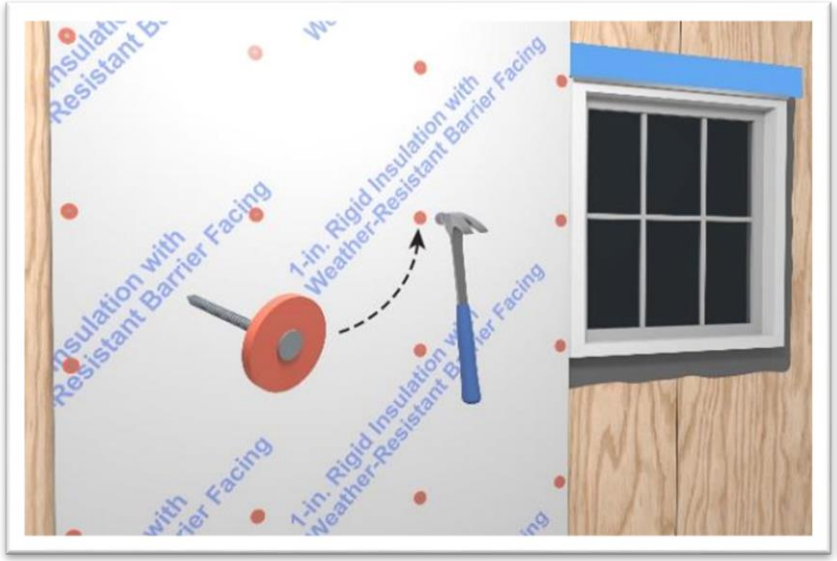
Adding Insulation when Re-Siding (AIRS)



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1.2.2.72 AIRS (Formerly Residential Façade Upgrades) (adjacent to 1.4.2.3 AIRS Campaign)
PNNL-SA-184007

Project Summary

Objectives and Outcomes

- Develop **refined installation guidance** by documenting a range of retrofit wall and window details **as implemented in the field** by cooperating contractors
- Document the **real and perceived value** of the AIRS energy upgrade and identify **key decision points**
- Identify implementation **challenges and research gaps to help remove barriers** for wide-scale adoption

Re-siding contractors are a prime entry point to widescale adoption of exterior continuous insulation (ext. c.i.) and air sealing.

Photo credit: Del Ramey, Flikr

Team:

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NJIT | Christine Liaukus

Partners:

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Green River, LLC, TN
Hight on Homes, MD
Energy Home Inspection, NC
Appalachia Service Project
Jerusalem Farms
Mr. Roof, TN

Stats

Performance Period: FY21–FY24

DOE FY23 Budget: $450k, Official Cost Share: $0k

M1: Durability test matrix development

M2: Draft AIRS installation guidance

M3: Finalize recommendations for campaigns

M4: Draft marketing material and edu. content

M5: Draft technical report

Problem – Decision-Making

Homeowners DO upgrade their homes' exteriors! In 2021[1],

- ~3.5M homeowners spent money on siding projects
- ~4B sq. ft. of exterior siding for re-siding projects alone

But, very few projects added 1-in or more of exterior continuous insulation[1]

What prevents the addition of thermally-robust insulation when re-siding?

- **PUSH** (Marketing) = Contractors, retailers, manufacturers, utility energy program implementers
  - ✓ May not know the upsell opportunity
  - ✓ May not understand added value compared to additional effort and cost
  - ✓ May lack skill or knowledge
  - ✓ May fear liability

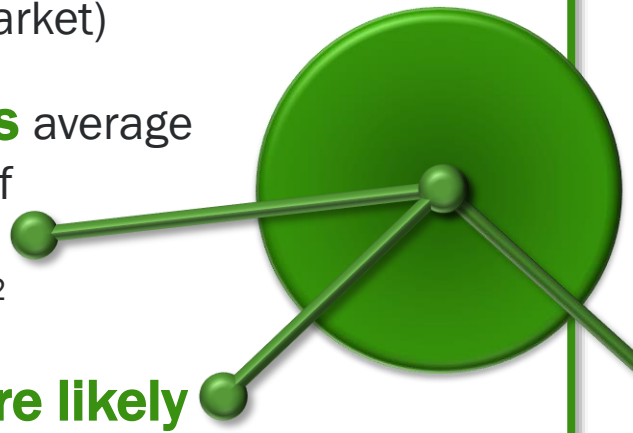
- **PULL** (Demand) = Homeowners, building owners, utility energy program implementers
  - ✓ May not realize potential comfort improvements—noise, draft, and surface temps
  - ✓ May not know savings opportunity
  - ✓ May worry about cost

[1] Guidehouse, Residential Wall Insulation Retrofit Market Research Study, November 2021
[2] The Harris Poll, to answer the question, "Why Are Americans Updating Homes with Siding?"
Additional Sources: Home Innovation Labs Survey; Exploring Homeowners' Insulation Activity, 2015; and stakeholder interviews

Problem – Re-Siding and Insulating Practices

Only about 10% of re-siding projects in 2021 added 1-in or more of ext. c.i.

