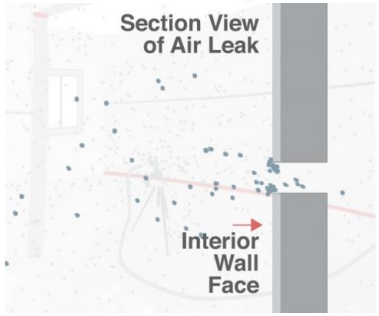
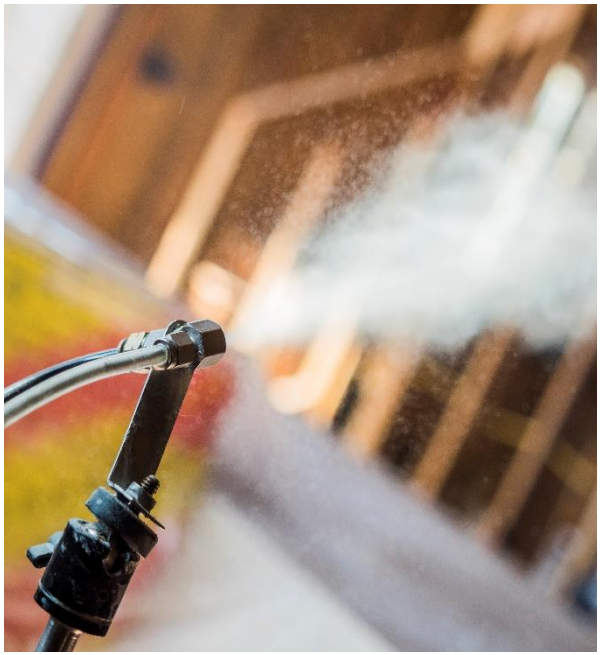
U.S. DEPARTMENT OF ENERGY

Office of ENERGY EFFICIENCY & RENEWABLE ENERGY

Aerosol Sealing in New Construction





Center for Energy & Environment
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Project Summary

Timeline:

Start date: 8/1/2016

Planned end date: 7/31/2019

Key Milestones

1. **Recruit 1st two builders; Aug. 2017**
2. 1st group of 14 houses sealed for all 4 builders; April 2018
3. 2nd group of houses sealed for all 4 builders; Jan 2019

Budget:

Total Project $ to Date:

- DOE: $223,898
- Cost Share: $56,883

Total Project $:

- DOE: $533,760
- Cost Share: $134,143

Key Partners:

University of California, Davis, WCEC (Western Cooling Efficiency Center)
Building Knowledge, Inc.
University of Minnesota, Cold Climate Housing Program
Aeroseal, LLC.

Project Outcome:

Demonstrate 70% to 90% improved house tightness through aerosol sealing. Greater tightness will save 20% to 25% of space conditioning energy use. Work with builders to identify best methods for integrating AeroBarrier sealing into the production building process.

Team

Dave Bohac

Center for Energy and Environment

Ed VonThoma

BUILDING KNOWLEDGE

Curtis Harrington

WCEC Western Cooling Efficiency Center

Amit Gupta, Aeroseal

AEROBARRIER™

Breakthrough Envelope Sealing Technology

2018 NAHB IBS™

BEST IN SHOW AND MOST INNOVATIVE BUILDING PRODUCT

Pat Huelman, Univ. MN

Challenge

High performance **moisture managed envelopes** require more effective air barriers.

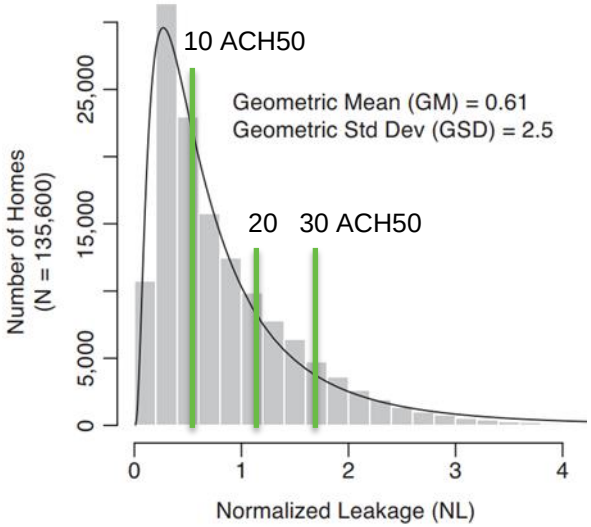
The U.S. residential building sector was responsible for 23% of U.S. energy use[1]. A total of 9.5 quads or 43% of that energy due to space conditioning. **Air infiltration responsible for 2.85 quads or 29% of that use.**

