

Building Technologies Program

U.S. DEPARTMENT OF
ENERGY

Energy Efficiency &
Renewable Energy



Window and Envelope Solutions for
Today and Tomorrow

National Association of
Home Builders Webinar
December 14, 2011

Goals of this presentation

- Show DOE purpose and planning for window-related programs
- Introduce a market transformation program that is increasing the availability of highly insulating windows and low-E storm windows
- Explain the benefits of these products and how they work



DOE and Windows

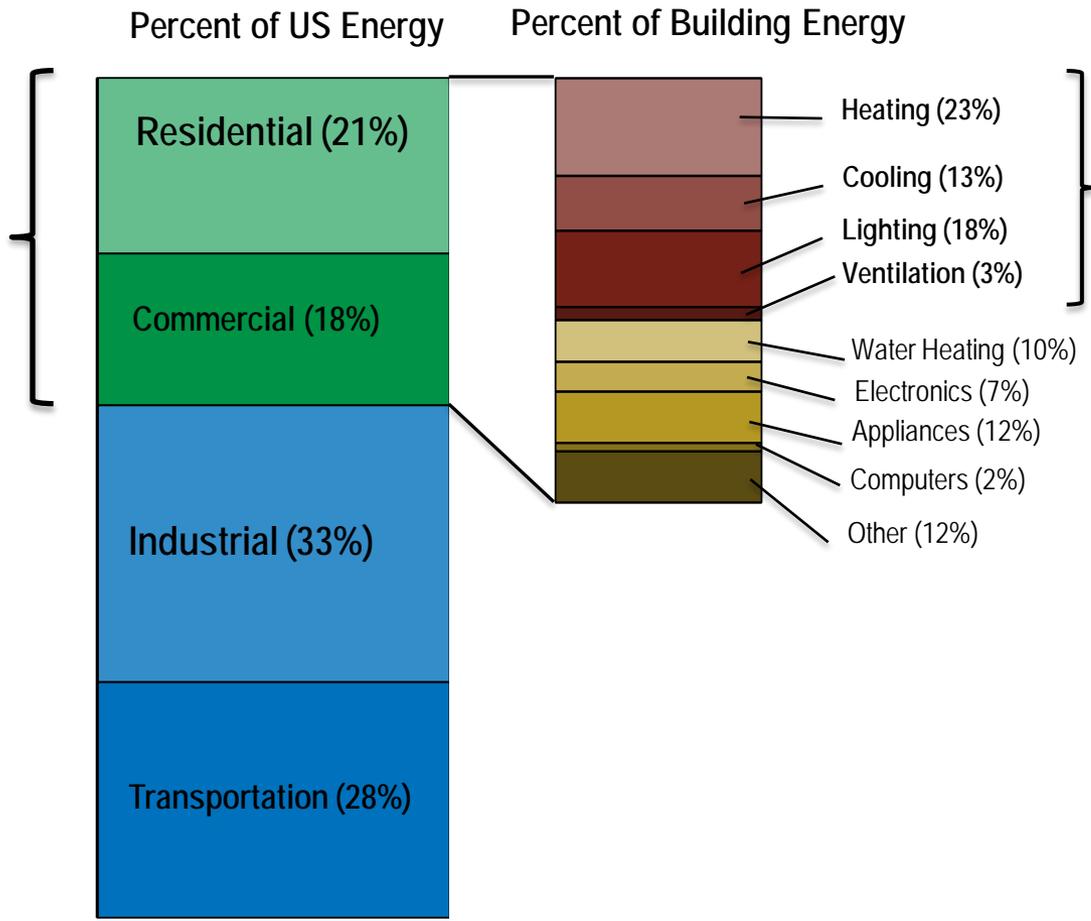
How the WVP program fits
into the big picture



Terry Mapes
Pacific Northwest National Laboratory

Why worry about windows?

Buildings are responsible for about 40% of US primary energy consumption



58% of the energy used in a building is impacted by windows. Almost 14% of the total energy in the US.

Current Residential Windows Market

Home / Doors & Windows / Windows / Single Hung

Single Hung

PRICE

- \$50 - 100 (18)
- \$100 - 200 (15)

BRAND

- American Craftsman, an Andersen Company (16)
- JELD-WEN (9)
- TAFCO (6)
- TAFCO WINDOWS (2)

ENERGY STAR COMPLIANT

- Energy Star (25)

ECO OPTIONS

- Eco Options (21)

MATERIAL

33 Products

Sort By: Top Sell

Select up to 4 items to compare. COMPARE

American Craftsman, an Andersen Company 2301 Single Hung Vinyl Windows, 3/0 in. x 5/0 in. White with LowE3 Insulated Glass, Argon Model 2301

American Craftsman, an Andersen Company 2301 Single Hung Vinyl Windows, 3/0 in. x 5/0 in. White with LowE3 Insulated Glass, Argon Model 2301

Home Depot
Three largest window categories

Over 85%
Energy Star
compliant

Home / Doors & Windows / Windows / Double Hung

Double Hung

PRICE

- \$50 - 100 (1)
- \$100 - 200 (55)

PRO

- Pro (1)

STORM WINDOW

- No (32)

MORE WAYS TO SHOP

- Special Values
- Most Popular

56 Products

Sort By: Top Sell

Select up to 4 items to compare. COMPARE

American Craftsman, an Andersen Company 8500 Double Hung Vinyl Windows, 28 in. x 54 in. White, with LowE3 Insulated Model 8500

American Craftsman, an Andersen Company 3000 Double Hung Vinyl Windows, 2/4 in. x 3/2 in. White with LowE3 Insulated Model 3000

Product Comparison

Here are the products you have to compare:

	Model 3000	Model 8500	Model 3000	Model 8500
Remove Product	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Image				
Price	\$137.00/EA-Eac	\$128.00/EA-Eac	\$133.00/EA-Eac	\$138.00/EA-Eac
Shipping	Ships FREE with \$249.00 Order			
Manufacturer	American Craftsman, an Andersen Company			
Window Type	Double Hung	Double Hung	Double Hung	Double Hung
Collection Name	3000 Double Hung	8500 Double Hung	3000 Double Hung	8500 Double Hung
Color/Finish	White	White	White	White
Energy Star Compliant	Yes	Yes	Yes	Yes

R3 is now
becoming the
BASELINE

Home / Doors & Windows / Windows / Gliders

Gliders

PRICE

- Less than \$50 (1)
- \$50 - 100 (17)
- \$100 - 200 (17)

BRAND

- JELD-WEN (21)
- TAFCO (6)
- TAFCO WINDOWS (4)
- American Craftsman, an Andersen Company (4)

ENERGY STAR COMPLIANT

- Energy Star (25)

ECO OPTIONS

- Eco Options (20)

MATERIAL

35 Products

Sort By: Top Sell

Select up to 4 items to compare. COMPARE

JELD-WEN Vinyl Horizontal Sliding Window Low-e Glass 48 in. x 48 in. LH Model A92967

JELD-WEN Vinyl Horizontal Sliding Window Low-e Glass 48 in. x 36 in. LH Model A92965

Total Building Envelope and Window R&D Budget

	Administration Budget Request	Enacted Appropriations
FY05	5.0M Windows 0 Envelope	5.8M Windows 2.8M Envelope
FY06	5.0M Windows 0 Envelope	*3.8M Windows (*earmarks) 2.9M Envelope
FY07 & FY08	4.7M Windows 2.4M Envelopes	4.7M Windows 2.4M Envelope
FY09	5.2M Windows 3.4M Envelopes	5.5 Windows 4.5 Envelope
FY 10	10.5M Windows 5.5M Envelope	Core 10.5M Windows 5.5M Envelope
FY 11	10.5M Windows 8.5M Envelope	TBD – Not expected to exceed FY10 Continuing Resolution
FY 12	25 M (9M BIPV)	TBD

ARRA
25M



Integrated Programs to Reduce Price of Highly Insulating Windows

Technical Support

Building America demonstrations/ production housing for easy markets

High-performance specs in LEED for Homes & NGBS

Production Engineering RFP – 50%
Cost Share

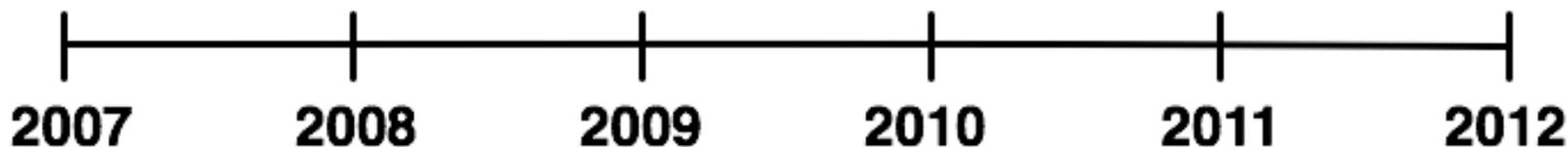
Technology Procurement/Volume Purchases

Develop
advanced utility
program specs

Support utility programs for
advanced windows

ENERGY STAR spec revision

ENERGY STAR Spec
Development

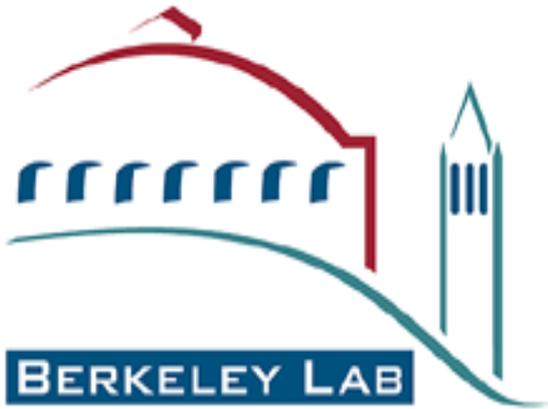


- **Highly Insulating Windows**
 - Goal is U-factor 0.10
 - Evaluate vacuum glazing
 - Advance dynamic glazing
- **Market-Based Approach**
 - Alternative to codes and standards
 - Technology specifications & procurement
 - Demonstrations



**Prototype – Concept Window
Highly Insulating and Dynamic
SHGC 0.04 – 0.34**

DOE Assists with Technical Support Activities

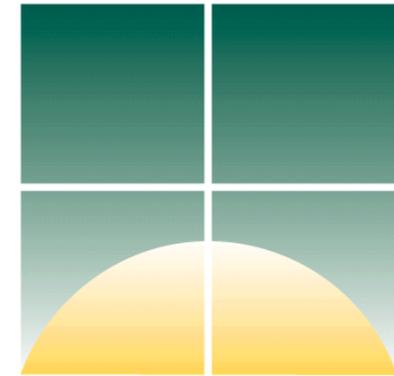


<http://windows.lbl.gov/software>



www.nfrc.org

Efficient Windows



Collaborative

www.efficientwindows.org

- Full range of software support tools, education materials and expansion to new product categories
- Continued financial support to assist industry in rating and promoting efficient products

Contact Information

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Building Technologies Program

