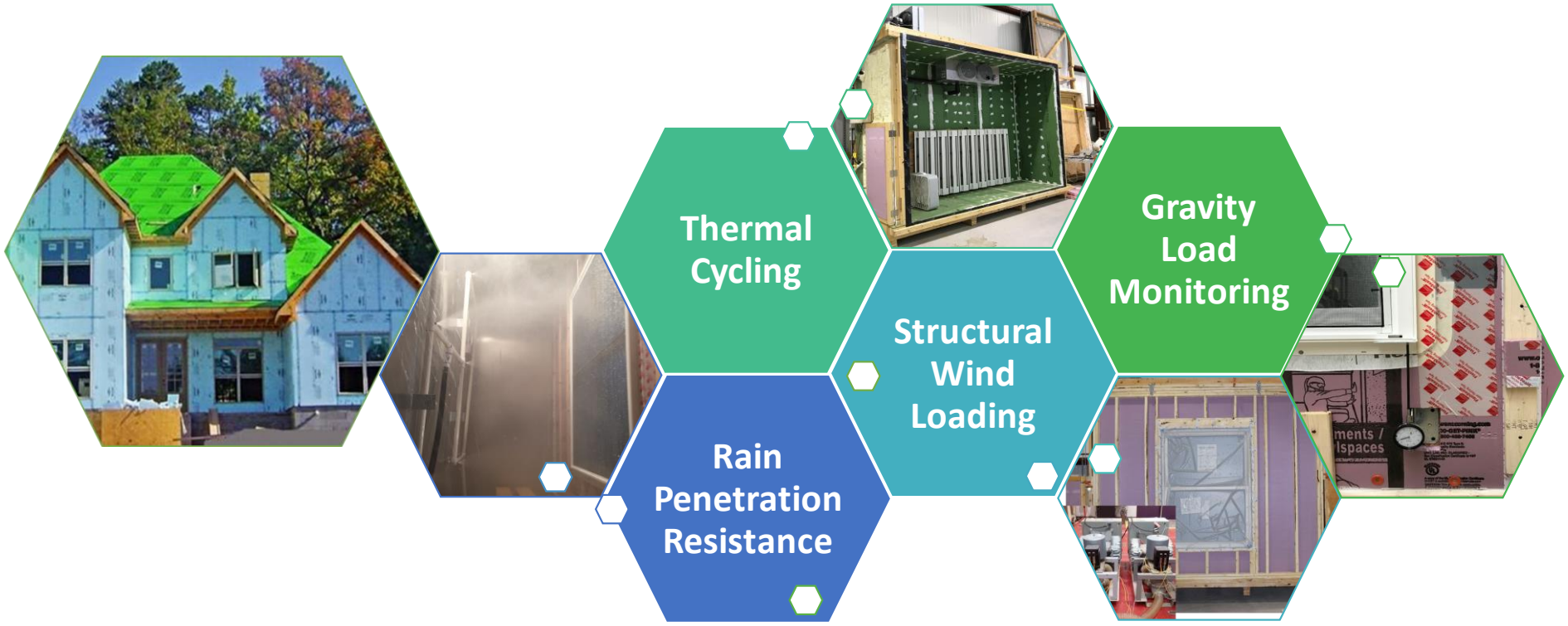
U.S. DEPARTMENT OF ENERGY

Office of ENERGY EFFICIENCY & RENEWABLE ENERGY

Durability of Windows In Walls with Continuous Insulation



Home Innovation Research Laboratories
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Project Summary

Timeline:

Start date: **August 2016**

Planned end date: **December 2019**

Key Milestones

1. Agreement by Advisory Group on Test Protocols – October 2017
2. Results of Phase I Testing – October 2018

Budget:

Total Project $ to Date:

- DOE: $402,000
- Cost Share: $100,000 ($50,000 monetary; $50,000 in-kind)

Total Project $:

- DOE: $479,889
- Cost Share: $120,000 ($70,000 monetary; $50,000 in-kind)

Key Partners:

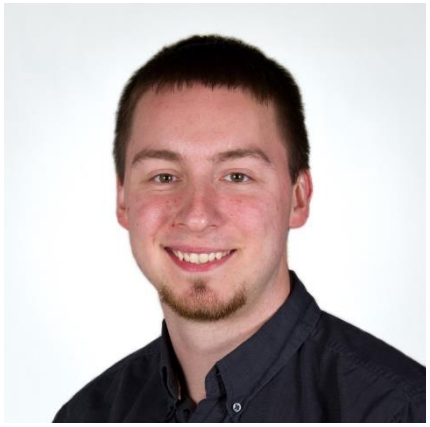
American Architect. Manufacturers Assn.	American Chemistry Council
Window and Door Manufacturer Assn.	Individual Companies: window manufacturers, foam sheathing manufacturers, house wrap manufacturers, builders
National Assn. of Home Builders	

Project Outcome:

1. Enabling continuous insulation technology for high performance enclosures in new homes to achieve target EUI reductions, as well existing homes undergoing a cladding replacement
2. A simplified set of window installation solutions that ensure durability of the window-wall interface in walls with CI.
3. Broad industry acceptance for the proposed solutions to facilitate code acceptance.

