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)
Webinar Objectives

• 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
The Problem

64% of U.S. homes have non-low-e single or double pane windows. Windows make up 30% of a typical home’s heating and cooling energy.

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

Energy Savings Potential
- Reduces home’s HVAC consumption by 3-30%
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 ft², 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 ft² (13%) window area

Modifications include extensive metering and 3 EV charging stations
Located in Richland, WA
Low-e Storm Windows

Exterior Low-e storm window

Interior Low-e storm window

Low-e Storm Windows

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

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

<table>
<thead>
<tr>
<th>Technology (experiment)</th>
<th>Baseline and Experiment Description</th>
<th>Energy Savings (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Exterior low-e storm windows</strong></td>
<td>Double-pane metal-frame clear glass windows (no window coverings)</td>
<td><strong>Average Annual Savings: 10.1 ±1.4%</strong>&lt;br&gt;<strong>Simple Payback = 5-7 yrs</strong></td>
</tr>
<tr>
<td>2014 (Larson Manufacturing)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Interior low-e storm windows</strong></td>
<td>Covering ~75% of window area over double-pane metal-frame clear glass windows</td>
<td><strong>Average Annual Savings: 7.8 ±1.5%</strong></td>
</tr>
<tr>
<td>2015 (Quanta Technologies)</td>
<td></td>
<td></td>
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Infrared Images – Interior Storm Windows

![Baseline Home](image1.jpg)  
**Baseline Home**<br>43.0°F<br>ε=0.95

![Experimental Home](image2.jpg)  
**Experimental Home**<br>39.4°F<br>ε=0.95

See PNNL youtube video that includes installation instructions: [https://www.youtube.com/watch?v=DeU6wn0psrU](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.\(^1\)

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

\(^1\) 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

**Modeled Energy Savings**

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


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)

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

<table>
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<tr>
<th>Cooling Test Protocol – Dynamic Control of Cellular Shades Lab Homes Testing</th>
<th>Duration</th>
<th>HVAC Savings % (+/- 95% confidence)</th>
<th>Average W-hr/day Savings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Static Use (always down) of Cellular Shades (compared to no window coverings)</td>
<td>10 days</td>
<td>24.8% (±8.6%)</td>
<td>3,359</td>
</tr>
<tr>
<td>Typical Use with Cellular Shades (compared to no shades in baseline)</td>
<td>4 days</td>
<td>4.7% (±1.3%)</td>
<td>1,808</td>
</tr>
</tbody>
</table>
Part 3. Attachments Energy Rating Council
AERC is an independent, public interest organization whose mission is to rate, label, and certify the energy performance of window attachments.
• 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

PHASE 1
Early 2018
- Blinds
- Cellular Shades
- Roller Shades
- Storm Windows
- Solar Screens
- Pleated Shades

PHASE 2
Late 2018
- Awnings
- Window Quilts
- Roller Shutters

PHASE 3
2019
- Drapes
- Interior Shutters
- Roman Shades
AERC Technical Ratings

- 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
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**

<table>
<thead>
<tr>
<th>ENERGY STAR Climate Zone</th>
<th>Emissivity</th>
<th>Solar Transmission</th>
<th>Air Leakage (cfm/ft²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Northern</td>
<td>≤ 0.22</td>
<td>&gt; 0.55</td>
<td>≤ 1.5</td>
</tr>
<tr>
<td>North-Central</td>
<td>≤ 0.22</td>
<td>≤ 0.55 or &gt; 0.55</td>
<td>≤ 1.5</td>
</tr>
<tr>
<td>South-Central</td>
<td>≤ 0.22</td>
<td>≤ 0.55</td>
<td>≤ 1.5</td>
</tr>
<tr>
<td>Southern</td>
<td>≤ 0.22</td>
<td>≤ 0.55</td>
<td>≤ 1.5</td>
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</table>

