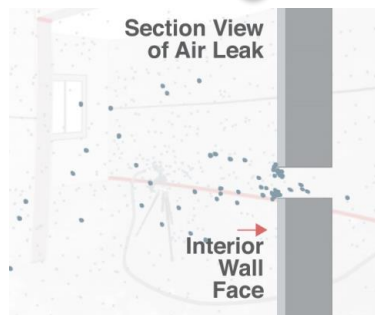


Aerosol Sealing in New Construction



Center for Energy & Environment
Dave Bohac, Director of Research
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Project Summary

Timeline:

Start date: 8/1/2016

Planned end date: 7/31/2019

Key Milestones (complete)

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: \$411,074
- Cost Share: \$104,318

Total Project \$:

- DOE: \$535,037
- 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



Ed VonThoma



Curtis Harrington



Amit Gupta, Aeroseal



Pat Huelman, Univ. MN

Challenge

High performance moisture managed envelopes require more effective air barriers

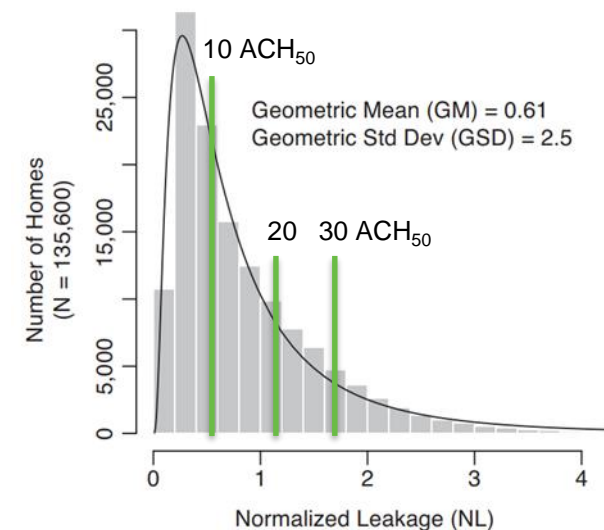
U.S. residential building sector = 23% of U.S. energy use¹

- Space conditioning = 9.5 quads or 43% of that
- Air infiltration = 2.85 quads or 29% of that

Standard construction has produced leaky houses – 135,000 houses in the LBNL ResDB database had a geometric mean leakage of about 11 ACH₅₀².

About 1 million new residential units built in 2014. With requirements for tighter envelopes.

- IECC 2012/15/18: 3 – 5 ACH₅₀
- DOE Zero Energy Ready: 2 – 3 ACH₅₀



Tight envelopes can be achieved with current sealing methods

- Current methods require additional cost, time, quality control, and crew training
- Reliable method is needed for consistently tight envelopes

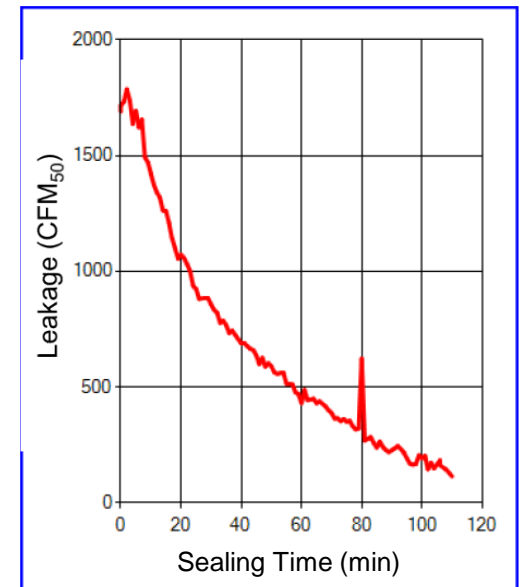
1. "Windows and Building Envelope Research and Development: Roadmap for Emerging Technologies," 2014. U. S. DOE

