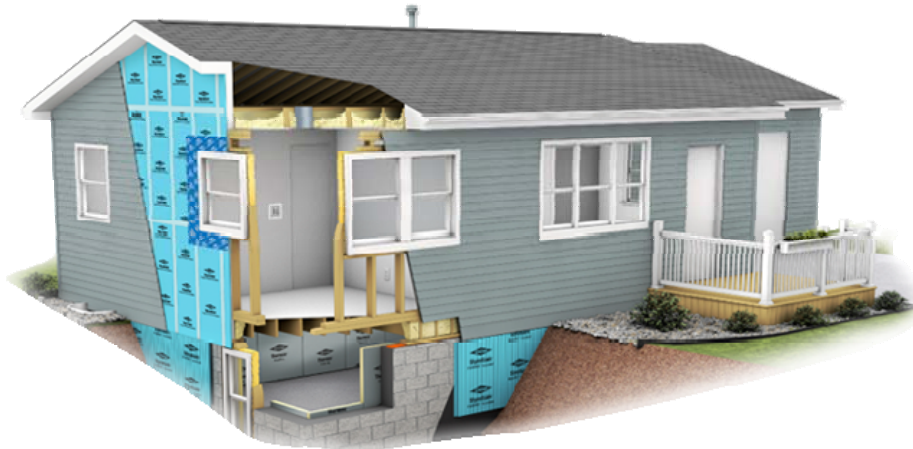




## Building Solutions

A business unit of Dow Advanced Materials Division

# Air Infiltration Solutions and Products



**Linda Jeng and Devin Marino**  
**Feb., 2013**



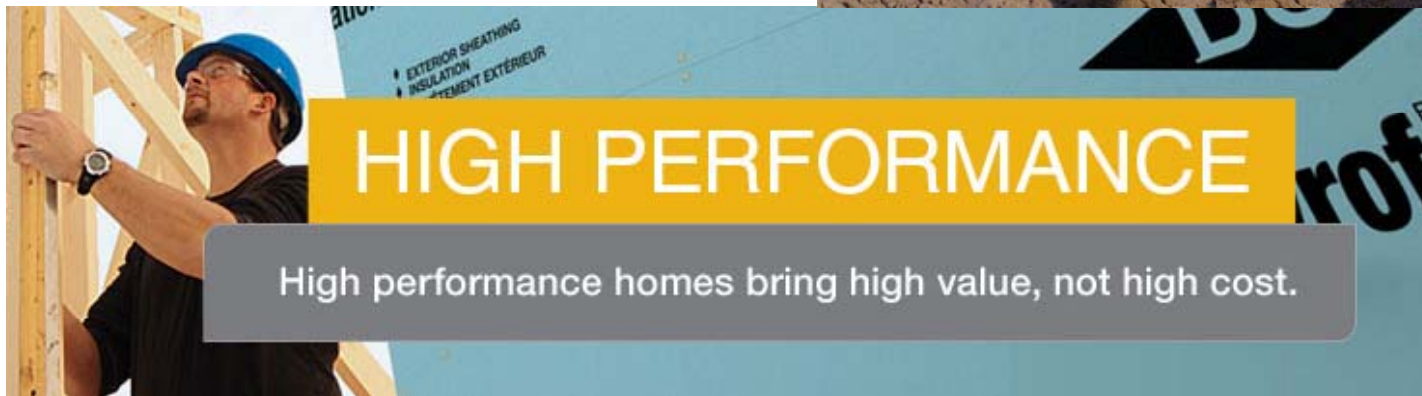
**RESNET**  
Residential Energy Service Network

# Agenda



Building Solutions

- ❑ Introduction
- ❑ New Construction Case Study
- ❑ Retrofit Case Study
- ❑ Air Sealing Product Study
- ❑ Demo: Products



# Current Situation



Building Solutions

- ❑ Based on information from DOE, as many as **116 MM existing homes, about 500, 000 new homes each year** in US need different degrees of insulation and air sealing
- ❑ U.S. Department of Energy reports air infiltration accounts for approximately **40%** of a building's energy loss.
- ❑ Sealing and insulating can **save up to 20%** on homeowner heating/cooling costs.
- ❑ **Utilities are 2nd highest monthly bill** after mortgage, for middle income homeowners.





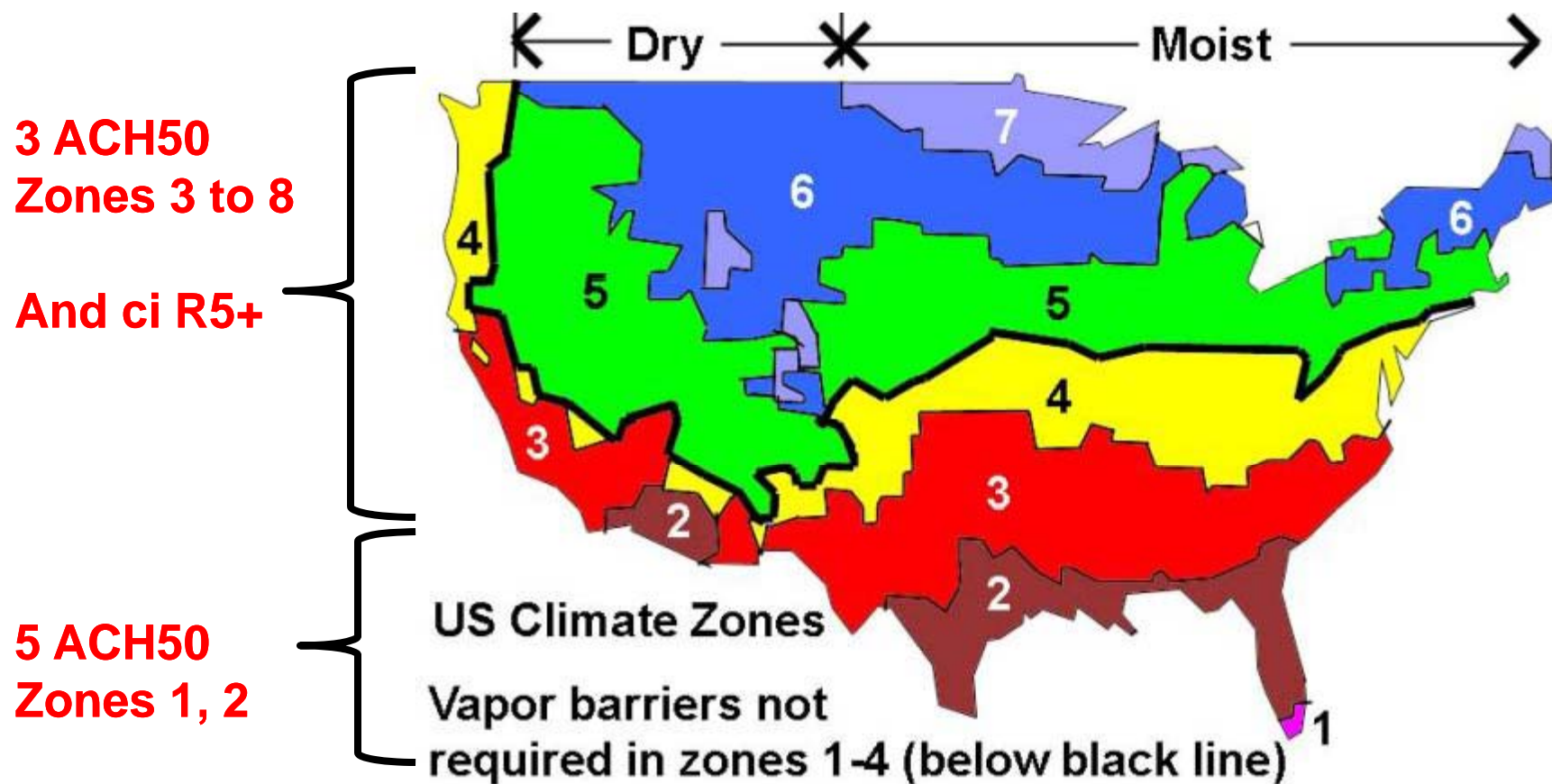
# ENERGY CODE DEVELOPMENT



Building Solutions

IECC Code Version	Zone	Wall	Ceiling	Slab	Base-ment	Crawl-space
<b>2006</b>	4	13	38	10@ 2 Ft.	10/13	10/13
	5	19/13+5	38	10@ 2 Ft.	10/13	10/13
	6	19/13+5	38	10@ 4 Ft.	10/13	10/13
<b>2009</b>	4	13	38	10@ 2 Ft.	10/13	10/13
	5	20/13+5	38	10@ 2 Ft.	10/13	10/13
	6	20/13+5	49	10@ 4 Ft.	10/13	10/13
<b>2012</b>	<b>3</b>	<b>20/13+5</b>	<b>38</b>	10@ 2 Ft.	5/13	5/13
	<b>4</b>	<b>20/13+5</b>	<b>49</b>	10@ 2 Ft.	10/13	10/13
	<b>5</b>	20/13+5	<b>49</b>	10@ 2 Ft.	<b>15/19</b>	<b>15/19</b>
	<b>6</b>	<b>20+5/ 13+10</b>	49	10@ 4 Ft.	15/19	<b>15/19</b>

