Re-Side Tight, Ventilate Right
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Final Report

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1 Executive Summary

Re-Side Tight, Ventilate Right explored the opportunity for improving energy efficiency while homes were being re-sided. Infiltration is recognized as one of the biggest energy wasters in single-family homes. EPA studies have found that in a typical American house infiltration accounts for 25 to 40 percent of the heating and cooling loads. Considering that every year thousands of homes are re-sided for maintenance and aesthetic reasons, the opportunity to improve energy efficiency through exterior air sealing while re-siding is promising. The Re-Side Tight project included the installation of an air barrier as part of the re-siding of seventeen homes in New Jersey. Originally, the project also intended to provide mechanical ventilation in homes that were tightened beyond an industry prescribed minimum. Ultimately, none of the homes in the study needed mechanical ventilation.

The average reduction in infiltration among the homes was 18.64%[1] and ranged from an increase of 1% to a decrease of 40%[10]. The average annual projected savings was $105 and ranged from an increase $6 to a savings of $252. The average savings to investment ratio for the re-side tight homes was 1.2 and ranged from -.10 to 3.4. Among the 17 homes in the study, one had inconclusive results (House 2) and four had poor results. Of the four, two had other changes to the building envelope during the re-siding work that influenced the post-siding infiltration rate (House 5 and House 6) and two had air barrier application issues (House 9 and House 13). These are discussed further in section 3.11 on individual house results.

The hypothesis of this study was that a re-siding job could incorporate a reduction in infiltration at a relatively low incremental cost once contractors are made familiar with detailing a water resistant barrier (WRB) to function as an air barrier. The study proposal raised the goal of a 15 – 20 reduction in heating and cooling costs. The more appropriate goal is a 15 – 20% reduction in infiltration, which does not translate directly to a 15 – 20% reduction in heating and cooling energy costs. This reduction in infiltration was found to be readily attained at an incremental cost of about $1500 while contractors are learning the installation techniques and can drop to the material and testing costs only, about $500, as crews become more accustomed to air barrier detailing.

This study used the Savings to Investment Ratio (SIR) as the measure of cost effectiveness. The DOE Weatherization Assistance Program (WAP) requires an SIR of one for an energy saving measure to be implemented. Among the 16 homes with measured results, nine achieved an SIR of one or more and seven did not. Among the seven with an SIR below 1:

- One had a 1600 sf addition done with the residing work and as such the SIR calculation did not appropriately apply (House 3)
- Five had poor or modest infiltration reduction results, (Houses 5, 6, 8, 9 and 13)
- One had a good infiltration reduction percentage, but because the initial leakage was not excessive, the actual cfm reduction and related cost savings were modest. (House 7)

To achieve an SIR of one or greater, the Re-Side Tight houses had to have at least $75 in energy savings.[2] Ultimately, the study found that when the WRB is properly installed to act as an air barrier, the result is a cost-effective infiltration reduction strategy.

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[1] This average does not include House 2 where the team could not get a reading from the post-siding blower door test. This is discussed further in section 3.11.3.

[2] Using $1500 as the initial investment and 20 years as the life of the measure results in an annual savings of $75 for an SIR of one.

Achieving effective air sealing at a low incremental cost aligns with a study by the National Renewable Energy Laboratories, which concludes that moderate air sealing in the area of a 20% reduction is much more cost effective than aggressive air sealing at a 50% reduction range. **(Casey & Booten, 2011)**.

2 Introduction

Air sealing existing homes is commonly considered a cost-effective first step toward improved energy efficiency. Air sealing is an energy efficiency measure used in the two largest national existing home energy efficiency programs, the Weatherization Assistance Program, (WAP) and Home Performance with Energy Star (HPwES). In the WAP, 26 states out of 50 use a priority list for weatherization work rather than completing an audit and running an energy model on every home that is weatherized. A priority list itemizes weatherization measures that computer analysis has shown to be cost-effective for typical housing stock. **(Kelso, 2009)** On these priority lists, air sealing ranks as the first recommended measure. This is also the typical finding from WAP energy audits. In HPwES, sealing air leaks is cited as among the most common home improvements executed in the program. **(Energy Star, 2011)**.

While it is understood that air sealing is an appropriate measure for existing homes, both the WAP and HPwES primarily air seal homes from the inside, as that is the most accessible area for the work. The WAP air sealing procedure focuses on basements, crawl spaces and attics. HPwES air sealing is also targeted at the "low holes" in basements and crawlspaces and "high holes" in the attic. The Re-Side Tight project focuses its air sealing on the exterior walls, beneath the siding.

3 Re-Side Tight Study Design and Execution

The Re-Side tight study was designed to test the change in infiltration rates of fifteen homes[3] after a water resistant barrier (WRB) was installed as an air barrier as part of a re-siding job. This required selecting appropriate WRBs to install, devising a strategy for mechanical ventilation when needed, locating fifteen homeowners that were planning to re-side their homes, finding siding contractors to participate in the study and establishing a testing protocol. A post-study survey of the homeowner participants was also planned.

3.1 Water Resistant Barrier Materials

The Re-Side Tight team wanted to include commonly used residential WRBs as well as one liquid applied WRB. The WRB acts as a second line of defense to water penetration when water gets behind cladding. The re-side tight project limited itself to houses clad with siding and did not include any stucco or brick veneer homes[4]. Wood, fiber cement, and vinyl siding all use a WRB beneath them, installed over the home's sheathing. The WRBs had to be code approved air barriers and vapor permeable for use in the study.

The Re-Side Tight study did not intend to compare among different WRBs that are code-approved air barriers. It did intend to use WRBs that are commonly used in the marketplace and show contractors how to detail WRBs to function as air barriers.

[3] The study ultimately included 17 homes.
[4] Three of the homes did have small masonry veneer areas.

The study used four WRBs: two house wraps, Tyvek and Rain Drop; one rigid insulation underlayment, GreenGuard XP38; and one liquid applied air barrier, Sto Gold. These are all code approved air barriers. Tyvek and Rain Drop are commonly used in the residential market. GreenGuard is a common siding underlayment, but it is not typically detailed as an air barrier. Sto Gold is less common in the stick built residential market and more common for commercial applications. The team was eager to include a liquid applied WRB as this product type performs well in the commercial market.

3.1.1 Code Approved Air Barriers

WRBs that are code approved air barriers have been tested in accordance with the ASTM E2178 Standard Test Method for Air Permeance of Building Materials or through an evaluation report stating that the material is code compliant as an air barrier. This ensures that these materials have a sufficiently low air permeance and can be part of an effective air barrier system. Not all WRBs are code approved air barriers. Perforated home wraps are not air barriers, precisely because of their perforation, nor is 15# felt, commonly used under siding.

3.1.2 Vapor Permeability

The team wanted vapor permeable WRBs to ensure that wall drying could occur to the outside when conditions allowed. For new construction, the relative importance of a WRB's vapor permeability has been questioned, since most common wall sheathings currently used, such as plywood and oriented strand board, are only semi permeable. However, for the re-side tight homes, the existing sheathing was unknown. Therefore staying with a vapor permeable WRB was considered a preferable strategy.

Despite this original intent, one re-side house did use a vapor semi-permeable WRB, Green Guard XP38. To ensure that its use would not cause potential moisture issues, the study team ran a hygrothermal analysis on the wall assembly of the house with GreenGuard XP38 installed. This is discussed further in section 3.11.3.

3.1.3 WRB Industry Partners

After considering these criteria, the principal investigator contacted Dupont® (Tyvek), Pactiv (Rain Drop and Green Guard XP38) and Sto® (Sto Gold) regarding study participation and support. All three companies committed to the project from the outset and all agreed to provide technical support and discounted or entirely donated materials. Technical support consisted of printed material appropriate for use in the field and direct on-site guidance.

Table 1 - Re-Side Tight WRBs

WRB	Code Approved Air Barrier	Vapor Permeability
GreenGuard Max	Yes	16 perms
GreenGuard XP38	Yes	1 perm
Rain Drop	Yes	8 perms
Sto Gold	Yes	5 perms
Tyvek	Yes	58 perms[5]

[5] Perms are a measure of moisture vapor permeance (MVP).

3.2 Mechanical Ventilation

If homes in the study were tightened beyond their building tightness limit (BTL), the team would have to install mechanical ventilation. The BTL is a threshold of air exchange below which the maintenance of acceptable indoor air quality is potentially compromised. The study required a mechanical ventilation solution that was relatively easy to install in existing homes, provided balanced ventilation, and was energy efficient. Panasonic's WhisperComfort spot energy recovery ventilator (ERV) met the criteria. Energy Recovery Ventilators exhaust stale air and replace it with outdoor air. Conditioned indoor air passes by the incoming outdoor air and tempers it. As an ERV, it also transfers some of the moisture in the more humid air stream. This is done with very little mixing of the two air streams. The project lead met with Panasonic and they agreed to provide technical support and WhisperComfort spot ERVs for the re-side tight homes as needed.

Figure 1 - Panasonic WhisperComfort Spot ERV

3.3 Recruiting Homeowner Participants

Initially the research team attempted to recruit homeowners by sending out an email blast to the Center's contacts database, which has over 6,000 recipients. The email explained the purpose of the Re-Side Tight, Ventilate Right study, the potential benefits of participating in the study and directions for how to be considered for participation. The Center also posted a notice on its homepage, calling for homeowners that might be interested. Among the respondents to the email and web posting, only one candidate ended up in the study. The others lost interest when they confirmed that the study would not pay for their house to be re-sided. In a few cases, interested parties were not allowed to participate because they worked for the state of NJ.[6]

The team then decided that rather than approaching homeowners directly, they would recruit siding contractors with their own client base. This tack recognized the importance of working with reputable, quality contractors and letting them bring their clients forward as potential study participants.

3.4 Recruiting Siding Contractor Participants

The Re-Side Tight team looked to several sources for potential contractor participants including:

[6] NJIT is a state university. State employees were ineligible to participate because NJIT competed for the grant to do this research. Therefore, for ethics reasons, NJIT employees and all other state employees could not directly benefit from the research activities.

- New Jersey Chapter members of the National Association of the Remodeling Industry (NARI)
- Vinyl Siding Institute (VSI) certified installers,
- NJ Home Performance with Energy Star (NJHPwES) contractors
  And
- Contractor contacts from the industry partners, Dupont (Tyvek), Pactiv (RainDrop) and Sto (StoGold).

The team generated an informational flyer with study participation requirements for contractors. Excerpts from the flyer are below:

How do I qualify?

- *You are a licensed, insured contractor*
- *You re-side homes in the PSE&G service territory*
- *You have a reputation for quality*
- *You have or anticipate having siding jobs in 2011*

What will I have to do?

- *You will install an air barrier beneath the new siding, over the home's sheathing. The air barrier will either be:*
  - *Tyvek,*
  - *Rain Drop*
    Or
  - *Sto Gold*

  Any technical guidance needed to install the air barrier properly will be provided by manufacturer representatives on site. You may choose which air barrier you want to install.

What's in it for me?

- *An honorarium of $1,000 per siding job in the study*
- *The air barrier material will be provided free of charge, even if you were planning to use it anyway*
- *The opportunity to increase the value of your services by providing overall envelope improvement, giving you a leg up on the competition.*

The $1,000 per house honorarium was intended to cover the incremental time it would take a contractor to learn how to install the WRB as an air barrier. The flyer was distributed among the NARI, VSI and HPwES contractors. Research team members also made announcements about the study at energy code trainings at NJIT in May of 2011, the AIA East Coast Green conference at Brookdale Community College in June of 2011; and various other venues.

Four contractors signed up for the study

- Acorn Home Improvement, Inc.

Acorn is an HPwES contractor that learned of the study while attending building energy code training at NJIT. The Tyvek industry representative also referred Acorn as a potentially interested contractor.

- Home Solutions Plus, LLC

Home Solutions Plus, LLC, came to the study by way of the homeowner. This homeowner was the one participant secured because of the Center's blast email.

- JayCue Construction

JayCue Construction is a member of NARI and found out about the study at a NARI chapter meeting.

And

- Roeland Home Improvers

Roeland Home Improvers is a Vinyl Siding Institute Certified installer. This company responded to a cold call from the research team.

