



Center for Sustainably Integrated Buildings and Sites (SIBS)

Case Study of Shading Technologies

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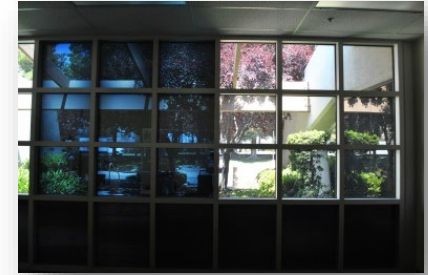
Study Summary & Hierarchy

- Two components of shading study:
 - Quantitative measurements
 - Qualitative measurement of occupant comfort
- Hierarchy of issues associated with shading technologies:
 - Glare Control
 - Access to Daylight & Quality Views
 - Energy Impacts



Motivation

- Can we quantify the impact of various strategies and help to identify what makes sense in a given climate zone and building type?
- Quantification should account for thermal impact, lighting savings, and the effect of glare on the occupant





Case Study Sites and Shading Technologies

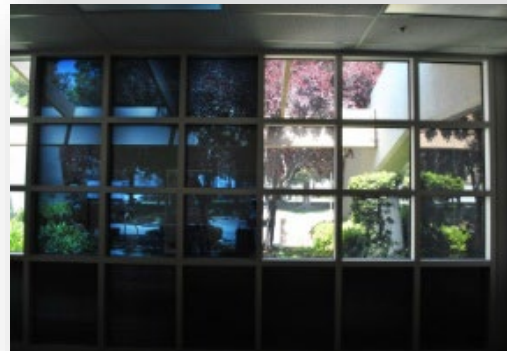
**Automated
Venetian Blinds,
Light Redirecting**



**Automated
Fabric Shade
Screens**



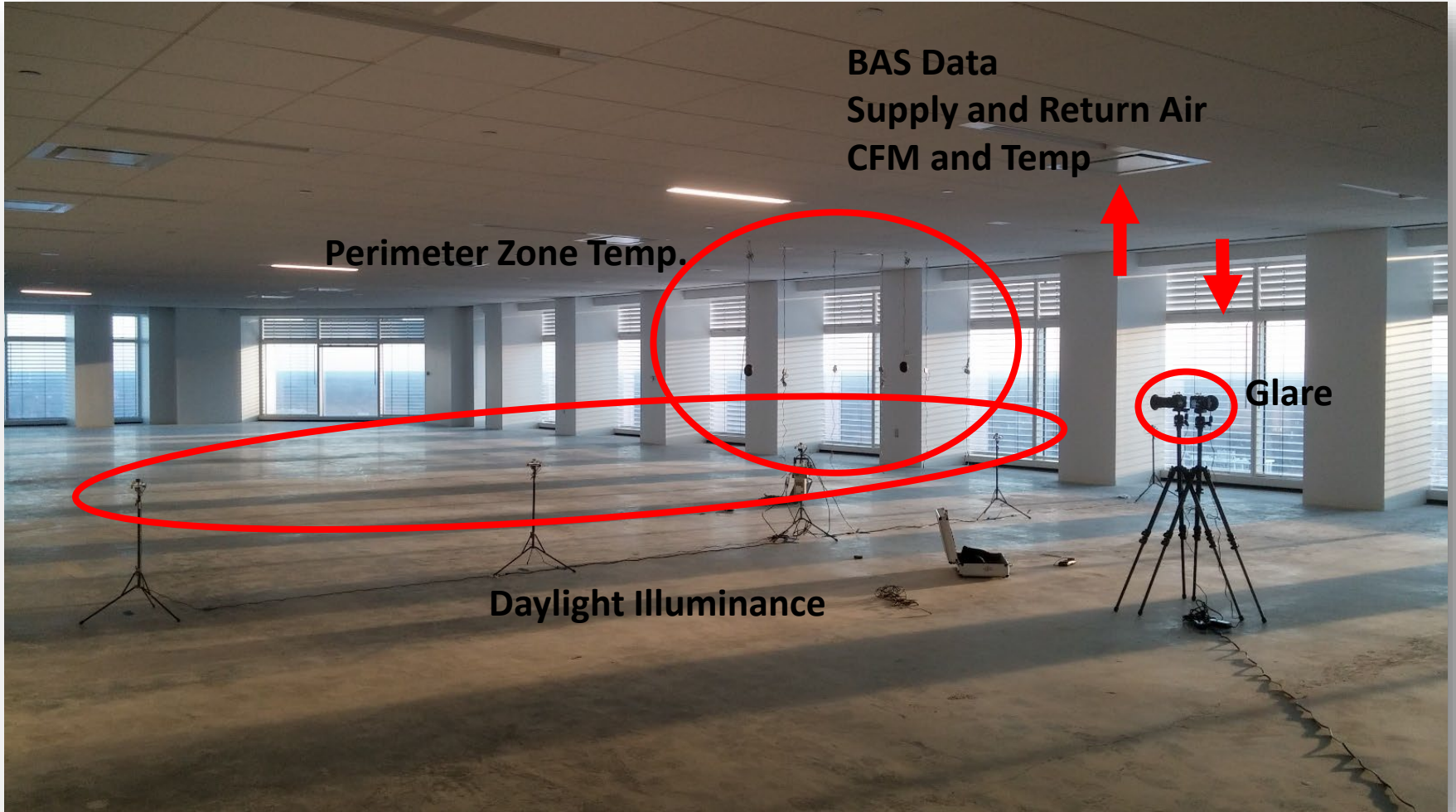
**Electrochromic
Glass**





Summary of Measurements

Data collected at 15 min. intervals





Summary of Data Collection

- Survey was sent to occupants of
 - Duke Energy Center
 - Research Drive
 - Innslake
- 20+ Questions related to visual and thermal comfort
- Over 1,000 responses





