Welcome

Conservation Applied Research & Development (CARD) Webinar

September 22, 2020
Capture Energy Savings in New Commercial Construction in Minnesota
Capture Energy Savings in New Commercial Construction in Minnesota

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Webinar Basics

Open or close your control panel

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Audio options
Select either the Computer audio or a Phone call.

• If you are using your telephone:
  • Select the “Phone call” button
  • Dial in and enter your access code
  • Enter your audio pin and press #

You will be joined into the webinar on mute.

Participation
Type in a question and hit “send” to ask a question.
• 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
Acknowledgments

Thank you to our research partners!
Agenda

• Study Goals and Approach
• Results
• Recommendations and Opportunities
• Questions
Study goals and approach
Why study building energy codes?

Building energy codes can be an effective tool to improve building energy performance.

But...only as effective as the rate of compliance.
1) **Characterize energy efficiency** in Minnesota for new and renovated buildings;

2) Identify specific opportunities for increased energy savings through **existing** commercial energy codes; and

3) Identify specific opportunities for increased energy saving measures that **go beyond existing** commercial energy code requirements
We are _not_ code officials deciding whether a commercial building complied with building code or not ….

… But rather, this is a study of _lost energy savings_ relative to prescriptive energy code

… which builds upon a legacy of work on energy code compliance
Study Approach

• Four major building segment groups:
  1) High-rise multifamily
  2) Office
  3) Food service and retail
  4) Education and other (which encompasses public assembly, public order and religious facilities)

• All segments split between small (<100,000 SF) and large (>=100,000SF) except for FS/Retail

• 78 projects
Data collection methods

- Recruit
- Review detailed plans
- On-site verification
- Lost savings calculations
## Analytic tool

## Data collection tool

<table>
<thead>
<tr>
<th>Measure Code</th>
<th>Measure description</th>
<th>Apply to</th>
<th>Factor</th>
<th>Units</th>
<th>Measurable Condition</th>
<th>Observations</th>
<th>As Found Condition</th>
<th>Verification</th>
<th>Factor</th>
<th>Discrepancy or Quality</th>
<th>Affected quantity</th>
<th>Applicable units</th>
<th>Measure specific Comments</th>
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</thead>
<tbody>
<tr>
<td>5012</td>
<td>Roofs shall be insulated to meet C2 requirements</td>
<td>Y</td>
<td>U-factor</td>
<td></td>
<td></td>
<td></td>
<td>Select Condition</td>
<td></td>
<td></td>
<td></td>
<td>72 net roof area</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>5014</td>
<td>Slope of roofs in C2-3 shall be cool roofs</td>
<td>N</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>72 net roof area</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5018A</td>
<td>Above grade frame walls shall be insulated to meet C2 and density requirements</td>
<td>Y</td>
<td>U-factor</td>
<td></td>
<td></td>
<td></td>
<td>Select Condition</td>
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<td></td>
<td></td>
<td>72 net façade wall area</td>
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<td>5018B</td>
<td>Exterior frame floors shall meet the insulation requirements</td>
<td>Y</td>
<td>U-factor</td>
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<td></td>
<td></td>
<td>Select Condition</td>
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<td></td>
<td></td>
<td>72 exterior floor</td>
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<tr>
<td>5023A</td>
<td>Exterior mass floors shall meet the minimum K-value or U-value by assembly type</td>
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<td>72 exterior floor</td>
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<tr>
<td>5024</td>
<td>Exterior mass floors shall meet the minimum U-factor requirements</td>
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<td>Door U-factor</td>
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<td>Select Condition</td>
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<td></td>
<td></td>
<td>72 doors</td>
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<tr>
<td>5014</td>
<td>Windows-to-wall ratios shall meet maximum limits</td>
<td>Y</td>
<td>% window area</td>
<td></td>
<td></td>
<td></td>
<td>Select Condition</td>
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<td></td>
<td></td>
<td>72 gross floor area</td>
<td>X</td>
<td></td>
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<td>5055</td>
<td>Skylights to roof ratio shall meet maximum limits</td>
<td>Y</td>
<td>% skylight area</td>
<td></td>
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<td></td>
<td>Select Condition</td>
<td></td>
<td></td>
<td></td>
<td>72 gross roof area</td>
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<tr>
<td>5042A</td>
<td>Windows shall meet U-factor requirements</td>
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<td>U-factor</td>
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<td>Select Condition</td>
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<td>5042B</td>
<td>Windows shall meet SHGC requirements</td>
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<td>U-factor</td>
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<td>Select Condition</td>
<td></td>
<td></td>
<td></td>
<td>72 window area affected</td>
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</tr>
</tbody>
</table>
Results
Key Takeaways

