

# Energy Saving Opportunities from Innovative New Window Treatments

February 1, 2018

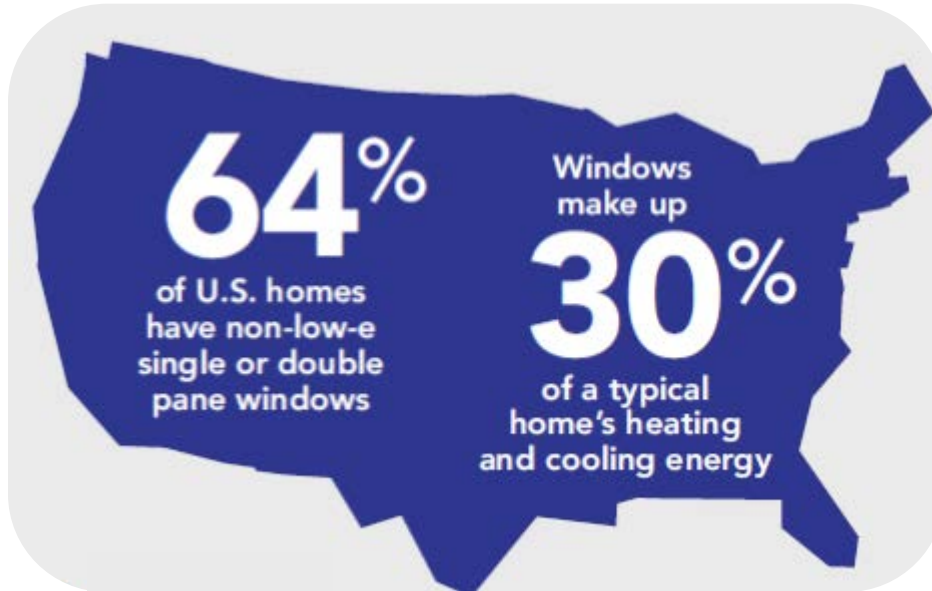
Presenters: Lara Bonn (Efficiency Vermont) and  
Katie Cort (Pacific Northwest National Laboratory)

Moderator: Emily Phan-Gruber (AERC)

- We hope webinar participants will learn:
  - The variety of window attachments in the market today
  - The energy savings potential of window attachments
  - Rating through the AERC program
  - Research and efforts other stakeholders have taken in this space
  - What might be required for you to consider adopting window attachments as a measure

- Part I: Introduction to Window Attachments
- Part II: Lab Home Experiments
- Part III: Attachments Energy Rating Council
- Part IV: Market Impact Pilots and Survey Work

# **Part I. Introduction to Window Attachments**



Most household heat is lost through the windows and roof.

Only **2%** of homes replace  
their windows each year



**93** million homes have  
inefficient windows

# What are Window Attachments?

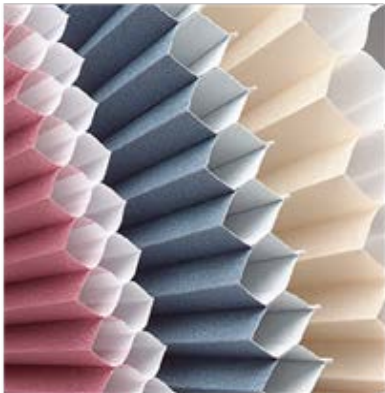
## Interior Shutters



## Horizontal Blinds



## Cellular Shades



## Roller Shades





# What are Window Attachments?

## Exterior Storm Windows



## Exterior Roller Shades



## Exterior Roller Shutters



## Awnings



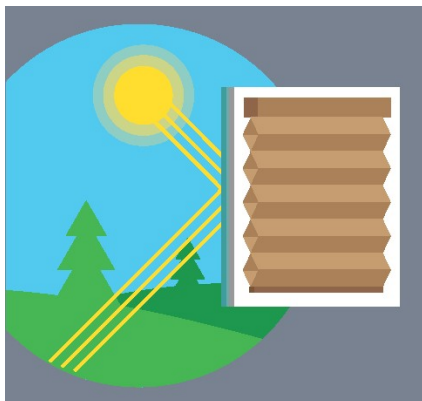
# Window Attachment Value Proposition

## Large Market Opportunity

- >100 million units sold annually

## Energy Savings Potential

- Reduces home's HVAC consumption by 3-30%



## Non-Energy Benefits

- Reduce glare
- Reduce noise
- Increased home resale value
- Privacy



# Window Attachment Efficiency Landscape

- DOE

- Attachment Energy Rating Council (AERC)
- Emerging Technologies windows research
- Building America research, testing, and technical assistance
- ENERGY STAR® program for storm windows



- Utilities

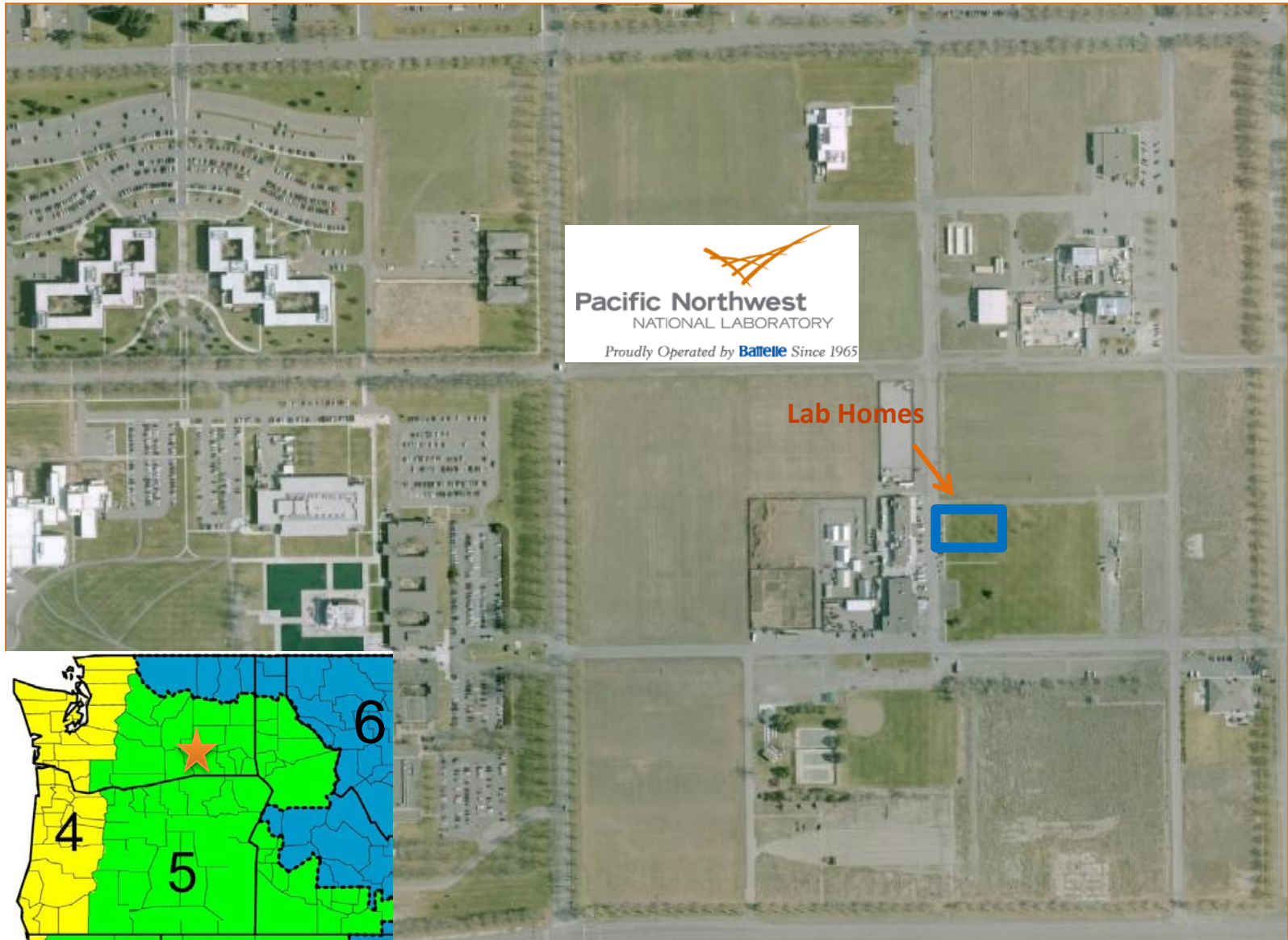
- Consortium for Energy Efficiency
- BPA and NEEA
- Silicon Valley Power (with assistance from the American Public Power Association)
- Efficiency Vermont
- Focus on Energy Wisconsin



# Part 2. PNNL Lab Home Experiments

- Specified to represent existing manufactured and stick-built housing
  - 3 BR/2BA, ~1500 ft<sup>2</sup>, double-wide
  - All-electric with 13 SEER/7.7 HSPF heat pump central HVAC + alternate Cadet fan wall heaters throughout
  - R-22 floors, R-11 walls & R-22 ceiling with composition roof
  - 195.7 ft<sup>2</sup> (13%) window area
- Modifications include extensive metering and 3 EV charging stations





# Low-e Storm Windows



Exterior Low-e  
storm window



Interior Low-e  
storm window

## Cost

- 1/3 of replacement window
- Payback 4-14 years
- 80% DIY install at low cost

## Energy Savings

- Similar to full replacement window

## Characteristics

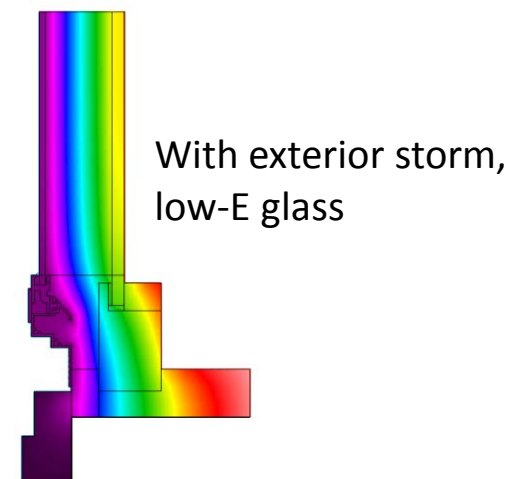
- Operable
- Permanent installation
- Year-round comfort
- Aesthetically pleasing