Experimental Design

Lower Blinds
Retracted

Lower Blinds
Down and Open

Lower Blinds
Down and Closed

Upper Blinds
Retracted



Upper Blinds
Automated

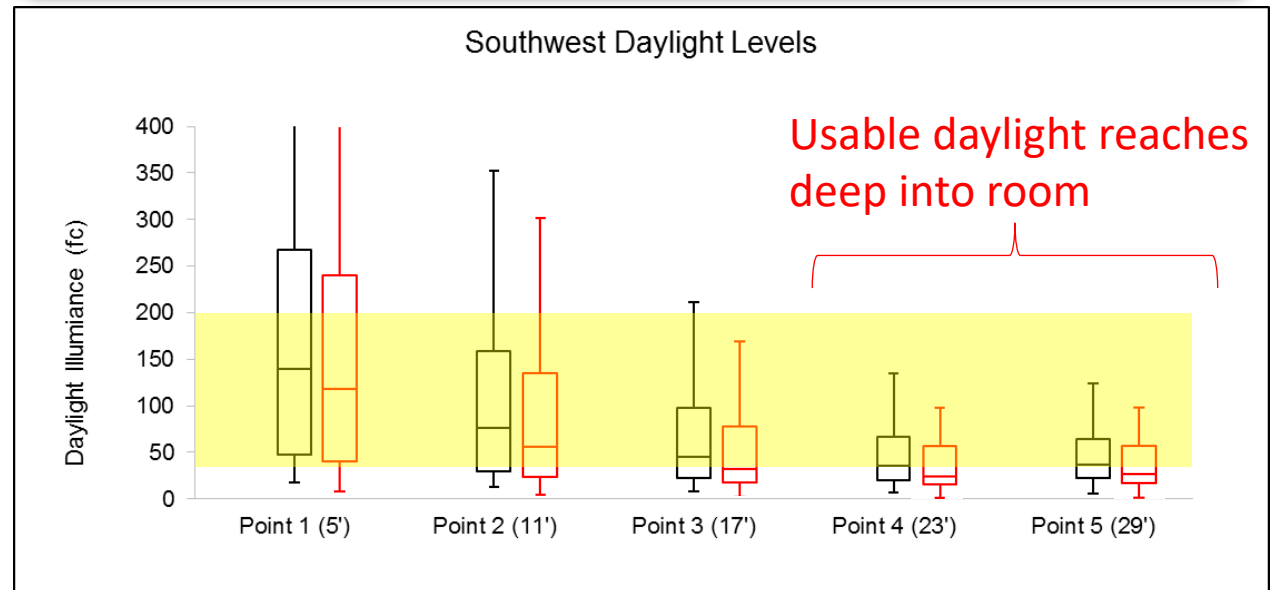


Data collected on a clear sky day for each scenario



Daylighting Trends – Automated Venetian Blinds

- **Light Redirecting Louvers** prevented glare from upper window
 - Have added benefit of preserving daylighting potential while controlling glare when direct sunlight is present