Team

Home Innovation RESEARCH LABS™



Kevin Kauffman	Nay Shah	Vladimir Kochkin
Project Lead	Testing and Information Mgnt.	Project Oversight

American Architectural Manufacturers Association

American Chemistry Council

WINDOW & DOOR MANUFACTURERS ASSOCIATION WDMA

NAHB

ARES CONSULTING SERVICES

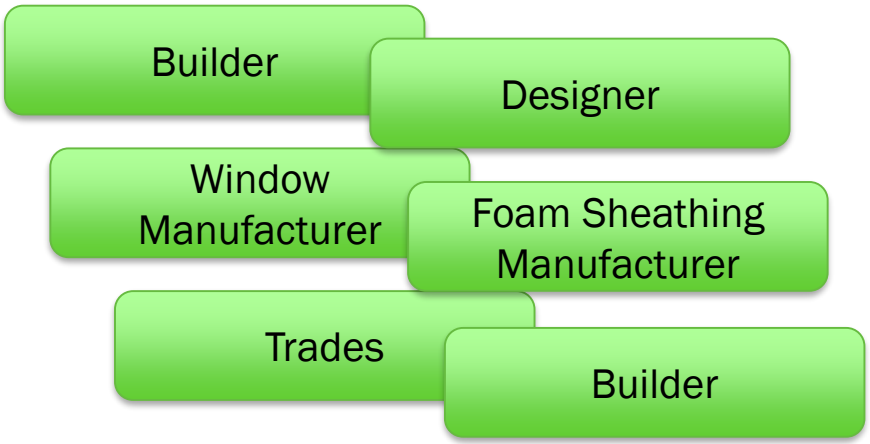
Challenge

Problem Definition:

1. High-R enclosures are integral to achieving BA goal of reducing EUI by 60% for new and 40% for exist. homes
2. Continuous insulation (CI) offers a technology that achieves energy load reduction and provides a solution for moisture management – yet, CI is only 13 percent of the wall market share
3. One of the barriers to adoption of CI -- no code-approved methods for installation of flange windows
4. Recently, window manufacturers published installation instructions that require significant changes to conventional practices
5. The new requirements lead to significant implications on cost, construction process, labor, and scheduling

Fragmented Value Chain:

1. Risk transfer – who is responsible?
2. Communication barriers – who is the decision maker?
3. Trades sequencing and system integration
4. Which installation instructions to follow?
5. Fallback – lowest common denominator



Market Opportunity:

Low-rise residential construction in Climate Zones 3-8 – about 70% of all housing starts in the country – market opportunity for the technology

Approach

Provide industry with objective laboratory test results on the performance of window/wall assemblies to inform the development of practical installation recommendations.

Broad Industry Advisory Group:

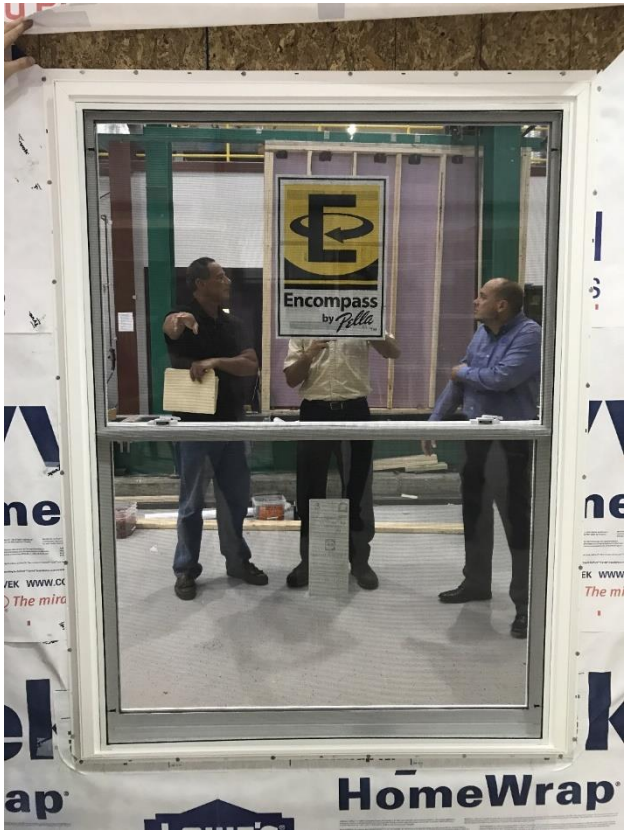
1. Entire value chain
2. Buy-in on the project
3. Development of a test protocol and performance criteria
4. Agreement on the test protocol and performance criteria
5. Agreement on construction practices for test specimens
6. Review of results: interim and final

