Welcome. Today’s webinar is being recorded and will be posted at:

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You may submit questions at any time during the webinar. We’ll answer them during the Question & Answer session after the presentation.
Residential Window Treatments

- Energy Impact
- Performance Metrics
- Products
  - Window Films
  - Insulated Cellular Shades
  - Exterior Storm Windows
  - Interior Panels
- Summary
- Next Steps
BPA’s Interest in This Area

• Determine feasibility for a new measure opportunity
• Investigate currently available technologies with greatest potential for energy savings
• Criteria included:
  – Estimated cost
  – Estimated savings (based on U-factor and SHGC)
  – Visible Transmittance
  – Lifespan compatible with original window
  – Availability around the Pacific Northwest
Impact of Windows on Typical Building Performance

- Heating: 23%
- Cooling: 13%
- Lighting: 18%
- Water Heating: 10%
- Electronics: 7%
- Appliances: 12%
- Computers: 2%
- Other: 12%

- Has Impact on 57% of Loads
- 133 Billion $/yr
- 13.9% US Energy
- 3.5% Global Energy
DOE Prioritization Tool: Unstaged Potential

Unstaged Maximum-Adoption Potential, 2030

- R+C: R-10 windows
- R+C: Dynamic windows
- R+C: Low-e storm window
- R+C: Window attachments
- R: R-5 repl. Windows
- R: Insulating shutters
- R+C: Window films

2010 average cost for fossil-fuel electricity and natural gas

Levelized Cost of Conserved Energy ($/MMBTU)

Primary Energy Savings: trillion BTUs in 2030

Dept of Energy EERE
Product Performance Metrics

• U-Factor (Btu/h-ft2-degreeF)
  – Lower = better insulating value
• Solar Heat Gain Coefficient (SHGC)
  – Fraction of solar radiation passing through
  – Number between 0 and 1
  – Lower = less solar energy transmitted
• Visible Transmittance (VT)
  – Fraction of visible light spectrum transmitted through glazing
  – Higher = more visible light
• Air leakage (AL)
  – Lower = more air kept out
Energy Performance Metrics

U-factor measures the heat from INSIDE a room that can escape. The lower the number, the lower the potential for wasted heating expenses.

Visible Transmittance measures how much natural light can come into a room -- a HIGH number means more natural light.

Solar Heat Gain Coefficient measures the amount of OUTDOOR heat that can enter a room. The lower the number, the lower the potential for wasted cooling expenses.

Air Leakage measures how much air will enter a room through the product. The lower the number, the lower the potential for draft through the product.

National Fenestration Research Council
Other Considerations

Savings Related

• Comfort
• Daylighting

Non-savings Related

• Aesthetics
• Glare

Product Cost

• Maintenance
• Durability and service life
Ratings, Certification & Testing

• National Fenestration Rating Council (NFRC)
  – Only uniform, independent rating and labeling system for energy performance of windows, attachment, etc.

• AAMA, WDMA, NAMI, Keystone, etc.
  – Offer structural certifications and factory audits

• DOE
  – RFI for a fenestration attachment energy rating and labeling effort
  – Funding Opportunity Announcement (FOA) next step (funded FY 2014 if FOA is out prior to Sept 30, 2013)
  – Funds Lawrence Berkeley National Labs (LBNL)
Window Films

• Surface-applied window films
• Modern films
  – Retrofit or aftermarket
  – Improved lifespan and quality
  – Minimum 3 layers, greater adhesion and scratch resistance
  – Typically 2-7 mils thick
  – May have added dyes, metals, alloys and/or UV inhibitors for specific desired properties
Window Films

- Tinted (solar reflective and/or absorptive)
  - ↓ solar heat gain and daylighting level
  - ↑ winter heating loads

- Spectrally selective
  - ↑ visible light spectrum, blocks more heat than light
  - ↓ cooling loads