□ Redirecting Louvers Removed

UDI 54%

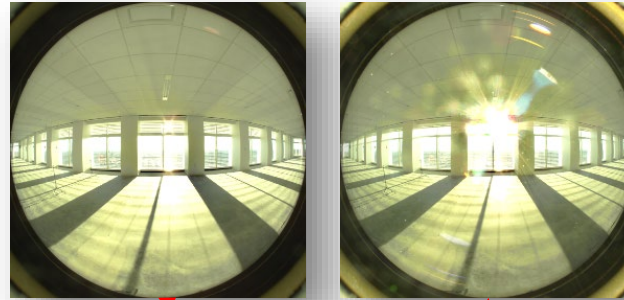
□ Redirecting Louvers Used

UDI 53%

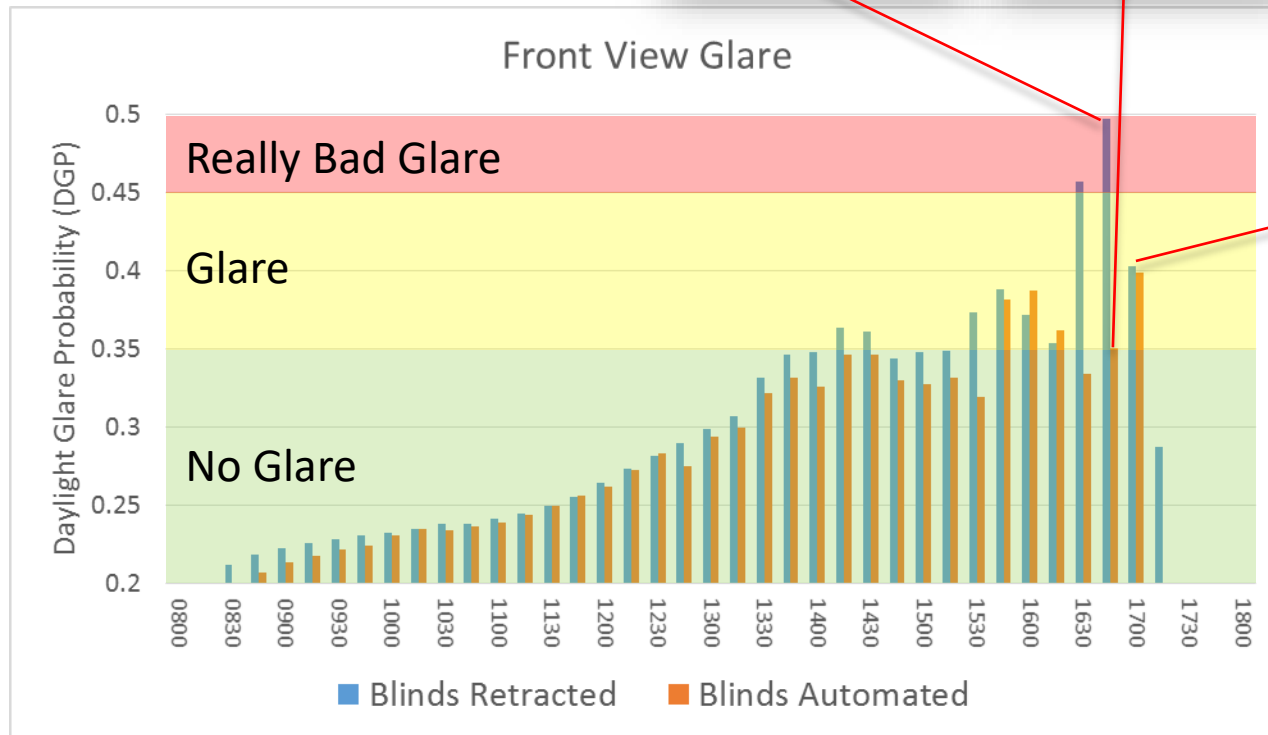


Glare Trends – Automated Venetian Blinds

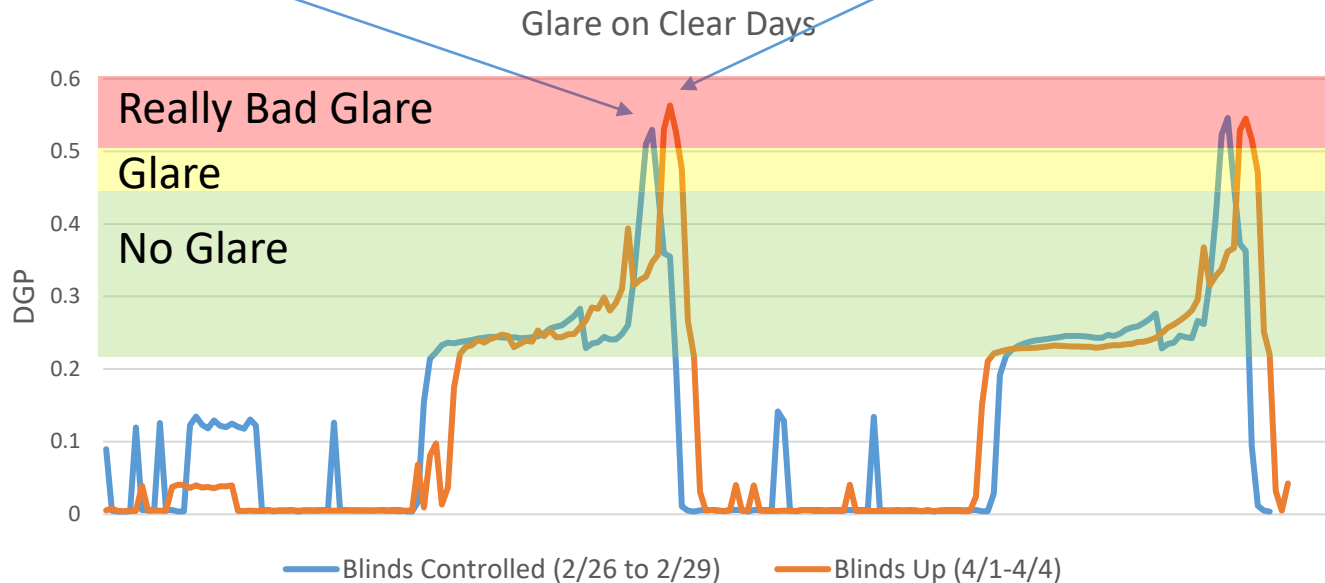
Primary benefit of upper blinds is glare control



