Building Technologies Program

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

Window and Envelope Solutions for Today and Tomorrow

Goals of this presentation

- 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
- Show you how you can participate in the program and find these products

DOE and Windows

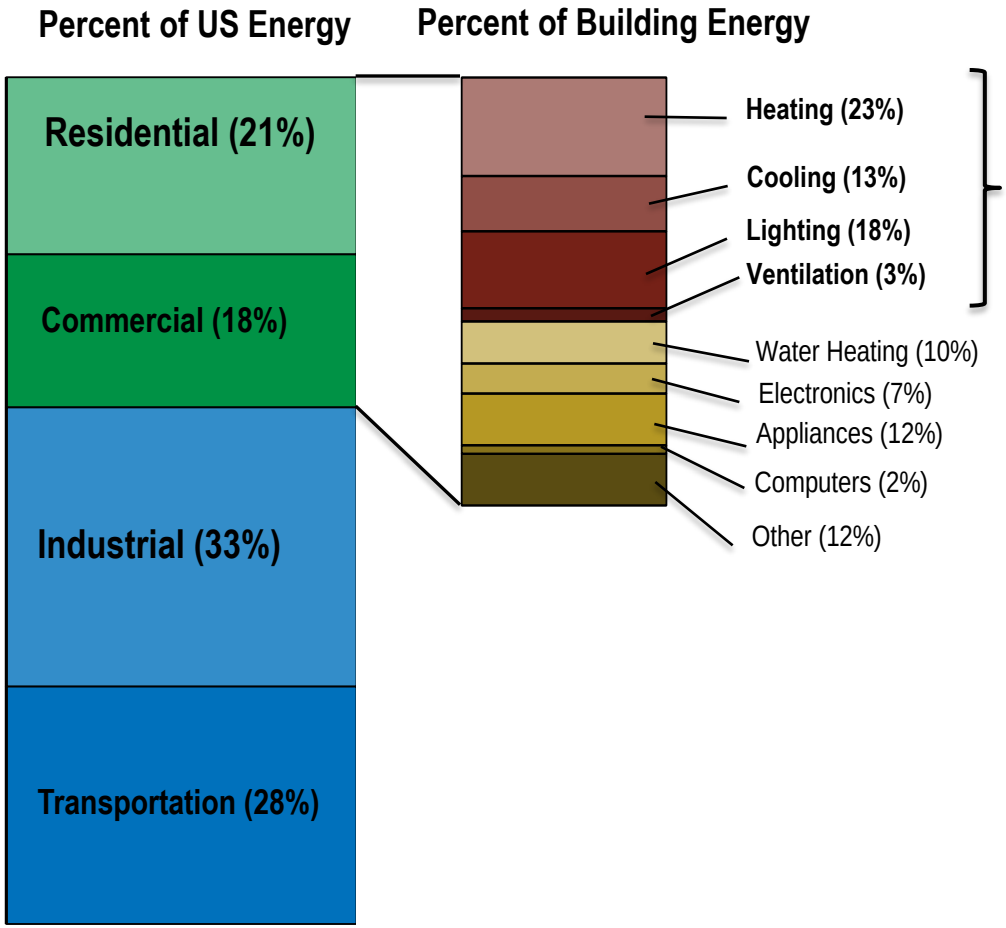
How the WVP program fits into the big picture

Marc LaFrance
US DOE

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

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.

Total Building Envelope and Window R&D Budget

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	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

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

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

The WVP Team

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Who's involved in the WVP Program?

- Pacific Northwest National Laboratory (Program administrator)
  - Graham Parker
  - Terry Mapes
- Lawrence Berkeley National Laboratory (Technical support)
  - Christian Kohler
- Alliance to Save Energy - Efficient Windows Collaborative (Window education and general support)
  - Nils Petermann
  - Neal Humphrey
- Energetics Incorporated (Outreach and marketing)
  - Jason Bogovich
  - Walt Zalis

Contact Information

P Marc LaFrance, CEM
Technology Development Manager
Building Technologies Program
Office of Energy Efficiency and Renewable Energy
US Department of Energy
marc.lafrance@ee.doe.gov
1-202-586-9142
Fax 1-202-586-4617
www.eere.doe.gov

www.eereblogs.energy.gov/buildingenvelope

What is the WVP Program?

Today's Residential Windows Market

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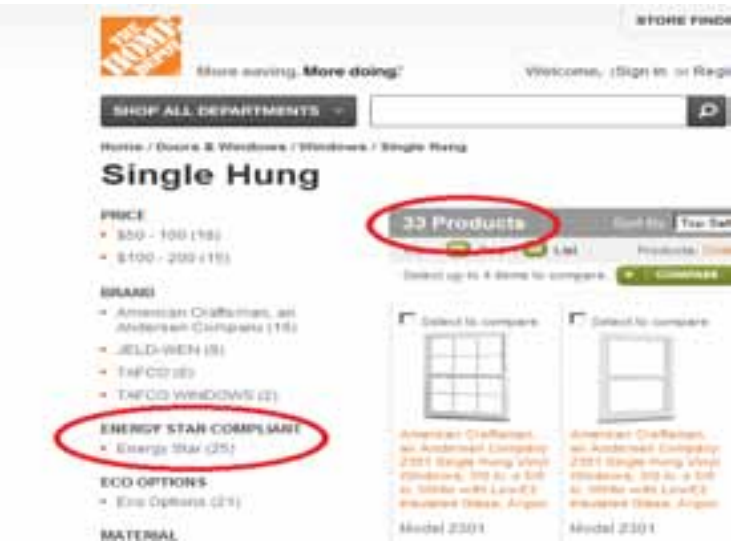
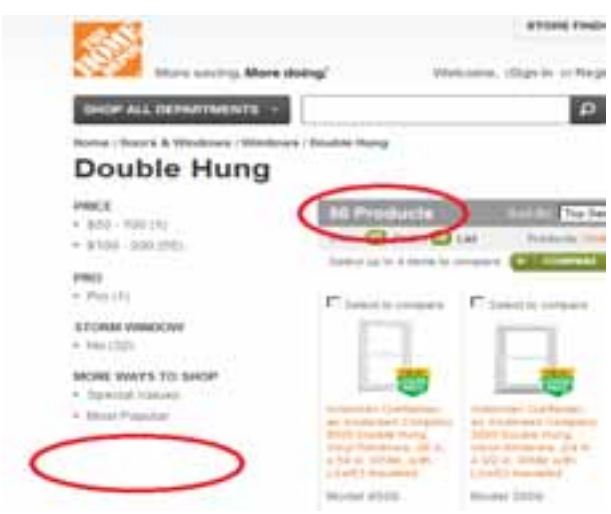
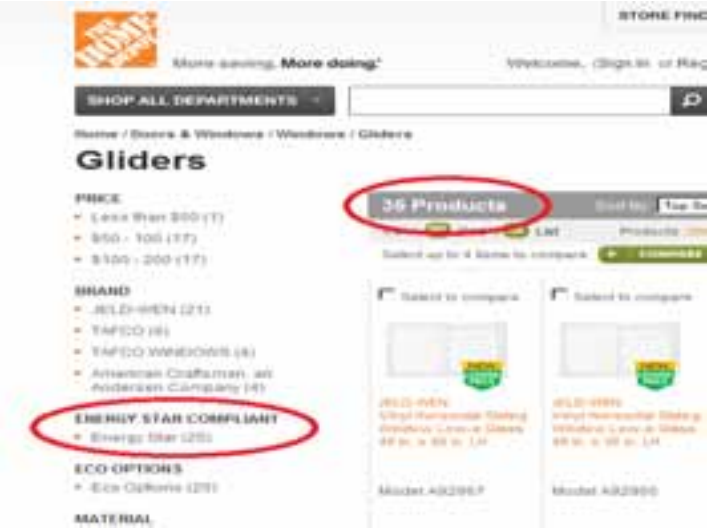


Home Depot

Major manufacturers of residential products



Over 85% ENERGY STAR in most markets



ENERGY STAR approaching the baseline for many regions

High Performance Window Volume Purchase Program

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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

What is the WVP Program?