- **Substantial lost savings** for meeting code
- **Envelope measures** were more likely to be complied with
- Non-compliance in mechanical code elements driven by control and configuration elements
- Several code elements commonly go **beyond prescriptive code**
Average compliance rates generally range between 70%–85%.

This translates to over $10 million in annual lost savings.
When focusing on end-use, some differences emerge...

Vertical lines are 90% sampling error margins. Large office does not have error bars because it is a sample of one.
Results: Worst-Performing Mechanical and Plumbing Code Elements

Worst-performing mechanical / plumbing code elements: lost savings and compliance rate

- Mech commissioning
- Thermostat deadband
- VAV ventilation optimization
- Thermostat heating setback
- Fan power - VAV
- Demand control ventilation
- Economizer high limit shutoff
- Energy recovery requirement
- Optimal start control

Percentages indicate overall compliance rate for all building segments

Note: this slide has been updated from the original webinar aired on September 22
Worst-performing mechanical / plumbing code elements: lost savings and compliance rate

- Mech commissioning: 53%
- Thermostat deadband: 13%
- VAV ventilation optimization: 10%
- Thermostat heating setback: 16%
- Fan power - VAV: 60%
- Demand control ventilation: 67%
- Economizer high limit shutoff: 23%
- Energy recovery requirement: 91%
- Optimal start control: 39%

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Examples of Compliant Mechanical Elements

Most commonly complied with mechanical code elements include:

- Cooling and heating equipment efficiency
- Air economizer present
- Hot water pipe insulation (space heating and domestic hot water)
- Duct insulation
Building Automation System (BAS) showing key operating inputs
Results: Worst-Performing Lighting and Electrical

Worst-performing lighting/electrical code elements: lost savings and compliance rate

- Lighting commissioning: 48% (Electricity)
- Receptacle control: 30% (Electricity)
- Daylighting control: 61% (Electricity)
- Exterior lighting control: 45% (Electricity)
- Garage light control: 73% (Electricity)
- Manual lighting control: 83% (Electricity)

Note: this slide has been updated from the original webinar aired on September 22.
Worst-performing envelope code elements: lost savings and compliance rate

- Fenestration orientation: 37%
- Window solar heat gain coefficient (SHGC): 68%
- Window-to-wall ratio: 96%
- Window U-factor: 64%

Total annual lost savings ($, thousands)

Percentages indicate overall compliance rate for all building segments.

Note: this slide has been updated from the original webinar aired on September 22.
Plan documentation is **critical** in ensuring compliance of code elements

If elements are poorly documented...

... increased risk for **confusion**

... any compliance is either **accidental** or due to a **contractor’s prior knowledge** of the code.

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C. ZONE TEMPERATURE
   1. Occupied heating and cooling zone temperature setpoints shall be 68°F (adj.) and 75°F (adj.) respectively.
   2. Unoccupied heating and cooling zone temperature setpoints shall be 60°F (adj.) and 80°F (adj.) respectively.

