



Low-E Storm Windows & Panels: A New Tool for Utility and Weatherization Programs

A Cost-effective Energy Upgrade for Existing Windows

Windows are often the “weak link” in the building envelope.¹ Over 100 million homes in the United States lack energy-efficient windows (i.e., 50.7 homes have single-pane glass and 50.6 million homes have double-pane clear glass windows).²

While many weatherization programs do a great job of adding insulation, high-efficiency HVAC equipment, and high-efficiency lighting, they often walk away from windows because of the cost. Low-emissivity (low-E) storm windows (sometimes called panels) offer utilities a low-cost alternative to total window replacement that can turn existing windows into air-sealed, insulated, heat-reflecting assets.

(left) Researchers installed low-E storm windows over the left and right sides of a three-unit window assembly and then used an infrared camera to show areas of heat loss through the window. While the single-pane window in the center appears yellow due to heat loss to the outside, the side panes with low-E storm windows appear to be nearly as well insulated as the surrounding wall.



With a low-E storm window

Original single-pane window - the light colors show heat loss



Product Description

Modern high-performance low-E storm windows insulate and air seal existing windows to improve energy efficiency without the need for full window replacement. A storm window is a secondary window or panel that attaches to the inside or outside of the primary (or existing) window. Low-E windows have a nearly invisible low-emissivity coating on the glass that can significantly reduce heat loss in the winter and can also reduce heat gain in the summer. Properly installed modern storm windows can also significantly reduce the air leakage and drafts that occur around old window panes.

Pennsylvania Weatherization Program

In a 2010 study, the State of Pennsylvania chose to include low-E storm windows on its priority list of weatherization technologies after it calculated a savings to investment ratio (SIR) of 1.4 to 2.2 for low-E storm windows in a sample of gas-heated homes.

Benefits

Modern storm windows have evolved considerably from their old, ill-fitting, uncoated-glass, predecessors. Those early versions provided some insulation value but rarely improved air sealing and lacked the energy-efficiency properties of modern low-E glass coatings. Modern storm windows have sleek, durable, pre-painted aluminum frames that are available in many colors. The extra layer of glazing provided by the storm window provides insulation value and the low-emissivity coating provides even more heating and cooling savings.

REMAIN IN PLACE ALL YEAR. In contrast to our grandmother’s old seasonal storm windows, today’s low-E storms can remain in place year-round because the windows can open and close with positionable sashes and come with screens so the windows can be opened at any time for ventilation. Permanent installation improves program savings retention by reducing the likelihood that stored windows will be broken or never reinstalled and improves safety by eliminating the need to annually install, remove, and store the glass storm windows.

RETAIN A HOME’S HEAT IN COLD WEATHER. The low-emissivity coating consists of a very thin, durable material that is transparent in the visible spectrum and reflective in the infrared spectrum. The coating helps to retain the home’s heat in the winter by reflecting infrared heat off the inside of the window and back into the home. Studies have shown low-E glass can reduce the overall heat loss out of a window by 30% to 40%. To a lesser extent, low-E storm windows will also provide some reduction in solar heat gain coefficient (SHGC, the amount of solar heat that comes through the window on sunny summer days), thus lowering summer cooling demand.

How Low-E Storm Windows Measure Up to Replacement Windows

Tier	Existing Window	Existing Window, typical U-factor	With Low-E Storm, typical U-factor
I	Single-pane non-metal frame	0.84	0.36
II	Double-pane non-metal frame no coating	0.50	0.27

U-Factor is a measure of heat transfer. A lower U factor means the window insulates better. The table shows typical U-values, but the actual U-factor will depend upon the exact configuration of the existing window.

AIR SEAL. Modern storm windows can also provide air sealing when properly installed. Old windows can have several sources of air leakage, from loose panes to warped frames to weight and pulley holes and fittings. Interior low-E storm windows are especially air tight. When low-E storm windows are installed on the exterior, air sealing the primary window and keeping the weepholes clear will further improve performance and reduce the potential for condensation.

IMPROVE A HOME'S APPEARANCE. Low-E storm windows may also provide aesthetic benefits, for example, allowing homeowners to improve efficiency while retaining original solid wood jambs or antique or stained glass panes. Depending on the historic preservation requirements in the neighborhood, retention of these features may be a requirement. Externally mounted storm windows can provide a layer of protection for historically valuable windows.

Other benefits for the homeowner include added sound proofing and increased comfort from reducing the cold spots and drafts that can come with old, single-pane windows.

Specific Benefits to Utilities

ENERGY SAVINGS. From the utility perspective, the primary benefit of low-E storm windows is to reduce energy loss by lowering the window's U-factor and reducing air leakage. The exact amount of energy savings will depend on the specific location, type, and size of home, and type and condition of the existing windows.