Research Plan Development:

A broad review of window inventory, construction practices, previous studies, existing test methods and performance criteria

Approach

Advisory Group Members at Construction and Initial Testing



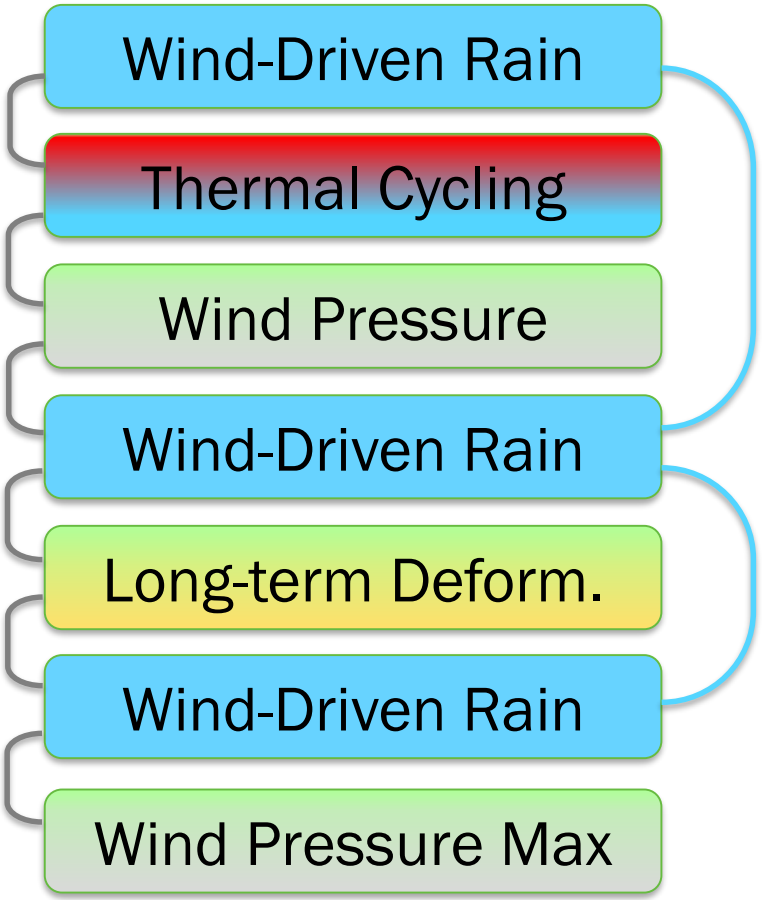
There was no shortage of opinions or interest in every detail of the evaluation

Approach

Testing Protocol – A coordinated, progressive series of laboratory tests to assess the durability of the window-wall interface under a wide range of simulated environmental conditions

Duration of a single series of tests: ~8 months with thermal cycling at about 2.5 weeks and long-term deformation monitoring at 6 months