Perforated lower blinds do not fully control glare



Glare Trends – Fabric Rollers

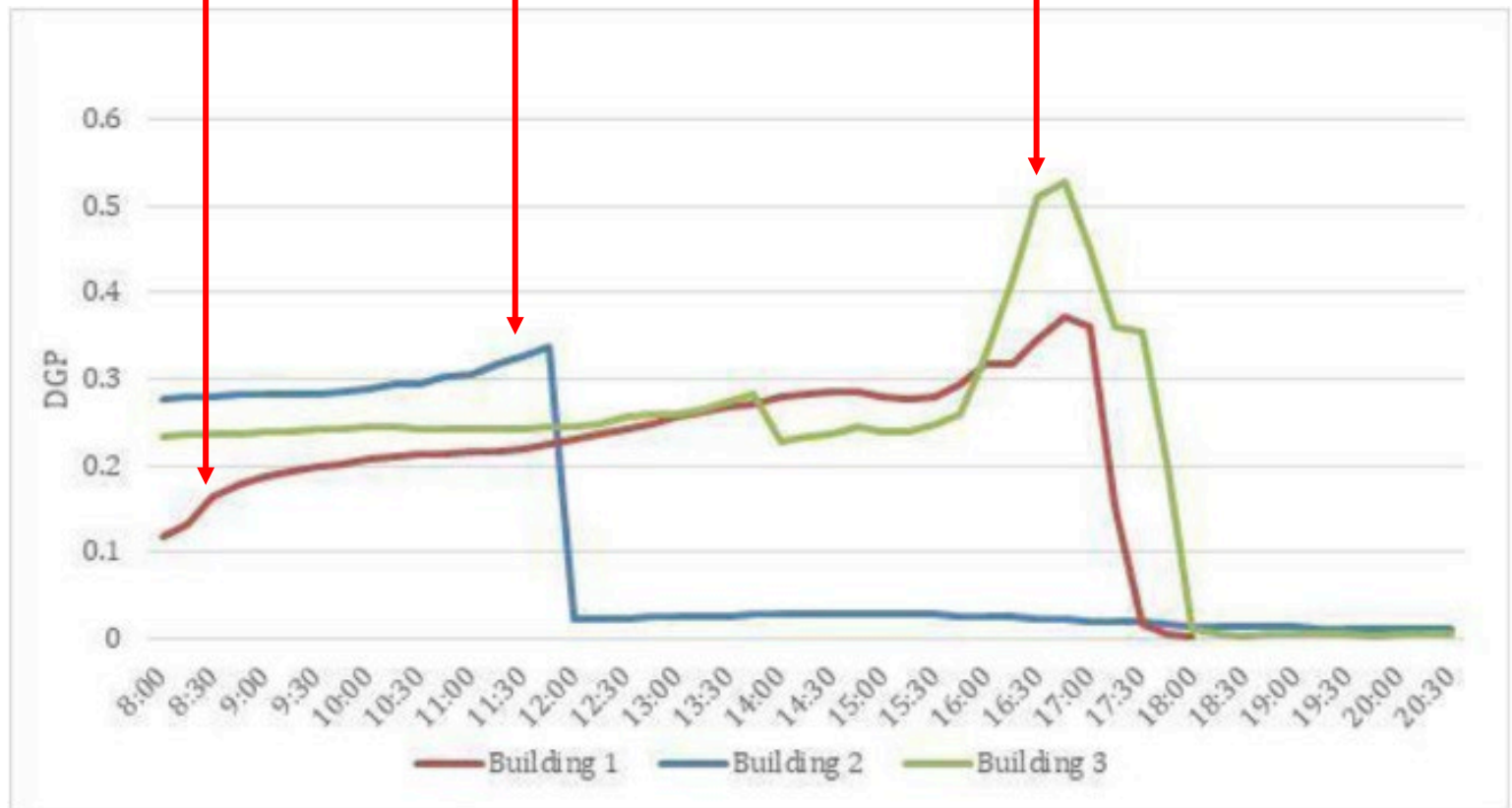


Glare Trends by Technology

Automated Venetian Blinds

Electrochromic Glass

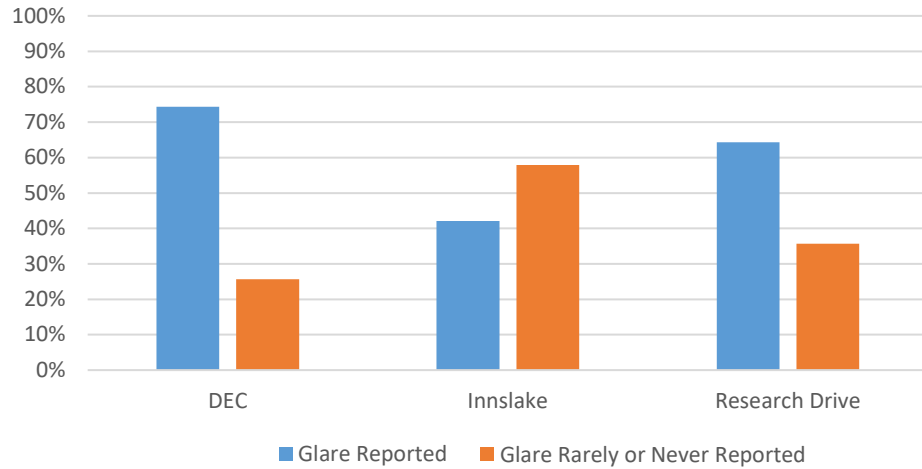
Automated Fabric Shade Screens



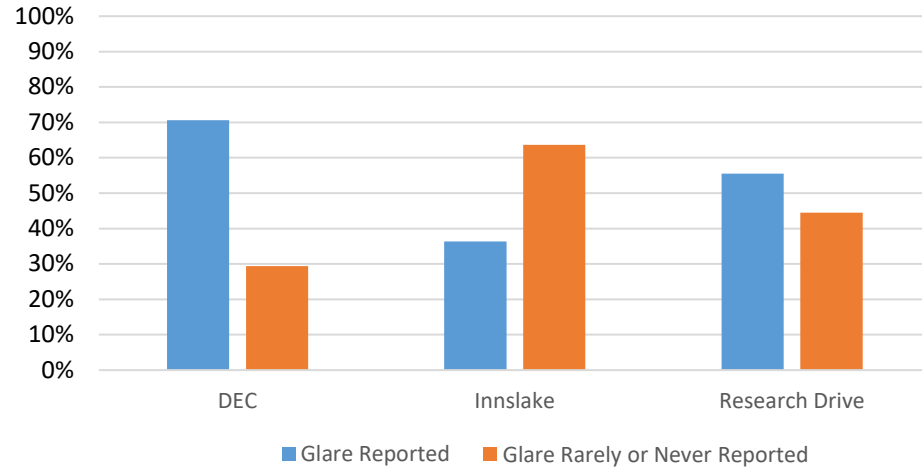


Glare Reports (occupants 0 to 5 Feet from Window)

