

Storm Window and Insulating Panel Utility Playbook

Overview

The Partnership for Advanced Window Solutions (PAWS) and the U.S. Department of Energy (DOE) Storm Window and Insulating Panel (SWIP) Campaign have assembled this playbook for utilities interested in implementing residential storm window programs. Storm windows have been around for decades, but modern storm windows are much more functional and efficient than the storms of past generations. Modern storm windows reduce energy use, improve comfort, are operable, affordable, and more aesthetically appealing than older storm windows. However, consumers are often unaware of the benefits that these products provide, or are misinformed regarding their modern appeal and operability.

This playbook outlines the technology of modern storm windows and insulating panels and provides guidance for utilities interested in implementing programs to get these products in the hands of consumers, resulting in significant energy savings. With recent advancements in window technology, momentum towards electrification, and a need to improve building envelope performance, there is an exciting opportunity to begin building window and window attachment programs that are cost-effective and popular among utility customers.

In addition to this playbook focused on strategy for residential storm window programs, the PAWS team has also developed a utility playbook focused on primary windows, which can be found [here](#). If you are interested in launching a residential storm window program, are curious about similar technology for application in commercial buildings, or have any questions about this document, please reach out to the SWIP team at techchallenge@pnnl.gov.

About PAWS and the SWIP Campaign

The Partnership for Advanced Window Solutions (PAWS) is a collaborative that promotes cost-effective, high performance window solutions for the nation's new and existing building stock. Launching with multi-year support from the U.S. Department of Energy and in-kind support from partners, the PAWS Collaborative will employ a variety of proven strategies to transform window markets.

The Storm Window and Insulating Panel (SWIP) Campaign is a collaborative initiative sponsored by the U.S. Department of Energy (DOE) and managed by Pacific Northwest National Laboratory (PNNL) to accelerate the adoption of modern storm windows and insulating window panels (sometimes

called window inserts or secondary glazing)—delivering energy savings and comfort in residential and commercial buildings at a fraction of the cost of full window replacements. The SWIP Campaign works closely with PAWS and serves as a national platform and one-stop-shop for sharing information and recognizing successes of key stakeholders, including utilities, energy efficiency programs, weatherization organizations, home performance contractors, and others. For more information on the SWIP Campaign, visit the [SWIP Campaign Website](#) or contact the team directly at techchallenge@pnnl.gov.



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Modern Storm Windows

The Window of Opportunity for Utilities

As the U.S. prioritizes net zero energy buildings, addresses carbon emissions and confronts the challenges of decarbonizing the grid, there is a pressing need to dramatically increase the availability and use of highly efficient window products. Utilities are uniquely positioned to take advantage of this market shift and create window programs that meet the needs of their customers.

- ◆ Windows and window attachments, such as storm windows, produce peak energy savings in both the heating and cooling season. As the need to reduce peak loads in the summer and winter increases, windows will play a crucial role in reducing peak demand.

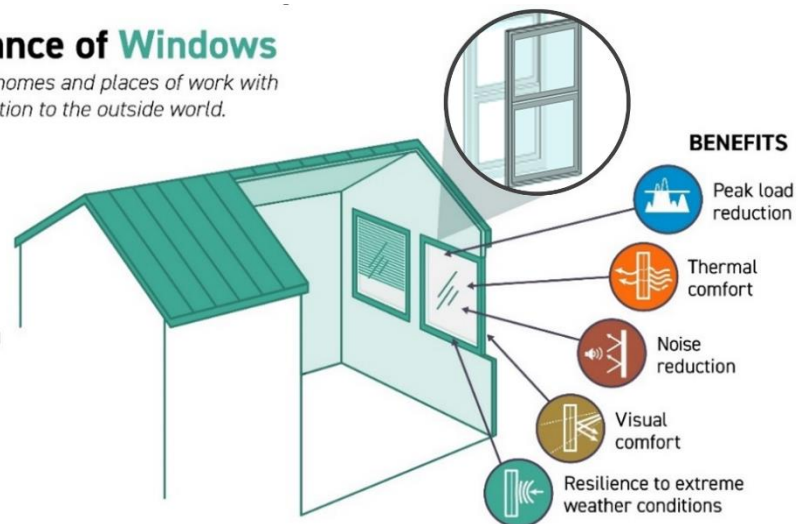
- ◆ Improving the performance of the building envelope can reduce the size and cost of HVAC equipment upgrades. This will become increasingly important as more cities implement electrification goals and consumers prioritize decarbonization.