Originally, the intent was that five or more contractors would participate in the study, each having a maximum of three projects. As the study progressed, the team saw the benefits of contractors having several projects, allowing them to increase their understanding of the air barrier installation. They became more adept with each home by refining their field techniques for the desired result. As such, the study allowed contractors to exceed three jobs.

3.5 Infiltration Testing

A Minneapolis Blower Door and was used for the before and after infiltration testing of the re-side tight homes. The team performed blower door testing using the Energy Conservatory Tectite 4.0 Building Airtightness Test Analysis Program, and depressurized each home to -50 Pascals (Pa)[7] using a calibrated blower door fan installed in the home's front door, see Figure 2.

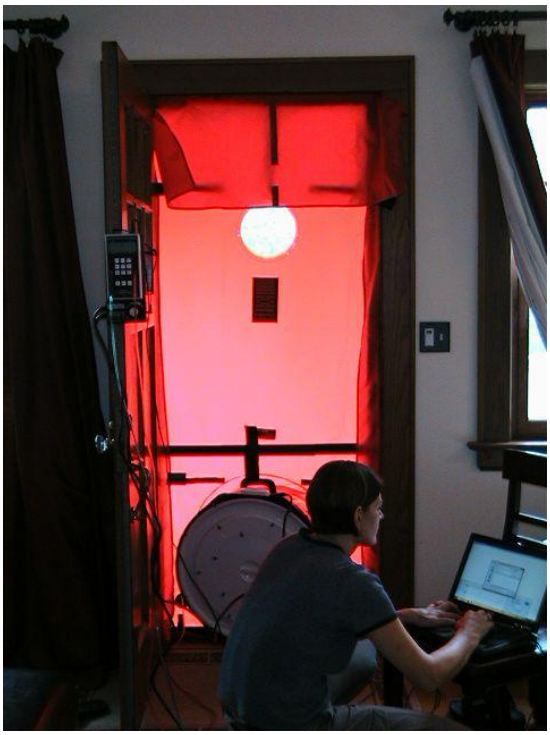


Figure 2 - Blower Door Testing

All exterior doors and windows are closed for this test. As the fan pulls air out of the home to depressurize it to negative 50Pa, air is forced through all the cracks and leaks in the building envelope. The blower door measures the airflow through the fan and the airtightness of the building envelope in CFM50 (cubic feet per minute at -50 Pascals). Tighter houses require less air flow to get to -50Pa and so have lower CFM50 readings. Generally homes at 1,200CFM50 or less are considered tight, homes between 1,500 and 2,500 CFM50 are considered moderately leaky and anything over 3,000CFM would be leaky. (Keefe, 2010).

3.6 Energy Use Projections

The Tectite software used to run the blower door testing also provides the estimated cost of air leakage. This estimate was used to determine the projected energy savings (or increase) because of the WRB/air barrier installation. For each house, pre and post blower door tests were compared. See Figure 3

[7] A Pascal is a unit of pressure. Fifty Pascals is equivalent to .2inches of water column and approximates a 20 mph wind.

Figure 3 - Example Air Leakage Comparison Report

These results were crosschecked with a multiplier derived from an evaluation of Ohio's Home Weatherization Assistance Program (HWAP). In this evaluation, the energy savings achieved in over 2,000 single-family homes in the HWAP were assessed using weather-normalized energy use based on utility data. Analysis of this data led to the finding that for each CFM50 reduction, .08 – .09 therms were saved annually. (Blasnik, 1999) The Re-Side Tight team contacted the author of the Ohio evaluation study and found that for New Jersey's climate, each CFM50 reduction results in a savings of .07 therms annually. The author also noted that for cooling, savings of about 10 kWh/100 CFM50 reduction for a home with a SEER 11 central AC, uninsulated basement ducts, and a cooling set point of 74F[8].

3.7 Post-Study Survey

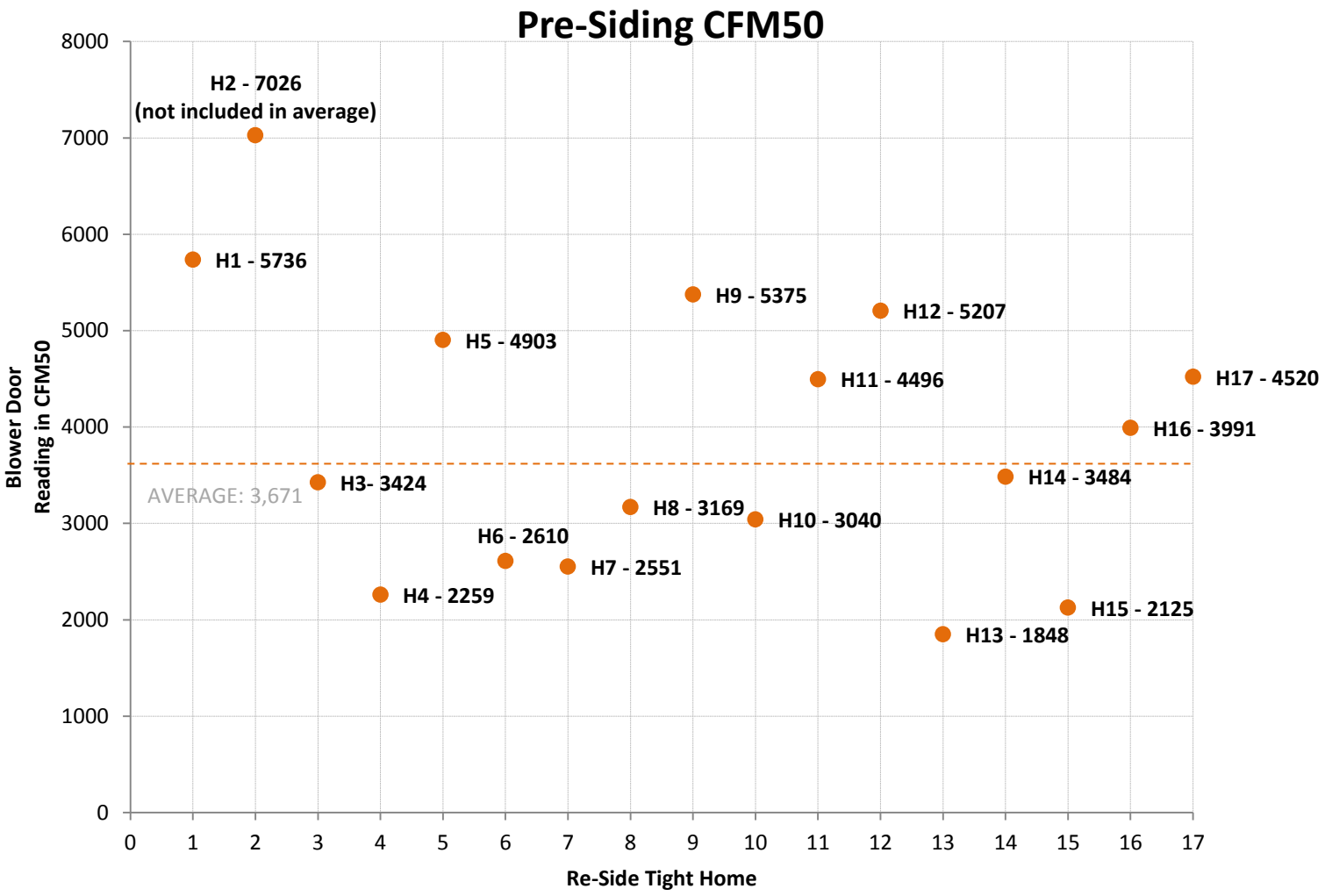
The team created a brief survey for homeowner participants in the Re-Side Tight study. The survey was designed to evaluate the homeowner's impression of their home's performance after their siding was installed and whether they would pay more for the re-side tight approach. The eight question survey and homeowner responses are included in section 3.12.

[8] The total cooling use per year would be about 2100 kWh in a 2000 square foot home. The savings would be lower in a home that is cooled less consistently throughout the summer. (Blasnik, 2012)

3.8 Existing Infiltration Testing

The Re-Side Tight homes' ACH50 range from 1848CFM50 to 7026CFM50 with an average of 4117CFM50 overall, and 3671CFM50 when excluding House 2.[9] If we refer to the guidelines in Figure 5, air sealing would be recommended for all the homes in the study. Further, one home (House 2) would not even appear on the Guideline chart at 7026 CFM50. [9]

Figure 4 - Pre-Siding CFM50 of Re-Side Tight Homes



[9] House 2 is not included in the average leakage among the re-side tight homes, because its post-siding test data is not available.

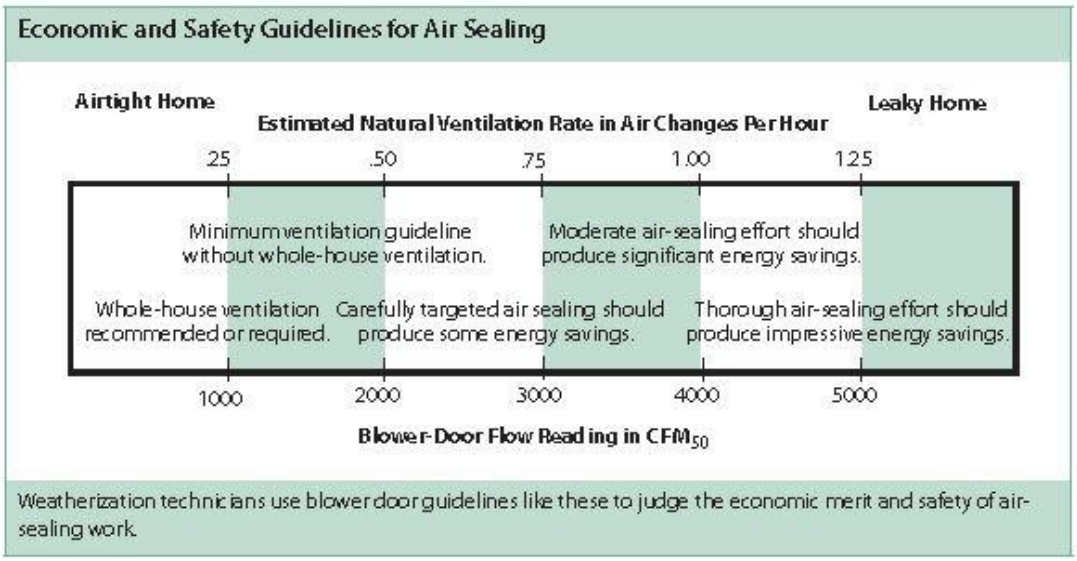


Figure 5 - Range of Home Air Leakages (Krigger & Dorsi, 2009)

Air changes per hour at 50 Pascals (ACH50) is another measure of house leakage that can be more useful than CFM50, as it accounts for a home's volume. Air Changes per Hour at 50 Pascals is the number of complete air changes per hour the house will have when 50 Pascals of pressure are applied. The calculation to convert the CFM50 blower door number to ACH50 is:
ACH50 = (CFM50x60)/house volume.

The re-side tight houses ACH50 numbers are shown in Table 2 – Existing Infiltration Rates in CFM50 and ACH50
and range from 8.34 to 29.09 ACH50.

Existing Infiltration Rates		
House	**Exist CFM50**	**ACH50**
House 1	5736	17.42
House 2	7026	29.09
House 3	3424	13.56
House 4	2259	10.52
House 5	4903	11.49
House 6	2610	9.34
House 7	2551	14.32
House 8	3169	16.12
House 9	5375	15.15
House 10	3040	17.21
House 11	4496	16.86
House 12	5207	29.04
House 13	1848	11.04
House 14	3484	14.33
House 15	2125	8.34
House 16	3991	18.97

House 17	4520	17.09
Average	**3671**	**15.1**

Table 2 - Existing Infiltration Rates in CFM50 and ACH50

The graph in Figure 5 shows a range of ACH50 measurements for new and existing homes. According to this graph, the majority of re-side tight homes would be considered very leaky and most would not even appear on the chart with greater than 12ACH.