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US Department of Energy

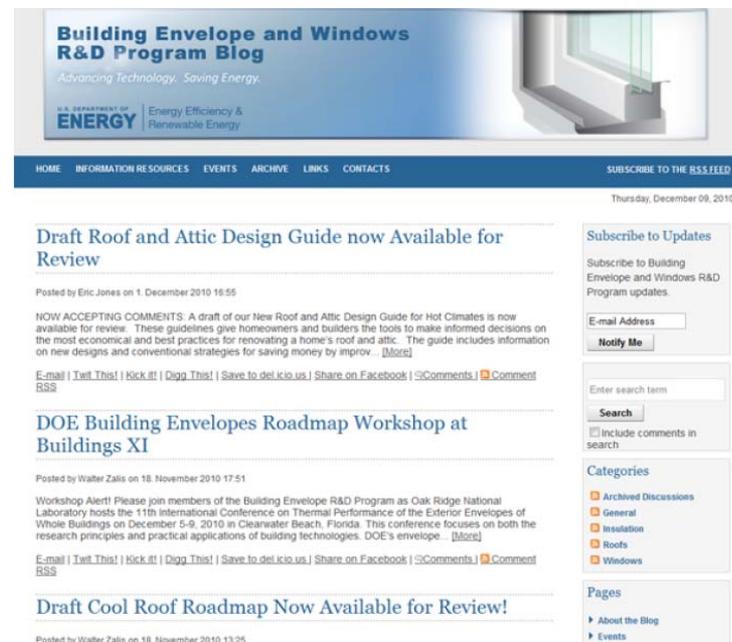
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www.eere.doe.gov

www.eereblogs.energy.gov/buildingenvelope

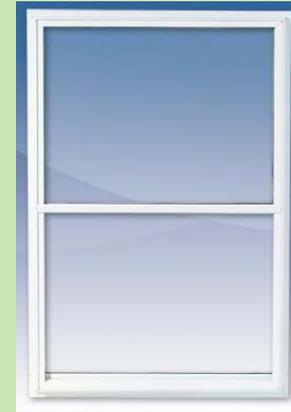


Energy efficiency and the WVP Program products

Highly Insulating Windows

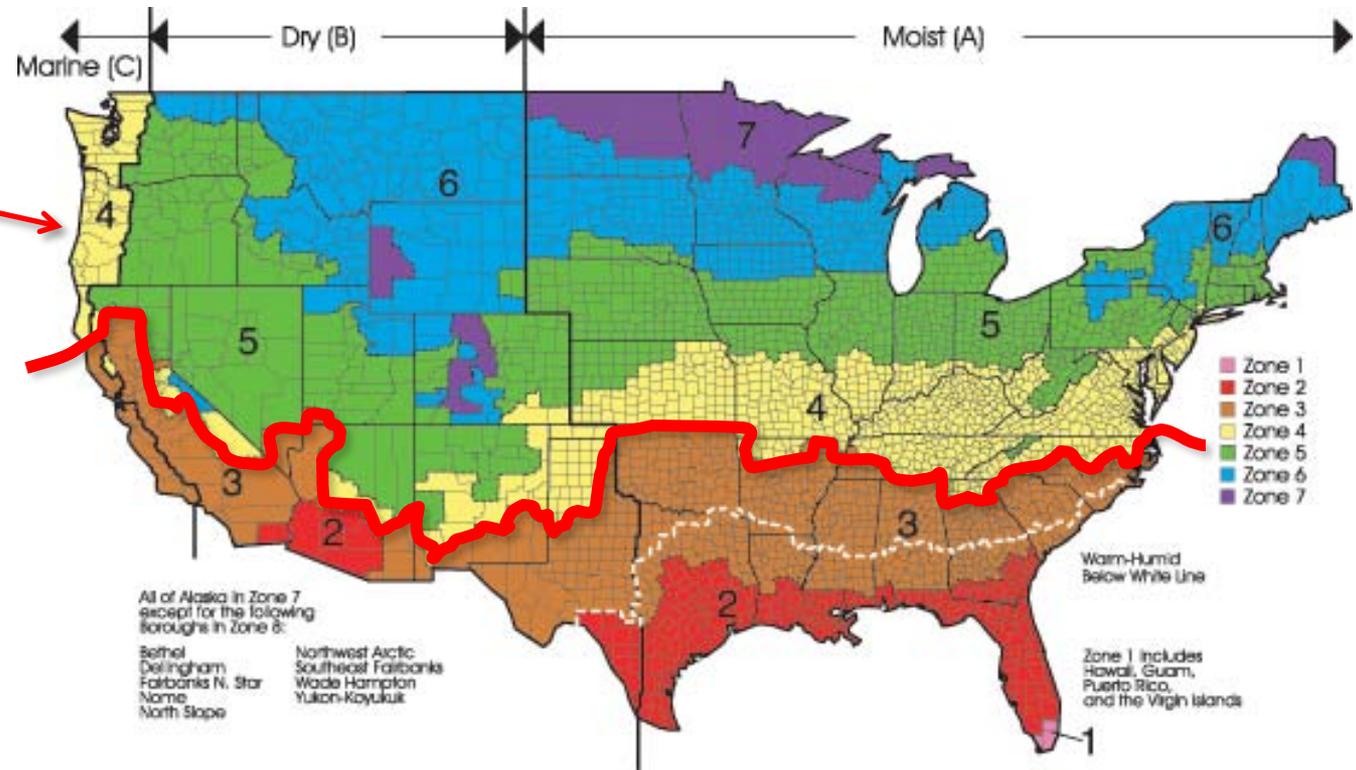


Low-E Storm Windows



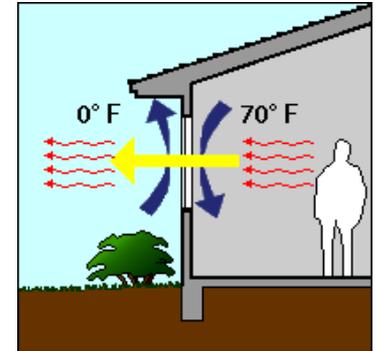
DOE High Performance Windows Program: Focus on cold climates / U-factor