- Low-emissivity (low-e)
  - ↓ U-factor, ↓ Reduces solar heat gain in summer

- Low-emissivity with high visible light transmission
  - ↓ winter heat loss
  - Allows more visible light in
## Window Films

### Single Pane, Clear Glass

<table>
<thead>
<tr>
<th></th>
<th>U-Value</th>
<th>SHGC</th>
<th>VT</th>
<th>Price range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline window</td>
<td>1.04</td>
<td>0.86</td>
<td>0.90</td>
<td></td>
</tr>
<tr>
<td>w/ Reflective film</td>
<td>1.06</td>
<td>0.36</td>
<td>0.28</td>
<td>$5.50-$8.00</td>
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<tr>
<td>w/ Spectrally selective film</td>
<td>1.07</td>
<td>0.62</td>
<td>0.62</td>
<td>$7.00-$12.50</td>
</tr>
<tr>
<td>w/ Low-E film</td>
<td>0.58</td>
<td>0.26</td>
<td>0.34</td>
<td>$6.00-$9.50</td>
</tr>
<tr>
<td>w/ Low-E, high VT film</td>
<td>0.61</td>
<td>0.52</td>
<td>0.70</td>
<td>$11.00-$18.00</td>
</tr>
</tbody>
</table>

### Double Pane, Clear Glass

<table>
<thead>
<tr>
<th></th>
<th>U-Value</th>
<th>SHGC</th>
<th>VT</th>
<th>Price range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline window</td>
<td>0.48</td>
<td>0.76</td>
<td>0.81</td>
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<tr>
<td>Reflective Solar Film</td>
<td>0.49</td>
<td>0.46</td>
<td>0.26</td>
<td>$5.50-$8.00</td>
</tr>
<tr>
<td>Spectrally Selective</td>
<td>0.49</td>
<td>0.65</td>
<td>0.57</td>
<td>$7.00-$12.50</td>
</tr>
<tr>
<td>Low-E</td>
<td>0.33</td>
<td>0.31</td>
<td>0.32</td>
<td>$6.00-$9.50</td>
</tr>
<tr>
<td>Low-E, High VT</td>
<td>0.34</td>
<td>0.53</td>
<td>0.63</td>
<td>$11.00-$18.00</td>
</tr>
</tbody>
</table>
Insulating Cellular Shades
Insulating Cellular Shades

- Cellular construction (honeycomb)
  - Multiple layers joined at pleats to form cells that trap air
  - Single or multiple cell, or cell-in-cell
  - Horizontal or vertical
- Traps air within cells, between shade and window
- Available with radiant barrier for more insulation
- Reflective outer surface reduces unwanted solar heat gain
- Adjustable for daylight control, view, privacy
- May fit into edge tracks, good weather stripping
- Operation – motorized, sensor, manual
Insulating Cellular Shades

Total R-Value with Cellular Insulating Shades Installed
Insulating Cellular Shades

• Benefits
  – Reduces nighttime heat loss and cold drafts near windows
  – Offers energy savings during heating and cooling seasons
  – Large variety helps meet aesthetic needs
  – Addition of side track can reduce heat loss further
  – Self-installation is possible

• Drawbacks
  – Consumer behavior dictates savings – e.g. not always in use during winter daylight hours
  – Interferes with visibility
Exterior Storm Windows

Alliance for Low-E Storm Windows
Exterior Storm Windows

• Most mature of existing treatment technologies
• Low-e coatings added about ten years ago to enhance insulating benefits
• Government studies have verified the results
• Operable windows and screens eliminate the need to install and remove seasonally
• Distribution channels well established
• Basic low-e storms from name brand manufacturers start below $8/ft²
• 80% are installed by the homeowner
Low-e Storm Window Performance

