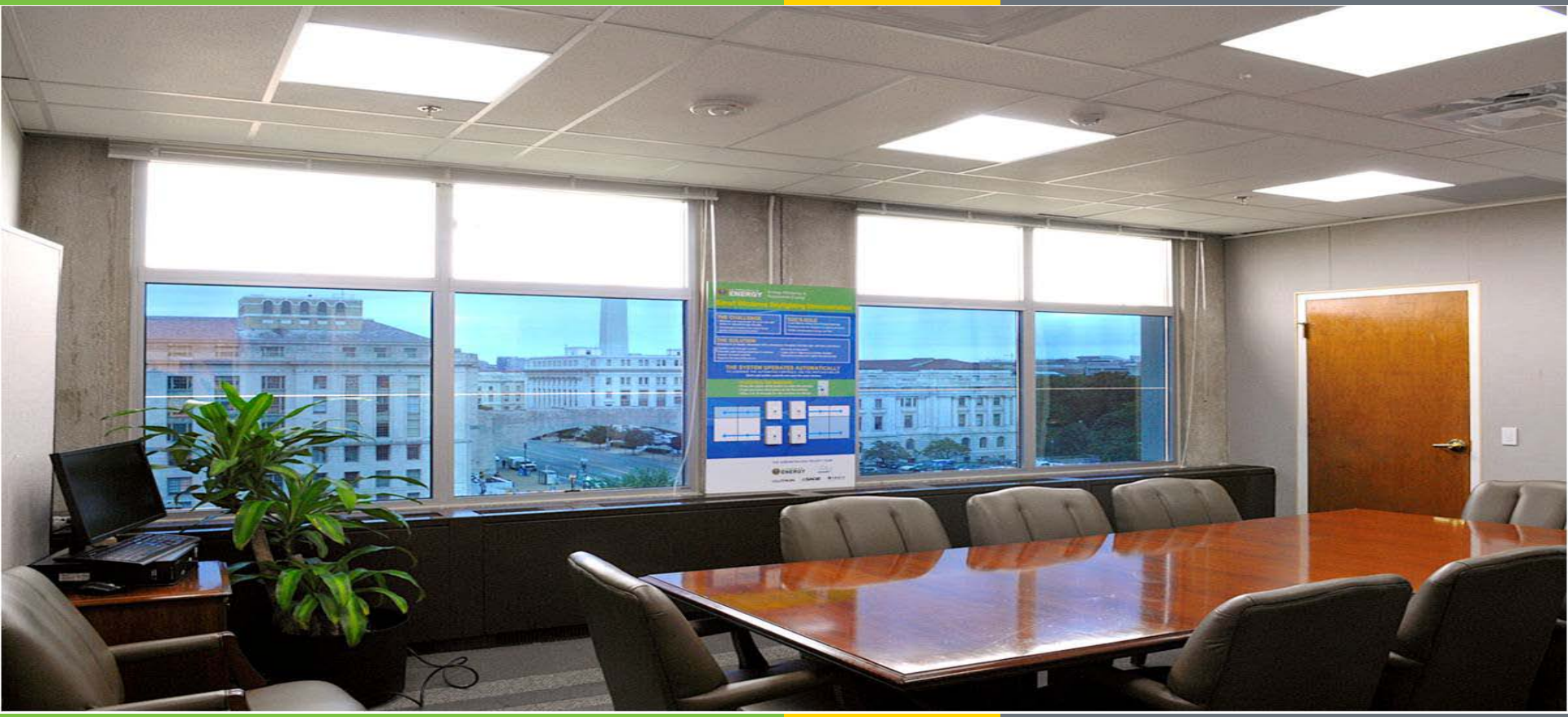
Building Technologies Program

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy



Window and Envelope Solutions for Today and Tomorrow

Colorado Regional Workshop
NREL, Golden, CO
October 4, 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

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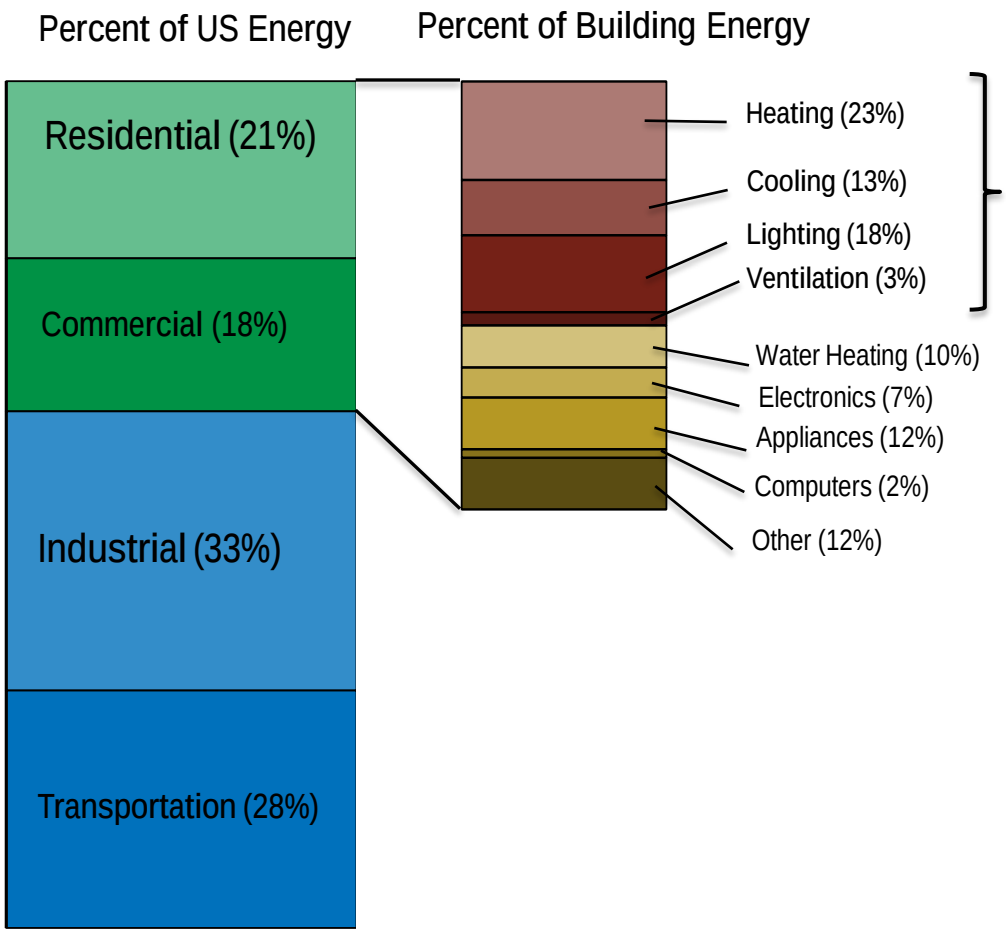
Why worry about windows?

