# New Air and Water Resistive Barriers for Commercial Buildings

2017 Building Technologies Office Peer Review




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

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# Project Summary

## Timeline

Start date: 10/1/14

Planned end date: 9/30/17

## Key Partner: 3M

## Key Milestones

1. 3/31/17: air leakage data from 1 to 2 demo buildings selected in FY16
2. 6/30/17: air leakage data from 1 to 2 demo buildings selected in FY17
3. 9/30/17: energy savings estimates from 2 to 4 demo buildings

## Budget

### Total Project to Date

- DOE: $1M
- Cost Share: $1.5M

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- Cost Share: $1.5M

## Project Outcomes

- Development and commercialization of new air barrier technologies that reduce installation errors, time, and cost
- Data demonstrating that new air barriers that are easier to install perform equally or better than available products
- Build early adopter market for new air barrier technologies

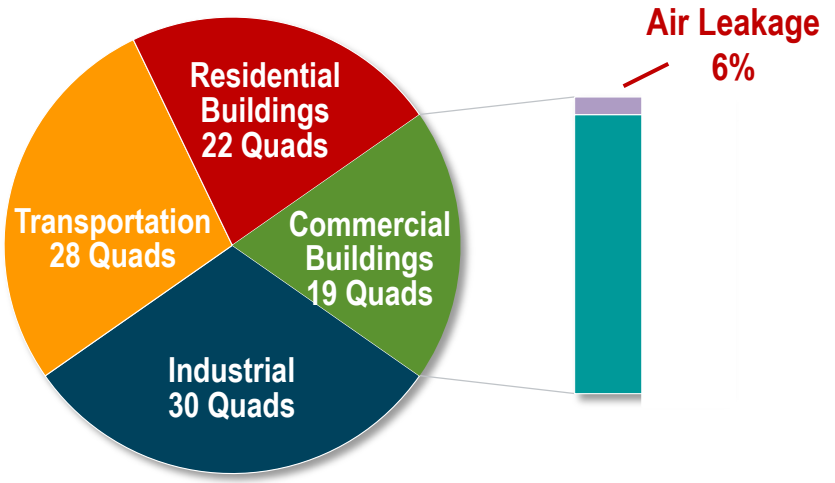
# Purpose

## Problem Statement

1. The performance of air barriers tends to be highly dependent on the installer. Air barrier technologies are needed that reduce installation errors, time, and cost without compromising performance. New technologies will require that an early adopter market is built.

2. This is an Emerging Technologies (ET)/ Commercial Building Integration (CBI) pilot project in which CBI aimed to accelerate the adoption of air barriers that were developed under ET.

**US Primary Energy Consumption - 98 Quads**




*Building Energy Data Book (Office of Energy Efficiency and Renewable Energy)*

## Target Market and Audience

- Market: commercial buildings
- Audience: architects, spec writers, general contractors, subcontractors
- 2030 total energy market for air leakage (BTO calculator): Pre-2010 ≅ 350 TBtu New ≅ 330 TBtu

# Logic Model of Project's Objectives

| Objectives | Activities | Key Outputs | Short-term Outcome | Mid-term Outcome | Long-term Outcome |
|---|---|---|---|---|---|
| **ORNL** Demonstrate performance of new air/water resistive barriers for commercial buildings that are easier to install than existing technologies to accelerate market adoption | Data collection from test facilities that use new and prevailing air barriers | Data shows that new air barriers perform equally or better than prevailing technologies | Leading building owners have data on how the new and prevailing air barriers compare to each other to commit to install the new air barriers | Designers, spec writers, and owners integrate the new air barriers into their new and existing buildings | New air barriers are widely used to meet or exceed airtightness requirements in new and existing buildings |
| | Data collection from new or existing buildings that use the new air barriers | Data shows that new and existing buildings with new air barriers meet air leakage rate of <2 L/s·m$^2$ at 75 Pa per IECC | Leading building owners have data from actual buildings to commit to install the new air barriers | | |
| **3M** Commercialize new air/water barriers | Development of commercialization plan | New air barriers have established marketing and distribution channels, and training/certification programs | Leading building owners have access to the new air barriers and a trained workforce to install them | | |

