, designers & operators do is critical to maximizing efficiency

• Market: Very Few Key Trade Allies
  • Installation contractors
  • Service contractors
  • Designers
Market Study Investigation Approaches

• Utility Program Reviews

• Facility & Construction Data

• 20 national level Interviews

• 41 local market interviews

• 15 site reviews

• Estimated cost-effectiveness & potential increase to program impact for 25 “new” measures
Utility Programs & Facility/Construction Activity Data:

Melanie Lord, Slipstream
## Minnesota Energy Efficiency Programs for Refrigeration

<table>
<thead>
<tr>
<th>Program</th>
<th>Incentives</th>
<th>Utility</th>
<th>Common participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>HVAC+R (Refrigeration component)</td>
<td>Prescriptive and Custom</td>
<td>Xcel Energy</td>
<td>Grocery stores, large central cold storage facilities, food banks, hospitals</td>
</tr>
<tr>
<td>Custom Business Efficiency</td>
<td>Custom</td>
<td>Minnesota Power</td>
<td>Convenience stores and ice arenas</td>
</tr>
<tr>
<td>Refrigeration</td>
<td>Prescriptive</td>
<td>Otter Tail Power</td>
<td>Large customers with facility managers</td>
</tr>
</tbody>
</table>
Estimated Number of Grocery Stores, Indoor Ice Arenas and Food Manufacturing & Cold Storage

- 979 Grocery Stores
- 223 Refrigeration-dominated Food Manufacturing And Cold Storage Facilities
- 208 Indoor Ice Arenas
New Construction and System Replacement Rates

Trends in Grocery Stores

- **New construction**
  - 2015: 1
  - 2016: 3
  - 2017: 29
  - 2018: 9
  - 2019: 6

- **Remodel/addition**
  - 2015: 1
  - 2016: 0
  - 2017: 9
  - 2018: 15
  - 2019: 9

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**New construction regression**

**Remodel/addition regression**
New Construction and System Replacement Rates (cont.)

Trends for Food Manufacturing and Cold Storage

Trends for Indoor Ice Arenas
<table>
<thead>
<tr>
<th>Program</th>
<th>Incentives</th>
<th>Utility</th>
<th>Common participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy Smart Industrial</td>
<td>Prescriptive/ Custom</td>
<td>Bonneville Power Administration</td>
<td>Food processors and pulp &amp; paper</td>
</tr>
<tr>
<td>Industrial System Optimization Program</td>
<td>Custom</td>
<td>Puget Sound Energy</td>
<td>Cold storage</td>
</tr>
<tr>
<td>Industrial Refrigeration Study</td>
<td>Custom</td>
<td>ComEd</td>
<td>Food processors and cold storage</td>
</tr>
<tr>
<td>Large Energy Users</td>
<td>Prescriptive and Custom</td>
<td>Various Wisconsin utilities</td>
<td>Food processors and cold storage</td>
</tr>
<tr>
<td>Municipal Ice Rink</td>
<td>Prescriptive and Custom</td>
<td>SaskPower</td>
<td>Indoor ice rinks</td>
</tr>
<tr>
<td>Pilot: Monitoring Based Commissioning</td>
<td>Custom</td>
<td>NYSERDA</td>
<td>Grocery stores</td>
</tr>
<tr>
<td>EnergySmart Grocer</td>
<td>Prescriptive</td>
<td>PG&amp;E and National Grid</td>
<td>Grocery stores</td>
</tr>
</tbody>
</table>
Successful Program Approaches

Outreach recommendations

<table>
<thead>
<tr>
<th>Subsector</th>
<th>Key Contact Type</th>
<th>Recommended Outreach</th>
</tr>
</thead>
<tbody>
<tr>
<td>All</td>
<td>Service and Installation Contractors</td>
<td>Personal contact every other month to discuss potential projects</td>
</tr>
<tr>
<td>All</td>
<td>Service Contractors and ESPs(^a)</td>
<td>Engage in the development and delivery of approaches targeting operational savings and retrofits to existing systems</td>
</tr>
<tr>
<td>All</td>
<td>Designers and Vendors</td>
<td>Personal contact semiannually to increase program awareness and as needed to address issues or conflicts with individual measures</td>
</tr>
<tr>
<td>Grocery</td>
<td>Retail Chain Decision Makers</td>
<td>Personal contact 2–6 times per year to ask about potential projects</td>
</tr>
<tr>
<td>Ice Arenas</td>
<td>Ice Arena Managers</td>
<td>Join trade association (MIAMA) and participate in trade shows</td>
</tr>
<tr>
<td>Industrial</td>
<td>Facility Operators</td>
<td>Work with trade association (RETA) local chapters to develop and promote approaches targeting operational savings measures</td>
</tr>
<tr>
<td>All</td>
<td>Other End Users</td>
<td>Regular project marketing and annual personal outreach</td>
</tr>
</tbody>
</table>