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

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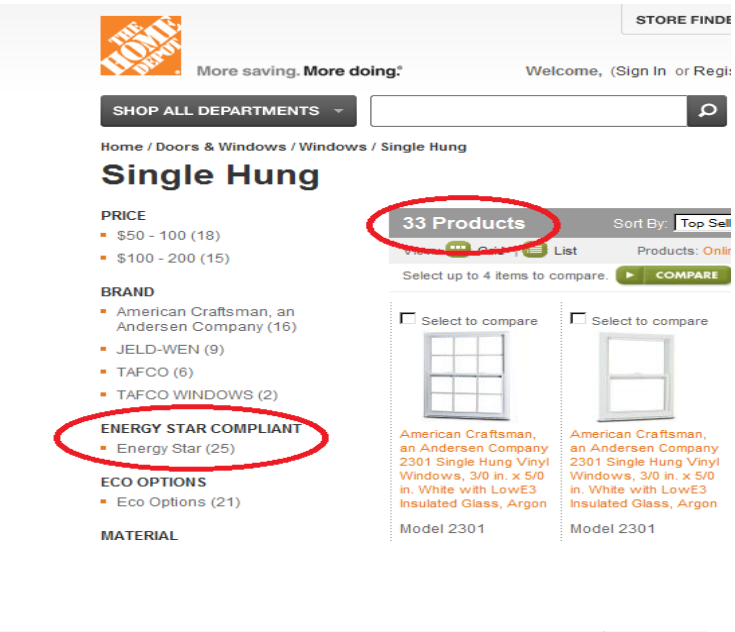
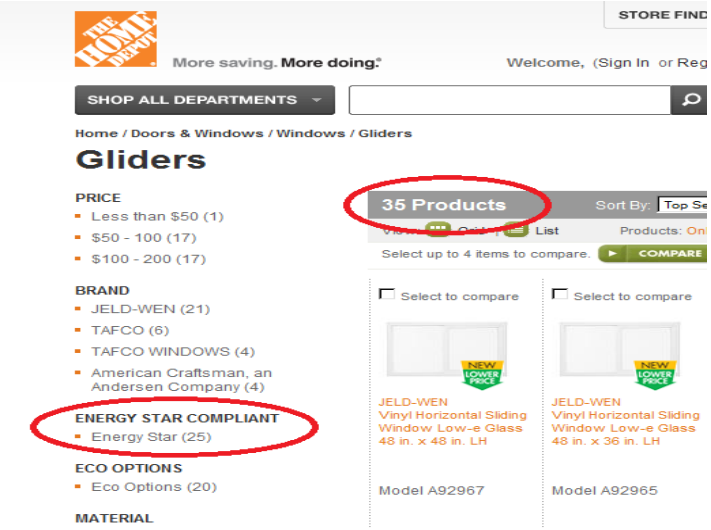


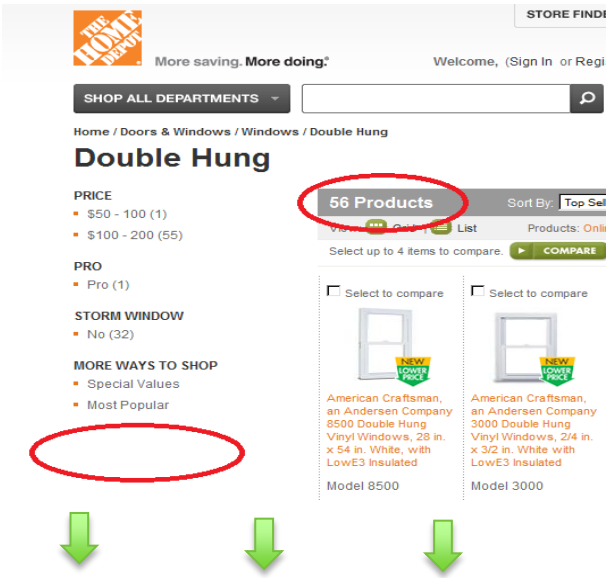


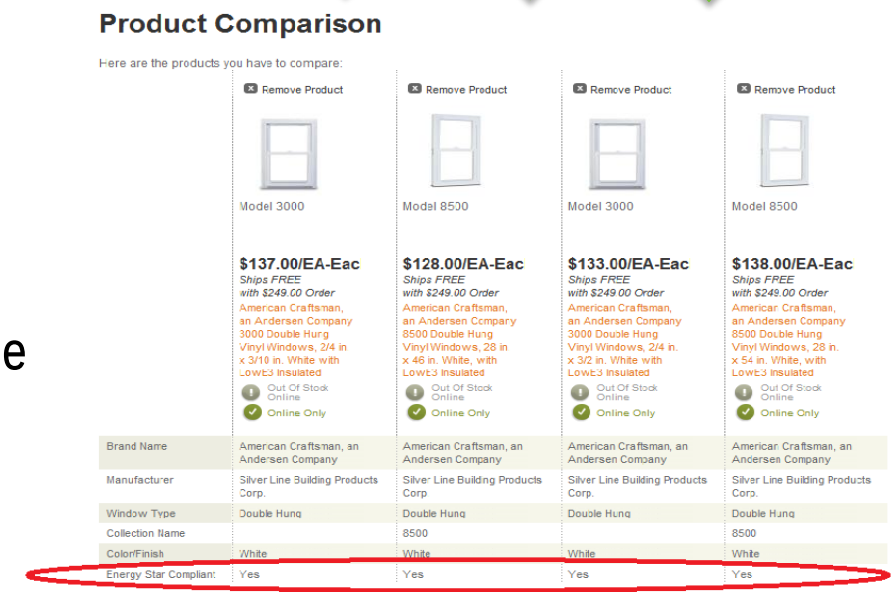
Home Depot

Three largest window categories

Over 85% Energy Star compliant

R3 is now becoming the BASELINE





Total Building Envelope and Window R&D Budget

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

	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 ARRA 25M
FY 11	10.5M Windows 8.5M Envelope	TBD – Not expected to exceed FY10 Continuing Resolution
FY 12	**25 M (9M BIPV)**	TBD

Integrated Programs to Reduce Price of Highly Insulating Windows

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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

2007 | 2008 | 2009 | 2010 | 2011 | 2012

DOE Goals for Windows Programs

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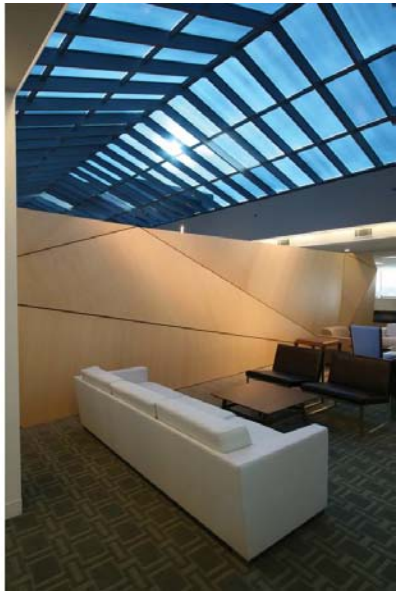
- Highly Insulating Windows
  - Goal is U-factor 0.10
  - Evaluate vacuum glazing
  - Advance dynamic glazing
- Market-Based Approach
  - Alternative to codes and standards
  - Technology specifications & procurement
  - Demonstrations



