



SUMMARY REPORT

Background

Window attachments alter energy performance of a base window, often improving energy efficiency of the window and providing additional benefits, such as glare control and other comfort improvements. Some attachments worsen certain secondary performance characteristics, such as increased condensation, excessive temperature build-up, and reduced view. The U.S. Department of Energy (DOE) and the attachment industry have been investing in research and development (R&D) of new modeling methods, software tools, and measurement techniques to better characterize the properties of attachments and predict their energy performance, so that industry can develop new products more effectively that maximize their energy efficiency and reduce their drawbacks.

A stakeholder workshop was organized to identify knowledge gaps and determine an action plan to fill them. This entailed constructive discussion about the goals for development of attachment performance indices, and then the status of the technical approach for determining required performance indices, and readiness of simulation and testing procedures and identification/prioritization of products for which the performance indices need to be established.

Meeting objectives:

- Provide up to date information on window attachment performance assessment methods to stakeholders
- Discuss with key stakeholders what is needed and what is available to properly characterize window attachment performance, including:
 - Test procedures
 - Simulation programs
 - Indices of performance
 - Product categories

Expected outcomes:

- A report identifying product categorization rules and simplified performance metrics
- A documentation of current capabilities and gaps in assessment methods
- A plan and timeline for the development of new technical capabilities to characterize attachment products
- A set of technical requirements for window attachment deployment programs

I. Opening Remarks

Marc LaFrance, DOE Building Technologies Program, Building Envelope and Windows R&D Technology Development Manager

DOE seeks to prioritize programs that have the biggest ‘bang for the buck.’

- The area of attachments is a high priority due to the ‘bang for the buck’ criteria.
- Blinds, awnings, shades, films are all good options to consider if homeowner does not choose to replace or cannot afford to replace old windows, or if replacement windows don’t deliver the performance improvements needed.
- DOE’s job is to provide information to consumers to determine what is the best option for them; what are the metrics (economic and energy performance) that people should use when making a decision to purchase a product?
- Important to have an appropriate estimation of savings; we do not want to exaggerate or underestimate the savings.
- The impact of occupant behavior and attachment operation on energy savings must be considered.
- The question of how DOE is going to move ahead on a rating program will not be handled today, but DOE legal is examining this and moving forward.

Doug Anderson, EPA ENERGY STAR, Home Improvement Program

At this time it is unclear to EPA whether these products can meet the requirements of the ENERGY STAR program. There are several challenges facing window attachments in order to become part of the program, including:

- Proven energy savings that can be measured and verified with testing.
- Proven significant energy savings on a national basis.
- Proof that the technology is cost-effective.

Further efforts are needed within the window attachments sector to provide the information needed by EPA. Industry should continue working with D&R and LBNL toward a better understanding of the window attachment market, user behavior for specific products, and energy performance of specific products. EPA will consider ENERGY STAR labeling for each attachment category (type) on its own merit based on research and analysis that support the guiding principles of ENERGY STAR.

II. Workshop Presentations

Categorizing Fenestration Attachment Products

Bipin Shah and Ross McCluney, WinBuild

The presentation focused on defining, and categorizing attachment products. To simplify the process, stakeholders must determine:

- Technical needs.
- Infrastructure needs for different categories.
- Properly categorize products and define rules for simplification so that millions of possible options can be reduced to a meaningful and manageable set.
- Steps necessary for testing, simulation, quality assurance, and database verification and compliance.

Window Attachments Characterization—Current State of the Art, Knowledge Gaps and Plans for Future Work

Steve Selkowitz and Charlie Curcija, Lawrence Berkeley National Laboratory

The presentation provided an overview of Lawrence Berkeley National Laboratory's simulation and measurement methods, performance indices, and available software tools for window attachments, as well as details on standards and international collaboration. WINDOW 7 allows many commonly used attachments to be modeled today for U and SHGC. For exterior, between glass and interior products the presentation outlined 1) those models completed, 2) those models nearing completion, and those yet to be developed. DOE has been funding the refurbishment of the Mobile Window Thermal Test (MoWiTT) facility that will allow comparative field measurements of attachment performance to better validate models. LBNL's work covers daylighting as well as thermal performance and is designed to be used for commercial shading and insulating systems as well as residential.

Industry position and rationale for window attachment product prioritization and phasing

Teri Williamson, Window Covering Manufacturers Association

The presentation focused on the Window Covering Manufacturers Association's phased program strategy for establishing an ENERGY STAR program for window attachments. The strategy would prioritize products for test procedure and simulation program development based on energy savings potential, market share, and existence of industry champions.