- **50%** added fan-fold
- **3-5%** insulated siding (total market)
- **8 years** average length of owning a home[2]
- **3x more likely** to re-insulate their walls upon move-in than any other year they live in the home



One manufacturer's homeowners survey[1]

- **39%** cited damage as the reason for replacement
- **36%** sought to increase their home's curb appeal
- **32%** hoped to boost their home's energy efficiency
- **32%** wanted to reduce maintenance

53% have had new siding installed!

Some cohort of homeowners will be familiar with the basic concepts – leverage that!

[1] The Harris Poll, for Alside: "Why Are Americans Updating Homes with Siding?" [2] Susan Meyer, The Zebra, https://www.thezebra.com/resources/home/average-length-of-homeownership/#infographic

Alignment and Impact – Nationwide Goals and Opportunity

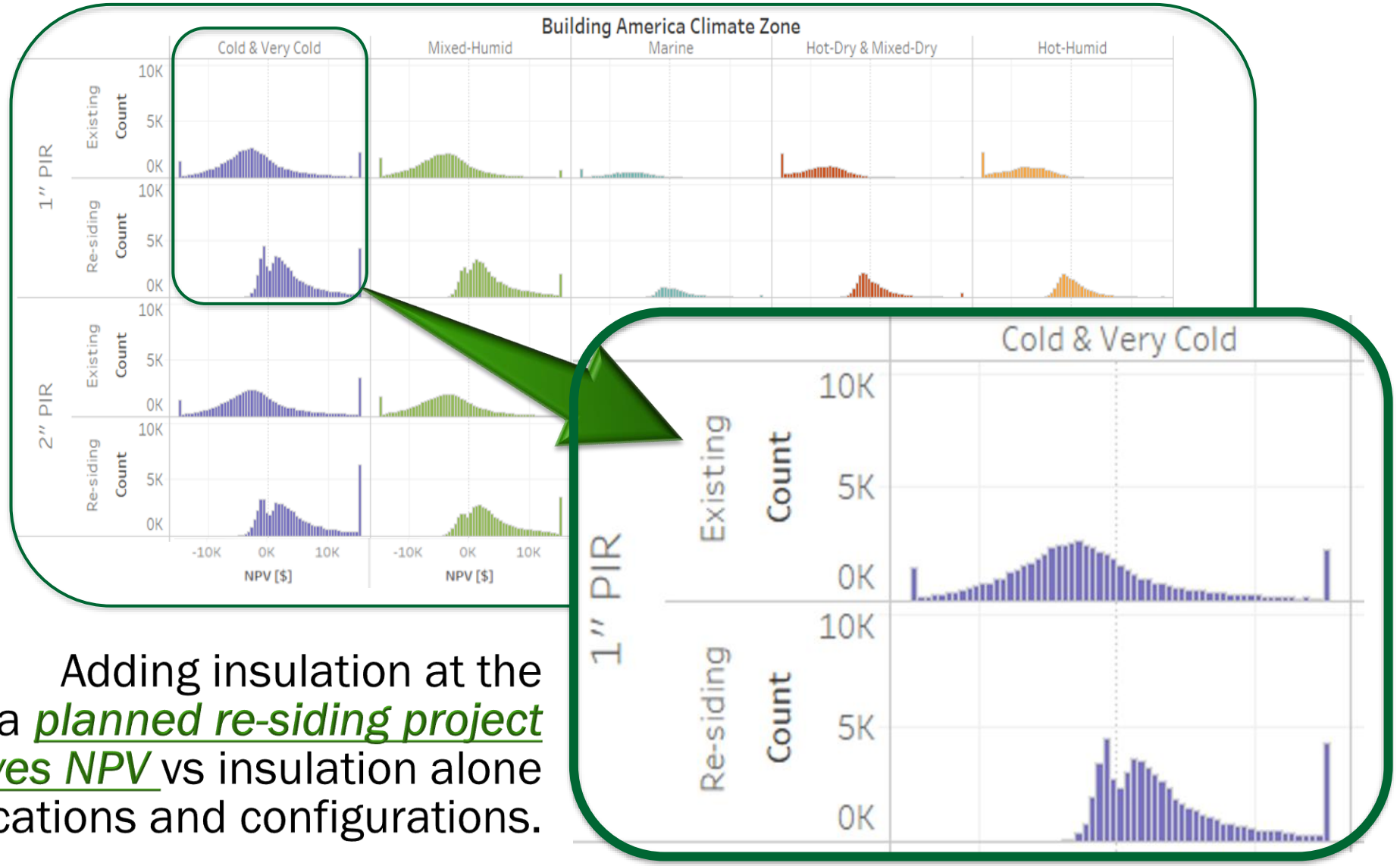
- Building Technologies Office aims to ***decarbonize the building stock by 2050***
- RMI and tri-lab ***research shows a major need for the AIRS approach*** to reach that goal

