COMMERCE DEPARTMENT

Welcome

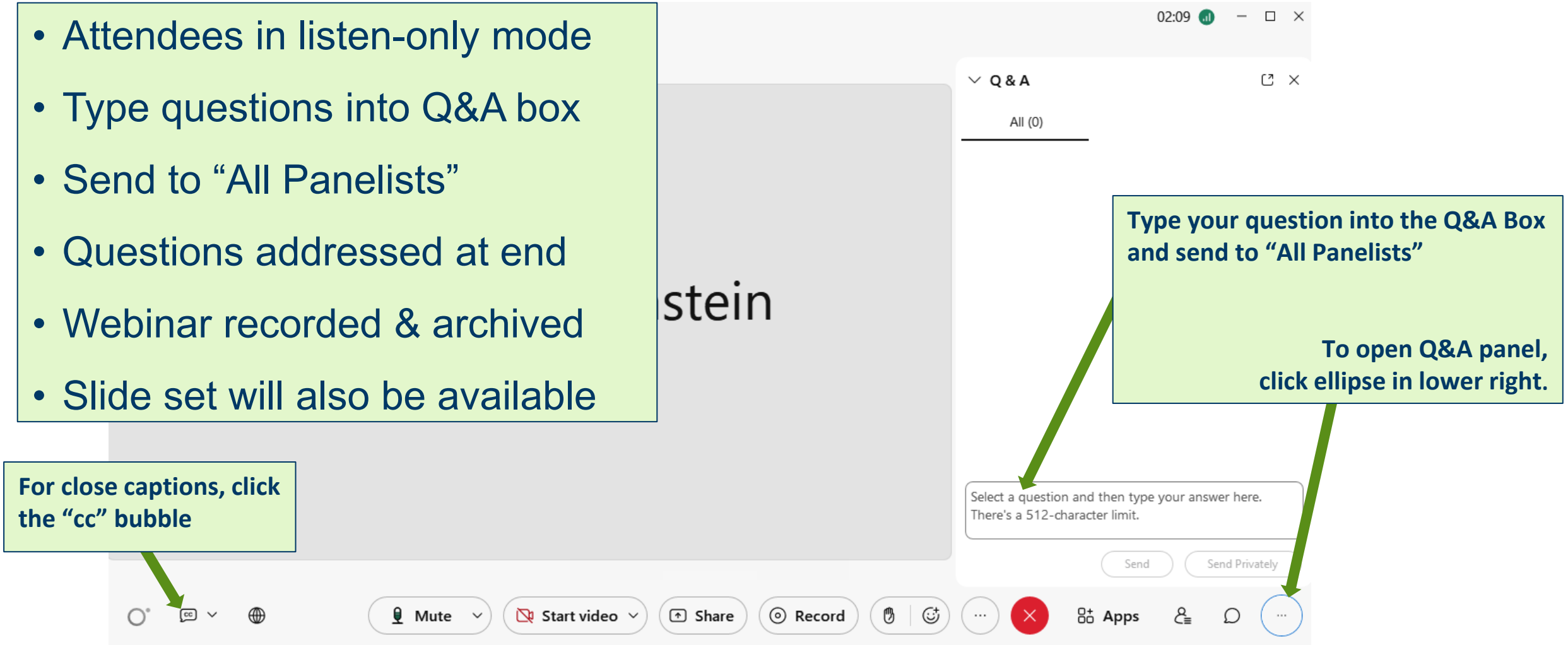
Conservation Applied Research & Development (CARD) Webinar

October 25, 2022

Project Overcoat: Affordable High-Performance Enclosure Upgrades for Multifamily Buildings

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



Project Overcoat: Affordable High-Performance Enclosure Upgrades for Multifamily Buildings

COMMERCE DEPARTMENT
ENERGY RESOURCES



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Presenter Introductions



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Minnesota Applied Research & Development Fund

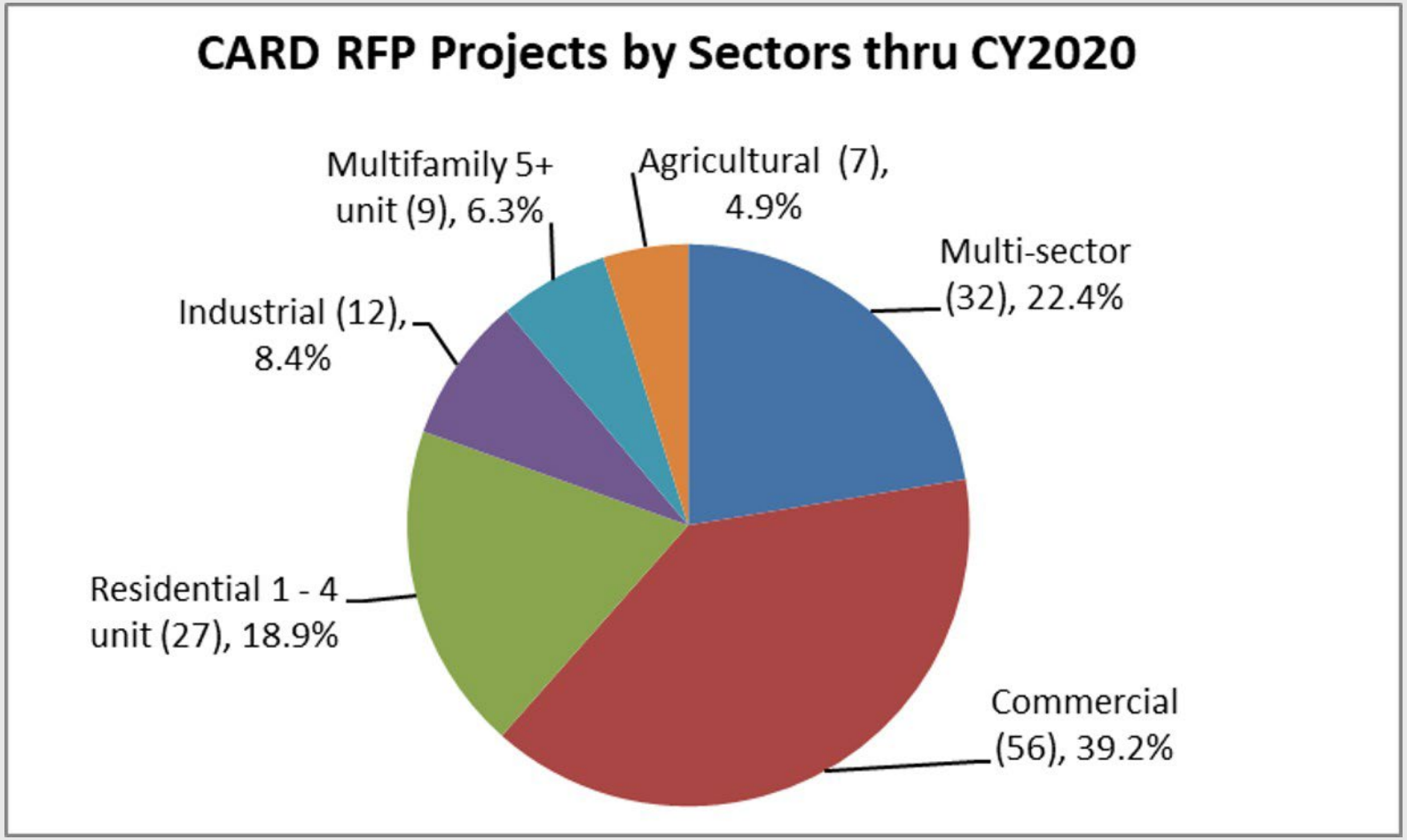
- **Purpose to help Minnesota utilities achieve 1.5% energy savings goal by:**
  - ***Identifying new technologies or strategies to maximize energy savings;***
  - ***Improving effectiveness of energy conservation programs;***
  - ***Documenting CO_2 reductions from energy conservation programs.***

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**

State Capitol Image: Courtesy Minnesota Department of Administration

CARD RFP Spending by Sector thru FY2020



RFP Summary

- 12 Funding Cycles
- 513 proposals
- 143 projects funded
- $31.2 million in research



Project Overcoat

Investigation of a Process for Affordable High-Performance Enclosure Upgrades for Multifamily Buildings

CSBR
Center for Sustainable Building Research

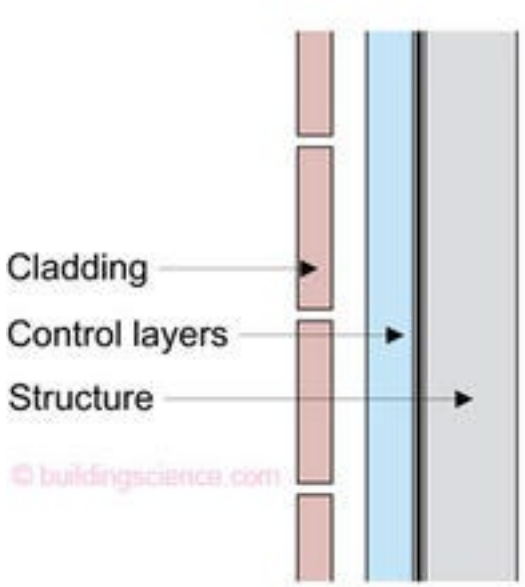
slipstream

Agenda

- Background
- Overcoat Panel System
- Determining Candidates for Retrofit
- Building Characteristics
- Modeled Results and Savings
- Questions and Discussion

History and Development

2010: “The Perfect Wall”

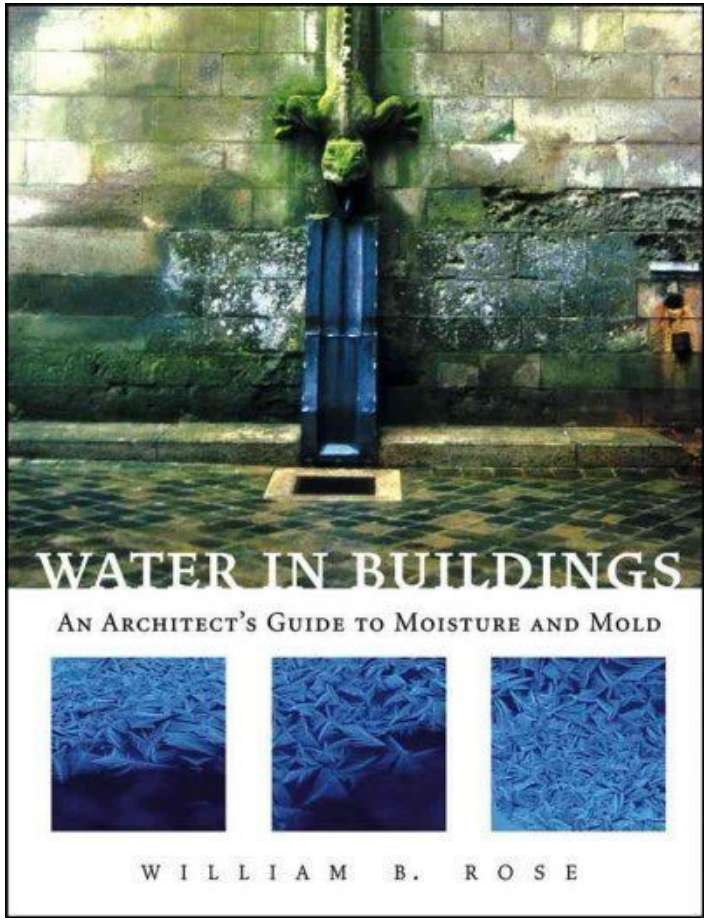


https://www.buildingscience.com/documents/insights/bsi-001-the-perfect-wall

Pre-2010: Fifty-ish years of development

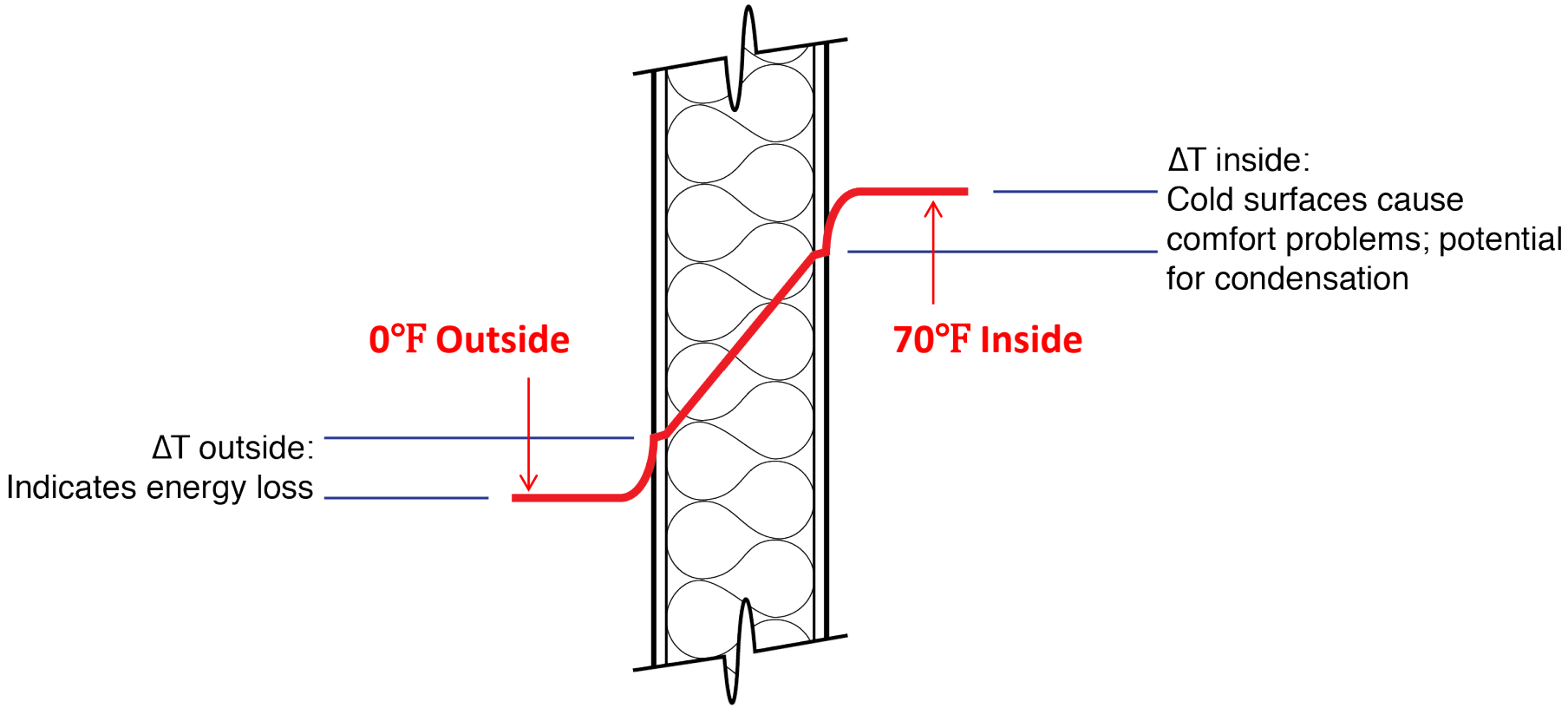
- PERSIST
  Pressure Equalized RainScreen Insulation Structure Technique
- REMOTE
  Residential Exterior Membrane Outside insulation TEchnique
- ETMMS
  Exterior Thermal and Moisture Management System