2. Chan, WR, Joh, J, and Sherman, M. "Analysis of air leakage measurements of US houses", 2013. Energy and Buildings

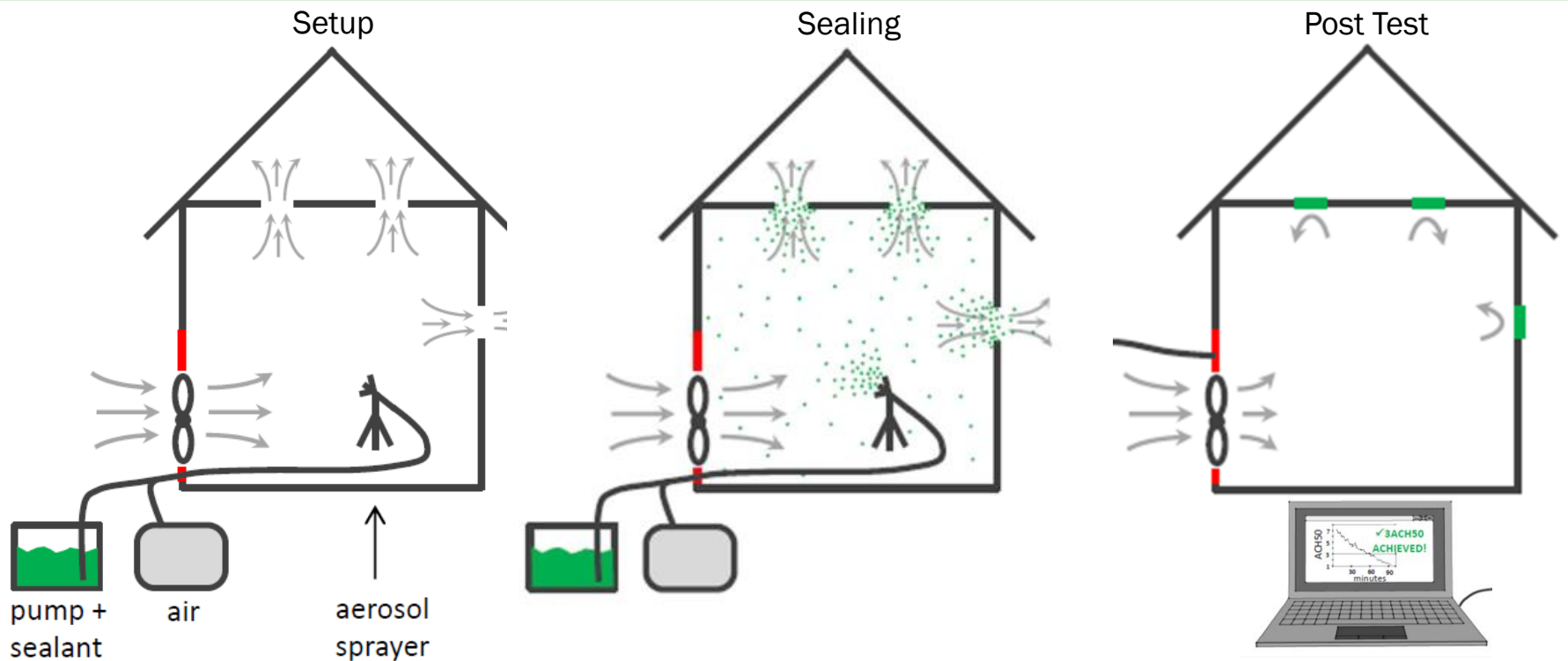
Impact

Enable tight envelopes for high performance homes

- Goals: DOE Zero Energy Ready; Stretch - 0.6 ACH₅₀ passive house
- Minnesota: ↓ tightness 3 to 0.5 ACH₅₀ >> ↓ 6.5% space heating & ↓ HERS by 5
- 6 state code study: 4.6 ACH₅₀ - 80% improvement saves 20% to 25%
- Can apply at multiple stages of construction
- Simplified sealing: sealing at one point during construction can replace conventional sealing by multiple trades at multiple stages
- Reliably lower infiltration can reduce HVAC sizing
- **More reliable with confirmed tightness at end of process**