Building Type	Prioritized performance level	Number of Housing Units (M)	Percent of Stock
Single-Family / Small Multifamily[1] • Single-family detached • Single-family attached • Multifamily, 2-4 units	Not prioritized for upgrade	7.3	7%
	All Equipment Swap Out	30.7	30%
	Equipment + 1” AIRS	34.5	34%
	Equipment + IECC envelope	18.8	19%
	Equipment + Phius envelope	10.5	10%

[1] Results from Market Guidance Report developed by RMI, with support from LBNL, PNNL and NREL data from NREL, (final report expected summer 2023)

Alignment and Impact – Impact of Re-Siding Synergy on NPV

- Adding exterior continuous insulation *increases annual bill savings* and *reduces carbon emissions*
- There is *very little difference in NPV* between 1-in. and 2-in.
- Polyisocyanurate, 2021: 1-in. $1.40, 2-in. $1.90



Adding insulation at the time of a *planned re-siding project substantially improves NPV* vs insulation alone for nearly all locations and configurations.

Developed with DRAFT data from NREL, Residential Façade Retrofits Modeling, by Elaina Present, Eric Wilson and Rachel Romero (final report expected summer 2023)

Alignment and Impact – Nationwide Savings Opportunity

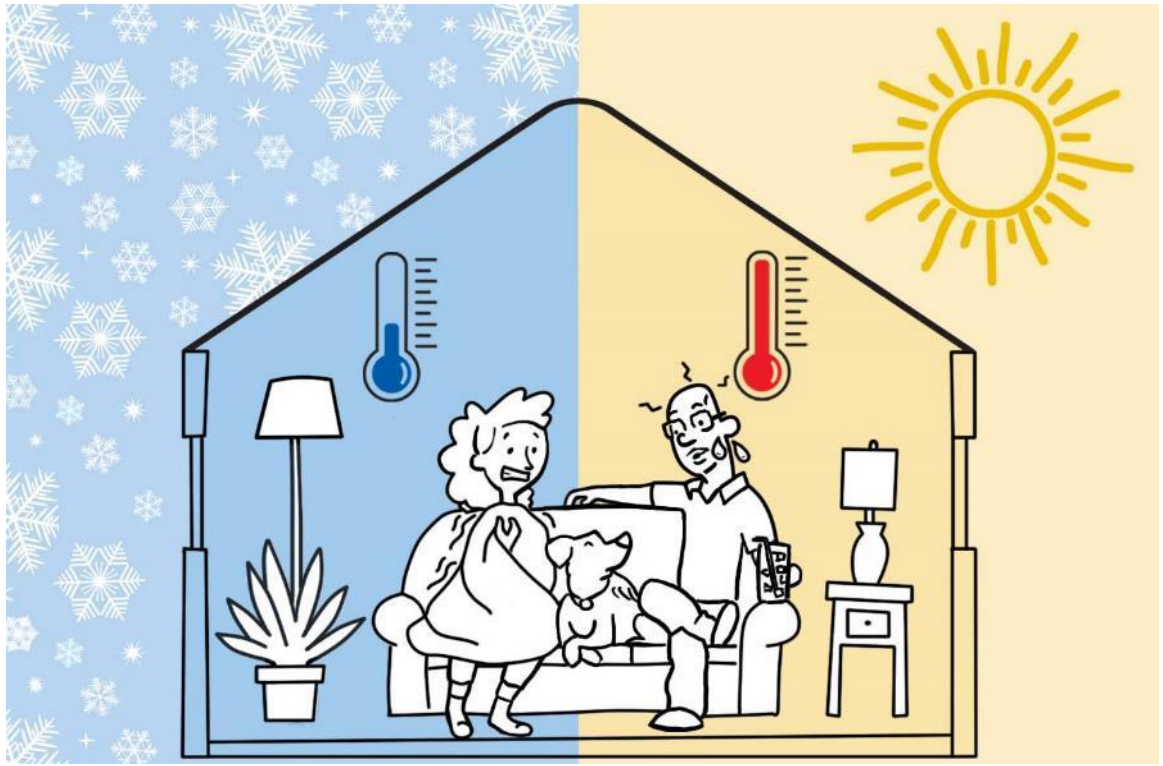
- Simulated 1-in. polyisocyanurate **R-6.5**
- Simulated **19% infiltration reduction**
- Consider opportunities everywhere
- High eligibility X High Savings = **OPPORTUNITY!**