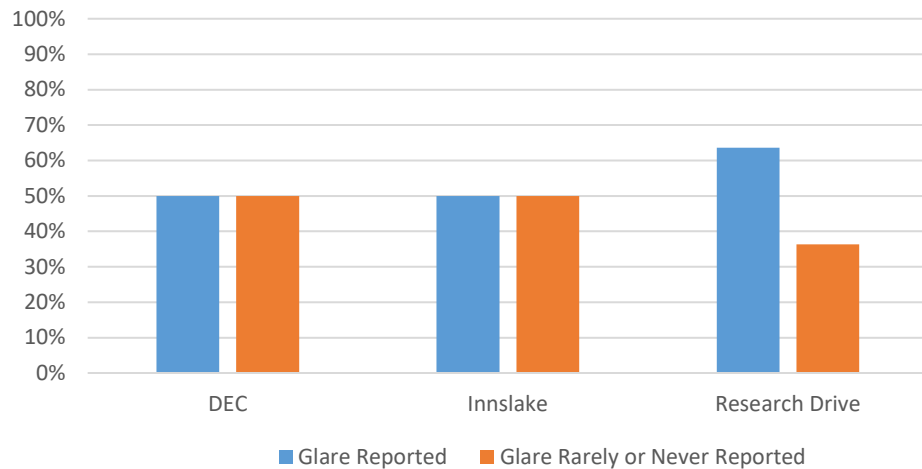
North



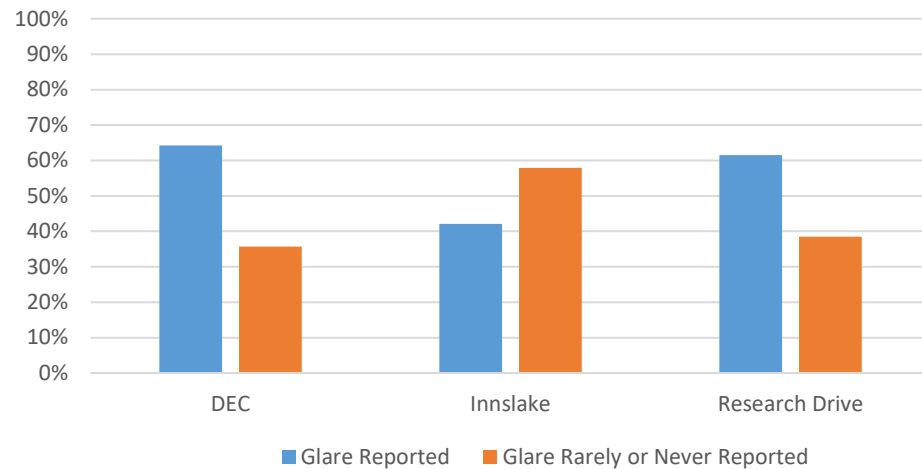
South



East



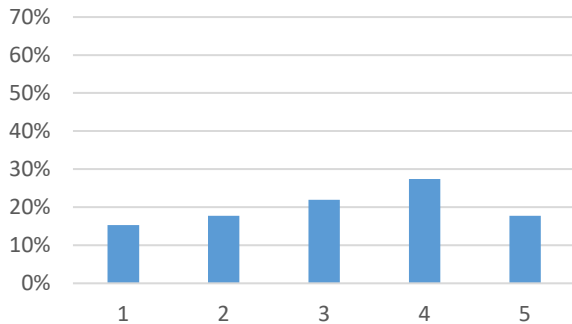
West



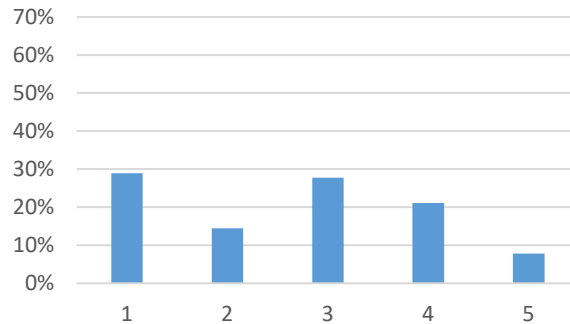


Visual Satisfaction of Interior Occupants Varied Greatly between Shading Technologies