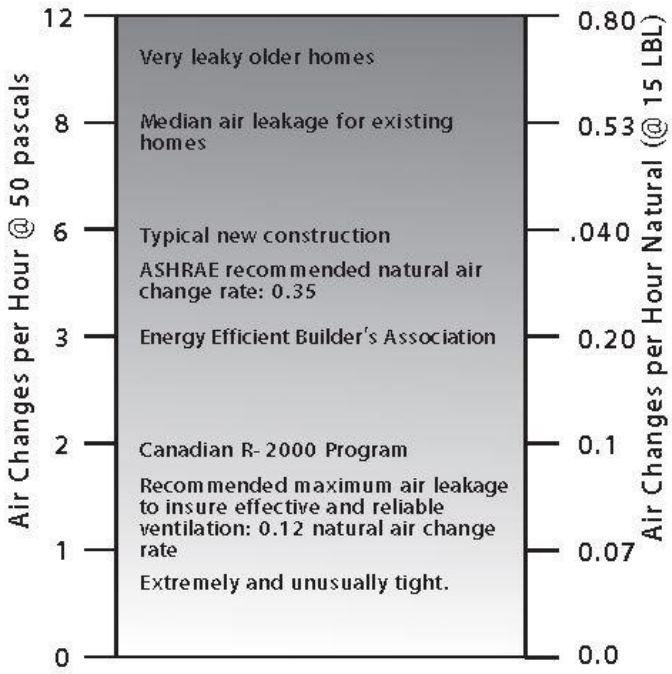


Figure 6 - Example Range of ACH50 (Krigger & Dorsi, 2009)

3.9 WRB Installations

After completion of the pre-siding blower door tests, the WRB installations began. The installations occurred from August 2011 through July 2012. Ten homes had Rain Drop house wrap installed, two homes used Tyvek house wrap, one used GreenGuard 3/8" siding underlayment, one used GreenGuard MAX home wrap and three homes had the Sto Gold liquid applied WRB installed.

House #	Location	WRB Material	Installation Dates
1	West Orange	Rain Drop	August 3, 2011
2	Rutherford	Green Guard 3/8" rigid insulation re- siding board	August 16, 2011
3	Madison	Green Guard MAX building wrap (Green Guard ½" rigid insulation re-siding board	October 17, 2011
4	Landing	Rain Drop	August 18, 2011
5	Morristown	Rain Drop	August 30, 2011
6	Butler	Rain Drop	September 19, 2011
7	Cedar Grove	Rain Drop	October 5, 2011
8	Towaco	Tyvek	September 20, 2011
9	Wayne	Tyvek	September 30, 2011
10	Parsippany	Rain Drop	October 15, 2011
11	Branchville	Rain Drop	November 9, 2011
12	Verona	Rain Drop	November 7, 2011
13	Livingston	Sto Gold	November 17, 2011
14	Rockaway	Rain Drop	January 26, 2012
15	Parsippany	Sto Gold	May 31, 2012
16	Morris Plains	Rain Drop	May 10, 2012
17	West Caldwell	Sto Gold	July 10, 2012

Research team representatives were on site during the WRB installations. For the first installation of each WRB type, industry representatives were also present. The industry representatives were particularly valuable in that they demonstrated installation techniques, answered contractor questions and helped contractors improvise solutions when facing challenging installation issues, such as at plumbing or electrical penetrations.

A description of the installation at each home is included in section 3.11, Individual House Results and Survey Excerpts on page 18.

3.10 Post Siding Infiltration Rates

Table 3 provides a summary of the pre and post siding infiltration rates and the percentage reductions for each house.

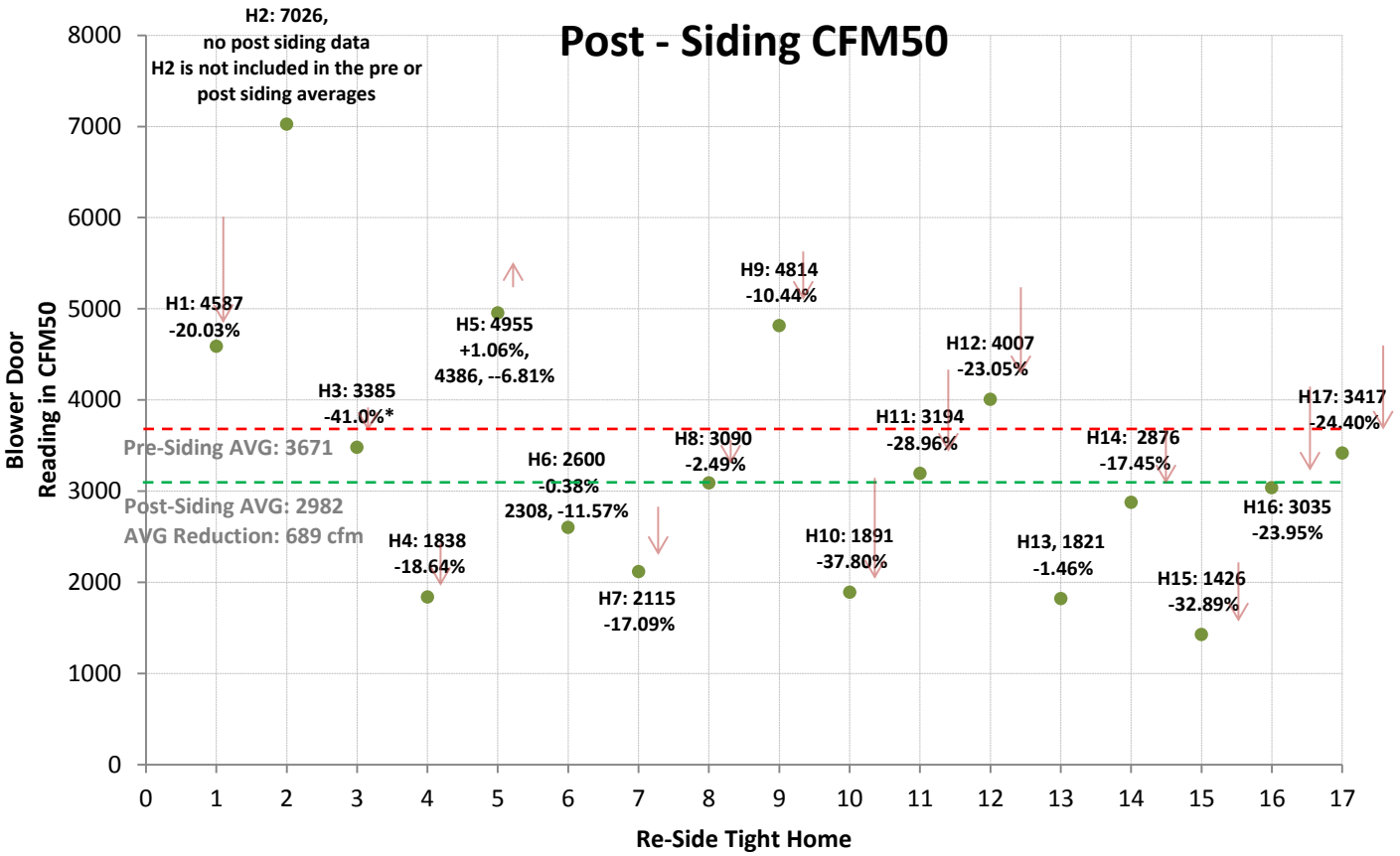
Table 3 - Pre and Post-Siding Change in Infiltration

	Pre-Siding		Post-Siding			Annual Savings	SIR
House	ACH50	CFM50	ACH50	CFM50	% Change		
House 1	17.4	5736	13.9	4587	-20.03%	$109	1.4
House 2	29.1	7026	NA	NA	NA	NA	NA
House 3	13.6	3424	8.1	3385[10]	-40.27%	$34	.47
House 4	10.5	2259	8.6	1838	-18.64%	$82	1.1
House 5	11.5	4903	11.6	4955	1.06%	-$6	-.10
House 6	9.3	2610	9.3	2600	-0.38%	$1	.01
House 7	14.3	2551	11.9	2115	-17.09%	$38	.55
House 8	16.1	3169	15.7	3090	-2.49%	$17	.23
House 9	15.2	5375	13.6	4814	-10.44%	$51	.68
House 10	17.2	3040	10.7	1891	-37.80%	$220	2.9
House 11	16.9	4496	12.0	3194	-28.96%	$252	3.4
House 12	29.0	5207	22.3	4007	-23.05%	$242	3.2
House 13	11.0	1848	10.9	1821	-1.46%	$3	.03
House 14	14.3	3484	11.8	2876	-17.45%	$122	1.6
House 15	8.3	2125	5.6	1426	-32.89%	$136	1.8
House 16	19.0	3991	14.4	3035	-23.95%	$85	1.1
House 17	17.1	4520	12.9	3417	-24.40%	$98	1.3
AVERAGE	15.1	3671	12.1	2982	-18.64%	$105	1.2

The infiltration reduction among the Re-Side Tight homes ranged from an increase of 1% to a decrease of 40.27% with an average of 18.64%[11]. A discussion of the results for each home is in section 3.11.

[10] CFM50 results for house 3 calculated from the change in ACH50 would be 2051CFM50. This house had an addition constructed along with the re-siding work. This is discussed further in section 3.11.4.

[11] This average does not include house 2, as the team could not measure valid post-siding test results. This is discussed further in section 3.11.3.



The average reduction among all but house 2 is 689CFM, this includes the calculated CFM50 reduction for House 3 based on the ACH50 reduction.

Figure 7 - Post-Siding CFM50

* This is the calculated reduction %, actual CFM only dropped 1.1%, but the house volume increased with a 1600 square foot addition, so the ACH dropped by 41%

3.11 Individual House Results and Survey Excerpts

Pre and post testing information for each of the re-side tight homes follows. The location, square footage, volume and building tightness limit (BTL) are shown for each home. This is followed by the pre and post infiltration CFM50 and ACH50 measurements, and the percentage reduction (or increase). Next are the estimated annual energy savings (or increase) and savings to investment ratio (SIR) for the WRB as air barrier installation. Finally, where available, homeowner survey responses to selected survey questions are noted. All the survey questions and responses are included in section 3.12.

3.11.1 Methods and Calculations for Results

3.11.1.1 Building Area and Volume

The building square footage and volume were calculated from field measurements of each home.

3.11.1.2 CFM50 and ACH50

Cubic feet per minute at 50 Pascals (CFM50) measurements were taken using a blower door and following the standard testing protocol as set forth by the Energy Conservatory (The Energy Conservatory, 2011).

Air changes per hour at 50 Pascals are calculated by multiplying CFM50 by 60 minutes per hour and dividing that by building volume (WAPTAC, 2011).

3.11.1.3 Combustion Safety Testing

The team performed combustion safety testing at the re-side tight houses to ensure that combustion appliances were venting properly, even under worst case conditions and that during combustion carbon monoxide levels did not exceed safe limits. This health and safety measure should be performed whenever air-sealing work is executed in existing homes.

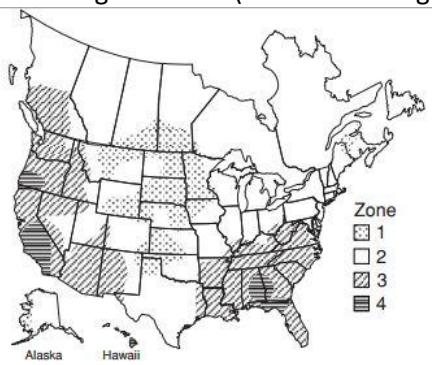
Figure 8 - Combustion Safety Testing at House 6

3.11.1.4 Building Tightness Limit (BTL)

The building tightness limit (BTL) was calculated using the DOE Weatherization Program's calculation:

BTL= (.35xVOLUMExN)/60.

The N factor accounts for building height and exposure to wind. The map and table shown in Figure 9 were used to determine each home's n-factor. Within the table, "well shielded" would be an urban location with high buildings;" normal shielding" would be a residential neighborhood and "exposed" would be an open setting with few buildings or trees. (Nebraska Energy Office, 2011)



n-Factor Table

Zone	# of stories →	1	1.5	2	3
1	Well-shielded	18.6	16.7	14.9	13.0
	Normal	15.5	14.0	12.4	10.9
	Exposed	14.0	12.6	11.2	9.8
2	Well-shielded	22.2	20.0	17.8	15.5
	Normal	18.5	16.7	14.8	13.0
	Exposed	16.7	15.0	13.3	11.7
3	Well-shielded	25.8	23.2	20.6	18.1
	Normal	21.5	19.4	17.2	15.1
	Exposed	19.4	17.4	15.5	13.5
4	Well-shielded	29.4	26.5	23.5	20.6
	Normal	24.5	22.1	19.6	17.2
	Exposed	22.1	19.8	17.6	15.4

Figure 9 - Determining n-Factor (WAPTAC)

3.11.1.5 Estimated Savings

Estimated savings were derived using Tectite™4.0 Building Air Tightness testing software. For natural gas a price of $1.18 per hundred cubic feet (ccf) was used, based on average prices in New Jersey in 2012 (U.S. Energy Information Administration, 2013). For homes heated with fuel oil, a price of $4.10 per gallon was used, based on New Jersey's average fuel oil price in 2012. (U.S. Energy Information Administration, 2013). Cooling savings were based on a kilowatt/hour cost of $0.12/kWh based on utility bill data.