# Approach: New Air and Water Barrier Technologies

## 3M 3015

- Primer-less self-adhered membrane
- 67% lighter than asphalt-based membranes
- Up to 2 times faster installation than membranes that require priming
- Low temperature installation (~0°F)
- 0.26 perms

## 3M 3015VP

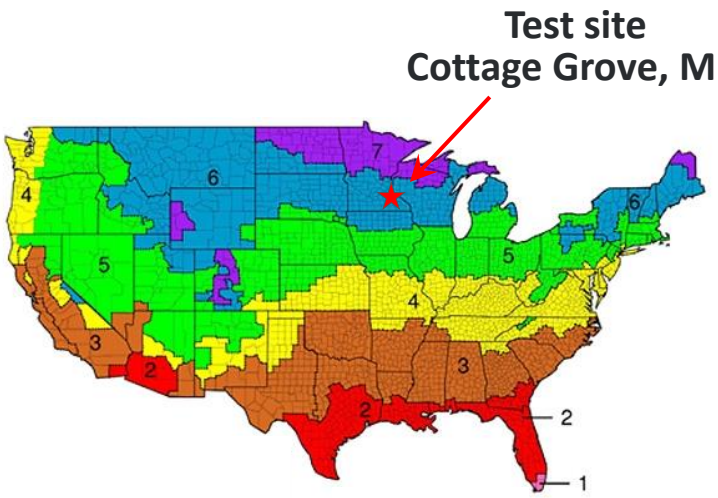
- Primer-less self-adhered membrane
- Up to 2 times faster installation than membranes that require priming
- Low temperature installation (~0°F)
- 20 perms

## 3M 2085VP

- Silyl-Terminated Polyether (STPE) technology
- 93% solid content: single-pass application, fast drying, low shrinkage
- Low temperature installation (~25°F)
- ~30 perms

# Approach: Data from Test Facilities

- 3M built 8 test facilities (FY15)
  - (2) 3015
  - (2) 2085VP
  - (1) 3015VP
  - (2) competing products
  - (1) baseline
- ORNL
  - Instrumented the facilities (FY15)
  - Conducting blower door tests (FY16 – FY17)
  - Analyzing data (FY16 – FY17)
  - Calibrating models (FY16 – FY17)
  - Estimating energy savings (FY16 – FY17)





**3M Test Facilities**

# Approach: Data from New and Existing Buildings

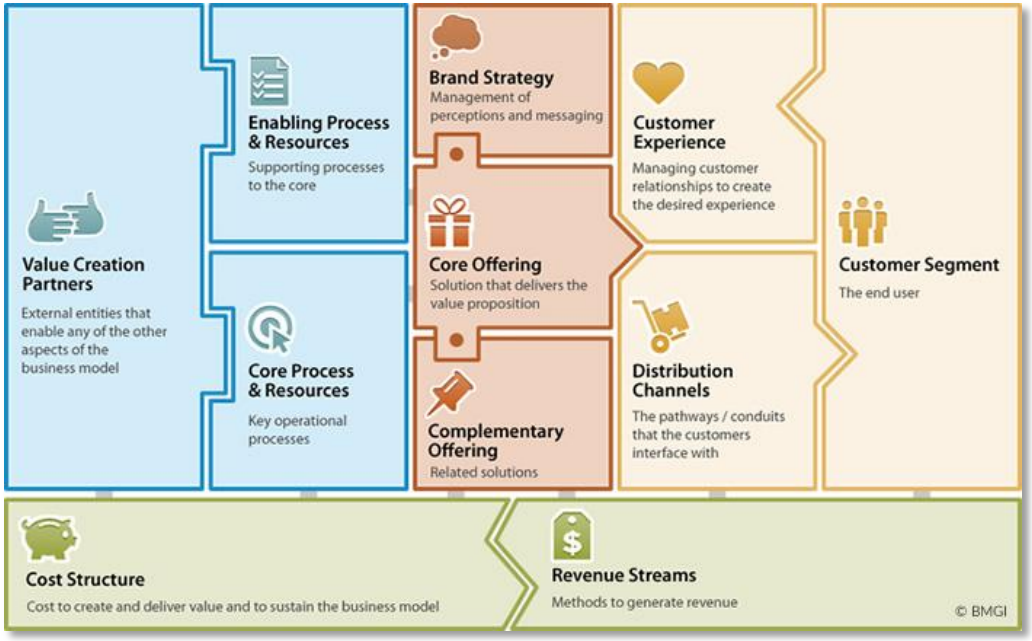
- Retrofit envelopes with new air barriers
  - Measure air leakage rate before and after retrofit
  - Run E+ simulations to estimate energy savings from improvements in airtightness
  - Estimate return on investment
  - Document lessons learned
- New buildings with new air barriers
  - Measure air leakage rate
  - Use air leakage rate form the literature as baseline
  - Run E+ simulations to estimate energy savings from airtightness