- Frequent outreach
- Promote operational improvements and cost-effective retrofits
- Minimize program barriers
Key Grocery Sector Findings:

Jim Kelsey, kW Engineering
Topics to cover

- Basic system characterization
- Decision makers
- Refrigerant phase-out impacts
Turnover is slow
Existing systems

- Custom design/build
- Centralized controls
- Semi-hermetic compressors
- Air-cooled condensers
- Fixed head pressure
- HCFC / HFC Refrigerants
- Long piping runs → leaks
Prevalent Heat Recovery
15-year-old controls, underutilized
Driving greater program results

- Small number of decision makers influence market
- Their trust is hard won / they are risk averse
- Experience with custom incentives

Options
- Eliminate or reduce hassles of custom incentives
- Apply deemed or “quick calc” scaled incentives
Refrigerant Phase Outs

• “There is still a lot of R-22 out there”
• Minnesota is U.S. Climate Alliance member
• Participants are regulatory driven
• New stores – gaining experience with CO2
  • MN climate makes this option a likely market leader
  • Some chains using micro-distributed propane
Lower GWP Refrigerant Pathways

Mid GWP

- R-448 / R-449 HFO Blends
- GWP ~ 1400
- Minor system mods needed
- Utilize existing systems
- Little performance impact

Low GWP

- Entire system replacements
- New
- Very costly
- Primarily new construction

www.bitzerus.com
Opportunities: Grocery

- Adding doors to open cases
- Replacing island cases
- Commissioning existing controls
- LED lighting (area and case)

- Consider: incentives for high efficiency TC CO₂ options (new only)
Take home points

• Opportunities in existing stores:
  • Case retrofits
  • Commissioning
  • Controls

• Regulatory trends (HFC phase outs) will drive investments
  • Already occurring
  • MN is good opportunity for CO2 systems
  • Make sure we make them as efficient as possible
Key Industrial Sector Findings:

Steve Mulqueen, Cascade Energy
## Industrial Refrigeration System Types

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Large Systems</th>
<th>Small Systems</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Type</strong></td>
<td>Central System</td>
<td>Packaged Units</td>
</tr>
<tr>
<td>Assembly</td>
<td>Field</td>
<td>Factory</td>
</tr>
<tr>
<td>Compressors</td>
<td>Screw</td>
<td>Reciprocating</td>
</tr>
<tr>
<td>Condensers</td>
<td>Evaporative</td>
<td>Air Cooled</td>
</tr>
<tr>
<td>Refrigerant</td>
<td>Ammonia, R-22</td>
<td>R-22, Synthetic</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Uses</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Space Cooling/Freezing</td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td>Product Cooling/Freezing</td>
<td>✔️</td>
<td>✔️</td>
</tr>
</tbody>
</table>

**Refrigerants**

- Ammonia more efficient than R-22.
- Difficult to retrofit ammonia with R-22.
- Phaseout of R-22 may increase major retrofits (non Ammonia)
## Industrial Refrigeration
### National & Local Market

<table>
<thead>
<tr>
<th>Interviews</th>
<th>National</th>
<th>Local</th>
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<tbody>
<tr>
<td>Number</td>
<td>7</td>
<td>16</td>
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<tr>
<td>Experience with EE programs</td>
<td>High</td>
<td>Moderate</td>
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</table>