3.11.1.6 Savings to Investment Ratio (SIR)

A savings to investment ratio is calculated by dividing an energy conservation measure's lifetime savings by the initial investment (WAPTAC, 2009). The Weatherization program requires an SIR of one for a measure to be implemented. The measure cost assumed for the SIR was $1,500. This is based on the re-side tight contractors who estimated that they spent 10 – 15 extra minutes per window, or about five additional hours of labor for the windows on each re-side tight home. They also spent about three to

seven additional hours for taping joints between courses of building wrap and at the top and bottom of walls. Total additional time was between 5 and 15 hours and declined with each successive job. The material costs were calculated only for the additional sealants, flashings and tapes. The WRB material itself would ordinarily be purchased for a siding job and so was not included in the price difference. While manufacturers recommend that flashing, tape and sealants be used in specific locations with their products, many contractors do not. As such, those items were considered additional costs. Specific costs were derived from material costs and average amounts used among the re-side tight homes.

Table 4 - Re-Side Tight Average Material Costs

Re-Side Tight Average Material, Labor and Testing Costs	
Contractor tape	$30
Flashing	$175
Sealant	$40
Labor	$1,000
Combustion Safety Testing	$250
Total increase	Approximately $1500

Contractors may increase this cost with an overall markup. For the purpose of the SIR calculations, $1500 was used as the initial investment. The cost may ultimately be lower or higher. Over time it is anticipated that the labor costs will reduce to near zero, especially considering the 2012 International Energy Conservation Code® (IECC) requirement for a continuous air barrier in the building envelope (PNNL, 2012). While this code applies to new construction and additions, installing an intact air barrier will become a more common practice and requirement among siding contractors that work on both new and existing homes. The measure lifetime was set to 20 years, the typical siding warrantee.

3.11.2 House 1, West Orange

House 1 is a late 1800's farmhouse style home located in West Orange. This house had a leakage reduction of just over 20% through the installation of the WRB as an air barrier. This home was wrapped over the existing siding, rather than being stripped down to the sheathing. House 1 used Pactiv's Rain Drop wrap. The projected energy cost savings for this home are $109 annually. House 1 has an SIR of 1.4.

Home Statistics

Dwelling	***Stories***	***Cond. Area***	***Cond. Volume***	***BTL***
West Orange	2.5	2325 SF	19762 CF	1625.42 CFM

	CFM 50	***ACH 50***
Existing Conditions	5736	17.4
Post Siding Results	4587	13.9
20.03% reduction in infiltration		
Estimated annual savings, $109		
Savings to Investment Ratio 1.45		

Survey Responses

Have you noticed a change in your utility bills?
My utility bills are lower

If it had cost you an additional $1600 to re-side your home this way (with the air-barrier), would you pay it?
Yes

3.11.3 House 2, Rutherford



House 2 is an early 20th century American foursquare. The blower door test for house 2 revealed significant leakage at 7026 CFM50. This was the leakiest of the re-side tight houses by over 2,000cfm. House 2's existing painted cedar shake siding was covered with GreenGuard XP38 siding underlayment, detailed as the WRB/air barrier and was then clad with vinyl siding.

Post-siding blower door tests were attempted at House 2 on two different days without results. The research team was not able to conduct the test using Tectite's "cruise control" mode, where the software controls the fan speed. Therefore, they attempted to run the test manually, using readings on the blower door pressure gauge, but kept getting error messages. After contacting technical support and not being able to resolve the issue, the team decided another test date would have to be scheduled. The team returned to House 2 for re-testing one week later. The second day of testing also resulted in error messages on the blower door manometer. The equipment had been used successfully on another home between the first and second day of testing at House 2, so the team concluded that the blower door was not the problem[12]. While the blower door fan was running during the attempted test, team members did notice significant airflow coming down the central stair well from the second floor ceiling and attic. The team planned to return to the house for a third testing attempt, and to perform supplemental air sealing between the attic and the living space. Unfortunately, the homeowner did not agree to the supplemental air sealing and as such, the air sealing and testing was not performed. Despite the lack of testing data, the homeowner was very happy with the WRB/air barrier as part of the siding work. She commented to the contractor that her house is much quieter. She is on a busy street and has much less street noise.

Home Statistics

Dwelling	***Stories***	***Cond. Area***	***Cond. Volume***	***BTL***
Rutherford	2.5	1684 SF	14490 CF	1191.8 CFM

	CFM 50	***ACH 50***
Existing Conditions	7026	29.1
Post Siding Results	No Data	No Data
Estimated annual savings, No Data		
Savings to Investment Ratio, No Data		

Survey Responses *– no data*

[12] A possible post siding scenario for House 2 might have been that the blower door could not reach 50 Pascals. When that occurs, the house is brought to an attainable pressure and a "can't reach 50" (CRF) factor is applied to the CFM reading. The team could not achieve a lower pressure reading or anything other than the error message.

House 2 was the only house in the study that used GreenGuard XP38 as the WRB/air barrier. The product is a code-approved air barrier, but it is rated as one perm, making it vapor semi-permeable (Lstiburek, 2006). Because the WRB/air barrier would be only vapor semi-permeable and could inhibit drying of the wall assembly, the team had a WUFI® (Wärme und Feuchte instationär) analysis done. WUFI software is used to calculate the coupled heat and moisture transfer in building components. The hygrothermal analysis of the assembly determined that relative humidity levels and liquid moisture formation did not meet failure criteria, see partial results in Figure 10 and Figure 11.[13]

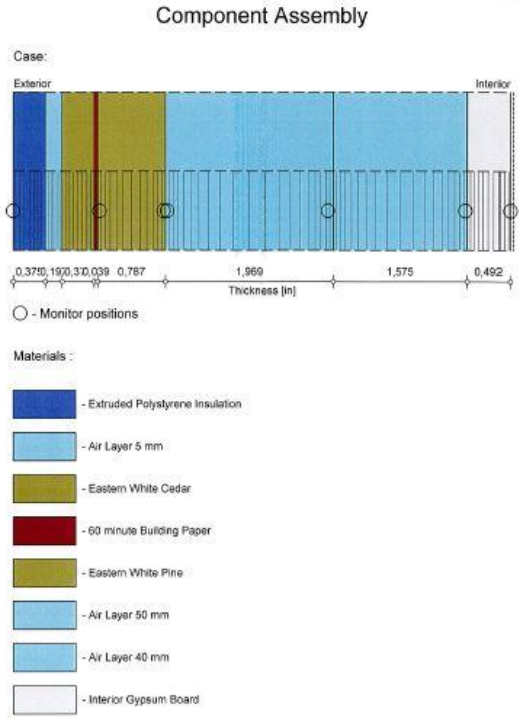


Figure 10- Component Assembly, Exterior Wall, House 2

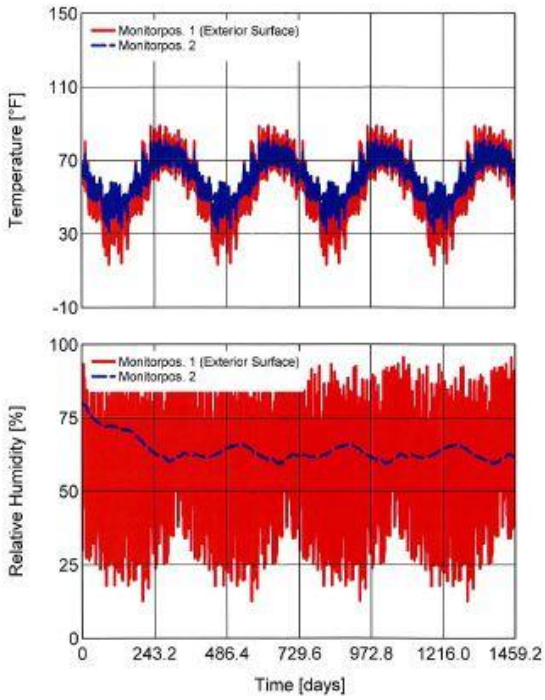


Figure 11 - Relative Humidity and Temperature Levels for Monitor Positions 1 and 2

Since the wall assembly modeling did not reveal potential condensation issues, the planned installation proceeded. Pactiv's industry representative was on-site for the GreenGuard XP38 install at House 2 and provided valuable guidance on detailing to the contractors.

[13] Failure criteria were relative humidity levels above 80% and liquid moisture formation (100% relative humidity) within the assembly.

3.11.4 House 3, Madison



House 3 is the only house in the study that had the re-siding work done as part of a 1600 SF addition. The siding contractor stripped the existing wooden clapboard siding from the house and then installed the GreenGuard Max wrap as the air barrier, which was then covered with ½" GreenGuard rigid insulation and fiber cement siding. The blower door readings went down slightly, from 3424CFM50 to 3385CFM50, while the house volume increased from 15,150cubic feet to 24,148 cubic feet. Therefore, while the CFM50 went down only1.1percentage, the ACH50 went down just over 40%. In the survey, this homeowner said their utility bills have gone down slightly, despite adding 1600 square feet to the home. Because of the increase in this home's volume, the SIR calculation results in a .47SIR.

Home Statistics ***Dwelling***	***Stories***	***Cond. Area***	***Cond. Volume***	***BTL***
Madison	2	1888 SF	15150 CF	1307.95 CFM
	3	3488 SF	24148 CF	

	CFM 50	***ACH 50***
Existing Conditions	3424	13.6
Post Siding Results	3385*	8.1*
-40.1% reduction in infiltration based on ACH		
Estimated annual savings, $34		
Savings to Investment Ratio .47		

Survey Responses

Have you noticed a change in your utility bills?

My utility bills are lower. I added 1600 ft^2 and the heating bill went down slightly

If it had cost you an additional $1600 to re-side your home this way (with the air-barrier), would you pay it?

Yes

As with house 2, the research team ran a WUFI analysis on this home's wall assembly to verify that the ½" rigid insulation would not cause a potential moisture issue for the home. While the rigid insulation here was not acting as the WRB and was not detailed as the air barrier, there was still motive for investigation, as the International Residential Code (IRC) guidance on exterior foam sheathing in climate zone 5 requires at least an R5 on 2x4 walls. The ½ in Green Guard product is an R3 (Pactiv Corporation, 2011). The IRC applies to new construction, but the team wanted to run further analysis as the concern

was present. The analysis revealed that the wall assembly would not meet the modeling failure criteria[13] and therefore would not be in danger of having a moisture problem because of the rigid insulation. See Figure 12 and Figure 13. These results were helpful regarding other re-side tight homes where rigid insulation was installed.[14]

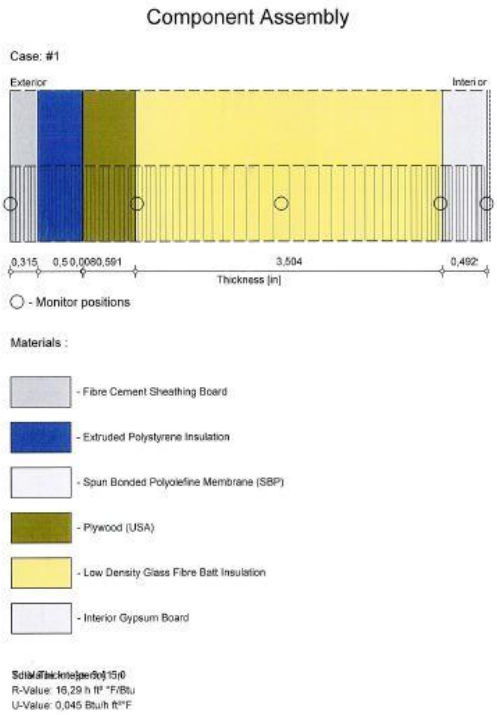


Figure 12 Component Assembly, Exterior Wall, House 3

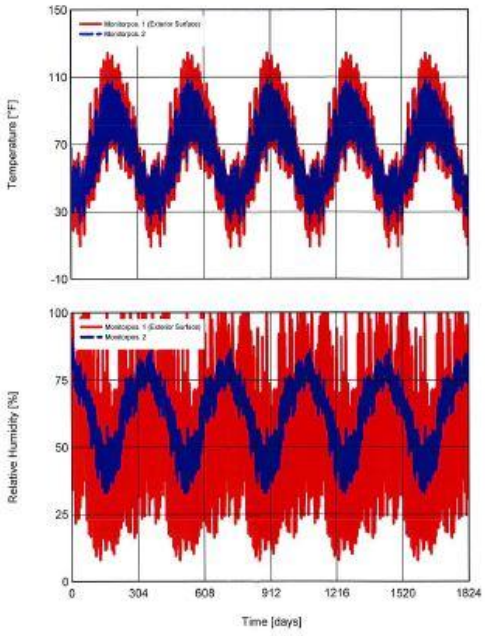


Figure 13 - Relative Humidity and Temperature Levels for Monitor Positions 1 and 2

[14] Siding contractors often install thin rigid siding underlayment to even out the existing wall or thicker rigid insulation as part of a residing job. It is not typically thick enough to meet the IRC requirement of R5 in climate zone 5.