# Approach: Commercialization Plan

- 3M to issue Tech to Market report to DOE
  - Targeted markets
  - Distribution channels
  - Outreach: seminars, trade shows, conferences
  - Quality enforcement: training and certification programs
  - Sales strategies
  - Evolution of commercialization plan

- ET/CBI benefits

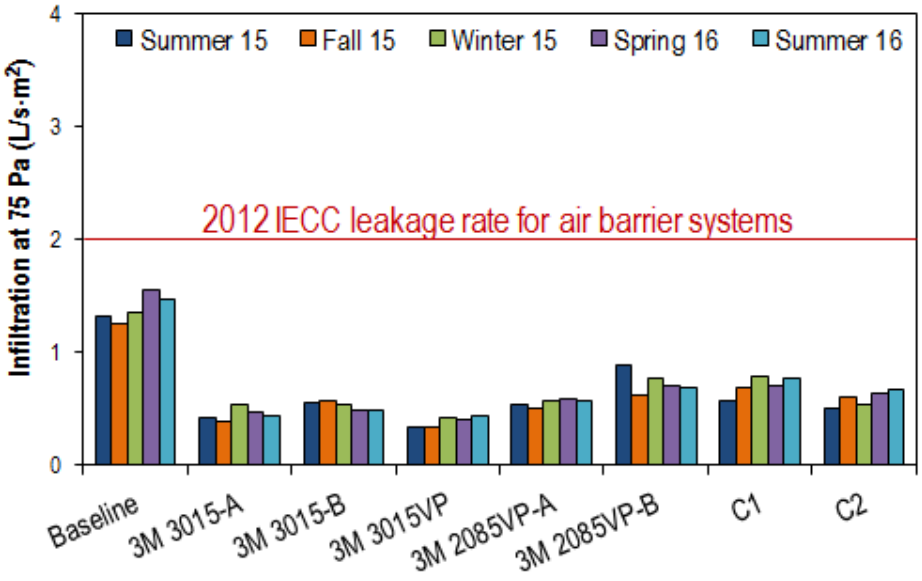
  Lessons learned on market barriers and potential solutions to commercialization of new envelope technologies

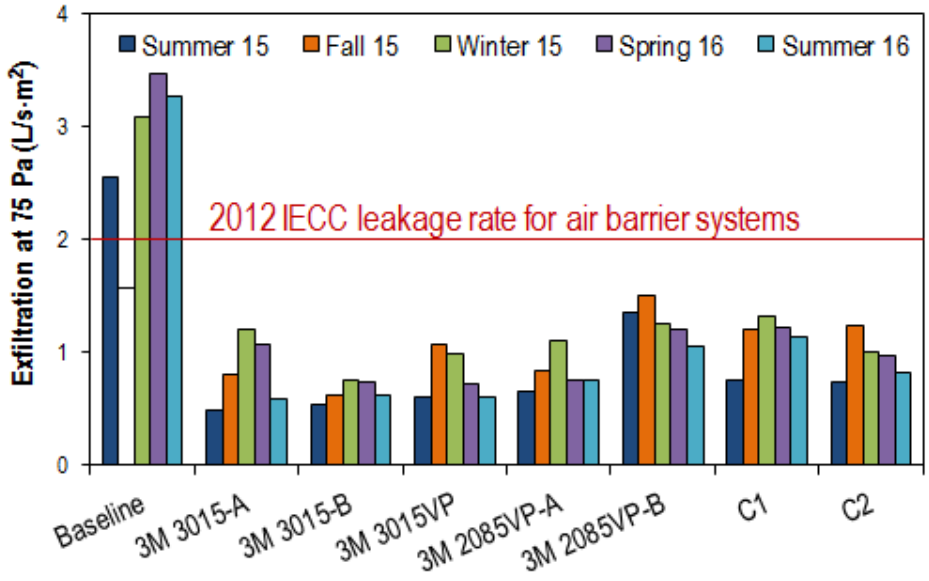


# Progress: Test Facilities

## New air barriers

- Performance similar or better than that of available products
- Complied with IECC leakage rate <2 L/s·m$^2$ @ 75 Pa




