General Services Administration
Public Buildings Service

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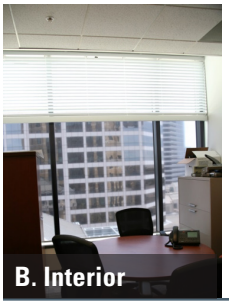
DUAL-ZONE INDOOR SHADES

More Efficient than Roller Shades but Less Efficient than Venetian Blinds

Traditional window shades, such as roller shades and venetian blinds, block sunlight from interior workspaces in an effort to reduce glare and unwanted heat gain, resulting in increased reliance on artificial lighting. Dual-zone indoor shades address glare and heat gain by integrating two separate daylight control strategies into a single unit—an upper louvered blind that maximizes daylight harvesting and a lower roller shade that controls glare and reduces heat transfer, while at the same time preserving views. To test the efficacy of dual-zone shades, CEBT worked with Lawrence Berkeley National Laboratory (LBNL) to assess a test-bed installation at the Ronald V. Dellums Federal Building in Oakland, California. Researchers found that compared to roller shades, the dominant shading technology in commercial buildings, the dual-zone shades decreased energy use from 8% to 20%. However, when compared with venetian blinds, which are more prevalent within GSA's portfolio, the dual-zone shades increased lighting energy use from 150% to 300% and HVAC cooling load from 5% to 36%. LBNL's assessment also revealed that glare and thermal discomfort were reduced and that occupants appreciated the unobstructed views provided by the lower roller shades; 80% of them preferred the dual-zone shades over the legacy vertical blinds. From a cost-savings standpoint, dual-zone shades are not broadly recommended for GSA. From an occupant satisfaction standpoint, however, they should be considered—increased daylight and unobstructed views have both been shown to augment occupant satisfaction and productivity.

INTRODUCTION

A. Exterior Gray/Silver and Gray/Gray


B. Interior

Preserves Views to the Exterior

A. Left window shows the roller shade with the reflective silver exterior. Right window shows the non-reflective gray exterior.

B. Lower gray/gray shade is fully lowered

" Shading systems come with trade-offs. You can have a view, for instance, or you can reduce energy consumption, and it's often hard to decide. A new rating system from the Attachments Energy Rating Council (AERC) will help evaluate these trade-offs."

—Eleanor Lee
Staff Scientist
Building Technology and Urban Systems
Lawrence Berkeley National Laboratory

TESTED CONFIGURATIONS
Dual-Zone Indoor Shades

Automated Upper Shade
+ reflective silver exterior lower shade

Manually-Operated Upper Shade
+ reflective silver exterior lower shade
+ non-reflective gray exterior lower shade

What Is This Technology?

UPPER ZONE FOR DAYLIGHT, LOWER ZONE FOR VIEW

The upper light-harvesting zone of the dual-zone shade is composed of inverted horizontal louvers, while the lower zone is made of a translucent solar shade that diffuses natural light and reduces glare, while maintaining outdoor views. The upper section can be manually or automatically controlled, either with a stand-alone application or through integration with a building automation system (BAS). CEBT tested two dual-zone shade control configurations one in which the upper and lower shades were both manually controlled, and another in which upper shades were automated by a stand-alone application while lower shades were manually controlled. In the automated configuration, an outdoor photosensor and software, using sun angles and times of year, triggered the venetian louvers to raise when the sky was cloudy and lower when it was sunny. CEBT also tested two different configurations of the lower roller shade—a gray/silver version with a transparent gray interior and a reflective silver exterior; and a gray/gray version, with a transparent gray interior and a non-reflective gray exterior.

What We Did

QUANTITATIVE EVALUATION AT ADVANCED WINDOWS TESTBED, QUALITATIVE AT DELLUMS FEDERAL BUILDING

Quantitative performance was measured at the Advanced Windows Testbed Facility at the Lawrence Berkeley National Laboratory in three side-by-side test chambers with large-area, south-facing dual-pane windows. The dual-zone shades were compared to a horizontal white venetian blind and a light gray roller shade that blocked 97% of ultraviolet (UV) radiation. Researchers measured lighting energy use, HVAC load and visual and thermal comfort.

Qualitative performance was evaluated at the Ronald V. Dellums Federal Building in Oakland, California. Dual-zone indoor shades were installed in 20,000 ft^2 of office space with large-area, south-, east- and west-facing, single-pane windows, and a mix of both open-plan and private-office layouts. The existing shading system at the Dellums federal building consisted of manually operated white vertical fabric blinds. Three configurations of the dual-zone shades were tested: automatically controlled upper horizontal louver shades with gray/silver lower shades, and manually controlled upper horizontal louver shades with both gray/gray and gray/silver lower shades. Researchers interviewed installers and building managers and issued occupant surveys before and after the installation of the dual-zone shades.

M&V FINDINGS

MORE EFFICIENT THAN ROLLER SHADES, LESS EFFICIENT THAN VENETIAN BLINDS Compared to fabric roller shades, manually operated upper louver shades with gray/gray lower shades decreased energy use by 0.35 kWh/ft^2/yr, or 8%; the gray/silver reflective lower shade configuration saved an additional 0.24 kWh/ft^2/yr or 6% (14% total). Automatically controlled upper louver shades with a gray/gray lower shade saved 0.86 kWh/ft^2/yr or 20%.