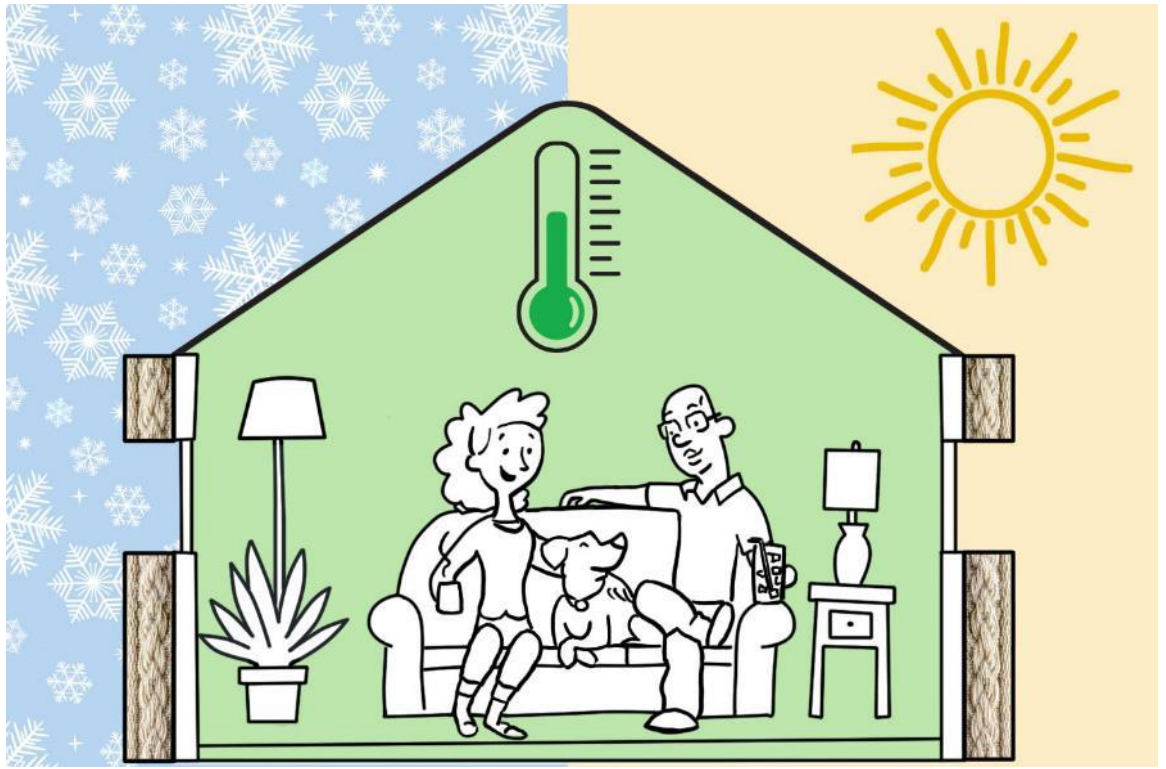
Adding R-6.5 exterior continuous insulation with air sealing to an existing wall with:	Avg Annual Site Energy Savings (MMBtu)							Avg Annual Site Utility Bill Savings ($)						
	Cold	Very Cold	Mixed Dry	Mixed Humid	Marine	Hot Humid	Hot Dry	Cold	Very Cold	Mixed Dry	Mixed Humid	Marine	Hot Humid	Hot Dry
Wood Stud, Uninsulated	47	33	26	24	16	12	11	699	514	495	438	281	281	243
Wood Stud, R-7	14	10	9	7	5	4	4	225	163	169	151	93	94	96
Wood Stud, R-11	11	9	8	6	5	3	4	193	146	176	135	89	89	89
Wood Stud, R-15	9	8	*	*	*	*	*	157	98	*	*	*	*	*
CMU. 6-in. Hollow, Uninsulated	*	27	*	17	*	4	7	*	609	*	358	358	120	189
CMU. 6-in. Hollow, R-7	*	8	*	5	*	1	*	*	202	*	114	114	37	*
CMU. 6-in. Hollow, R-11	*	7	*	4	*	1	*	*	171	*	84	84	28	*
Brick, 12-in. Wythe, Uninsulated	*	20	12	12	13	3	8	*	297	144	240	240	82	155
Brick, 12-in. Wythe, R-7	*	7	*	5	*	1	*	*	100	*	101	101	34	*
Brick, 12-in. Wythe, R-11	*	6	*	4	*	1	1	*	95	*	80	80	18	33