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

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DOE Assists with Technical Support Activities

http://windows.lbl.gov/software

www.nfrc.org

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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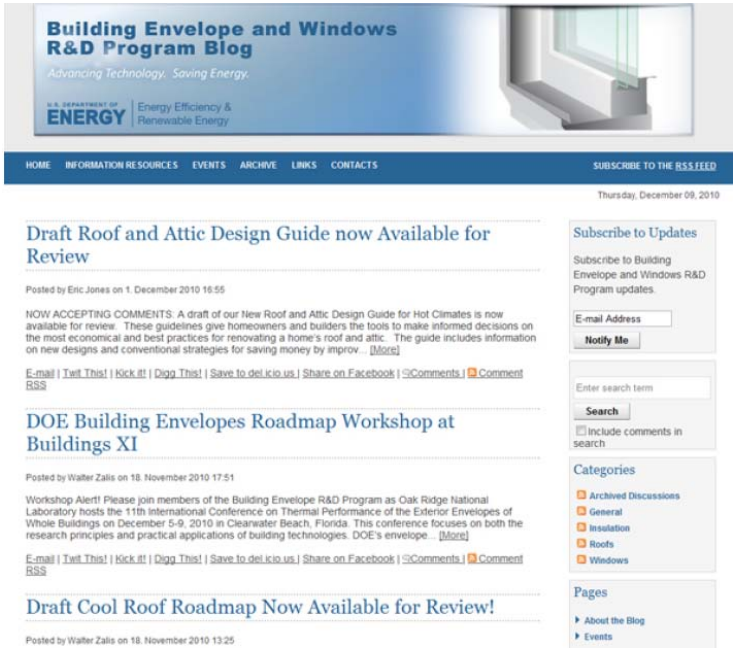
1-202-586-9142

Fax 1-202-586-4617

www.eere.doe.gov

www.eereblogs.energy.gov/buildingenvelope



Energy efficiency and the WVP Program products

Highly Insulating Windows

Low-E Storm Windows

How do we know how a window performs?

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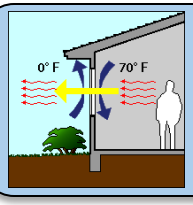
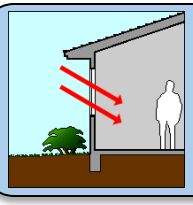
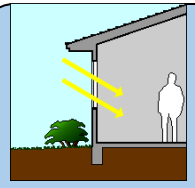
ENERGY STAR
Voluntary program with performance targets appropriate for each climate.



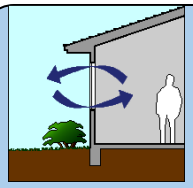
U-factor
Measures of insulating value
Lower = less heat loss



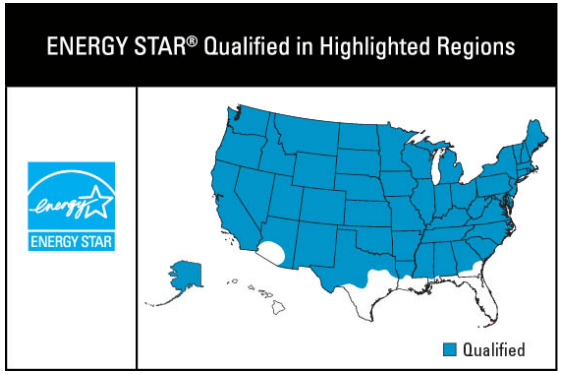
Solar Heat Gain Coefficient (SHGC)
Fraction of solar energy entering the window
Higher = more solar heat gain



Visible Transmittance (VT)
Fraction of visible light entering the window
Higher = more daylight



Air Leakage (AL)
Volume of air infiltration
Lower = less infiltration



National Fenestration Rating Council (NFRC) label

Components of Efficient Windows

Ball-park impact on window properties

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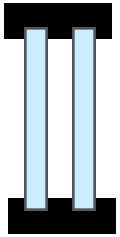
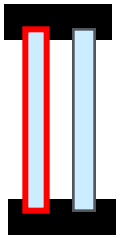


Conventional dual pane

U-factor: about 0.5

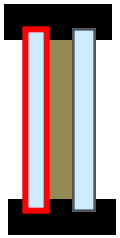
SHGC: about 0.55



Dual pane low-E

U-factor: about 0.35

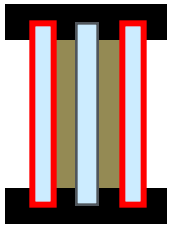
SHGC: 0.2-0.5 depending on low-E



Dual pane low-E w/ argon

U-factor: about 0.3

SHGC: same as w/o argon



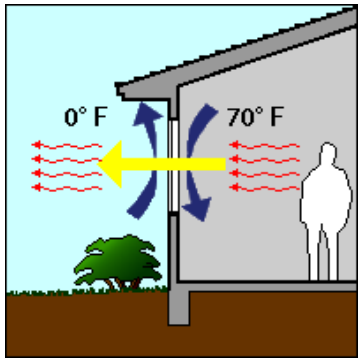
Triple pane 2x low-E w/ argon or krypton

U-factor: about 0.2

SHGC: 0.15-0.4 depending on low-E

Focus on U-factor

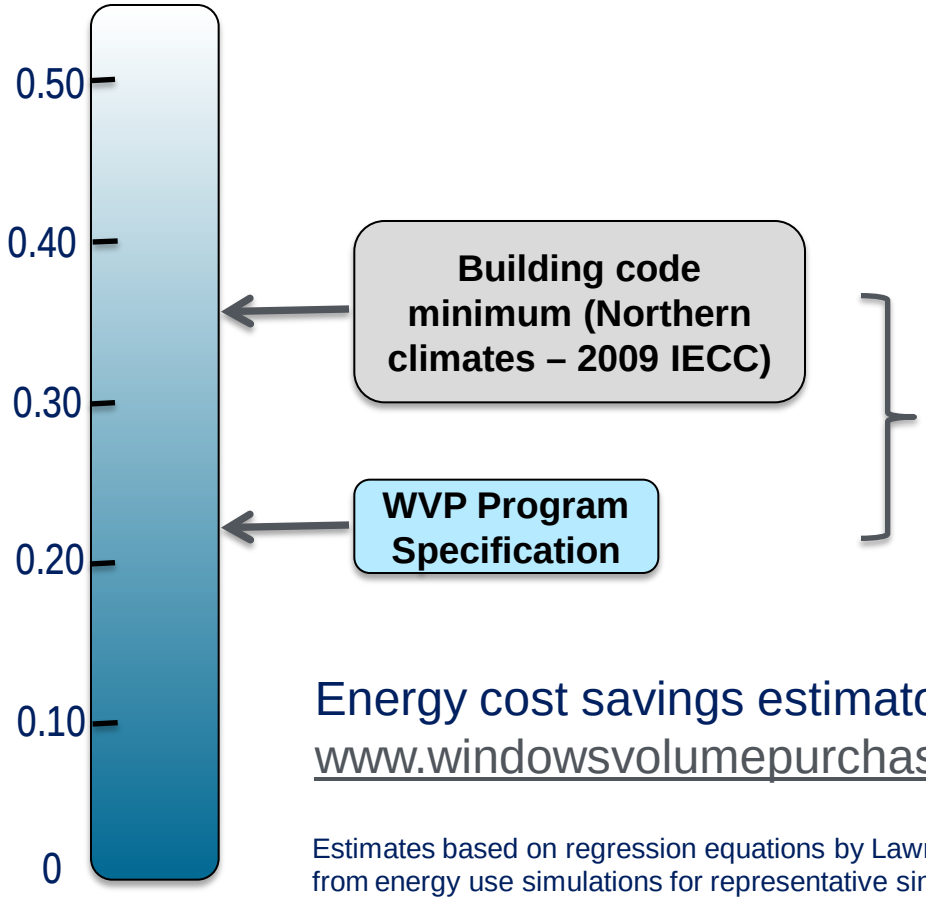
- U-factor units: Btu/hr-ft^2-F
- Whole-window U-factors are generally higher than glass-only U-factors (frames and spacers more conductive than efficient glazing)
- Specify NFRC whole-window U-factor
- For general reference: R-value is inverse of U-factor
  - e.g. if U = 0.2, then R = 1/0.2 = 5
  - But: test conditions differ between windows and walls, so no direct equivalence to wall R-value