3.11.5 House 4, Landing



House 4 is a raised cape over a single car garage and partial finished basement. House 4 had an initial leakage of 2,259 CFM50. The home's existing siding was removed, Pactiv Rain Drop home wrap was installed with air barrier detailing, and the home was re-sided. The post-siding blower door test was 1,838 CFM50, an 18.64% drop. House 4 had an SIR of 1.1.

Home Statistics

Dwelling	***Stories***	***Cond. Area***	***Cond. Volume***	***BTL***
Landing	2.5	1587 SF	12885 CF	1059.79 CFM

	CFM 50	***ACH 50***
Existing Conditions	2259	10.5
Post Siding Results	1838	8.6
18.64% reduction in infiltration		
Estimated annual savings, $82		
Savings to Investment Ratio 1.1		

Survey Responses

Have you noticed a change in your utility bills?
Not sure yet.

If it had cost you an additional $1600 to re-side your home this way (with the air-barrier), would you pay it?
No

3.11.6 House 5, Morristown

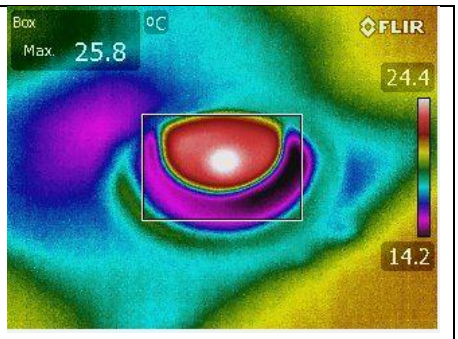


Figure 14 – Infrared Image of recessed light in House 5 second floor ceiling

House 5 is 1960's 3,100 square foot side hall colonial. House 5's initial blower door results were 4,903 CFM50, and a post siding result of 4,955, a 1.06% increase in infiltration. The project team investigated what may have caused the increase. During the air barrier installation, the contractor attempted to modify the installation details at window heads. He was told that the details provided in the manufacturer's literature had to be followed. The testing results suggest that some of the window heads may not have been corrected. Additionally, as part of the re-siding job a new roof was installed. The home's original roof was not vented; the new roof included the installation of soffit vents and a ridge vent. As such, the team concluded that existing leakage between the living space and the attic was amplified because of the new soffit and gable venting. The team performed additional air leakage testing and looked at areas with high leakage potential using an infrared camera. For example, recessed lights in the second floor ceiling showed significant leakage. See Figure 14. After the testing, the team performed additional air sealing between the living space and the attic, reducing the leakage to 4,569CFM50, a 6.81% drop. House 5 had an SIR of -0.08 because of the initial increase in infiltration. The post air sealing SIR was .26.

Home Statistics

Dwelling	***Stories***	***Cond. Area***	***Cond. Volume***	***BTL***
Morristown	2	3185 SF	25594 CF	2209.61 CFM

	CFM 50	***ACH 50***
Existing Conditions	4903	11.5
Post Siding	4955	11.6
1.06% increase in infiltration		
Estimated annual savings, $6 cost increase		
Savings to Investment Ratio -.10		
	CFM 50	***ACH 50***
Post Attic Air Sealing	4569	10.71
6.81% decrease in infiltration		
Estimated annual savings, $36		
Savings to Investment Ratio .26 *(using $2815 as investment cost, which includes additional air sealing cost of $1315)*		

Have you noticed a change in your utility bills?
Yes, we have a lower budgeted amount on our utility bill

If it had cost you an additional $1600 to re-side your home this way (with the air-barrier), would you pay it?
Yes

3.11.7 House 6, Butler

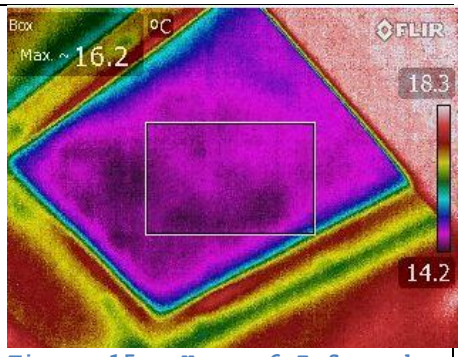


Figure 15 - House 6 Infrared Image of Attic Access Hatch

House 6 is a 1960's-split level home with initial leakage of 2,610 CFM 50. House 6 had the existing siding stripped and Rain Drop house wrap installed as a WRB/air barrier beneath the new siding. The post-siding testing of House 6 showed a 1.9% increase in infiltration. As with House 5, this house had a new roof with soffit and ridge vents installed as part of the siding job. (There was not an issue with correct window detailing at House 6). The existing roof did not have a ridge vent and had limited soffit venting. An evaluation of the air leakage between the living space and the attic revealed that there was air leakage at the home's two attic access points; see Figure 15, at the recessed light fixtures in the living room ceiling and at various ceiling penetrations. After air sealing the ceiling penetrations with foam, installing stainless steel boxes over non I.C. rated recessed light fixtures[15] and weatherstripping the two attic access hatches, the testing results went down to 2,308, an 11.57% drop. House 6 had an SIR of .01 and a post air sealing SIR of .17.

Home Statistics

Dwelling	***Stories***	***Cond. Area***	***Cond. Volume***	***BTL***
Butler	2	2096 SF	16762 CF	1632.9 CFM

	CFM 50	***ACH 50***
Existing Conditions	2610	9.3
Post Siding	2600	9.3
0.38% decrease in infiltration		
Estimated annual savings, $1		
Savings to Investment Ratio, 0.01		
	CFM 50	***ACH 50***
Post Attic Air Sealing	2308	8.26
11.57% decrease in infiltration		
Estimated annual savings, $24		
Savings to Investment Ratio .17 *(using $2870 as investment cost, which includes additional air sealing cost of $1370)*		

[15] I.C. rated recessed lights are Insulation Contact rated.

<u>Survey Responses</u>

Have you noticed a change in your utility bills?
Not sure yet

If it had cost you an additional $1600 to re-side your home this way (with the air-barrier), would you pay it?
Yes

3.11.8 House 7, Cedar Grove

House 7 is a 1300 square foot side hall colonial with an initial leakage of 2,551CFM50. House 7's existing siding was removed and Rain Drop house wrap was installed as the WRB/air barrier. After the siding installation was complete, the infiltration dropped by just over 17%, to 2,115 CFM50. Despite the 17% drop in infiltration, House 7 had an SIR of only .55. This is because the 17% drop only represents a 436cfm and a savings of $41.

Home Statistics

Dwelling	***Stories***	***Cond. Area***	***Cond. Volume***	***BTL***
Cedar Grove	2	1336 SF	10668 CF	922.73 CFM

	CFM 50	***ACH 50***
Existing Conditions	2551	14.3
Post Siding	2115	11.9
17.09% reduction in infiltration		
Estimated annual savings, $38		
Savings to Investment Ratio .55		

Survey Responses – *no survey data*

3.11.9 House 8, Towaco


House 8 is a 1400 square foot ranch home with an initial leakage rate of 3,169 CFM50. Removal of the home's existing siding revealed a loose patchwork of rigid insulation over felt paper covered sheathing. The contractor installed Tyvek Home Wrap as the WRB/air barrier beneath the new siding. At House 8, an industry representative from Tyvek instructed the contractor not to completely seal the house wrap to the bottom of the wall. His rationale was that if moisture got behind the Tyvek, an opening at the bottom would let it drain out. This ran counter to Tyvek's own installation guide. The wrap was installed as instructed by the industry representative. NJIT reached out to another technical representative at Tyvek expressing concern over the guidance originally provided. As a result, the Tyvek representative did agree with sealing the Tyvek completely at the base of the wall for the next Tyvek house, (House 9).The post siding test came in at 3,090 CFM50, a 2.49% drop. House 8 had an SIR of .23.

Home Statistics

Dwelling	***Stories***	***Cond. Area***	***Cond. Volume***	***BTL***
Towaco	1	1448 SF	11792 CF	1272.55 CFM

	CFM 50	***ACH 50***
Existing Conditions	3169	16.1
Post Siding	3090	15.7
2.49% reduction in infiltration		
Estimated annual savings, $17		
Savings to Investment Ratio .23		

Survey Responses

Have you noticed a change in your utility bills?

No

If it had cost you an additional $1600 to re-side your home this way (with the air-barrier), would you pay it?

No

3.11.10 House 9, Wayne

House 9, Wayne, results – 10.4% reduction in infiltration


House 9 is a 1960's split-level home. Removal of the existing siding on house 9 revealed existing rigid insulation over the house sheathing. The contractor installed Tyvek Home Wrap as the WRB/air barrier beneath the new siding. At House 9, another industry representative from Tyvek guided the contractor and agreed that the Tyvek should be sealed at the bottom of the walls for proper air barrier detailing. The post siding test came in at 4,814CFM50, a 10.4% drop. House 9 had an SIR of .68.

Home Statistics

Dwelling	***Stories***	***Cond. Area***	***Cond. Volume***	***BTL***
Wayne	2	2632 SF	21284 CF	2073.42 CFM

	CFM 50	***ACH 50***
Existing Conditions	5375	15.2
Post Siding	4814	13.6
10.4% reduction in infiltration		
Estimated annual savings, $51		
Savings to Investment Ratio .68		

Survey Responses

Have you noticed a change in your utility bills?

Not sure yet

If it had cost you an additional $1600 to re-side your home this way (with the air-barrier), would you pay it?

Yes

3.11.11 House 10, Parsippany

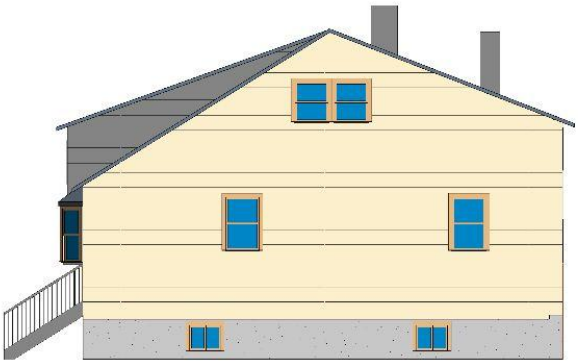


Figure 16 - House 10 Rendering of Post Siding North Elevation

House 10 is a 1960's side split-level home. Rain Drop home wrap was installed as the WRB/air barrier. This was put over new rigid insulation installed over the home sheathing. The infiltration in House 10 went from 3,040CFM50 down to 1,891CFM50, a 37.8% drop. Using the Weatherization Program's calculation for a building tightness limit House 10 had a BTL of 1,032CFM50 and as such did not need mechanical ventilation. House 10 had an SIR of 2.9.