Approach



Bottom plate/sheathing gap



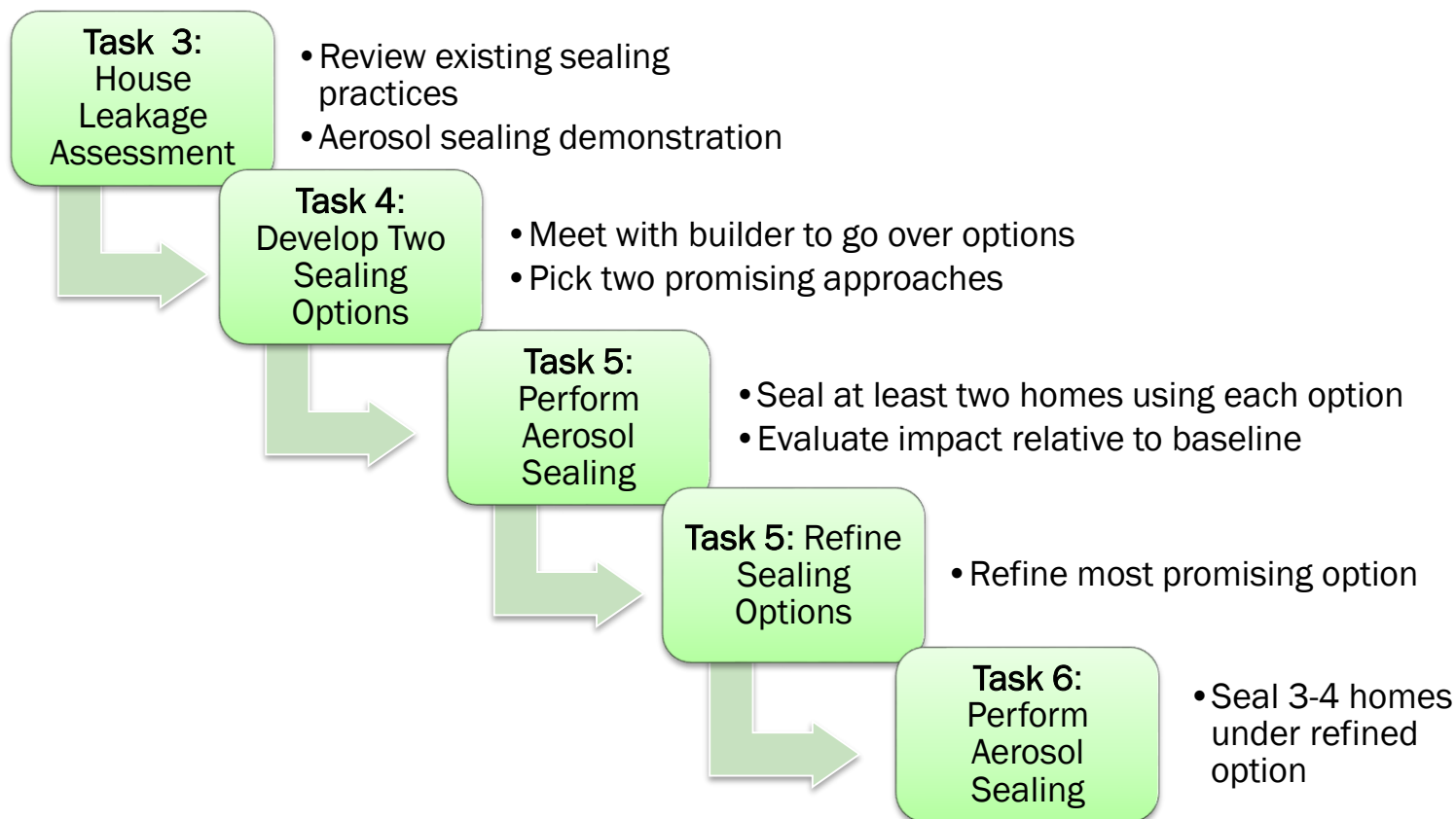
Missing foam



Penetrations

Approach

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

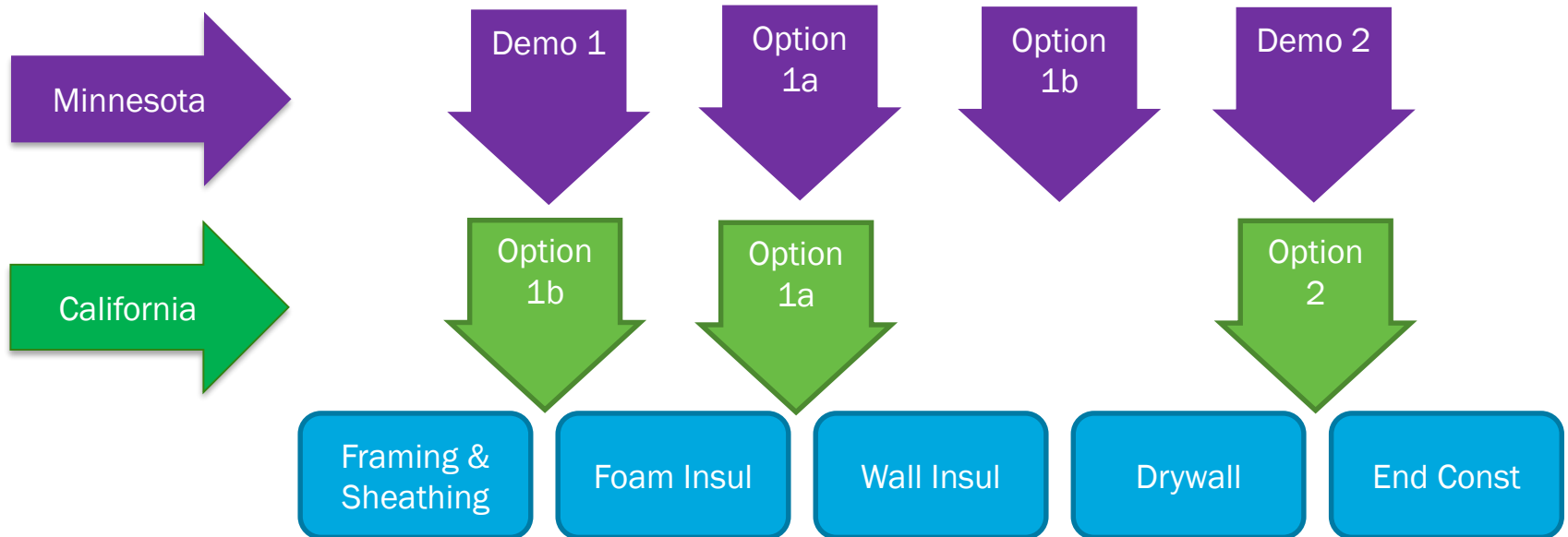


Required: two builders in Minnesota and two in California.

Added Minnesota builders to demonstrate technology for challenging situations.

Approach

When can AeroBarrier be applied effectively?