<table>
<thead>
<tr>
<th>Existing Window</th>
<th>Base U-factor</th>
<th>Base SHGC</th>
<th>With low-E Storm U-factor</th>
<th>With low-E Storm SHGC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single pane, metal frame (e.g., aluminum)</td>
<td>1.18</td>
<td>0.78</td>
<td>0.70</td>
<td>0.61</td>
</tr>
<tr>
<td>Single pane, non-metal frame (e.g., wood or vinyl)</td>
<td>0.86</td>
<td>0.68</td>
<td>0.40</td>
<td>0.52</td>
</tr>
<tr>
<td>Double pane, metal frame, no coating</td>
<td>0.8</td>
<td>0.7</td>
<td>0.63</td>
<td>0.57</td>
</tr>
<tr>
<td>Double pane, non-metal frame, no coating</td>
<td>0.49</td>
<td>0.6</td>
<td>0.34</td>
<td>0.48</td>
</tr>
<tr>
<td>Double pane, metal frame, low-e coating</td>
<td>0.46</td>
<td>0.6</td>
<td>0.26</td>
<td>0.48</td>
</tr>
<tr>
<td>Double pane, non-metal frame, low-e coating</td>
<td>0.29</td>
<td>0.5</td>
<td>0.19</td>
<td>0.38</td>
</tr>
</tbody>
</table>

Effects of adding Low-e storm windows to existing windows
Exterior Storms – Low-e Glass

• Benefits
  – Increase air tightness, insulating properties
  – Convenient operation of glass and screen (not for fixed)
  – Improve comfort near window
  – Less maintenance needed on existing window
  – Protects primary window from wear, damage, forced entry

• Considerations and drawbacks
  – Conflicts with historical codes, condo regulations
  – Interferes with outswing casements, awning windows
  – Difficult in some retrofit situations (depending on existing frame and siding)
Interior Panels

• Detachable or fixed
• Plastic panels mounted in frame
  – inexpensive, lightweight
• Glass
  – heavier, durable, scratches less, some with low-e coatings
• Frames – aluminum, steel, vinyl, wood
• Magnetic, velcro, snap-in or mechanical attachment
• Good choice for moderate or cold climates
• Can include weatherstripping
Interior Panels

Total R-Value with Interior Energy Panels Installed

- Single Pane, No Treatment
- Indow Window
- Quanta Panels
- Bostonia System II
- Magnetite
- Climate Seal
- Quanta Panels Low-E
Interior Panels

• Benefits
  – Reduces air leakage, increases thermal insulation
  – Easy installation, especially multi-stories
  – Plastic panels are low cost
  – May be allowed by historic codes, covenants, etc
  – Interior glass panel with low-e can bring performance close to a new double-paned low-e window

• Considerations and drawbacks
  – Obstructs window egress
  – May require seasonal installation and storage
  – Plastic panels can affect visibility
Other Window Attachments

Technologies Not Covered Here

Lack of information or appropriateness for Northwest

- Awnings – savings designed for cooling dominated climates
- Roller shades – similar to awnings with slightly better results
- Drapes, curtains and blinds – Used primarily to control light, and therefore solar heat gain. More information is needed for cooler climates.
Summary

Findings

• Poor insulation values for windows make them a primary target for enhancement
  – IECC 2012 residential code requires:
    Ceilings - R38  Walls - R19  Windows - <R3
• A wide range of low cost, energy saving technologies are currently available
• Additional independent testing is needed to accurately estimate savings
• PNW is a heating-dominated climate with specific needs
  – Low U-factor with high solar heat gain is best
Summary

Products

• Consumer behavior has significant impact on savings for many technologies
  – E.g. Cellular shades left open for daylighting on a cold day
• Majority of market-ready products target cooling reduction
• Maintaining visibility and aesthetics is a key issue with all products. Savings often secondary.
• Not as cost prohibitive as window replacement
• Effective lifespan and installation costs should be factored into savings estimates
Next Steps for BPA

• Final assessment report
• Further research
  – Sector needs
  – Gaps
• Field tests, lab tests, etc
• Potential measures
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