Baseline: no air barrier, just water-resistive barrier

3M 3015: air/water/vapor barrier, primer-less self-adhered membrane

3M 3015VP: air/water barrier , primer-less self-adhered membrane

3M 2085VP: air/water barrier, spray-applied membrane

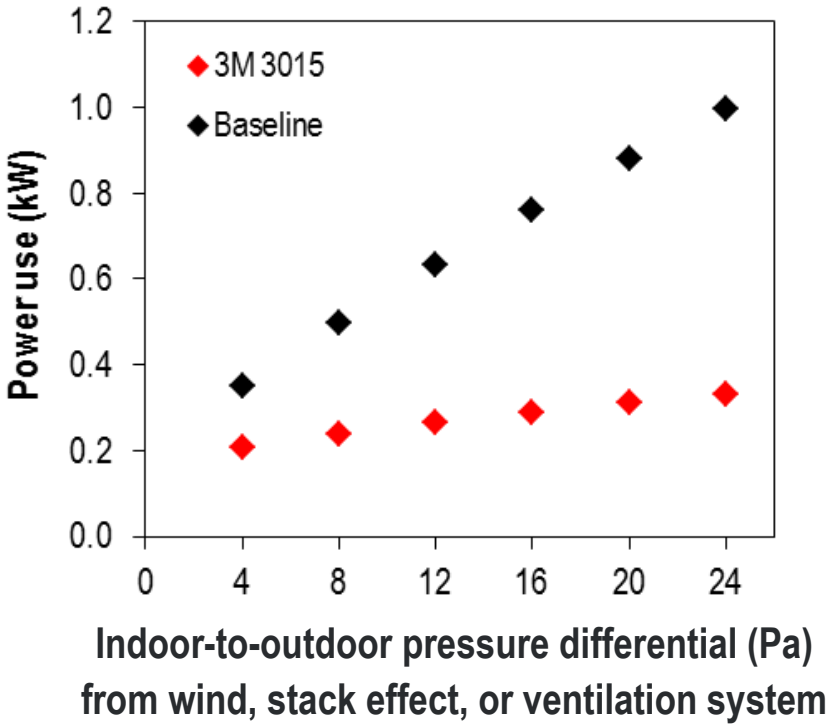
C1: competitor 1

C2: competitor 2

# Progress: Energy Models of Test Facilities

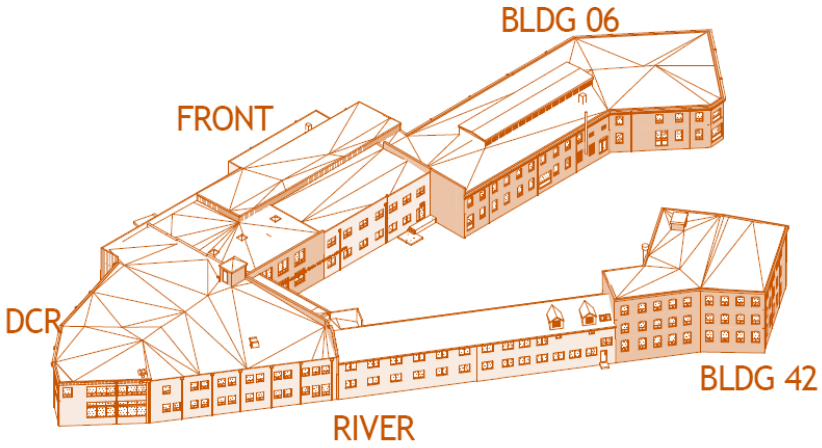
## Preliminary results from calibrated models

New air barriers can reduce energy use by 40-65% when compared to building w/o air barrier



# Progress: Chase Mills Retrofit Demonstration

- Chase Mills (partner: Sasaki Associates)
  - Watertown, MA
  - Circa ~1950s
  - Two-story office, 55,000 ft$^2$ footprint
  - Wood structure




