Welcome

Conservation Applied Research & Development (CARD) Webinar

July 21, 2021

Expanded Scope of Commercial Boiler Tune-Ups
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

Additional WebEx Controls at Bottom of Your Screen

Q&A on right side of WebEx panel

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 FY2020

RFP Summary
- 12 Funding Cycles
- 513 proposals
- 143 projects funded
- $31.2 million in research
Presentation Overview

- **Project Goal:** “Develop and field test an expanded scope commercial boiler tune-up protocol that goes beyond burner adjustments to provide a comprehensive review and adjustment of boiler (temperature & staging) control settings to increase energy savings.”

- **Why?**...temperature and staging controls
- **How & Who?**...protocol development & testing
- **What?**...we learned
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Why Boiler Temperate & Staging Control Optimization?

- To fully capitalize on outdoor reset control savings
Boiler System Outdoor Reset Control
Why Boiler Temperature & Staging Control Optimization?

- To fully capitalize on outdoor reset control savings
- To respond to market shift towards condensing boilers
  - Less burner setting drift
  - Operating efficiency is very sensitive to system return temperature (and firing rate)
Condensing Boiler Operating Efficiency Range

- Conventional Boiler
- Condensing--Minimum
- Condensing--Ideal
- Condensing--Your Building

If condensate drain dry

- Conventional
- Condensing
Condensing Boiler Operating Efficiency Variation

Graph showing efficiency variation with return water temperature.
Why Boiler Temperate & Staging Control Optimization?

• To fully capitalize on outdoor reset control savings
• To respond to market shift towards condensing boilers
  • Less burner setting drift
  • Operating efficiency is very sensitive to system return temperature (and firing rate to a lesser degree)
• To follow-up on savings opportunities identified in previous CARD-funded condensing boiler optimization project
Savings Potential In Existing Commercial Condensing Boiler Systems

- Improved (or New) Variable Speed Pump Control
- Burner Tune-Ups
- Piping Changes
- Temperature Control Adjustments
- Staging Control Improvements
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- To leverage existing program service delivery and sales
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- **Why?** temperature and staging controls
- **How & Who?** protocol development, recruitment & impact
- **What?** we learned
How & Who? Protocol Development

- Market Study to Inform Development
  - Interviews with 21 local boiler industry contacts
  - State boiler and pressure vessel database (smaller boiler systems omitted)

- Protocol Development
  - Review other forms, etc.
  - Input from Trade Allies
  - 1st Draft
  - Early Initial Trial: Interactive
  - Final Pilot Protocol
  - Final feedback from trade allies
  - Refined during use at 17 sites
  - Revised & Added Makes/Models
How & Who? Recruitment

- Targeted #s Within Categories for 7 Different Characteristics

- Recruited contractors, who then recruited end-users
  - 5 contractors, 4 of which recruited 1+ appropriate sites
  - 17 buildings selected from a pool of 32 (5 different building owners)
• How & Who? Impact—Long-Term Monitoring

• Boiler system temperatures—all sites
How & Who? Impact—Long-Term Monitoring

- Boiler system temperatures—all sites
- Boiler cycling—13 sites
  - On board counters
  - BAS & loggers
How & Who? Impact—Long-Term Monitoring

- Boiler system temperatures—all sites
- Boiler cycling—14 sites
  - On board counters
  - BAS & loggers
- Natural Gas Savings
  - Measurement
    - Meters--11 sites
    - BAS firing rates--6 sites
  - Analysis
    - Pre-post regressions
    - Limited Post data (before COVID shutdowns at schools) vs pre-regressions
How & Who? Impact—Program Projections

• Cost-Effectiveness
  • Contractor billed costs
  • Based on $7.60 per mcf and 2021-2023 CIP filing inputs

• Program Potential
  • Population of existing boilers
  • (Burner) tune-up program participation
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- **How & Who?…protocol development & testing**
- **What?…we learned**
What We Learned? Detailed Protocol Application