Focus on mixed and heating climates
(Climate Zones 4-8)



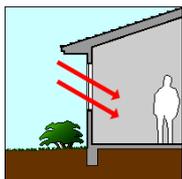
Focus on U-factor

- U-factor measures insulating value
lower = less heat loss
- For general reference: R-value is inverse of U-factor
 - e.g. if $U = 0.2$, then $R = 1/0.2 = 5$
 - But test conditions differ btw. windows and walls
- Whole-window U-factors (including frames) are generally higher than glass-only U-factors
- Specify NFRC whole-window U-factor

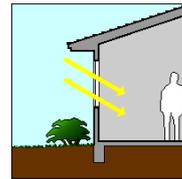


 National Fenestration Rating Council® CERTIFIED	World's Best Window Co. Millennium 2000+ Vinyl-Clad Wood Frame Double Glazing - Argon Fill - Low E Product Type: Vertical Slider	
	ENERGY PERFORMANCE RATINGS	
U-Factor (U.S./I-P)	Solar Heat Gain Coefficient	
0.35	0.32	
ADDITIONAL PERFORMANCE RATINGS		
Visible Transmittance	Air Leakage (U.S./I-P)	
0.51	0.2	
<small>Manufacturer stipulates that these ratings conform to applicable NFRC procedures for determining whole product performance. NFRC ratings are determined for a fixed set of environmental conditions and a specific product size. NFRC does not recommend any product and does not warrant the suitability of any product for any specific use. Consult manufacturer's literature for other product performance information. www.nfrc.org</small>		

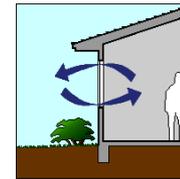
Other window energy ratings:



Solar heat gain coefficient



Visible transmittance

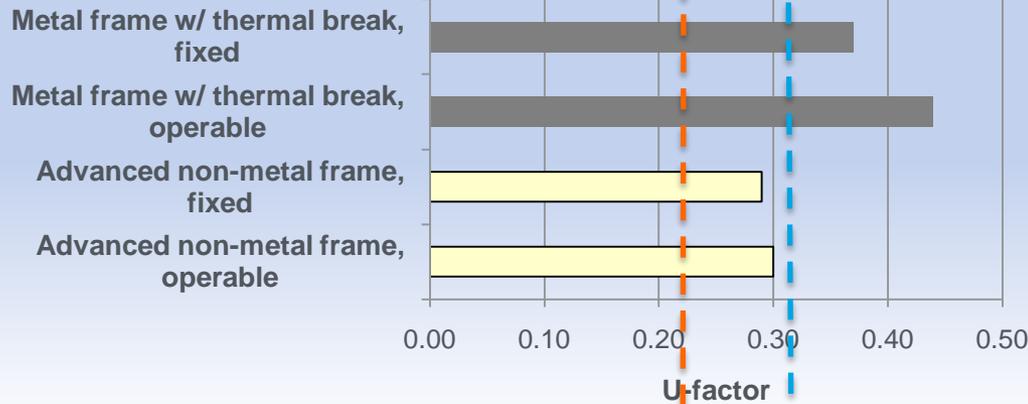


Air leakage

Window U-factors in Perspective

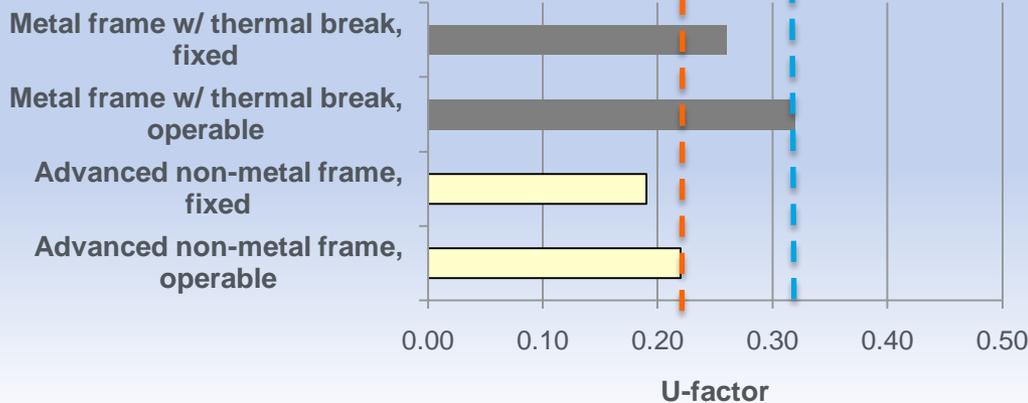
Representative U-factor with 2-pane Low-E Glass

Data from ASHRAE Handbook of Fundamentals



Representative U-factor with 3-pane Low-E Glass

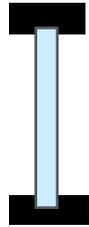
Data from ASHRAE Handbook of Fundamentals



DOE High-Performance Window U-factor Specs

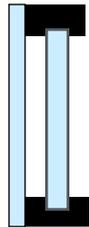
Structural Performance	Operable	Fixed
Residential & light commercial		
R or LC performance class	0.22	0.2
Commercial		
CW performance class	0.27	0.24
AW performance class	0.32	0.27