[1] Developed with DRAFT data from NREL, Residential Façade Retrofits Modeling, by Elaina Present, Eric Wilson, and Rachel Romero (final report expected summer 2023)

*Indicates fewer than 100 samples for baseline wall / climate zone combination

Alignment and Impact – Benefits





- ✓ Improves thermal and moisture performance of walls
- ✓ Saves energy and reduces utility bills
- ✓ Increases occupant comfort (temperature and noise)
- ✓ Allows for the use of off-the-shelf trim and moldings
- ✓ Maintains most siding warranties

Approach – Advisory Group & Project Partners

AG: Manufacturers and Trade Organizations

Amy Schmidt	American Chemistry Council
Alex Schiel	ProVia Vinyl Siding
C.J. Johnson	Royal Building Products
Luis Espada	BASF
William Ranson	DuPont
Art Evans	GCP Applied Technologies
Jay Murdoch	Owens Corning
Dan Edelman	Rock Wool
Matt Dobson	Vinyl siding Institute, Inc. (VSI)
Sarah Krompholz	Vinyl siding Institute, Inc. (VSI)
Dan Auer	King County Housing Authority
David Howard	National Rental Home Council

Field Demo Partners

Jessie Schiele	Jerusalem Farm
Kristina Rowles	Appalachia Service Project
Lora Corder	Green River
Jonathan Gach	Energy Home Inspection
Lesley Herrmann	E3 Innovate
Bobby Hight	Hight on Homes

Approach – Adding Insulation when Re-Siding (AIRS)




During a typical re-siding project rigid exterior continuous insulation (ext. c.i.) is added under the new siding and taped to provide a complete weather resistive barrier and air seal.

Approach – Recruitment and Messaging

Enrolling Homeowners and Contractors

- Postcards to neighborhoods with houses that meet inclusion criteria
- Manufacturer prompts, referrals, and cold calls to re-siding contractors in target communities
- AIRS webpage: rationale, field study contact information, installation guidance and resources

Gathering Performance Data

- Local research partners: blower door and infrared testing, site observation, photography
- Smart thermostats: T, RH and equipment runtime
- Before and after utility bills; before and after surveys and interviews

Selling the Concept

- The process of removing old siding and replacing with new is a great time to assess the condition of the building, add a layer of insulation, and improve air sealing.
- AIRS can lower utility bills, improve building durability, and increase indoor comfort.
- Piggy-backing with a planned re-siding project = maximum benefit for the lowest cost.
- Missing this window of opportunity means a future energy upgrade could cost far more, and miss the chance to invest in energy and carbon savings in coming decades.

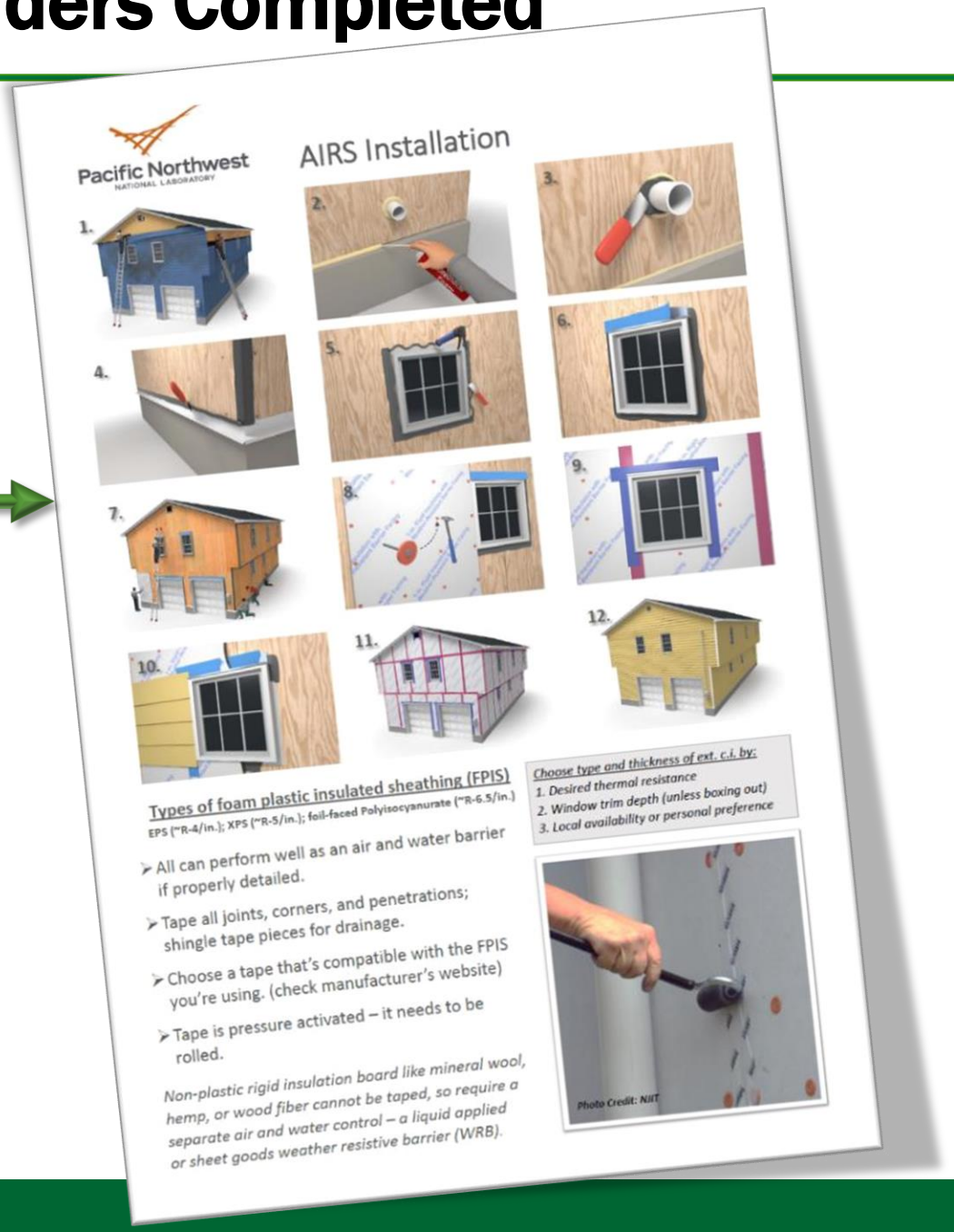
Progress – Internal Milestones Completed