Approximately 1 million new residential units were built in 2014. Codes and standards are requiring tighter envelopes

IECC 2012/15/18: 3 – 5 ACH50

DOE Zero Energy Ready: 2 – 3 ACH50

Existing houses are relatively leaky – 135,000 houses in the LBNL ResDB database had a geometric mean leakage of about 11 ACH50[2].



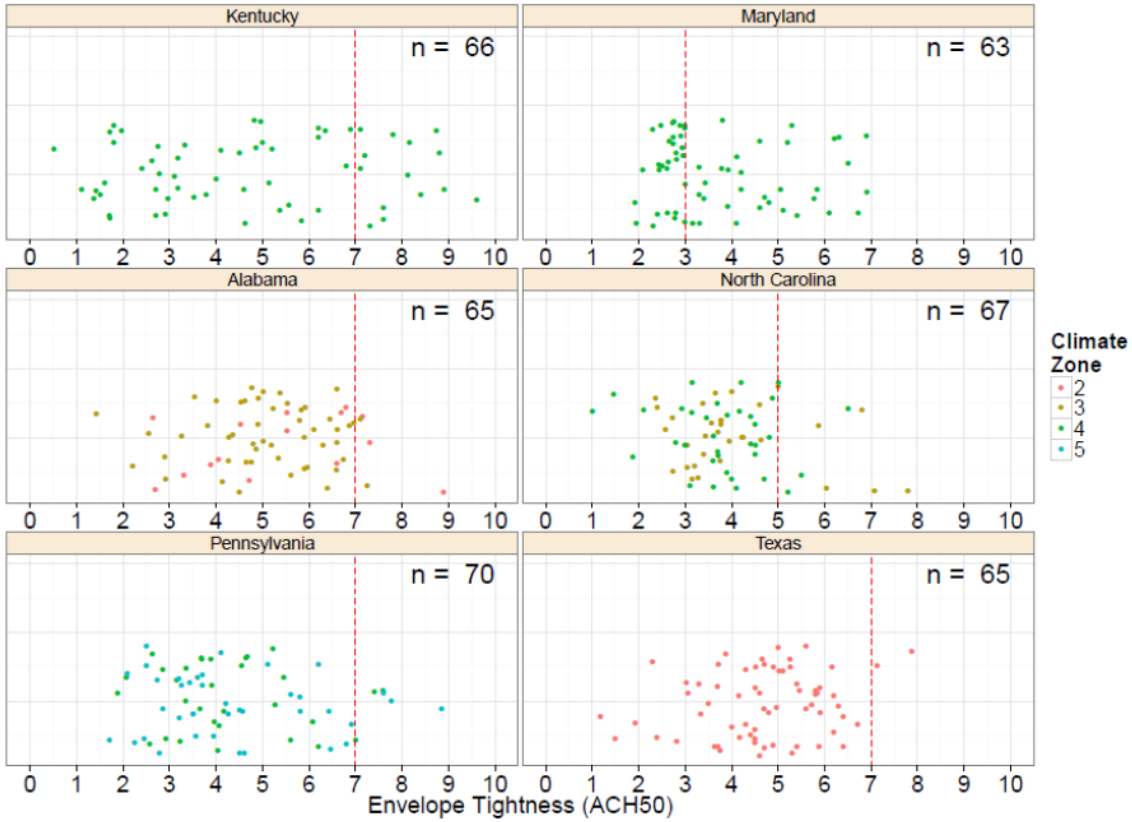
Current sealing methods can produce tight envelopes. These **add cost, crew training, quality control** and sometimes require a "learning curve" to properly seal new construction details.

1. "Windows and Building Envelope Research and Development: Roadmap for Emerging Technologies," 2014. U. S. DOE
2. Chan, WR, Joh, J, and Sherman, M. "Analysis of air leakage measurements of US houses", 2013. Energy and Buildings

Challenge

Are builders ready to meet these requirements?

87% compliance in five states with requirement of 7 and 5 ACH50. In Maryland about half of the houses met the 3 ACH50 requirement. Only 10% of houses met the DOE Zero Energy Ready program requirement (2 to 3 based on Climate Zone).