- **Interior Storm Windows**

<table>
<thead>
<tr>
<th>ENERGY STAR Climate Zone</th>
<th>Emissivity</th>
<th>Solar Transmission</th>
<th>Air Leakage (cfm/ft²)</th>
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<tr>
<td>Northern</td>
<td>≤ 0.22</td>
<td>&gt; 0.55</td>
<td>≤ 0.5</td>
</tr>
<tr>
<td>North-Central</td>
<td>≤ 0.22</td>
<td>&gt; 0.55</td>
<td>≤ 0.5</td>
</tr>
<tr>
<td>South-Central</td>
<td>ENERGY STAR certification not available for Interior Storm Windows in these zones.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Southern</td>
<td></td>
<td></td>
<td></td>
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</table>

- **Q1 2018** – Comment response and updated analysis released

- **Q2 2018** – Final specification (V1.0) released
Recent Interest in Low-e Storm Window Incentives

- **2010**: Added to Pennsylvania Wx “Priority List”
- **2011**: Added to AZ and TX Wx Programs
- **July 2015**: Approved by NW RTF as “Proven UES” for single-family
- **Jan. 2016**: Approved by NW RTF as “Proven UES” for manufactured housing
- **Mar. 2016**: Approved by NW RTF as “Proven UES” for multi-family
- **2015**: Up-stream program piloted by Efficiency VT
- **2016**: ENERGY STAR Specification Framework released for storm panels
- **2017**: Focus on Energy (Wisconsin) launches pilot
Efficiency Vermont Pilot Design

- 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
Customer Survey

- 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
Results – Overall Sales

Low-E Storm window sales

22% 2014 → 70% 2015

- Storm window sales increased 37%
- Low-E sales increased 337%
Results – Sales & Outreach

• 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
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
Q9. Within the past 2 years, have you done any of the following? [Multiple Mention]

<table>
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<th>Workaround</th>
<th>Percentage</th>
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<tr>
<td>Covered some/all of your windows using plastic, heavy curtains or blankets</td>
<td>34%</td>
</tr>
<tr>
<td>Closed off a room or an area in your home to stay warmer in the winter</td>
<td>27%</td>
</tr>
<tr>
<td>Received a recommendation from a contractor or other professional to replace or upgrade your windows</td>
<td>11%</td>
</tr>
<tr>
<td>Replaced a majority/all of the windows in your home</td>
<td>10%</td>
</tr>
<tr>
<td>None of the above</td>
<td>44%</td>
</tr>
</tbody>
</table>

50% of respondents used workarounds and/or received a recommendation from a professional to replace or upgrade their windows.

n = 316
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?

- Drafts/leaks: 53%
- Mold/moisture: 30%
- Ice build-up: 13%
- Cracks/breaks in the frame or glass: 13%
- Noise/rattling: 6%
- None of the above: 32%

n = 316
42% of respondents were interested or very interested in replacing or upgrading any of the windows in their home.

Q14. What is your level of interest in replacing or upgrading any of the windows in your home?

n = 316
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)

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

n = 316
Q27. If you were to upgrade or replace your windows, which of the following would you be most likely to purchase?

- Full window replacements: 45%
- Weatherization materials: 7%
- Low-E storm windows: 7%
- Standard storm windows: 6%
- Glass pane replacements: 3%
- Argon windows: 3%
- Not likely to upgrade or replace any of my windows: 28%
- Other: 2%

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

Q25. What [did/would] motivate you to purchase storm windows? [Open-ended]
58% of respondents said the cost or their lack of money was preventing them from purchasing storm windows.

Q26. What, if anything, is preventing you from purchasing storm windows? [Open-ended]
• 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

2/22/2019 Attachments Energy Rating Council
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 landing page:
http://focusonenergy.com/low-estorms
Low-E Market Share by Region

2016 2017

Madison
Control Area
29% 37%

Milwaukee
Experiment Area
30% 62%

Thank You!

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