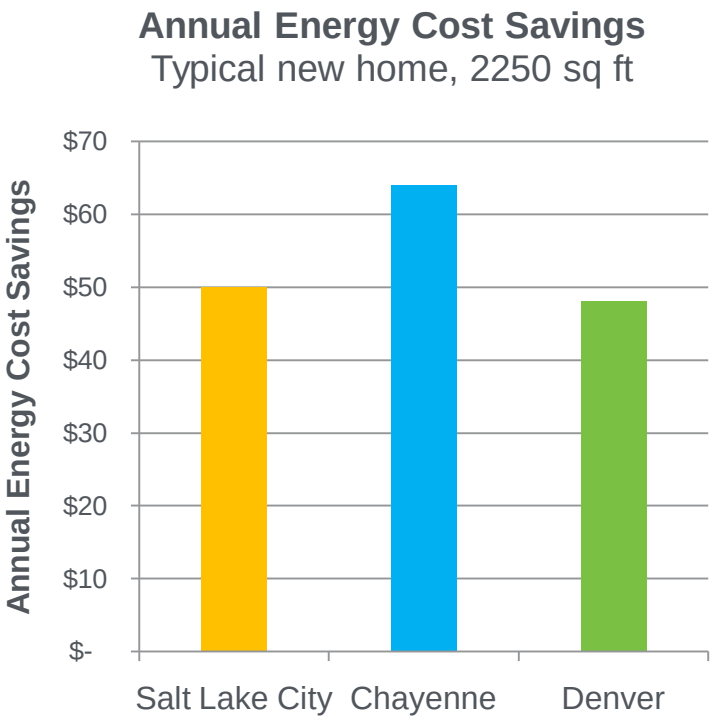


Estimated Energy Savings – High Performance Windows

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

Savings depend on climate, building type and energy prices



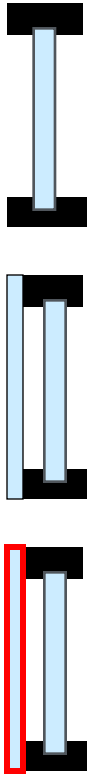


Energy cost savings estimator available for download at:
www.windowsvolumepurchase.org

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).

Estimated Energy Savings – Low-E Storm Windows

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy



Single pane

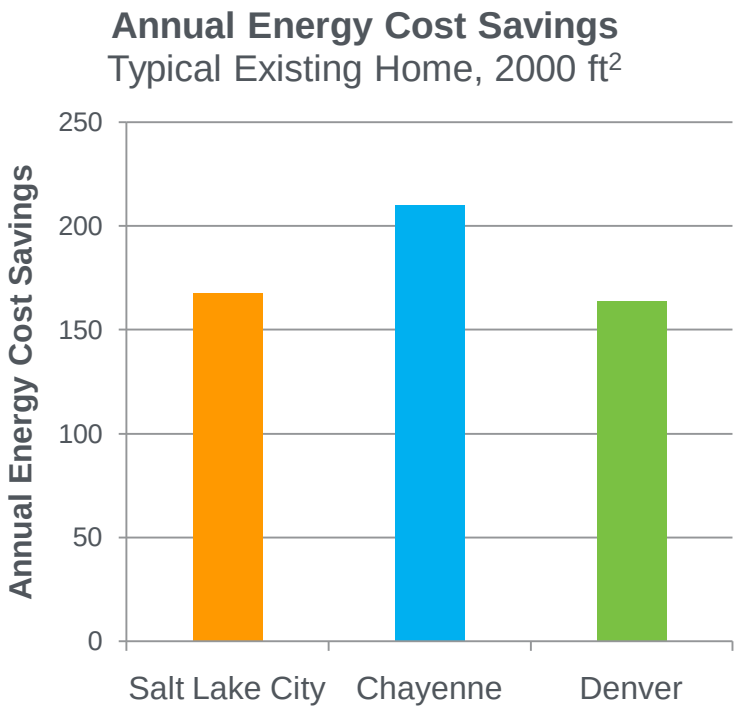
U-factor: about 0.85

Single pane + storm window

U-factor: about 0.5

Single pane + low-E storm

U-factor: about 0.4



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More Low-E Storm Windows Info

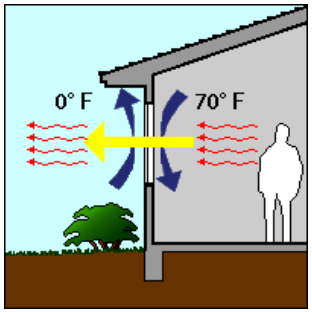
U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