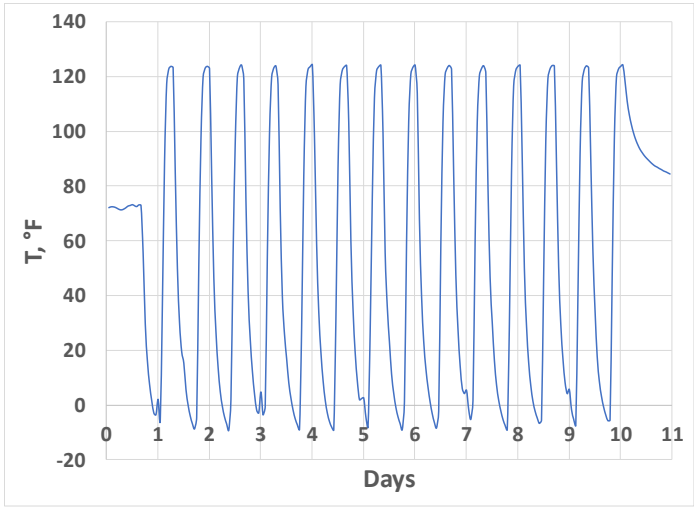
Test Sequence



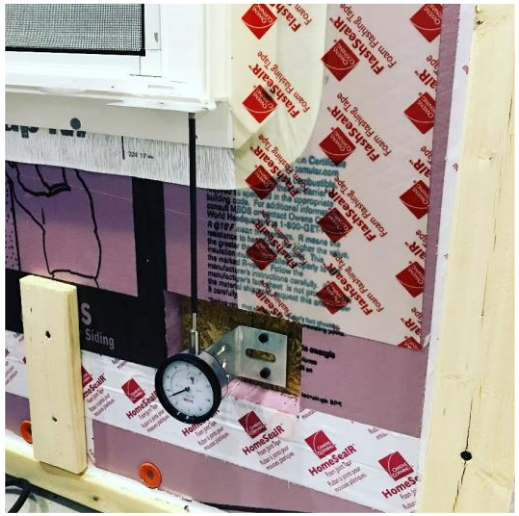
Approach

Water Penetration

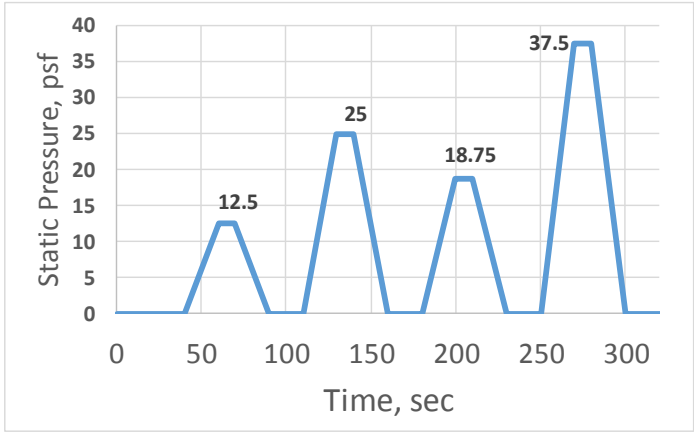
Thermal Cycling



Gravity Loading



Wind Loading



Structural Wind Testing – Both Directions

Positive Wind Pressure

Negative Wind Pressure

Pressure Load Actuators (PLAs)

Window Types

Slider

Mulled Casement

Mulled Double Hung

Double Hung

Test Matrix

Specimen Configurations:

- **Baselines:** No foam sheathing; ROESE (blocking)
- **Foam:** XPS, Polyiso, EPS
- **Thickness:** 1' and 2" foam sheathing
- **Foam Compressive Strength:** 15 psi and 25 psi foam sheathing
- **Window sizes**: 48x64; 96x64; 72x72
- **Window ratings:** PG-25; PG-35
- Two window **flange types**
- **WRB baseline:** house wrap or felt paper
- **WRB walls with foam:** taped joints

Impact

- **Help transform the enclosure market to achieve energy load reductions and EUI targets**
  - Current market penetration for CI is about 13 percent nationally – growth opportunity
  - Some local markets as high as 30 percent
  - Current market share can erode if not addressed
- **Establish applicability boundaries for simplified installation methods**
- **Provide the basis for developing optimized installation solutions and details**
- **Establish a blueprint for follow-up evaluations**
- **Help builders meet energy codes and above-code program**

Progress

- **The project in mid-to-late stage of progress**
- **Agreement on test procedures and evaluation methods is achieved**
- **Test method validation is performed**
- **Phase I set of specimens has been tested (10 specimens) and testing of Phase II set (5 specimens) is underway**
- **Observations based on results to date:**
  - The testing regime does not appear to impact **water resistance** of the window-to-wall interface
  - **Long-term gravity** loading does not lead to creep effects
  - **Window functionality** after a **significant wind event** needs further evaluation

Progress

- Sash slider mechanism (balance) damaged by wind pressure test

Normal—sash connected to window balance

Sash detached from window balance

Sash sliding down under its own weight (balance not engaged)

Stakeholder Engagement

- “Baked” into the project from the beginning
- Key to success of the overall effort
- Stakeholders contributing cash, time, expertise, products
- The project was kicked off with an all-day, face-to-face meeting of the Advisory Group
- For the first series of tests, stakeholders were invited to oversee construction and testing
- AG is updated routinely and engaged with key decisions
- Stakeholders will help with disseminating results

Remaining Project Work

- Complete testing (75% progress mark)
- Evaluate results against established performance criteria
- Make recommendations based on observed performance
- Propose construction solutions and associated limitations
- Provide test results to support development of industry consensus for installation practices
- Support development of a standardized testing framework for future evaluation of these types of assemblies

Thank You

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REFERENCE SLIDES

Project Budget

Project Budget: See Table below
Variances: None
Cost to Date: See Table below
Additional Funding: None

Budget History					
FY 2016 – FY 2018 (past)		FY 2019 (current)		FY 2020 (planned)	
DOE	Cost-share	DOE	Cost-share	DOE	Cost-share
$357,130	$100,000	$112,759	$18,000	$10,000	$2,000

Project Plan and Schedule