- Reclad retrofit (spring to fall 2017)
  - Change cladding, air/water barrier and exterior sheathing
  - Design team considered using 3015VP
  - A month ago the design team decided to keep the exterior sheathing
    - Tongue and groove wood boards
    - Not suitable for self-adhered membranes
    - Will use mechanically-fastened membrane as the air and water barrier
  - DOE instructed ORNL to continue collaborating with the design team
  - Before retrofit blower door test to be conducted in March

# Progress: LifeSource Demonstration

## LifeSource (partner: LifeSource)

- Minneapolis, MN
- Circa ~2015
- Two-story organ, eye and tissue donation center
- 50,000 $ft^2$ footprint
- 3M 3015 air barrier on drywall and CMU
- Blower door test to be conducted in April


# Progress: Commercialization & Outreach

- 3M
  - 50+ certified contractors
  - 280+ presentations
  - Installation video: https://www.youtube.com/watch?v=ChyiuPvMa20
  - Annual T2M reports to DOE
- ORNL
  - Presentations or articles on air barriers and air leakage

**2015 and 2016**

Energy Exchange
Collaborate • Connect • Conserve
An educated approach to resiliency
U.S. Department of Energy Federal Energy Management Program

Better Buildings
U.S. DEPARTMENT OF ENERGY

**Building Envelope Tech Team**


BUILDINGS XIII
CONFERENCE
DECEMBER 4–8, 2016

DURABILITY + DESIGN

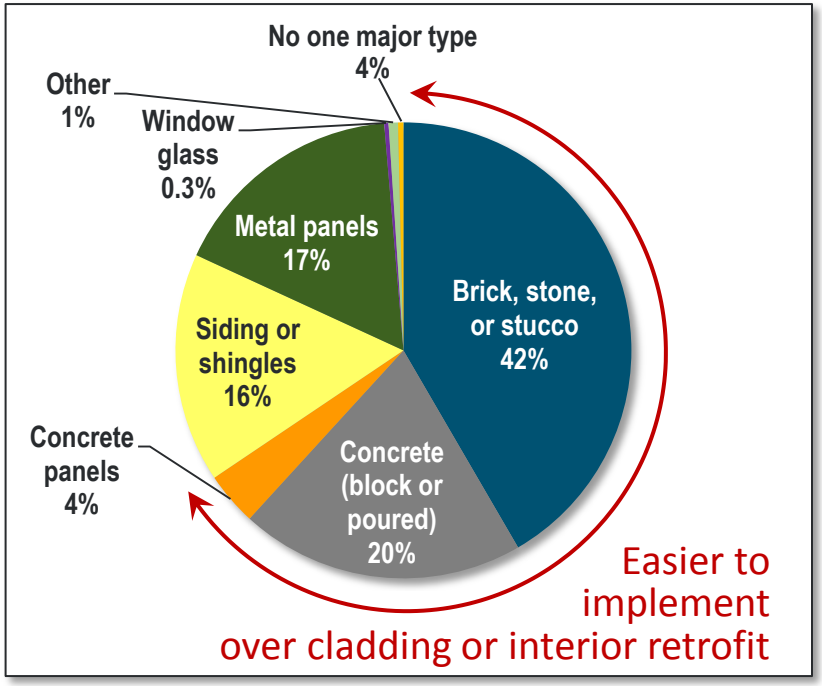
U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

# Progress: Lessons Learned

- High reluctance from the construction industry to adopt new technologies despite ease of installation

- Retrofit demonstration projects
  - Limited number as owners and ESCOS prefer to focus first on lighting and HVAC
  - One air barrier type does not fit all
    - Reclad
    - Overclad
    - Interior retrofit
  - Existing buildings with masonry façade
    - Some consultants advice not to increase thermal insulation in cold climates
    - Envelope retrofit can be accomplished but requires more planning
  - More than 12 months needed to identify, collect data, and run simulations

**Cladding in Existing Commercial Buildings**




*2012 Commercial Buildings Energy Consumption Survey*

# Integration and Collaboration

## Project Integration

- Test facilities
  - 3M coordinated the construction of the test facilities at their site
  - ORNL instrumented and collected data and calibrated models to estimate energy savings
- Demonstration projects
  - 3M and ORNL searched for new and retrofit projects
  - ORNL collects data, calibrates models, and estimates energy savings