- Program specification sets minimum targets for performance
  - Primary focus is insulating properties (U-factor or low-E on storm windows)
  - Other basic requirements add a degree of quality control (e.g. structural, air leakage, and warranty requirements)
- WVP staff does marketing, education and outreach about the products

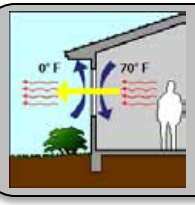
Energy efficiency and the WVP Program products

Highly Insulating Windows

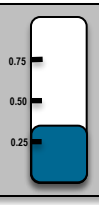
Low-E Storm Windows

Nils Petermann
Alliance to Save Energy

How do we measure how a window performs?

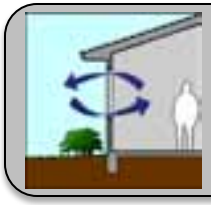


U-factor
Measures how insulating a window is
Lower = less heat loss



Solar Heat Gain Coefficient (SHGC)
Fraction of the solar energy that enters the window
Higher = more solar energy

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



Air Leakage (AL)
Volume of air that passes through the window when closed
Lower = less infiltration

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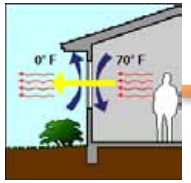
How do we know a specific window's rating?

Using the National Fenestration Rating Council (NFRC) Label



NFRC ratings provide a measure of how all components perform together, making it easier to compare products.

Typical U-factors - Windows

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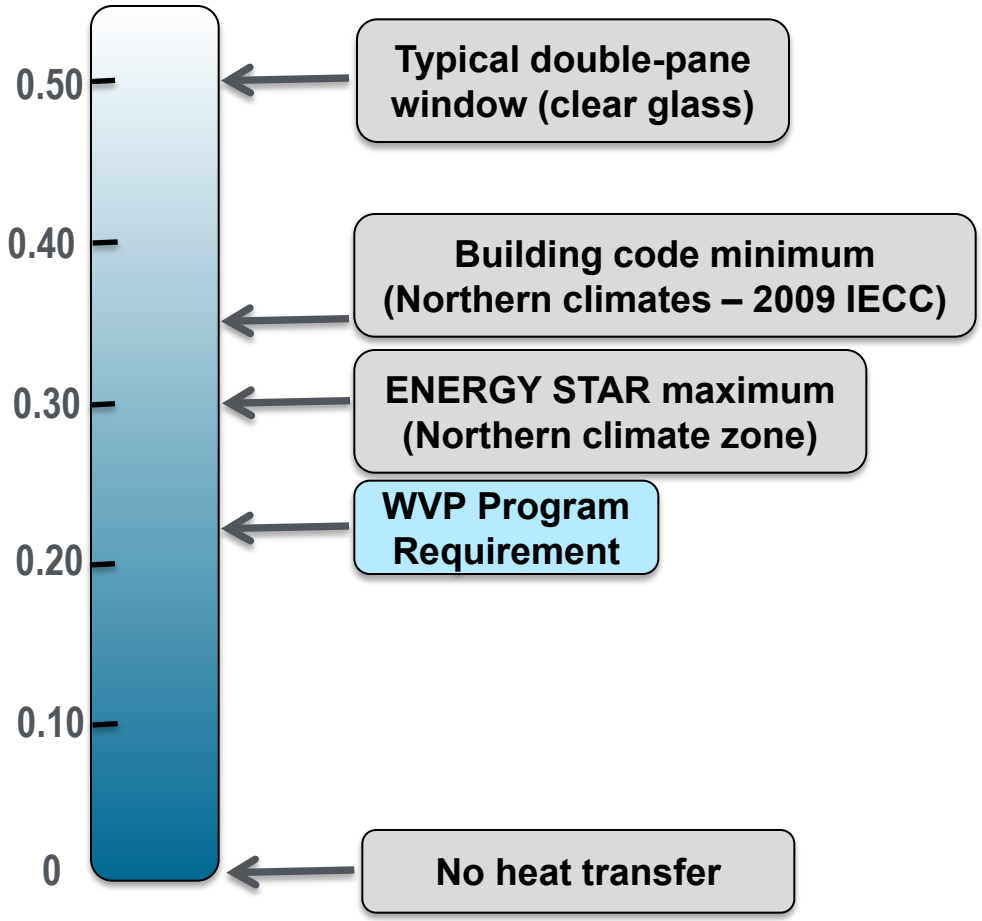
- For this program, 'Highly Insulating' is defined as a U-factor of 0.22 for operable windows, 0.20 for fixed



Windows in the program have advanced components:

- **Typically triple-pane**
- **All use low-E coatings**
- **Gas fills**
- **Low-conductance frames**

Estimated Energy Savings - Windows

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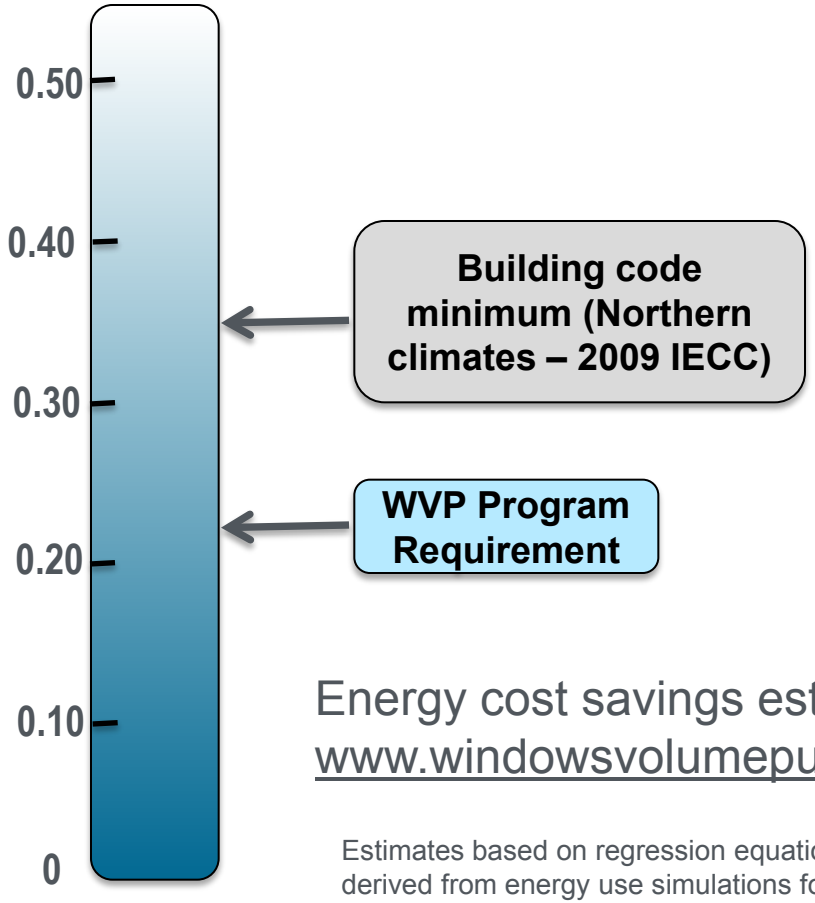
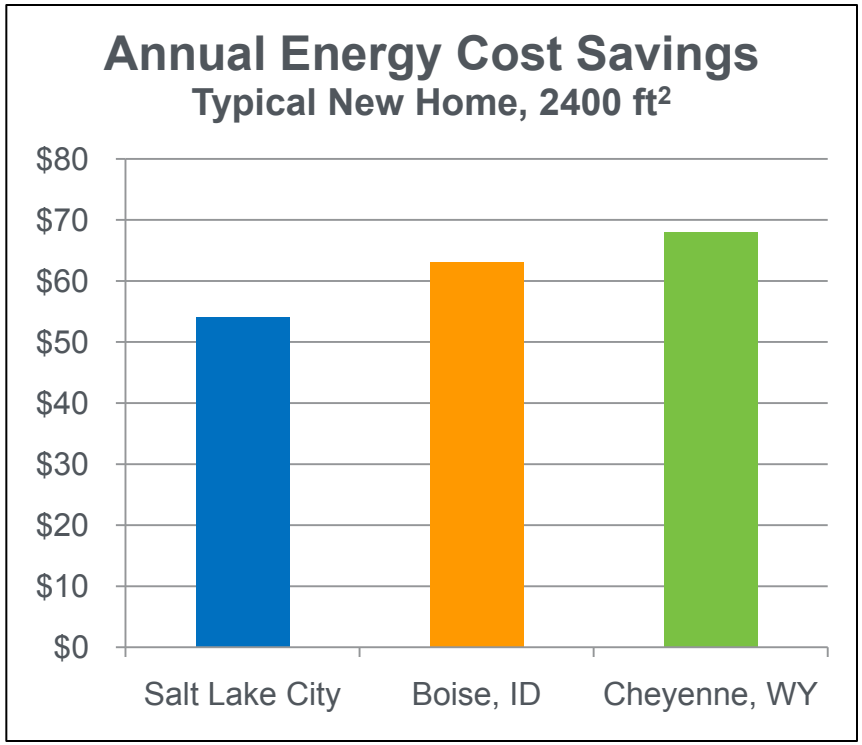
- **High performance windows can provide significant energy cost savings**