Home Statistics

Dwelling	***Stories***	***Cond. Area***	***Cond. Volume***	***BTL***
Parsippany	2	1346 SF	10597 CF	1032.32 CFM

	CFM 50	***ACH 50***
Existing Conditions	3040	17.2
Post Siding	1891	10.7
37.8% reduction in infiltration		
Estimated annual savings, $220		
Savings to Investment Ratio 2.9		

Survey Responses

Have you noticed a change in your utility bills?

My utility bills are lower

If it had cost you an additional $1600 to re-side your home this way (with the air-barrier), would you pay it?

Yes

3.11.12 House 11, Branchville



House 11 is 2,200 square foot circa 1900 farmhouse. Removal of the existing siding revealed wide plank sheathing and some areas of rigid insulation. The initial blower door test results for this house were 4496CFM50, post siding testing results were 3194CFM50 for a close to 29% reduction. The homeowner began demolishing a portion of the existing kitchen after the initial blower door test was done and before the post siding test was completed. Part of his demolition left large openings to the outside in the kitchen. As such, the post siding test isolated the kitchen from the test. Volumes and areas were adjusted accordingly for the CFM50 and ACH50 calculations. House 11 had an SIR of 3.4.

Home Statistics

Dwelling	***Stories***	***Cond. Area***	***Cond. Volume***	***BTL***
Branchville	2	2200 SF	16000 CF	1381.33 CFM

	CFM 50	***ACH 50***
Existing Conditions	4496	16.9
Post Siding	3194	12.0
28.96% reduction in infiltration		
Estimated annual savings, $252		
Savings to Investment Ratio 3.4		

Survey Responses *– No Survey Data*

3.11.13 House 12, Verona


House 12 is a 1920's bungalow with an enclosed porch. The initial blower door test for this house came in at 5,207 CFM 50 and an ACH50 of 29.0. This was the second highest ACH50 of all the re-side tight houses. At house 12, the original siding was wrapped over with Rain Drop as the WRB/air barrier. This was covered in rigid insulation and then new vinyl siding was installed. Post-siding results were 4,007 CFM50 or about a 23% reduction in infiltration. House 12 had an SIR of 3.2.

Home Statistics

Dwelling	***Stories***	***Cond. Area***	***Cond. Volume***	***BTL***
Verona	2	1840 SF	10760 CF	928.95 CFM

	CFM 50	***ACH 50***
Existing Conditions	5207	29.0
Post Siding	4007	22.3
23.05% reduction in infiltration		
Estimated annual savings, $242		
Savings to Investment Ratio 3.2		

Survey Responses

Have you noticed a change in your utility bills?
Not sure yet.

If it had cost you an additional $1600 to re-side your home this way (with the air-barrier), would you pay it?
Yes

3.11.14 House 13, Livingston


House 13 is a 1950's ranch. The initial leakage at House 13 was 1,848CFM50. The home's existing siding was asbestos shingle siding. The project team confirmed with Sto that their product could be painted on existing siding to function as an air barrier. At House 13, the siding was not removed, and Sto Gold liquid applied air barrier was painted over the siding. A sales representative from Sto was on site for the installation. Large gaps where the bottom course of shingles met the house were filled with spray foam. The infiltration reduction for this home was much less than anticipated, with a 1.5% reduction. Further blower door testing was done to see if there was significant leakage between the living space and the attic. The pressure differences found did not indicate excessive leakage. The project team went on to speak with other technical support people at Sto and were later told that installation of Sto Gold on existing siding is not a recommended application and that the product should be installed over the house sheathing. Therefore, the slight reduction in infiltration was attributed to the suboptimal application of the Sto Gold system. Lessons learned from House 13 informed the other two liquid applied air barrier locations, House 15 and House 17. House 13 had an SIR of .03.

Home Statistics

Dwelling	***Stories***	***Cond. Area***	***Cond. Volume***	***BTL***
Livingston	1	1256 SF	10048 CF	1084.35 CFM

	CFM 50	***ACH 50***
Existing Conditions	1848	11.0
Post Siding	1821	10.9
1.5% reduction in infiltration		
Estimated annual savings, $3		
Savings to Investment Ratio .03		

Survey Responses - *No Survey Data*

3.11.15 House 14, Rockaway



House 14 is a 1970's 2,000 square foot home that appears to have been inspired by midcentury modern design. The existing vertical cedar siding was wrapped over with Rain Drop wrap as the WRB/air barrier. Rigid insulation was then installed over the WRB. The initial infiltration rate was 3,484CFM50, which was dropped to 2,876CFM50, a 17.5% reduction. House 13 had an SIR of 1.6.

Home Statistics

Dwelling	***Stories***	***Cond. Area***	***Cond. Volume***	***BTL***
Rockaway	2	1960 SF	14586 CF	1131.63 CFM

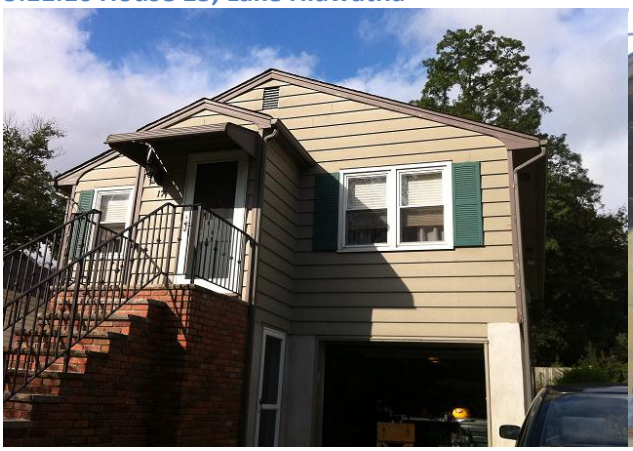
	CFM 50	***ACH 50***
Existing Conditions	3484	14.3
Post Siding	2876	11.8
17.5% reduction in infiltration		
Estimated annual savings, $122		
Savings to Investment Ratio 1.6		

Survey Responses

Have you noticed a change in your utility bills?
Big reduction in oil bill

If it had cost you an additional $1600 to re-side your home this way (with the air-barrier), would you pay it?
Yes

3.11.16 House 15, Lake Hiawatha




House 15 is a 1960's minimal traditional home with a masonry foundation/first level and a frame storey above. House 15's existing infiltration rate was 2,215CFM50. Removal of the home's existing siding revealed fiberboard sheathing with a few areas of material degradation. Holes and gaps on the walls were patched with spray foam insulation. Larger damaged sections of the fiberboard were replaced with new pieces of rigid insulation. Once the walls were prepped, Sto Gold liquid applied WRB with fibermesh tape at gaps and seams was installed as the air barrier. After the siding was completed, the infiltration rate dropped to 1,426CFM50, a 32.9% the building tightness limit for House 15 was 1,374, which the house exceeded. House 15 had an SIR of 1.8.

Home Statistics

Dwelling	***Stories***	***Cond. Area***	***Cond. Volume***	***BTL***
Lake Hiawatha	2.5	2024 SF	15290 CF	1373.55 CFM

	CFM 50	***ACH 50***
Existing Conditions	2125	8.3
Post Siding	1426	5.6
32.89% reduction in infiltration		
Estimated annual savings, $136		
Savings to Investment Ratio 1.8		

32.9% decrease in infiltration

Survey Responses

Have you noticed a change in your utility bills?

No

If it had cost you an additional $1600 to re-side your home this way (with the air-barrier), would you pay it?

No

3.11.17 House 16, Morris Plains

House 16 is a 1600 square foot 1950's center hall colonial. The pre-siding infiltration rate for House 16 was 3,991CFM50 and 19 ACH. The contractor installed Rain Drop house wrap over the existing siding as the WRB/air barrier. The crew then installed a rigid insulation drainage board, over which they installed insulated vinyl siding. Post siding infiltration was 3,305CFM50, a 23.95% decrease. House 16 had an SIR of 1.1.

Home Statistics

Dwelling	***Stories***	***Cond. Area***	***Cond. Volume***	***BTL***
Morris Plains	2.5	1557 SF	12622 CF	1133.88 CFM

	CFM 50	***ACH 50***
Existing Conditions	3991	19.0
Post Siding	3035	14.4
23.95% reduction in infiltration		
Estimated annual savings, $85		
Savings to Investment Ratio 1.1		

Survey Responses

Have you noticed a change in your utility bills?

Not sure yet

If it had cost you an additional $1600 to re-side your home this way (with the air-barrier), would you pay it?

Yes

3.11.18 House 17, West Caldwell

House 17 is a 2,026 1970's bi-level home. Initial leakage at House 17 was 4520CFM50. Removal of this home's siding revealed fiberboard sheathing. This was covered with Sto Gold as the WRB/air barrier over which insulated vinyl siding was installed. The post siding infiltration testing result was 3417CFM50, a 24.4% drop. House 17 had an SIR of 1.3.

Home Statistics

Dwelling	***Stories***	***Cond. Area***	***Cond. Volume***	***BTL***
West Caldwell	2.5	2,026 SF	15,870 CF	1287 CFM

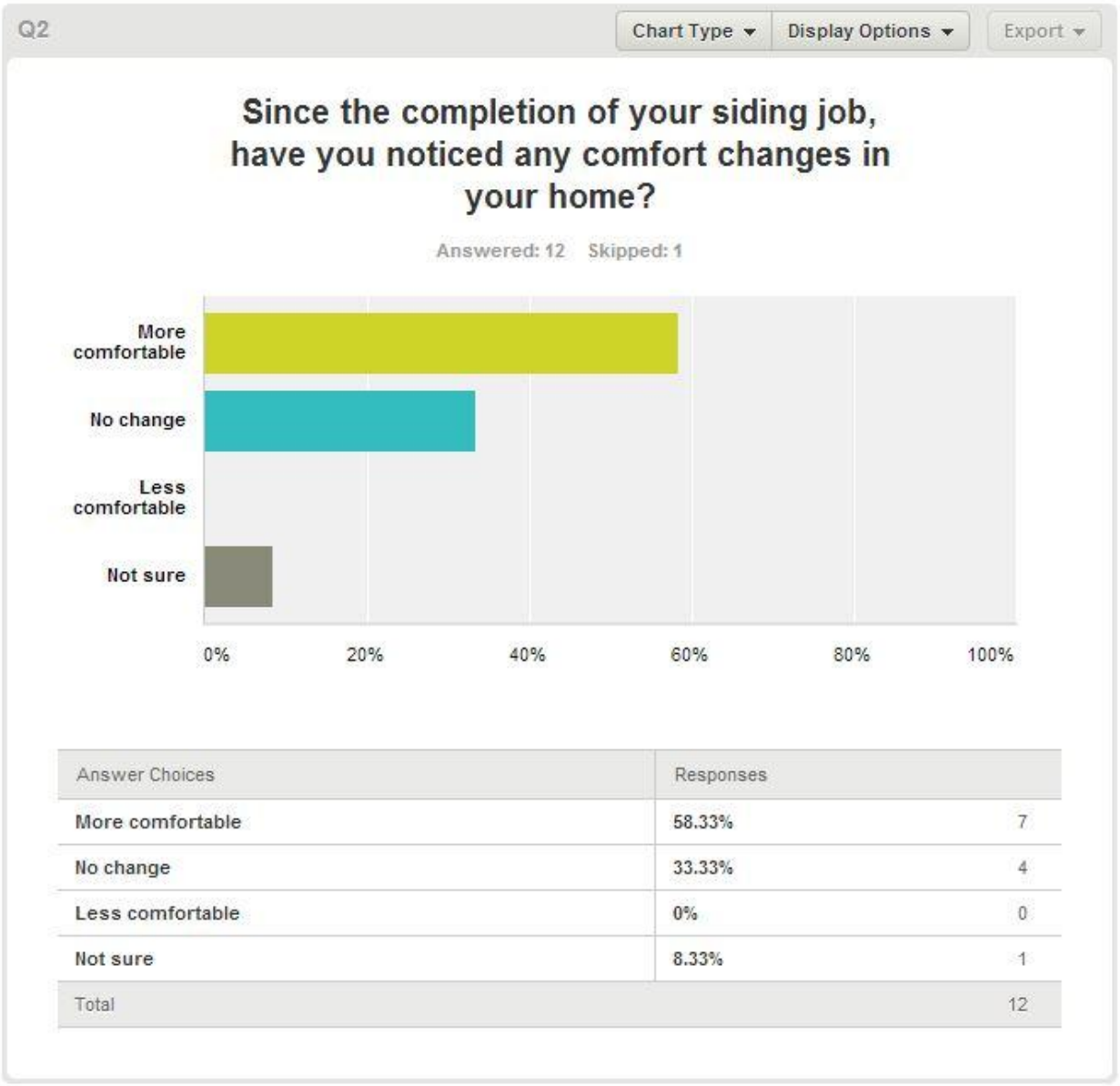
	CFM 50	***ACH 50***
Existing Conditions	4520	17.1
Post Siding	3417	12.9
24.4% reduction in infiltration		
Estimated annual savings, $98		
Savings to Investment Ratio 1.3		

Survey Responses – *no survey data*

3.12 Post-Study Survey

Thirteen of the 17 Re-Side Tight participants completed the survey. The research team completed most of the surveys via telephone call to the homeowners.