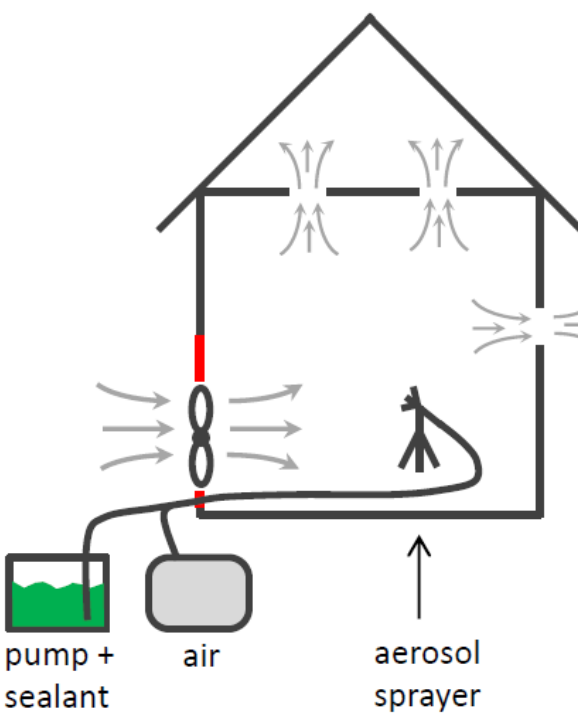
Source: "Building Energy Codes Program, Single Family Residential Energy Code Field Study", DOE 2015.

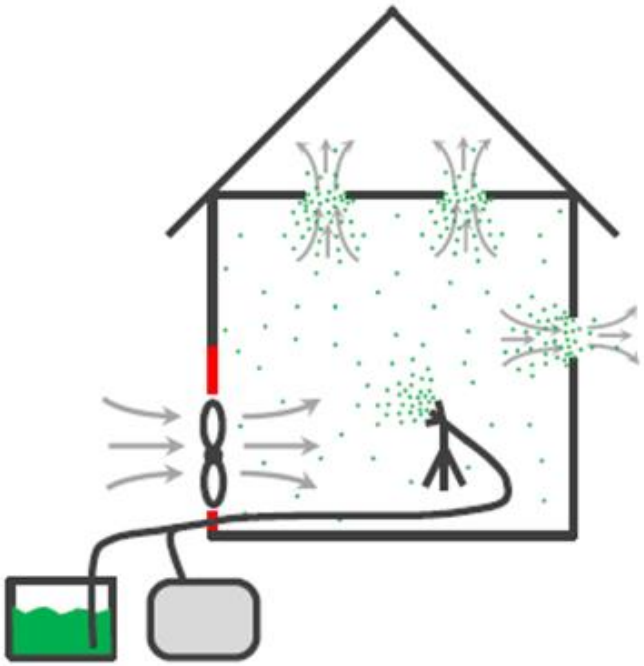
Impact

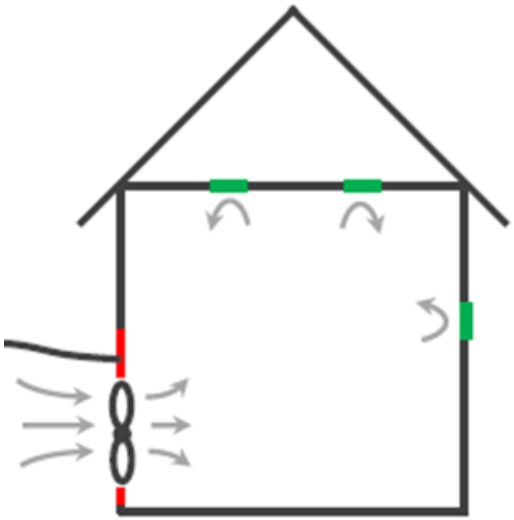
Enable easier adoption of tight envelopes needed for high performance homes