## Not Just for the Northern States...

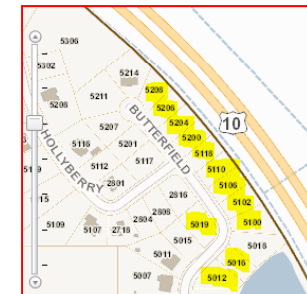


- ❑ 12 home energy efficient test home (TEETH) community in Midland, MI with partner builder
- ❑ Nation's first subdivision designed to generate scientific, whole home performance data starting 2012 for a five year project
- ❑ Fully instrumented to monitor real whole home data – 60 sensors/home!



Three homes built for each energy efficiency design, climate zone 5/6

<p><b>Baseline</b></p> <p><b>HERS 82</b></p>	<p><b>Meet 2006 IECC</b> lowest possible price point</p>	<p>Establish baseline for comparison</p>
<p><b>2012 Performance Minimum cost</b></p> <p><b>HERS 57</b></p>	<p><b>Meet 2012 IECC</b> lowest possible price point</p>	<p>Collect data for this likely choice of many builders</p>
<p><b>2012 Performance Premium Package</b></p> <p><b>HERS 57</b></p>	<p><b>Meet 2012 IECC</b> building science best practices</p>	<p>Show that with minimum additional up front cost, generate higher ROI through lower energy use</p>
<p><b>Beyond Code Premium Package</b></p> <p><b>HERS – mid 40s</b></p>	<p><b>Exceed 2012 IECC</b> Renewable ready</p>	<p>With more significant up front cost, achieve higher ROI</p>





# TEETH Design Details



Building Solutions

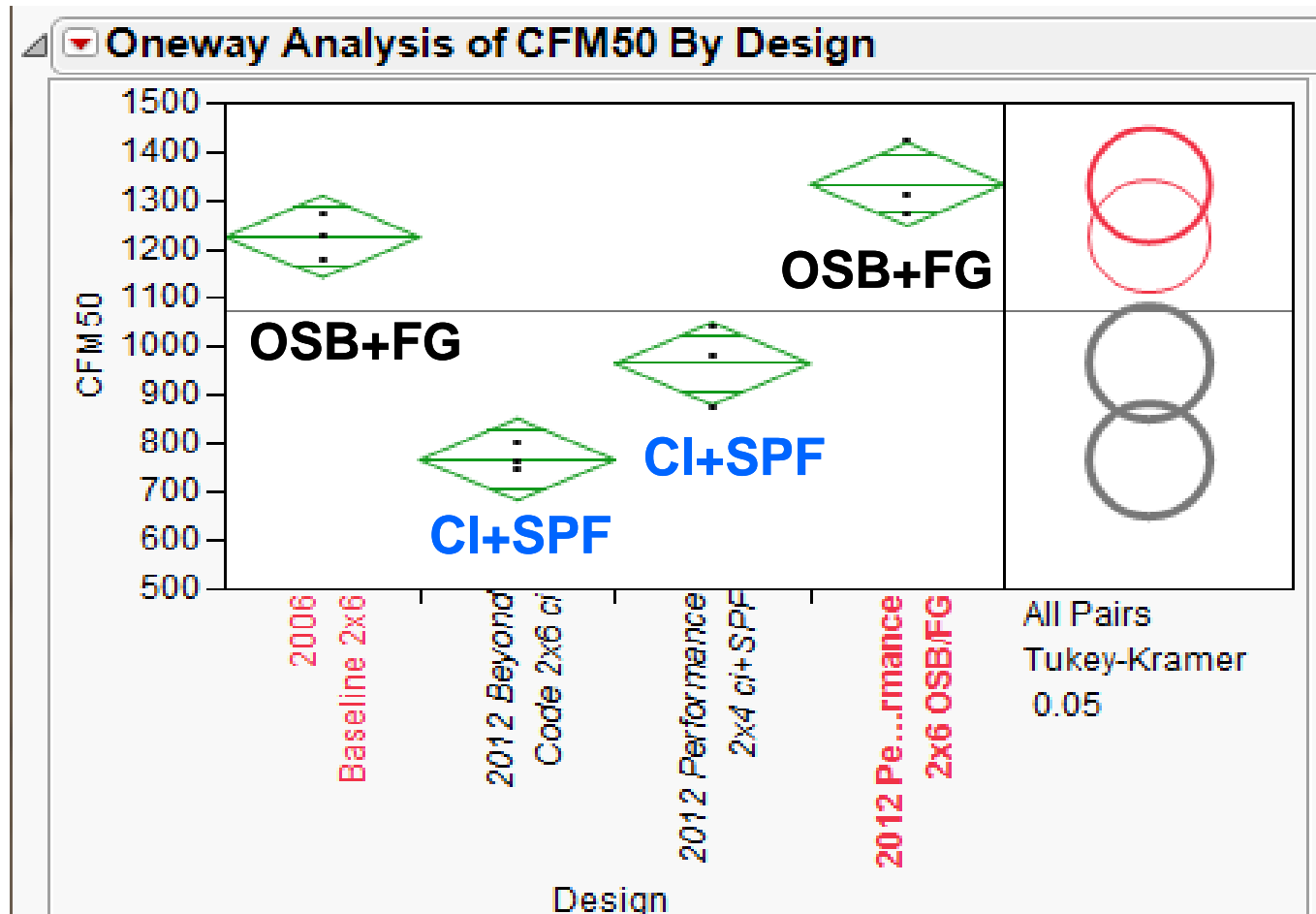
Energy Code Compliance:	2006 Prescriptive	2012 Performance 2x6	2012 Performance 2x4 ci	Beyond 2012 Performance
<b>Design HERS</b>	<b>82</b>	<b>57</b>	<b>57</b>	<b>45</b>
<b>Avg Actual</b>	<b>78</b>	<b>58</b>	<b>54</b>	<b>48</b>
<b>Avg Measured</b>	<b>1,227</b>	<b>1,336</b>	<b>965</b>	<b>768</b>
<b>Avg ACH50Pa</b>	<b>2.8</b>	<b>3.1</b>	<b>2.2</b>	<b>1.8</b>
<b>Total con. floor</b>	3.076	3.076	3.076	3.076
<b>RIM &amp; BAND JOIST</b>				
<b>Total R-Value of Rim Joist</b>	<b>19</b>	<b>19</b>	<b>(R5 ci +R16) 21</b>	<b>26</b>
<b>FOUNDATION</b>				
<b>Total R-Value of Basement Wall</b>	Unfinished = R-10 continuous Finished = R-13 stud cavity	Unfinished = R-15 continuous Finished = R-19 stud cavity	Unfinished = R-15 continuous Finished = R-15 continuous	Unfinished = R-20 continuous Finished = R-20 continuous
<b>ABOVE GRADE WALL</b>				
<b>Stud Dimensions</b>	<b>2" X 6"</b>	<b>2" X 6"</b>	<b>2" X 4"</b>	<b>2" X 6"</b>
<b>Total R-Value Above Grade Wall</b>	<b>19</b>	<b>19</b>	<b>21.5</b>	<b>41.5</b>