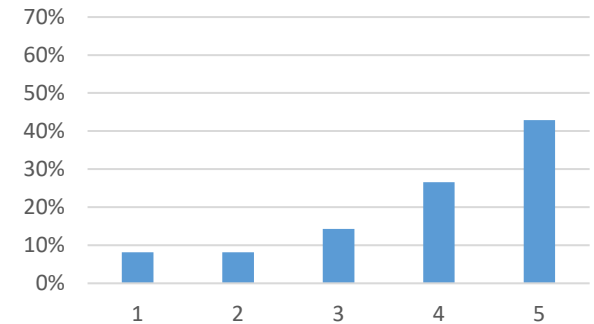
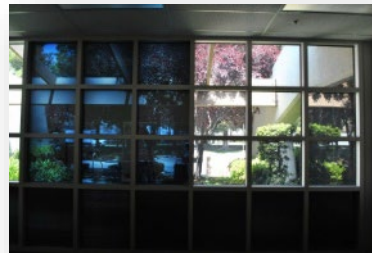
I am pleased with ACCESS to natural daylight in my office workspace –
Occupants greater than 16' from window in an open office setting with partitions less than 5' tall



Automated Venetian Blinds



Electrochromic Glass



Automated Fabric Rollers



Results are from a larger survey
20+ Questions related to visual and thermal comfort
Over 1,000 responses



Effective Glare Control Technologies

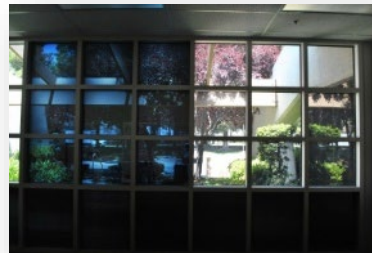
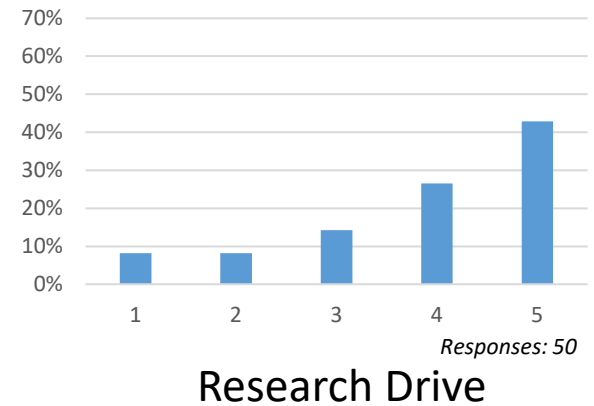
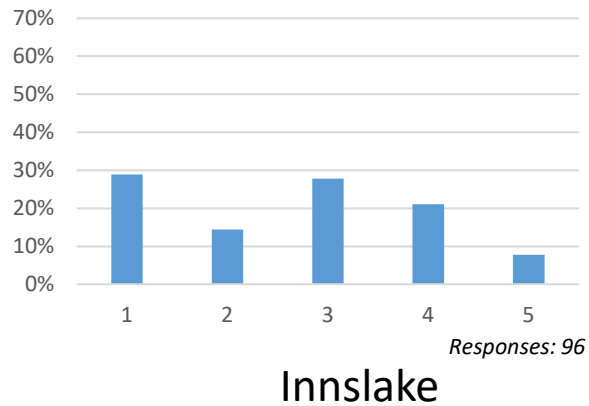
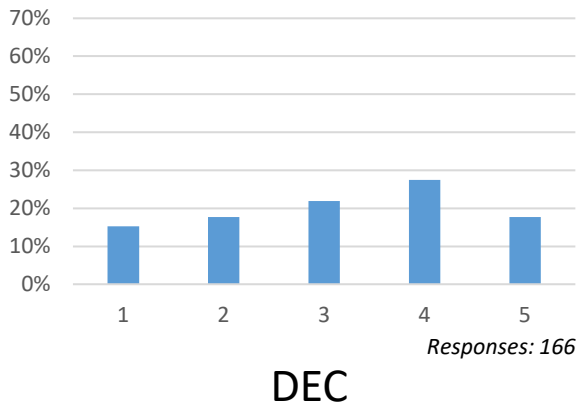
- Light Redirecting Louvers
 - Have added benefit of preserving daylighting potential when direct sunlight is present in upper windows
 - View through upper window is always obstructed
- Properly Selected Fabric Roller Shades
 - Dark colored blinds tend to preserve some amount of view when direct sunlight is present
 - Automation can preserve daylighting potential when direct sunlight is not present
- Electrochromic Glass (*view Dynamic Glass*)





Visual Satisfaction of Interior Occupants Varied Greatly between Shading Technologies

I am pleased with ACCESS to natural daylight in my office workspace –
Occupants greater than 16' from window in an open office setting with partitions less than 5' tall





View and Lighting Satisfaction/Comfort

- Interior occupants at Research Drive (light colored fabric roller shades) are significantly more pleased with their access to daylight than at other buildings
- This may be influenced by the building design and interior layout but is likely a result of the light colored fabric shades that transmit greater amounts of daylight when down
- The light colored shades likely avoid the “gloomy” feeling reported in comments by occupants of Innslake with EC glass which gets very dark when tinted
 - The light colored shades also have the benefit of greater daylighting potential when down compared to EC glass or dark colored shades
- The benefit of greater access to daylight by interior occupants at Research Drive comes at the cost of less glare control for occupants close to the windows
 - Reports of glare by occupants 5’ or closer to a window
 - Research Drive: 61.3%
 - Innslake: 42.5%



Energy Benefits of Shading Technologies

- Shading technologies have the potential to save energy through
 - Reduced solar gains
 - Daylighting
 - Reduced electric lighting energy
 - Reduced heat gain from lighting