- Phase 1 would establish residential program with a sufficient number of product types that can deliver expected national impact.
- Phases 2+ would add products as technically valid test procedures and validated simulation programs are developed.

Update on Market and Behavioral Research Efforts

Steve Bickel and Emily Phan-Gruber, D&R International

The presentation provided an overview of D&R's behavioral, market, and energy savings research for EPA, DOE and WCMA. D&R is collecting window attachment manufacturer data as well window attachment user-behavioral data through surveys to provide analysis to various window attachment stakeholders.

III. Discussion Summaries

Window Attachment Product Categories

Previously discussed and noted categories for product lines and phases for window attachments:

- Cellular type attachment
- Slat or louver type attachment
- Sheer type attachment
- Shutter type attachment
- Pleated type attachment
- Roller type attachment
- Roman shade type attachment
- Drape type attachment
- Flat panel attachment
- Drop arm awning/slide arm awning
- Marquisolette awning/combination awning
- Fixed awning—shed shape
- Fixed awning—dome shape

Two proposed modifications:

- “Fixed awning—dome shape” should be simplified
- “Flat panel attachment” should be renamed to consider storm windows and interior panels

Additional product categories that were discussed and noted by the workshop participants:

- Insect screens
- Films
- Skylight shading

Workshop participants agreed upon several window attachment characteristics and attributes, which include:

- Characteristics
 - Fit and orientation
 - Placement
 - Operation
 - Geometry
 - Slope considerations
 - Emissivity
- Attributes
 - Optical
 - Thermal
 - Material

There was no clear consensus as to how characteristics and attributes affect product categorization in terms of their energy performance. For example, geometry or emissivity are characteristics that will define product lines or individual products within product line (e.g., presence of side tracks for cellular shades may define separate product line, while low-e coating, applied to the interior glazed panel will define new individual product within the product line). At the same time, characteristic like operation or placement is independent of the categorization (i.e., same individual product may be operated differently or placed differently). Similar applies to attributes. While material is an attribute, its choice affects optical and/or thermal performance, which are listed as fellow attributes.

Window Attachment Product Performance Metrics

U-factor and Solar Heat Gain Coefficient (SHGC) are the primary metrics that need to be considered in testing and validating window attachment products against baseline windows. Other secondary metrics to consider are energy performance (EP), annual energy performance (AEP), visual transmittance (VT), daylighting, thermal comfort, glare reduction, illumination quality, and air infiltration. Air infiltration will be especially necessary for storm window attachments.

Established product performance metrics would most likely involve definition and use of base case window or multiple windows. Ideally, the performance of the attachment product would be expressed as a delta indices of performance (e.g., ΔU , $\Delta SHGC$, or ΔVT), that would indicate how much the performance of a base window is changing. This should eliminate the effect of the window (single pane, double pane, etc.), however this is difficult proposition, since thermal and optical performance of the attachment is quite tightly coupled to the performance of the base window. If the option of developing delta indices of performance is deemed realistic, an effort should be planned to research if it is feasible to develop methodology for separating attachment performance from the base window performance.

Window Attachment Simulation, Testing, and Measurement methods/tools

Simulation methods for many attachment types have been developed and the full set of products could be incorporated into WINDOW in a relatively short time frame. Further investigation is required to determine if an existing window or door test method would apply to window attachments and how much modification is needed. A standardized test method for certain interior and exterior attachments would simplify the testing process. The MoWiTT testing facility at LBNL must be a funding priority in the next fiscal years; It is the only research level window measurement facility in U.S. that can measure U and SHGC. Research level testing is needed to validate simulation methods, for which commercial testing facilities are not well suited.

Simulation Method Validation Priority

Simulation methods for cellular shades, including single cell, multi-cell and complex-cell, planned to be completed by the end of FY12. Products for which we already have simulation methods do not need to be prioritized. For those products that are not complete yet, industry was asked to prioritize those categories.

Test Method Development Priority

When comparing priorities for simulation vs. testing, they have the same priority and are both needed. Three priority tiers for the development of specific test method areas:

- Tier 1: Interior U-Factor, SHGC, coplanar
- Tier 2: Exterior coplanar and non-coplanar SHGC
- Tier 3: Exterior coplanar U-Factor

Important in any commercial testing program is how to standardize results of testing from multiple labs.