## Partners, Subcontractors, and Collaborators

3M LifeSource ORGAN, EYE AND TISSUE DONATION SASAKI

## Communications

ORNL disseminated general information on air barriers and the importance of air leakage

2015 and 2016 Energy Exchange Collaborate • Connect • Conserve An educated approach to resiliency U.S. Department of Energy Federal Energy Management Program

Better Buildings U.S. DEPARTMENT OF ENERGY Building Envelope Tech Team

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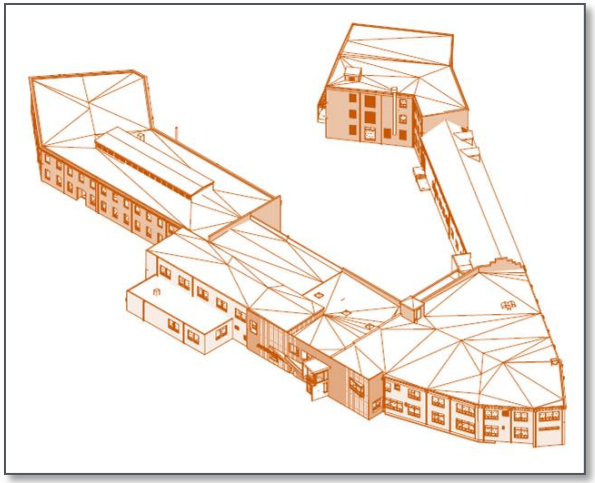
2016 SAVE THE DATE BETTER BUILDINGS SUMMIT WASHINGTON, DC • MAY 9–11

# Next Steps

- Test facilities
  - Finish calibrating models and estimate energy savings due to new air barriers
  - Measure leakage rate of test facilities to determine deterioration after two years of exposure
- Demonstration projects
  - LifeSource: blower door test in April, E+ simulations May/June
  - Chase Mills: before retrofit blower door test in March, after retrofit blower door test in fall 2017, E+ simulations fall 2017
- Final report
  - Lessons learned from the commercialization of new air barriers and demonstration projects