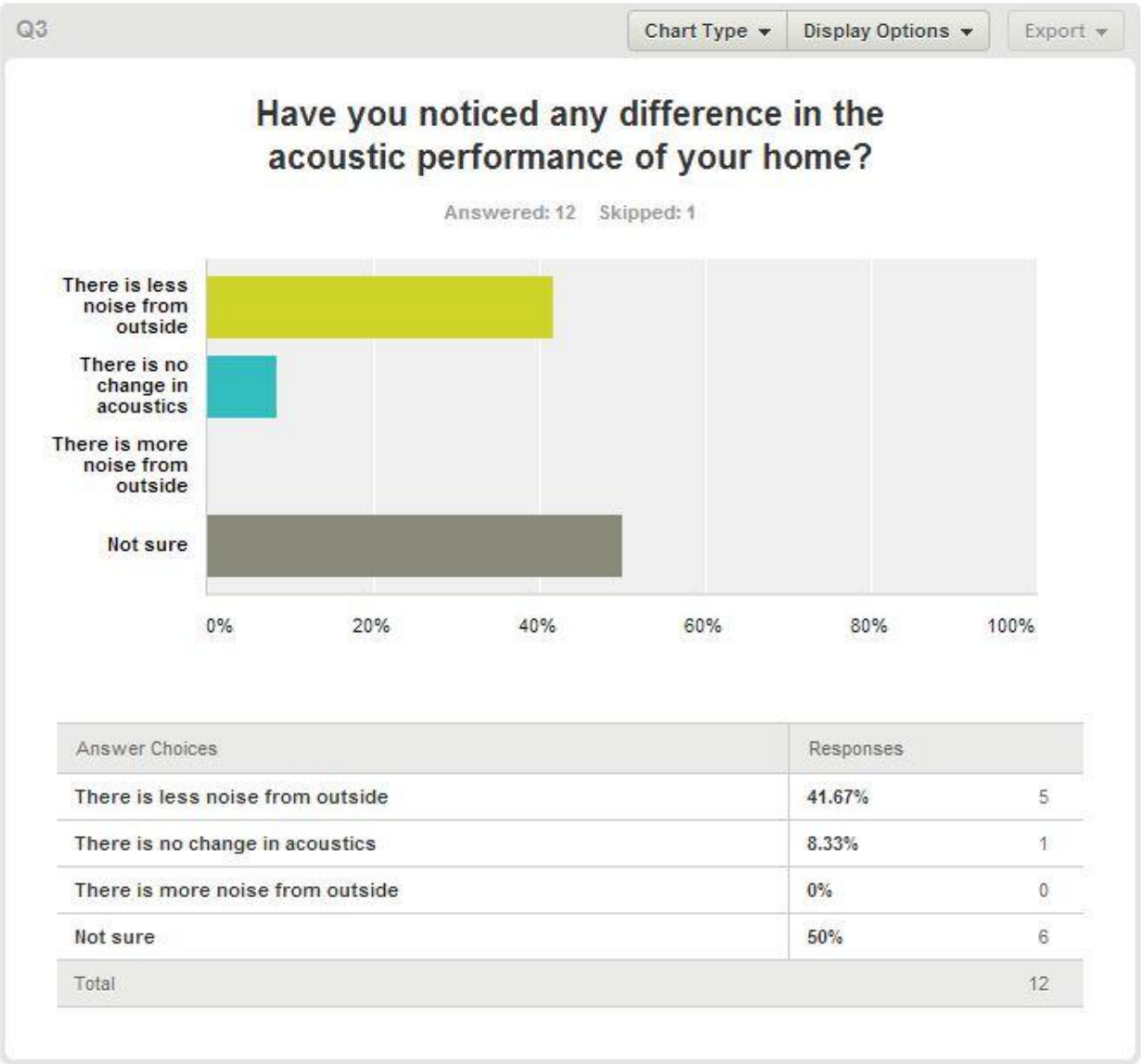
The first question of the survey asked participants in which town they lived. That was included to identify results entered via the survey website. Questions two – eight follow.



Answer Choices	Responses	
More comfortable	58.33%	7
No change	33.33%	4
Less comfortable	0%	0
Not sure	8.33%	1
Total		12

Figure 17 - Survey Question 2 Responses

Survey question two asked respondents if they noticed comfort changes in their home since the completion of their siding job. Seven homeowners reported that their homes were more comfortable, four had no change and one homeowner was not sure.

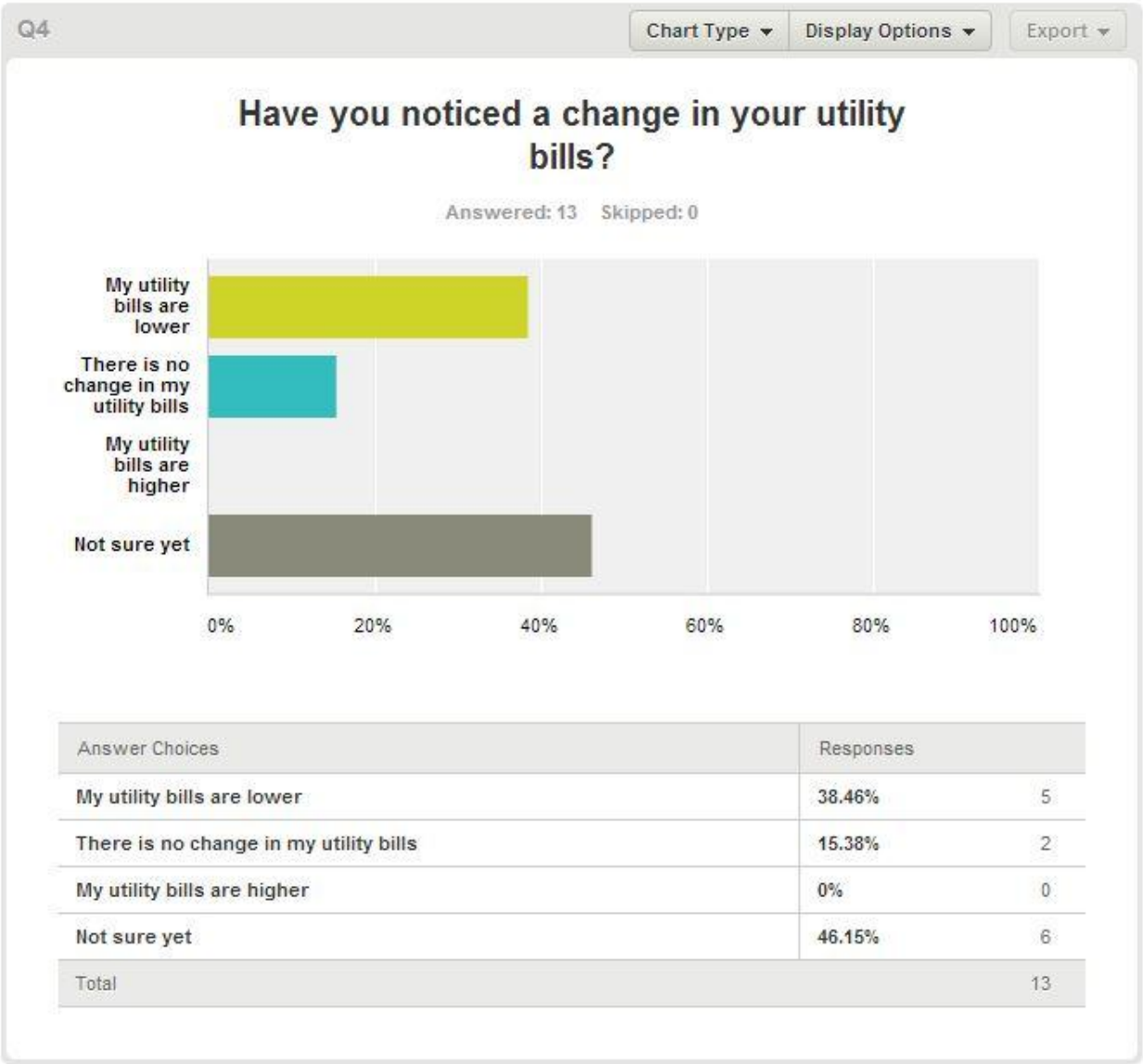


Answer Choices	Responses	
There is less noise from outside	41.67%	5
There is no change in acoustics	8.33%	1
There is more noise from outside	0%	0
Not sure	50%	6
Total		12

Figure 18 - Survey Question 3 Responses

Survey question two asked whether homeowners noticed a change in the acoustic performance of their home. Five participants said there was less noise from outside, one said there was no change in acoustics and six participants were not sure.[16]

[16] One homeowner that did not participate in the survey commented that she was delighted at how much quieter her home was after the siding installation.



Answer Choices	Responses	
My utility bills are lower	38.46%	5
There is no change in my utility bills	15.38%	2
My utility bills are higher	0%	0
Not sure yet	46.15%	6
Total		13

Figure 19 - Survey Question 4 Responses

Survey question four asked whether participants noticed a change in their utility bills. Five homeowners stated that their utility bills were lower, two said there were no changes in their utility bills and six said they were not sure yet.