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

U-factor and Winter Comfort

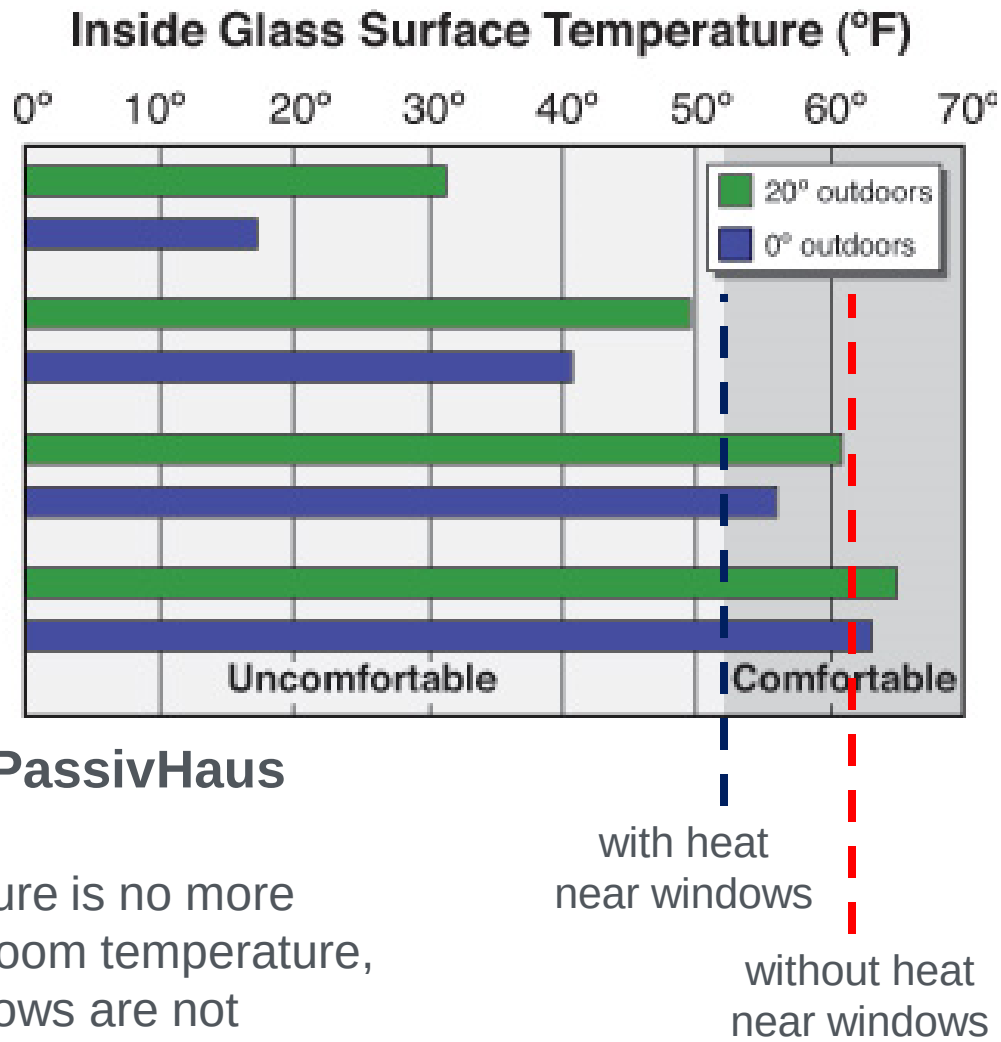


Single pane (U ~0.85)

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 5-9°F below average room temperature, heating registers near windows are not needed.

Example of a Compact Heating System

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

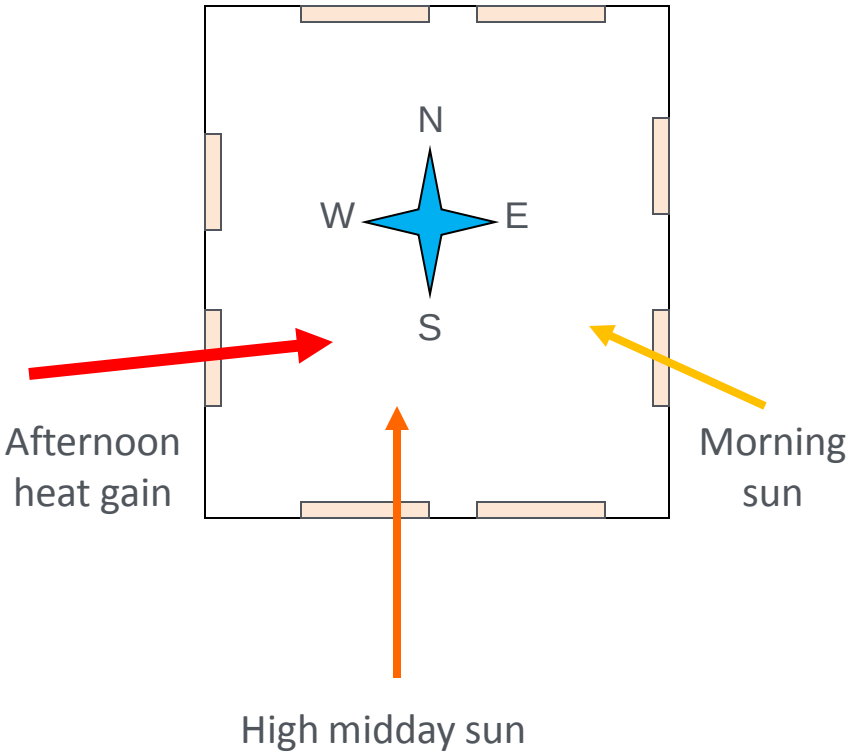
Wisdom Way Solar Village, Massachusetts

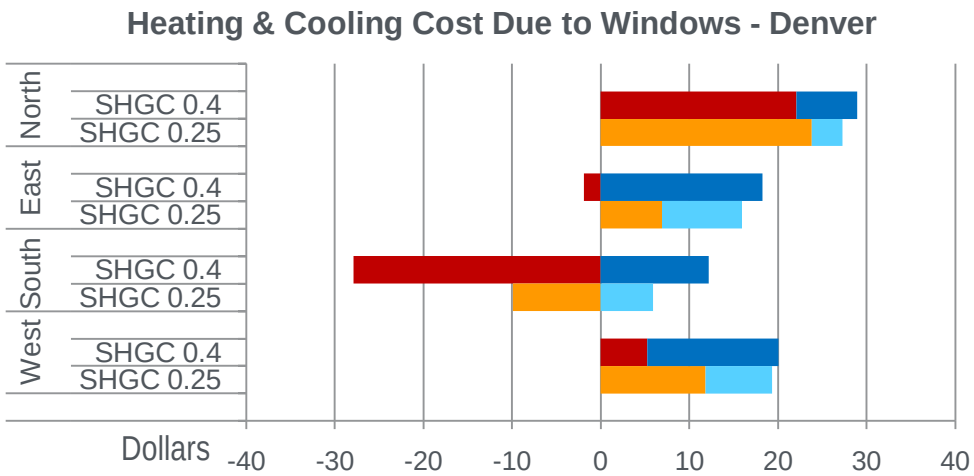
- $7,000 incremental cost for high-performance envelop
  - including $1,500 for U-factor 0.18 windows
- $4,500 mechanical system cost savings
- Up to $1,000 annual heating cost savings from envelope improvements and south-facing orientation

