

Residential Window Attachments

Window attachments include the many interior and exterior coverings installed over windows and doors in homes and commercial buildings. Interior and exterior storm windows are examples. Other interior window attachments (also known as window treatments) include blinds, drapes, shades, shutters, window quilts, and window films. Exterior products such as awnings, roller shades, and roller shutters are also classified as window attachments. More sophisticated products incorporate controls and sensors allowing for remote and/or automated product operation.¹

Attachments can improve the thermal performance of existing windows to reduce heating and cooling needs and, in turn, lower energy bills and increase occupant comfort. Window attachments in homes can reduce heating and cooling energy use by more than 20% depending on climate. In commercial buildings, they can generate substantial cooling savings and save money on lighting. These energy savings come at a fraction of the cost of window replacement and can offer cost-effective alternatives for multifamily buildings, rental housing, historic homes, and other properties where window replacement options are limited or cost prohibitive.

This brief focuses on residential window attachments. We will cover commercial products in a separate brief.

The Opportunity

Windows are often the weakest link in a building's thermal envelope, providing the lowest insulation value in winter and allowing the greatest solar heat gain in summer. Energy-efficient window attachments can improve window performance by preventing or blocking the transfer of heat—maintaining warm interior temperatures in winter and keeping out solar heat gain in summer. Figure 1 illustrates how window attachments prevent heat transfer during summer and winter.

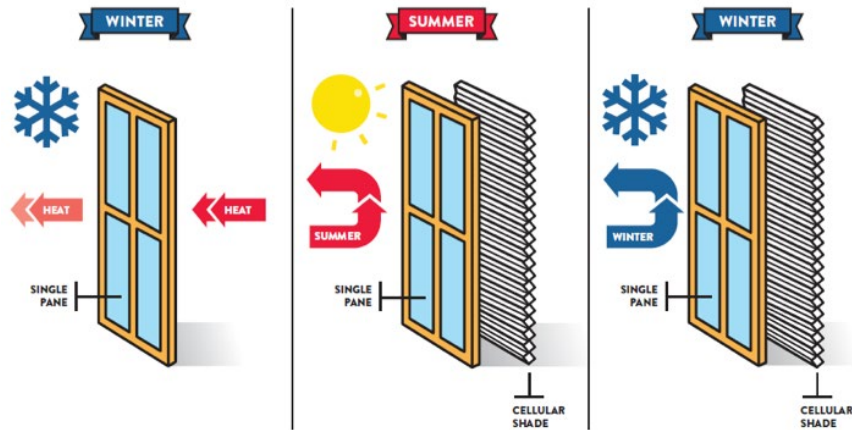


Figure 1. Window attachments prevent heat transfer

An estimated 80% of all residential windows have some type of window attachment. These products are popular with consumers for many reasons.² Interior attachments are often installed primarily as a decorative or privacy feature but are also used to enhance comfort through light/glare control, draft reduction, and sound dampening. Exterior products are used primarily for shading, reducing drafts, and saving energy.

The role of window attachments in energy savings has long been recognized, but little effort has been made to quantify the energy savings potential or understand the relative performance of different products. Lacking this information, utilities and efficiency professionals did not consider window attachments to be a robust energy efficiency measure. Likewise, consumers, designers, and contractors could not effectively select products that save energy while meeting other occupant preferences and needs.

Two new developments may lead to greater adoption of energy-efficient window attachments. New program platforms launched in 2018, ENERGY STAR® and the Attachments Energy Rating Council (AERC) Energy Improvement label, provide the energy performance data needed by consumers, utilities, and others to differentiate products and select the most efficient attachments to meet their needs and preferences.

The ENERGY STAR Storm Windows program establishes climate-specific emissivity and solar transmittance ratings as well as air leakage ratings for exterior and interior storm panels. Only those products with low-e glazing are eligible for the program.* Tables 1 and 2 summarize the ENERGY STAR criteria for storm windows.³

Table 1. ENERGY STAR storm windows emissivity and solar transmission criteria

ENERGY STAR climate zone	Emissivity	Solar transmission
Northern	≤ 0.22	> 0.55
North-Central	≤ 0.22	Any
South-Central	≤ 0.22	≤ 0.55
Southern	≤ 0.22	≤ 0.55

Table 2. ENERGY STAR air leakage criteria

Product	Air leakage rating
Exterior storm window	≤ 1.5 cfm/ft ²
Interior storm window	≤ 0.5 cfm/ft ²

Source: EPA, "Storm Windows Key Product Criteria," accessed April 2019. www.energystar.gov/products/building_products/storm_windows_key_product_criteria.