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.

Window Components

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What makes a highly insulating window?

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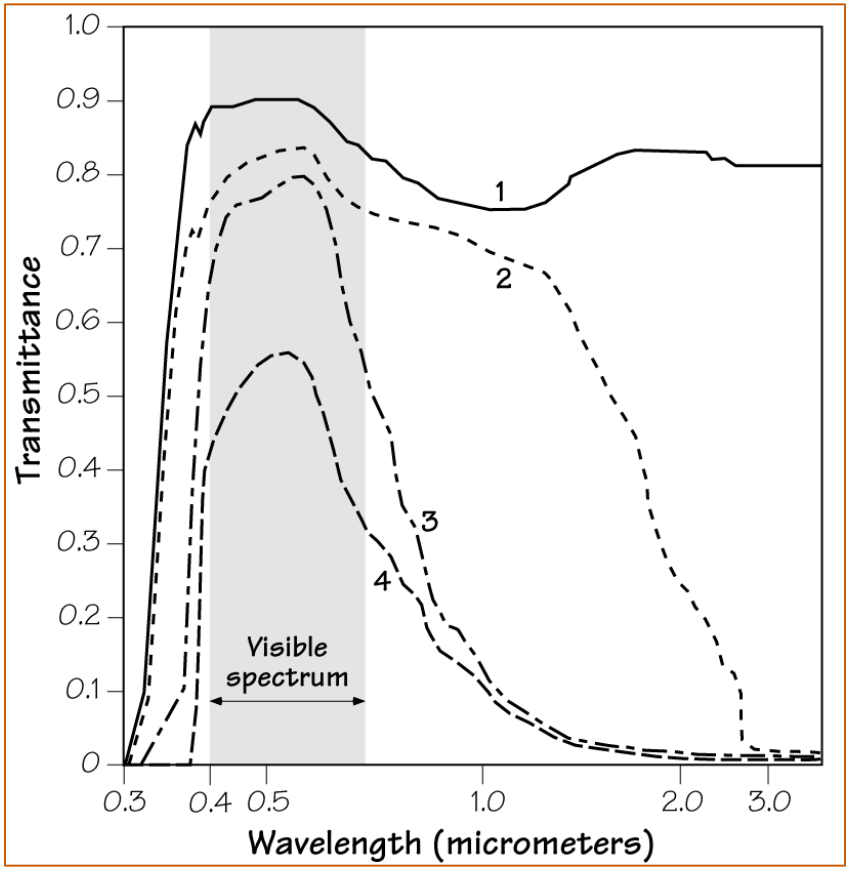
What is the effect of a low-E coating?

- Low-E coatings are 'spectrally selective' - most visible light passes, but little infrared
- Coating blocks radiation from one pane to the other



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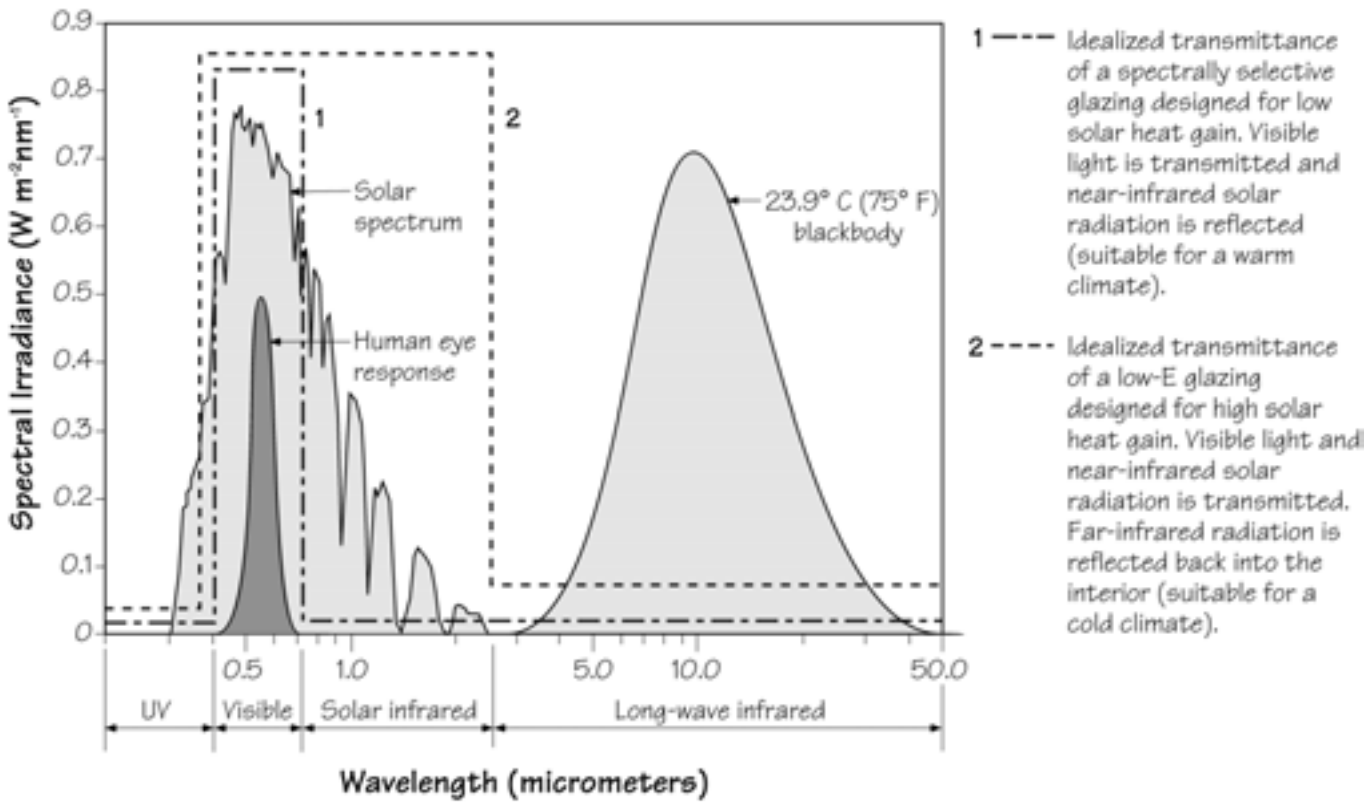
What is the effect of a low-E coating?