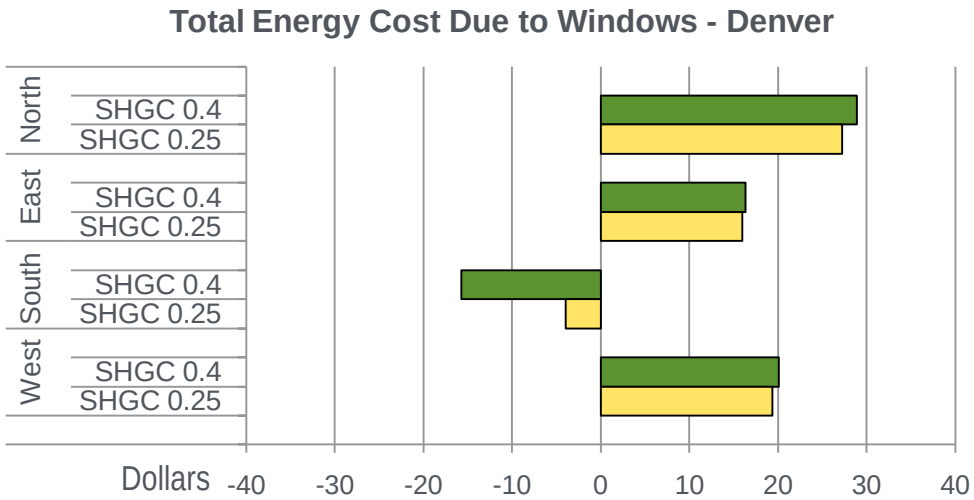
Source: Rural Development Inc.

Solar Heat Gain: Impact by Orientation

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy







Simulated with RESFEN by Lawrence Berkeley National Laboratory. Costs are for 90 sq ft of windows on each side. $0.83/therm of natural gas for heating, $0.10/kWh for cooling.

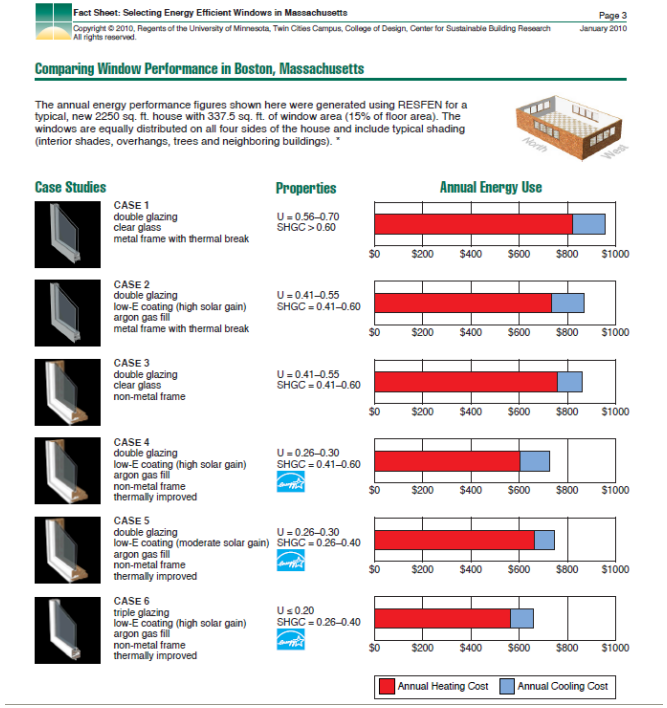
More Information

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

- Fact sheets and Window Selection Tool with pre-run simulations assuming typical houses: www.efficientwindows.org

- RESFEN by Lawrence Berkeley National Laboratory
  – free window energy simulation tool: www.efficientwindows.org/resfen.cfm

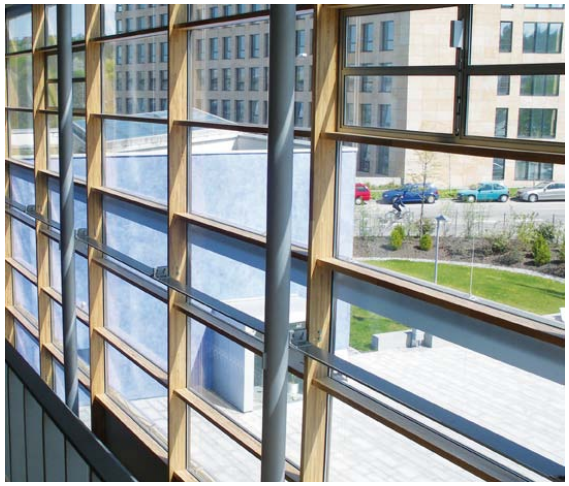
- Contact us at ewc@ase.org



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



Windows Volume Purchase Timelines

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

Phase I

Educate Buyer Groups
March 2009 – continuing

↓

Develop Draft Specifications with Buyers and Industry
July – Nov 2009

↓

Issue Solicitation – Dec 2009
Response Deadline – Feb 2010

↓

Finalize Agreements with Qualified Vendors April – 2010

↓

Promote Qualified Products
May 2010 – May 2011

Phase II

Develop new Specifications with Industry
Sept – Dec 2010

↓

Issue Solicitation – Jan 2011

↓

1st Responses Due – Mar 2011
Final Responses Due – Sept 2011

↓

Finalize Agreements with Qualified Vendors April – 2011

↓

Promote Qualified Products
May 2011

Phase II Status

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

To date, we have more than 30 bids in Phase II and are processing these bids.

35 bids
-3 with storm windows

-several with commercial grade windows

Agreement
Validated URL

Certified Vendors

Data base with products

Launch Phase II Web Site
May 3, 2011

- ❑September 18: Deadline for entry into Phase II.
- ❑May 2012: Tentative end of Phase II

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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/ft^2
- Condensation Resistance: ≥50
- Certifications: NFRC/NAFS
- Warranty (yr): 20 glass/10 non-glass
- NAFS 05: Performance Grade R25