# TEETH Blower Door Testing



Building Solutions



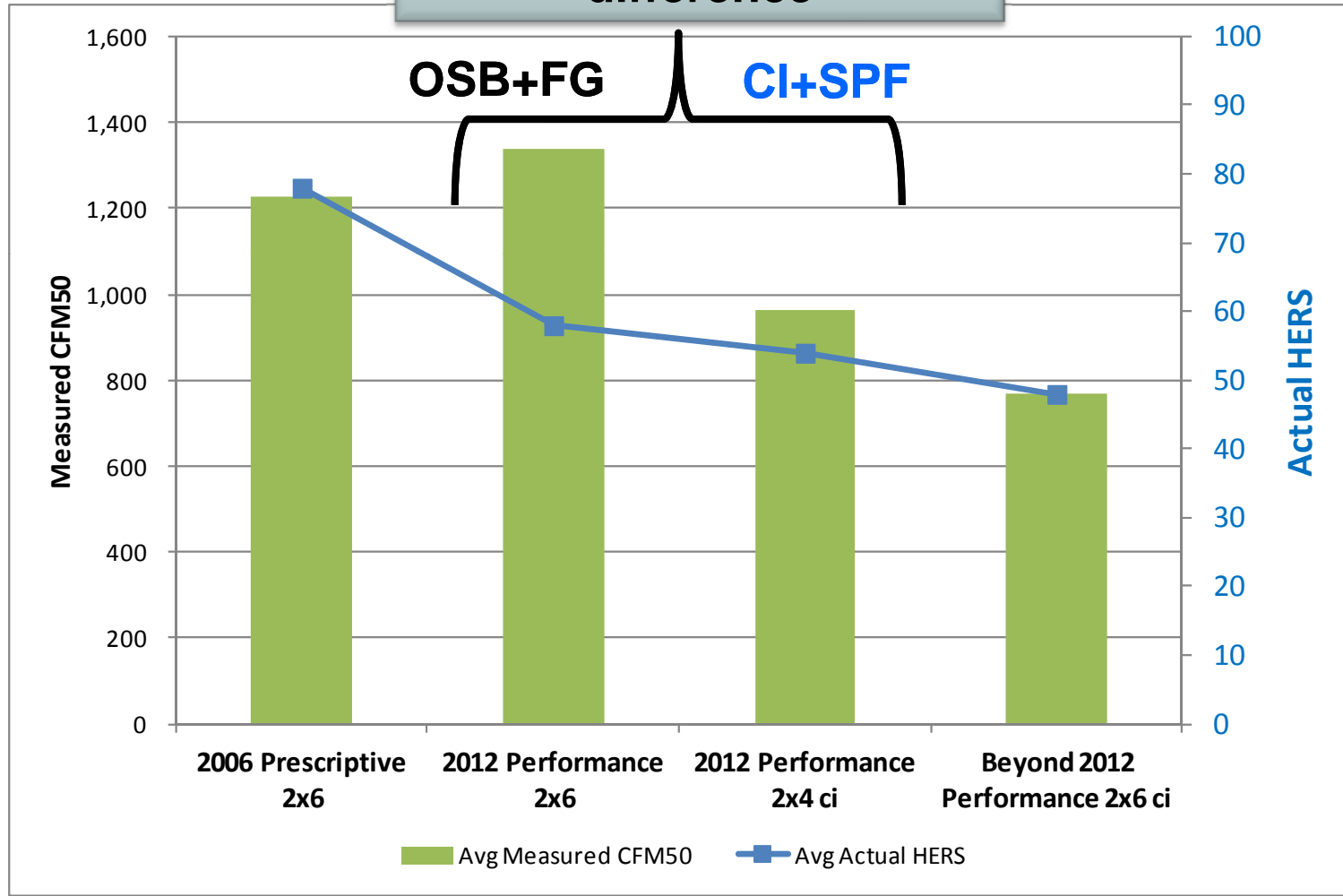
Continuous Insulation (CI) + cavity SPF helps lower the actual blower door test result

# TEETH Blower Door Testing



Building Solutions

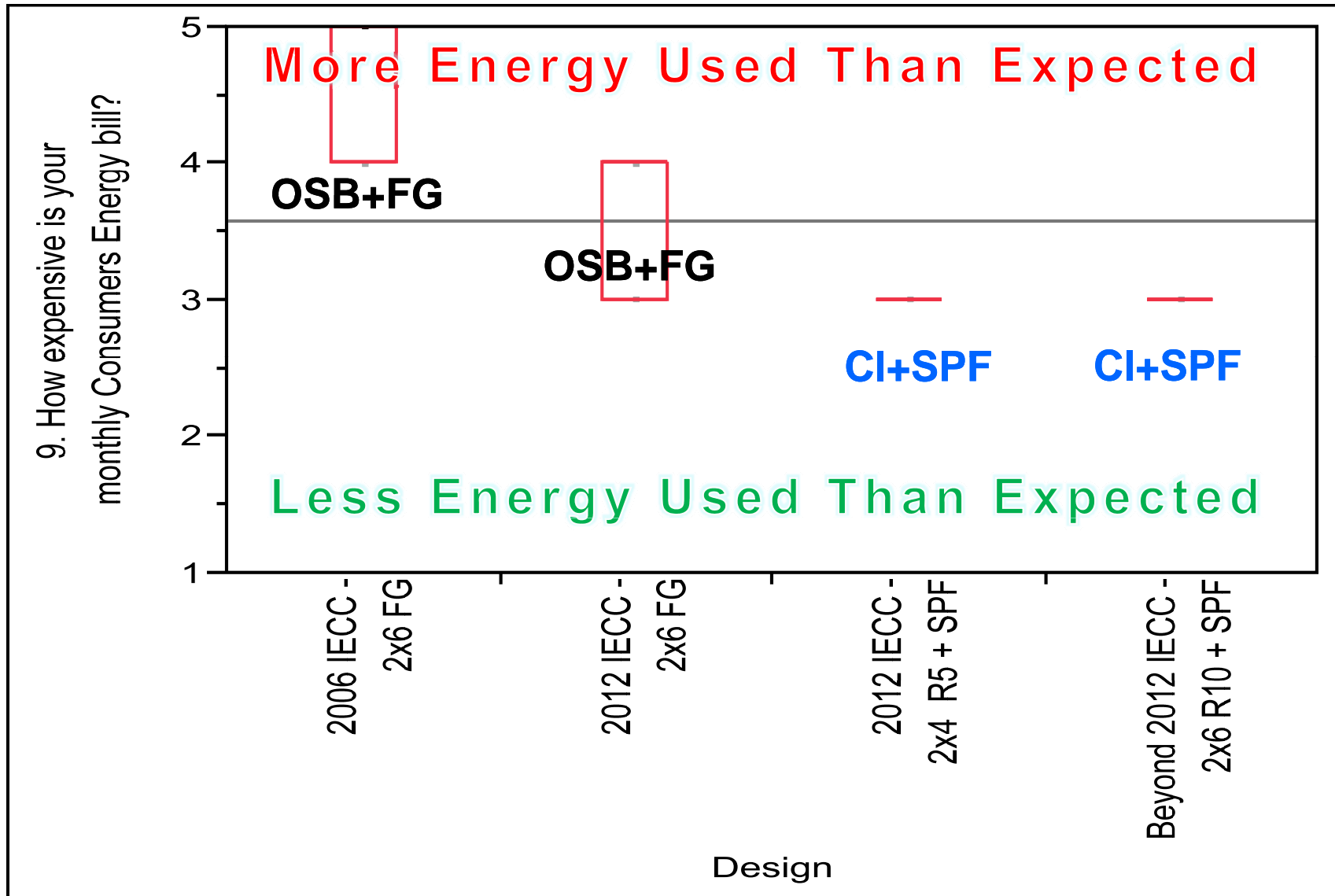
Similar HERS, but significant air leakage difference



# TEETH Tenant Feedback



Building Solutions



- ❑ Exterior continuous insulation (ci) and cavity spray foam can improve actual HERS from design
- ❑ Blower door results with “ci” and SPF are statistically better than OSB/FG at the 95% confidence level
- ❑ Do not need to go to 2x6 construction to meet 2012 IECC
- ❑ Home owners saw higher than expected utility bill with OSB/FG designs after first 6 months



