Welcome

Conservation Applied Research & Development (CARD) Webinar

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Energy Savings Opportunities in New and Renovated Minnesota Homes
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Open or close your control panel

Screen
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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
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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
Residential New Construction and Renovation Study

• Two CARD-funded studies of Minnesota new construction and renovation, distinguished by the applicable energy code
  • Residential – today’s topic
  • Commercial – webinar on September 22

• What kinds of buildings are covered by Residential code?
  • Single-family, detached homes
  • Townhomes (aka single-family, attached)
  • Duplexes
  • Multifamily (3+ unit) buildings that are three stories or less in height
1. **Characterize current construction practices** for new and renovated homes

2. **Quantify “lost” savings** from homes that are below prescriptive code

3. **Identify beyond-prescriptive-code measures** and energy savings potential

4. **Provide guidance** to Minnesota utilities for their new-construction and renovation programs
NOT a Formal Code Compliance Study

- Multiple available paths for compliance
  - Prescriptive
  - U-factor alternative
  - Total UA
  - Performance

- Study gauges energy consumption relative to the prescriptive requirements only

- Study data were collected after the homes were occupied
  - Owners could have changed some things (e.g. lighting)

- Some characteristics of interest to utility programs are not subject to state code requirements
  - E.g. equipment efficiency
• **Single family new construction**
  - Recruited and visited 87 single-family homes
  - Collected data on:
    - Basic home characteristics (geometry, foundation types, etc.)
    - Insulation levels and infrared scans
    - Windows
    - Air leakage and duct leakage
    - Equipment characteristics and efficiency ratings
    - Lighting
    - Utility program participation
  - Developed REM/Rate energy models for each home

• **Single family renovation** (13 homes)

• **Low-rise multifamily** (25 properties from separate DOE study)

_Not discussed today -- see final report_
Percent of new single-family homes with natural gas service

- 0-9%
- 10-19%
- 20-29%
- 30-39%
- 40-49%
- 50-59%
- 60-69%
- 70-79%
- 80-89%
- 90-100%

(County size proportional to housing starts)
Average Energy Costs for Single-Family Homes—Four Scenarios

A If built exactly to prescriptive code $2,245 (±$150)

B As-built average $2,160 (±$150)

C Below-code items brought up to prescriptive code $2,130 (±$140)

D Beyond-code potential $1,595 (±$110)

Current-practice savings, $85 (± $25)

Lost savings from below-code items, $30 (± $15)

Beyond-code savings potential $535 (± $65)
As-Built Modeled Energy Costs for Single-Family New Construction Subgroups

All fuels combined. Includes utility monthly customer charges. Horizontal lines are 95% sampling error margins.
Heating Load Intensity for New Single-Family Homes

- Statewide: 1.15
- Has natural gas: 1.17
- No natural gas: 1.06
- Enforcement jurisdiction: 1.19
- Non-enforcement jurisdiction: 1.00
- Southern climate zone: 1.16
- Northern climate zone: 1.12
- Utility program non-participant: 1.14
- Utility program participant: 1.17

Annual heating load (Btu) per square foot shell per heating degree day

Horizontal lines are 95% sampling error margins
“Lost” Energy Savings Associated with Below-Prescriptive-Code Items

- Water heater recirculation (+0.4%)
- Lighting (+0.8%)
- Duct leakage (+0.3%)
- Air leakage (+0.2%)
- Insulation (+0.7%)

Combined* (+0.8%)

Mechanical ventilation (-1.4%)

Lost savings (% of annual energy costs)

*Includes interactive effects of multiple items

Horizontal lines are 95% sampling error margins
Issues with Mechanical Ventilation

- Any issue (95%)
- Flow imbalanced by more than 10% (81%)
- Not interlocked with air handler (63%)
- Missing backflow dampers (33%)
- Unit undersized (28%)
- Used intermittently (21%)
- Intake clogged (17%)
- Disabled by homeowner (8%)
- Homeowner unaware or unsure of system (4%)
- Inaccessible for maintenance (3%)
- Intake near pollution source (e.g. driveway) (3%)
- Improperly installed (3%)
- Core filters clogged (1%)

*Based on randomly-imputed values for missing data on specific issues (primarily imbalanced flow)
*Based on 26 measured systems
*Percentage includes fully-ducted and hybrid systems where interlock is not needed and therefore not an issue
*Flagged as an issue if no integral dampers or no exterior damper observed for at least one port
*Highest rated flow < 90% of code-required total ventilation rate
*Based on one non-functional system and one system where intake both the intake and exhaust flow paths were configured for exhaust
Air Leakage for Single-Family Homes

By home, sorted from lowest to highest (n=86)

*Air changes per hour @ 50 Pa

Prescriptive code maximum

Mean ACH50

Code maximum

*No code requirement
Mechanicals and Lighting

**Heating systems**
- 130 systems in 87 homes
- 96% of homes have a gas or propane furnace
  - AFUE: 92-98%
- Heat pumps, electric boilers, etc. in homes w/o gas service

**Water heaters**
- 54% conv. gas or propane
- 30% conv. electric
- 12% tankless, high-efficiency
- 3% indirect-fired

**Cooling systems**
- 95% have central A/C or heat pump
- 3% ductless heat pump
- 50% are SEER 13
- Up to SEER 21

**Lighting**
- ~100 sockets per home
- 93% hard-wired fixtures
  - 75% LED
  - 8% CFL or LF
  - 17% incandescent or halogen
Beyond-Prescriptive-Code Opportunities for New Single-Family Homes

- Ultra low-leakage ducts
- R-60 ceilings
- Top-efficiency heat-recovery ventilation
- Top-efficiency fuel-fired heating systems
- R-30 slabs
- Air-source heat pumps
- 100% LED lighting
- Heat pump electric water heaters
- SEER 17 air conditioners
- R-30 foundation walls
- Fully ducted mechanical ventilation
- Top-efficiency fuel-fired water heaters
- Triple-pane windows

Statewide average energy-cost savings

- Passive House air leakage
- Triple-pane windows
- R-30 above-grade walls

Value shown is average across all homes. Mean energy-cost savings is 11.2% for the 30% of homes with electric water heaters.

Avoids need for main air handler operation with mechanical ventilation.

Value shown is average across all homes. Mean energy-cost savings is 1.3% for the 70% of homes with fuel-fired water heaters.

Instead of resistance electric heat. Value shown is average across all homes. Mean energy-cost savings is 12.5% for the 6% of homes with electric-resistance space heat.
Recommendations for Residential New-Construction CIPs

• Structure new-construction programs to incentivize going beyond current practice
• Work with regulators and stakeholders toward a common understanding of the role of new-construction programs in moving the market
• Mechanical ventilation (HRVs and ERVs)
  • Step up efforts to ensure proper specification, installation, operation and maintenance
  • Incentivize systems that don’t require an air-handler interlock
  • Incentivize high-efficiency systems
• Create joint programs to address the unique needs of the market that is outside of natural gas service areas and mostly served by rural cooperatives
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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/)
Thanks for Participating!

Upcoming CARD Webinars:

- **September 22** – Capture Energy Savings in New Commercial Construction (Slipstream)
- **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)

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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How Did We Do?

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