Product Testing Procedure Priority

Finalizing a test method for the following products should be the first priority for LBNL:

- Interior cellular shade
- Interior and exterior slat shade
- Interior and exterior roller shade
- Interior and exterior solar screen
- Awnings
- Roller shutter
- Louvered shutter
- Pleated shade

It is important to note that the results of D&R International's behavior study will help drive the schedule for testing and the energy performance calculations. At the completion of work in FY12 LBNL will release an updated list of available capabilities and data and a schedule for comment concerning simulation and test method creation.

Testing and Simulation Gaps

The WINDOW and THERM simulation tools have the most comprehensive set of simulation models for window attachments as compared to any other tool available in the world. The notable exception to that are awnings, which can be modeled in EnergyPlus. North American testing methods for combinations prime window + attachments are lagging, but this is worldwide issue. EU countries have more experience in testing shading devices and attachments in general, but those are not standardized and so are less useful.

Possible gaps that need to be investigated in order to realize proper testing and simulation methods include:

1. Standardizing testing results from multiple testing laboratories
2. Installation and preservation of the integrity of the attachment during testing (i.e., how to secure shading device on the exterior side, where we have high wind speed)
3. At which angle should testing take place? (Simulation can accommodate a wide range)
 - a. Is one angle sufficient, or is multi-angle testing necessary?
 - b. What information can be reported to realize the full impact of blinds?
4. What is the effect of air movement on various shading systems?
5. How will installation issues be considered?
 - a. Will edge/air gaps be considered in testing and simulating?

Testing and Simulation Gap Solutions

Possible solutions to the gaps referenced above should keep testing and simulation simple and cost effective. Methods of simplifying the testing and simulation include:

- Testing on two types of windows: single pane clear and double pane clear
- Testing on one agreed-upon base window with a realistic, simple set of angles of incidence

Window Attachment Indices of Performance

First and Second Priorities for Window Attachment Indices of Performance

The first priority is to show U-Factor and SHGC. The annual energy performance of a window attachment may be even more important for consumers for recognizing performance in window attachments. Secondary priorities include:

- Visual transmittance
- Air leakage (especially for storm windows)
- Peak electric demand
- Cost effectiveness (with information on payback period and the product performance vs. the baseline)
- Useful life

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- Condensation Resistance, *CR*
 - Thermal comfort
 - Glare reduction index
 - Behavioral component
 - Illumination index
 - UV Protection

Highlighting performance differences to consumers will help the public to understand the effect of a specific attachment on their window. Consumer education is essential to ensure successful use of window attachments for energy and cost savings. The role of automation in improving the reliability of operations was discussed.

Deployment Program Summary Needs

Deployment Program Targets

Ideally, an ENERGY STAR program will accelerate deployment of efficient window attachments but it is not yet clear if EPA will develop such a program or when it might be completed. Many other existing deployment programs could be engaged in the short term, including:

- Weatherization and other state-run programs
- USGBC's LEED for Homes
- REGREEN Residential Remodeling
- Home Performance with ENERGY STAR
- Energy Rating Programs (RESNET)
- Utilities
 - Energy Efficiency Programs
- GreenGlobes
- ASHRAE Green Guides
- Building Performance Institute
- Online Presence
 - BuildingGreen/LBNL website (<http://www.windowattachments.org/>)
 - DOE, EPA
 - Manufacturers
- Retailers
 - Home Depot (own EE logo – eco options)
 - Lowe's
 - Showrooms for blinds and shades

Deployment Program Technical Requirements

Priorities that need to be completed in order to work best with deployment programs include:

- Readily available data with U-Factor and SHGC information
- Validated methods to convert attachment properties to energy impacts, including operations.
- The completed behaviors survey from D&R International
- Energy performance and cost effectiveness information broken down according to climate zone

Deployment Program Priorities

- Resolving Testing and simulation gaps is the top priority
- Complete market survey analysis about behavioral patterns in use of attachments
- Perform rigorous, objective technical analysis of energy savings impacts that is persuasive to EPA—
- If EPA decides to proceed with ENERGY STAR for attachments, then EPA develops performance criteria in conjunction with the energy analysis, initiates technical work to develop program details and initiates a stakeholder review process
- If EPA decides not to pursue an ENERGY STAR label, then all of the technical work completed can be leveraged by other 3rd party market transformation programs

IV. Action Items and Next Steps

Window Attachment Product Categories

The window attachments master spreadsheet lists the currently discussed and noted product categories, characteristics and attributes, with the following modifications:

- Review product categories and develop final list, taking into consideration additional product categories that were discussed during the meeting
- Develop definitions of Product Lines and Individual Products for which energy performance indices will be developed
- Develop simplifications to the product lines and individual products so that large number of individual products and options can be substantially reduced

Window Attachment Product Performance Metrics

U-factor and SHGC are the primary metrics that need to be completed. If possible, eliminate the effect of the window type and base performance only on the actual attachment.