# Retrofit Case Study



Building Solutions

- ❑ Total Size 1,500 square feet
- ❑ Total Rooms 2 bedrooms, 1 bath
- ❑ full basement.
- ❑ HERS Index Before Renovation: **131**
- ❑ Blower Door Before: **2011** CFM50Pa
- ❑ **Below Grade:** 8" CMU (hollow core) uninsulated wall and rim joist
- ❑ **Above Grade:** 7/16" Fiberboard sheathing, R-11 Fiberglass Batt, 1/2" drywall
- ❑ **Attic:** R-19 batt



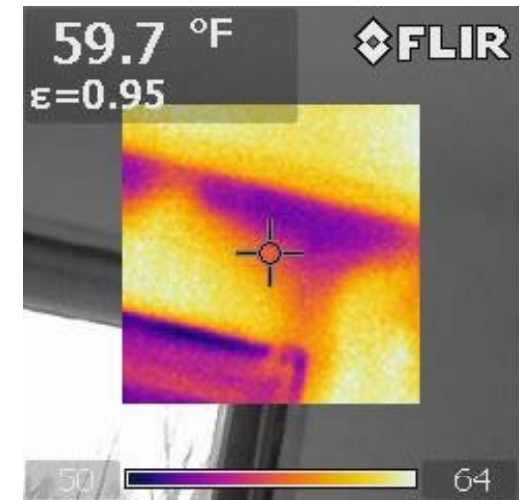
# Sources of Air Leakages



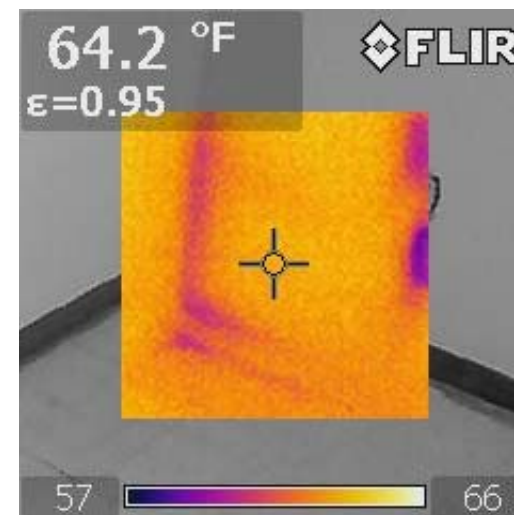
Building Solutions

□ Examples from retrofit bungalow, 2012 “Revitalize Home” project:

□ Roof-wall juncture:



□ Exterior Wall-Floor juncture:

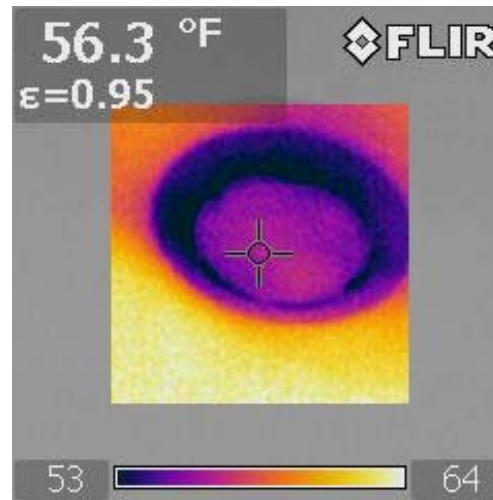


# Sources of Air Leakages

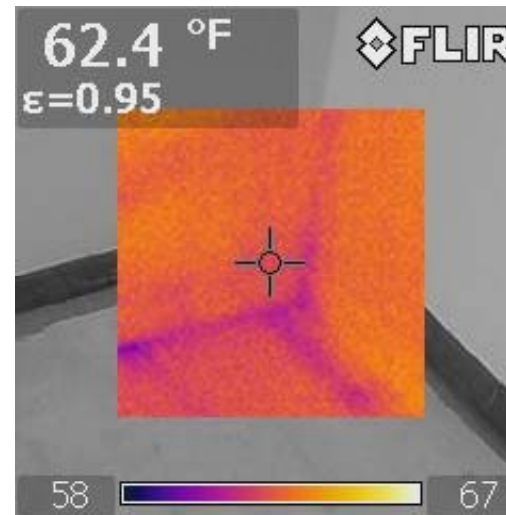


Building Solutions

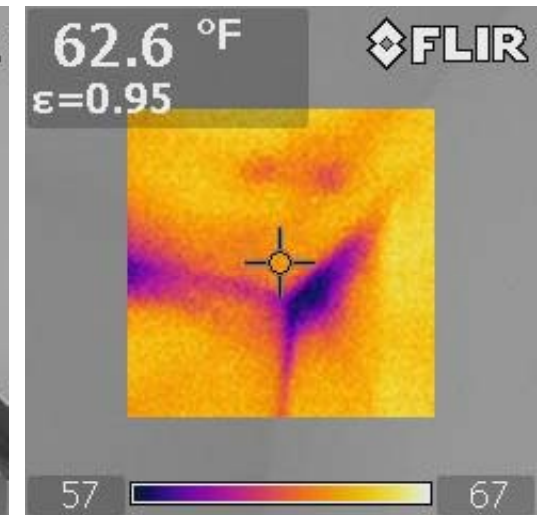
## ❑ Recessed Lights:



## ❑ Interior junctions:



Floor



Ceiling



# Retrofit Case Study - AFTER



Building Solutions

- ❑ Three target areas of improvement
- ❑ Blower door testing after each phase
- ❑ **Below Grade:**
  - 1.5" rigid ISO foam (R10) as internal, exposed insulation
  - 2" of spray foam class A insulation (R11) in rim joist
  - 1" XPS on exterior foundation
- ❑ **Above Grade:**
  - New Vinyl Siding (Med-Color)
  - 1" of XPS (R5 ci)
  - Air sealed windows from interior with foam sealant
- ❑ **Attic:**
  - 12" blown loose-fill cellulose
  - Spray foam sealant and insulation around attic perimeter







# Retrofit Work and Results



Building Solutions

Example	Retrofit Bungalow - 1500 sqft - 1960s	Retrofit Bungalow - 1500 sqft - 1960s
		
	<b>BEFORE</b>	<b>AFTER</b>
Wall Construction	Vinyl/fiber board/batt	Vinyl/fiber board/batt
<b>HERS</b>	<b>131</b>	<b>85</b>
Actual Whole House Air Leakage (ACH/50Pa)	10.6	5.1 <b>2009 IECC</b>
Actual Whole House Air Leakage (cfm/50Pa)	2011	811
Basement Air Leakage Reduction (CFM50Pa)	<b>13%</b>	
Above Grade Air Leakage Reduction (CFM50Pa)	<b>8%</b>	
Attic Air Leakage Reduction (CFM50Pa)	<b>78%</b>	

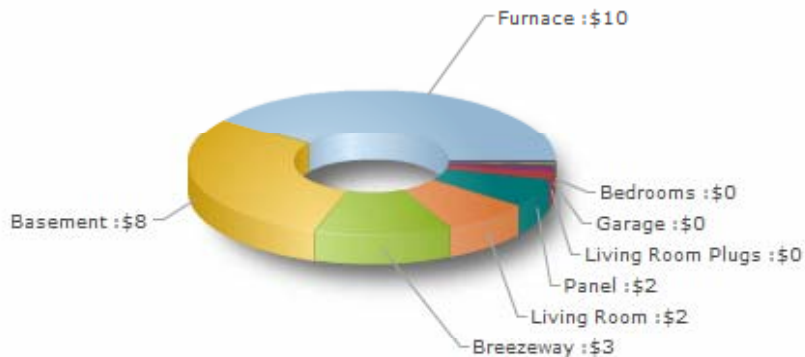
# Revitalize Actual Energy Use



Building Solutions

Where I've used electricity in the past 30 days: Top 12 Circuits

Click a slice or label for detail / [View All Circuits](#)