How does low-E improve insulating properties of windows?

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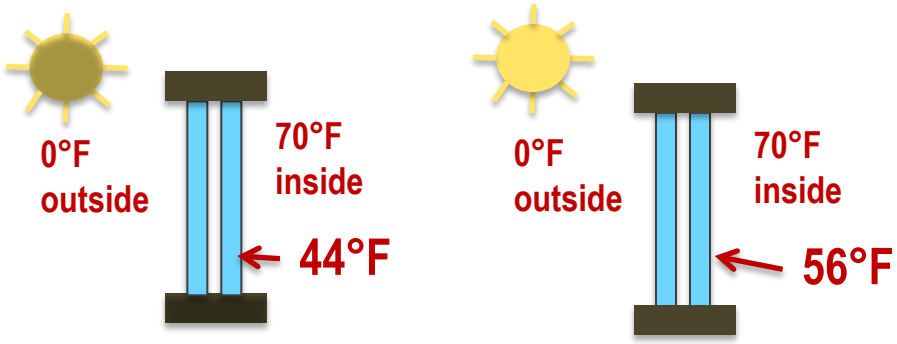

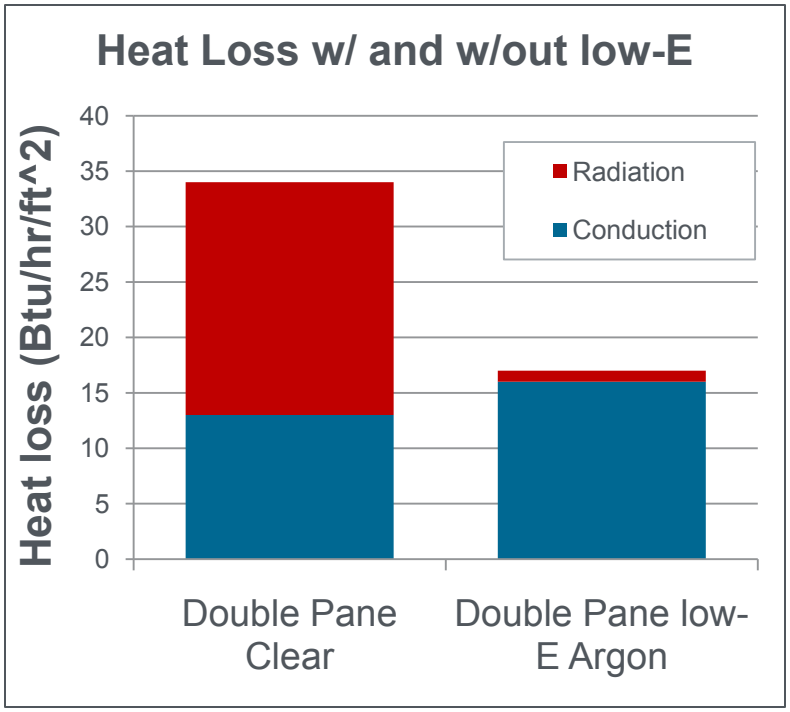

Low-E Storm Windows

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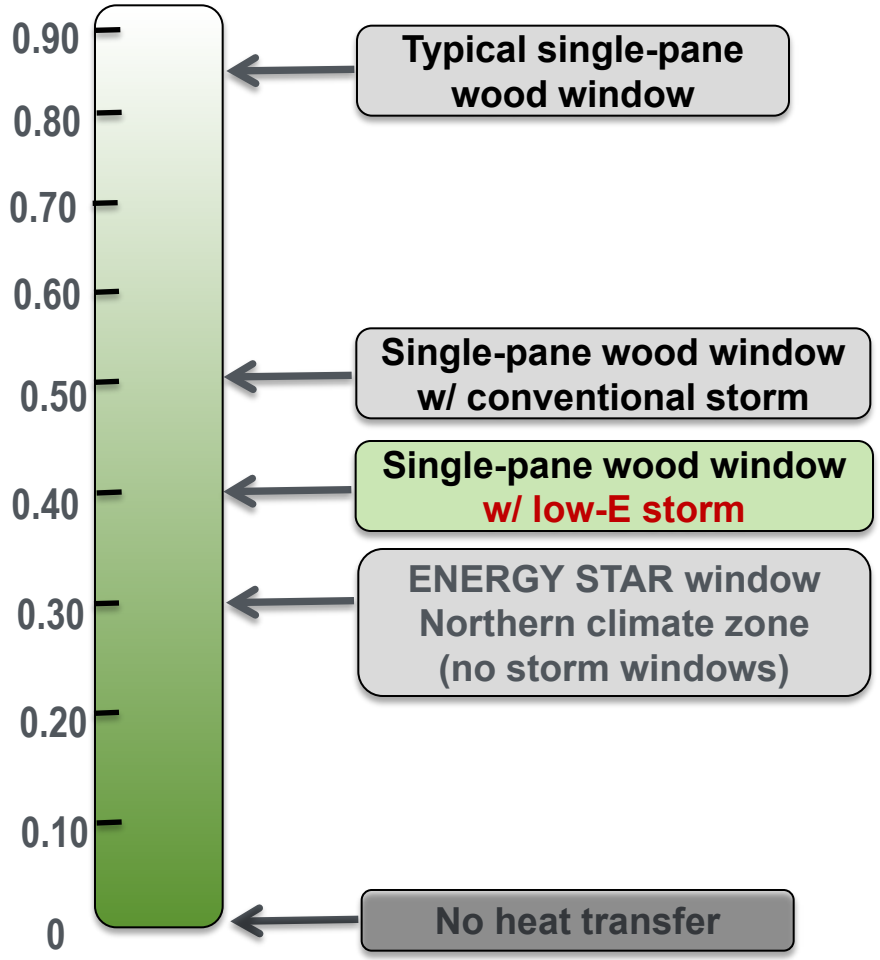
- A low-E storm window is similar to a typical storm, but with the addition of a pyroltic ("hard coat") low-E coating