- Produce house tightness levels below DOE Zero Energy Ready requirements with stretch goal for below 0.6 ACH50 passive house requirement.
- For a sample of new Minnesota homes, reducing house tightness from 3 to 0.5 ACH50 saved 16.5% space heating energy and reduced HERS rating by 5.
- Average tightness was 4.6 ACH50 for new houses in 6 state code study. An 80% improvement to 0.9 ACH50 would save 20% to 25% in space conditioning energy.
- Flexible application time – can be successfully applied at multiple stages of construction.
- Simplified sealing – AeroBarrier sealing at one point during construction can replace conventional sealing by multiple trades and multiple stages.
- Conservative" infiltration estimate not required for HVAC sizing - may reduce equipment size
- More reliable with confirmed tightness at end of process

Approach

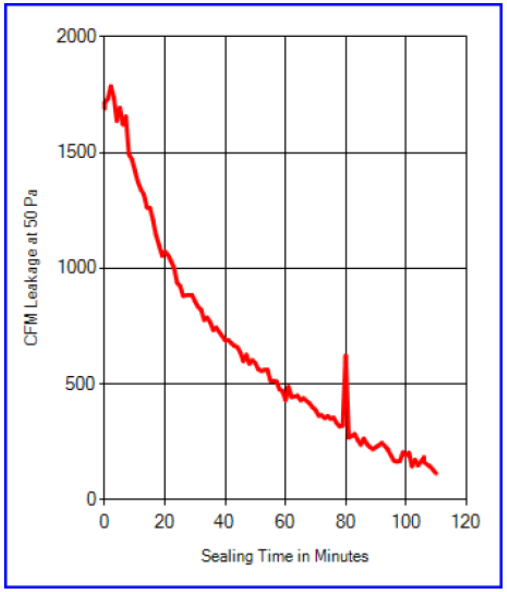






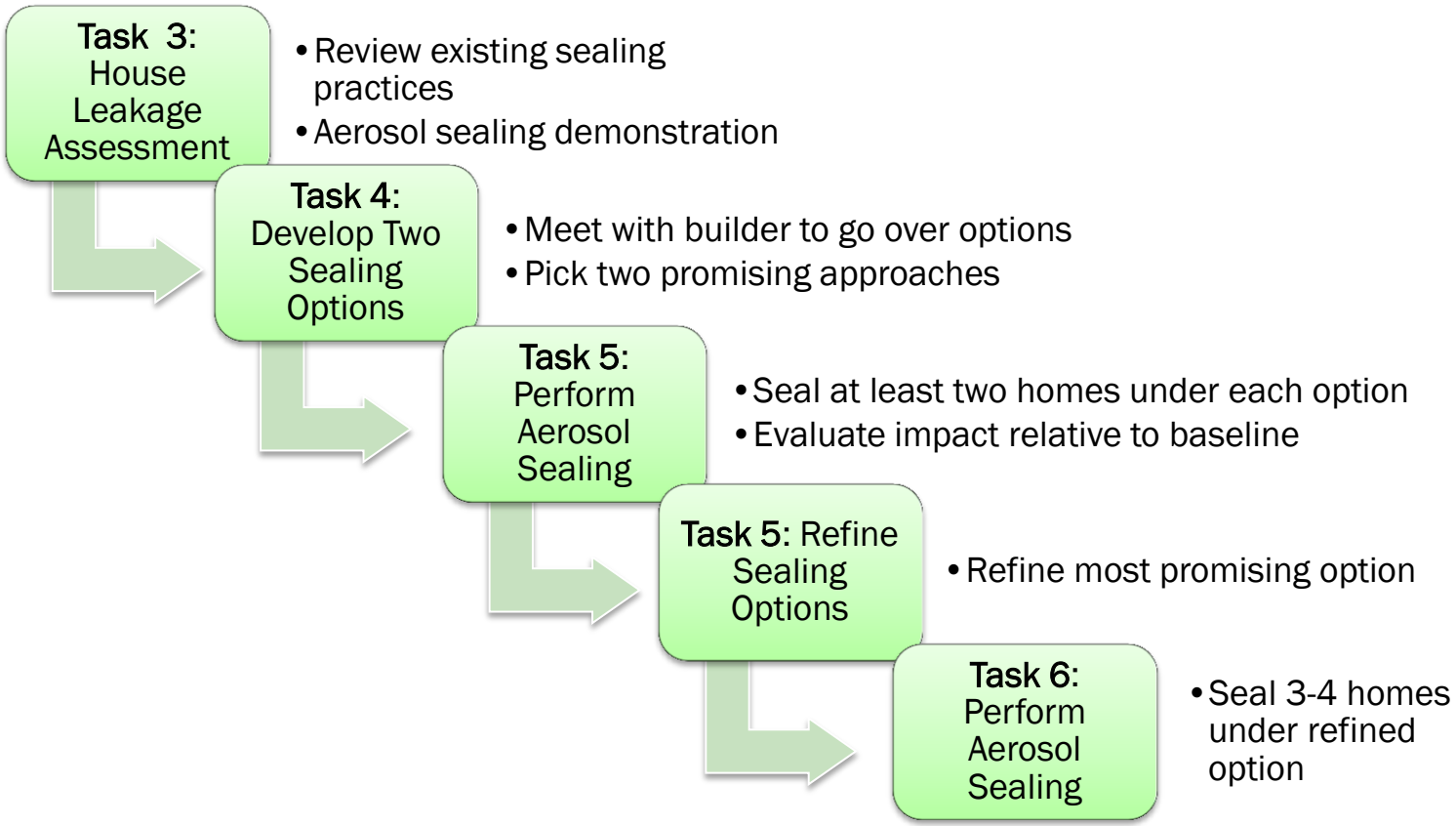
Bottom plate/sheathing gap

Missing foam



Approach

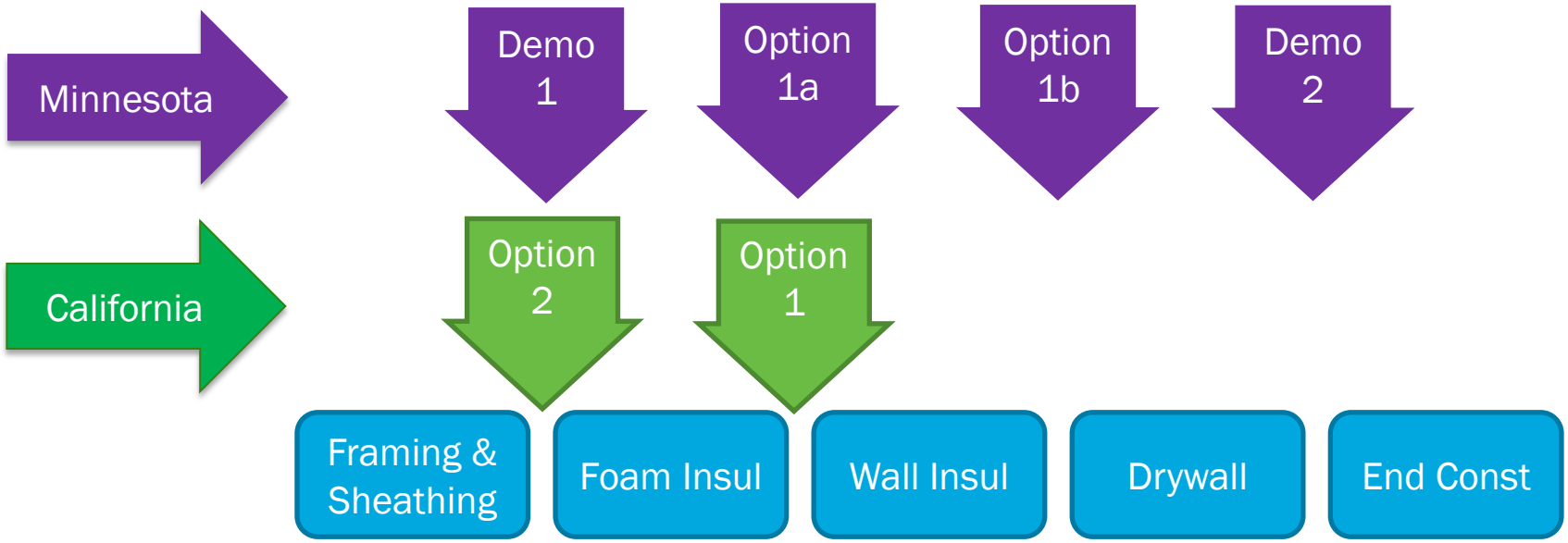
Iterative process to identify successful options for integrating AeroBarrier into the construction process.



Two builders in Minnesota and two in California. All sealing performed by AeroBarrier contractors.

Approach

When can AeroBarrier be applied effectively?