- Standardized indices of performance: U-Factor and SHGC
- Agree upon solar incidence angles for reporting SHGC and VT.
- Consider Energy Performance index (EP)
- Investigate feasibility of development of differential performance metrics (i.e., ΔU , $\Delta SHGC$, ΔEP)
- Consumer education will be a top priority in order to properly present window attachment performance indices and potential for energy savings.

Window Attachment Simulation, Testing and Measurement methods/tools

An updated schedule for completing window attachment simulation and testing methods will be completed and shared by LBNL. Other action items came from simulation and testing gaps:

- Prioritize and complete the development and validation of missing simulation methods
- Develop standards for measurement of U-factor and SHGC of window attachments with base window.
- Define the proper angle for reporting SHGC in testing
- Coordinate development of simulation and measurement methods with International partners through ISO and IEA

Deployment Program Requirements:

Technical Requirements:

Priorities that need to be completed in order to work best with deployment programs:

- Readily available data with U-Factor and SHGC information
- The completed behaviors survey from D&R International
- Energy performance and cost effectiveness information broken down according to climate zone

Other Deployment Program Requirements:

Explore all viable deployment options beyond ENERGY STAR:

- Building America
- SWEEP
- State Energy Programs
- Utility Programs
- REGREEN

Next Steps

DOE will coordinate with window attachment stakeholders on the following development efforts:

- Specific task groups based on the findings in this meeting. Proposed regularly meeting task groups will include:
 - Window Attachment Product Categories
 - Window Attachment Product Performance Metrics
 - Window Attachment Simulation Methods and Tools,
 - Window Attachment Standardized laboratory Measurement, and Field Measurement methods
 - Window Attachment Indices of Performance and Consumer Education
 - Deployment Program Requirements
- A window attachment action plan based on activities with these task groups.
- A schedule from LBNL will be shared with dates for technical work completion.
- Future window attachment workshops to present updates and identify commercial window attachment opportunities, including daylighting impacts.

If there are any comments concerning this report, please send them to wzalis@energetics.com.

Attendees

<p>The U.S. Department of Energy Marc LaFrance, Technology Development Manager, Building Envelope & Windows R&D Program Subid Wagley, Building Technologies Program (2nd day only) Alexis Abramson, Emerging Technologies Lead, Building Technologies Program (2nd day only)</p> <p>Lawrence Berkeley National Laboratory Charlie Curcija, Windows Group Deputy Leader Steve Selkowitz, Windows Group Leader</p> <p>Environmental Protection Agency Doug Anderson, ENERGY STAR Home Improvement Program</p> <p>National Fenestration Rating Council Ray McGowan, Senior Program Manager Jim Benney, Executive Director</p> <p>Window Covering Manufacturers Association Teri Williamson, Newell Rubbermaid Michael Cienian, Hunter-Douglass Rob Simons, Hunter-Douglass John Woestman, Kellen Company Ralph Vasami, Kellen Company</p> <p>Professional Awning Manufacturers Association John Gant, Glen-Raven Don Smallwood, ABC Sun Control Greg Schmieler, Laurel Awning Co.</p> <p>International Window Film Association (IWFA) Steve DeBusk, CP Films/Solutia Lisa Winckler</p>	<p>BuildingGreen Peter Yost</p> <p>D&R International Steve Bickel, Director of Market Research Emily Phan-Gruber Shannon Christie</p> <p>WinBuild Bipin Shah, President Ross McCluney</p> <p>Window and Door Manufacturers Association Joe Hayden, Pella Corporation Roger LeBrun, Velux America Jeff Inks, Vice President, Code & Regulatory Affairs</p> <p>Consortium for Energy Efficiency (CEE) Alice Rosenberg, Program Associate</p> <p>Larson Todd Stratmoen</p> <p>Quanta John Siegel</p> <p>Somfy Mark Dammeyer</p> <p>Energetics Incorporated Walter Scheib Walt Zalis</p>
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