The AERC is introducing a new energy rating, certification, and label for storm windows and a range of other window attachment products. This program will help consumers and other product specifiers select energy-efficient alternatives and will provide a simple platform that energy efficiency programs can add to their portfolios.

* Low-emissivity (low-e) glazing is window glass that has a microscopically thin transparent coating of metal or metallic oxide composition deposited directly on the surface to reduce its thermal infrared emittance by reflecting heat.

The AERC administers a comprehensive rating, labeling, and certification program for window attachments. The membership organization brings together window attachment and component manufacturers, utilities, and public interest organizations (including the American Council for an Energy-Efficient Economy) to support the AERC rating program and related information and education efforts.

AERC uses the Energy Performance (EP) metric for rating, certifying, and labeling window attachments. Developed by Lawrence Berkeley National Laboratory (LBNL), EP is the ratio of the heating or cooling energy savings for a baseline window with attachment to the heating or cooling energy use associated with a baseline window.* EP allows consumers to make apples-to-apples comparisons within and across product types. Table 3 shows EP values.

Table 3. EP values for window attachment installed over baseline window

EP value	Window attachment performance
<0	Causes the house to use more energy on an annual basis
0	Has no net impact on the energy performance of the home on an annual basis
>0-100	Improves the net annual energy performance of the home
>100	Improves the performance of the home so much that it is a net annual energy producer

Source: AERC

Manufacturers certifying their products with AERC can affix the Energy Improvement label so consumers can see and compare the energy savings of various attachment types. The label includes a Cool Climate Rating (showing the EP of the attachment in climates dominated by heating use) and a Warm Climate Rating (for climates dominated by cooling energy use). Figure 2 shows the label. Any attachment with a rating above 0 will improve the energy performance of a window that originally had no attachment.

* For details on development of the EP metric including assumptions and calculation methods, see Burns et al., "New Rating Opening Windows to a World of Comfort, Opportunity, and Cost-Effective Savings," in Proceedings of the 2018 ACEEE Summer Study on Energy Efficiency in Buildings. aceee.org/files/proceedings/2018/index.html#/paper/event-data/p008.

Consumers can search for products and access product performance data online at AERCEnergyRating.org.

Manufacturers began certifying products through the AERC program in March 2018. Certified products are listed in a database and are eligible to carry the Energy Improvement label. The AERC is limiting its initial certification and labeling to residential cellular shades, blinds, roller shades, storm windows and panels, pleated shades, and solar screens. Certification for additional residential window attachment types and for commercial sector products will begin in 2019. The certification program will eventually incorporate LBNL-developed metrics that cover automation.

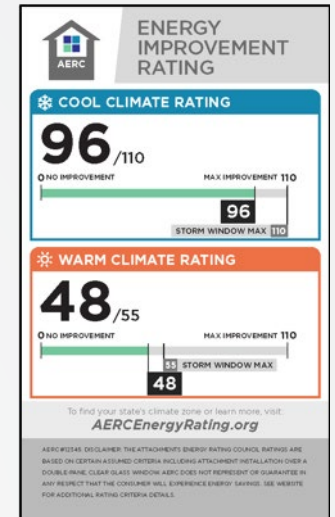


Figure 2. AERC Energy Improvement label

Savings Potential

Window attachments can save energy across building, product, and window types as well as climate zones. These savings are highest for attachments installed with single-pane windows or with double-pane windows that have clear glass as opposed to low-e glass. The Energy Information Administration estimates that over 47 million US homes (42%) have single-pane windows, and an additional 46 million homes have double-pane, clear glass windows.⁴

The rate of window replacement in US homes is relatively low—roughly 2% per year—leaving a large and stable opportunity for window attachments.

Residential field demonstrations of a variety of window attachments conducted by Pacific Northwest National Laboratory (PNNL) found heating season savings ranging from 6.5% to 22% and cooling season savings ranging from 3.5% to 16.5%.⁵ Table 4 presents PNNL findings.

Table 4. Window attachment energy savings

Whole home energy savings range		
Product category	Heating savings	Cooling savings
Cellular shades	7.5–22%	4–16.5%
Exterior storm windows	9–11.5%	8%
Interior storm windows	6.5–10%	3.5–5%

Using findings from these field demonstrations, LBNL modeled expected savings for typical window attachment products in 16 US cities. Figure 3 shows the modeled heating and cooling energy cost savings.