Perfect Wall for Moisture Control

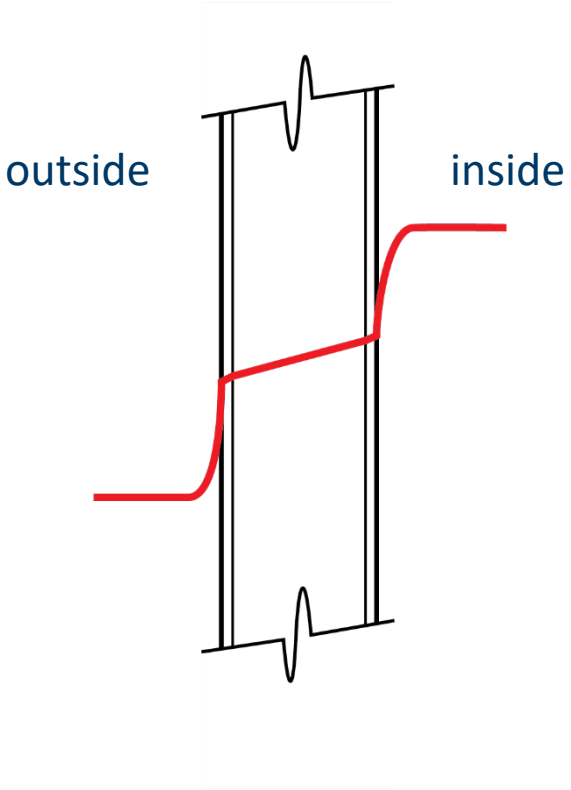


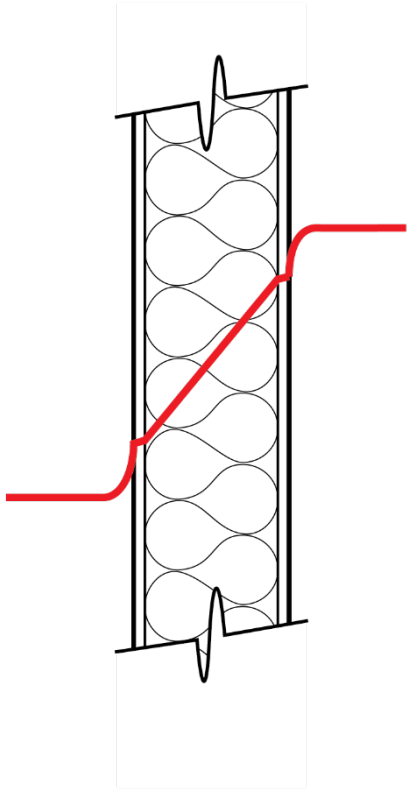
William Rose's Fundamental Rule of Material Wetness: ***Cold materials tend to be wet and warm materials tend to be dry.***

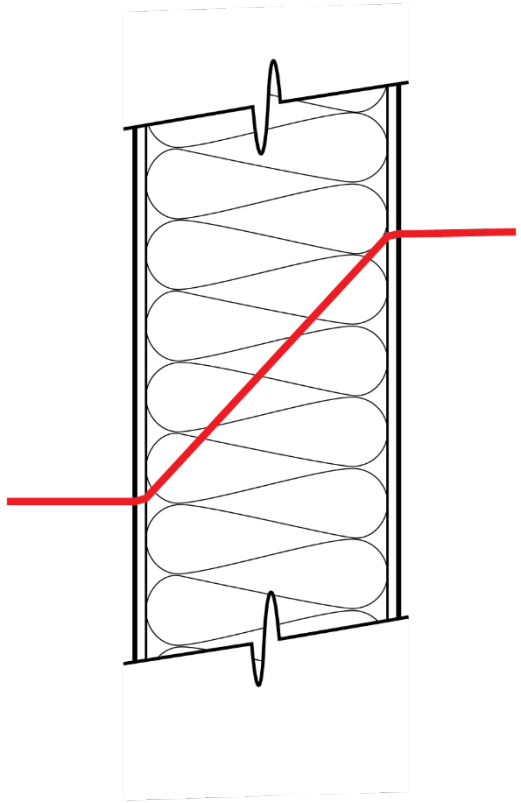
Wall Section Temperature Profiles



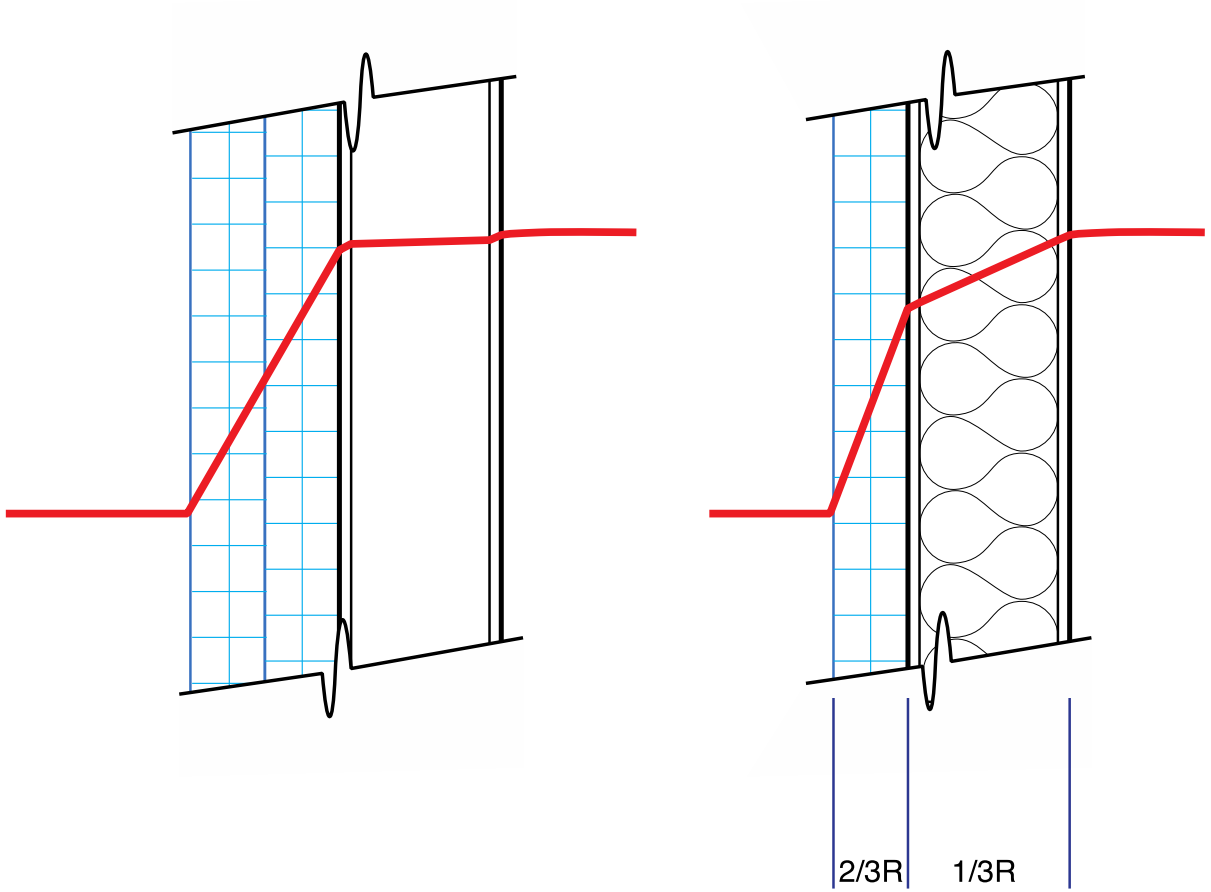
Cavity Insulation Temperature Profiles







Perfect Wall Temperature Profiles

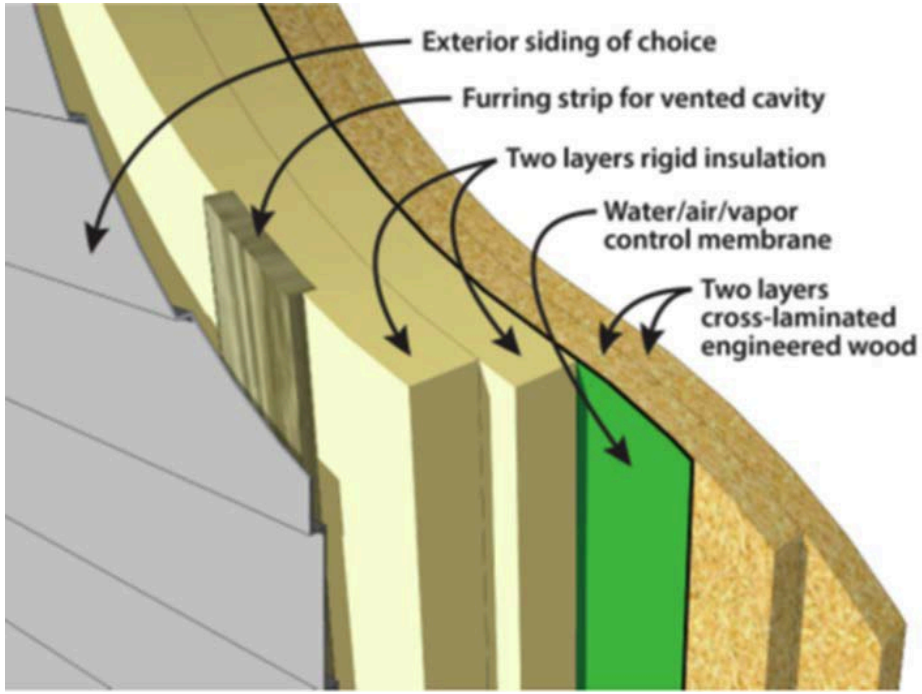


Additional benefits of the Perfect Wall:

- Reduces thermal bridging to near zero.
- Air barrier continuity is much easier to achieve.
- Works in any climate zone

2004-Current: U of M SEP-ETMMS (now SPS) Homes





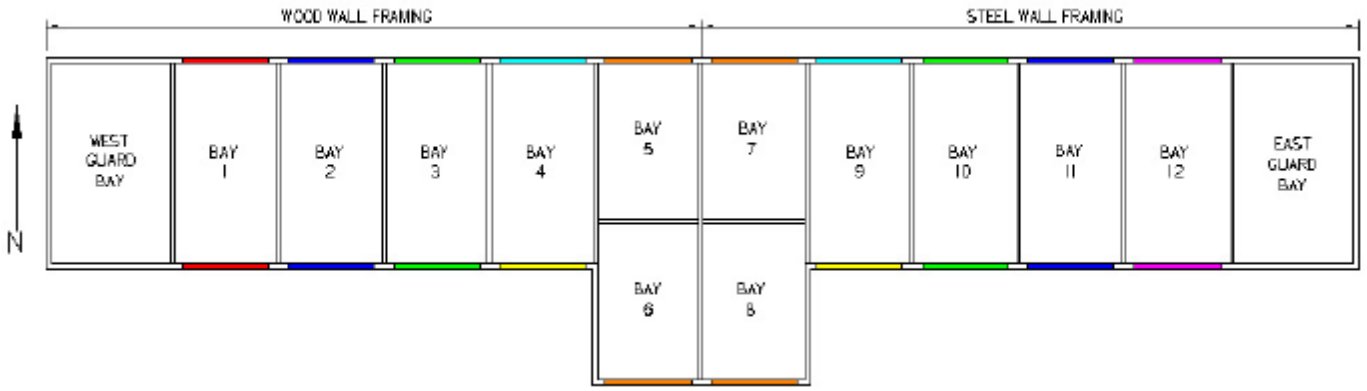
- Workforce Housing solution funded by Wilder Foundation
- “Studless” exterior walls built with two layers 1 1/8” OSB, 8’ x 24’ sheets
- Continued in 2014 with funding from DOE Building America Program, partnerships with Habitat for Humanity and Urban Homeworks.
- More than 18 homes and counting.

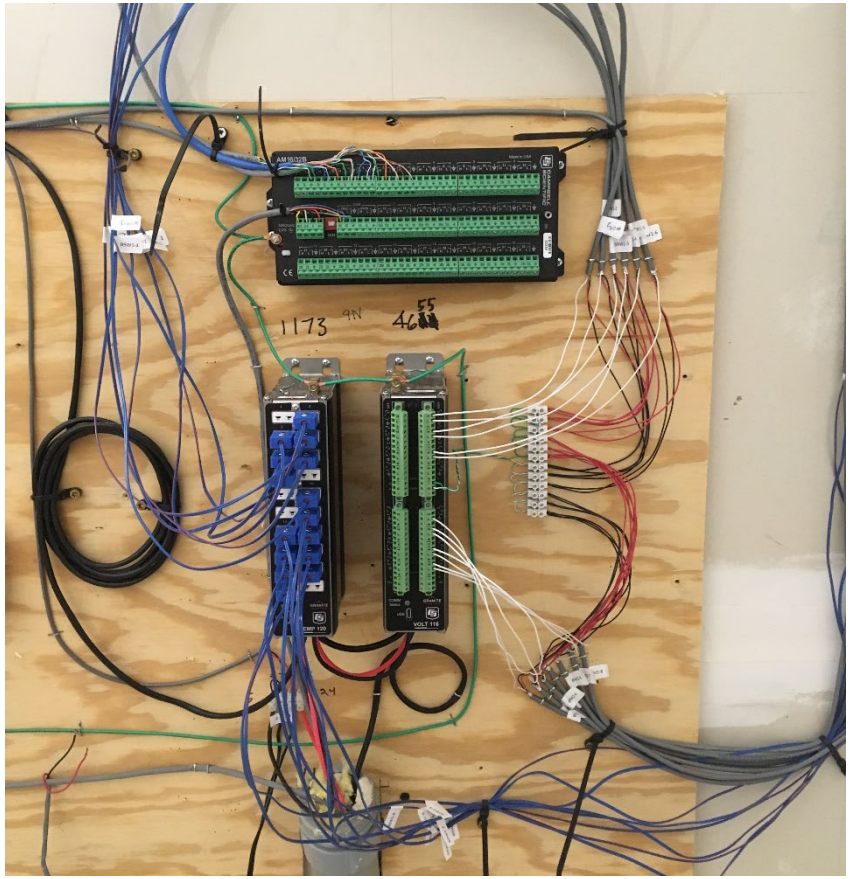
Retrofit Application: Testing at CRRF

2019-2021: PNNL study:

Wall Upgrades for Energy Retrofits: A Techno-Economic Study

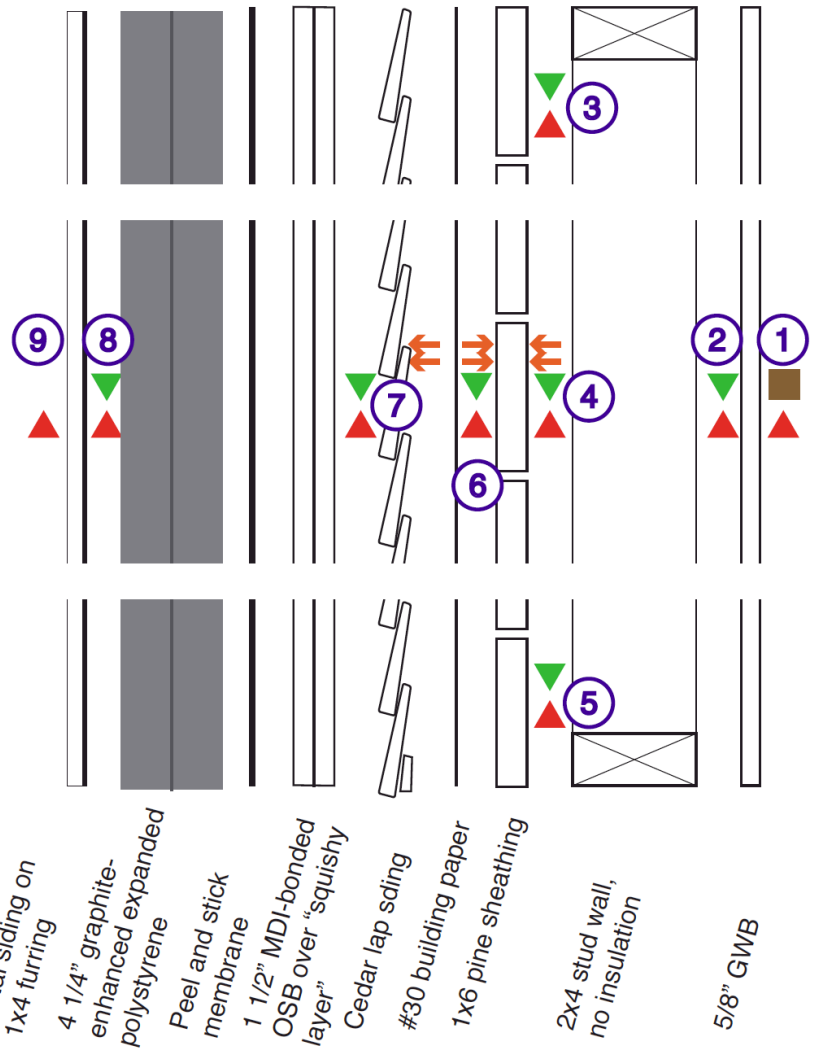


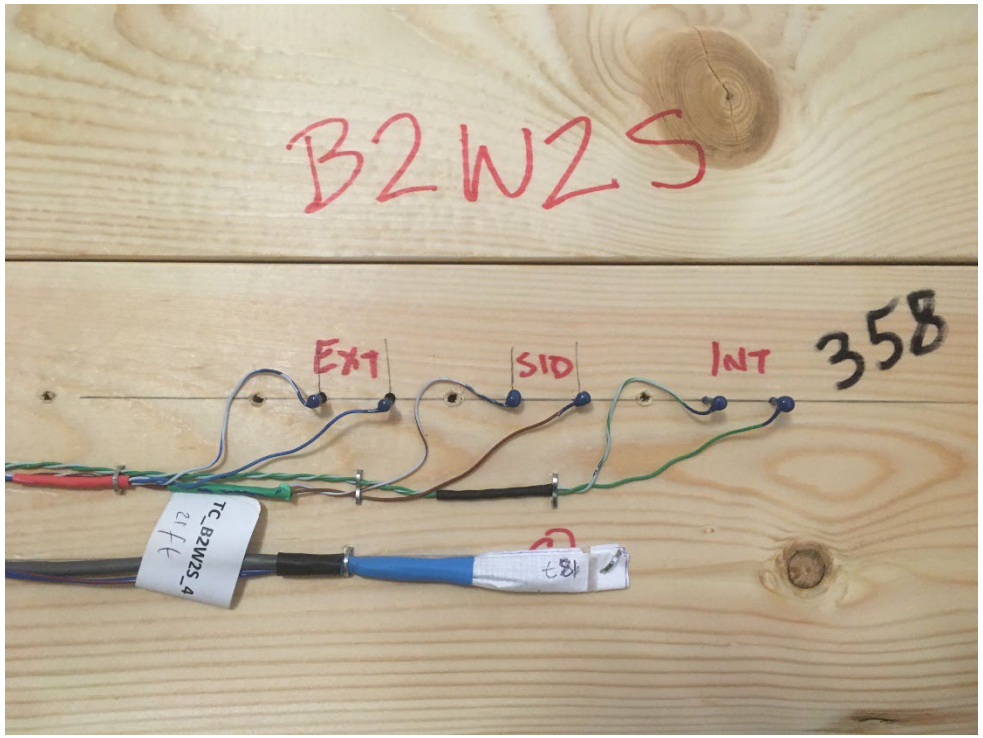




Retrofit Application: Testing at CRRF (continued_

- TC-Thermocouple temperature sensor
- RH-Relative humidity sensor
- MP-Pin-type moisture content sensor
- HF-Heat flux plate
- (#) Sensor position number

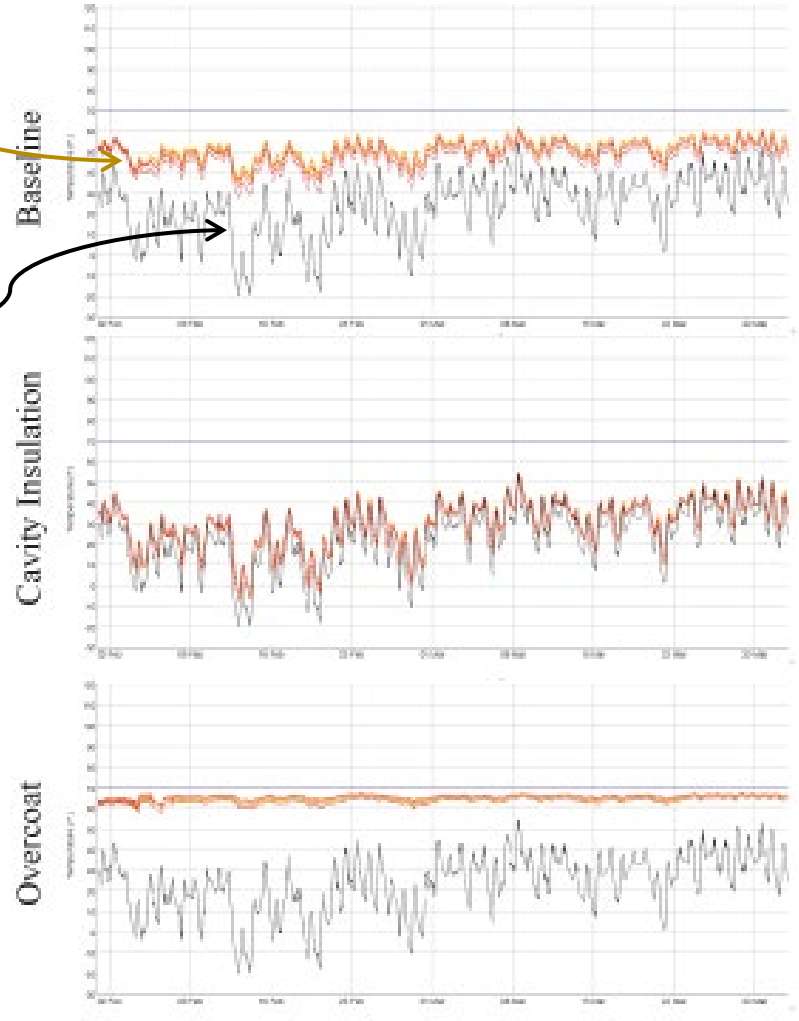




Results: Sheathing Temperature

Sheathing temperatures

Outdoor air temperature





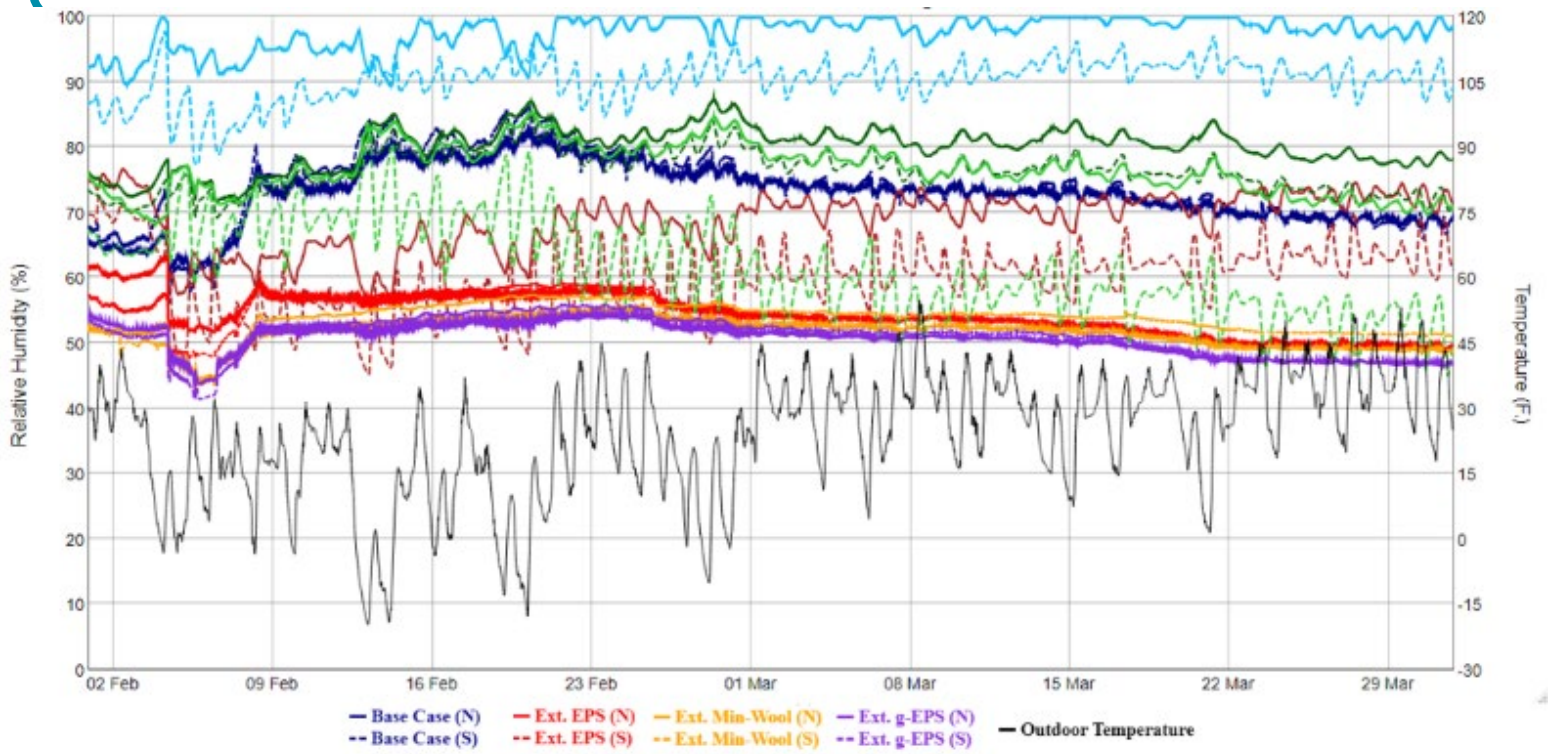
Results: Sheathing RH

Cavity insulation sheathing RH

Uninsulated sheathing RH

Exterior insulation sheathing RH

Outdoor air temperature



Deployment System: Energiesprong

EnergieSprong approach:

- Business model reduces risk for suppliers and consumers.
- 3-D Laser Scanning to measure the building
- CNC prefabricated overcladding panels to reduce thermal loads.
- New integrated mechanicals to meet reduced loads, ensure IAQ, and enable electrification.



genieclimatique.fr

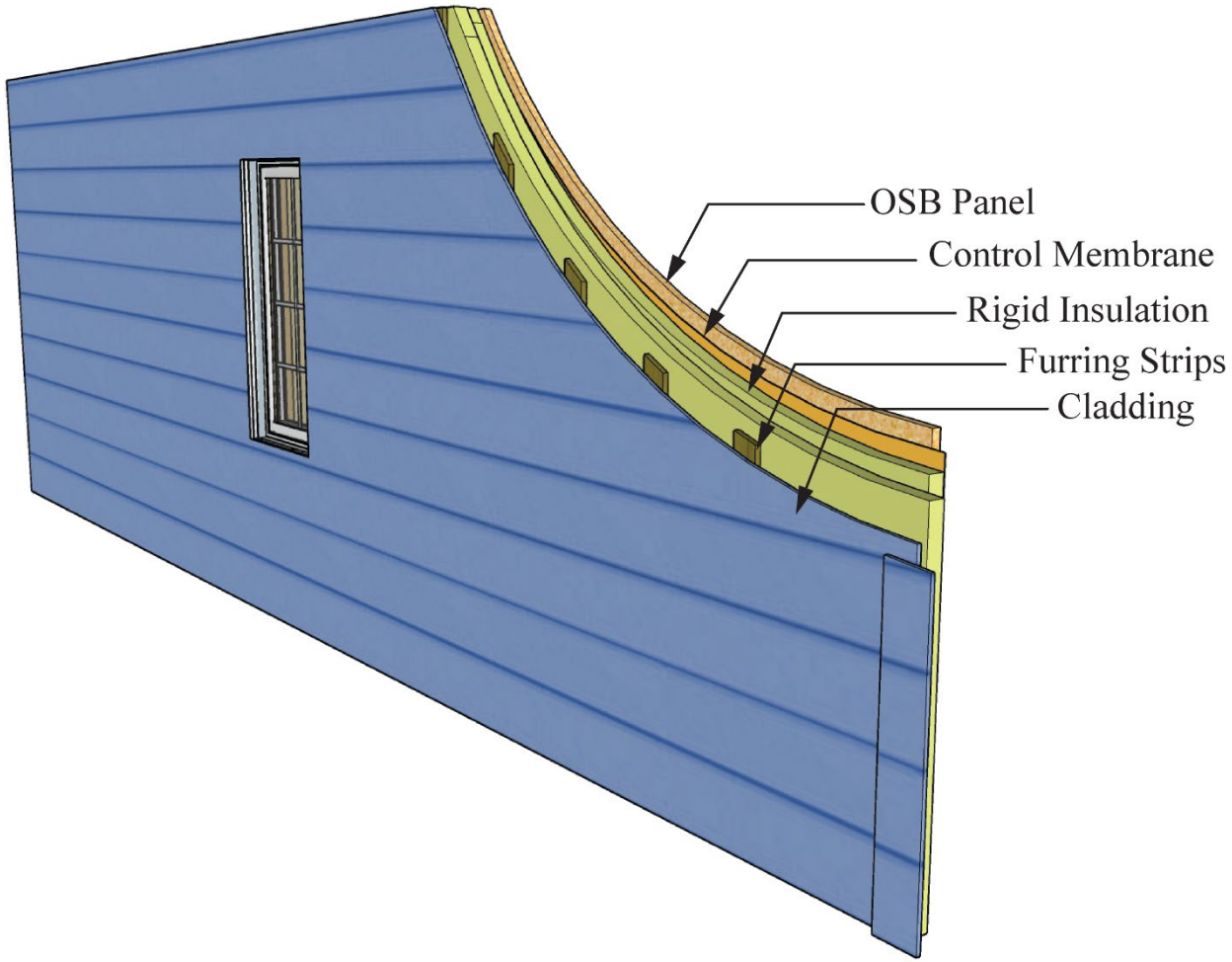


energiesprong.de

Agenda (2)