The Importance of Windows

Windows provide our homes and places of work with light, view, and connection to the outside world.

ENERGY USE

- 25%** of heating and cooling energy use
- 10%** of total building energy use
- 8%** of envelope area, but
- 45%** of envelope heat transfer



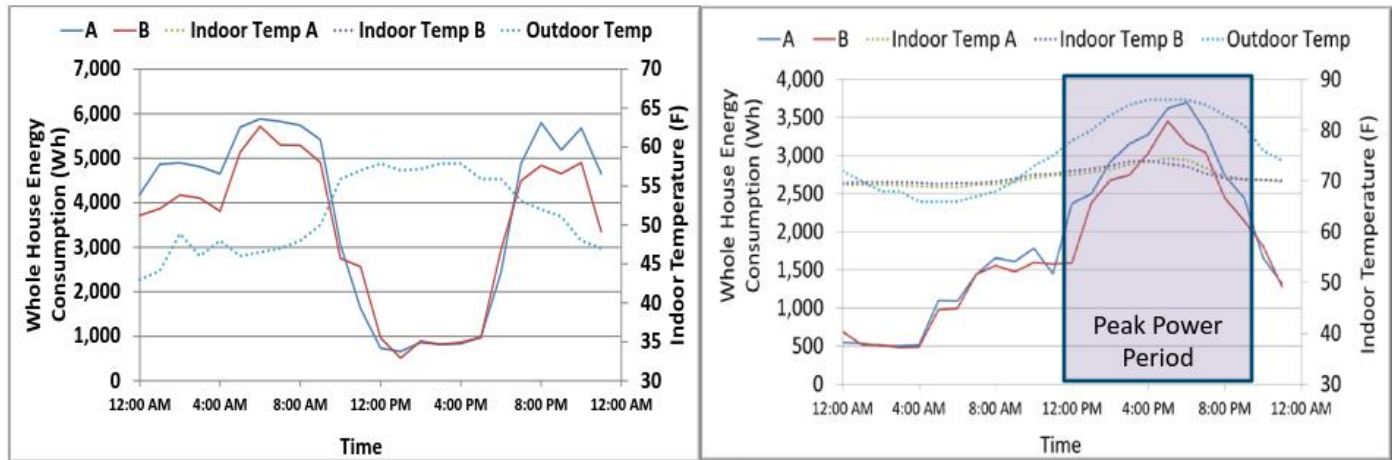
- ◆ Customers want better windows. Throughout our utility interactions we continue to hear that windows are one of the top products that customers ask about incentives for. By building consumer awareness about the advantages of modern storm windows, homeowners can benefit from a better performing envelope without investing in a complete window replacement. A storm window incentive can serve as a gateway to increase customer engagement in utility programs and may help reach underserved and lower income communities due to the affordability of storm windows compared to full window replacement.
- ◆ Numerous specifications exist that can make it easier for utilities to integrate the highest performing window products into their programs. These include ENERGY STAR's most efficient primary windows, the new ENERGY STAR version 7 specification for primary windows, [ENERGY STAR storm windows](#), and new performance ratings for a range of window attachments products (e.g., shades, blinds, storm windows, awnings, etc.) are now available through the [Attachments Energy Rating Council \(AERC\)](#).

For these reasons, utilities are in a great position to affect change in the window market. As savings from lighting upgrades diminish, and HVAC upgrades are prioritized, windows will become a crucial measure in the new age of energy efficiency programs.