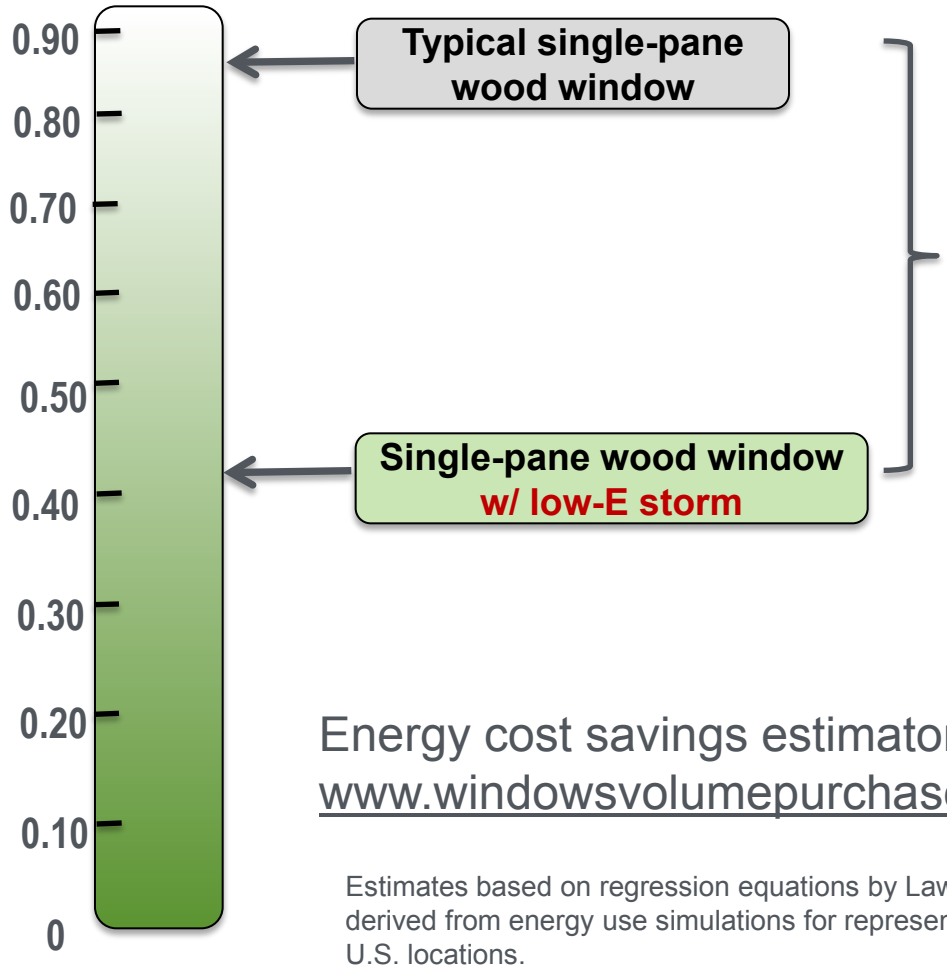


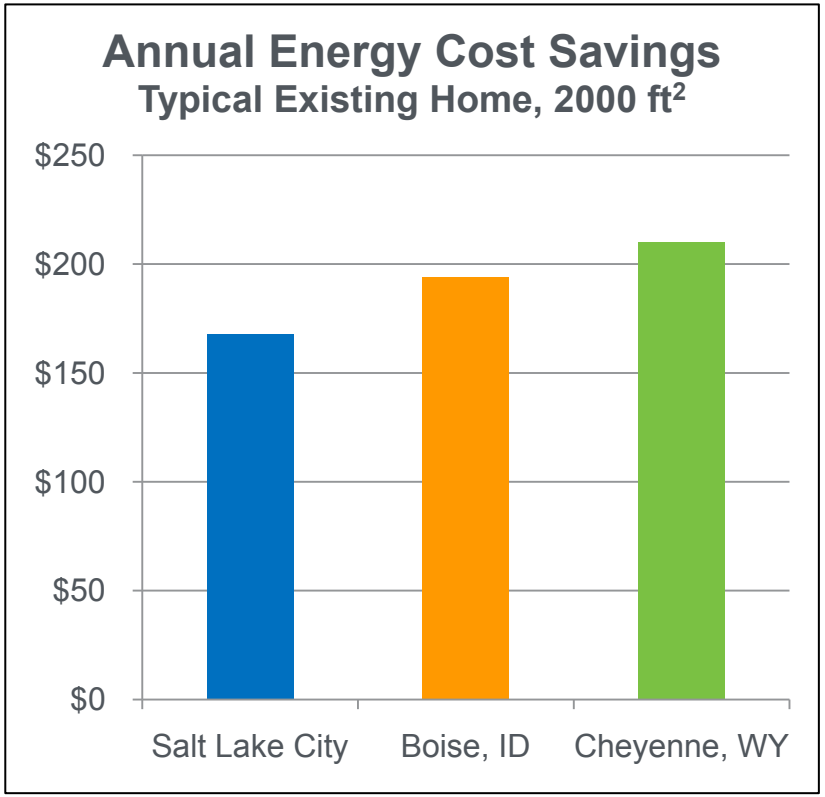
- Low-E coatings have been used for years on typical windows to improve their efficiency
- Use on storm windows is not as widespread – but very cost effective
- Installation costs are identical to standard storm windows

Low-E Storm Windows

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

- Adding a low-E storm window to a single pane window provides good energy savings, and a 4-5 year simple payback





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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.

Comfort Benefits of Well-Insulating Windows

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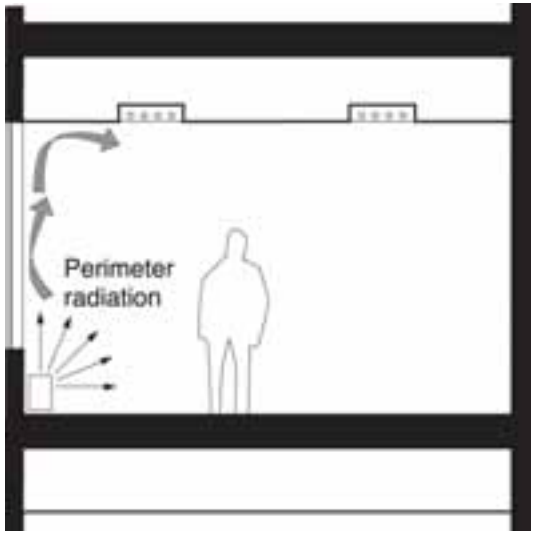
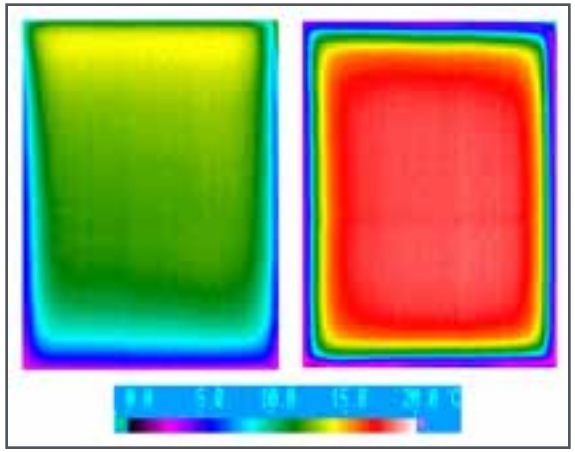
- Areas near windows are often places of great temperature variation and discomfort
- Conventional practice to avoid discomfort is to provide perimeter heating near windows
- Perimeter heat may not be necessary with highly insulating windows