Progress

California Builders: sealed and vented attics

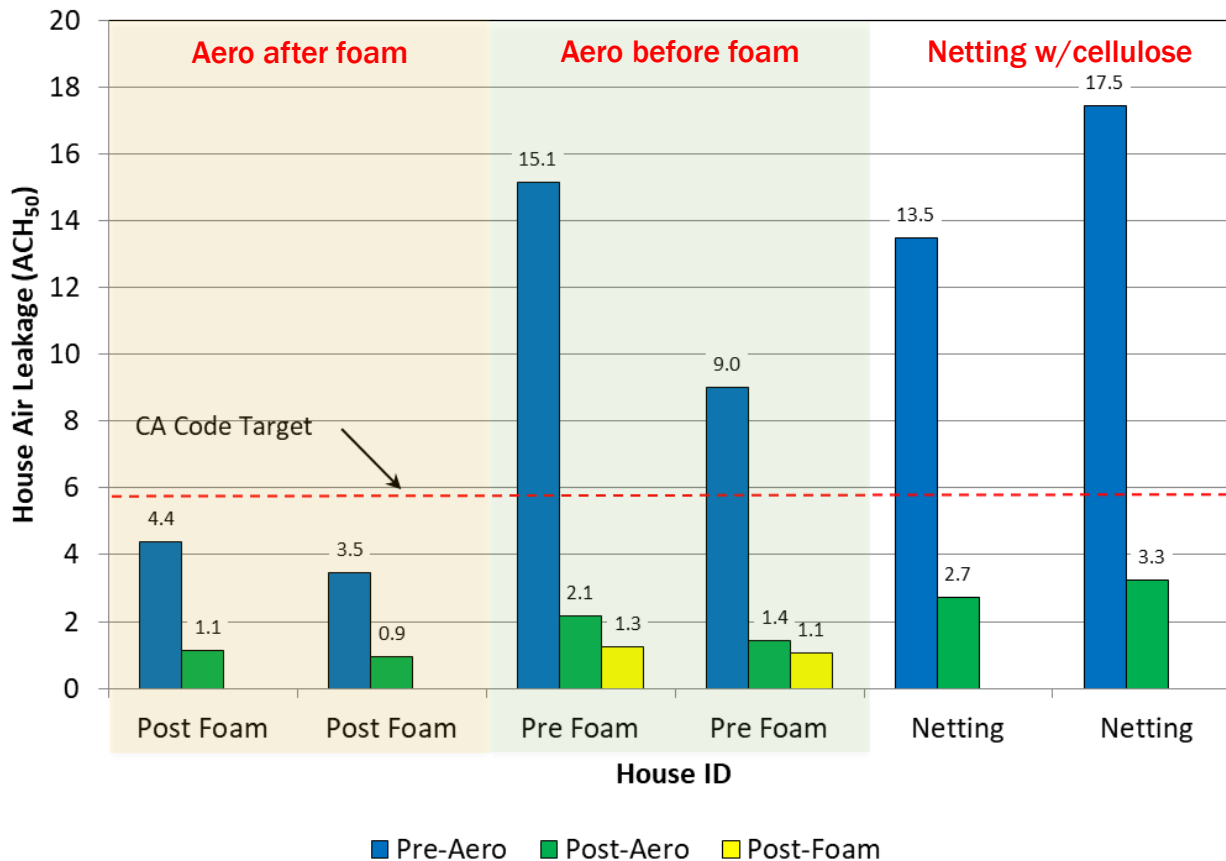
- Sealed, conditioned attics
 - Open-cell spray foam under attic roof deck
 - Sealed before wall insulation
 - Option 1a: after spray foam
 - Option 1b: before spray foam
 - Attic: netting and blown-in cellulose insulation
 - Sealed before wall & attic insulation
- Vented attics
 - Blown-in insulation in attic
 - Sealed after drywall, mud and tape