Progress

First California Builder – First Two Options

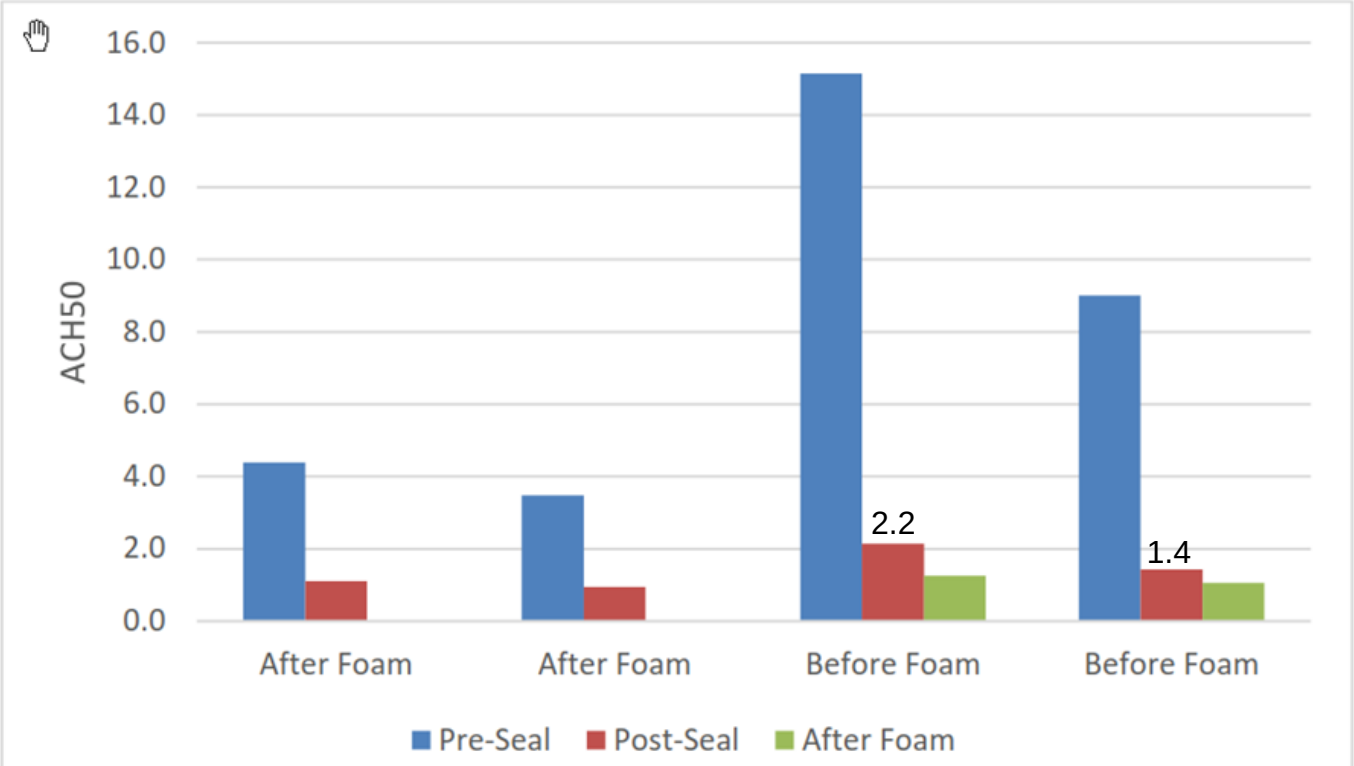
- **High performance, conditioned attic homes that use open-cell spray foam under attic roof deck**
- **Apply AeroBarrier before or after attic spray foam**
  - Option 1: after spray foam
  - Option 2: before spray foam
- **Compare sealing effectiveness and time**
  - If tightness target reached without foam, less expensive insulation methods can be considered.

