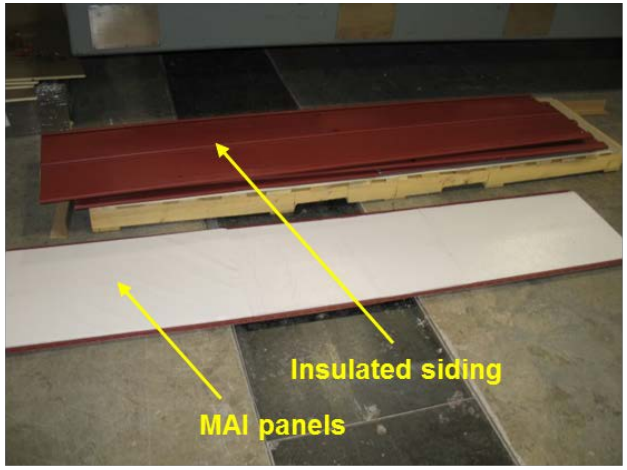
# Insulated Siding for Building Envelopes

2017 Building Technologies Office Peer Review






U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

**Andre Desjarlais, desjarlaisa@ornl.gov**
**Oak Ridge National Laboratory**

# Project Summary

**Timeline**:
Start date: FY16
Planned end date: FY18

**Key Milestones:**
1. Address the joints in the selected siding profiles using numerical modeling; 3/17.
2. Develop MAI panels for the thermally-improved MAI-siding composite designs; 6/17.

**Budget**:
**Total Project $ to Date**:
- DOE: $380K
- Cost Share: $100K

**Total Project $:**
- DOE: $570K
- Cost Share: $150K

**Building Envelope Core Funding**

**Key Partners**:

| | |
|---|---|
| Royal Building Products | Newport Partners |
| NanoPore, Inc. | |

**Project Outcome**:

Create insulated vinyl siding by integrating modified atmosphere insulation (lower-cost vacuum insulation) panels with commercial vinyl siding profiles achieving R10 with 1-inch of siding thickness.

# Purpose and Objectives

**Problem Statement**:

Insulated siding has represented a small but growing share of the overall siding market. However, recent adoptions of more aggressive energy codes are accelerating the specification of continuous insulation in wall systems. The latest energy code now recognizes insulated siding as a form of continuous insulation. Existing technologies are limited to an R2. Higher R-value levels of continuous insulation create "safer" walls hygrothermally.

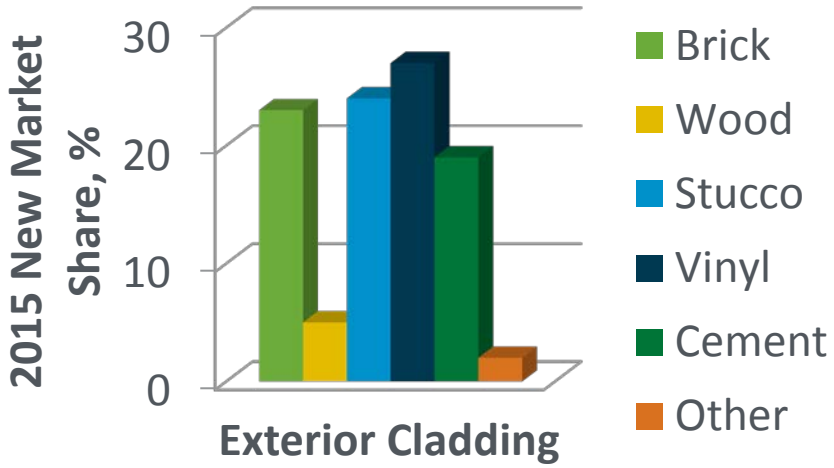
A higher performing technology could penetrate the new construction market by replacing the need for continuous insulation.

**Target Market and Audience**: Mainly older residential buildings needing siding replacement and/or insulation retrofit, but also new residential buildings (to meet newer building code insulation requirements).

# Purpose and Objectives (cont.)

**Impact of Project**:

- According to the DOE Building Market Calculator, the market size for new and retrofit wall assemblies is 1.6 quads.
- Vinyl siding is the most popular new construction cladding. According to U.S. Census data, vinyl has a 27% market share (200,000 units).
- 2015 U.S. Census data shows 1.1 million siding replacement projects implemented yearly.
- The National Association of Realtors cited vinyl siding replacement as one of the best long-term investments with an 83% cost recovery.