- Background
- **Overcoat Panel System**
- Determining Candidates for Retrofit
- Building Characteristics
- Modeled Results and Savings
- Questions and Discussion

Overcoat Panel - Assembly

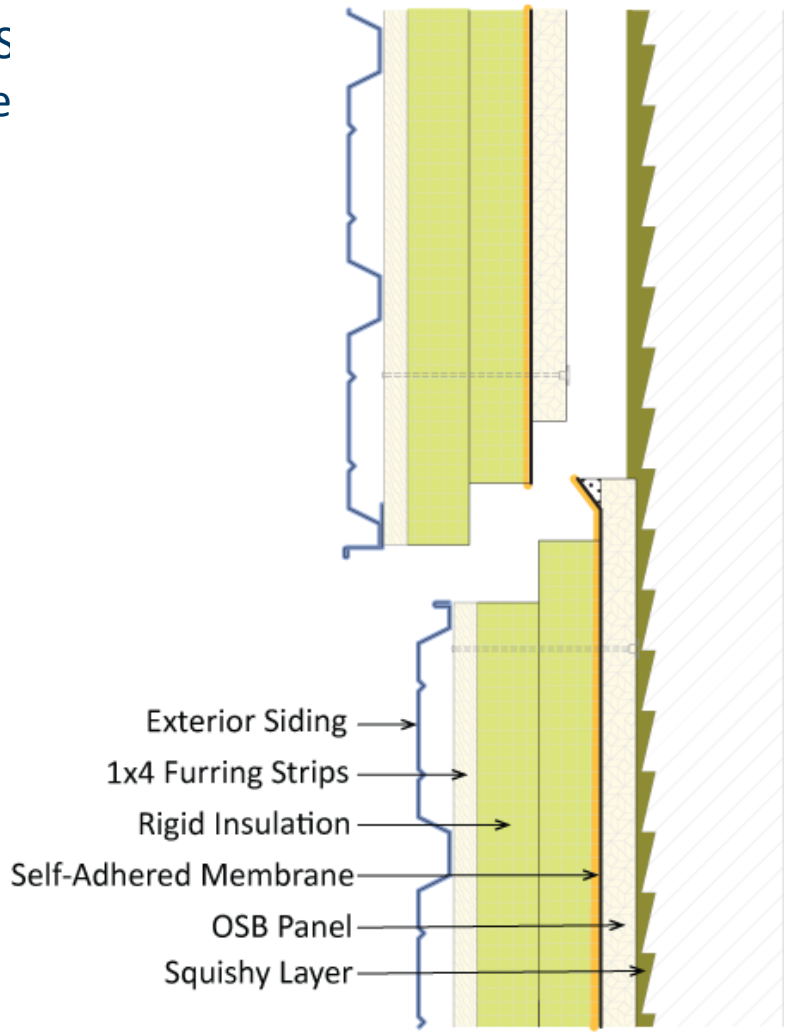


- Prefabricated panel with windows and doors installed
- Utilize large format Oriented Strand Board (OSB) to maximize panel size – 8’x24’



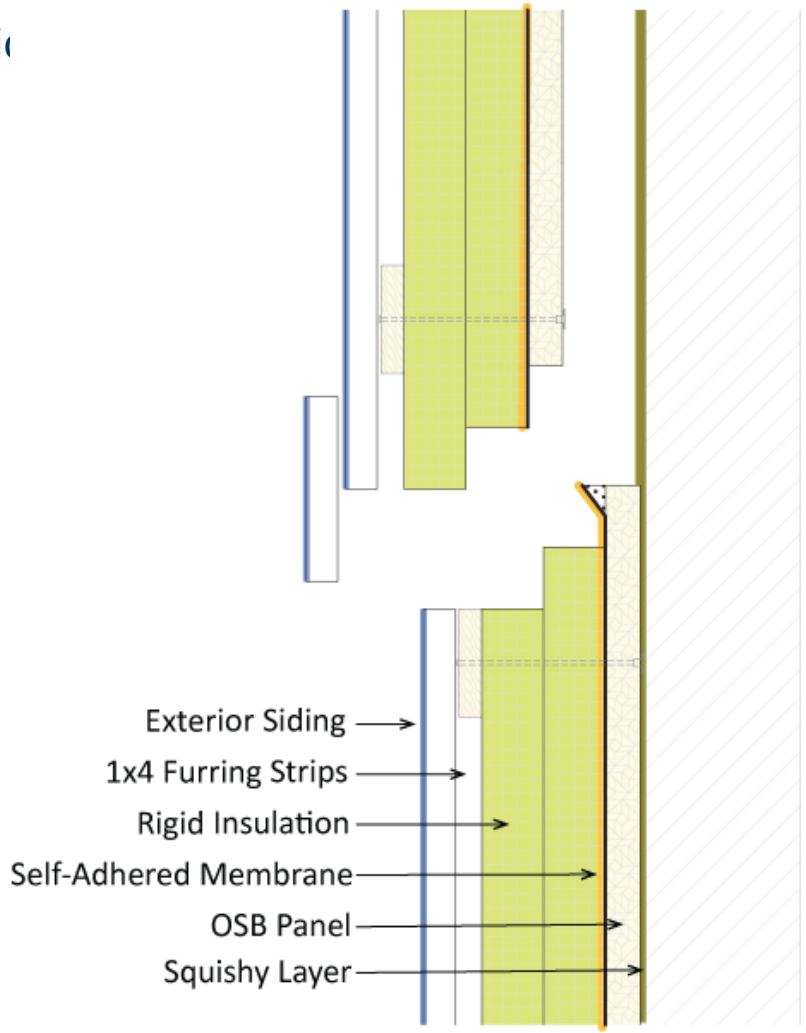
Overcoat Panel - Connection Details

- Panel Connection – S
- Staggered layers to e sealing
- Installs over existing



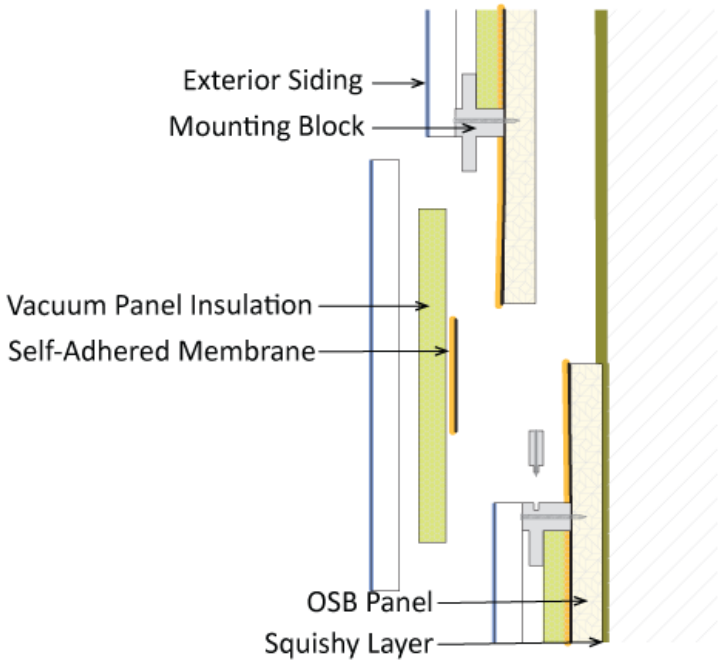


- Panel Connecti

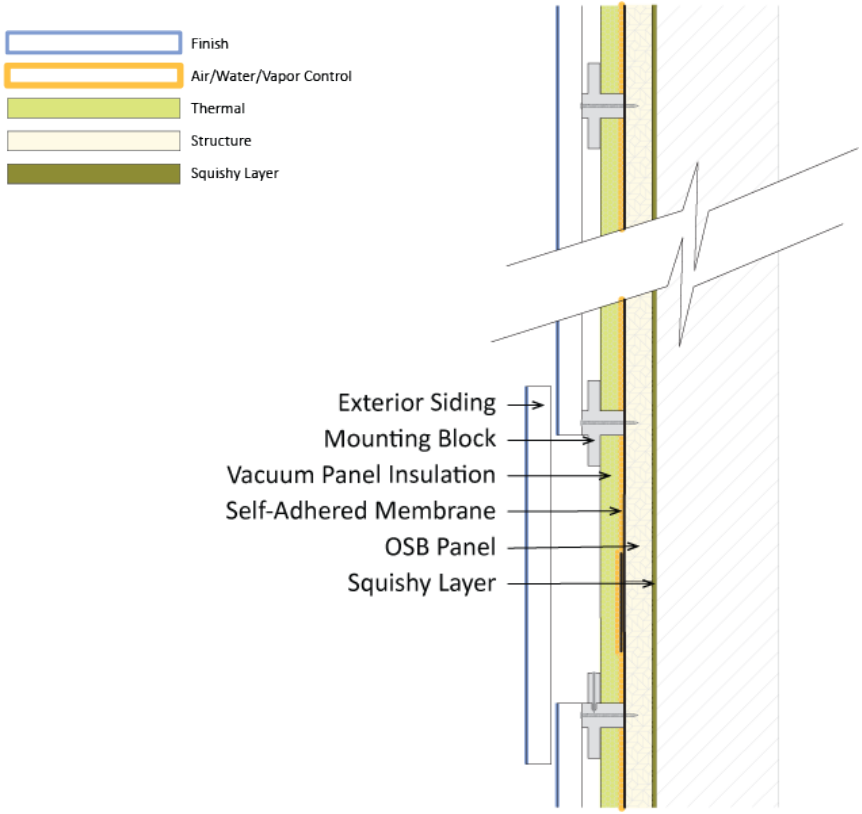


Overcoat Panel – Alternative Insulation – Plan View

- Highly insulating vacuum insulation panel (VIP) enables thinner overall panel construction
- VIPs are more fragile and cannot be punctured, so a modified installation sequence was developed to maintain air, water, vapor, and thermal performance