Estimated Home Energy Savings – Low-E Storm Windows



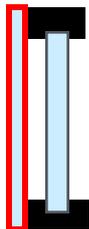
Single pane

U-factor: about 0.85



Single pane + storm window

U-factor: about 0.5

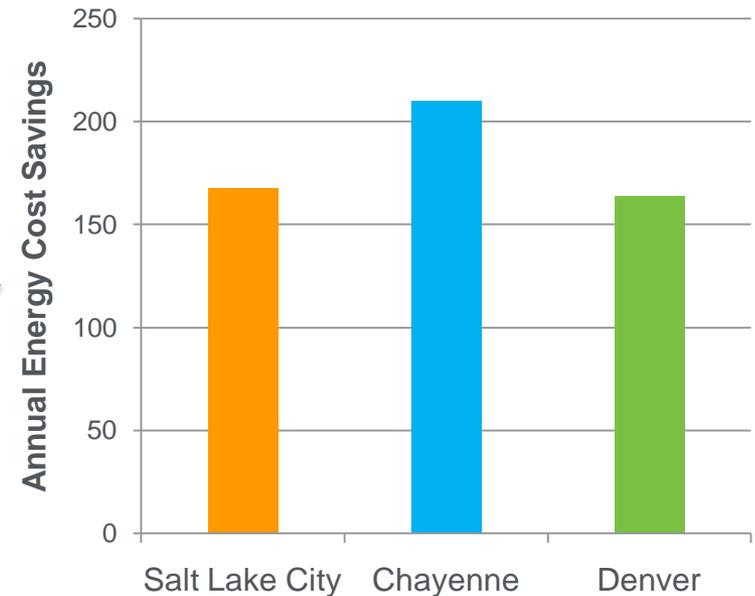


Single pane + low-E storm

U-factor: about 0.4



Annual Energy Cost Savings
Typical Existing Home, 2000 ft²



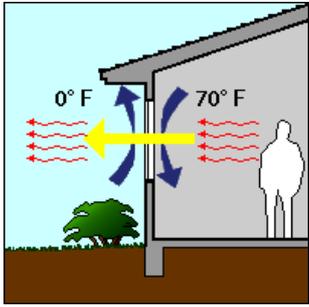
Energy cost savings estimator available for download at:
www.windowsvolumepurchase.org

Estimates based on regression equations by Lawrence Berkeley National Laboratory in 2008 derived from energy use simulations for representative single- and double-story homes in various U.S. locations. \$0.83-\$1.28/therm and \$0.07-\$0.10/kWh energy prices assumed (dependent on location).

Fact sheets about low-E storm windows, window film, awnings, insulating shades, etc.

- Info about performance
- Tips and cautions
- Authors: LBNL and Building Green

<http://www.windowattachments.org>

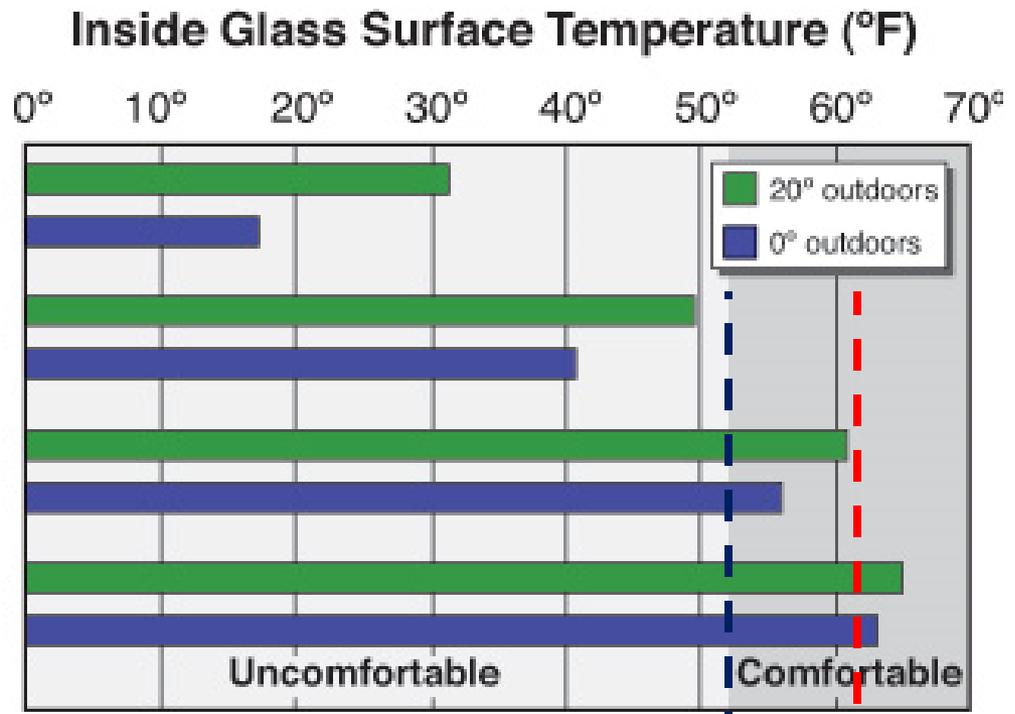


Single pane (U ~0.85)

Dual pane (U ~0.50)

Dual pane low-E, gas fill (U ~0.35)

Triple pane low-E, gas fill, insulated frame (U ~0.20)

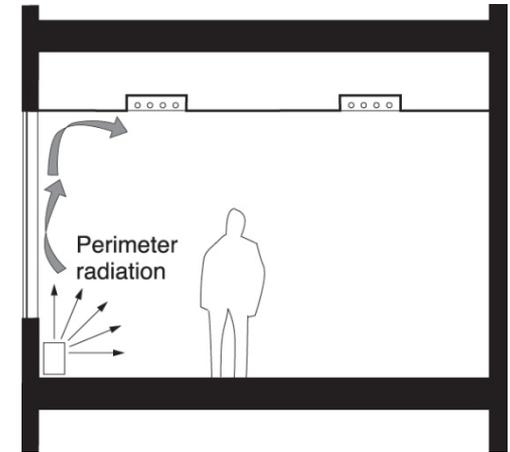


Guidance provided by the PassivHaus Standard and ISO 7730:

If window surface temperature is no more than 7-9°F below average room temperature, heating registers near windows are not needed.

with heat near windows
without heat near windows

- Cold window surfaces are a main cause of discomfort
- Conventional solution: perimeter heating near windows
- Perimeter heat may not be necessary with highly insulating windows



Case in Point: Cambria Office Facility, Ebensburg, PA

- Triple-pane windows, U-factor 0.24-0.26
- Incremental cost of windows compared to dual pane: \$15,000
- No need for perimeter heating = \$25,000 up-front cost savings
- At 20°F outside, interior window surface remains at 62°F

Source: Carmody et al. 2004. *Window Systems for High-Performance Buildings*

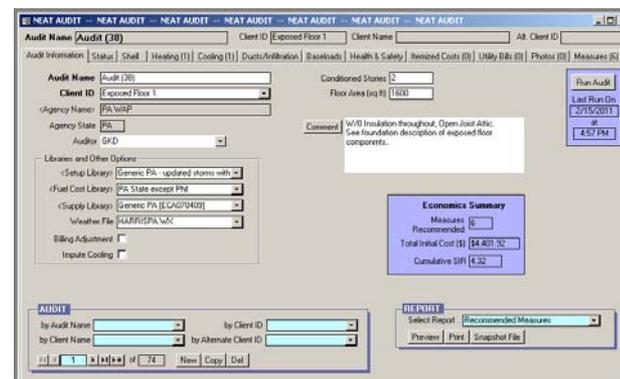
Wisdom Way Solar Village, Massachusetts

- \$7,000-\$10,000 incremental cost for high-performance envelope
 - including \$1,500 for U-factor 0.18 windows
- \$4,000-\$4,500 mechanical system cost savings
- Up to \$1,000 annual heating cost savings from envelope improvements and south-facing orientation



Source: Rural Development Inc.

- Pennsylvania's state weatherization program priority list now includes low-E storm windows and highly insulating windows
 - WVP qualified windows recommended whenever windows must already be replaced
 - Low-E storm windows recommended as a cost effective measure when used over single pane or metal framed clear double pane windows.
- Changes to the priority list were due directly to the availability of products through the WVP program and through analysis provided by Energetics
 - Similar analysis can be requested by any state or similar program by contacting the WVP team



Low-E Storm Windows

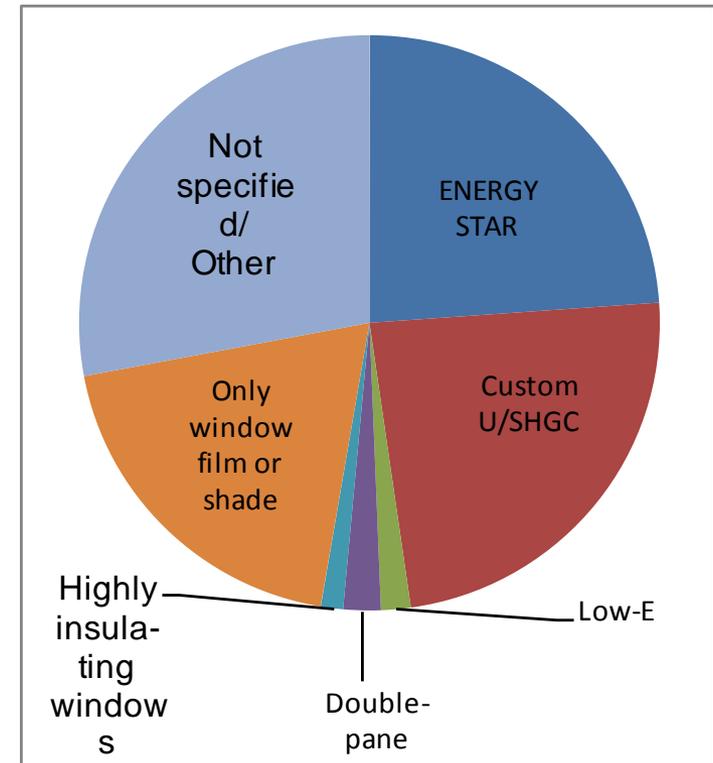
- Selected as qualified measure with standard investment ratio (SIR) values substantially higher than 1.
 - SIR values over single pane wood frame windows with a furnace at 80% efficiency: 1.4-2.2 (Average= 1.7)
 - SIR values over metal frame double pane windows with a furnace at 80% efficiency: 1.3-2.1 (Average= 1.6)

R-5 Windows

- “Necessary Replacement Scenario” SIR= 1.6-3.0 (Average= 2.3)
- Price point for high performance replacement: Installed Cost/ft² for SIR=1

City	Scranton	Harrisburg	Pittsburgh	Philadelphia
Single Pane Wood Frame	\$26.45	\$22.36	\$25.55	\$25.15
Metal Frame Double pane	\$25.45	\$21.50	\$24.55	\$24.35

- Over 200 individual programs that provide rebates or low-interest loans for windows, window films, sun screens and/or storm windows.
- Most programs incentivize ENERGY STAR or similar, or shading only



List of utility programs available at: <http://www.efficientwindows.org/utilities.cfm>

The Energy Trust of Oregon Aligns with WVP

- The Energy Trust of Oregon already provided incentives for ENERGYSTAR windows and needed a higher performance tier
- Current high performance tier aligns with the WVP program requirements, benefiting from increased product availability for incentive recipients
- **Applicable incentive**
 - Electric- and gas-heated homes: **\$3.50** per square foot of windows installed with **U-Value 0.22 or less**
 - No longer needs to be installed with second energy-saving improvement, though homeowners are encouraged to make further improvements