<table>
<thead>
<tr>
<th>Efficiency Projects</th>
<th>National</th>
<th>Local</th>
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<tbody>
<tr>
<td>VFDs</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Controls</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Condensing pressure</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Suction pressure</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Oil cooling retrofits</td>
<td>✓</td>
<td>✗</td>
</tr>
<tr>
<td>Envelope improvements</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Tuneups</td>
<td>✓</td>
<td>✓</td>
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<table>
<thead>
<tr>
<th>Project Economics</th>
<th>National</th>
<th>Local</th>
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<tbody>
<tr>
<td>Payback requirement</td>
<td>2-3 years</td>
<td>2-3 years</td>
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<tr>
<td>Trend</td>
<td>Higher ROIs</td>
<td>Higher ROIs</td>
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<table>
<thead>
<tr>
<th>Utility Support</th>
<th>National</th>
<th>Local</th>
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<tbody>
<tr>
<td>Technical</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Rebates</td>
<td>✓</td>
<td>✓</td>
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</table>
## Industrial Refrigeration
### National & Local Market (continued)

<table>
<thead>
<tr>
<th>New Technologies of Interest</th>
<th>National</th>
<th>Local</th>
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</thead>
<tbody>
<tr>
<td>Thermal energy storage</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td>Low refrigerant charge packaged sys.</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Smart controls</td>
<td>✓</td>
<td>✓</td>
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<table>
<thead>
<tr>
<th>R-22 Phaseout</th>
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<tbody>
<tr>
<td>Urgency</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>Low charge ammonia as replacement</td>
<td>✗</td>
<td>✓</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Opportunities for Minnesota</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Lower condensing pressure</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Tuneups</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
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<table>
<thead>
<tr>
<th>Improvements</th>
<th></th>
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<tbody>
<tr>
<td>• More awareness of utility offerings.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Utility involvement from beginning of project.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Lower burden of rebate &amp; M&amp;V process on contractors and customers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Improve contractor involvement</td>
<td></td>
<td></td>
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</table>
### Plan/Site Reviews

<table>
<thead>
<tr>
<th>Number</th>
<th>5</th>
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</table>

### Overview

<table>
<thead>
<tr>
<th>Refrigerant Controls</th>
<th>Ammonia Central/Computerized</th>
</tr>
</thead>
</table>

### Evaporators

<table>
<thead>
<tr>
<th>Coil Design</th>
<th>Good practice</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variable speed</td>
<td>Mix</td>
</tr>
<tr>
<td>Hot-gas defrost</td>
<td>Reasonable</td>
</tr>
</tbody>
</table>

### Compressors

<table>
<thead>
<tr>
<th>Type</th>
<th>Screw</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variable speed</td>
<td>Mix</td>
</tr>
<tr>
<td>Oil cooling</td>
<td>Mix</td>
</tr>
</tbody>
</table>

### Condensers

<table>
<thead>
<tr>
<th>Variable speed fans</th>
<th>All</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pumps</td>
<td>Remote</td>
</tr>
<tr>
<td>Opportunity to reduce condensing pressure</td>
<td>4 of 5</td>
</tr>
</tbody>
</table>
Industrial Refrigeration Facility
System Types

- ~90% of industrial refrigeration facilities are central (ammonia) systems
- Only a few new facilities are constructed each year.
Industrial Refrigeration Facility
Savings Potential – Existing Facilities

- Estimated 3-year program savings potential for retrofits is 7.3 GWh
- Largest opportunity is to reduce condensing pressure
Industrial Refrigeration Recommendations

- Target capital, recommissioning and O&M savings in existing facilities through detailed onsite assessments (i.e. tuneups)
  - Leverage control system and utility data to make informed recommendations
- Reduce effort required by customers and contractors for program participation.
- Use approved tools to expedite rebates for common measures (e.g. doors)
Key Ice Arena Sector Findings & Summary:

Russ Landry, Center for Energy and Environment
Ice Arena Summary

• Unique Sector Characteristic
  • Variety of commercial and industrial refrigeration equipment
  • Pump a secondary fluid under the ice sheet
  • Seasonality of ice rink schedule can have a big impact

• Trends/Technologies
  • Little urgency around R-22 phaseout
  • Ammonia dominant in new systems
  • Controls upgrades
  • Aqueous ammonia secondary fluid
  • Reduced resurfacer flood water temperature
Arena Interview Comments: Utility Program Support

- Rebates Received
  - VFDs
    - Condenser fans
    - Glycol pumps
  - Limited Custom Participation
    - Low Emissivity Ceilings
    - Reduced Resurfacer Flood Water Temperature (and Higher Ice Temperature)

- Comments
  - Make it easier to get rebates for control upgrades and low emissivity ceilings (savings calculations)
  - More outreach
  - Demonstration sites or technology evaluation
  - 3rd party rebate recipient
Top Measures for Existing Ice Arenas