All houses: fiberglass/mineral wool in wall cavity

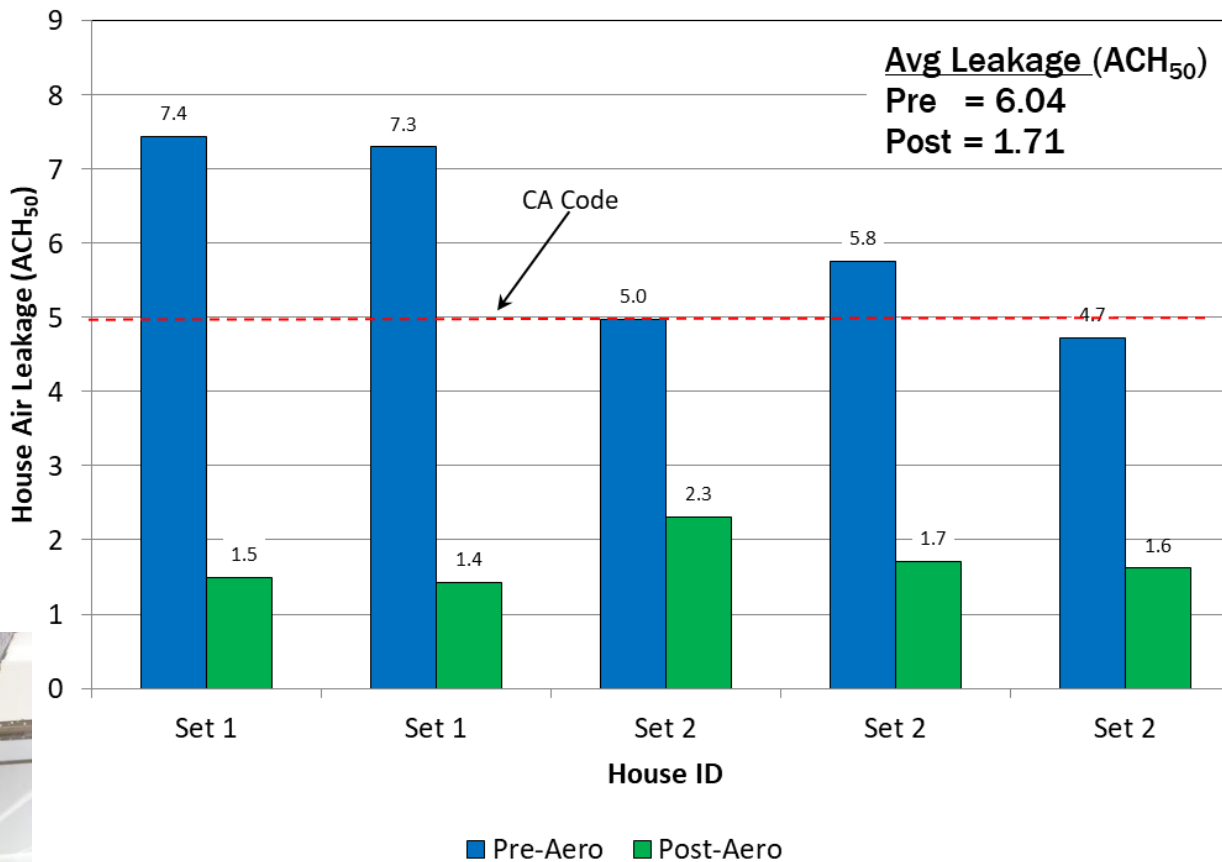
Progress: sealed attic houses

- Pre-Foam houses: 2.1 and 1.4 ACH₅₀ after AeroBarrier >> spray foam not needed
- 4 Foam houses: 78% tighter than target & 39% tighter than control houses
- Netting houses: 49% tighter than target & 48% tighter than control houses
- All: 80% average reduction (73% to 86%) , 1.6 ACH₅₀ at end-construction



Progress: vented attic houses

- Average leakage reduced from 6.0 to 1.7 ACH₅₀
- 70% average reduction (54% to 80%)
- 66% tighter than 5 ACH₅₀ target
- End of construction tests not yet complete