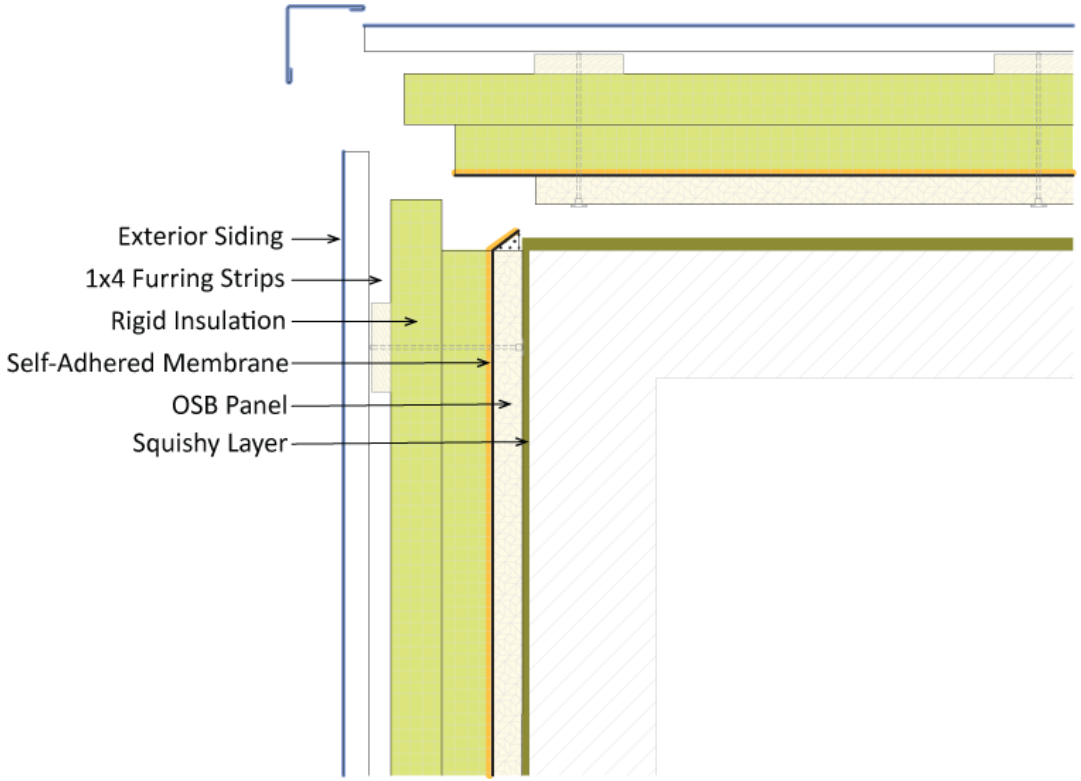


Overcoat Panel with VIP – Exploded Section

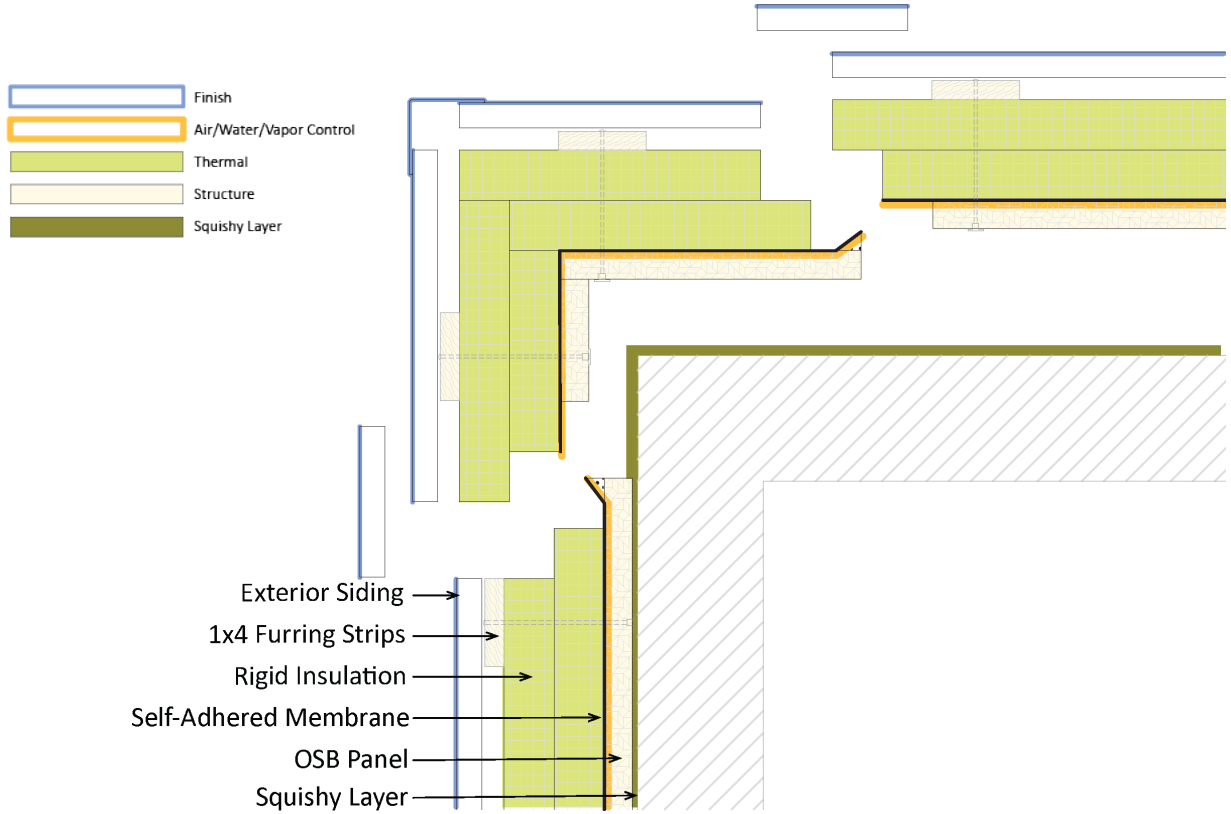


Overcoat Panel with VIP – Assembled Section

Overcoat Panel – “Blind” Outside Corner Details – Plan View



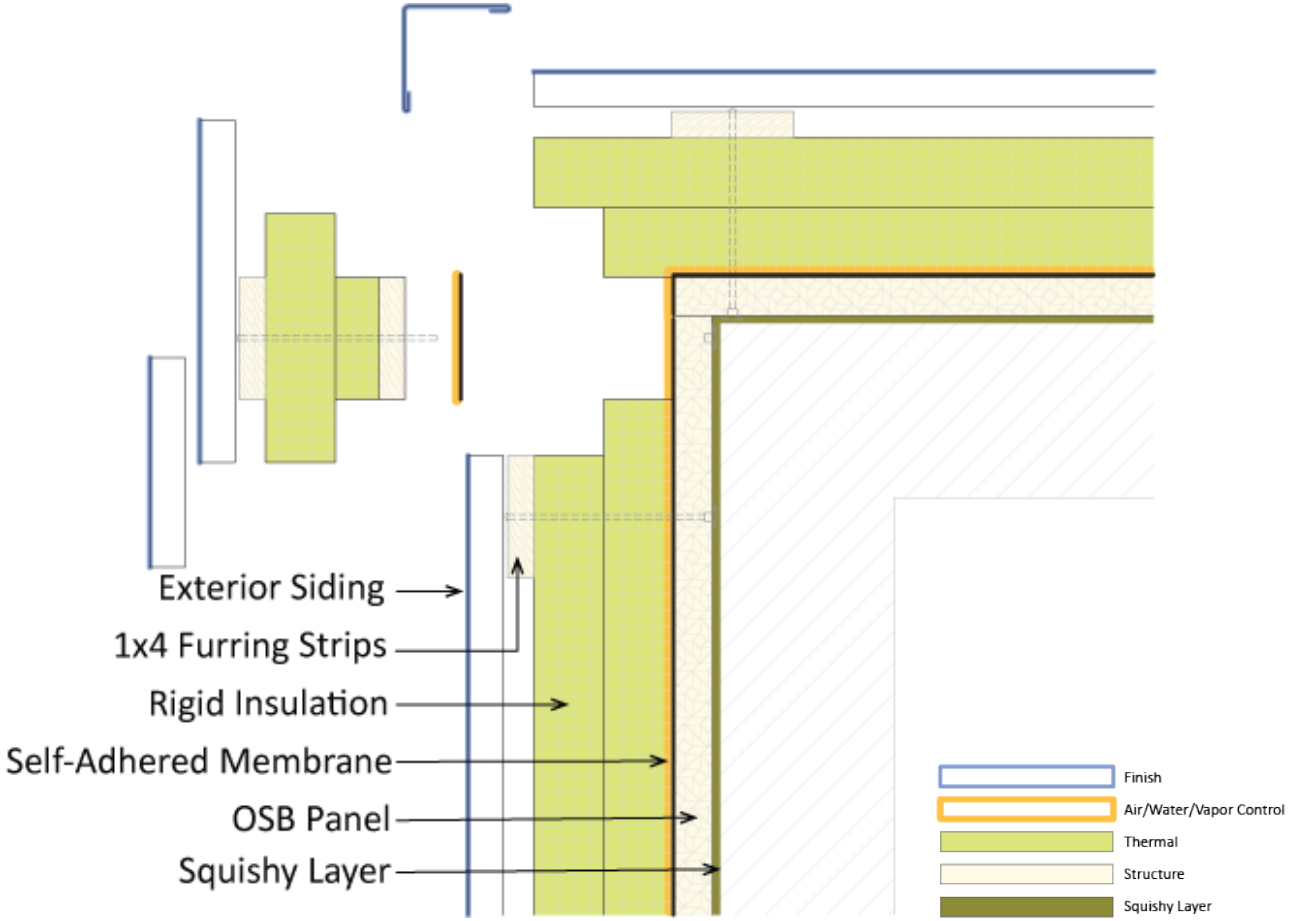
- Outer Corner Connection – Self Sealing
- Direct panel-to-panel connection



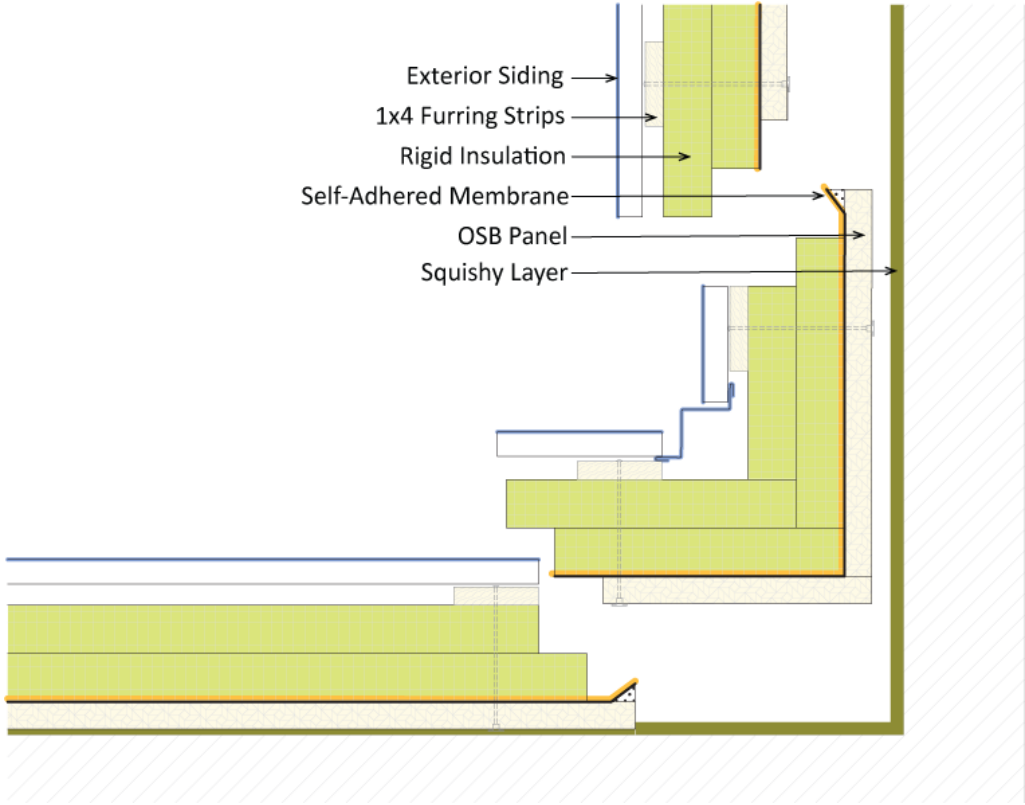
- Alternate Outer Corner Connection – Self Sealing
- Corner component

Overcoat Panel – “Open” Outside Corner Detail – Plan View

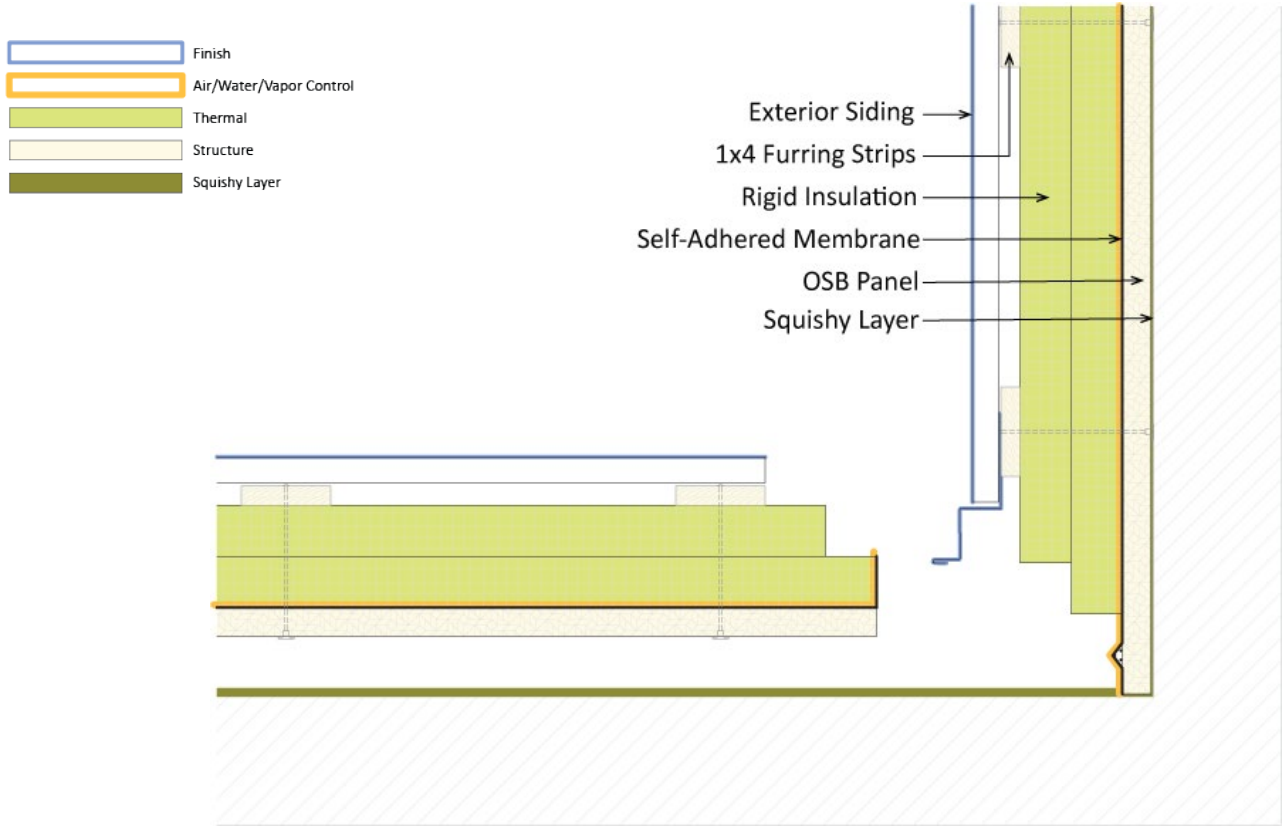
- Outer Corner Connection – Manually Sealed
- Field applied membrane and ‘plug’ component
- Staggered seams



Overcoat Panel - Inside Corner Details – Plan View



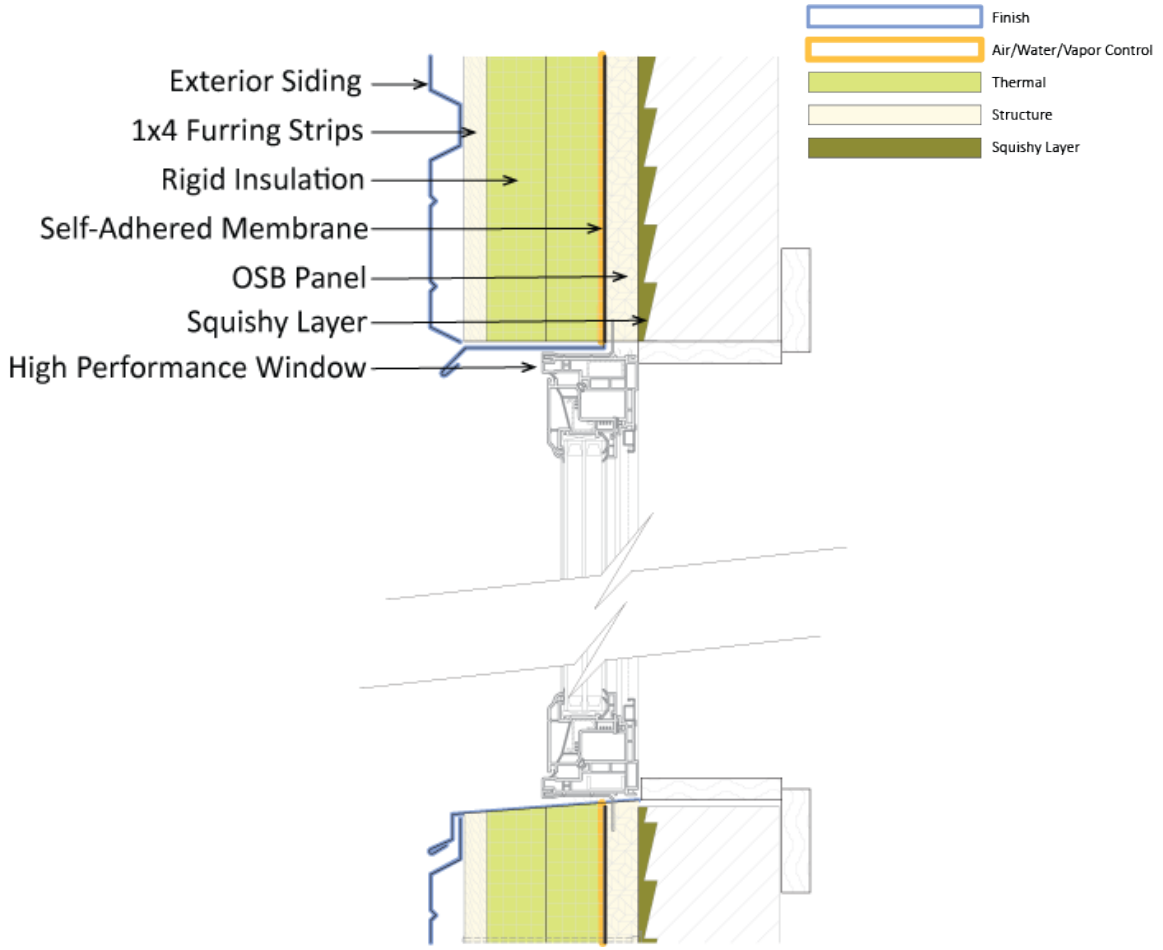
- Inner Corner Connection – Self Sealing
- Corner Component Piece