Low-e Storm Windows

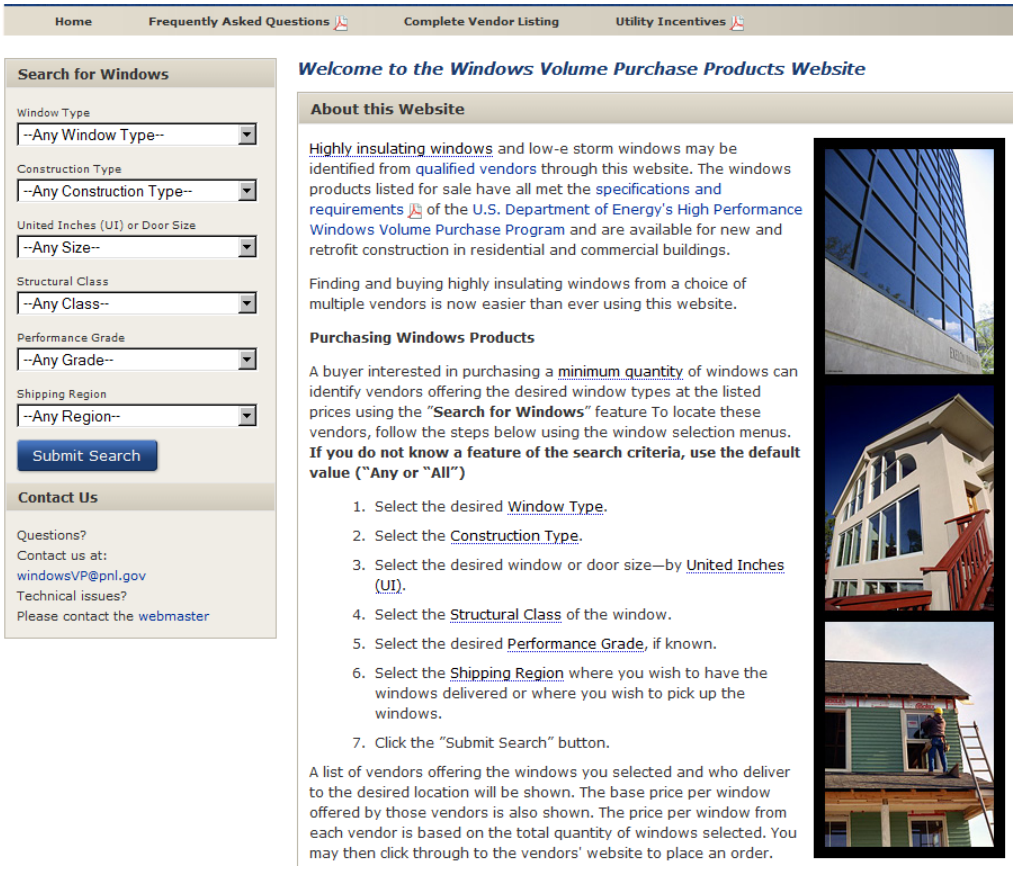
- Emissivity: <0.22
- Certifications: ANSI/AAMA 1002.10-93
- Registry: IGDB (LBNL database)
- Warranty (yr): 10 glass/non-glass

Windows Products Website

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

www.windowsvolumepurchase.org

- Many homeowners are responding.
- Focus is now on contractors, builders, remodelers, institutions, and weatherization agencies.
- Sales through 08/11:
  - ~5,000 windows
  - ~$1.6M in sales
- Phase II products: May 3, 2011

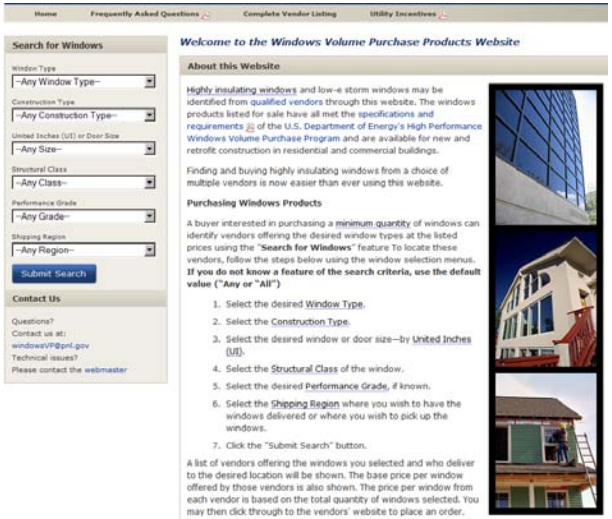


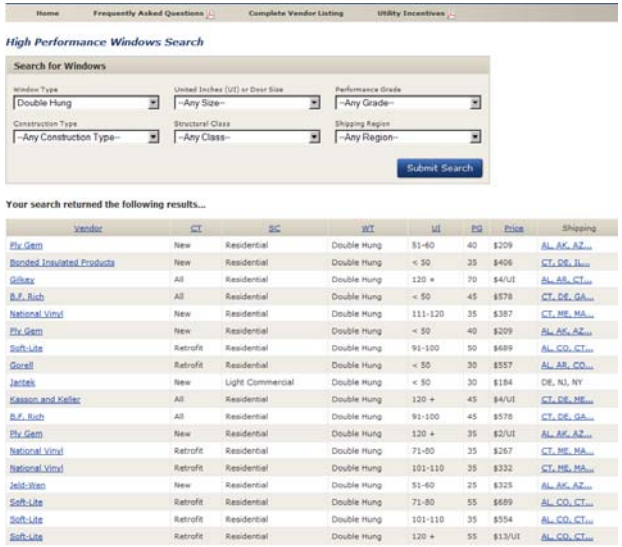
Phase II

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

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
- More complete data available for each product
- Descriptor boxes for each vendor (coming soon)
- Shipping regions more specific



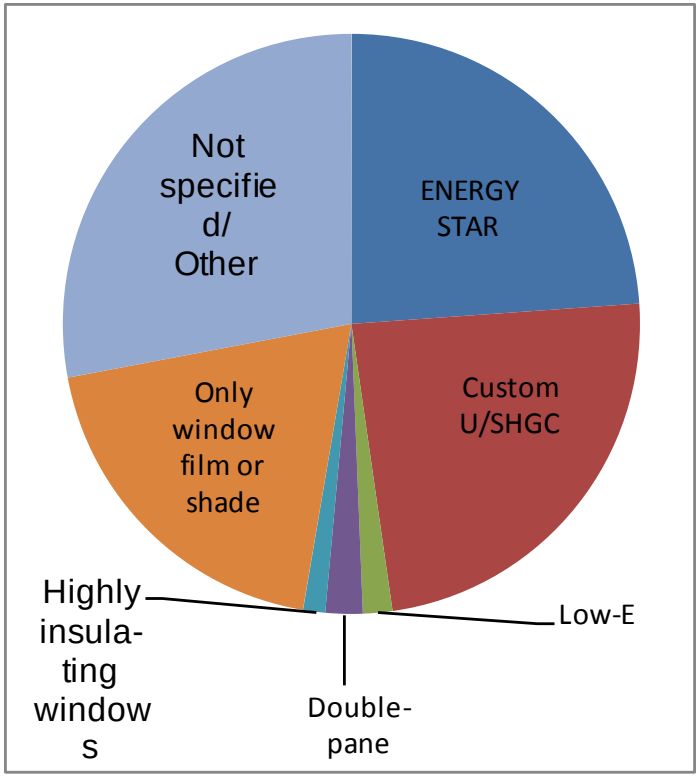


Vendor	CT	SC	WT	UI	PG	Price	Shipping
Ply Gem	New	Residential	Double Hung	51-60	40	$209	AL, AK, AZ...
Bonded Insulated Products	New	Residential	Double Hung	< 50	35	$406	CT, DE, IL...
Gilkey	All	Residential	Double Hung	120 +	70	$4/UI	AL, AR, CT...
R.F. Rich	All	Residential	Double Hung	< 50	45	$578	CT, DE, GA...
National Vinyl	New	Residential	Double Hung	111-120	35	$387	CT, ME, MA...
Ply Gem	New	Residential	Double Hung	< 50	40	$209	AL, AK, AZ...
Soft-Lite	Retrofit	Residential	Double Hung	91-100	50	$689	AL, CO, CT...
Gorell	Retrofit	Residential	Double Hung	< 50	30	$557	AL, AR, CO...
Jantek	New	Light Commercial	Double Hung	< 50	30	$184	DE, NJ, NY
Kasson and Keller	All	Residential	Double Hung	120 +	45	$4/UI	CT, DE, ME...
R.F. Rich	All	Residential	Double Hung	91-100	45	$578	CT, DE, GA...
Ply Gem	New	Residential	Double Hung	120 +	35	$2/UI	AL, AK, AZ...
National Vinyl	Retrofit	Residential	Double Hung	71-80	35	$267	CT, ME, MA...
National Vinyl	Retrofit	Residential	Double Hung	101-110	35	$332	CT, ME, MA...
Jeld-Wen	New	Residential	Double Hung	51-60	25	$325	AL, AK, AZ...
Soft-Lite	Retrofit	Residential	Double Hung	71-80	55	$689	AL, CO, CT...
Soft-Lite	Retrofit	Residential	Double Hung	101-110	35	$554	AL, CO, CT...
Soft-Lite	Retrofit	Residential	Double Hung	120 +	55	$13/UI	AL, CO, CT...