# Today's Options


**Sources:** http://www.jmofnb.com/_media/image/wall.JPG; http://www.greenbuildingadvisor.com/blogs/dept/guest-blogs/window-installation-tips-deep-energy-retrofit;

# Approach

**Approach**: After identifying industry partners, develop MAI panels that mate with the cross-section of typical vinyl siding profiles. Work with the vinyl siding manufacturer to redesign the joining technique to reduce the thermal bridging at the vinyl siding horizontal joints. Evaluate improvements using small scale experiments and computer simulations. Select best designs and evaluate in full scale using a guarded hot box.

**Key Issues**: Design systems that minimize impact of MAI panel failure. Address cutting of panels and thermal performance loss due to aging.

**Distinctive Characteristics**: Improving the energy efficiency of existing wall assemblies is clearly one of the most difficult envelope improvements to justify cost effectively. This project creates a product that is frequently used in retrofits that has a high cost recovery with the opportunity to satisfy new energy code requirements simultaneously.

# Progress and Accomplishments

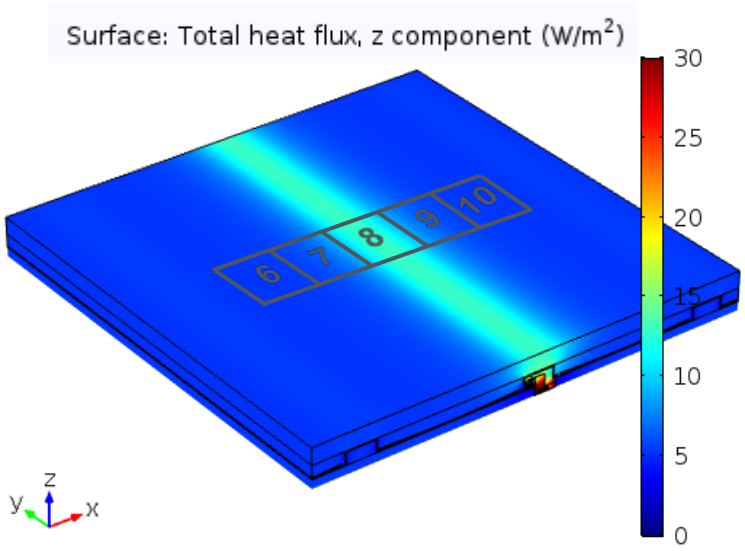
**Accomplishments**:

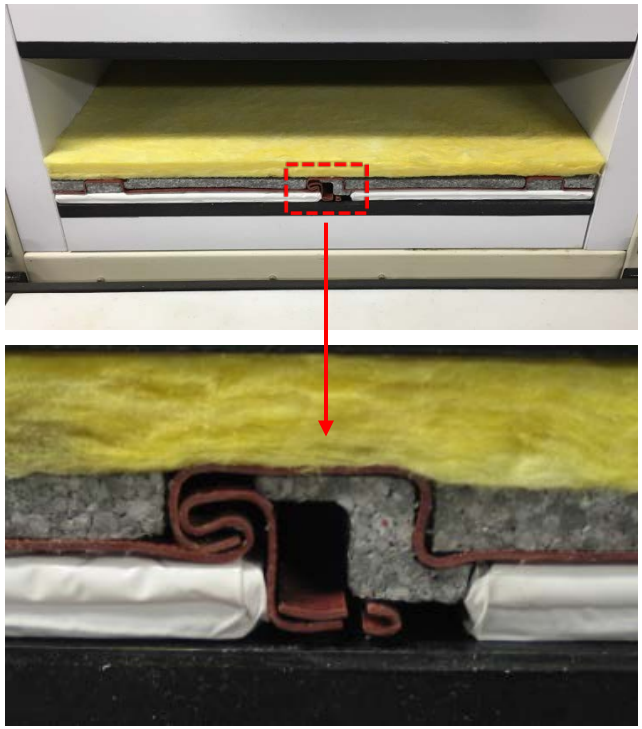
Work to date includes:

1. Identified Royal Building Products (vinyl siding manufacturer) to collaborate on this project.
2. Designed MAI-siding assembly achieving R10/inch using thermal modeling and small scale lab testing.
3. “Manufactured” full-scale composite MAI-siding assemblies and test thermal performance to verify R10/inch. Measured R11.7 for insulated siding assembly.