- High level of training, coaching & technical support still needed
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• Temperature control adjustments called for at every site
  • Fine-tuning callbacks needed at 4 of 17 sites
  • Backtracking of changes >20°F
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• Controls problems beyond settings
  • Issues at one-third of sites
  • Most resolved during initial visit
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  • Backtracking of changes >20°F
• Controls problems beyond settings
  • Issues at one-third of sites
  • Most resolved during initial visit
• BAS changes made without controls contractor
• Mechanical plans very helpful for buildings with newer HVAC
• Cost ~$750 per site or ~$250 per boiler
What We Learned? Control Tune-Up Impact on Temperatures

- **Average Pre-Tune-Up**
- **Average Post-Tune-Up**
- **Average 13 Months Later**
What We Learned? Control Tune-Up Impact on Cycling
What We Learned? Control Tune-Up Impact on Gas Use

First Year Savings %

-15% -10% -5% 0% 5% 10% 15% 20% 25%

S3 M6 M3 S9 S2 S1 S5 M2 S4 S10 S7 S6 M4 M5 M1
## What We Learned? Control Tune-Up Impact on Gas Use

<table>
<thead>
<tr>
<th>Sample</th>
<th>Mean Percent</th>
<th>Median Percent</th>
<th>Mean Gas</th>
<th>Median Gas</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multifamily Buildings (N=6)</td>
<td>10.3%</td>
<td>13.6%</td>
<td>152 Dth</td>
<td>67 Dth</td>
</tr>
<tr>
<td>School Buildings (N=9)</td>
<td>6.0%</td>
<td>6.5%</td>
<td>187 Dth</td>
<td>148 Dth</td>
</tr>
<tr>
<td>Both Building Types (N=15)</td>
<td>7.7%</td>
<td>7.1%</td>
<td>173 Dth</td>
<td>137 Dth</td>
</tr>
</tbody>
</table>
What We Learned? Savings Persistence

- Average of 66% into the 2nd year
- Persistence into 2nd year varied greatly by site
  - Most at 100%
  - Significant minority <20%
What We Learned? Savings & Persistence

![Graph showing average natural gas savings and persistence into 2nd year based on range of reduction in average boiler system supply temperature.]

- Average Natural Gas Savings
  - < 8°F
  - 8°F - 10°F
  - 12 - 17°F
  - 21 - 25°F

- Average Persistence into 2nd Year
  - 100%
  - 90%
  - 80%
  - 70%
  - 60%
  - 50%
  - 40%
  - 30%
  - 20%
  - 10%
  - 0%
  - -2%
What We Learned? Cost-Effectiveness & Impact

• Simple Payback
  • Median 0.73 years
  • 10 of 17 sites < 1 year

• Achievable Potential
  • 196,500 Dth (10% of C&I portfolio)
What We Learned?  Cost-Effectiveness & Impact

- Existing Program Costs

![Chart showing cost-benefit ratio for Societal Test and Gas Utility Test. Blue bars represent mean values, and orange bars represent median values.](chart.png)
What We Learned? Cost-Effectiveness & Impact

- Existing Program Costs
- 25% Larger Program Costs
What We Learned? Recommendations: CIP Program Development & Marketing

- End user market research
- Budget and timeline should allow for extensive contractor training, on-demand technical support, and quality control.
- Work with trade allies during program planning.
- Leverage boiler service contractors to promote the service.
- Test approaches to increase persistence.
What We Learned? Recommendations for CIP Program Implementation

- Provide extensive contractor training and on-demand technical support.
- Institute a robust quality control program.
- Provide clear customer expectations: BAS access & mechanical plans.
- Match technician make/model familiarity with each site.
Questions?

Expanded Scope of Commercial Boiler Tune-Ups

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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

CARD Project Information

CARD projects quantify the savings, cost-effectiveness and field performance of advanced technologies characterized by potential of products and technologies in the State and investigate and pilot innovative program strategies. Completed CARD projects provide utilities with informative and timely information to enhance energy efficiency program designs within their CIP portfolios.

To learn more about specific CARD projects and project results you can:
- Use our CARD Grant Search tool to see a list of all CARD projects or to find the most relevant CARD projects and final reports for your application(s).
- Do so our CARD Webinars area to view webinar results on the benefits of a completed CARD project or program event.

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

- **October 19, 2021:** Center for Energy and Environment – Strategic Market Opportunities for High-Performance Envelope Retrofits

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

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