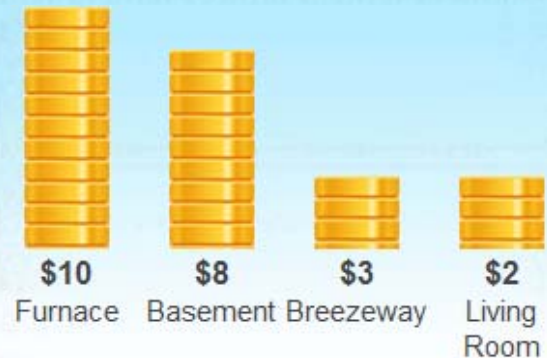


## Unoccupied

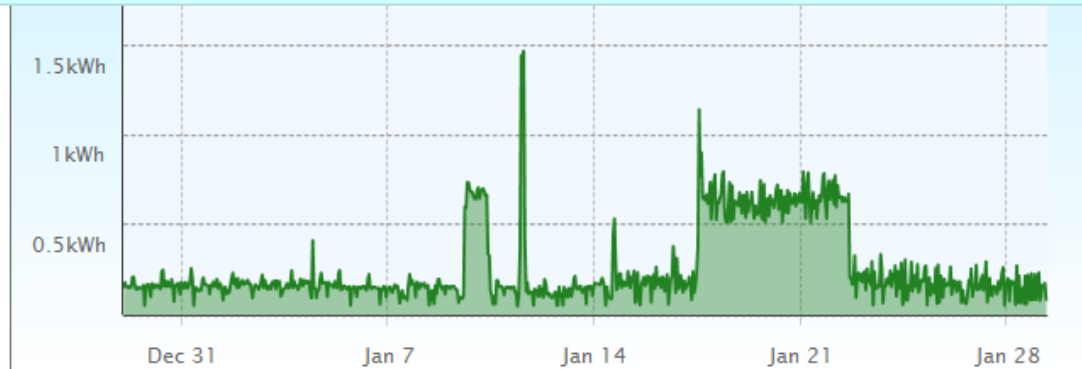
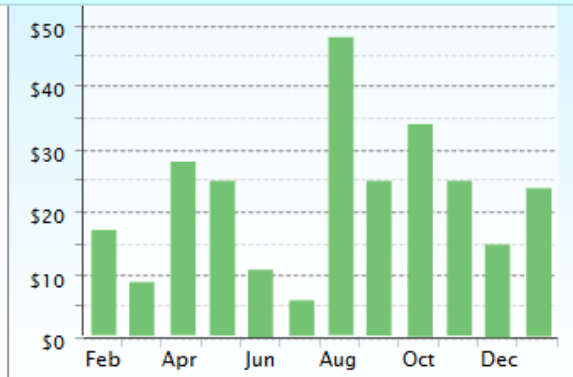
Electricity Cost by Month i

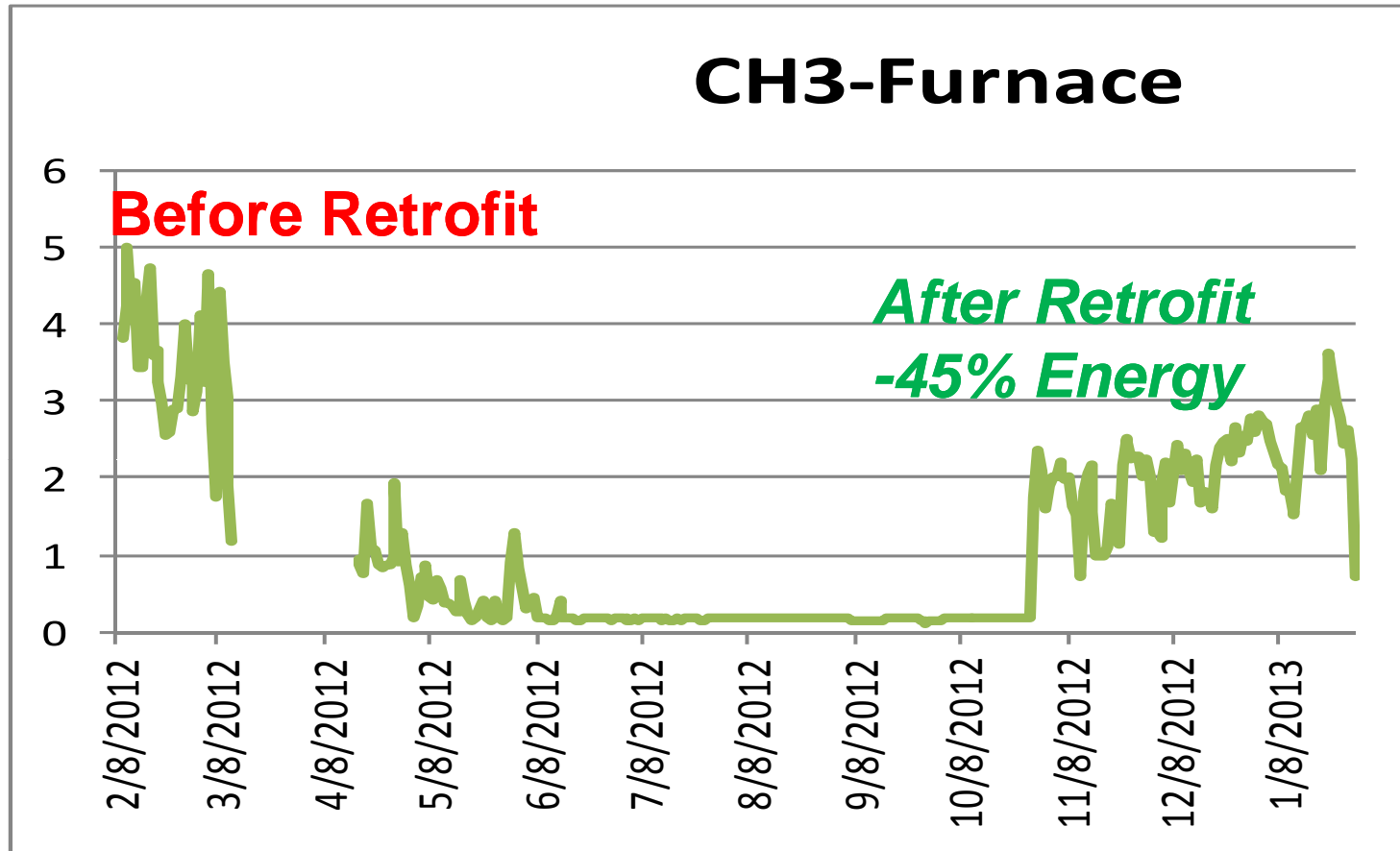


Top 4 Users by Cost - Last 30 days



**Renovations completed in May, 2012**  
**First winter of monitoring heating load in Michigan**





	Peak Heating Load from REMRate (kW) <b>Occupied</b>	Recorded Average kW per day (Furnace Fan Only) <b>- Unoccupied</b>	Gas Bill (MI Consumer Energy by month) <b>- Unoccupied</b>	Season	HDD
Furnace (Before)	11.6	3.6	\$222	Feb 1 - March 30	1619
Furnace (After)	5.6	2.0	\$109	Nov 1 - Dec 30	1905
Percent Change	<b>-51%</b>	<b>-45%</b>	<b>-51%</b>		

# Overall Results



Building Solutions

- ❑ 35% improvement on energy efficiency score (HERs rating)
- ❑ 30% savings on monthly energy costs
- ❑ 33% reduction in CO2 emissions per year, significantly lowering the environmental footprint



[www.revitalizehome.com](http://www.revitalizehome.com)

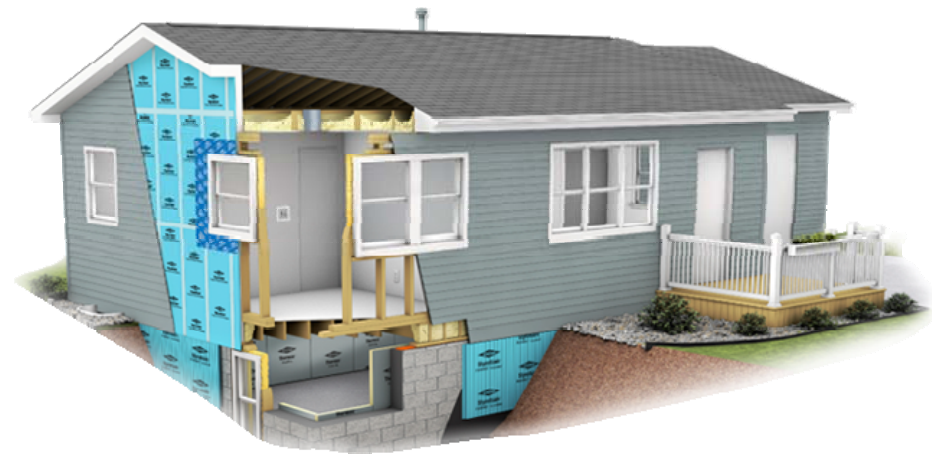


# Retrofit Summary



Building Solutions

- ❑ Largest air leakage reduction from attic
- ❑ Easiest to retrofit below grade with insulation (inside and outside foundation wall), and air seal
- ❑ Hardest to retrofit above grade walls
- ❑ Significant improvements in energy use can be realized: **~45% furnace energy use reduction!**