Corner of wall assembly

Under trusses

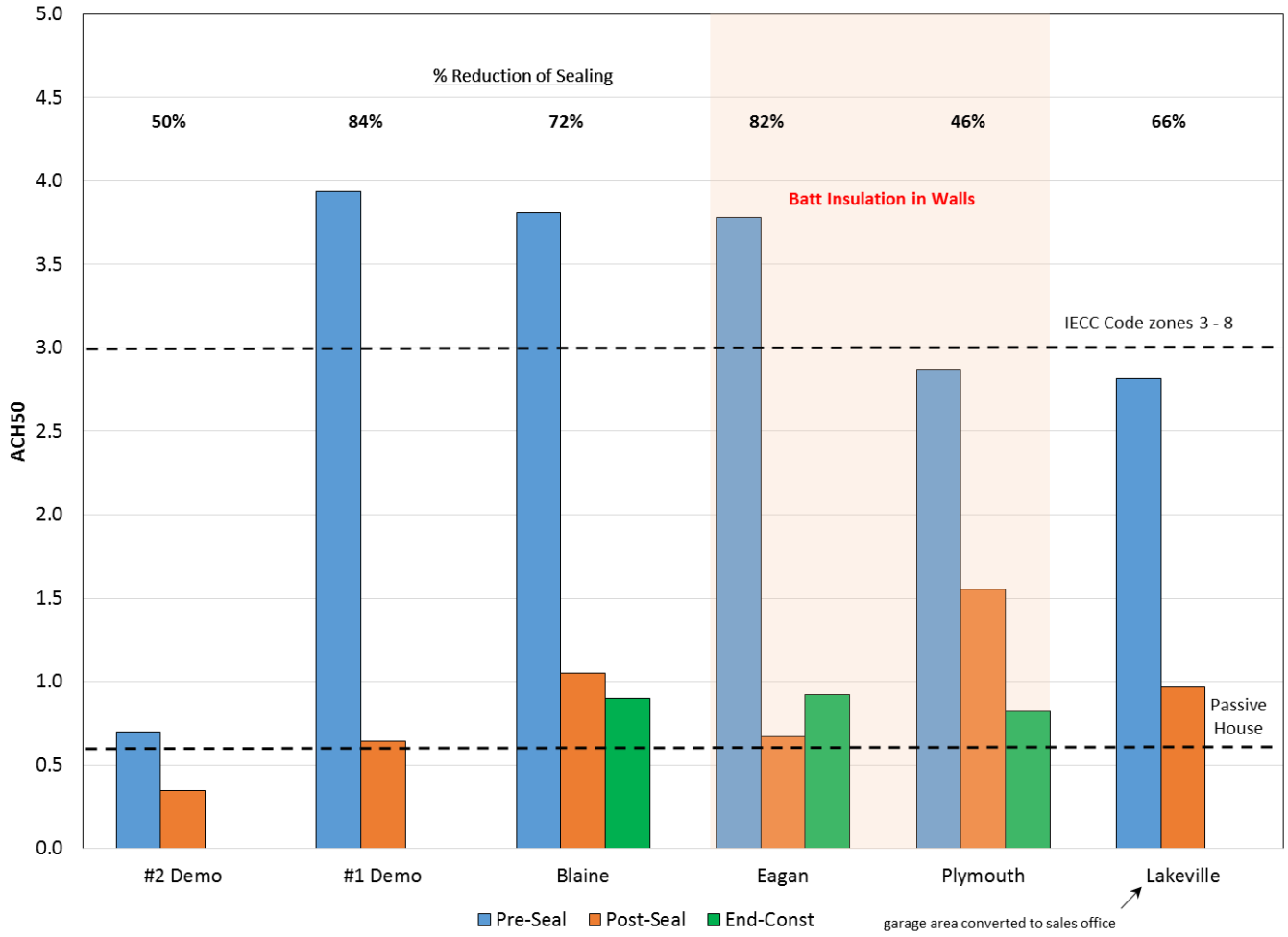
Progress

- Both options resulted in tightness below 1.3 ACH50 – 75% better than baseline
- AeroBarrier applied after foam was slightly tighter (1.03 ACH50) than application before foam (1.15 ACH50)
- Tightness of 2.2 and 1.4 ACH50 after AeroBarrier shows spray foam not needed to achieve tightness goal – other insulation methods can be considered



Progress

First Minnesota Builder Results



Seal after spray foam on rim joists and before drywall

Progress

Minnesota Builders Overall Results

- Tightness of three completed houses
  - Average = 0.88 ACH50, 0.07 CFM50/ft^2
  - 41% tighter than two control houses
  - Average 56% tighter than Zero Energy Ready requirement of 2.0 ACH50
- Average tightness = 1.06 ACH50 after sealing and before drywall
- Demonstrates that poly sheet on wall and air-tight electric boxes not required as air barrier
- Builders have not eliminated poly – will assist with cost savings estimates
- Tightness of three houses sealed in March was below 0.6 ACH50
- Successfully sealed at various stages of construction – except after wall insul & before drywall
- Project demonstrations and measured tightness improvements provide greater confidence to contractors who are considering this disruptive technology.