Windows produce peak demand reduction

A PNNL Lab Home field study found that low-emissivity (low-e) storm windows can achieve an average of **11% heating load and 8% cooling load savings** when compared to a baseline¹. In other DOE field validation studies, the application of storm windows demonstrated savings up to 30% on annual heating and cooling bills and reduced whole air leakage by 10% or more.²

Figure 1: PNNL Lab homes testing load shapes during heating and cooling seasons



Whole-House Energy Consumption on Cold, Sunny Winter Day

Whole-House Energy Consumption on Hot, Sunny Summer Day

High performance window products are one of the best technologies for reducing peak load. In the summer, products with lower SHGC and/or effective shading, can minimize solar heat gain which reduces cooling costs and system peaks. In the winter, a better insulated building envelope prevents heat from leaking out of the building, reducing peak heating load. This will be particularly important for buildings with electric heat. As the lowest performing component of a building’s envelope, windows and window attachments should be prioritized when addressing winter peak load reduction. Higher performing windows also improve thermal comfort, in some cases allowing lower thermostat set points which will save additional energy.

Consumers love windows

As many residential home energy auditors attest, windows have historically been one of the first things customers consider upgrading when assessing their home energy performance. Why? Windows offer numerous benefits beyond energy savings, including comfort, visibility, health (condensation reduction) and noise reduction. Windows are also known to increase the resale value of homes at a higher scale than other energy efficiency improvements, significantly improving the return on investment for homeowners. With envelope insulation becoming increasingly important as we move towards electrification, windows are

¹ This study assumed a baseline home with single-pane clear glass aluminum-framed windows, the PNNL lab homes are located in Richland, Washington. *Evaluation of Low-E Storm Windows in the PNNL Lab Homes*. JR Knox and SH Widder, 2014.

² See range of savings by climate zone in *Energy Savings of Low-E Storm Windows and Panels across US Climate Zones*. TD Culp and KA Cort, 2015.

finally on the menu for energy efficiency rebates. Modern storm windows are an excellent low-cost option for resolving customers dissatisfaction with their current windows while improving their homes energy performance. Utility storm window programs will not only satisfy customers eagerness to upgrade their windows, but they will also serve as a gateway to engage customers in more comprehensive home energy retrofits.

Deep energy retrofits

Within buildings, energy use is typically split between HVAC, lighting, and hot water; however, HVAC is the largest energy consumer in virtually all building types and climates. HVAC energy use is primarily driven by the thermal properties of the building envelope, where windows are historically the poorest performing element. **Replacing HVAC systems without upgrading or replacing windows requires larger, more expensive HVAC equipment, transmission, and storage to power these systems.**

Key Benefits of Modern Storm Windows

- Significantly increase air tightness/insulation
- Protect existing windows (exterior)
- Blocks heat from entering a room
- Improve comfort
- Reduced noise
- Option for low-e coating which significantly improves U-value.

This presents a unique opportunity for deep energy retrofit programs. When window measures are combined with HVAC and insulation upgrades, customers are able to reduce the size and cost of their replacement HVAC equipment because of their improved envelope performance. This will greatly improve payback and cost-effectiveness and produces a much more energy efficient and comfortable home compared to a home whose owners pursue these upgrades separately.

Technology Overview

Today's storm window

Storm windows are window attachments that are added to an existing window to protect it from weather and improve energy performance. While this type of product has been around for many years, modern products are significantly more efficient, functional, and attractive. There are several types of modern storm windows available on the market, including exterior storms and interior storms/insulating panels that are installed on the inside of the existing window. Interior storms and insulating panels do not protect the existing window from the elements, but still provide improved energy efficiency, air-sealing, thermal comfort, and outdoor noise reduction. Modern storm windows include the option for a low-e coating that substantially decreases the heat transferred through the window. Some acrylic insulating panel products do not come with the low-e coating but still offer excellent air-sealing capabilities. To compare the features and performance of modern storm windows, you can visit the [AERC Storm Window Product Search](#) or the [ENERGY STAR Storm Window Product Search](#).

Exterior Storms

High-performance, modern exterior storm windows often have a better seal, smoother long-term operation, and offer significantly better energy performance since they increase thermal insulation and reduce heat loss from your home. Modern exterior storm windows are selected to match the operation of the existing

window and are installed year-round, resulting in year-round energy savings. There are three basic types of exterior storms: triple-track, double-track and fixed (non-operable). Learn more about exterior storm windows [here](#).