Progress

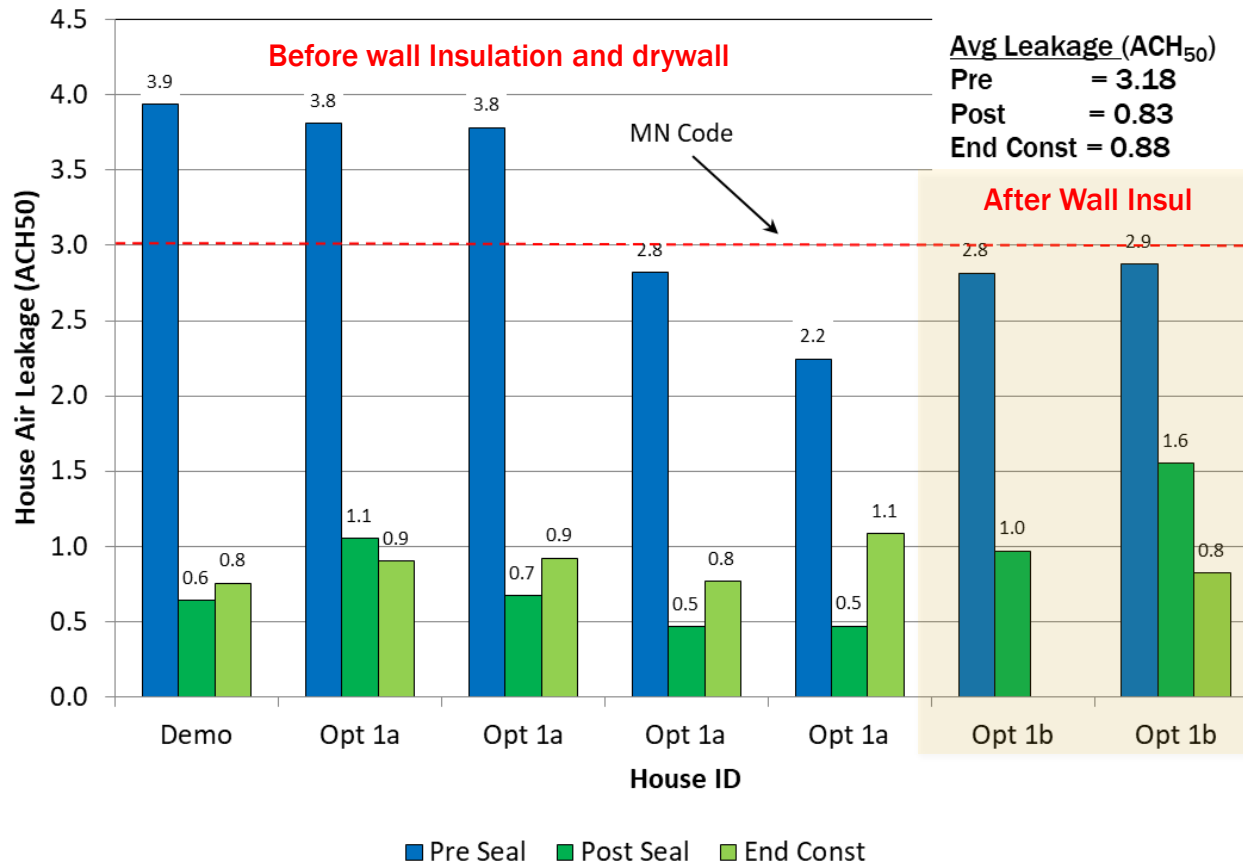
Minnesota Builders

- Vented attics
- Closed-cell spray foam at rim joist
- Interior poly wrap on exterior walls and top floor ceiling
- Fiberglass/mineral wool in wall cavity

- 13 of 18 sealed before drywall
 - 2 of 13 sealed after wall insulation
 - Ceiling poly wrap used to complete air barrier