Stakeholder Engagement

- Local builders invited to view sealing work.
- Sealing performed by AeroBarrier contractors
- Presentation at utility new construction program kickoff meeting.
- Enhance work scope to include demonstration sealing for Minnesota builders with challenging units (slab on grade and townhomes)
- National conference presentations: EEBA, RESNET, HPC, ACEEE Summer Study.
- Periodical articles: Professional Builder and Home Energy (?)
- Project results have been used by AeroBarrier to promote service.

Project Overview:

MANDALAY HOMES

Project: DOE Challenge Home
Builder: Mandalay Homes
Location: Prescott, Arizona

Mandalay Homes – first production builder to use AeroBarrier for all of their homes (not part of project)

- Sealed 115 homes from July 17' to March 18'
- Sealed attics with spray foam on walls and roof deck
- Homes sealed after foam/before drywall
- Average tightness 0.7 ACH50 (80% reduction)

7X WINNER
HOUSING INNOVATION AWARD
ZERO
ENERGY READY HOME
U.S. DEPARTMENT OF ENERGY

Remaining Project Work

California

- **Final leakage tests when Builder #1 homes are complete**
- **Work with Builder #2 high performance (sealed) attics**
  - Owens Corning box netting attic insulation
  - AeroBarrier produce tighter houses than current sealing?
- **Work with Builder #1 vented attic houses**
  - Before drywall in place

Minnesota

- **Builder #1**
  - Final report
- **Work with Builder #2**
  - Before drywall in place
- **Expand work scope?**
  - Include 1 - 2 house sealing for Minnesota builders with residential units that are a challenge to meet 3 ACH50 requirement (slab on grade and townhomes)

Overall Project

- **Work with builders to estimate cost savings from eliminated sealing**
- **Develop installation guidelines for various applications**
- **Dissemination: final report, webinar, ….**

Thank You

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REFERENCE SLIDES

Project Budget

Project Budget: The total project budget is $669,179 (DOE: $535,037; Cost Share: $134,143). About 7% of the funds will be used by Aeroseal staff to seal houses, 11% by Building Knowledge for builder engagement, and remainder split between CEE and WCEC to implement project. Current expenses were used primarily to generate the Test Plan, recruit four builders, initial house assessments, and seal first set of houses for first MN and first CA builders.

Variances: Expenses to date have been less than expected due to the decision to move back initial field work to warmer weather.

Cost to Date: DOE: $223,898, Cost Share: $56,883; 42% of the project budget has been spent to date.

Additional Funding: Builder's staff time for project was uncertain and has not been included as cost share.

Budget History					
8/1/2016 – FY 2017 (past)		FY 2018 (current)		FY 2019 – 7/31/2019 (planned)	
DOE	Cost-share	DOE	Cost-share	DOE	Cost-share
$206,181	$52,426	$251,768	$62,694	$75,811	$19,023

Project Plan and Schedule

- Three year project that started August 2016 & planned to be completed July 2019.
- First go/no-go decision point (recruit 1st two builders) **approved August 2017**.
- First round of sealing for first builders in MN & CA **complete September 2017**.
- First round of sealing for all 4 builders **to be completed July 2018**.
- All sealing and builder reports **to be completed January 2019**.
- All work expected to be back on schedule by end of 2018

Project Schedule													
Project Start: August 2016		Completed Work											
Projected End: July 2019		Active Task (in progress work)											
	◆	Milestone/Deliverable (Originally Planned)											
	◆	Milestone/Deliverable (Actual)											
			FY2016				FY2017				FY2018			
Task				Q1 (Oct-Dec)	Q2 (Jan-Mar)	Q3 (Apr-Jun)	Q4 (Jul-Sep)	Q5 (Oct-Dec)	Q6 (Jan-Mar)	Q7 (Apr-Jun)	Q8 (Jul-Sep)	Q9 (Oct-Dec)	
Past Work													
Q5 Go/No-go: Recruit 1st 2 builders													
Q7 Milestone: 1st round sealing for 1st builders													
Q5 Milestone: MN builder 1 sealing complete													
Current/Future Work													
Q6 Milestone: CA builder 1 sealing complete													
Q8 Milestone: MN builder 2 sealing complete													
Q9 Milestone: CA builder 2 sealing complete													