Interior Storms and Insulating Panels

Interior storm windows and insulating panels, sometimes known as window inserts, are similar to exterior storms but are installed on the inside of the existing window. Some interior storms are operable and are chosen to match the operation of the existing window, and others are non-operable. Interior storms are typically easier to install than exterior storms, particularly on upper levels because ladders or scaffolding aren't usually required. There are several non-glass insulating panel products on the market that do not offer a low-e option, but come with gaskets to provide very good air sealing benefits. Interior storm windows and insulating panels can be a good option for renters or homeowners who are unable to install exterior storms due to restrictions (e.g. HOA's, historic districts, etc.). Interior storms can bring a window's performance close to that of a new double pane window by reducing air leakage and adding an air-gap to improve thermal performance. These products also help prevent condensation in cold climates as they are more air-tight and therefore reduce moisture movement. However, a key consideration of this product is that they may hamper egress, depending on operability. Learn more about interior panels [here](#).

Common misconceptions

Years ago, storm windows were simply an extra pane of clear glass, installed over an existing window that must be removed depending on the season, or for cleaning or egress. Some consumers have unfond memories of the seasonal chore of dusting off the old storm windows, tediously carrying the heavy storm windows up a ladder, and installing them window by widow. Many consumers still have this image of the original storm window in their mind when it comes to window shopping. However, many modern storm windows are designed to be permanently installed and are available as operable units that match the operation of your existing window (e.g., single-hung, slider, etc.) These products are available in multiple colors and are designed to blend in with your existing architecture. They are also designed to be easily installed as a do-it-yourself measure or by a home performance contractor. For customers that only want to improve energy performance, there are new products that provide great air sealing benefits (draft reduction), improved insulation, noise reduction, and deliver energy savings to the customer.

Storm Window Cost

The cost for a new low-e storm window is approximately \$10 per square foot. This equates to \$150 per window assuming a standard 3'x5' window.

The incremental cost for a low-e storm window over a clear glass storm window is \$1/SF, or \$15/window assuming a standard 3'x5' window.

Energy savings potential

Window savings are heavily dependent on region. For example, cooling savings will be much more favorable in regions with hot summers where low-e storm window products with low solar control (lower solar heat gain coefficients) can reduce peak cooling load by minimizing heat gain through windows. Additionally, climates with extremely cold winters will produce more favorable heating savings because low-e storm windows reduce heating loads by improving the insulation of a building’s envelope.

The following tables include modeled savings for low-e storm windows installed over an existing single pane wood framed window and a double pane wood framed window³. Savings are averaged for two home types and interior and exterior storm applications. It is important to note that savings values can vary heavily depending on adjustments to SHGC for certain regions. For region specific modeling results or energy savings over alternative baselines (e.g. single pane with a clear glass storm), [reach out to the SWIP team](#).

Low-e storm window savings potential over a single-pane wood framed window

Climate Zone	Average Gas Heating Savings (therms/window)	Average Electric Cooling Savings (kWh/window)
7	30.3	1.0
6	24.0	5.4
5	18.6	6.8
4	13.6	15.2
3	7.6	34.1
2	4.7	49.4
1	- *	58.0

Base window characteristics: U-value: 0.88, SHGC: 0.61

*For more information on heating savings in climate zone 1, please reach out to the SWIP team.

Low-e storm window savings potential over a double-pane wood framed window

Climate Zone	Average Gas Heating Savings (therms/window)	Average Electric Cooling Savings (kWh/window)
7	11.8	1.0
6	9.2	4.7
5	7.1	6.0
4	4.7	12.0
3	2.4	24.5
2	1.5	33.5
1	- *	40.9

Base window characteristics: U-value: 0.51, SHGC: 0.57

*For more information on heating savings in climate zone 1, please reach out to the SWIP team.

The savings listed include energy savings associated with air leakage reduction. Case studies show that modern storm windows provide an average of 10% reduction in overall home air leakage. For older homes with old, leaky storm windows or no storm windows, this can be a very significant contributor to energy savings and improved occupant comfort.

³ https://www.pnnl.gov/main/publications/external/technical_reports/PNNL-24826.pdf

Utility Programs

How SWIP Can Support You

In an effort to increase the presence of utility window programs, PAWS and SWIP can provide additional support for interested utilities in the following areas:

TRM Support: We recognize the importance of integrating these measures into state Technical Reference Manuals (TRM) and can help advocate and provide support for adding these measures to your TRM. SWIP can provide savings analysis, whitepapers or other support as needed. Many states also have existing storm window TRM measures that are being underutilized. Check the adjacent table to see if your state has a TRM measure!