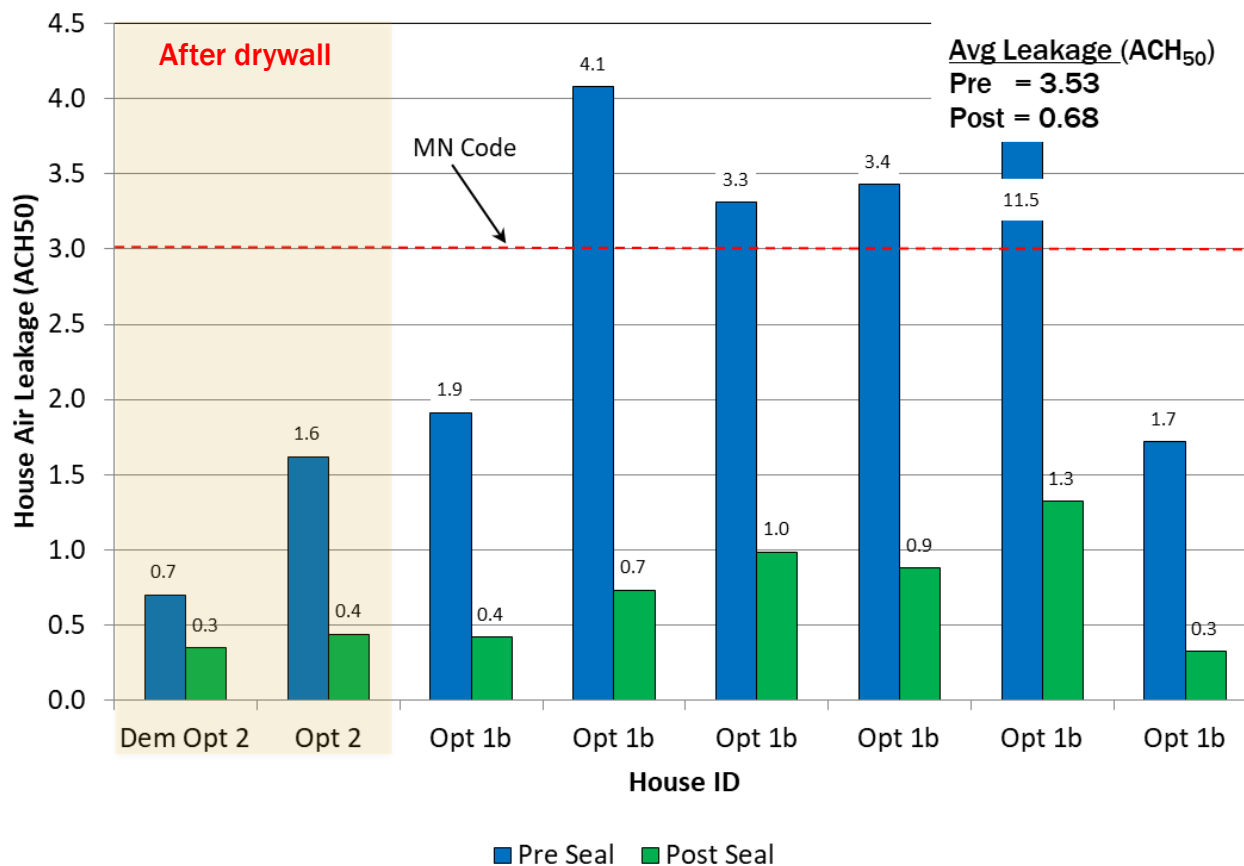
Progress: first builder – before drywall

- Average leakage reduced from 3.2 to 0.8 ACH₅₀, 73% average reduction (46% to 84%),
- 72% tighter than 3 ACH₅₀ code requirement
- Seal before wall insulation
- End of construction test typically within 150 CFM₅₀ of post-aero test



Progress – other builders

- Average leakage reduced from 3.5 to 0.5 ACH₅₀, 75% average reduction (50% to 88%),
- 77% tighter than 3 ACH₅₀ code requirement
- Half met passive house requirement and only 1 above 1 ACH₅₀
- End of construction tests not yet complete



Stakeholder Engagement

- Local builders invited to view sealing work
- Sealing performed by local 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 triplex)
- National conference presentations (EEBA, RESNET, HPC, ACEEE) & Home Energy articles
- Project results have been used by AeroBarrier to promote service

Mandalay Homes –

First production builder to use AeroBarrier for all of their homes

- 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)



Project Overview:



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

Remaining Project Work

Almost done

- End of construction air leakage tests for CA vented attic houses
- Summary reports
- Builder feedback on aerosol sealing tradeoffs vs conventional sealing
- Develop installation guidelines for various applications
- Energy savings analysis
- 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 is being used by AeroSeal staff to seal houses, 11% by Building Knowledge for builder engagement, and remainder split between CEE and WCEC to implement project. Remainder of project funds (23%) will be used for builder reports, analysis, and end-of-project dissemination.

Variations: Expenses to date have been less than expected due to delays in the sealing work.

Cost to Date: DOE: \$411,074, Cost Share: \$104,318; 77% 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	\$200,002	\$50,662	\$128,854	\$31,055

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.
- Second go/no-go decision point approved.
- All aerosol sealing is complete.
- All field work is complete except end-of-construction tests on 3 California houses and 3 Midwest residences.
- Builder reports, energy savings analysis, and end-of-project dissemination to be completed by July 2019.