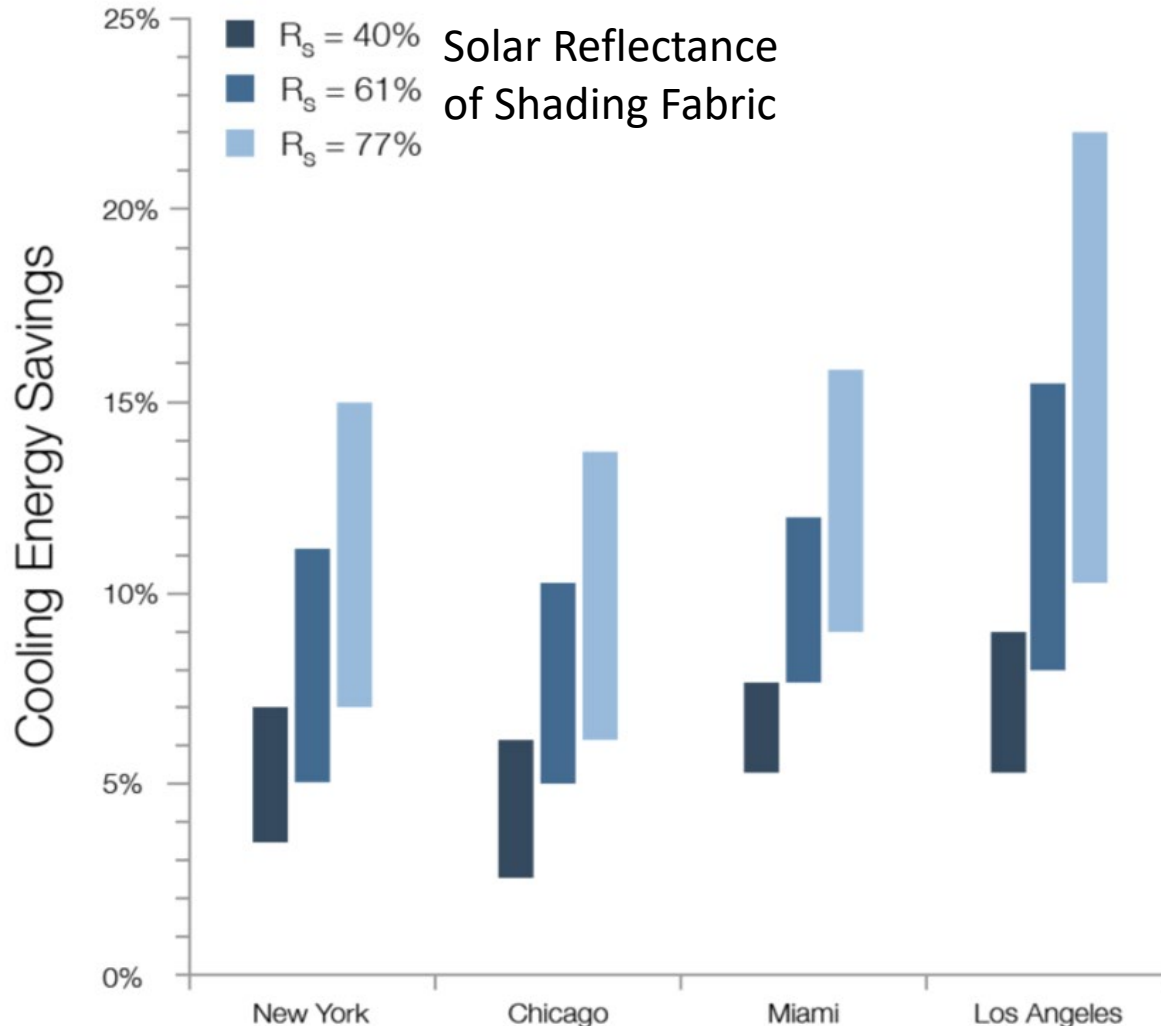
Energy Benefits of Shading Technologies

- Interior Blinds do not significantly reduce solar gains with glass types typically used in new buildings





Cooling Energy Savings Estimated by Lutron/Purdue Study (2010)



Cooling energy savings based on 0.40 to 0.47 SHGC. **Lower SHGC leads to lower savings from interior shades.**

SHGC of Studied Bldgs

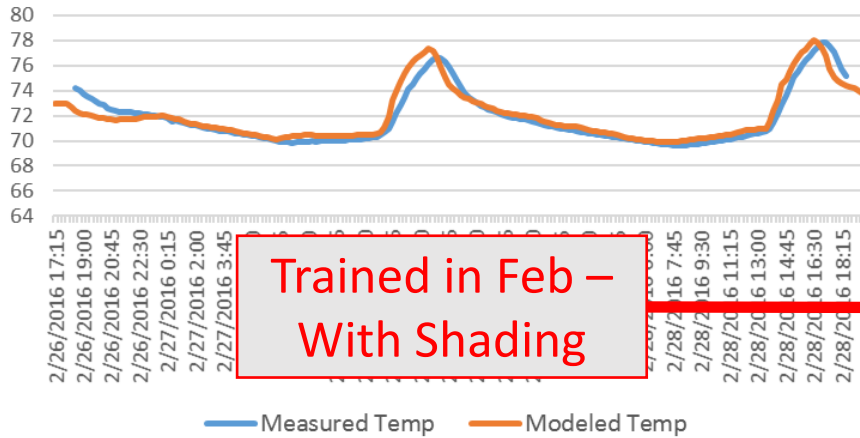
DEC:	0.25
Research Drive:	0.17
Innslake (org):	0.22
1BoA:	0.27