# Low-E Storm Windows: Concept

In late the 90's, LBNL identified low-e storm windows as a cost-effective **insulating** and air **sealing** measure for existing windows:

- Air Sealing of Prime Window
  - Case studies show 10% reduction in overall home air leakage
- Creation of “Dead Air Space”
  - Reduce conduction and convective losses across prime window
- Reflection of Radiant Heat: Low-E Glass
  - 35% increased performance over clear glass





# Lab Homes – Low-E Storm Windows

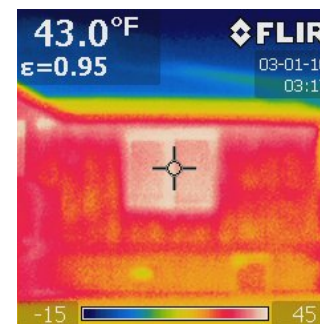
## Impact on Energy Savings

Technology (experiment)	Baseline and Experiment Description	Energy Savings (%)
<b>Exterior low-e storm windows 2014</b> (Larson Manufacturing)	Double-pane metal-frame clear glass windows (no window coverings)	Average Annual Savings: <b>10.1 ±1.4%</b> Simple Payback = 5-7 yrs
<b>Interior low-e storm windows 2015</b> (Quanta Technologies)	Covering ~75% of window area over double-pane metal-frame clear glass windows	Average Annual Savings: <b>7.8 ±1.5%</b>

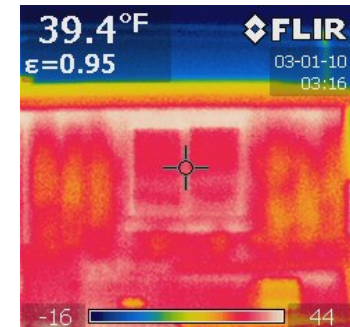


### Infrared Images – Interior Storm Windows

Baseline Home



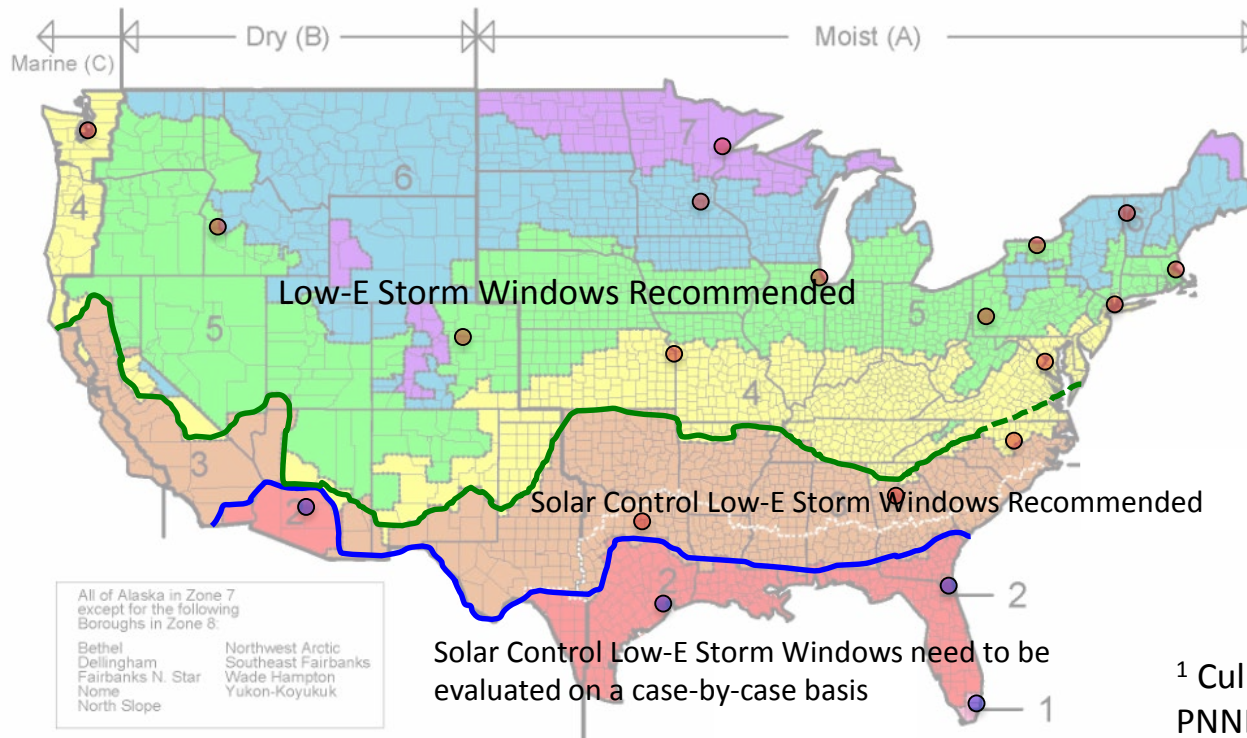
Experimental Home



See PNNL youtube video that includes installation instructions:  
<https://www.youtube.com/watch?v=DeU6wn0psrU>

Over all single-pane windows or double-pane metal-framed windows:

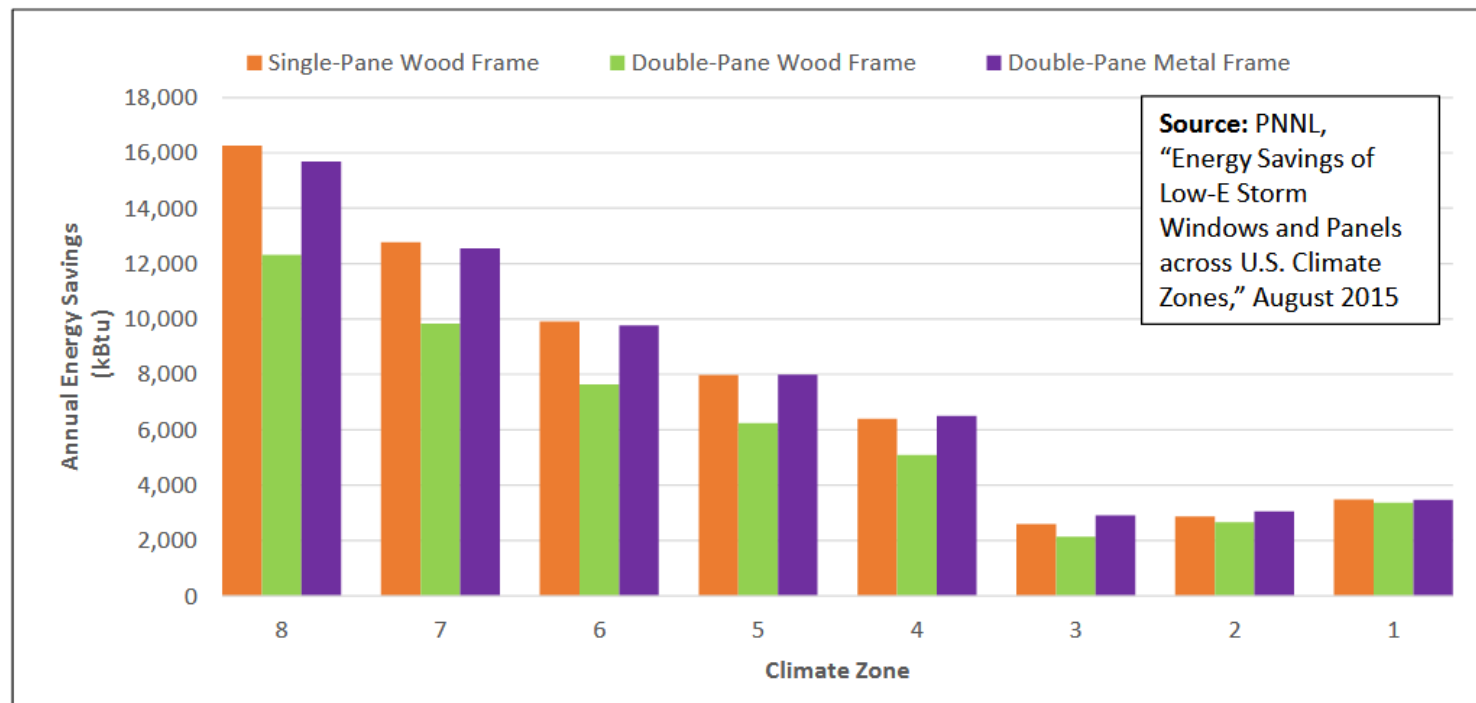
NEAT and RESFEN analysis expanded to 22 cities across all 8 climate zones.<sup>1</sup>



Cost effective in  
climate zones 3-8  
with Savings to  
Investment Ratio =  
1.2 – 3.2

<sup>1</sup> Culp et al. 2014 and 2015.  
PNNL-22864 rev2 and PNNL-24826

## Annual Household Site Energy Savings for Low-E Storm Windows vs Clear Glass Storm Windows

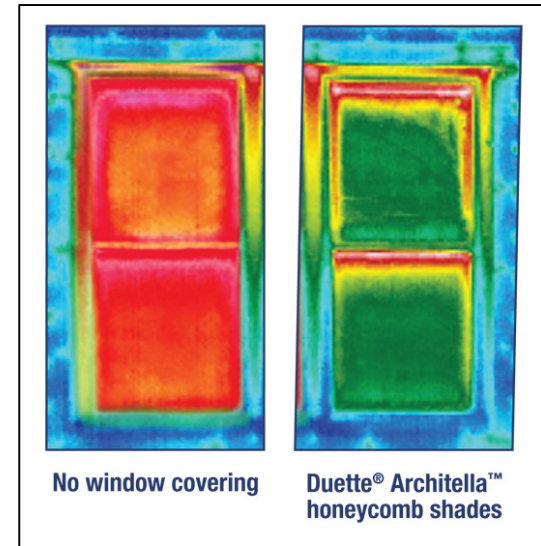


**Note: Savings for Climate Zones 1 – 3 based on low solar heat gain products**

EPA. ENERGY STAR for Exterior and Interior Storm Windows. Draft 1 Criteria Webinar. 3 August 2017.