- Robust test plan for up to 50 field demonstrations
- Contractor and homeowner outreach and enrollment, including direct mail
- One-page project explainers for contractors and homeowners
- Relationships with local partners to perform pre- and post-testing and gather installation data
- Human subjects research plan through the PNNL Institutional Review Board
- Field observation and documentation protocols
- Sample case studies for contractors

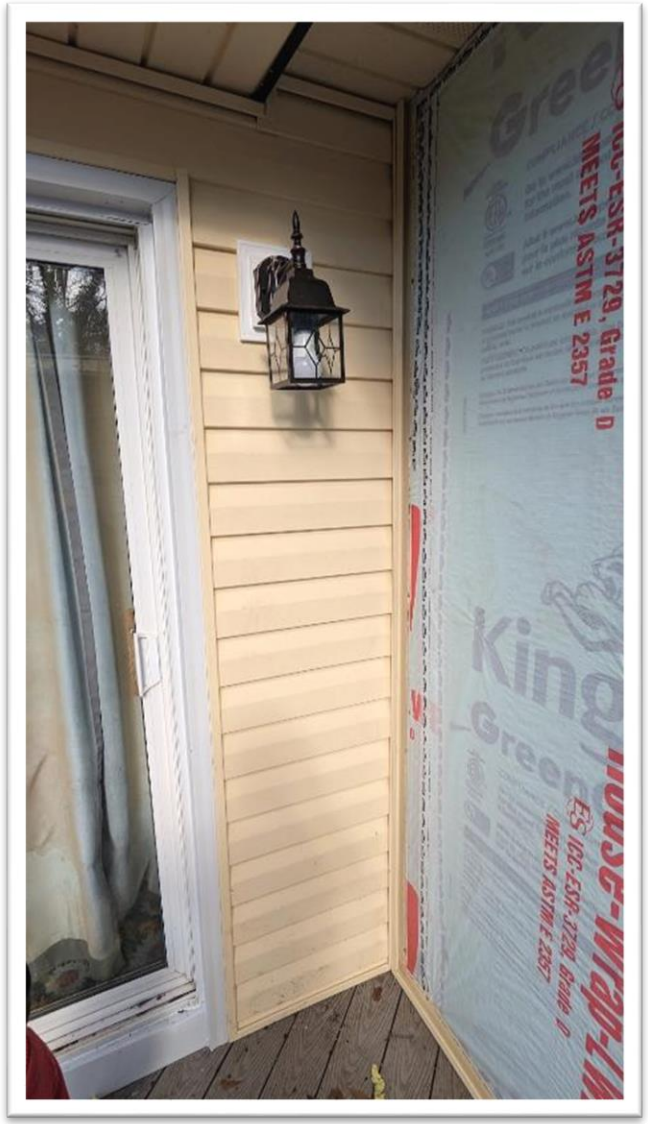
Postcards for homeowner outreach include branding of local partners to add credibility and reduce suspicion.