<http://www.performanceshadingadvisor.com/#thermalmanagement>

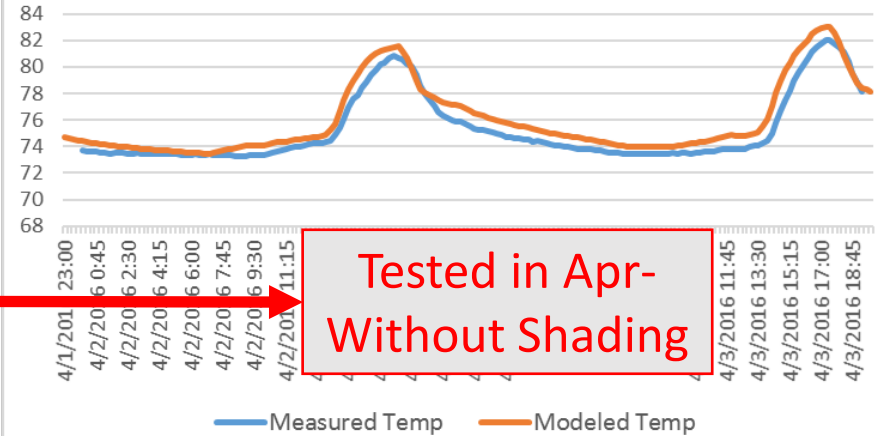


Energy Impact Analysis by Calibrated Modeling

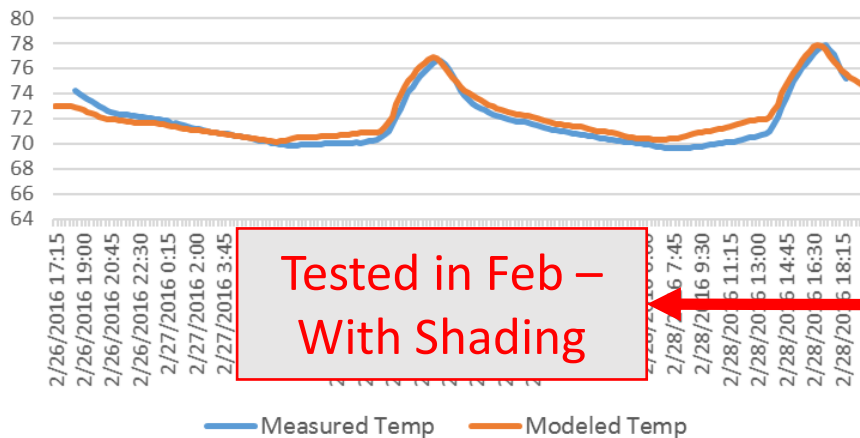
Training - Clearsky with Shades Automated



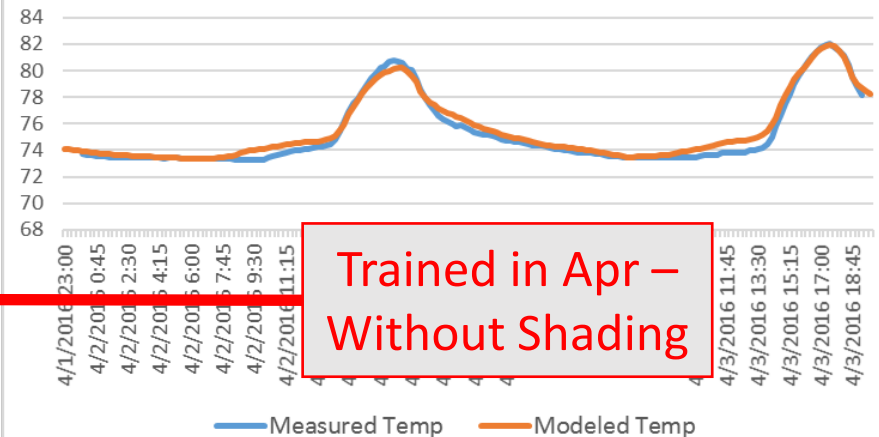
Test - Clearsky with Shades Retracted



Training - Clearsky with Shades Automated



Test - Clearsky with Shades Retracted





Summary Findings: Shading Technologies

- Glare: Least amount reported with electrochromic glass (5' from window)
- View Satisfaction:
 - Quantitative findings conflict with survey responses from occupants
 - Window treatment seems to minimally impact occupant experience of glare, close to and far from window
 - Interior occupants with light-colored fabric roller shades significantly more pleased with access to daylight than at other buildings
 - Likely a result of the light colored fabric shades that transmit greater amounts of daylight when down
 - “Gloominess” reported with electrochromic glass
 - Not bilaterally daylit, single daylighting wall visible to occupants
 - Daylighting effectively turned off when tinted
- Energy:
 - Interior blinds: No significant impact on solar gains when glazing SHGC is low (code compliant)
 - Electrochromic glass: greatest savings possible when replacing high SHGC glass





Center for Sustainably Integrated Buildings and Sites (SIBS)

Thank You

More information can be found in the this article.

Blinded by the light: Occupant perceptions and visual comfort assessments of three dynamic daylight control systems and shading strategies

Julia K. Day, Benjamin Futrell, Robert Cox, Shelby N. Ruiz

<https://doi.org/10.1016/j.buildenv.2019.02.037>