## Characteristics:

- Aesthetically pleasing
- Operable
- Motorization and automation available
- Privacy
- Median price of \$70/window




## Energy Savings:

- Heating: Can reduce heat loss through windows by 40% or more
- Cooling: Reduces unwanted solar heat through windows by up to 80%



# Lab Homes Cellular Shades Testing (2015-2016)

Technologies	Description	Picture
Cellular Shades (Hunter Douglas)	Hunter Douglas Duette® Architella® Trielle™ honeycomb fabric shades are made with six layers of fabric including two opaque layers and five insulating air pockets. Currently (2017) testing performance of double-cell semi-opaque Duette Elan cellular shades.	



# PNNL Lab Homes Cellular Shades Impact on Energy Savings (2015-2016 Testing)

Technology (experiment)	Baseline and Experiment Description	Energy Savings (%)
<b>High Efficiency Cellular Shades:</b> Static Operation – always down (Hunter Douglas)	Control: Vinyl blinds Use: Closed for duration	<b>Cooling: 13.3 <math>\pm</math>2.8%</b> <b>Heating: 10.5 <math>\pm</math>3.0%</b>
<b>High Efficiency Cellular Shades:</b> Optimum Operation Comparison (Hunter Douglas)	Control: Vinyl blinds Use: Hunter Douglas energy-saving schedule	<b>Cooling: 10.4 <math>\pm</math>6.5%</b> <b>Heating: 16.6 <math>\pm</math>5.3%</b>
<b>High Efficiency Cellular Shades:</b> Optimum Operation (Hunter Douglas)	Control: No blinds (double pane window) Use: Hunter Douglas energy-saving schedule	<b>Cooling: 14.8 <math>\pm</math>2.1%</b> <b>Heating: 14.4 <math>\pm</math>2.0%</b>

# How much energy do cellular shades save if they are used in a “typical” manner?

- See “Typical Use” Scenario (only window area in bedrooms on north and southeast side of home are covered, which is ~ 40% of the window area of the home)



Cooling Test Protocol – Dynamic Control of Cellular Shades Lab Homes Testing	Duration	HVAC Savings % (+/- 95% confidence)	Average W-hr/day Savings
Static Use (always down) of Cellular Shades (compared to no window coverings)	10 days	<b>24.8% (<math>\pm 8.6\%</math>)</b>	3,359
Typical Use with Cellular Shades (compared to no shades in baseline)	4 days	<b>4.7% (<math>\pm 1.3\%</math>)</b>	1,808



# **Part 3. Attachments Energy Rating Council**

# What is the AERC?

AERC is an independent, **public interest** organization whose mission is to **rate, label, and certify** the **energy performance** of **window attachments**.



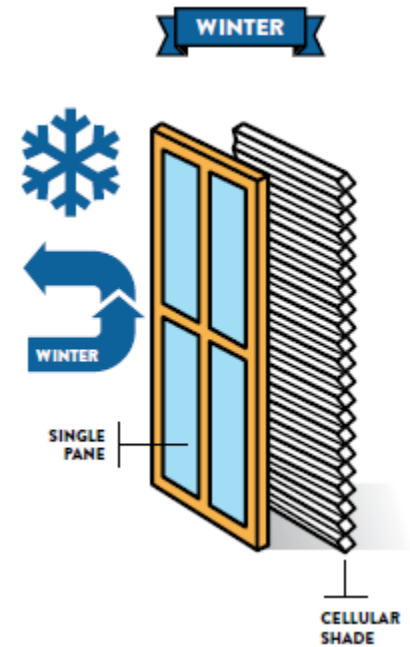
# What is the AERC?

- Founded in 2014 with support from DOE
- AERC members include
  - Public Interest Groups
  - National Labs
  - Commercial Labs
  - Product Manufacturers
  - Component Manufacturers
  - Utilities
- Board is majority public interest



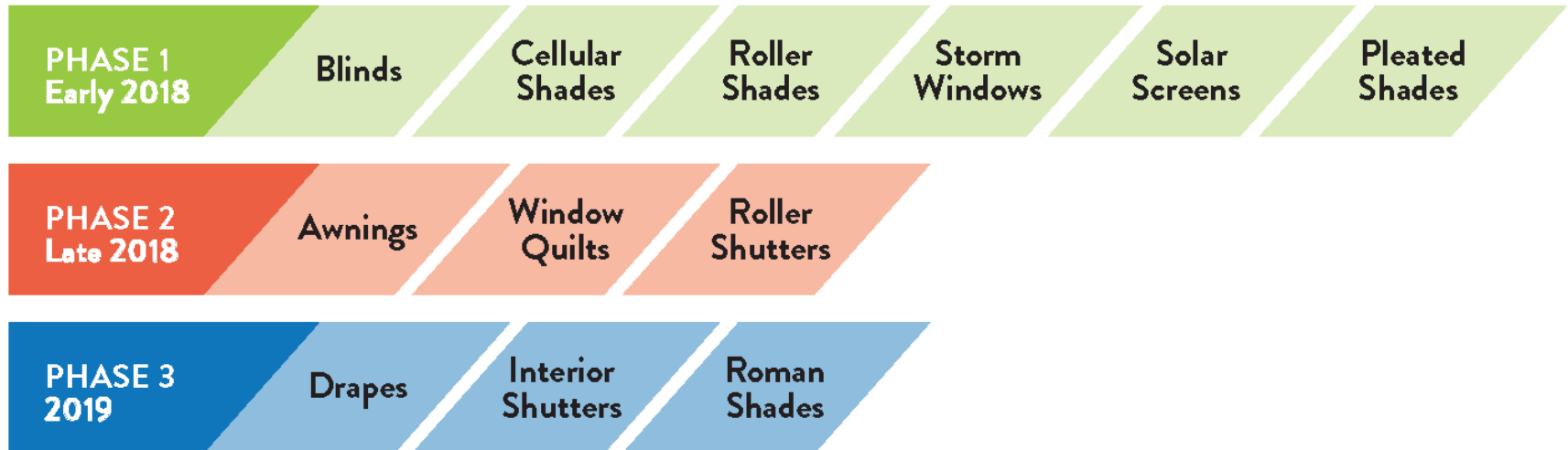
# Why is AERC Necessary?

- Window attachments can **save energy**
  - However, many consumers are unaware of their energy-saving capability
- Consumers have no way to compare the energy performance of attachments
- Energy Efficiency program managers also benefit from ratings and energy performance information



**The AERC rating allows consumers to make more informed decisions.**

# Phased Ratings Development



- U-Factor
- Solar Heat Gain Coefficient
- Visual Transmittance
- Air Leakage (as applicable)
- Annual Energy Performance
  - Comparative metric
    - Cold climates
    - Warm climates
  - Only number on product label



Attachments Energy Rating Council

# AERC

FEB  
2018

- What Are Window Attachments Infographic
- Utility Briefing Document
- **Association of Energy Service Professionals Brownbag Webinar**

MAR  
2018

- Understanding the AERC Energy Improvement Label
- Window Attachment Utility Program Design Primer

APR  
2018

- Launch of the Certified Products Website
- How to Find a Product Primer
- **National Home Performance Conference and Trade Show presentation**

MAY  
2018

- AERC Energy Improvement Rating label appears on store shelves
- CEE Whole House Roundtable Webinar
- **Efficiency Exchange Conference presentation**

# AERC Upcoming

Visit:

[www.aercnet.org](http://www.aercnet.org)

E-mail:

[info@aerc.org](mailto:info@aerc.org)