3-Year Statewide Program Savings Potential (MWh)

- Recommissioning Existing Controls
- Controls Capital Upgrades
- Glycol Pump Control of VFD
- Low Emissivity Ceiling
- Subcooling Reclaim for Pit/Subfloor
- VFD on Condenser Fan(s)
- Reduced Flood Water Temperature

0 200 400 600 800 1,000 1,200
Summary & CIP Program Recommendations:

Russ Landry, Center for Energy and Environment
Refrigeration Energy Saving Strategies

• Reduce Refrigeration Load
  • Display cases, ECM fans, pump VFDs or staging, fan cycling

• Increase Suction Pressure
  • Raise suction pressure when low loads (a.k.a. floating suction pressure)

• Reduce Head Pressure
  • Condenser control, different expansion valve

• Increase Component Efficiency
  • Condenser ECM motors, VFDs

• Provide Subcooling at Expansion Valve
Overall Recommendations for New Measures

• Reduce Refrigeration Load
  • Display cases, ECM fans, pump VFDs or staging, fan cycling
  • evaporator fans, glycol pump VFDs or staging

• Increase Suction Pressure
  • Raise suction pressure when low loads (a.k.a. floating suction pressure)

• Reduce Head Pressure
  • Condenser control, different expansion valve

• Increase Component Efficiency
  • Condenser ECM motors, VFDs

• Provide Subcooling at Expansion Valve
Overall Recommendations for Measures

- Identified 14 Top Priority Measures to Better Address
- Recommend Additional Technology Evaluation for 9 Measures
- Identified 4 Lower Priority Measures
- Noted 16 MN Energy Code & Federal Standard Requirements that may Limit Rebate Applicability for New Systems
3-Year Increased Program Savings Potential (MWh)

- Optimizing Existing Ice Arenas, 5,545
- Optimizing Existing Industrial, 7,298
- Optimizing Existing Grocery, 12,613
- New System Upgrades, 585
Recommendations: CIP Approaches

- Frequent Outreach to Key Contacts
- Target Operational Efficiency & Retrofits
- Minimize Barriers for Non-Rx Measures
Frequent Outreach to Key Industry Contacts

- Installation & service contractors—6 times/year
- Designers, vendors & energy service providers—consult on program development & 2 times/year
- Retail chain decision makers—2-6 times/year
- Industry Associations
  - MIAMA
  - Minnesota Grocers Association
  - RETA Northern Plains Chapter
Target Operational Efficiency & Retrofits

- Refrigeration Expert Work On-Site with Technicians
- Provide Reduced Cost Assessment
- Use Sector-Specific Expert
- Leverage Remote Monitoring
- Provide Operator Workshops
Minimize Barriers for Measures Without Prescriptive Rebates

- Develop More Prescriptive Rebates

- Shift Custom Analysis Burden to Utility/Implementer

- Develop TRMs and Other Approaches to Expedite Custom Measure Analysis

- Provide One Week Turnaround for Smaller Scale Retrofits and Equipment Replacement Projects
Summary of Study Findings

• Field assembly of systems and market dominance of a few key trade allies make this market unique

• >25 Refrigeration System Efficiency Measures Have Not Been Well Addressed in MN

• The 3-Year Potential for Increased Program Savings for These Items is ~26,000 MWh

• The Vast Majority of This Potential is for Optimizing Existing Systems
Questions?

CIP Opportunities in the C&I Refrigeration Market

Send us your questions using the Webex Q&A box
**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

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**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 **Cleaner Generation 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 savings goal of 5 percent of annual new electricity and natural gas sales for all utilities in the state. Utilities may reach this annual goal directly through utility Conservation Improvement Programs (CIPs) and indirectly, through energy codes, appliance standards, behavioral and other market transformation programs. To help utilities reach their energy savings goals, the Act authorizes the commissioner to assess utilities $2,000,000 annually for grants for applied research and development projects.

- $2,000,000 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 (CSBR)** to coordinate activities related to **Sustainability Building 2030** ($500,000) and **$20,000 for the Client Energy Resource Trust (CERT)** for community energy technical assistance and outreach.

**Webinar Recording & Final Report available in couple months**

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Thanks for Participating!

Upcoming CARD Webinars:
• January 21, 2021 – 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:
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R&D Program Administrator
marysue.Lobenstein@state.mn.us
651-539-1872
Let us know how we did today!

Your Feedback Matters