Progress – Materials for Stakeholders Completed

- Informational flyers to recruit both homeowners and contractors
- One page step-by-step installation posters with custom illustrations
- Project webpage with rationale, data, links to installation guidance from manufacturers and industry trade organizations **https://www.pnnl.gov/projects/re-siding-ext-insulation**



Progress – Field Demonstrations



Initial Findings

- Reduced air infiltration
- Both testing agent and homeowner noticed a marked improvement in interior conditions
  - Ability to maintain setpoint
  - Local radiant comfort ($T_{operative}$)
  - Quiet
- Took longer than expected
- Contractor found the process cumbersome and irritating
- Contractor still convinced a radiant barrier in the ceiling is the best buy for his customers
- Homeowner is ECSTATIC

Progress – Issues and Obstacles

- Following the pandemic contractors were lured by booming new construction opportunities – new construction work is easy, fast, pays better, and requires much less hassle – we engaged more than a dozen contractors over an entire year who seemed keen on the idea of AIRS and agreed to contact us with likely projects, but then never actually wrote contracts for any qualifying homes! Most contractors didn't even respond.
- Contractors seem reticent to add work outside their scope – re-siding is fast-paced and pretty basic. AIRS adds complexity, despite efforts to simplify it, and the contractors seem more inclined to use their time on multiple re-siding projects rather than fewer projects with the added scope of AIRS.
- The variety of starting conditions is vast.
- Even seemingly simple methods can be complex when new and different.

Progress – Increasing Reach

The test plan and IRB application modified to increase:

- Qualifying homeowners
- Qualifying regions
- Qualifying starting conditions
- Specs for the energy upgrade (not limited to 1-in.)
- Proactive "selling" by contractors

The Annual Operating Plan (AOP) modified to include:

- Influencers in the construction industry (e.g. YouTube, remodeling magazines, traditional co-advertising, etc.)
- Alternate messengers (HOAs, insurance agents/adjusters)
- Alternate installers (DIY, remodelers, non-profit home repair organizations

Homeowner inquiries are increasing – a dozen in the last month!

Future Work – Expansion through Technology Campaign

Technology Campaigns Help ***Document*** *Successful Technologies*

Advanced Rooftop Unit Campaign
- Over 1B kWh/yr savings
- $110M/yr savings
- 23 partners recognized
- 160,000 RTUs impacted

Lighting Energy Efficiency in Parking Campaign
- 229M kWh/yr savings
- $24M/yr savings
- 565M ft2 of parking facilities

Smart Energy Analytics Campaign
- $95M/yr savings
- Recognized 29 partners
- 600M ft2 of floorspace

Interior Lighting Campaign
- 880M kWh/yr savings
- $84M/yr savings
- 51 partners recognized
- 3.5M luminaires impacted

Integrated Lighting Campaign[a]
- 7 case studies published
- 20 partners recognized

Building Envelope Campaign[a]
- 14 projects recognized
- 1.5M ft^2 condition floor area impacted

[a] First year outcomes shown

Team Will Work With Partners in Industry to ***Promote*** *Insulating when Re-Siding*

Technology Campaigns Help ***Break Down*** *Technology Adoption* ***Barriers***

Barrier	Approaches
Benefits not well understood	Define business case, document resources
Not easy to distinguish between product offerings	Encourage use of performance specifications
Lack of awareness about benefits	Document participant/project benefits in case studies
Upfront costs / hard to find incentives	Consolidate (create) utility incentive program offerings, links to existing resources