## ENERGY STAR Proposed Draft 1 Criteria

- Exterior Storm Windows**

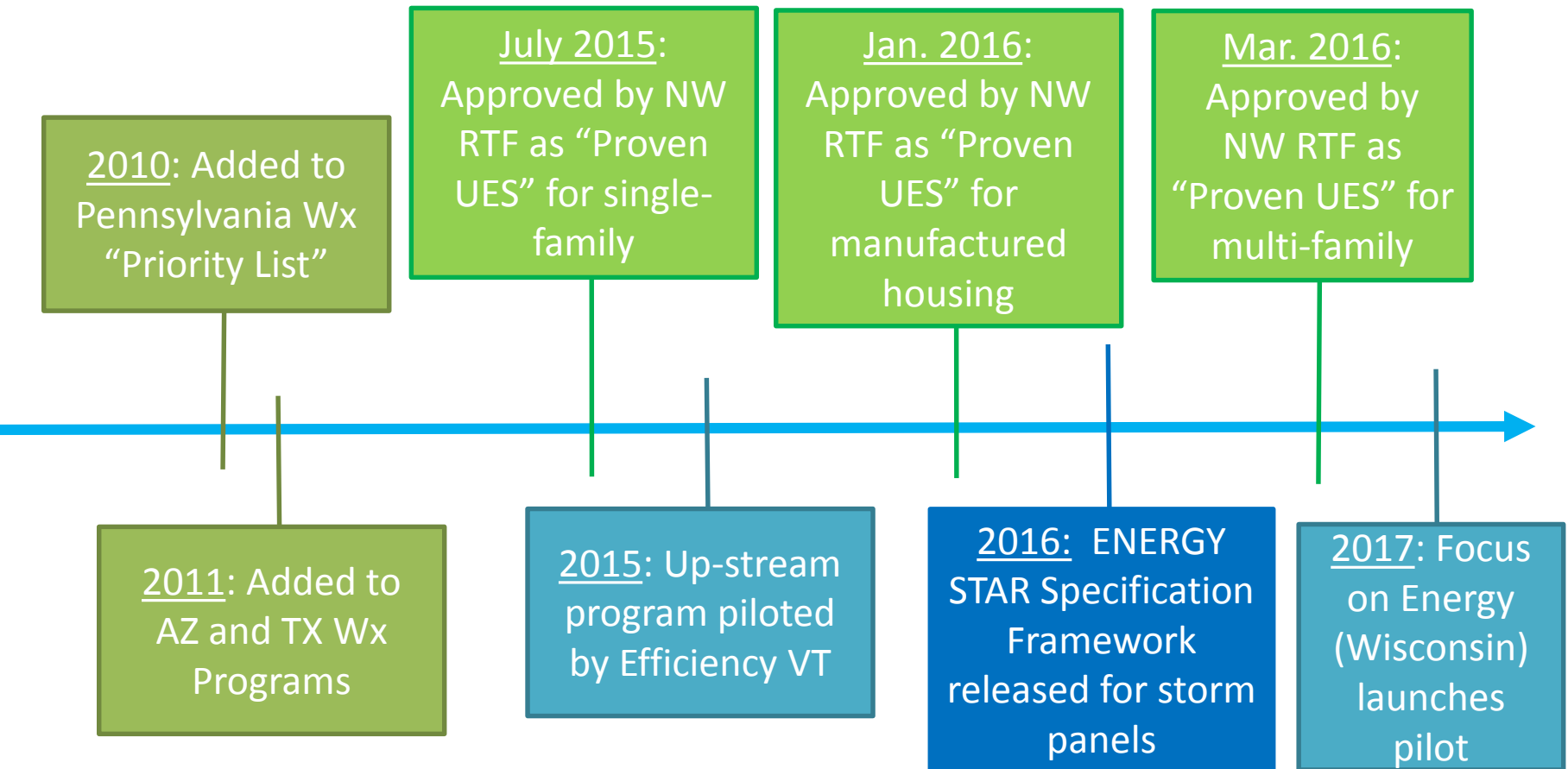
ENERGY STAR Climate Zone	Emissivity	Solar Transmission	Air Leakage (cfm/ft <sup>2</sup> )
Northern	≤ 0.22	> 0.55	≤ 1.5
North-Central	≤ 0.22	≤ 0.55 or > 0.55	≤ 1.5
South-Central	≤ 0.22	≤ 0.55	≤ 1.5
Southern	≤ 0.22	≤ 0.55	≤ 1.5

- Interior Storm Windows**

ENERGY STAR Climate Zone	Emissivity	Solar Transmission	Air Leakage (cfm/ft <sup>2</sup> )
Northern	≤ 0.22	> 0.55	≤ 0.5
North-Central	≤ 0.22	> 0.55	≤ 0.5
South-Central	ENERGY STAR certification not available for Interior Storm Windows in these zones.		
Southern			

- Q1 2018 – Comment response and updated analysis released
- Q2 2018 – Final specification (V1.0) released

# Recent Interest in Low-e Storm Window Incentives



# **Part 4. Market Impact Pilot & Survey Work**

- Full markdown of Low-E storm window incremental cost to clear glass (regular) storm windows
  - Assess Market Lift
  - Raise awareness of low-cost alternative
  - Survey participants
- Promotional Period:
  - August 17 – October 12, 2015





- Larson Manufacturing and D+R International
- Home Depot
  - Bennington, Rutland & Williston VT stores participating
- Lowe's
  - Essex & South Burlington stores participating



## Handout

**LARSON**  
**Low-E Storm Windows**  
An Efficiency Vermont SMART CHOICE

**What is Low-E?**  
Low emissivity (Low-E) glass is formed by adding an ultra-thin layer of metal to clear glass. LARSON® storm windows feature pyrolytic Low-E glass. The metal/oxide (pyrolytic) coating is applied when the glass is in its molten state, and the coating becomes so permanent and extremely durable part of the glass. The coating is also known as "hard-coat" Low-E.

**How does it work?**  
Low-E glass is designed to reflect heat back towards the interior.

**Warmer in Winter**

- Improves window performance by reflecting heat back into the home and reducing energy transfer through the window opening.
- Helps reduce heating energy costs.

**Cooler in Summer**

- Less solar energy is transmitted with Low-E glass.
- Helps keep interiors cooler.
- Helps reduce cooling energy costs.

**Visible Light Transmittance and Appearance**

- Minimizes reflections in visible light passing through the window.
- Provides interior and exterior appearance similar to clear glass.

**Reduces Ultraviolet Energy**

- Reduces fabric fading. UV energy more effectively helps protect interior furnishings, fabrics, and carpets from fading.

**Key upgrade selling features**  
LARSON® Performance Series Low-E Storm Windows offer the following upgrade selling features over standard clear glass storm windows:

- Low-E "hard coat" interior glass
- Expanded for uneven sills
- Extended Warranty

For a limited time, begins 01/17/15.			
SKU	Size	WBS	NOV
284010	28x40		
280209	28x29		
280477	28x47		
280505	35x26		
320422	32x42		
320435	32x35		
360406	36x46		
360477	36x77		
360510	36x50		

Special order Low-E storm windows will be priced at 20% off regular rates for a limited time, begins 01/17/15.

Efficiency Vermont  
See other side for more information on the Efficiency Vermont SMART CHOICE program.

## Survey

**GOT 5 MINUTES?**  
Respond to this survey and receive a \$10 Amazon.com gift card.\*

**amazon.com**  
**a**

Efficiency Vermont

\*Respond by 10/26/15 to receive an Amazon.com gift card. Limit 1 gift card per household/utility account. Contact information required for verification.

## Stack-Out



## Sales Staff Pocket Reference Card

**Efficiency Vermont**

**ABOUT LOW-E STORM WINDOW INSTANT DISCOUNTS**

Limited time only (offer could last until early October 2015, but will only be available while supplies last)

Customers should purchase windows or place special orders as soon as possible to ensure that they receive the instant discount.

Efficiency Vermont reserves the right to cancel this promotion at any time.

Limits: 15 windows per Vermont electric utility account. Efficiency Vermont is testing this promotion, and may decide to create a longer-term promotion at a later date.

**ABOUT EFFICIENCY VERMONT**

Efficiency Vermont was created by the Vermont Legislature and the Vermont Public Service Board to help Vermonters reduce their energy use.

Services include technical assistance, education, financing, and financial incentives for the purchase and installation of energy-efficient products.

Efficiency Vermont is funded through the Energy Efficiency Charge on electric bills.

www.efficiencyvermont.com | 888.921.5990



- Inserted Surveys with pre-paid return into windows
  - Could also be completed online
  - Participants received \$10 Amazon gift card
- Follow-up 15 minute phone survey with \$20 incentive.
- Surveys:
  - Gauged Promotion Impact
  - Improved understanding of purchase drivers





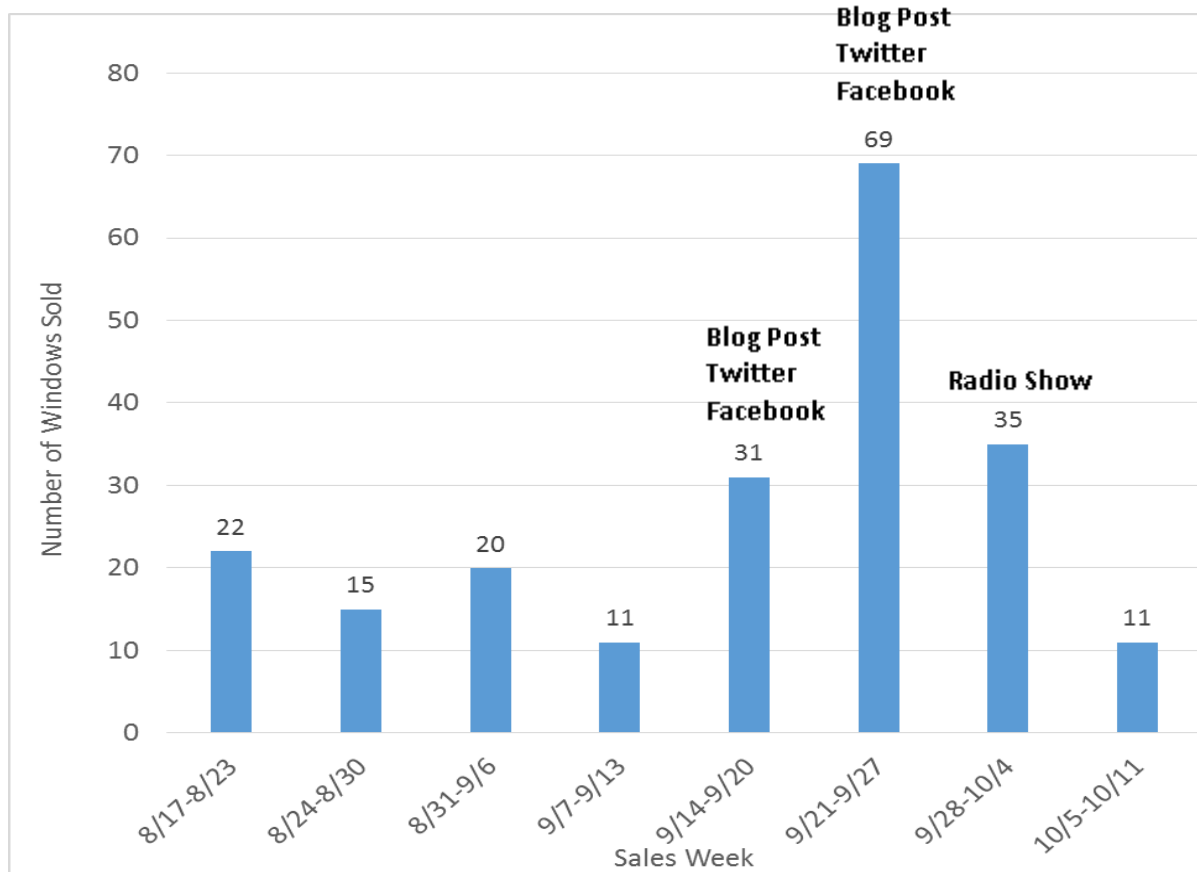
## Low-E Storm window sales

**22%**  
**2014**



**70%**  
**2015**

- Storm window sales increased 37%
- Low-E sales increased 337%



- Efficiency Vermont's in-market activities had a positive impact



- First low-E storm window incentive pilot
- Successfully demonstrated market impact & lift
- Utility outreach & marketing activities had impact
- Opportunity to engage DIY, low- to moderate-income groups
- Engage trade allies