Compared to horizontal venetian blinds, different configurations of dual-zone indoor shades increased lighting energy use 150% to 300%, from 0.16 kWh/ft^2/yr (automatic, gray/gray in winter) to 0.75 kWh/ft^2/yr (manual, gray/silver in summer). They also increased HVAC cooling load 5% to 36%, from 0.08 kWh/ft^2/yr (manual, gray/silver in summer) to 3.14 kWh/ft^2/yr (automatic, gray/gray in winter).

Researchers found that venetian blinds are in general more energy efficient than roller shades. Compared to a fabric roller shade that is partially lowered, horizontal venetian blinds with a slat angle of 40° demonstrated a 0.91 kWh/ft^2/yr lighting energy savings (84%) and a 0.45 kWh/ft^2/yr HVAC savings (10%) during summer months.

USEFUL DAYLIGHT INCREASED ON SUNNY WINTER DAYS Compared with venetian blinds, the dual-zone shades increased access to daylight on sunny winter days by 12 minutes (when manually controlled) and by 42 minutes (when automatically controlled). Compared with roller shades, dual-zone shades increased useful daylight by 165 minutes, or 2 ¾ hours. On overcast days, manual dual-zone shades were less successful at maintaining adequate useful daylight levels, compared to the reference horizontal venetian blind.

GLARE AND THERMAL COMFORT CONTROLLED IN ALL THREE TEST-BED CONFIGURATIONS At the Advanced Windows Testbed Facility, glare was found to be below the perceptible threshold with all three dual-zone configurations, except when the sun was in the field of view or when the upper shade was raised. At the Dellums building, visual discomfort due to glare was reduced with all three dual-zone configurations, compared to the original vertical blinds. Some occupants reported glare discomfort when sunlight through the upper louvers was viewed directly or reflected on computer screens. Occupants also reported improved thermal comfort for all three shade configurations, compared to the original vertical blinds.

80% SURVEY RESPONDENTS PREFERRED DUAL-ZONE SHADES OVER EXISTING VERTICAL BLINDS The unobstructed view provided by the lower dual-zone shade was cited by a majority of occupants as one of the primary benefits of the technology. However, 10% of survey respondents expressed dissatisfaction with the automated control of the dual-zone shade. Problems included noise from the motors, a single switch controlling multiple private offices, and controls not responding properly to outside conditions.

NOT COST-EFFECTIVE COMPARED WITH BOTH VENETIAN BLINDS AND ROLLER SHADES Compared to venetian blinds, energy use increased and the technology was not cost-effective. Compared to roller shades, the most cost-effective configuration was a manual upper shade with a reflective silver lower shade. When replaced at end-of-life, this configuration of the dual-zone shade had an estimated payback of 16 years, assuming a utility rate of $0.12 and fluorescent fixtures with advanced lighting controls already in place.

CONSIDER FOR REPLACEMENT OF ROLLERSHADES From a cost-savings standpoint, dual-zone shades are not broadly recommended for GSA. Where views to the outside are critical, dual-zone shades should be considered. The manual (not automatically controlled) configuration provided the best balance between financial performance, facility requirements, and occupant satisfaction.

CONCLUSIONS

These Findings are based on the report, "Dual-Zone Solar Control Indoor Shae," which is available from the GSA website, www.gsa.gov/cebt

For more information, contact GSA's Center for Emerging Building Technologies cebt@gsa.gov

What We Concluded

INCREASED DAYLIGHT, UNOBSTRUCTED VIEWS

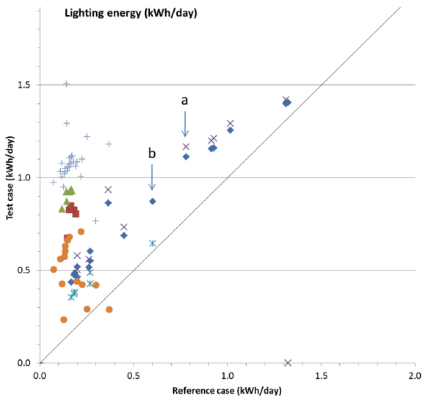
Overall, the idea underlying dual-zone shades is a good one. Increased daylight and unobstructed views have both been shown to augment occupant satisfaction and productivity. Moreover, by subdividing the window wall into a lower view zone and an upper daylight zone, the function of each of these components is optimized. This was corroborated by survey responses in which occupants voiced preference for the unobstructed views provided by the lower-portion of the dual-zone shades. From an energy savings perspective, however, the dual-zone shades were not found to be cost-effective, particularly when compared with GSA's legacy venetian blinds. Though roller shades may be more contemporary, GSA's continued reliance on the more old-fashioned venetian blind turns out to be prudent.

Measured Energy Use

Points above diagonal line indicate energy use is greater than venetian blinds

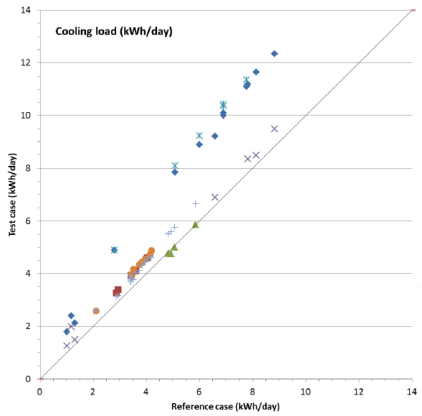
Lighting Energy

with Dimmable Fluorescent



Cooling Energy

Daily Cooling Load



Man-GG-W Man-GG-S Man-GS-W Man-GS-S Auto-GG-W Auto-GG-S RS-S Series8 Linear (Series8)

Technology for test-bed measurement and verification provided by LouverShade.

Cover photo, courtesy of LouverShade.

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