Thank You

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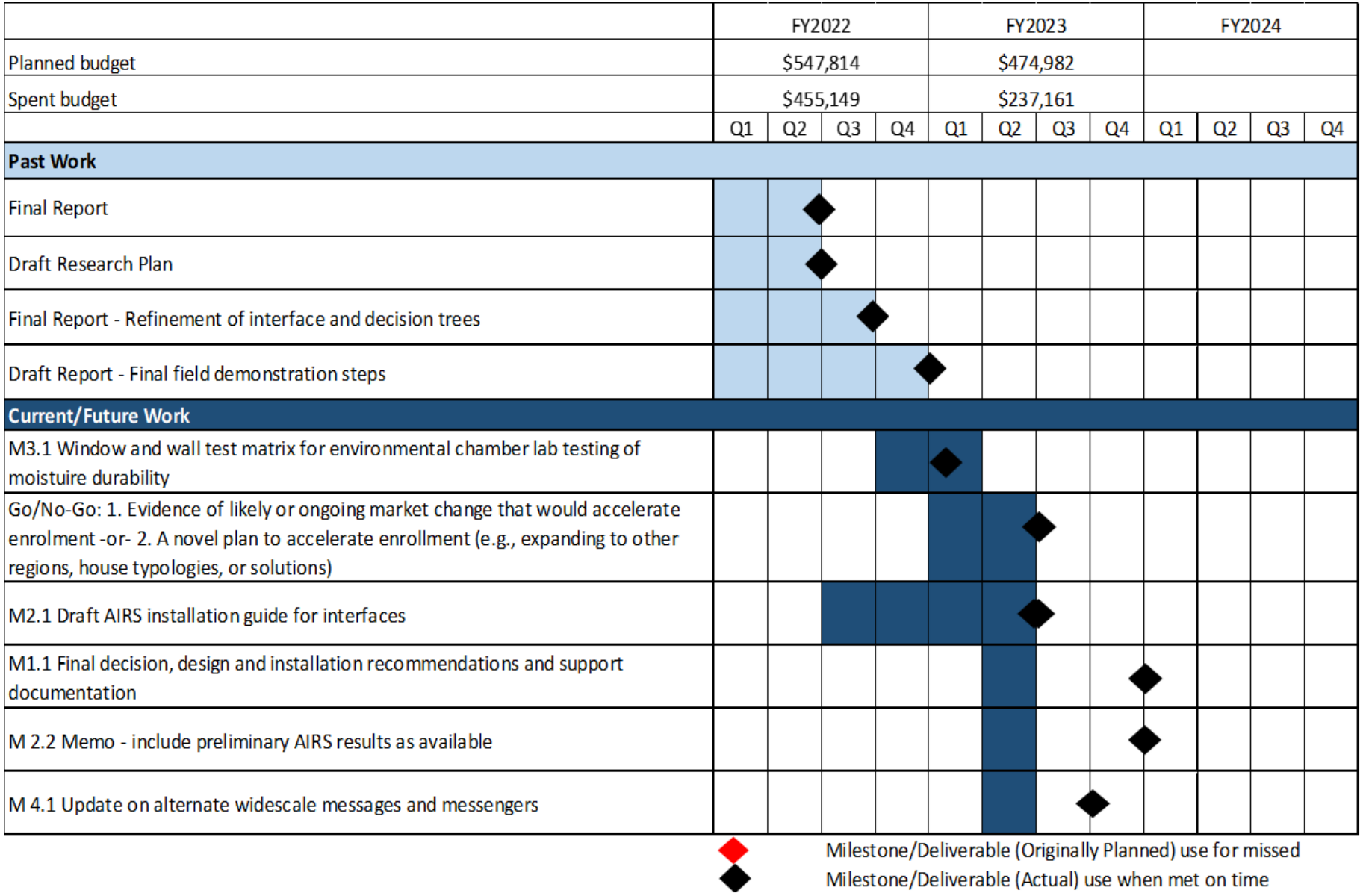
REFERENCE SLIDES

Project Execution

Go/No-Go was added due to slow field demo enrollment

- Market pressure seems to be easing
  - less new construction is now freeing up contractors to take on retrofit projects
- IRB has been modified to include homeowners
  - in a broader region, and
  - with less typical starting conditions and
  - With insulation choices different than 1-in.



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Alignment and Impact – Nationwide Eligibility for Energy Upgrades

Building America Climate Zone	Eligibility:	Total Simulation Runs (each simulation represents ~250 homes)		Ext. c.i + residing (1-in. OR 2 in.; R-6.5 OR R-13)		Window Upgrade (low-e storms OR triple pane windows)		Any combination of ext. c.i. + window upgrade	
	Vintage Bin	% Vintage, CZ	% by CZ	% Vintage, CZ	% by CZ	% Vintage, CZ	% by CZ	% Vintage, CZ	% by CZ
Cold & Very Cold	Before 1950	14%	39%	11%	30%	7%	17%	13%	34%
	1950-1969	14%		11%		6%		12%	
	1970-1989	11%		8%		4%		9%	
Mixed-Humid	Before 1950	7%	29%	6%	24%	4%	15%	7%	27%
	1950-1969	11%		9%		6%		10%	
	1970-1989	11%		9%		5%		10%	
Hot Humid	Before 1950	2%	15%	2%	10%	2%	12%	2%	14%
	1950-1969	5%		4%		4%		5%	
	1970-1989	8%		5%		6%		7%	
Hot-Dry & Mixed Dry	Before 1950	2%	11%	2%	11%	1%	8%	2%	11%
	1950-1969	5%		4%		3%		5%	
	1970-1989	5%		4%		3%		5%	
Marine	Before 1950	1%	5%	1%	5%	1%	3%	1%	5%
	1950-1969	2%		2%		1%		2%	
	1970-1989	2%		2%		1%		2%	
48,200,000 Homes		**100%**		**81%**		**54%**		**91%**	

[1] Developed with DRAFT data from NREL, Residential Façade Retrofits Modeling, by Elaina Present, Eric Wilson and Rachel Romero (final report expected summer 2023)