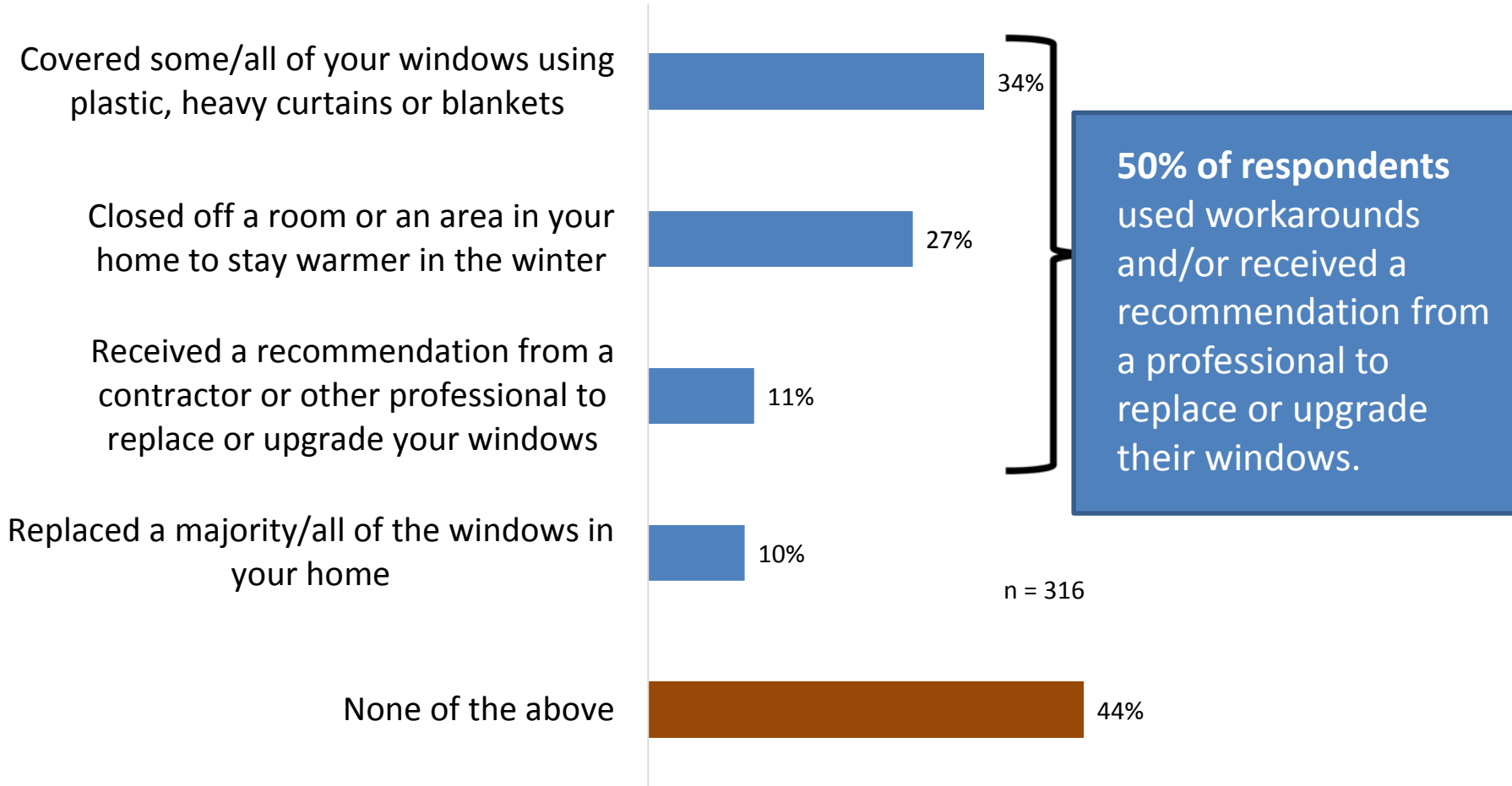


# Broader Survey Objectives & Methodology

1. Measure Vermont homeowners' awareness, knowledge, interest and adoption of storm windows; specifically Low-E storm windows.
  2. Identify the motivators and barriers surrounding storm window adoption.
- 10-minute online survey – November 2016
  - Criteria: Homeowners, decision maker on improvement projects, and quotas by age/gender to match VT census
  - 316 completed responses