Thermograms comparing a conventional dual-pane with a highly insulating window

U-factor and Winter Comfort

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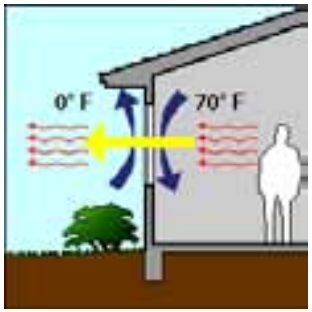
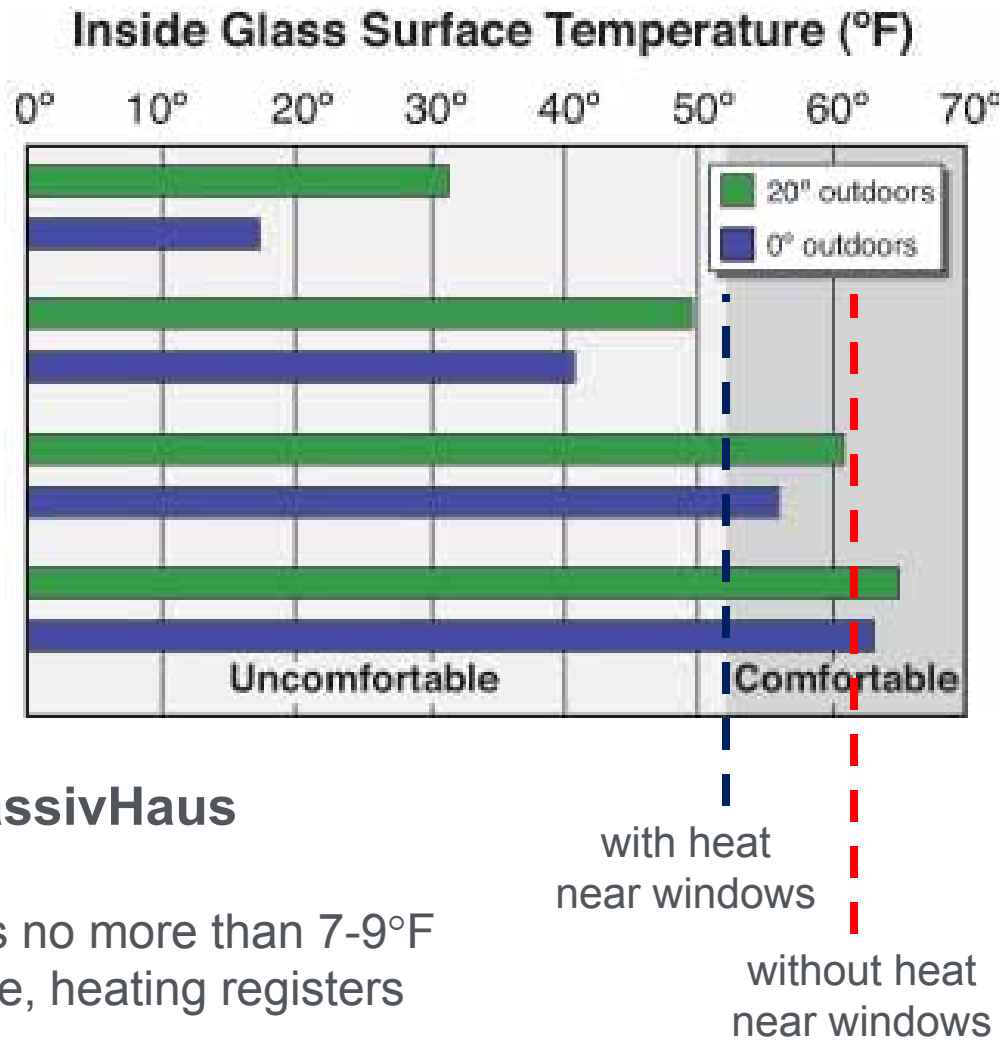


Single pane (U ~0.85)

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.

Compact Heating Systems

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Eliminate perimeter heating with highly insulating windows:

Per a 1998 study by Hawthorne et al.:

- With moderately sized, highly insulating windows, perimeter heating not needed even with design temperatures below -15°F
- 10-15% heating energy savings due to improved duct delivery system
- Fan electricity savings
- 20-25% duct system cost savings ($500 for 1,200 ft^2 house)

Source: Rural Development Inc.

* Savings estimates from 1998 study by Hawthorne, W. and Reilly, S. (Enermodal Engineering), Anderson, R. (NREL), Hancock, E.

Example of a Compact Heating System

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Wisdom Way Solar Village, Massachusetts

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

Solar Heat Gains

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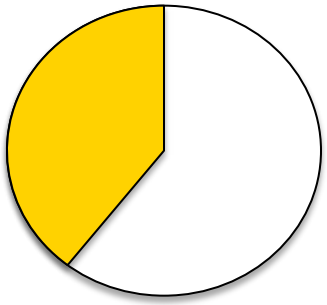
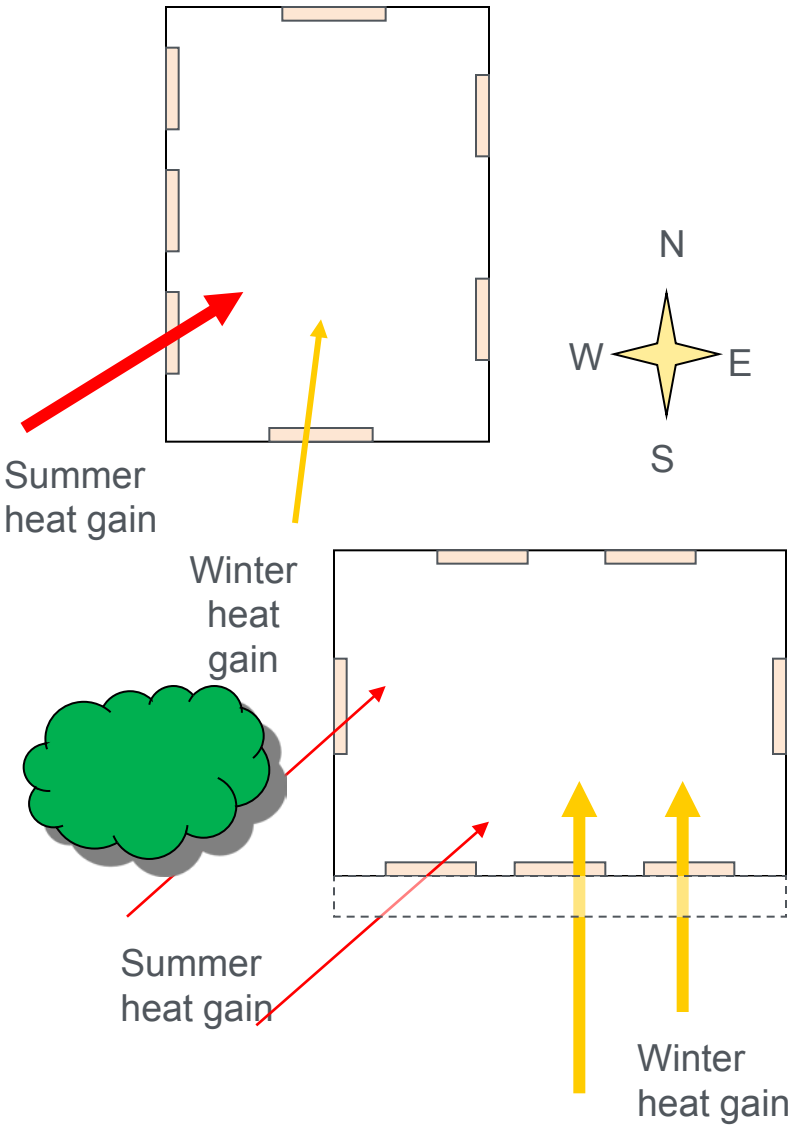
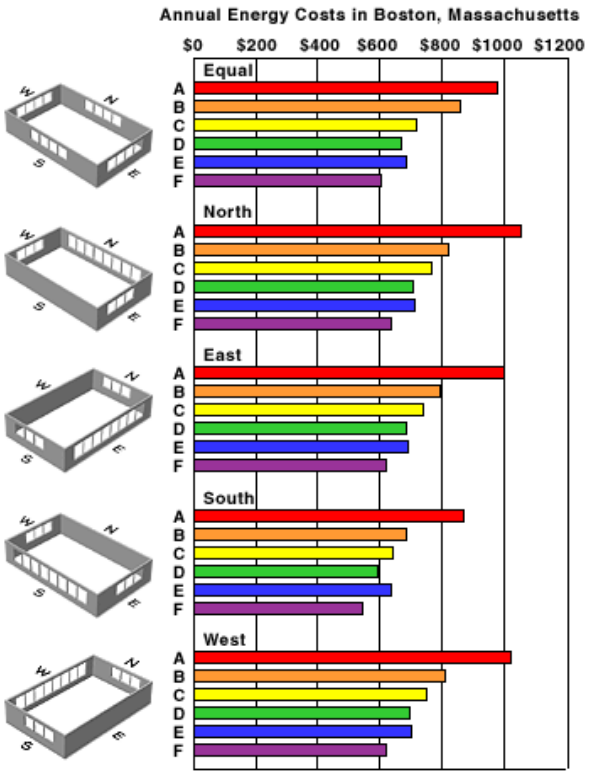
- Important for window energy, but not addressed in this program
- The right Solar Heat Gain Coefficient (SHGC) depends strongly on climate and house design:
  - Solar heat gain through windows helps offset heating loads (east and south facing windows)
  - Can increase cooling load (above all with west facing windows)