- Inner Corner Connection – Self Sealing
- Direct panel to panel connection

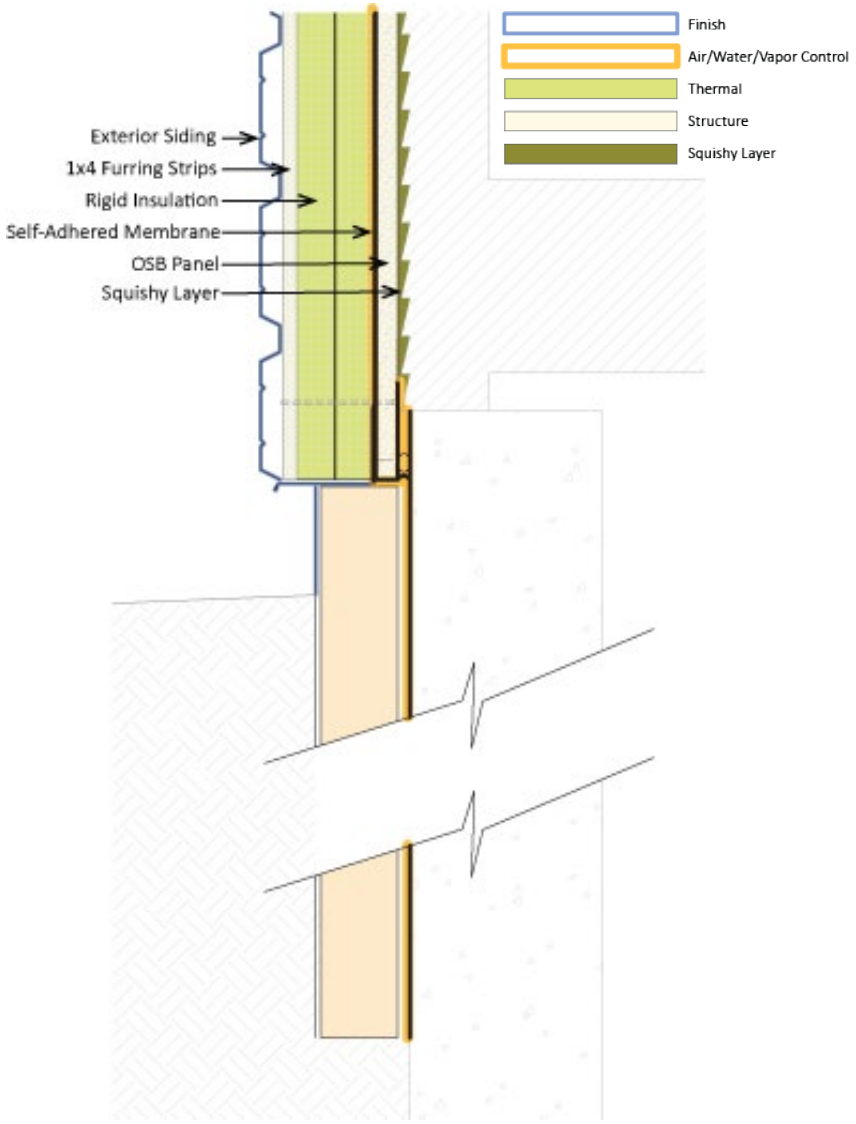
Overcoat Panel - Window Opening Detail – Section View

- Windows installed before panels arrive on site
- High efficiency windows to maintain thermal performance
- Blocking over existing wall creates deep sill



Overcoat Panel - Foundation Detail – Section View

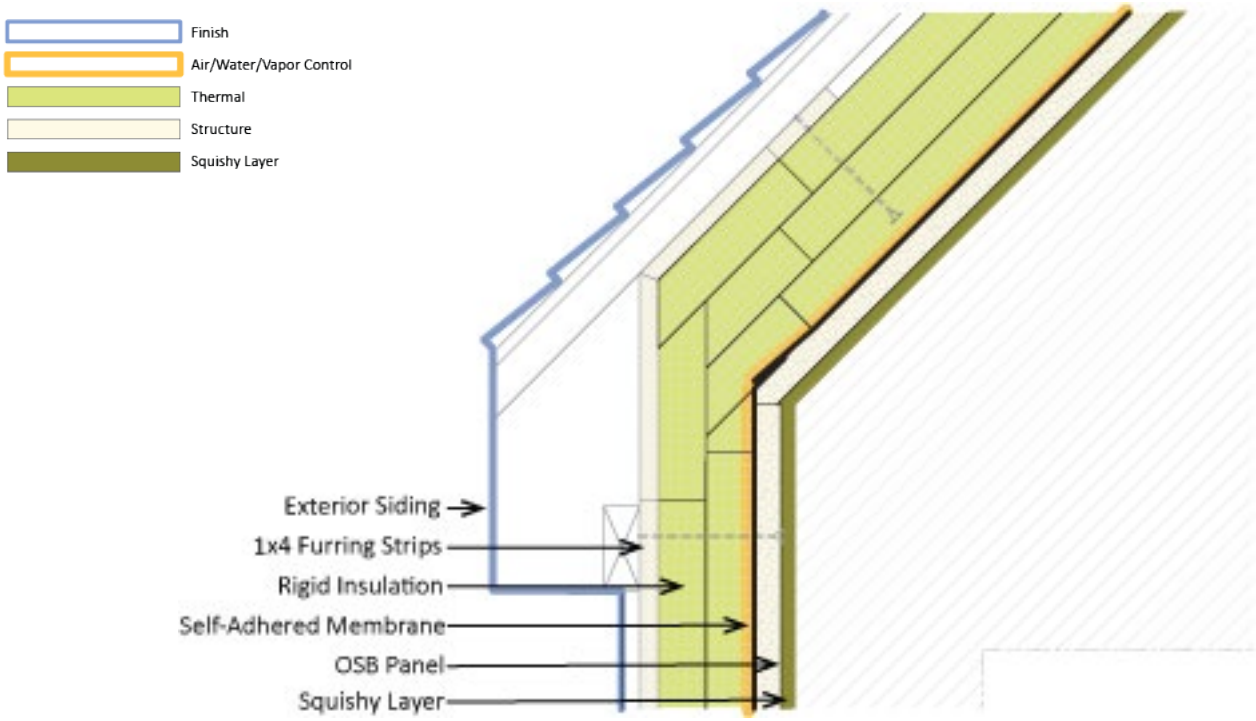
- Air, water, and vapor membrane extends below panel along existing foundation wall
- Rigid insulation installed below panel and extending down to frost line, at minimum
- Gasketing and seals at bottom of panel



Overcoat Panel – Story-and-a-Half– Section View

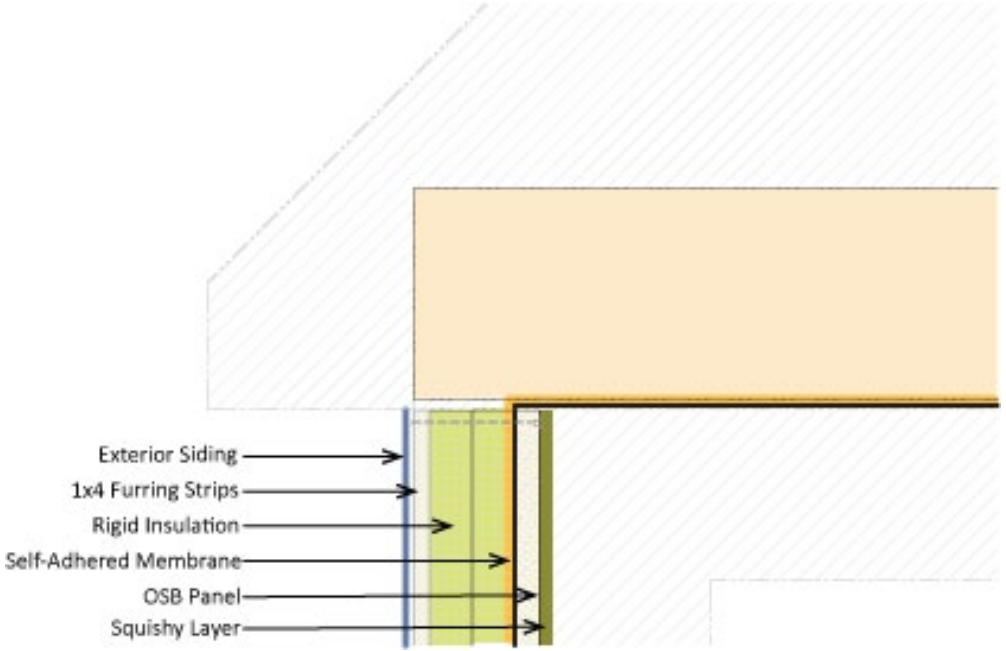


- Sloped roof panel with additional insulation
- Self-sealing with edge component piece

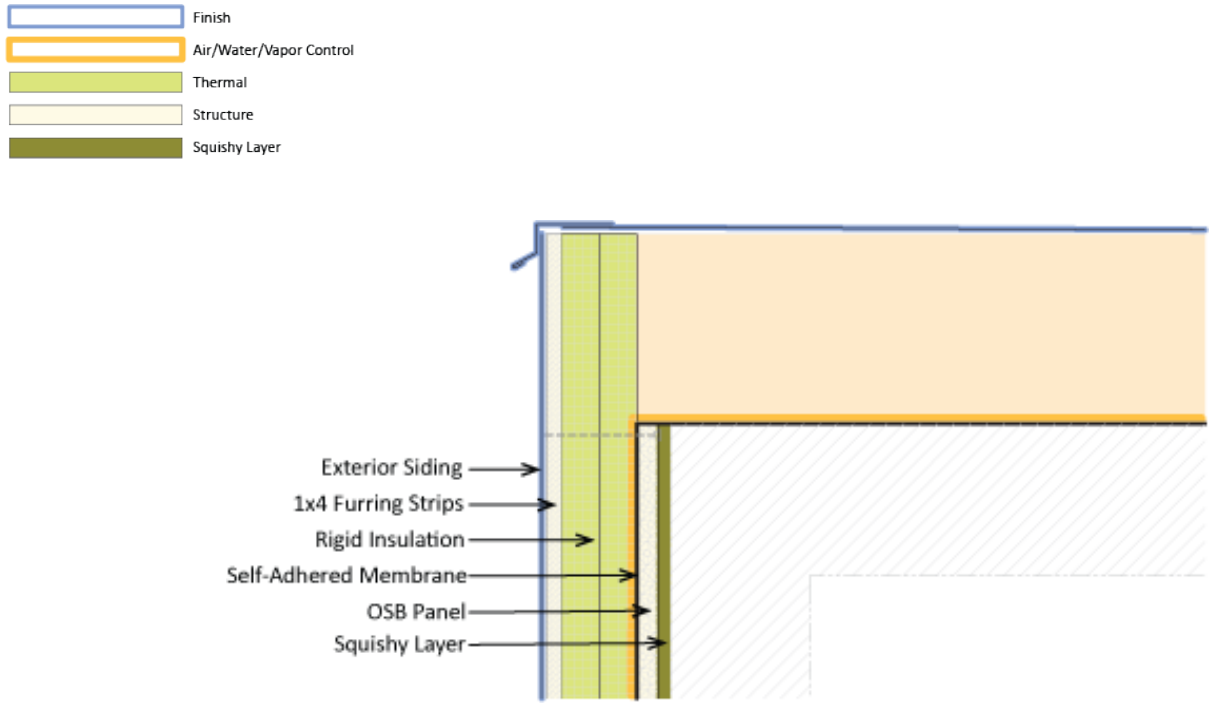


- New roof decking, roofing system, and soffits installed over roof and wall panels

Overcoat Panel – Roof Details – Section View

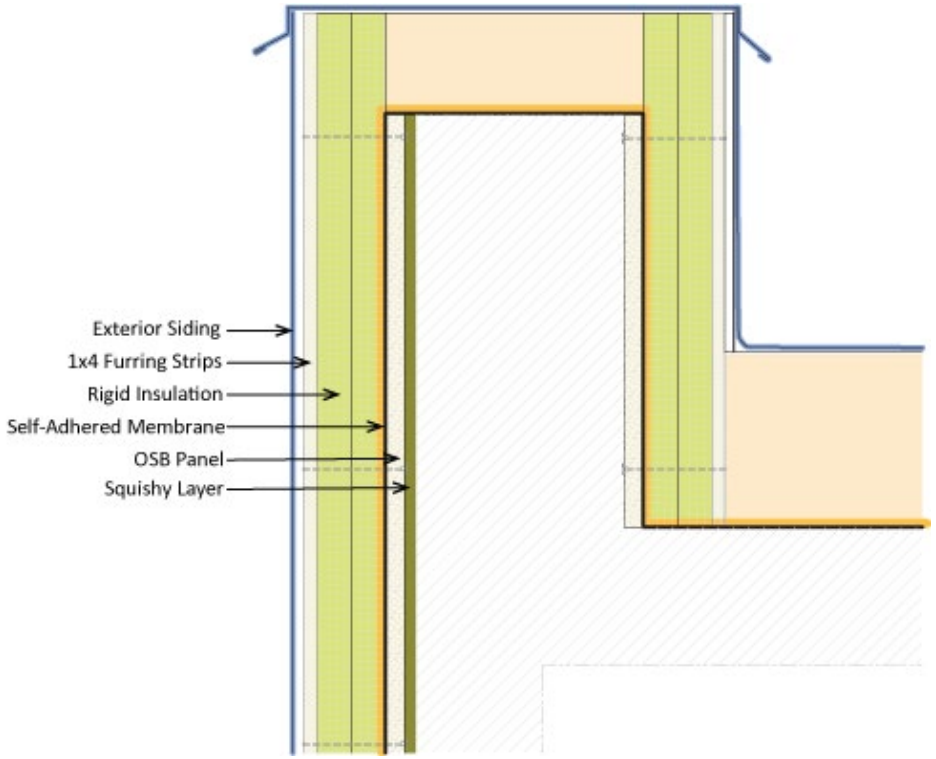


- Existing sloped roof, unconditioned attic
- Additional insulation installed at attic floor