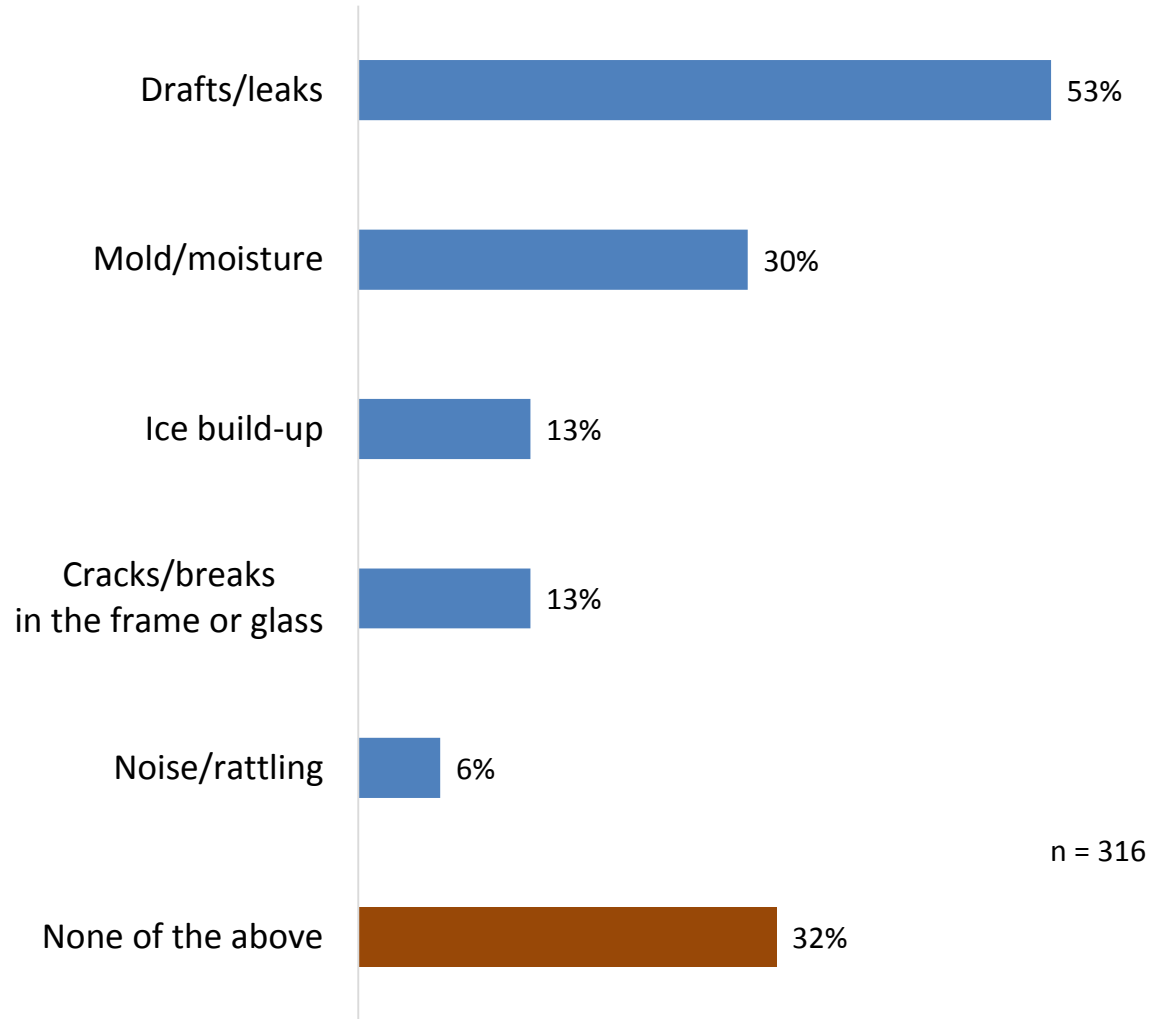


# Window Workarounds & Recommendations



# Window Concerns

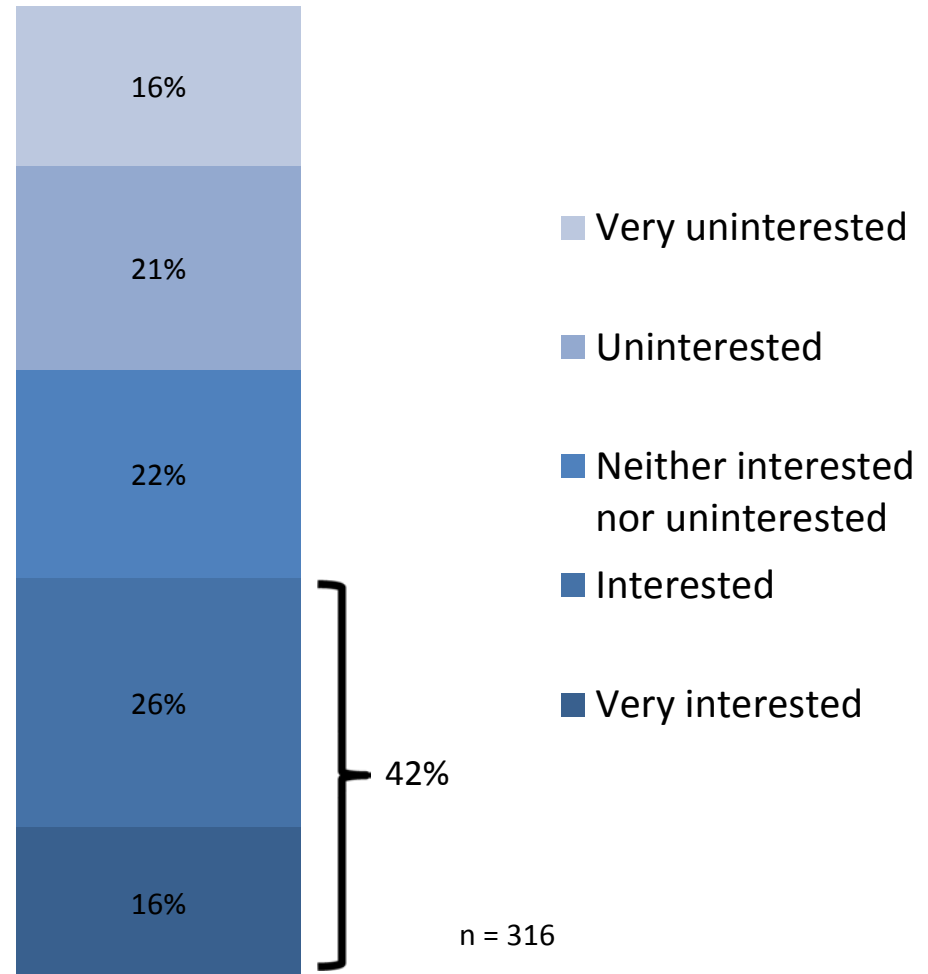
**68% of respondents** had a concern with their existing windows, **with 31%** having more than one concern.



Q10. What, if any, of the following concerns do you have with the windows in your home?

# Interest in Replacing/ Upgrading Windows

**42% of respondents**  
were interested or  
very interested in  
replacing or upgrading  
any of the windows in  
their home.

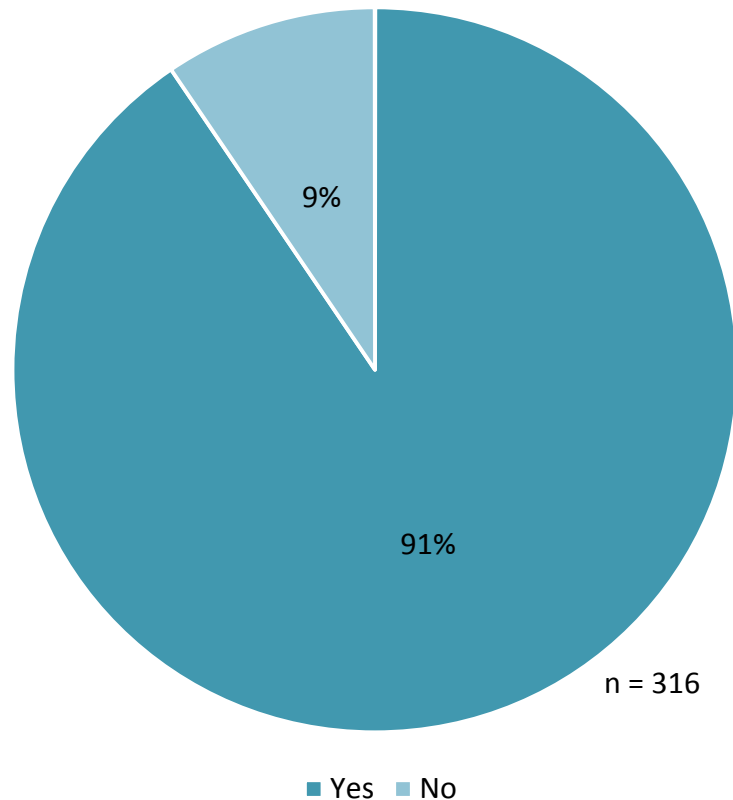


# Storm Window Target Market

**91% of respondents qualified as Efficiency Vermont's target market for storm windows.**

The target market for storm windows was defined as anyone who:

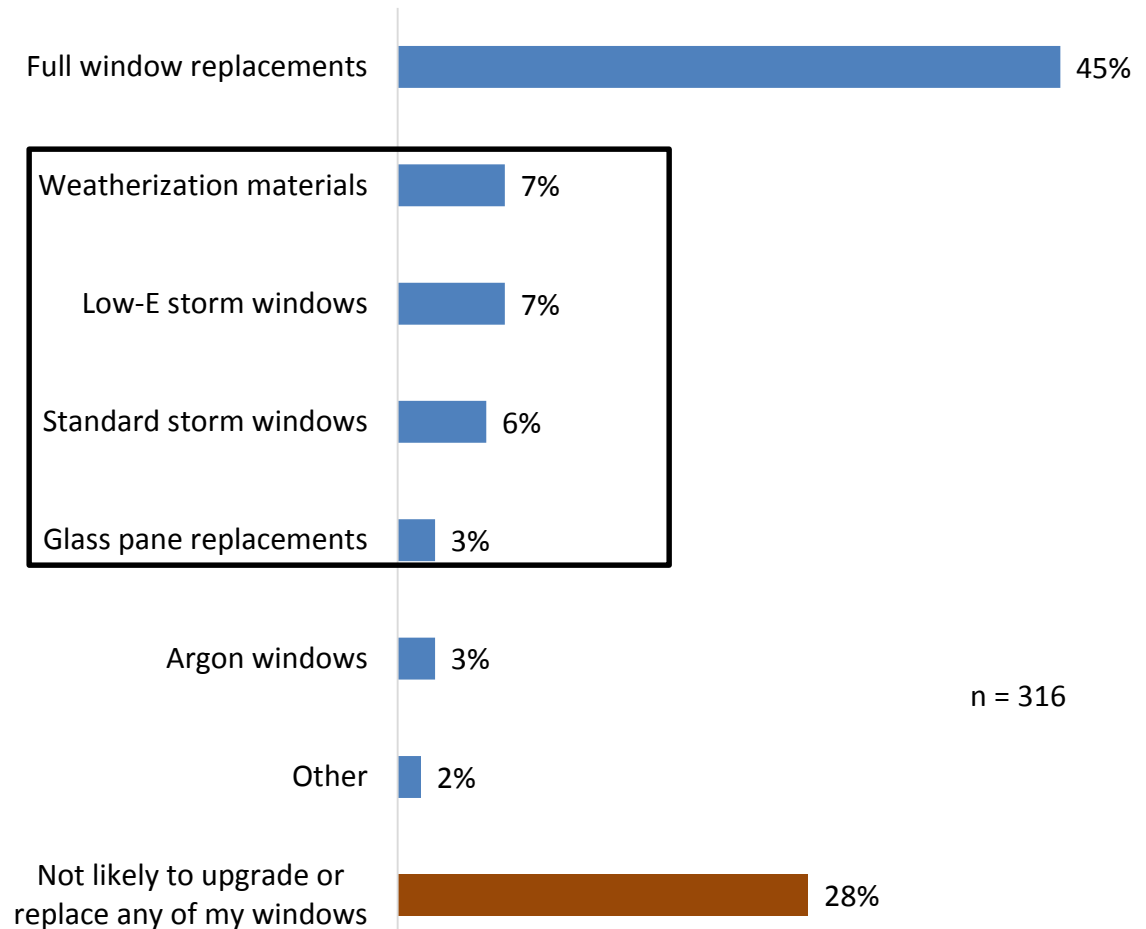
- Uses workarounds to compensate for less efficient windows (Q9)
- Received a recommendation from a professional to replace or upgrade their windows (Q9)
- Has concerns with their current windows (Q10)
- Has a home with single pane or older windows (Q12 & Q13)
- Has interest in replacing or upgrading their windows (Q14)