# Progress and Accomplishments

- Parameter tuning to account for geometry-related approximations, imperfections at the joints and interfaces, etc.
- Assuming no convection in the air gap at the joint.

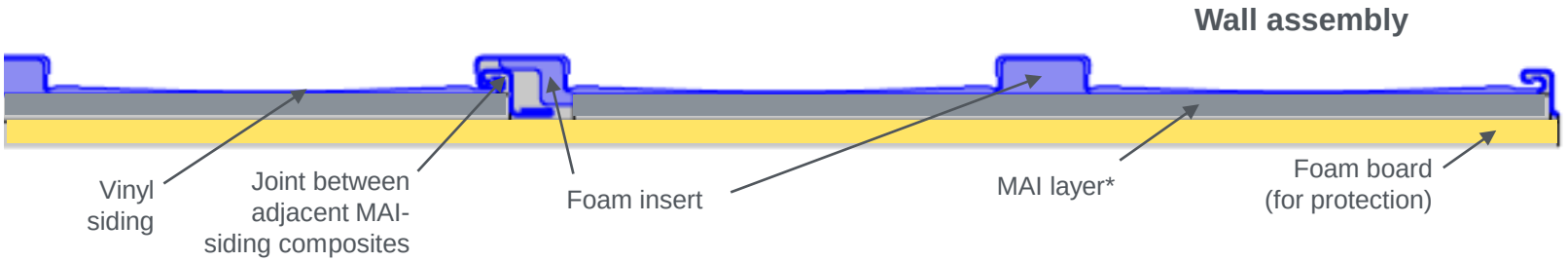


**Comparison of measured and calculated heat fluxes**

| | HFT # | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|
| Upper Plate | Measured | 6.4 | 7.4 | 12.3 | 7.9 | 6.1 |
| | Calculated | 5.3 | 6.2 | 11.6 | 7.4 | 5.4 |
| Lower Plate | Measured | 5.8 | 5.4 | 16.2 | 5.7 | 5.5 |
| | Calculated | 5.3 | 5.0 | 15.9 | 4.6 | 5.2 |

# Progress and Accomplishments




**Market Impact**:
Still in the product development phase. Information on the project shared with industry as part of "program overview" presentations.

**Awards/Recognition**: None.

**Lessons Learned**: None.

# Project Integration and Collaboration

**Project Integration**:
Project staff provide connections to the manufacturing community (Royal Building Products and NanoPore) and the builders (Newport Partners).

**Partners, Subcontractors, and Collaborators**:
**ORNL:** Supply experimental and analytical tools for analyzing performance of the insulated siding composites and coordinate team efforts.

**Royal Building Products:** Provide vinyl siding manufacturing expertise.

**Newport Partners:** Provide expertise on market.

**NanoPore:** Develop non-planar MAI panels to mate with popular vinyl siding profiles.

**Communications**:

- Abstract titled "*Thermal characterization of novel vacuum-insulated vinyl siding,*" submitted to the International Thermal Conductivity Conference and Expansion Symposium 2017, May 2017.
- Information on project shared with industry as part of "program overview" presentations.

# Next Steps and Future Plans

**Next Steps and Future Plans**: During the balance of FY 2017, we will:

1. Investigate how to improve the thermal performance of the composite siding using numerical simulations to address the joints, MAI coverage, etc.
2. Create MAI panels with non-uniform thickness to be compatible with a popular horizontal siding profile.
3. Develop and verify the thermal performance (>R10/inch) of full-scale MAI-horizontal siding composites.
4. Begin gathering cost data.

| Vinyl (Standard) | Vinyl (Premium) | Poly-propylene | Fiber Cement (Painting included) | Brick | Stucco | Wood (Grade A Cedar with stain) | Insulated | LP Smartside (OSB) |
|---|---|---|---|---|---|---|---|---|
| **$3.24** | **$4.46** | $8.04 | $6.13 | $18.89 | $9.39 | $9.36 | NA | NA |

# REFERENCE SLIDES

# Project Budget

**Project Budget**: $190K per year for FY16-17

**Variances**: None

**Cost to Date**: $270K

**Additional Funding**: $50K per year of cost share.

| Budget History | | | | | |
|---|---|---|---|---|---|
| FY 2016 (past) | | FY 2017 (current) | | FY 2018 (planned) | |
| DOE | Cost-share | DOE | Cost-share | DOE | Cost-share |
| $190K | $50K | $190K | $50K | $190K | $50K |

# Project Plan and Schedule