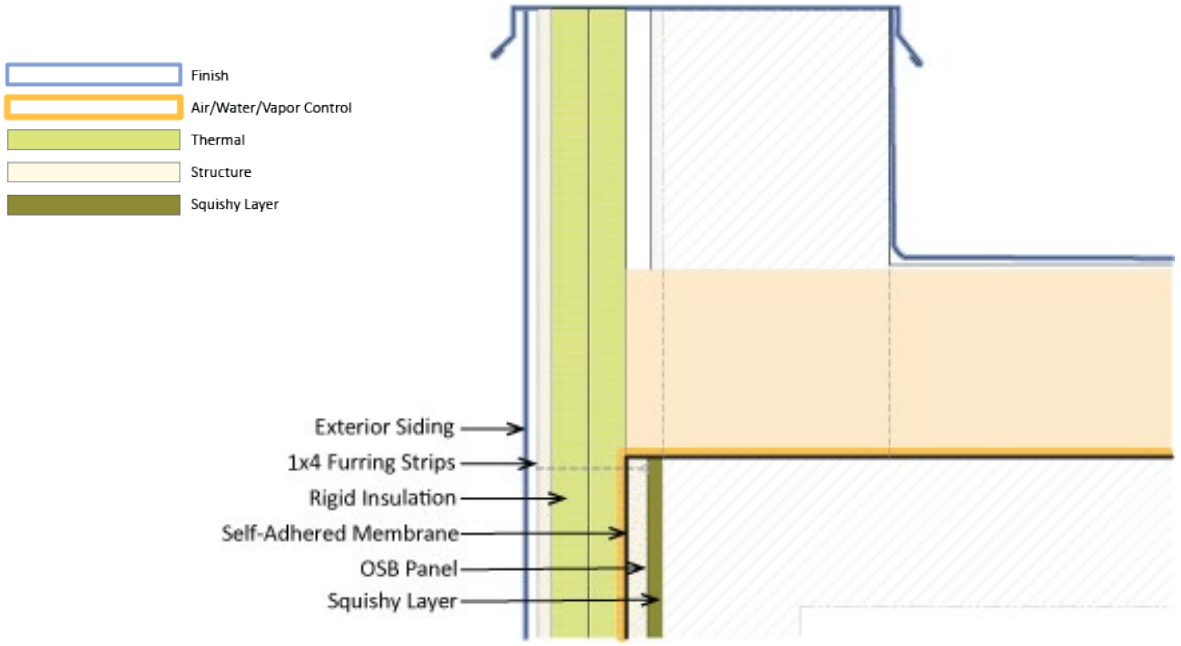


- Existing flat roof with no parapet
- Additional insulation installed below roofing system

Overcoat Panel – Roof Details (Continued) – Section View



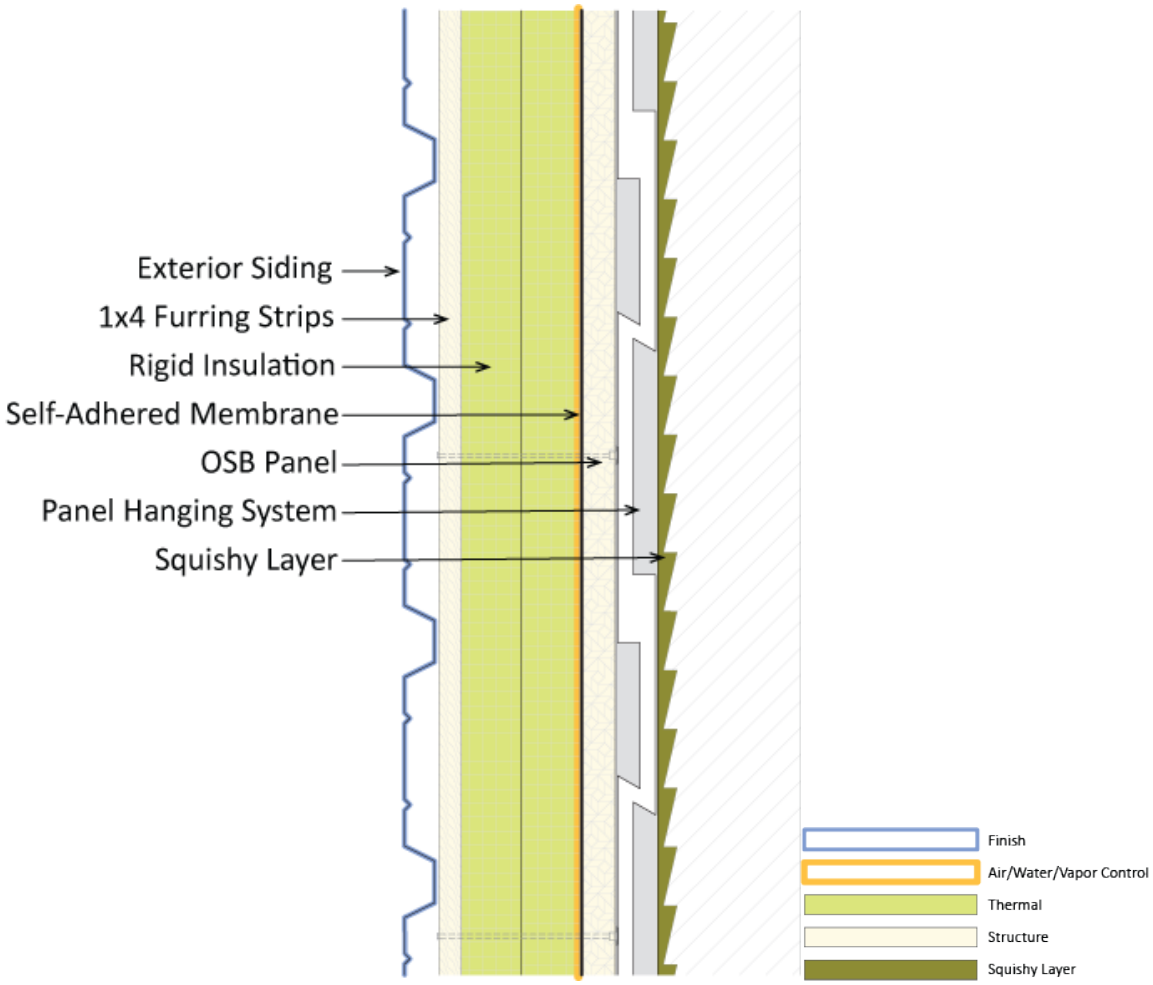
- Existing flat roof with parapet
- Parapet is clad in Overcoat Panels and additional insulation
- Appropriate for steel or masonry parapet structure



- Existing flat roof with parapet
- Additional insulation run through structure of parapet
- Appropriate for wood-framed parapet structure

Overcoat Panel – French Cleat – Section View

- Overcoat Panel hangs by French cleat affixed to existing wall structure to transfer vertical and horizontal loads to building



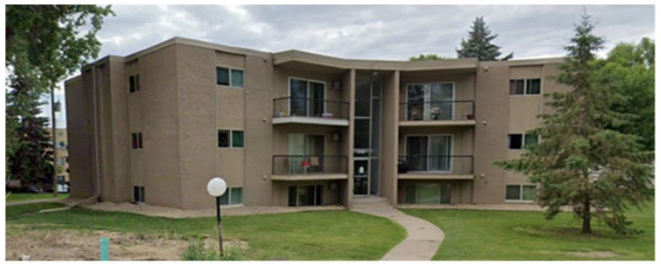
Agenda (3)

- Background
- Overcoat Panel System
- **Determining Candidates for Retrofit**
- Building Characteristics
- Modeled Results and Savings
- Questions and Discussion

What Makes a Good Candidate Building

Poor Candidates







Good Candidates







Required Alterations

Temporary Removal



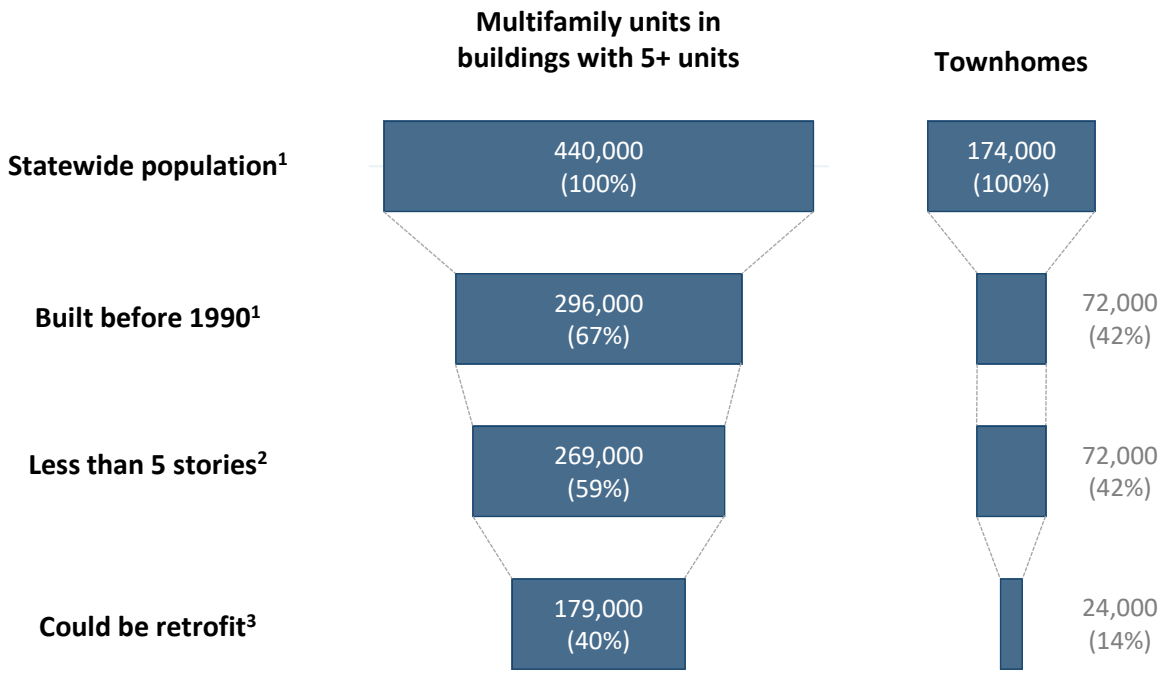
Permanent Removal



Item	% Properties with Observed Instance [g]
Sleeve air conditioner	60%
Drainpipe(s)	41%
Entry overhangs or awnings	37%
Exterior lighting	35%
Electric or gas service	25%
Wall venting (dryers, etc.)	22%
Satellite dishes	6%
Window shutters	4%

- Major architectural changes may occur on some buildings
- Mechanical, electrical, and plumbing systems need to be considered when overcladding

Housing Stock Analysis



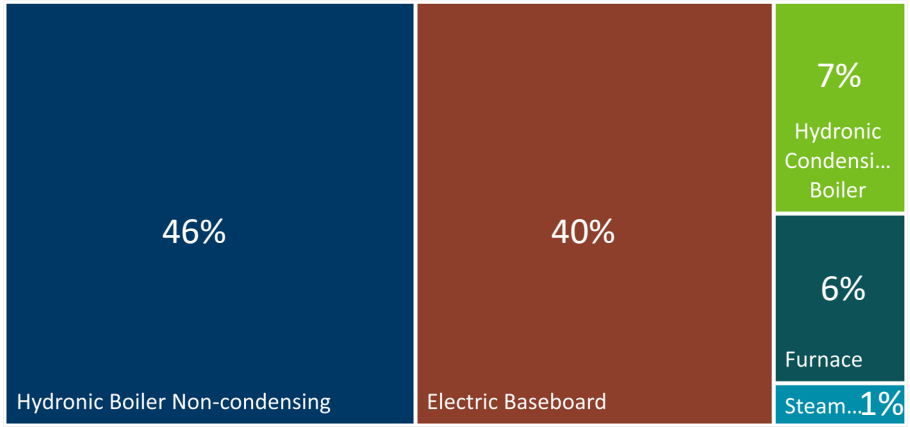
1. Source: 2015-2019 Census American Community Survey
2. Source: 2013 Minnesota Multifamily Rental Characterization Study
3. Based on visual review of Rental Characterization Study sample properties

Decade Built	Amenable to retrofit?*	
	Yes	No
<1940 (n=22)	64%	36%
1940s (n=4)	75%	25%
1950s (n=6)	67%	33%
1960s (n=28)	82%	18%
1970s (n=23)	70%	30%
1980s (n=8)	75%	25%

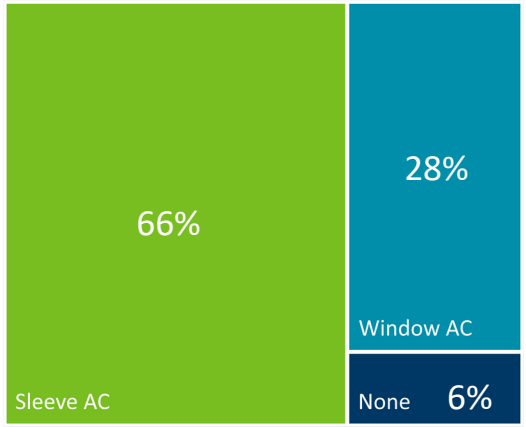
*Based on visual review of public imagery
Fischer's exact Chi-square: p=0.779