# Window Upgrade/Replacement Consideration

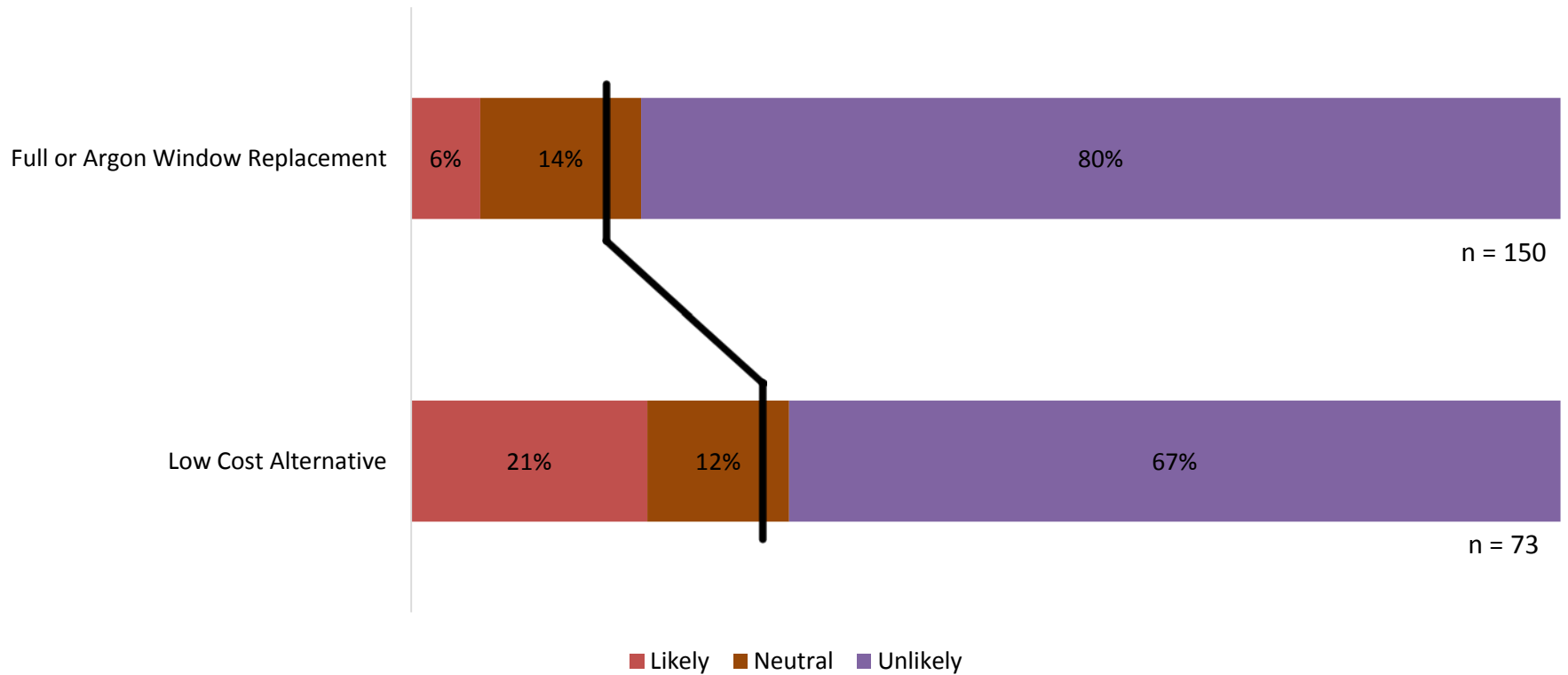
**23% of respondents** would select a low cost alternative over full window or argon window replacements.



Q27. If you were to upgrade or replace your windows, which of the following would you be most likely to purchase?

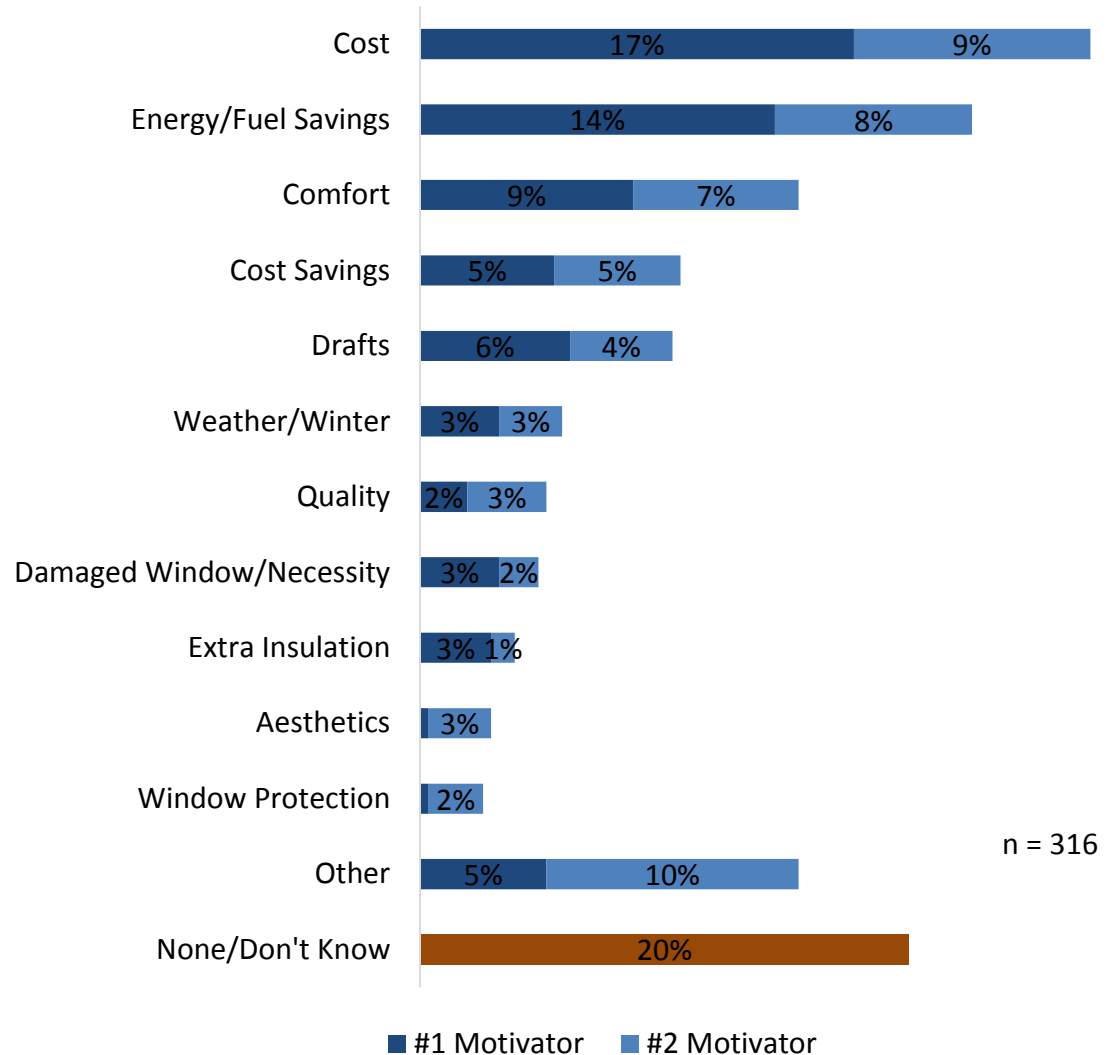
# Window Upgrade/Replacement Likelihood

Respondents who would consider low-cost window alternatives over full or argon window replacements were significantly more likely to purchase them within 60 days as compared to those who considered more expensive (full or argon replacement) options.

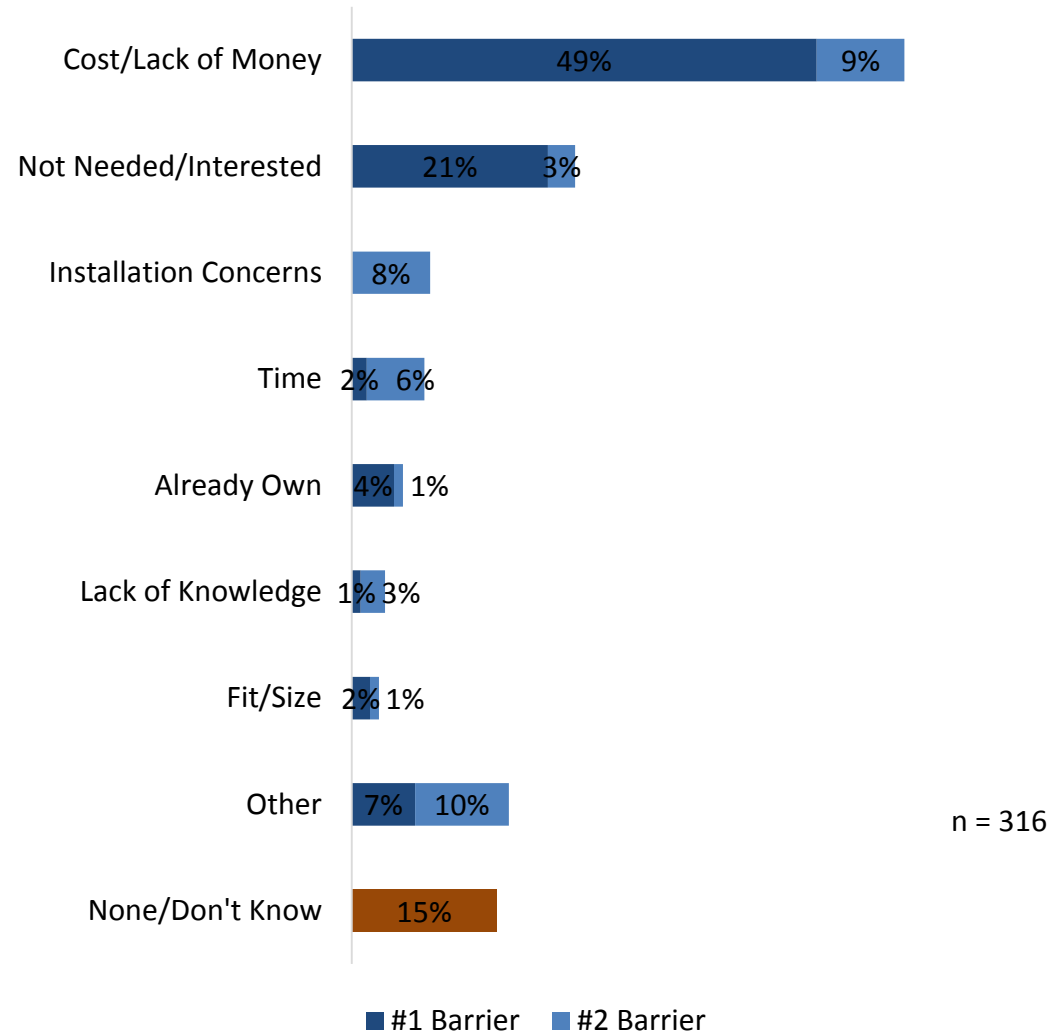


Q29. How likely are you to replace or upgrade any of the windows in your home in the next 60 days?