Building Configuration

Effect of SHGC, Orientation





Solar Heat Gain Window Properties

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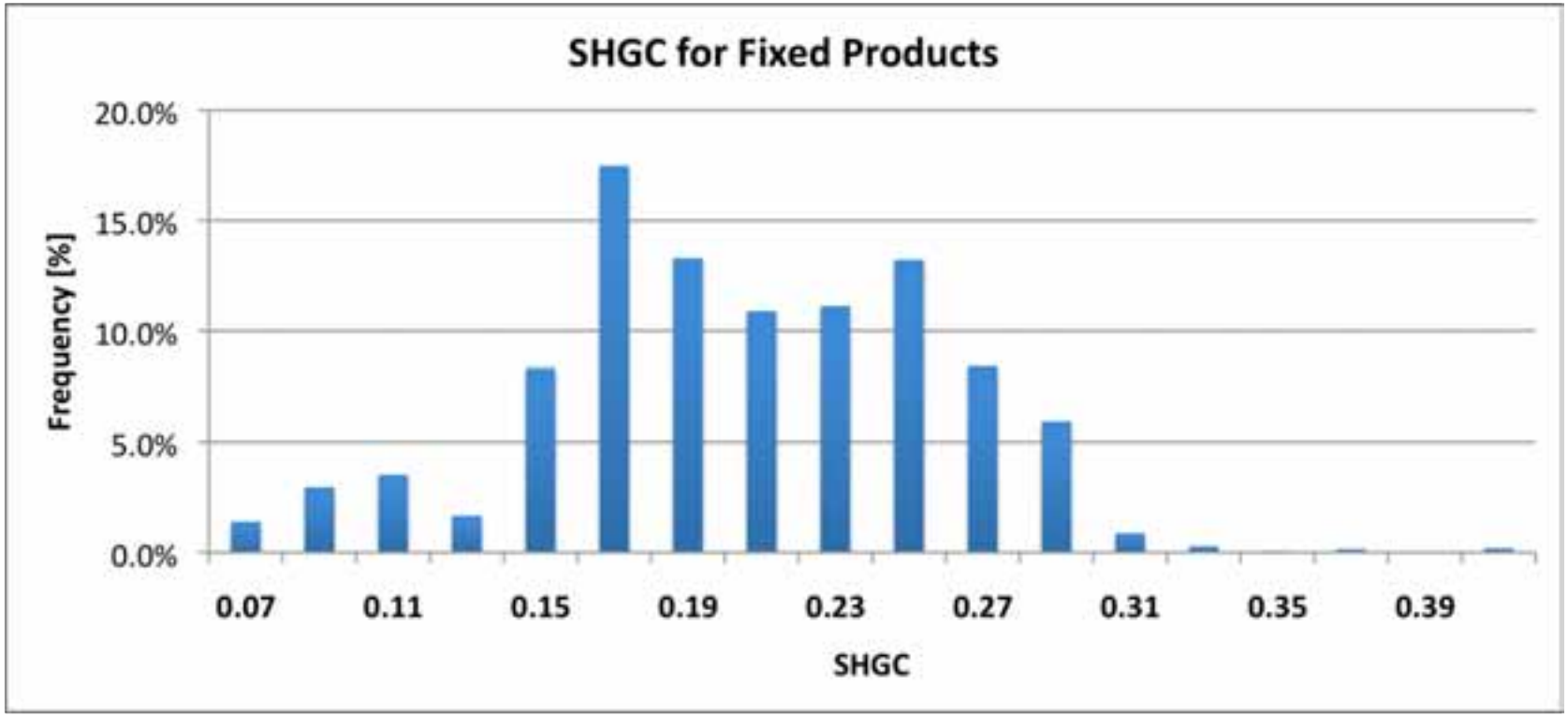
Key point – broad range of SHGC levels available within products the program



Visit www.efficientwindows.org for more info on appropriate SHGC

The Windows Volume Purchase (WVP) Web Site

Terry Mapes, PNNL

Windows Volume Purchase Timelines

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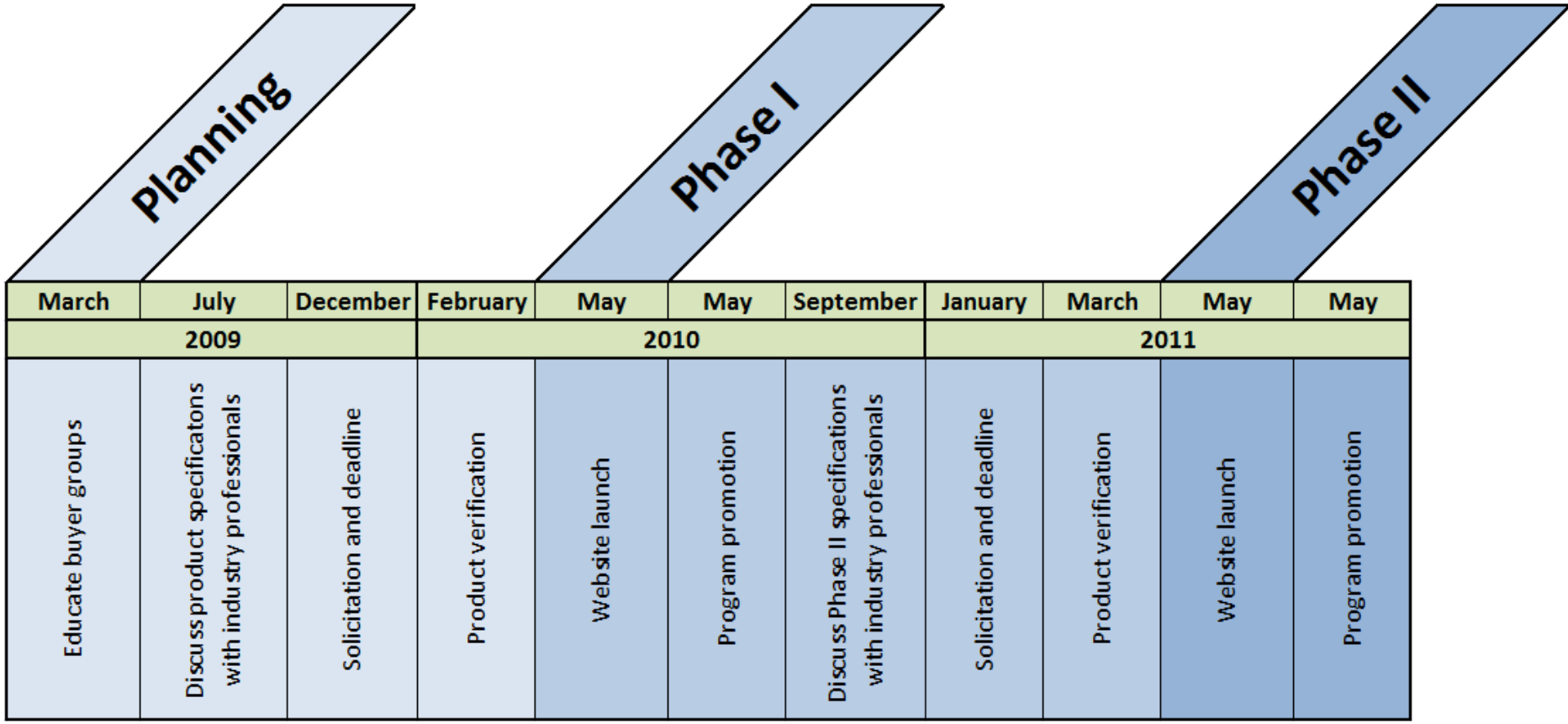