Window attachment performance varies by climate, with some products offering the greatest savings in heating climates and others performing best in cooling climates. Some products are not recommended for climates where they offer no benefit or may even negatively impact energy use. In cooling climates, solar screens, window films, roller shades, and cellular shades have the greatest energy savings potential. Some of these same products (window films and solar shades) can negatively impact energy performance in heating-dominated climates. Conversely, low-e storm windows offer negligible benefits in cooling climates but are by far the greatest savings opportunity in heating climates.

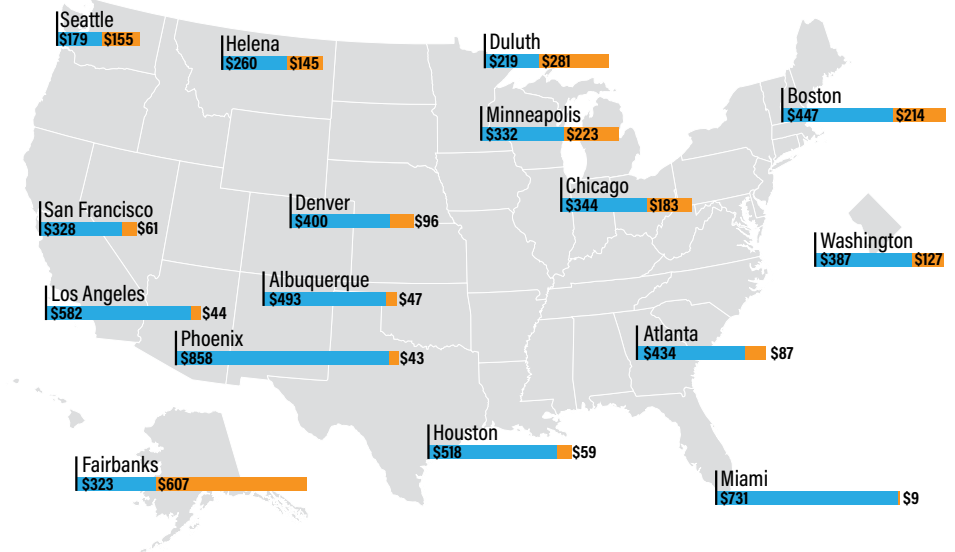


Figure 3. Potential residential cooling and heating cost savings from window attachment products. Source: AERC, Window Attachments: Utility Program Design Primer.

Even the most basic efforts to promote product replacements can have positive results. The savings reported in this brief are based on typical user behavior patterns observed in a large-scale consumer study funded by the Department of Energy (DOE) and incorporated into the AERC EP metric.⁶ LBNL found that window attachments could save energy even without occupants changing their habits and practices.

Greater savings are possible when product replacement is coupled with education and resources about optimal operation of window attachments. Automated systems will save even more. More research is needed to understand consumer behavior, preferences, and key drivers. What percentages of occupants are active, passive, or nonusers of their window attachments? Which issues drive consumer preference and behavior? Which factors impact manual use of blinds and the time spent in each position? Answers to these questions will help develop models that portray typical baseline usage for comparison to automated systems.

Economics

Residential products have a wide range of prices, with the median around \$100 for most interior product types. Prices for blinds, shades, and similar products vary from less than \$20 for stock blinds to more than \$200 for custom products using high-end materials.

Exterior attachments are generally more expensive because they need to be more durable and tend to have longer lifetimes. Storm windows, for example, range from \$50 to \$100 for a standard window or roughly \$6 to \$10 per square foot for larger or unusual window configurations. On average, low-e storm windows are only 30% of the cost of a replacement window and offer paybacks ranging from 4 to 14 years. Among storm windows, low-e products typically incur a low (roughly \$15) cost increment over standard clear glass storm windows.

Unlike many other heating and cooling savings measures, many window attachment products can be self-installed, yielding additional savings for consumers. One study found that up to 80% of low-e storm windows are installed by do-it-yourself (DIY) consumers.⁷



Program Approaches

Programs can play a critical role in educating customers on the energy savings capabilities of window attachments. Consumers are familiar with many window attachment products but may not realize their potential to reduce energy bills and improve home and building comfort. Promotions and incentives offered through retail channels, contractors, and others can increase awareness among consumers and trade channels.