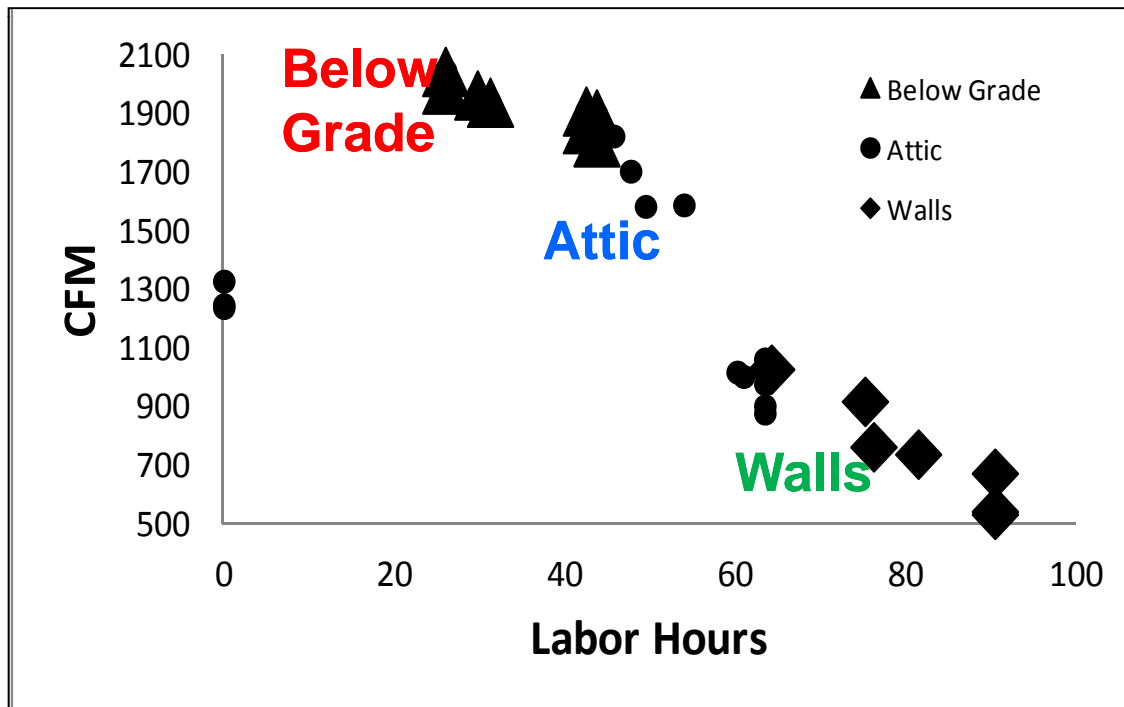
# Cost Effective Retrofit - 2012

## Building America Study



Building Solutions

- ❑ Below grade and attic required the least labor for air sealing
- ❑ Above grade is the most labor intensive for retrofit



Reference: DOE Technical Report: Evaluation and Testing of Individual Air Sealing Retrofit Measures, CEER Team, Dec., 2012 (in peer review)

# Summary: Energy Efficiency



Building Solutions

- ❑ Get the walls “right” the first time
  - Hardest to change after the fact
  - 2x4 construction with ci can perform better than 2x6 with just cavity insulation
- ❑ In retrofit houses, take the time to air seal the attic



1. Caulks
2. Foam sealants
3. Foam gaskets – sill seal
4. Foam sheathing – “ci” installed directly on studs with taped joints
5. Spray foam cavity insulation

STYROFOAM™ Brand  
Tongue & Groove Insulation



WEATHERMATE™  
Construction Tape



STYROFOAM™ Brand  
PERIMATE™ Insulation



WEATHERMATE™ Flashing



ENERFOAM™ Professional  
Foam Sealant



GREAT STUFF PRO™ Window &  
Door Insulating Foam Sealant



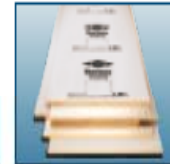
GREAT STUFF PRO™  
Gaps & Cracks Insulating  
Foam Sealant



Wall & Floor Adhesive &  
ENERBOND™ Professional  
Foam Adhesive



THERMAX™ Sheathing



FROTH-PAK™ Foam  
Insulation/Sealant Kit





## Which of these air sealing techniques have you used/recommended?

1. Caulks
2. Foam sealants
3. Foam gaskets – sill seal
4. Foam sheathing – “ci” installed directly on studs with taped joints
5. Spray foam cavity insulation

STYROFOAM™ Brand  
Tongue & Groove Insulation



WEATHERMATE™  
Construction Tape



STYROFOAM™ Brand  
PERIMATE™ Insulation



WEATHERMATE™ Flashing



ENERFOAM™ Professional  
Foam Sealant



GREAT STUFF PRO™ Window &  
Door Insulating Foam Sealant



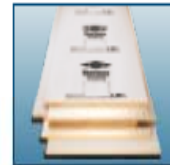
GREAT STUFF PRO™  
Gaps & Cracks Insulating  
Foam Sealant



Wall & Floor Adhesive &  
ENERBOND™ Professional  
Foam Adhesive



THERMAX™ Sheathing



FROTH-PAK™ Foam  
Insulation/Sealant Kit



# Caulks vs. Sealants



Building Solutions

- Which is more effective?
- Which is more efficient?
- When would you use one vs. the other?
- Why would you use one vs. the other?
- What other properties should you consider?





## Call a “Friend / Expert”



Building Solutions

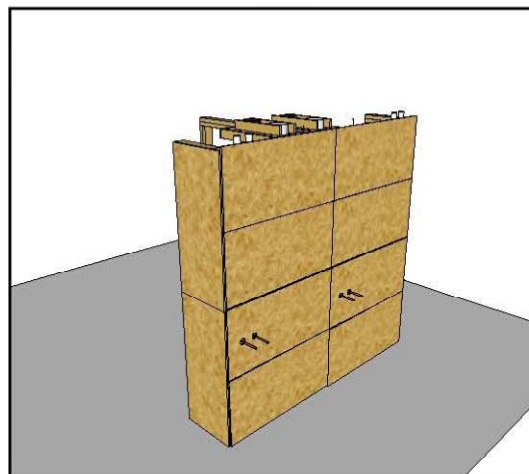
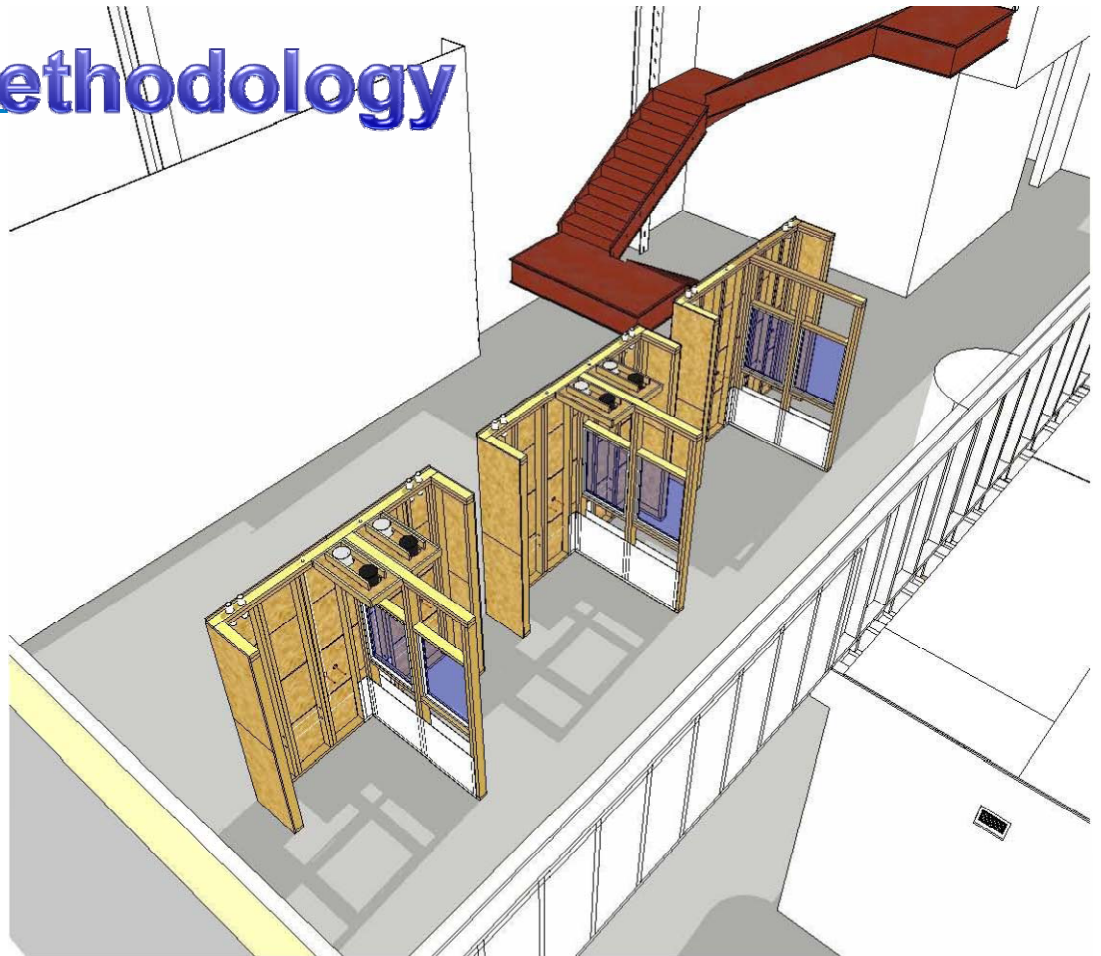
- ❑ Building Science consulting firm
- ❑ Designed independent study
- ❑ 16 different common residential sealing applications were evaluated
  - Identical 8’ x 8’ wall mock-ups were constructed to standardize the details
- ❑ Three installers
- ❑ Evaluation Factors include:
  - Success of fill
  - Ease of Use
  - Cleanliness and Trade Disruptions
  - Weight Used / Cost