- A 2010 study completed by nationally recognized expert on green home design, Ann V. Edminster, reviewed popular energy improvement options, including R-5 windows
- "If I have \$15,000 to spend on my home to reduce energy use as much as possible, what gives the best bang for the buck?"
 - In the single-pane (R-1) window replacement scenario, the high R-value replacement windows were the top choice performance-wise with 38.4% energy savings improvement.
 - Compared to a whole house energy improvement package (12.4%) and installation of a PV solar system (12.1%)
 - Study results clearly indicate that high R-value replacement windows are competitive with other retrofit alternatives in various situations

"R-5 and above windows represent a game-changing entry into the residential replacement window market and into the broader realm of energy efficiency retrofit options. While in the past, window replacement was not typically viewed as offering a good return on investment from an energy perspective, it should now be considered routinely for home energy retrofit projects, with comfort improvements the icing on the cake."

--Ann V. Edminster
M. Arch., LEED AP+ Homes

A Builder's Perspective

- In our typical home, 18-25% of walls are comprised of glazing
- Potentially reduce size of AC unit by 50% when combined with the following:
 - Proper Orientation
 - Increased Air Tightness
 - Insulation



- Benefits of using high performance windows in your home:
 - Greater Insulation
 - Higher SHGC
 - Less Air Infiltration
 - Decreased UV Damage



The National Green Building Standard awards points in the prescriptive path for higher performing windows:

Table 703.3.1(a)

Enhanced Fenestration Specifications

Climate Zones	U-Factor	SHGC
	Windows and Exterior Doors (maximum certified ratings)	
1 and 2	0.45	0.30
3	0.35	0.30
4 to 8	0.30	Any
	Skylights and TDDs (maximum certified ratings)	
1 to 3	0.55	0.35
4 to 8	0.55	Any
Points		
Zones 1-3	8	
Zones 4-5	5	
Zones 6-8	6	

Table 703.3.1(b)

Enhanced Fenestration Specifications

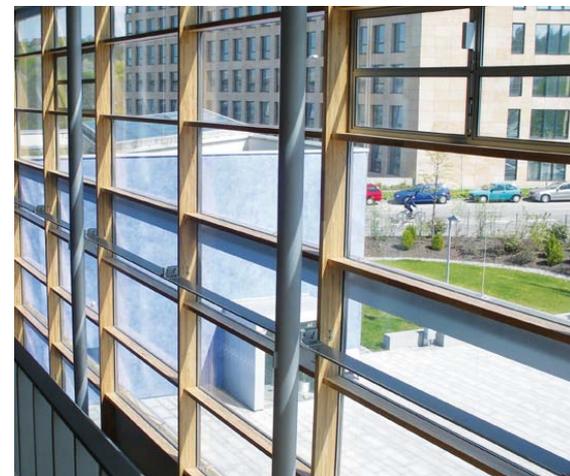
Climate Zones	U-Factor	SHGC
	Windows and Exterior Doors (maximum certified ratings)	
1 and 2	0.45	0.25
3	0.35	0.25
4 to 8	0.25	Any
	Skylights and TDDs (maximum certified ratings)	
1 to 3	0.50	0.35
4 to 8	0.50	Any
Points		
Zones 1-3	10	
Zones 4-5	10	
Zones 6-8	12	

Tables reprinted with permission from the National Association of Home Builders

What is the WVP Program?

What is the WVP Program?

- Market transformation program
 - Goal is to increase the availability of high performance products
- Website lists many manufacturers of high performance windows
 - Interested buyers can find products
 - Easier comparison of prices
 - Educate consumers about these products
- WVP staff does marketing, education and outreach about the products



Final Windows and Low-E Storm Windows Specifications and Certifications

High Performance Windows

- U-factor: (R,LC) **0.20/0.22**
(CW) **0.24/0.27** (AW) **0.27/0.32**
- Air leakage: **≤ 0.30 cfm/ft²**
- Condensation Resistance: **≥50**
- Certifications: **NFRC/NAFS**
- Warranty (yr): **20 glass/10 non-glass**
- NAFS 05: **Performance Grade R25**



Low-e Storm Windows

- Emissivity: **<0.22**
- Certifications: **ANSI/AAMA 1002.10-93**
- Registry: **IGDB (LBNL database)**
- Warranty (yr): **10 glass/non-glass**



www.windowsvolumepurchase.org

- Many homeowners are responding.
- Focus is now on contractors, builders, remodelers, institutions, and weatherization agencies.
- Sales through 10/2011:
 - ~8,000 windows
 - ~\$1.7M in sales

The screenshot shows the website's navigation bar with links for Home, Frequently Asked Questions, Complete Vendor Listing, and Utility Incentives. Below this is a search form titled "Search for Windows" with dropdown menus for Window Type, Construction Type, United Inches (UI) or Door Size, Structural Class, Performance Grade, and Shipping Region, followed by a "Submit Search" button. To the right, a "Welcome to the Windows Volume Purchase Products Website" message is displayed, along with an "About this Website" section. This section includes a paragraph about highly insulating windows, a "Purchasing Windows Products" heading, a list of seven steps for searching, and a final paragraph about vendor selection. On the far right, there are three small images: a modern glass skyscraper, a multi-story house with a red staircase, and a worker installing a window on a house.