Current Windows Incentive Programs

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

- 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

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WVP Program Impacts and Achievements

Walt Zalis, Energetics Incorporated

Program Results and Feedback

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

- 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 technologies …..at 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

Media Coverage and Support

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

- WVP program has appeared in **85 articles** in top media and building industry publications **in less than 2.5 years**
  - **New York Times:** “DOE Aims to Make 'Low E' Windows a Must-Have for Home Construction,” June 2010
  - **Chicago Tribune:** “Government raising bar on windows,” January 2010
  - **Window and Door:** “Phase II Begins for DOE Volume Purchase Program,” May 2011
  - **Door and Window Manufacturer:** “Are you ready for Phase II?,” May 2011
- Window and Door magazine conducted a poll in September 2011 asking, **“Is Your Company Still Promoting R-5 Products”**
  - **Over 50% respond, “Yes, and it still works well for us”**
    - Only 5% respond, “We did, but we have stopped”
  - The author states “I know a lot of manufacturers liked the simplicity of DOE's R-5 rating. It was something they could hang their hat on in their marketing.”
- Obtained 23 letters of support from builders, weatherization agencies, non-profits and others

Building Science Corporation (BSC) working with DOE's Building America

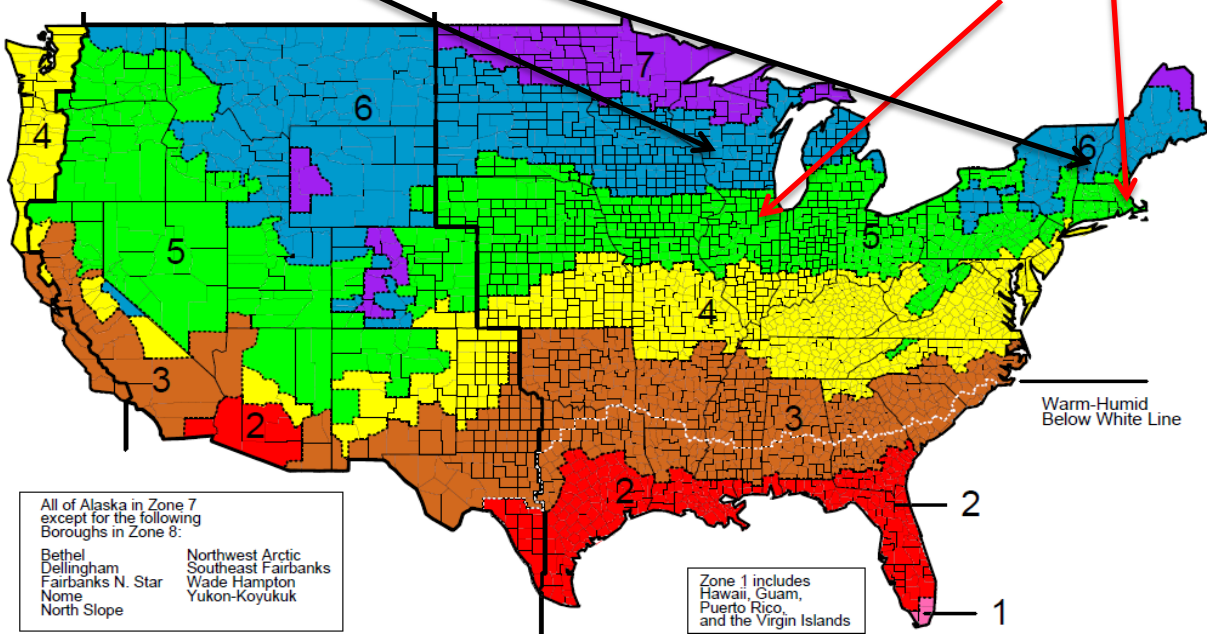
U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

BSC developed recommendations for window performance in Northern climates that are closely aligned with WVP requirements

Based on Building America program experience – recommendations for homes with low energy needs that can be met by renewable energy sources

U-factor for Climate Zone 6 (Minneapolis, Vermont) = 0.18

U-factor for Climate Zone 5 (Chicago, Boston) = 0.24



WVP Window = 0.22 U-factor

The Building Science Corporation Report: Building America Special Research Project: High R-Value Enclosures for High Performance Residential Buildings in All Climate Zones

< *http://www.buildingscience.com/documents/reports/rr-1005-building-america-high-r-value-high-performance-residential-buildings-all-climate-zones*>

The Energy Trust of Oregon Aligns with WVP

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- 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

EnergyTrust of Oregon

Increased Visibility of R-5 Windows

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

- 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

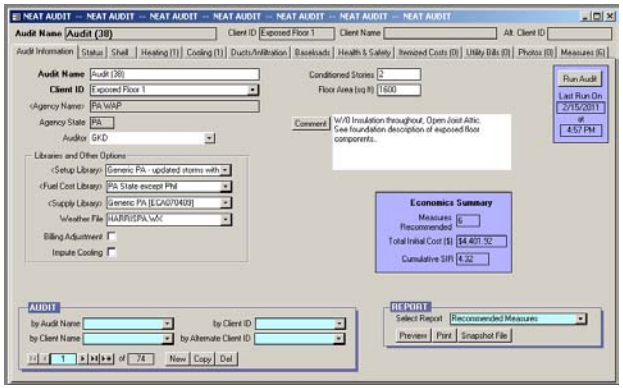
"R-5 and above windows represent a game-changing entry into the residential replacement window market and into the broader realm of energy efficiency retrofit options. While in the past, window replacement was not typically viewed as offering a good return on investment from an energy perspective, it 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

WVP Supports PA State Weatherization

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

- 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

WVP Supports PA State Weatherization

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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/ft^2 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

Educational Workshops and Conferences

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

- Coordinated 7 regional workshops across the country
  - Chicago, IL (September 2010)
  - Portland, OR (October 2010)
  - Philadelphia, PA (October 2010)
  - Columbus, OH (April 2011)
  - Clearfield, UT (May 2011)
  - Bozeman, MT (July 2011)
  - Golden, CO (October 2011)
- Facilitated 10 webinars with trade associations and non-profits
- Presented at 28 conferences and meetings

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