In a study of older homes in Chicago, adding low-E storm windows over single-pane wood windows resulted in an average reduction of 21% in overall home heating load, a 7% reduction in the overall home air leakage, and a simple payback of under 5 years.³ Low-E storm windows deliver the same air leakage benefits as other modern storm windows. In studies of 10 homes in Atlanta and 14 apartments in Philadelphia, overall building air leakage was reduced by an average of 17% and 10%, respectively, when modern low-E storm windows were installed.⁴

COST EFFECTIVENESS. The cost of low-E storm windows varies based on size and purchase location, but they are significantly less expensive than double-pane low-E replacement windows, ranging from \$80 to \$150 for a low-E storm window versus \$200 to \$500 for a double-pane low-E replacement window (see table on next page).

Labor costs are significantly less for low-E storms than for replacement windows. Installing low-E windows is simpler, faster, and less expensive than removing and disposing of old windows and installing, leveling, sealing, insulating, trimming, and painting new windows.

The savings-to-investment ratio (SIR) will depend upon the specific location, but studies have shown that low-E storm windows are well qualified for weatherization programs in climates with moderate or cold winters (SIR > 1). In contrast, replacement windows and non-low-E storm windows generally do not satisfy cost effectiveness criteria for weatherization and utility programs due to high purchase and installation costs. As an example, the State of Pennsylvania determined that low-E storm windows consistently have a SIR of 1.4 to 2.2 across a wide range of home types. Based on these findings, Pennsylvania added low-E storm windows to its weatherization measure selection priority list for single-family homes in 2010.⁵



Low-E storm windows are easy to install with a drill, a screwdriver, and a tube of caulk. Most models have operable windows and screens so they can be kept up for year-round energy savings and increased comfort.^{3,4}

"If you weatherize a home and walk away leaving it with single-pane, clear-glass windows, you should be put in energy-efficiency jail!"

Marc LaFrance, energy analyst, In comments made at the FEMP Energy Savings Performance Contracts Working Group Meeting Feb. 8, 2012.

Resources

Alliance for Low-E Storm Windows
www.low-estormwindows.com

Consortium for Energy Efficiency
www.cee1.org

Efficient Windows Collaborative
www.efficientwindows.org

Low-E Storm Windows Cost Considerably Less Than Replacement Windows & Perform Just as Well

Window Properties	Single-Pane Wood Window	Double-Pane Replacement Window	Clear Storm Window	Low-E Storm Window
Typical Cost Range of window	--	\$200 - \$500	\$70 - \$125	\$80 - \$150
Typical Installation cost	--	\$100 - \$500 per window	\$2 (DIY) to \$60 per window	\$2 (DIY) to \$60 per window
SIR (Savings-to-Investment Ratio) compared to single pane	--	< 1 (generally not qualified for WX programs)	<1 to 1.2 (usually not qualified)	1.4 - 2.2 in Pennsylvania. Higher in colder climates. Well qualified.
Typical Heating and Cooling Energy Cost Savings compared to single pane		11% - 35%	5% - 20%	12% - 33%
Typical U-factor (Btu/hr ft ² F)	0.84	0.30 - 0.35	0.50 (over single-pane wood window)	0.36 (over single-pane wood window)
Typical SHGC	0.63	0.25 - 0.30	0.56	0.48
Typical Air leakage (cfm/ft ²)	1 - 4	0.1 - 0.3	0.3	0.1 - 0.3

Sources: Consortium for Energy Efficiency, Residential Windows Working Group; and references 4 and 5.

ENDNOTES:

- 1 D. Arasteh, S. Selkowitz, J. Apte, and P.M. LaFrance. 2006. "Zero Energy Windows," LBNL-60049, Lawrence Berkeley National Laboratory. <http://gaia.lbl.gov/btech/papers/60049.pdf>
- 2 EIA. 2005. *2005 Residential Energy Consumption Survey*, Energy Information Administration, U.S. Department of Energy. http://www.eia.gov/emeu/recs/recs2005/c&e/detailed_tables2005c&e.html
- DOE. 2009. *2009 Buildings Energy Data Book*, U.S Department of Energy. http://buildingsdatabook.eren.doe.gov/docs%5CDataBooks%5C2009_BEDB_Updated.pdf
- 3 Drumheller, S.C., C. Kohler, S. Minen. 2007. "Field Evaluation of Low-E Storm Windows," LBNL-1940E, Lawrence Berkeley National Laboratory, presented in *Proceedings of the Thermal Performance of the Exterior Envelopes of Whole Buildings X International Conference*, Dec. 2-7, 2007. http://buildings.lbl.gov/sites/all/files/1940e_0.pdf
- 4 Culp, TD and SC Drumheller, 2013. *Low-E Retrofit Demonstration and Educational Program*, August 2010-2013, Research Project # DE-EE0004015 conducted by Quanta Technologies Inc. for the U.S. Department of Energy.
- 5 Zalis, W. et al. 2010. *Evaluation of Low-E Storm and R-5 Windows for Inclusion in Pennsylvania's Weatherization Priority List*, Prepared by W. Zalis, Energetics Incorporated; T. Culp, Birch Point Consulting; C. Kohler, LBNL; and P.M. LaFrance, U.S. DOE; for the Pennsylvania Department of Community and Economic Development, May 2010, unpublished.