Phase II Program Specifications

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High Performance Windows

- U-factor: 0.20-0.22 (R); 0.24-0.27 (CW); 0.27-0.32 (AW)
- Air leakage: ≤ 0.30 cfm/ft^2
- Condensation Resistance: ≥50
- Certifications: NFRC/NAFS
- Warranty (yr): 20 glass/10 non-glass
- Minimum order: 20

Phase II Program Specifications

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

Low-E Storm Windows

- Emissivity: <0.22
- Structural test: ANSI/AAMA 1002.10-93 or ASTM E1886-05
- Performance Grade: ≥ 15
- Registry: IGDB (LBNL database)
- Certification required
- Warranty (yr): 10 glass/non-glass
- Minimum order: 20

Phase II

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The second year of the program begins May 3:

- New Website
- Changes to manufacturer requirements

Changes to the product requirements:

- Commercial-grade windows now included
  - NFRC Component Modeling Approach (CMA) used
  - Allows for inclusion of site-built products
- Low-E storm windows must be structurally certified

Phase II

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Changes to the website:

- Database format allows for filtering by desired criteria
  - SHGC
  - Structural performance grade
  - Condensation Resistance
  - Shipping Region
- Specific price bids shown for each product
  - Different prices allowed for small (1-19), medium (20-49) and large (50+) quantities
  - NFRC Component Modeling Approach (CMA) used
  - Allows for inclusion of site-built products
- More complete product descriptions included on the WVP page
- External manufacturer links will go to program-specific information

Phase II Status

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To date, we have received 32 bids in Phase II and are processing these bids.

32 bids
- -4 with storm windows
- -2 with commercial grade windows

Agreement Validated URL

Certified Vendors

Data base with products

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

How is the program being received?

Walt Zalis, Energetics

WVP Message

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The Windows Volume Purchase Program offers a "Window of Savings" with new ways for consumers to save money and energy.

- **The Energy Trust of Oregon**
  - Already provided incentives for ENERGYSTAR windows and needed a higher performance tier
  - **Applicable incentive**
    - Electric- and gas-heated homes: $3.50 per square foot of windows installed with U-Value 0.22 or less
    - Must be installed with second energy-saving improvement
  - Current high performance tier aligns with the WVP program requirements, benefiting from increased product availability for incentive recipients.

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Potential Buyers, Marketers, and End-Users of High Performance Windows Share "Letters of Interest"

Over 20 letters of support from builders, weatherization agencies, non-profits and others

*"The Department of Energy's plan to create a market for new and emerging technologies will certainly have **profound energy savings impacts** for American families as well as for the Nation's energy security."* -CEDA

Notable supporters:

Builders/Contractors (11 total)

- Building America Industrialized Housing Partnership (BAIHP)
- Clayton Homes .
- Palm Harbor Homes

Non-profits (7 total)

- Consortium for Energy Efficiency (CEE)
- Energy Trust of Oregon
- Habitat for Humanity
- Midwest Energy Efficiency Alliance (MEEA)

Weatherization (2)

- Community and Economic Development Association of Cook County, Illinois (CEDA)
- National Community Action Foundation (NCAF)

K-12 Schools (1)

Local/State (1)

- Commonwealth of Massachusetts

Financial Institutions (1)

WVP Supporting State Weatherization

- 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

Updates to Pennsylvania's Weatherization Priority List

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Low-E Storm Windows

- Selected as qualified measure with 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

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

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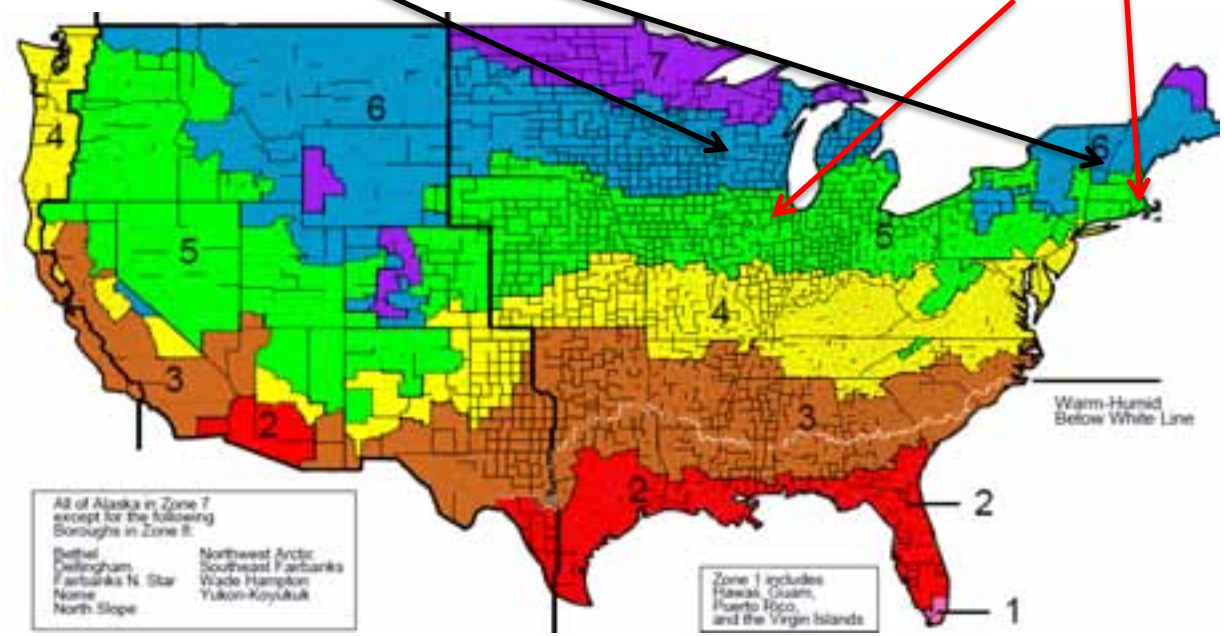
BSC: recommendations for window performance in Northern climate that are closely aligned with WVP requirements

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*>

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Planned Marketing and Media Events

- Conferences/trade shows*
  - AIA, New Orleans, May 12-14
  - PHADA, New Orleans, May 15-18
  - Greenbuild, Toronto, October 4-7
- Workshops*
  - June, New York & Washington D.C.
  - Fall, Denver, CO

***With vendors as partners**

Contacts

Graham Parker, CEM/PBEP
Pacific Northwest National Lab
graham.parker@pnl.gov
509-375-3805

Terry Mapes
Pacific Northwest National Lab
terry.mapes@pnl.gov
509-371-6745

Nils Petermann
Efficient Windows Collaborative
NPetermann@ase.org
202-530-2254

Neal Humphrey
Efficient Windows Collaborative
NHumphrey@ase.org
202-448-8760

Jason Bogovich
Energetics Incorporated
jbogovich@energetics.com
410-953-6257

Walt Zalis
Energetics Incorporated
wzalis@energetics.com
410-953-6256

Questions?

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