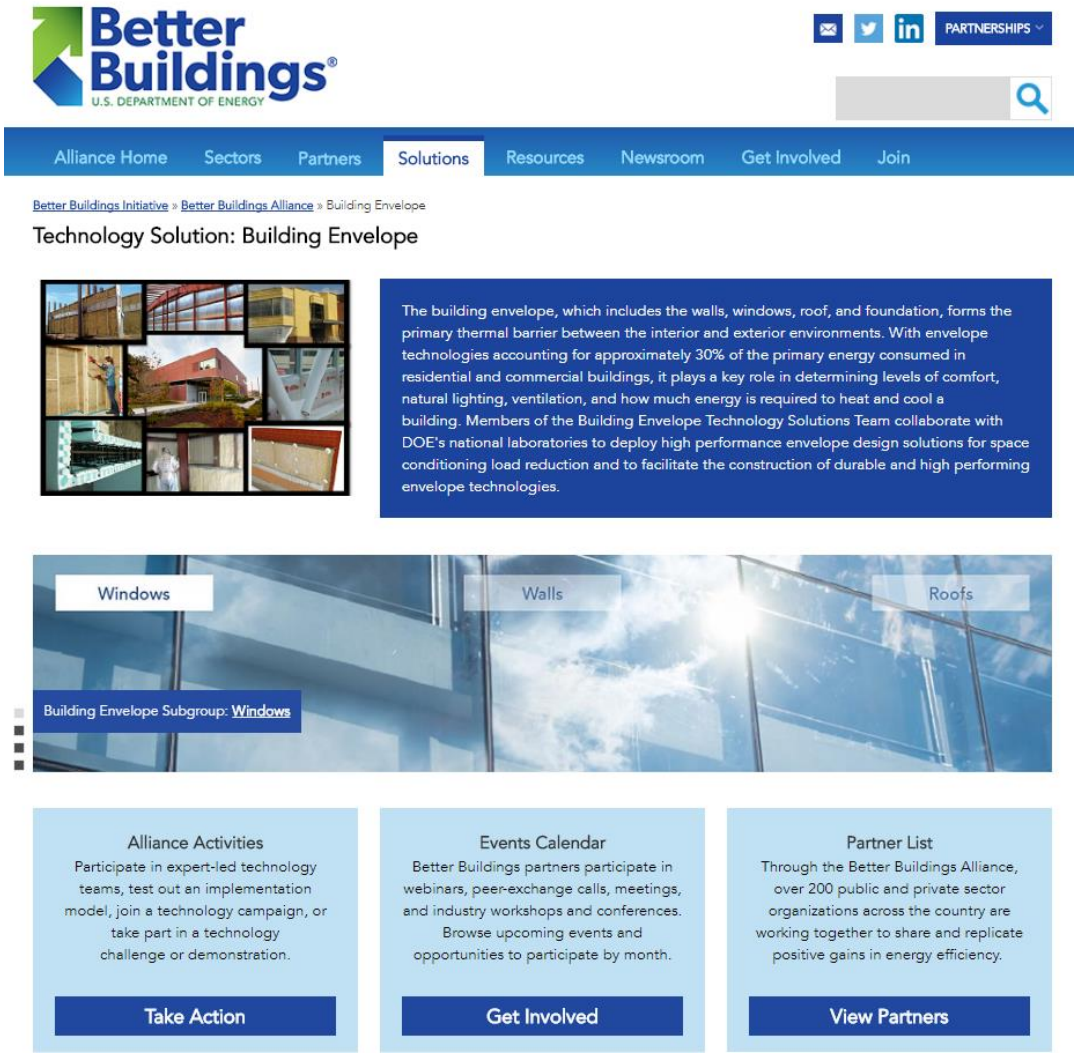
**LifeSource Building**
Minneapolis, MN



**Chase Mills Building**
Watertown, MA

# Next Steps

Incorporate reports and lessons learned into the Building Envelope Tech Team website



# REFERENCE SLIDES

# Project Budget

**Project Budget**: $1M from 1/10/15 to 9/30/17
**Variances**: slow identification of demonstration projects in FY16. Carried over $135K into FY17.
**Cost to Date**: $625K
**Additional Funding**: none

| Budget History | | | | | |
|---|---|---|---|---|---|
| FY 2015 (past) | | FY 2016 (past) | | FY 2017 (current) | |
| DOE | Cost-share | DOE | Cost-share | DOE | Cost-share |
| $350K | $650K | $215K | $405K | $435K (includes $135K carryover from FY16) | $445K |

# Project Plan and Schedule

| Project Start: Oct 1, 2015 Project End: Sep 30, 2017 | | FY15 | | | | FY16 | | | | FY17 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Completed work ■ Active task ■ | | | | | | | | | | | | | |
| Original Milestone/Deliverable ◆ Actual Milestone/Deliverable ◆ | | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 |
| **Task #** | **Task or Subtask Title** | | | | | | | | | | | | |
| 1 | **Test Facilities** | | | | | | | | | | | | |
| D1.1 | Final experimental design | | | | | | | | | | | | |
| D1.2 | Final construction drawings | | | | | | | | | | | | |
| M1.3 | Start data collection | | | | | | | | | | | | |
| D1.4 | Complete E+ models | | | | | | | | | | | | |
| 1.5 | Report w/ results from calibrated models | | | | | | | | | | | | |
| 2 | **Demonstration buildings** | | | | | | | | | | | | |
| M2.1 | Selection of 1-2 demo buildings in FY16 | | | | | | | | | | | | |
| D2.2 | Air leakage rates from 1-2 demo buildings selected in FY16 | | | | | | | | | | | | |
| D2.3 | Selection of 1-2 demo buildings in FY17 (G/NG 12/31/16) | | | | | | | | | | | | |
| D2.4 | Air leakage rates from 1-2 demo buildings selected in FY17 | | | | | | | | | | | | |
| D2.5 | Report w/ results from demo buildings | | | | | | | | | | | | |
| 3 | **Commercialization** | | | | | | | | | | | | |
| D3.1 | Presentation on market assessment | | | | | | | | | | | | |
| D3.2 | T2M report (G/NG 7/31/15) | | | | | | | | | | | | |
| D3.3 | Updated T2M report | | | | | | | | | | | | |
| D3.4 | Market evaluation report | | | | | | | | | | | | |
| D3.5 | Final T2M report | | | | | | | | | | | | |

- Deliverables on demo buildings were delayed because several potential projects did not materialize
- T2M report delayed to improve coordination between 3M and ORNL