Region Specific Savings Analysis: For interested utilities, SWIP can provide tailored savings analysis for your region along with suggested rebate structures.

Program Design: SWIP can support in the design and early implementation of window programs and pilots. Utilizing the expertise within the PAWS leadership team and PAWS utility members with successful programs, we can help design a program that fits your region’s needs.

Marketing Support: SWIP is developing consumer facing marketing materials for utilities to use to market their programs. A key barrier in this market is consumer misinformation. We will be working to create materials that will help raise awareness regarding the benefits and common misnomers surrounding storm windows.

Online Resources: As we move forward, resources like this one and the previously mentioned marketing materials will be uploaded to the [SWIP Campaign website](#). Additional window attachment resources can be found on [AERC’s utility page](#).

Let us know! Our goal is to assist utilities in overcoming the barriers that exist to implementing window programs. Reach out to set up a call to discuss any of these topics or let us know where else you can use support and we will continue to work to develop supporting resources for you.

State/Region	Product Category
Arkansas	Low-E Storm Windows
Connecticut	Storm Window
Oregon, Washington, Idaho and Montana ¹	Low-E Storm Windows
Illinois	Low-E Storm Windows
Iowa	Low-E Storm Windows
New Orleans, LA	Low-E Storm Windows
Massachusetts ²	Low-E Storm Windows
Michigan	Low-E Storm Windows
Minnesota	Low-E Storm Windows
Missouri	Low-E Storm Windows
New York	Low-E Storm Windows
Rhode Island	Low-E Storm Windows
Texas	Low-E Storm Windows
Vermont	Low-E Storm Windows

¹The Regional Technical Forum (RTF) maintains a measure library in support of energy programs in these regions.
²The new Massachusetts TRM is currently under development and a storm window measure has been approved to be included in the new edition.

Utility Program Strategies

This section focuses on program strategies for modern storm windows and insulating panels. If you are interested in launching a residential storm window program, are curious about similar technology for application in commercial buildings please reach out to the SWIP team at techchallenge@pnnl.gov. PAWS has also developed a utility playbook for primary windows which can be found on the [PAWS website](#). For more information, reach out to info@PAWS.energy.

Single Family

Single family programs are the most common utility rebate offering for windows. Many homeowners are already purchasing windows and window attachments for the benefits they offer beyond energy savings (comfort, noise reduction, etc.), and a utility rebate can help motivate homeowners to choose modern storm windows. This also creates a great opportunity for utilities to engage with their residential customers. Windows tend to be the first thing homeowners ask about when they think about comfort and home energy, so a modern storm window offering can serve as a gateway to additional utility program participation.

Downstream – Direct to Consumer

A downstream window program allows customers and/or contractors to apply for a rebate directly. Savings can be calculated using the data referenced in the energy savings section of your local TRM. Check the table above to see if your state has a low-e storm measure. If you'd like support for getting a window measure added to your states TRM or calculating savings for your window program, let the PAWS team know (info@PAWS.energy).

Program Design	
Program Type	Downstream - Direct to Consumer
Target Sector	Single Family
Suggested Rebate Structure	Prescriptive Rebate; \$25 per window
Key Program Activities	<ul style="list-style-type: none"> • Design online application for customers and/or contractors • Simple per window rebate amount <ul style="list-style-type: none"> • Easier for customer compared to \$/sq. ft. • Launch Consumer Awareness Campaign

Upstream/Midstream - Retail

Providing incentives at the retail level has also been a successful approach. Typically, these incentives are provided to the retailer and passed through to the customer. This approach is most successful when it is paired with in-store marketing and educational materials. Manufacturer engagement is also key, as they can help provide marketing and training support for the program. This approach has proven successful in pilots in Wisconsin and Vermont.