D. SUPPLY FAN CONTROL
   1. Fan shall run continuously during occupied mode.
   2. Fan shall run intermittently only to provide heating and cooling as required during unoccupied mode.
   3. VFD command, power, and speed signals shall be hardwired to/from BAS controller. VFD status shall be determined in software. VFD status shall read as on when power is above normal minimum operating range, to be field determined. For example, status may be on
Most common non-compliant elements that were poorly documented:

- Mechanical and lighting commissioning
- Thermostat deadband and setbacks
- Economizer high-limit shutoff control
- Receptacle controls
- Window properties
- Optimal start controls
Going beyond code

- **Mechanical** code elements have significant potential across all three building segments.
- High-rise multifamily shows potential regarding code elements related to *glazing*.
- **Lighting and electrical code elements** showed highest potential in office and food service/retail.
Potential savings beyond ASHRAE 90.1-2010 prescriptive code, by end use

This totals **over $6 million** in additional potential energy savings for MN commercial customers.
Elements Already Exceeding Code

A number of elements already were going beyond code:

- Mass wall insulation
- Interior and exterior lighting power
- Equipment cooling and heating efficiency
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- Mass wall insulation
- Interior and exterior lighting power
- Equipment cooling and heating efficiency
Opportunities and Recommendations
Opportunities for Reaching Full Potential of the Energy Code

Support for...

**Code officials** in the plan review and inspection process

**Design teams** to improve understanding of code elements and documentation practices.

**Controls documentation and commissioning**
Reaching Full Potential: Support for Code Officials

Support for Code Officials

Opportunities

- Educate design teams
- Catch non-compliant code elements during plan review
- Verify commonly non-compliant elements through on-site inspections

Examples: Minnesota’s 2018 Commercial Energy Code Compliance Enhancement Pilot, Florida, Massachusetts, Dallas, District of Columbia

Recommendation

Provide a menu of support options for code officials:

- Circuit rider
- Third-party reviewers
Opportunities
Minimize code elements that are either:
• Not specified in the design documents
• Specified, but not meeting energy code requirements

Recommendation
Provide a shared set of resources, including:
• A sample agenda an early design kick-off meeting
• Phase-specific checklists
  • Design phase
  • Construction phase
  • Testing and commissioning phase
Support for Controls Documentation and Commissioning

Opportunities
• Improve documentation of controls and commissioning requirements
• Increase number of projects that are commissioned

Recommendations
• Educate owners on value of commissioning
• Provide commissioning guidance and resources
• Improve enforcement of controls and commissioning

Examples: Washington State, California, and Austin, Texas
Achieve Beyond Code Savings

Promote **high-impact prescriptive strategies**

Promote **energy modeling**

Address **operational performance**
Achieve Beyond Code Savings: Promote Prescriptive Strategies

Promote Prescriptive Strategies

Opportunities

• Expand use of market-ready efficiency strategies
• Preview future code requirements

Recommendation

• Incorporate into new construction CIPs
  • A la carte
  • Strategy bundles
Achieve Beyond Code Savings: Promote Energy Modeling

Promote Energy Modeling

Opportunities

- Expand use of performance code pathways
- Expand energy modeling analysis of non-regulated elements

Recommendations

- Conduct a market analysis of energy modeling in Minnesota
- Expand energy modeling through CIPs
Achieve Beyond Code Savings Address Operational Performance

Address Operational Performance

Opportunities

• Verify operations-dependent savings are maintained

• Ensure hard-to-verify code elements achieve savings

Recommendation

• Offer a pay-for-performance program
Future Code Pathways

Options for future code pathways

1. More aggressive pathways within building energy code
2. Step energy code option for local jurisdictions
3. Pilot outcome-based energy code pathway

Examples: New York State, Boulder, California, Seattle, Minnesota's SB 2030 Program
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Type questions into the Q&A box on the bottom right side of the WebEx panel and send them to “All Panelists.”
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/)
How Did We Do?

Location:

https://app.keysurvey.com/f/41507551/3ead/
Thanks for Participating!

Upcoming CARD Webinars:

- **September 29** – Improve Your Commercial Light Levels and Save on Cost (Slipstream)
- **October 20** – Portable Dehumidification in MN Single-Family Homes (Center for Energy and Environment)
- **November 10** – Market Potential for Saving Energy and Carbon Emissions with Load Shifting Measures (Slipstream)

[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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