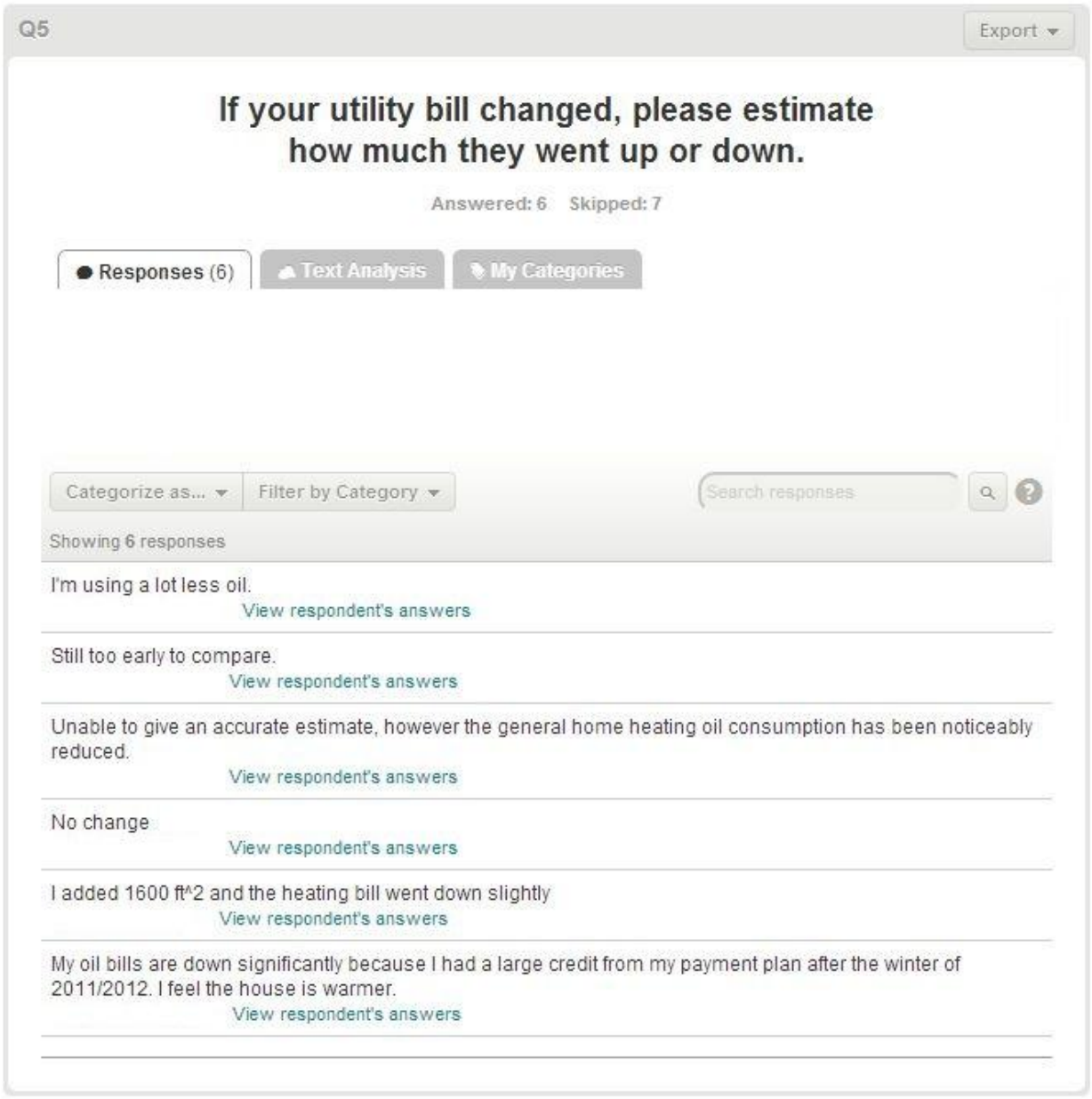


Figure 20 - Survey Question 5 Responses

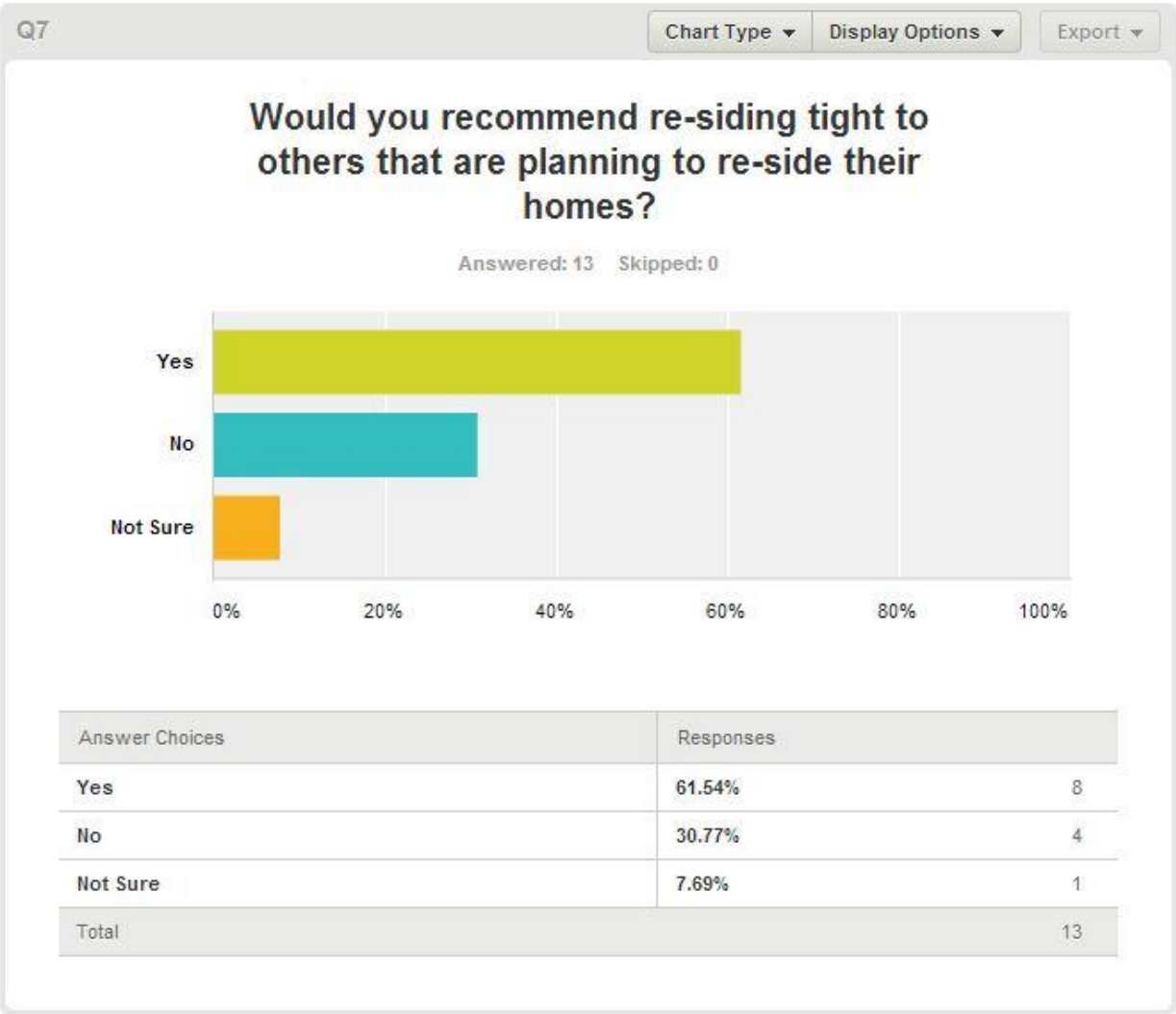
Survey question five asked for more detail regarding utility bill changes. Six respondents offered more information, as shown in Figure 20.

Answer Choices	Responses	
Yes	69.23%	9
No	30.77%	4
Not Sure	0%	0
Total		13

Figure 21 - Survey Question 6 Responses

Survey question six asked whether homeowners would be willing to pay an additional $1600 for the re-side tight approach. [17] Nine participants said they would pay an additional $1600, four said they would not.

[17] A later refinement of the re-side tight costs came out to $1500. At the time the survey was posted, the estimate of $1600 was used.



Answer Choices	Responses	
Yes	61.54%	8
No	30.77%	4
Not Sure	7.69%	1
Total		13

Figure 22 - Survey Question 7 Responses

Survey question seven asked whether participants would recommend the re-side tight approach to others. Eight respondents said they would recommend the approach, four said they would not and one was not sure.

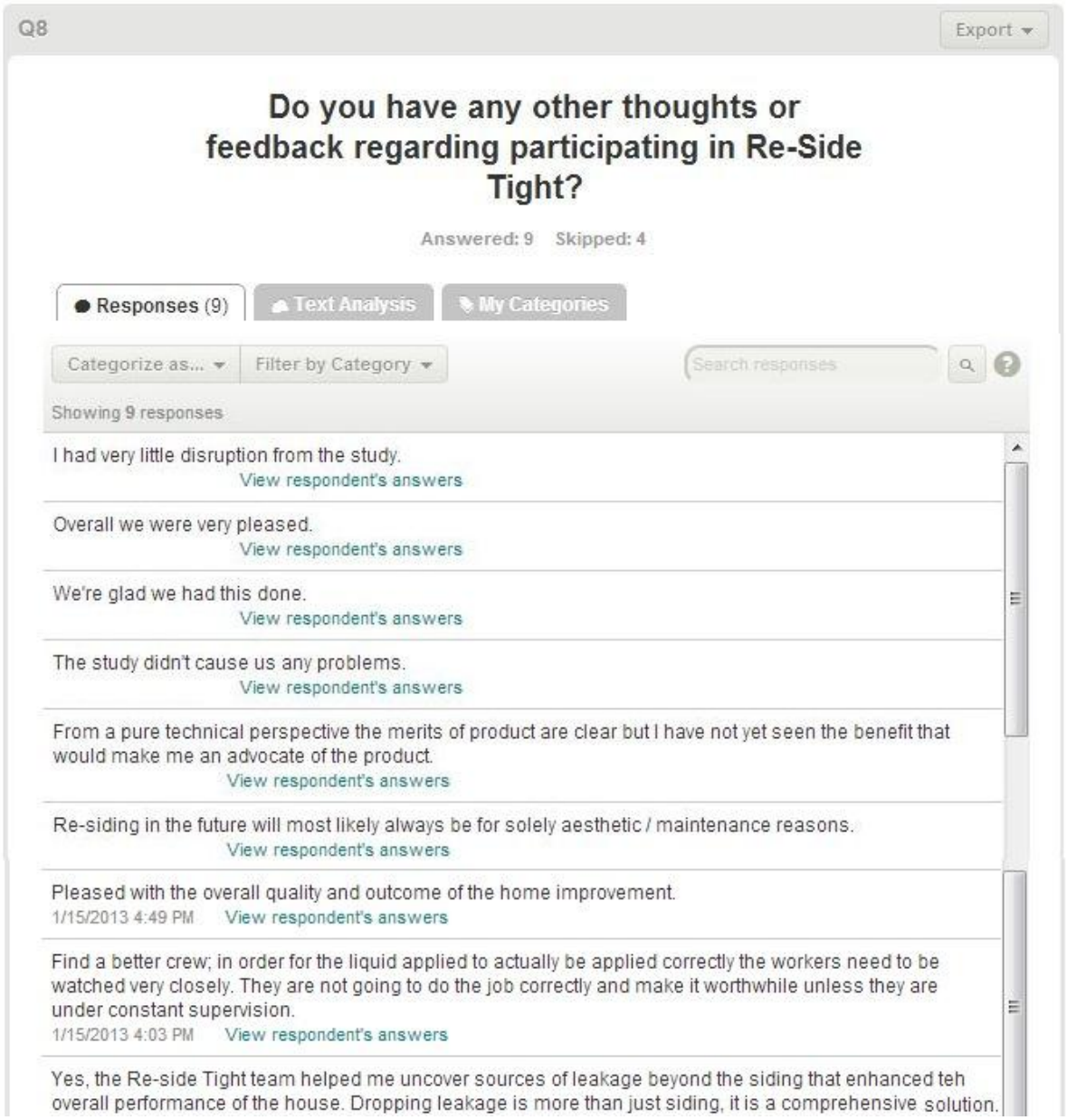


Figure 23 - Survey Question 8 Responses

Survey question eight asked if participants had any further feedback about the study. Nine participants' responses are shown in Figure 23

4 Conclusions

4.1 Cost Effective Infiltration Reduction

While the proposal for this study sought a 15 – 20% reduction in heating and cooling costs, the more realistic goal for the re-side tight approach is a 15 – 20% reduction in infiltration, which does not translate directly to a 15 – 20% reduction in heating and cooling energy. A common post weatherization infiltration reduction goal is 20%. This infiltration reduction was achieved in twelve of the seventeen study homes, and lessons learned from this research could make that level of reduction more reliably met in more homes. An SIR of one or greater was achieved in nine of the 17 homes. With the $1500 price point for the re-side tight approach, annual savings of $75 or more is required to achieve an SIR of one.[2]

4.2 Scaling Up the Re-Side Tight Approach

4.2.1 Contractor Training

To make the re-side tight approach more widespread, siding contractors need to be trained in the installation of the WRB as an air barrier. As part of the re-side tight study, the project team created online contractor training, as seen in Figure 24. This online training can serve as a standalone or supplemental resource for contractors to learn the re-side tight techniques.[18]

Figure 24 - Re-Side Tight Online Training Introduction Tutorial

4.2.2 Potential Market

One of the clear benefits of the re-side tight approach is the broader opportunity for greater energy efficiency in existing homes. Considering New Jersey alone, in 2009 the NJ HPwES program made energy efficiency upgrades to 3,310 homes (NJ Clean Energy Program, 2012). There were 1,136,000 re-siding jobs done in the US in 2009. Ne Jersey has approximately 2.6 percent of the housing units in the United States. If the 2.6 percent is multiplied by the total U.S. re-siding jobs, the sum is 28,400 New Jersey re-siding jobs. If even one in ten of those homes is re-sided using the re-side tight method, the number of homes with infiltration reduction measures being implemented would nearly double.

[18] The training can be viewed at http://media.buildingmedia.com/projects2/NJIT/residetight/1.1/player.html

If siding contractors know how to quantify the benefits of exterior air sealing when re-siding, they could potentially take advantage of Clean Energy Program rebates through the NJ HPwES program.

The re-side tight approach could also be a stand-alone incentive program, whereby utilities or HPwES provide an incentive for installing an air barrier while re-siding if performance or prescriptive installation measures are met.

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