The top motivators for purchasing storm windows were cost, energy/fuel savings, and comfort.



**58% of respondents** said the cost or their lack of money was preventing them from purchasing storm windows.



- 9 out of 10 Vermont homeowners would benefit from installing storm windows.
  - 41% own at least one storm window. The vast majority have them installed in multiple rooms in their home.
- Only about one third of the market is even aware that Low-E storm windows exist.
- Once customers understood the Low-E storm window value proposition, 28% said they would be likely to purchase them within the next 60 days.



# Why Window Attachments?

- Program Drivers

- Proven energy savings of 3-30%
- Research confirmed >90% of Vermonters in target market, >20% would consider this upgrade
- Pilot confirmed potential for program impact & market lift
- Pilot confirmed marketing & utility outreach create lift
- Opportunity for low- to moderate income customers as well as DIY & trade allies



# Focus on Energy Pilot Program

- Ran September through November 15, 2017
- Goal: Low-E storm window market expansion and energy savings
  - Overall low-E storm window sales increase
  - Increased low-E market share vs. clear glass
  - Developed energy savings calculation methodology



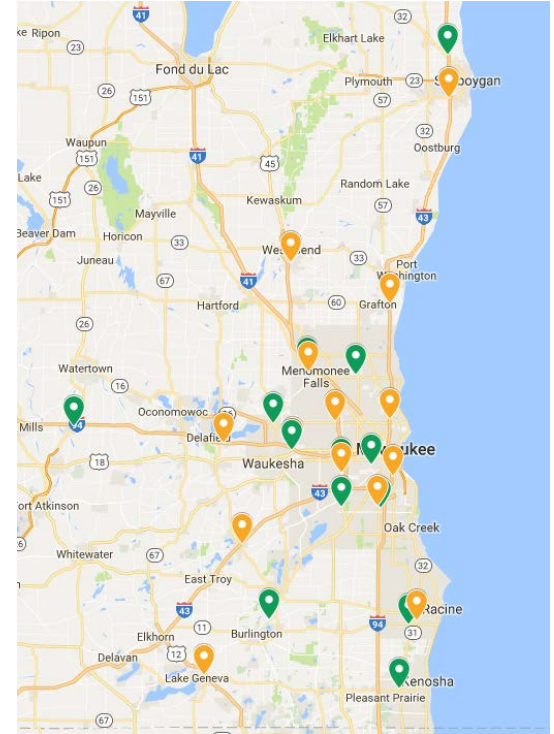
**BENEFITS OF LOW-E STORM WINDOWS**

		
<b>MODERN DESIGN</b> A visually appealing addition to your home with an easy, ready to use design.	<b>NO BRAINER ECONOMICS</b> The elimination of wasted energy pays for itself many times over.	<b>SUPERIOR COMFORT</b> Regain comfort everywhere in your home, all year long.



# Focus on Energy Pilot Program

- By the numbers:
  - 2 manufacturers
  - \$55,000 incentive budget
  - 25% customer discount
  - 28 participating Milwaukee-area retail stores
    - Madison served as control



# Focus on Energy Pilot Program

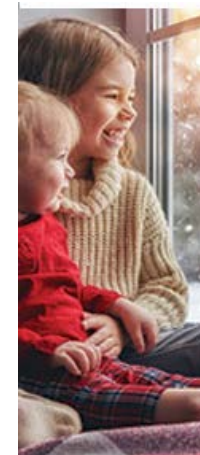
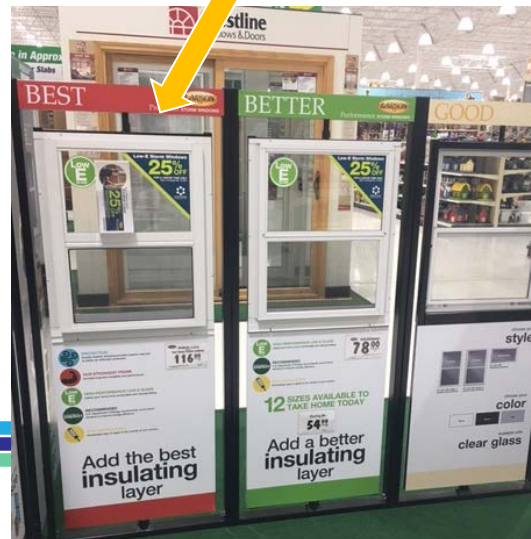
Focus on Energy landing page:  
<http://focusonenergy.com/low-estorms>

In-store merchandising

Digital marketing

The screenshot shows the Focus on Energy website with a navigation bar for Home, Business, Contractors, About Us, and Support. The main heading is "Low-E Storm Windows" with the tagline "Every window needs another layer. Layer it on for energy savings and comfort." Below this, there are sections for "No trailer economics", "Superior comfort", and "Modern design". A map of the Milwaukee area shows the program's coverage. A sidebar on the right includes "Contact Us" and "What's New? Residential Programs".

A large green and blue graphic with the text "Low-E Storm Windows 25% OFF FOR A LIMITED TIME ONLY Sept. 15 to Nov. 15". It features the Focus on Energy logo and a yellow arrow pointing towards the in-store merchandising image.

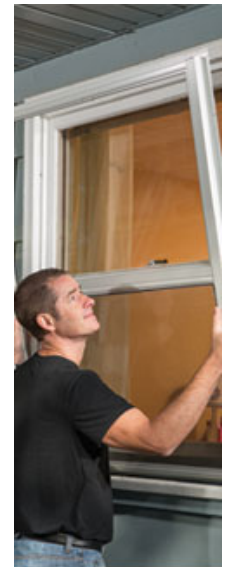


Millwaukee Residents!

**NOW 25% OFF**

LOW-E Storm Windows

focus on energy  
Partnering with Wisconsin utilities



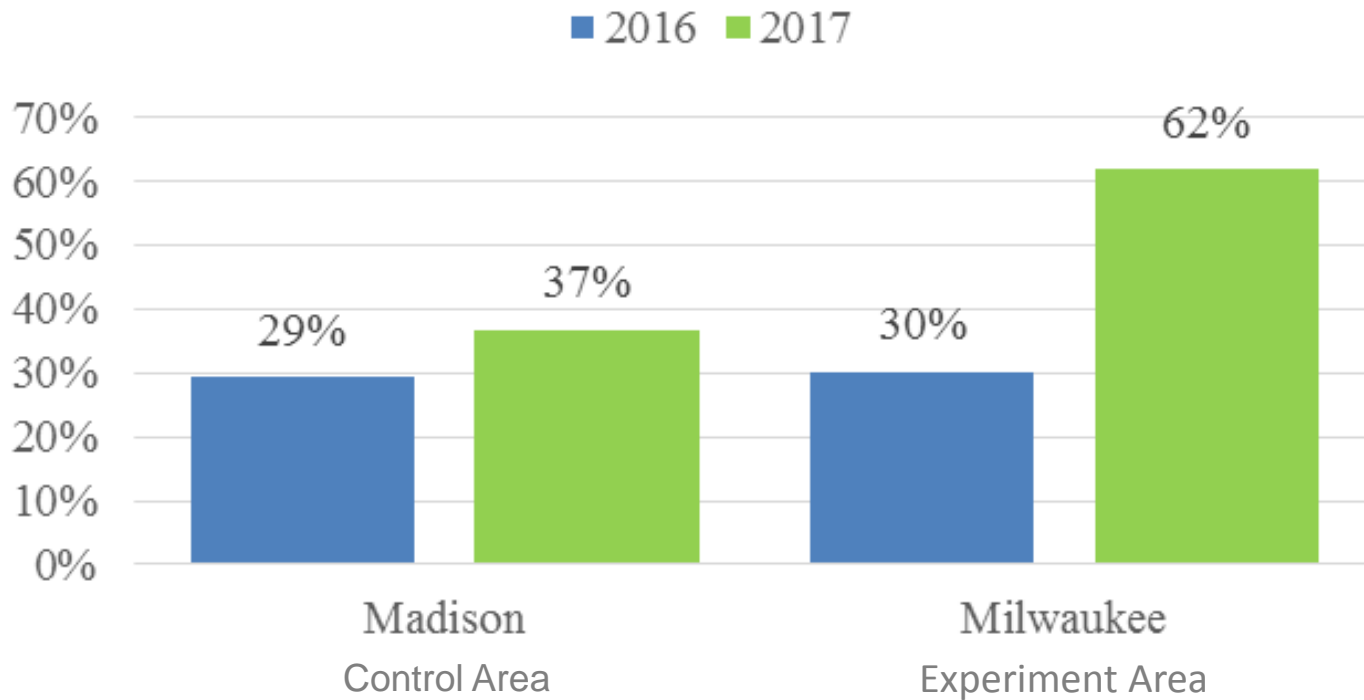
Millwaukee Residents!

**NOW 25% OFF**

LOW-E Storm Windows

focus on energy  
Partnering with Wisconsin utilities

## Low-E Market Share by Region



Focus on Energy. Low-E Storm Window Market Expansion Pilot. Final Report. 2017. [https://focusonenergy.com/sites/default/files/2018-01/Low-E%20Storm%20Window%20Pilot%20Final%20Report\\_1-10-18.pdf](https://focusonenergy.com/sites/default/files/2018-01/Low-E%20Storm%20Window%20Pilot%20Final%20Report_1-10-18.pdf)

# Thank You!

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