Program Design	
Program Type	Upstream/Midstream - Retail
Target Sector	Single Family
Suggested Rebate Structure	Varies - 25% in-store discount and/or \$25 per window
Key Program Activities	<ul style="list-style-type: none"> • Engage with retailers and manufacturers in your region and discuss program approaches that will work for them • Provide incentives for retailers to stock and promote low-e storm windows • Provide in-store promotion, discounts, and staff to training to increase program participation

Multifamily

Multifamily programs offer a large energy savings opportunity but require increased engagement with building owners and/or property management. Window programs pair well with multifamily programs that may already be in place, for example a multifamily direct install or energy audit program. Modern storm window installations can easily be incorporated into these programs as either a more comprehensive direct install measure or a low-cost upgrade that can be installed by a contractor. These programs provide a great opportunity to educate building owners on the opportunities, energy savings, and benefits that modern storm windows provide.

Program Design	
Program Type	Downstream
Target Sector	Multifamily
Suggested Rebate Structure	Prescriptive Rebate - \$25 per window
Key Program Activities	<ul style="list-style-type: none"> • Leverage MF audits or direct install programs to promote low-e storm windows • Offer rebates to provide building owners with a lower cost option to upgrade windows • Work with manufacturers to facilitate bulk purchases of windows for multifamily projects

Low-Income/Weatherization

Modern storm windows provide a great opportunity to increase savings and impact in low-income programs. However, many programs have not re-evaluated this opportunity and therefore are not including them in their program’s measure list or home evaluation. Results from a PNNL modeling study, using NEAT⁴, show that low-e storm windows have an SIR (savings investment ratio) above one in climates zones 3-7. This is a measure that needs to be re-evaluated and included in low-income programs. Utilities can work with their local weatherization and low-income program implementers to reassess this, and PAWS can help. We are happy to provide assistance with energy savings and cost data, as well as connections to training resources and manufacturer products.

Program Design	
Program Type	Low-income/Weatherization
Target Sector	Single Family
Suggested Rebate Structure	Low-income and weatherization programs would cover the full cost of the product for homeowners
Key Program Activities	<ul style="list-style-type: none"> • Reevaluate low-e storm measure for low-income and weatherization programs • Incorporate measure into home evaluation and ensure energy audit assumptions are up to date • Train staff and/or contractor to complete storm window installations

Utility Program Examples

The following are examples of low-e storm window rebate programs from across the country. If you would like to connect these utility program managers for more details, PAWS can help connect you.

Utility - Focus on Energy Pilot in Wisconsin Learn More >>	
Program Type	Midstream - Retail
Target Sector	Homeowners
Rebate Structure	25% in-store discount for shoppers
Key Program Activities	<ul style="list-style-type: none"> • In-store promotion and marketing materials • Retail partners and relationships • In-store staff training materials

⁴ NEAT - National Energy Audit Tool used in weatherization programs to determine measure cost effectiveness

Utility - PSEG Long Island, New York		Learn More >>
Program Type	Downstream	
Target Sector	Single Family	
Rebate Structure	\$1 per sq. ft. rebate	
Key Program Activities	<ul style="list-style-type: none"> • Utility bill account credit or mail in rebate • Products must be ENERGY STAR certified 	

Utility - National Grid Rhode Island		Learn More >>
Program Type	Downstream	
Target Sector	Single Family	
Rebate Structure	\$25 per window	
Key Program Activities	<ul style="list-style-type: none"> • Instant rebate for residential customers • Products must be ENERGY STAR certified • Online resources for homeowner education on why storm windows 	

Utility - Chelan PUD		Learn More >>
Program Type	Midstream - Retail	
Target Sector	Homeowners	
Rebate Structure	\$8 per sq. ft. rebate	
Key Program Activities	<ul style="list-style-type: none"> • In-store promotion and marketing materials • Retail partners and relationships • In-store staff training materials 	

Utility - Avista Idaho		Learn More >>
Program Type	Downstream	
Target Sector	Single Family	
Rebate Structure	\$3.00 per sq. ft. rebate	
Key Program Activities	<ul style="list-style-type: none"> • Online rebate application • Products must be ENERGY STAR certified 	

Utility - Avista Washington		Learn More >>
Program Type	Downstream	
Target Sector	Single Family	
Rebate Structure	\$3.00 per sq. ft. rebate	
Key Program Activities	<ul style="list-style-type: none"> • Online rebate application • Products must be ENERGY STAR certified 	