Home Frequently Asked Questions Complete Vendor Listing Utility Incentives

Search for Windows

Window Type
--Any Window Type--

Construction Type
--Any Construction Type--

United Inches (UI) or Door Size
--Any Size--

Structural Class
--Any Class--

Performance Grade
--Any Grade--

Shipping Region
--Any Region--

Submit Search

Welcome to the Windows Volume Purchase Products Website

About this Website

Highly insulating windows and low-e storm windows may be identified from qualified vendors through this website. The windows products listed for sale have all met the specifications and requirements of the U.S. Department of Energy's High Performance Windows Volume Purchase Program and are available for new and retrofit construction in residential and commercial buildings.

Finding and buying highly insulating windows from a choice of multiple vendors is now easier than ever using this website.

Purchasing Windows Products

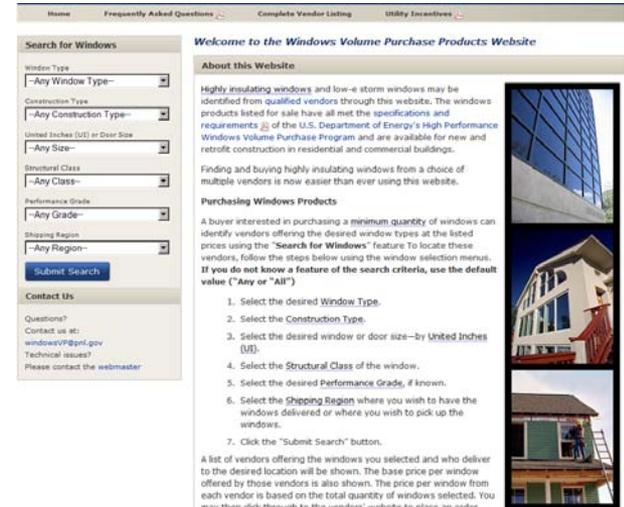
A buyer interested in purchasing a minimum quantity of windows can identify vendors offering the desired window types at the listed prices using the "Search for Windows" feature. To locate these vendors, follow the steps below using the window selection menus. **If you do not know a feature of the search criteria, use the default value ("Any" or "All")**

1. Select the desired Window Type.
2. Select the Construction Type.
3. Select the desired window or door size—by United Inches (UI).
4. Select the Structural Class of the window.
5. Select the desired Performance Grade, if known.
6. Select the Shipping Region where you wish to have the windows delivered or where you wish to pick up the windows.
7. Click the "Submit Search" button.

A list of vendors offering the windows you selected and who deliver to the desired location will be shown. The base price per window offered by those vendors is also shown. The price per window from each vendor is based on the total quantity of windows selected. You may then click through to the vendors' website to place an order.

WVP Website:

- Database format allows for filtering by desired criteria
 - Window type and size
 - Structural performance class and grade
 - Shipping Region
- Discrete manufacturers' prices shown for each product



Vendor	CT	SC	WC	UI	SG	Price	Shipping
PhyGem	New	Residential	Double Hung	51-60	40	\$209	AL , AK , AZ , ...
Bonded Insulated Products	New	Residential	Double Hung	< 50	35	\$406	CT , DE , FL , ...
GIBEX	All	Residential	Double Hung	120 +	70	\$4/UI	AL , AZ , CA , ...
B.F. Bush	All	Residential	Double Hung	< 50	45	\$578	CA , DC , GA , ...
National Vinyl	New	Residential	Double Hung	111-120	35	\$387	CT , ME , MA , ...
PhyGem	New	Residential	Double Hung	< 50	40	\$209	AL , AK , AZ , ...
Soft-Lite	Retrofit	Residential	Double Hung	91-100	50	\$689	AL , CA , CO , CT , ...
Jorald	Retrofit	Residential	Double Hung	< 50	30	\$557	AL , AZ , CA , ...
Jactek	New	Light Commercial	Double Hung	< 50	30	\$184	DE , NJ , NY
Season and Keller	All	Residential	Double Hung	120 +	45	\$4/UI	CA , DC , ME , ...
B.F. Bush	All	Residential	Double Hung	91-100	45	\$578	CA , DC , GA , ...
PhyGem	New	Residential	Double Hung	120 +	35	\$2/UI	AL , AZ , CA , ...
National Vinyl	Retrofit	Residential	Double Hung	71-80	35	\$267	CA , ME , MA , ...
National Vinyl	Retrofit	Residential	Double Hung	101-110	35	\$332	CA , ME , MA , ...
Jeld-Win	New	Residential	Double Hung	51-60	25	\$325	AL , AK , AZ , ...
Soft-Lite	Retrofit	Residential	Double Hung	71-80	35	\$689	AL , CA , CO , CT , ...
Soft-Lite	Retrofit	Residential	Double Hung	101-110	35	\$554	AL , CA , CO , CT , ...
Soft-Lite	Retrofit	Residential	Double Hung	120 +	55	\$13/UI	AL , CA , CO , CT , ...

- In 15 months, the program sold **over 5,000 windows** and achieved **~\$1.6 million in sales**
- Over 40 Phase I participants
- Over 30 Round II participants

“We are glad to have been part of the R-5 Windows Volume Purchase program since its inception in 2010. The program has challenged B.F. Rich and our vendors to look at the development of new technologiesat an affordable cost to the consumer We have grown our R-5 program at B.F. Rich in both triple and double glazed windows....”

*--George Simmons
President and CEO, B.F. Rich Windows & Doors*

“The value of the DOE High Performance WVPP has been in setting the table for future sales during a down market. My belief is that manufacturers such as JELD-WEN have seen only small incremental sales increases attributable to the launch of the program. However, heightened awareness of high performance windows during a lean time when industry design and construction professionals are slow will serve to grow sales once the market picks up....”

*--Rob Worthington
Market Development Director, JELD-WEN*

<http://www1.eere.energy.gov/buildings/windowsvolumepurchase/>

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