The new ENERGY STAR and AERC platforms will make it easier for efficiency programs to promote efficient window attachments, adding a new source of energy savings to their program portfolio. Recent pilot programs offer lessons learned for successful window attachment program design and delivery. While these programs contribute valuable insights, they focus only on low-e storm windows. Additional pilots could provide constructive input on programs targeting a wider range of window attachments, especially in warmer climates with greater cooling season savings. At least one utility has filed for regulatory approval to include cellular shades in its 2020 efficiency programs.



Efficiency Vermont

Efficiency Vermont ran a pilot in fall 2015 to test a markdown of residential low-e storm windows at big-box stores. Through the program, low-e products could be purchased for the same price as non-low-e products. Over an eight-week period in September and October, the pilot increased low-e sales more than 300%, and the overall increase in storm panel sales was 37%. Efficiency Vermont now offers low-e storm windows as a full program measure.

Following on this experience, Efficiency Vermont is working to expand its program to include low-e storm windows sold through home performance and other contractor-driven channels.



Focus on Energy

Focus on Energy funded a pilot program over eight weeks in fall 2017 to assess whether low-e storm windows offer a cost-effective energy efficiency measure in the Milwaukee, Wisconsin area. The pilot generated a 125% increase in the sales of low-e storm windows and a 9% increase in the sales of all storms over the same period in 2016. The year-over-year market share of low-e storm windows increased from 30% to 63%. Focus on Energy launched a full-scale program in fall 2018.

Recommendations

Building on the experiences from early programs and tried-and-true approaches for market transformation, we make several recommendations. To achieve maximum savings and consumer acceptance, window attachments programs should consider the following strategies.

- ♦ *Leverage established product certifications.* For low-e storm windows, programs can use the ENERGY STAR storm panel certification as the basis for promotions and incentives. For other products, programs can require AERC certification as a minimum or establish minimum Energy Performance ratings that yield cost-effective savings for consumers in the region.
- ♦ *Establish meaningful incentives.* Cost markdowns that achieve or come close to price parity with standard, less-efficient products can drive consumer interest. Experience from pilots demonstrates how markdowns can yield big increases in low-e storm sales amid more modest increases in overall storm window sales.
- ♦ *Build on retail, dealer, and manufacturer partnerships.* These relationships can maximize access to the targeted consumer base, making in-store and digital marketing efforts more effective. Partners can also amplify the reach of educational materials to engage consumers and raise awareness of the savings associated with window attachments.
- ♦ *Explore ways to incorporate window attachments into a variety of existing programs.* Window attachments can be added to the portfolio of products in retail incentive programs with instant discounts or rebates and/or midstream or upstream incentives for retailers or manufacturers. They can also be added as eligible upgrade measures in home performance or similar retrofit programs. Similarly, window attachments can serve as highly cost-effective upgrades to existing windows in weatherization and other income-eligible programs. Automated window attachments offer another measure for smart homes programs.



Notes

- 1 J. King, *Energy Impacts of Smart Home Technologies* (Washington, DC: ACEEE, 2018), [aceee.org/research-report/a1801](https://www.aceee.org/research-report/a1801).
- 2 S. Bickel, E. Phan-Gruber, and S. Christie, *Residential Windows and Window Coverings: A Detailed View of the Installed Base and User Behavior* (Washington, DC: Department of Energy, 2013). www.energy.gov/sites/prod/files/2013/11/f5/residential_windows_coverings.pdf.
- 3 EPA (Environmental Protection Agency), "Storm Windows Key Product Criteria," accessed April 2019. www.energystar.gov/products/building_products/storm_windows_key_product_criteria.
- 4 EIA (Energy Information Administration), "2009 Residential Energy Consumption Survey," 2012. www.eia.gov/consumption/residential/data/2009/.
- 5 J. Knox and S. Widder, *Evaluation of Low-E Storm Windows in the PNNL Lab Homes* (Washington, DC: DOE, 2014). labhomes.pnnl.gov/documents/PNNL_23355_Lab_Homes_Low-e_Storms.pdf. J. Peterson, G. Sullivan, K. Cort, M. Merzouk, and C. Metzger, *Evaluation of Cellular Shades in the PNNL Lab Homes*, Revision 2 (Washington, DC: DOE, 2016). labhomes.pnnl.gov/documents/PNNL_24857_Cellular_Shades_rev2.pdf.
- 6 Bickel, Phan-Gruber, and Christie, 2013.
- 7 Larson Manufacturing Company presentation to 2018 AERC annual meeting, Annapolis, May 23.