HVAC Impacts

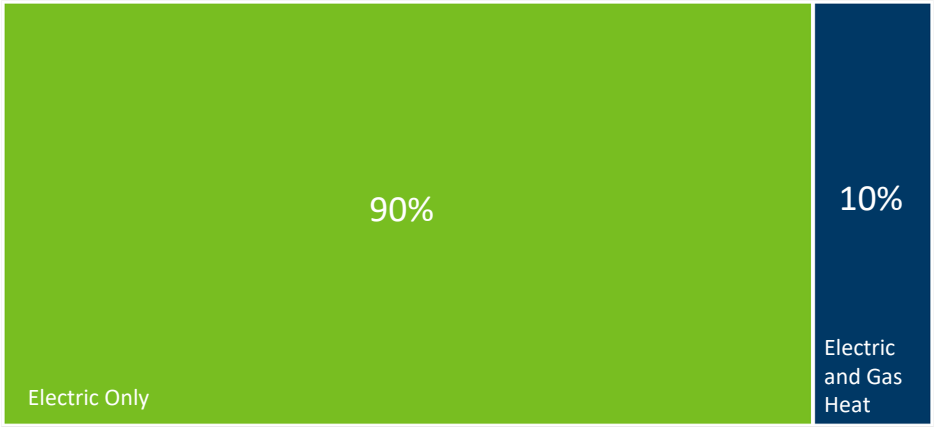
Heating System Breakdown



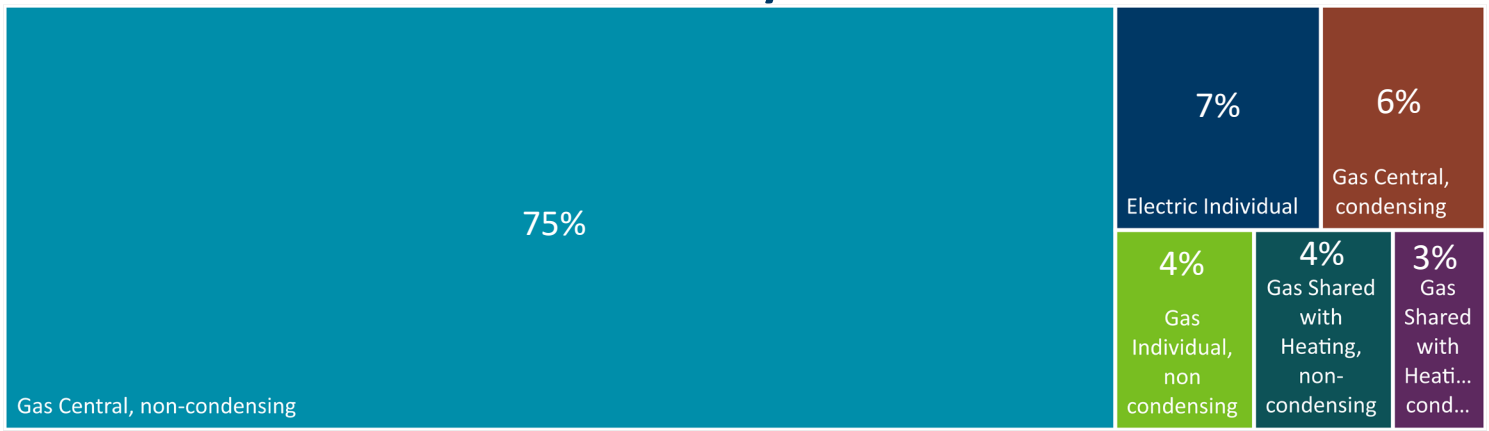
Cooling System Breakdown



What Bills Tenants Pay



Domestic Hot Water System Breakdown



- Even mix between electric and gas heating
- Majority of homes use window or sleeve AC units which need to be switched to a non-envelope degrading system
- Exhaust of flue gases should be considered with non-condensing systems due to significant infiltration reductions
- Metering of heating systems may change if heat pumps are incorporated

Agenda (4)

- Background
- Overcoat Panel System
- Determining Candidates for Retrofit
- **Building Characteristics**
- Modeled Results and Savings
- Questions and Discussion

Prototypical buildings

Building #1



Building #3



Building #2



Building #4



HVAC Parametrics

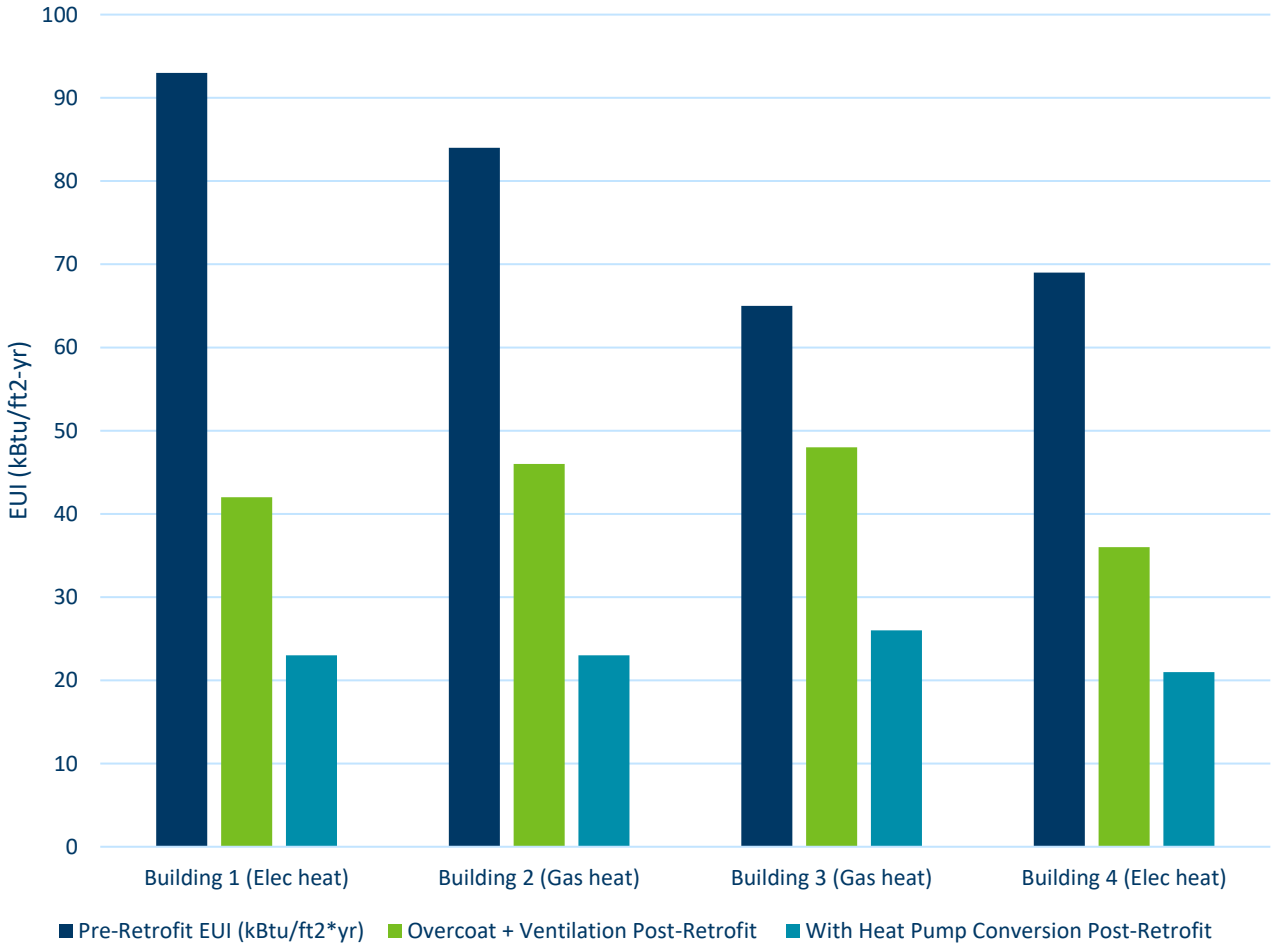
Existing Prototypical Configurations and Upgrades

	Building 1	Building 2	Building 3	Building 4	Upgrades
Building Area (ft2)	5,000	9,100	58,600	22,000	-
Number of Stories	3	2	3	3	-
Number of Units	5	8	123	23	-
Exterior Wall Construction	Standard wood frame, no insulation [h]	Standard wood frame, no insulation [h]	Brick cavity wall, no insulation [h]	Standard wood frame, no insulation [h]	R-20 or R-30 overcladding, installed over existing wall
Alternate Exterior Wall Construction	Standard wood frame with R-13 batt insulation	Standard wood frame with R-13 batt insulation	n/a	Standard wood frame with R-13 batt insulation	
Roof Construction	6-inch batt insulation (R-19)	12-inch loose fill insulation (R-30)	6-inch batt insulation (R-19)	6-inch batt insulation (R-19)	R-60 insulation
Window Type	Single pane (U = 1.05, SHGC = 0.86)[i]	Single pane (U = 1.05, SHGC = 0.86)[i]	Single pane (U = 1.05, SHGC = 0.86)[i]	Single pane (U = 1.05, SHGC = 0.86)[i]	Triple pane (U=0.2, SHGC=0.34)
Infiltration	4-6 Air Changes Per Hour @50 Pa	4-6 Air Changes Per Hour @50 Pa	4-6 Air Changes Per Hour @50 Pa	4-6 Air Changes Per Hour @50 Pa	1 air change per hour @50 Pa
HVAC System	Electric baseboards with through-wall air conditioners [j]	Hot water boiler [k] with through-wall air conditioners [j]	Hot water boiler [k] with through-wall air conditioners [j]	Electric baseboards with through-wall air conditioners [j]	Same As Baseline Retrofit with mini-split heat pumps
Ventilation	Bath fan only	Bath fan only	Bath fan only	Bath fan only	75 cfm in-unit balanced ventilation with energy recovery ventilator

Agenda (5)

- Background
- Overcoat Panel System
- Determining Candidates for Retrofit
- Building Characteristics
- **Modeled Results and Savings**
- Questions and Discussion

Energy Impacts



- All buildings had a >45% reduction in energy use with just overcoat and an ERV
- The inclusion of heat pumps in-lieu of electric resistance or gas heat improved EUI savings up to 75% to 60%
- Energy savings translated into utility cost savings more impactful for electrically heated buildings
- Each of these buildings also now have the potential with heat pumps to be net zero ready with EUIs less than 30 allowing for solar offsets

Savings and Cost Summary

	Floor Area (ft2)	Enclosure Area (ft2)	Overcoat Panel System cost [n]	Mechanical Cost [o]	Total Cost	Annual Energy Cost Savings	Simple Payback (years)
Building 1 (Electric heat baseline)	5,000	7,750	$162,750	$125,000	$287,750	$12,800	22
Building 2 (Gas heat baseline)	9,100	11,080	$232,680	$227,500	$460,180	$4,459	103
Building 3 (Gas heat baseline)	58,600	40,450	$849,450	$1,465,000	$2,314,450	$15,236	152
Building 4 (Electric heat baseline)	22,000	22,750	$477,750	$550,000	$1,027,750	$39,380	26

n) $21 / square foot of enclosure

o) $25 / square foot of floor space

Conclusions

- The Overcoat Panel System offers a building-science based solution for overcladding existing buildings. Radical reductions in building energy use follow.
- Due to the decreased thermal loads, and increased air tightness, mechanical systems must be upgraded at the same time.
- Costs for the system are currently estimated as being very high, likely precluding retrofit in buildings heated with natural gas
- Innovative business models are needed to stimulate demand and then supply.
- Pilot projects are needed to refine panel details.

Questions?

Project Overcoat: Affordable High-Performance Enclosure Upgrades for Multifamily Buildings



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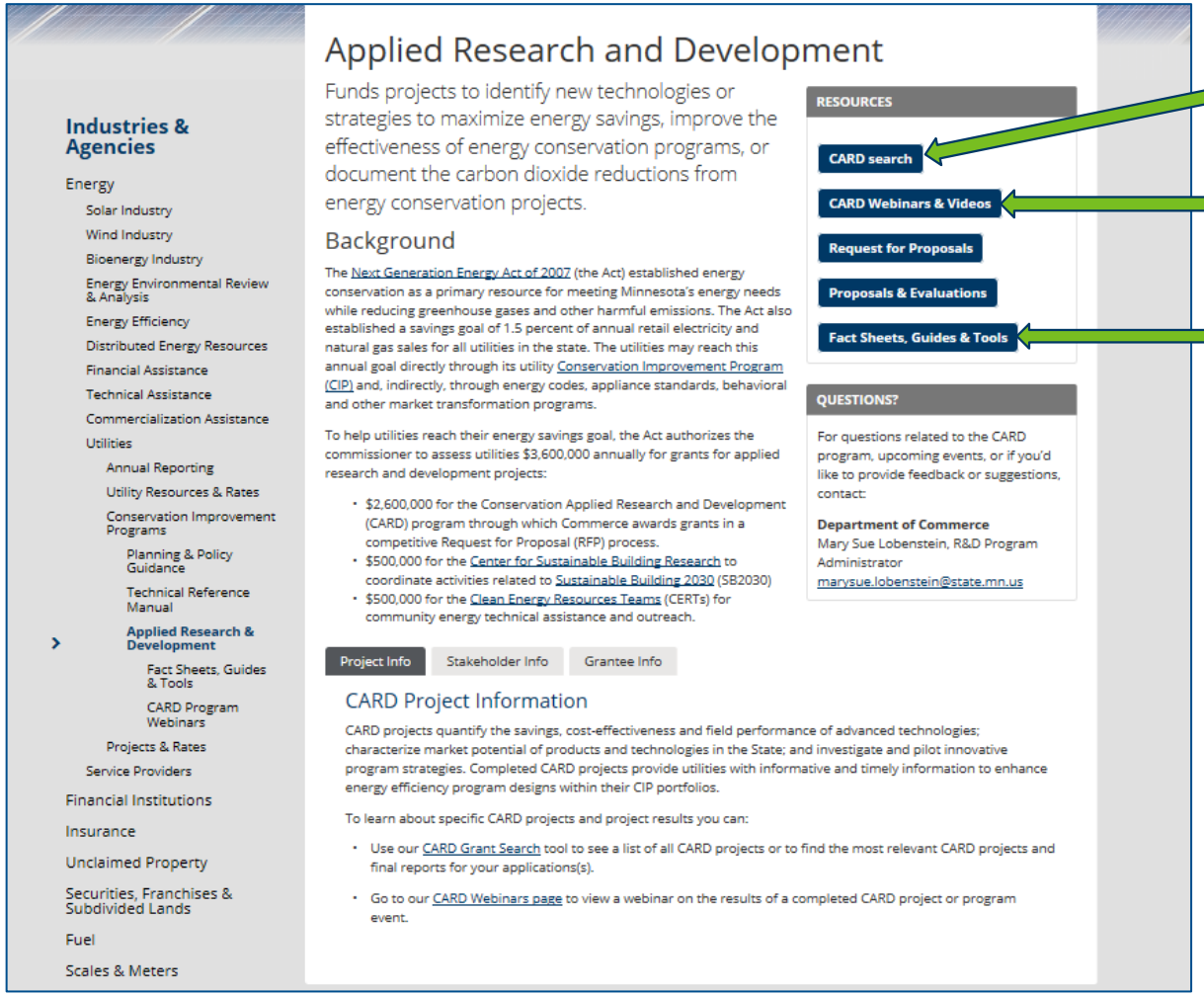
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Send us your questions using the Q&A panel

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

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

Thanks for Participating!

Upcoming CARD Webinars:

- **December 7, 2022**: Econometric – How do HVAC Contractors Make Decisions?

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

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Let us know how we did today!