Time (s)

# Third Party Study Methodology

- ❑ 3 identical 8'x8' wood frame mock-ups
- ❑ 2 sections in each mock-up with 16 details
- ❑ The details include:
  - sheathing gaps ranging from  $3/32''$  to  $1/2''$
  - studs, windows
  - plumbing holes
  - duct penetrations
  - stud corners
  - T-ply
  - sill plate to concrete slab





# Products Compared



Building Solutions

## ❑ Spray foam sealant

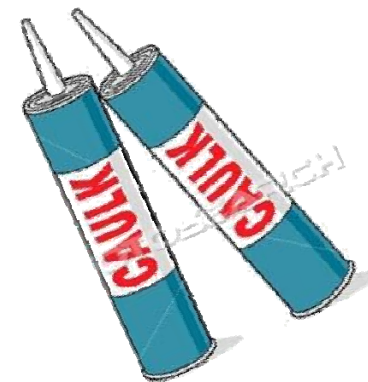
- 12oz with straw valve attachment
- Homeowner use only

## ❑ Spray foam sealant

- 20oz with Spray Gun
- Handyman and Professional use

## ❑ Acrylic Latex Caulk Plus Silicone

- 10oz tube
- Used by homeowners, handyman and professionals



## □ Measurements – 5 categories

- Success of fill – holes, trim needed
- Ease of use
- Cleanliness and trade disruption
- Weight and cost used – g, ACE Hardware Store pricing
- Installation time – seconds

## □ Scoring System

- 5 points max for each category (1-5 pts)
- 5 is the best performance
- 1 is the poorest performance
- Add the total score from the above 5 categories

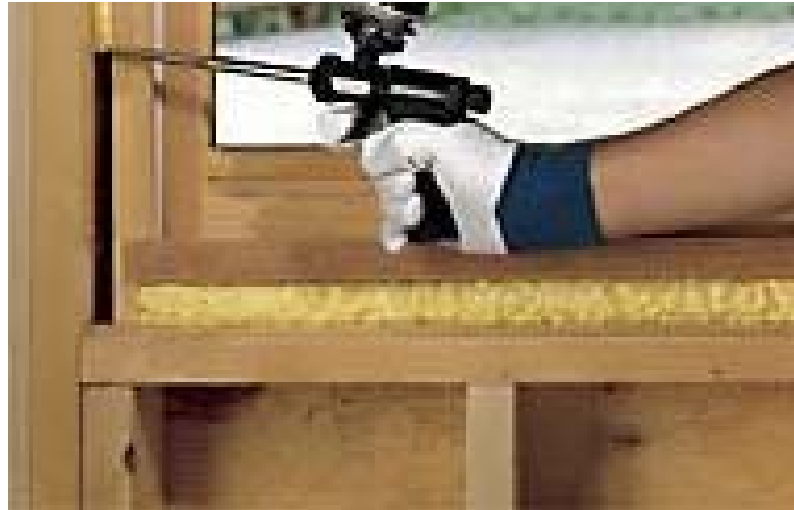
# Comparative Results



Building Solutions

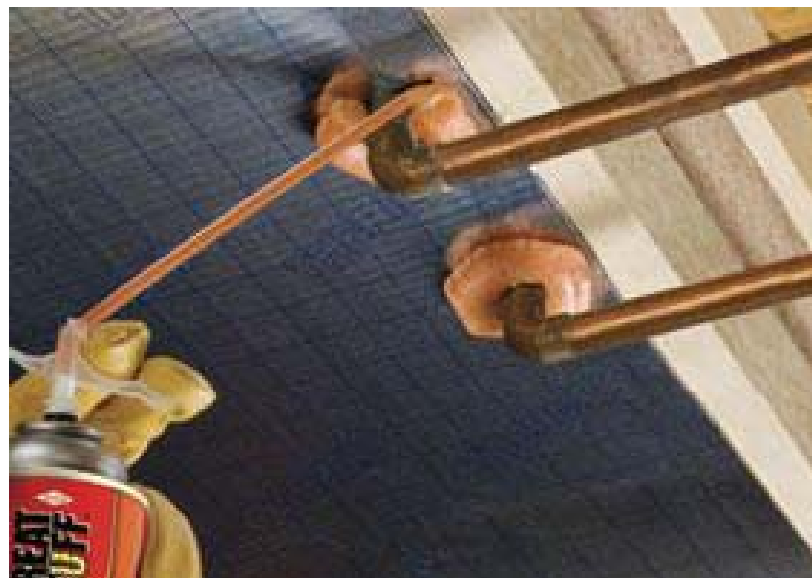
## Window frames to rough openings:

**Foam preferred**



Comparative Results  
2" hole through OSB sheathing w/plumbing pipes:

**Foam preferred**

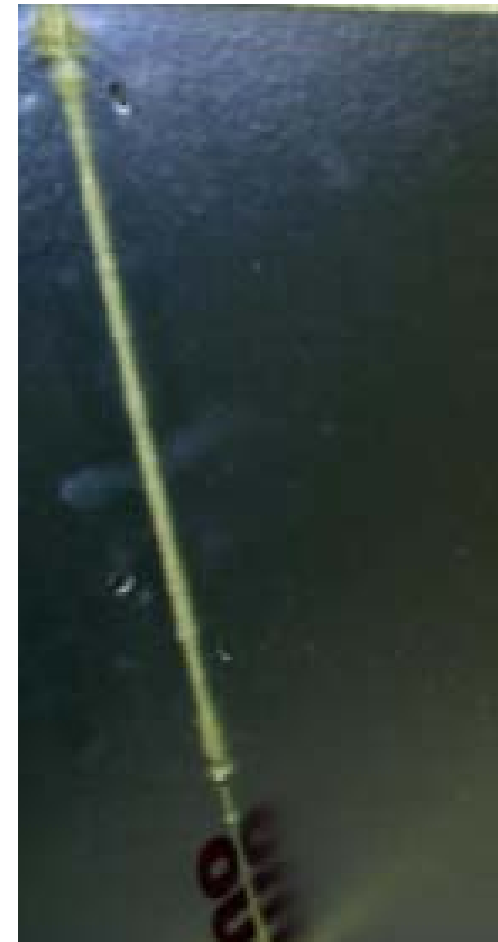


# Comparative: Joint Gap – 1/2" horizontal and vertical



Building Solutions

## Foam Preferred





# Comparative Results

---



Building Solutions

8" hole w/ 6" sheet metal duct penetrations:

**Foam preferred**



# Comparative Results

**1/16" wood stud gaps:  
Caulk Preferred**



**Three Stud Corner:  
Caulk Preferred**



Building Solutions

**Wood Sill Plates to Concrete Slab  
Caulk Preferred**



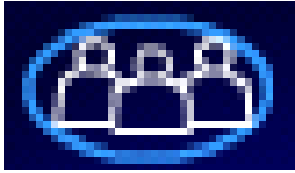
*Caulk preferred with narrow gaps, ~ < 1/8" and smooth finished surface is desired.*

# Preference by Installer

# IBACOS®

| Home Quality + Performance |

Application	Handyman		Professional	
	Foam Sealant	Caulk	Foam Sealant	Caulk
1/4" Sheathing Gap, Vertical 4'	Foam preferred for larger gaps > 1/8"			
1/2" Sheathing Gap, Horizontal 4'				
Inconsistent Gap from tight to 1/2" Gap, Horizontal 4'				
Window Frame to Rough Opening Gap (tight on one side and 1/2" gap on other), 24"x36"				
Two, 2" Holes Throught OSB Sheathing w/ 1/2" Plumbing Pipes				
8" Hole w/ 6" Flex Duct Penetration Throught OSB Lid				
8" Hole w/ 6" Sheet Metal Duct Penetration Throught OSB Lid				
Two, 2 1/2" Holes Through Top Plates w/2" PVC pipes				
Three, 1" Holes w/ 14/2 Romex Wires				
1/16" Wood Stud to Wood Stud Vertical Butt Joint Gap, Vertical 8'				
1/16" to 1/2" Wood Stud to Wood Stud Vertical Butt Joint Gap, 8'				
3/32" Sheathing Gap, Horizontal 2'				
1/8" Sheathing Gap, Horizontal 4'				
Three Stud Corner Vertical Butt Seam, Vertical 8'				
T-Ply, Used as Draftstopping Attached to Studs, 208" of Edges				
Wood Sill Plate of Concrete Slab Transition, 48" of Edges				



# Audience Participation



Building Solutions

## ❑ Spray foam sealant

- 12oz with straw valve attachment
- Homeowner use only



## ❑ Spray foam sealant

- 20oz with Spray Gun
- Handyman and Professional use



## ❑ Acrylic Latex Caulk Plus Silicone

- 10oz tube
- Used by homeowners, handyman and professionals



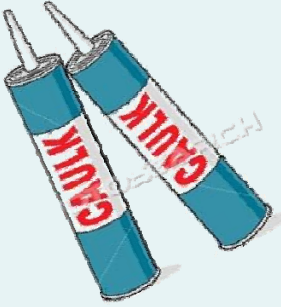




# Today's Audience Preference



Building Solutions

Sealant Product	Votes
	
	
	

# Whole House Evaluation



Building Solutions



Basis:

- 2200 ft<sup>2</sup>
- single family,
- two-story house

**IBACOS**<sup>®</sup>  
| Home Quality + Performance |



- ❑ Study based on the extrapolation of the previous mock-up results vs. actual house
  
- ❑ Three scenarios were calculated:
  - Foam sealant only
  - Caulk only
  - Combination: A combination of foam sealant and caulk using the Handyman preference

# Foam vs. Caulk Whole House



Building Solutions

	Linear ft. or Area	Dow Great Stuff Pro®		Caulk		Combination	
		Cost	Time	Cost	Time	Cost	Time
1. Window and door frames to rough opening gaps	320.58 ft.	<b>\$32.25</b>		<b>\$95.59</b>		<b>\$42.38</b>	
2. Wood stud to wood stud vertical butt joints with an average gap of 1/8"	296 ft.	<b>3hr 34min</b>		<b>6hr 24min</b>		<b>3hr 45min</b>	
3. 2" Holes through OSB sheathing with 1/2" plumbing pipes	0.168 ft. <sup>2</sup>	\$0.16	5.04 min.	\$0.80	7.36 min.	\$0.16	5.04 min.
4. 8" Holes with 6" flex and metal duct penetrations	1.83 ft. <sup>2</sup>	\$0.20	3.2 min.	\$0.76	4.4 min.	\$0.48	3.8 min.
5. 2 1/2" Holes for 2" PVC pipes through top plates	0.044 ft. <sup>2</sup>	\$0.40	4.53 min.	\$0.08	4.47 min.	\$0.08	4.47 min.
6. 1" Holes for 14/2 Romex wire through studs	2.54 ft. <sup>2</sup>	\$19.04	76.16 min.	\$47.60	185.64 min.	\$19.04	76.16 min.
7. Three stud corner vertical butt seams	288 ft.	\$0.72	14.4 min.	\$0.97	19.2 min.	\$0.97	19.2 min.
8. T-ply to studs and concrete slabs	34.66 ft.	\$0.16	3.9 min.	\$0.44	3.34 min.	\$0.44	3.34 min.
9. Wood sill plates to sub-floors and band joists	544 ft.	\$2.72	54.4 min.	\$10.88	38.08 min.	\$10.88	38.08 min.

**\$32.25      3:34.47      \$95.59      6:24.51      \$42.38      3:45.26**

foam: \$26.81      1:56.22  
caulk: \$15.57      1:47.04 40

# Foam vs. Caulk



Building Solutions

**IBACOS**<sup>®</sup>

| Home Quality + Performance |

- ❑ Use of spray foam sealant can save more than 50% in materials and be twice as fast compared with caulk alone
- ❑ Use of spray foam gun improved application precision, and required less material
- ❑ Handyman and professional installer were able to complete the job twice as fast as the homeowner with better tool and material choice





# Summary



Building Solutions

- ❑ Meet the 2012 IECC with 2x4 walls
- ❑ Get the walls “right” the first time
  - Hardest to change after the fact
  - 2x4 construction with ci can perform better than 2x6 with just cavity insulation
- ❑ In retrofit houses, take the time to air seal the attic
- ❑ Below Grade retrofit, should factor in:
  - Exterior foundation wall insulation
  - Interior air sealing and insulation
- ❑ Choose the product to best fit the field need
- ❑ Take advantage of Professional accessories



# Acknowledgement



Building Solutions

- ❑ Chuck Cribley, HERS Rater, Cobblestone Homes
- ❑ Patrick O'Malley, Building Knowledge Inc. (BKI), HERS Rating and Training Provider
- ❑ Mark and Melissa Wahl, Cobblestone Homes
- ❑ Doug Bibee, President at Improved Habitats International, LLC
- ❑ Gary Parsons, Dow Building Scientist
- ❑ Brian Lieburn, Dow Residential Technology Leader
- ❑ Dan Darling, Dow Building Solutions, System Development Lab
- ❑ IBACOS, High Performance Home consulting services
- ❑ Matt Erdmann, Dow Building Solutions CTSC

- **NOTICE:** The data provided in this slide presentation was collected upto Feb. 2013, and is given in good faith for informational purposes only. No freedom from infringement of any patent owned by Dow or others is to be inferred. Because use conditions and applicable laws may differ from one location to another and may change with time, Customer is responsible for determining whether products and the information in this document are appropriate for Customer's use and for ensuring that Customer's workplace and disposal practices are in compliance with applicable laws and other government enactments. The product shown in this literature may not be available for sale and/or available in all geographies where Dow is represented. The claims made may not have been approved for use in all countries. Dow assumes no obligation or liability for the information in this document. References to "Dow" or the "Company" mean the Dow legal entity selling the products to Customer unless otherwise expressly noted. **NO WARRANTIES ARE GIVEN; ALL IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE ARE EXPRESSLY EXCLUDED.**



Building Solutions



# Building Solutions

## Questions?

Linda Jeng, [jengl@dow.com](mailto:jengl@dow.com)

Devin Marino, [marino@dow.com](mailto:marino@dow.com)

[www.dowbuildingsolutions.com](http://www.dowbuildingsolutions.com)

