LBNL TECHNOLOGY ASSESSMENT OF MICROLOUVRE
VS DYNAMIC SOLAR SHADING IN
HIGH PERFORMANCE BUILDING ENVELOPES

by Carter Gilbert
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Exterior solar shading has significant technical potential to reduce envelope loads but broad market adoption has not occurred in the US, unlike the more progressive European Union with its milder climate. Shading that projects out from the face of the façade (called “noncoplanar” shading) such as overhangs and fins affect the architectural aesthetics of the exterior façade, require engineering to handle wind and seismic loading, and increase maintenance costs when it comes to washing the windows. Co-planar exterior shading (shading that is parallel to the face of the façade) presents somewhat less of an engineering challenge and is therefore potentially a more cost-effective candidate for retrofit applications – but less is known about available products and their performance.

Innovative, cost-effective, energy efficiency technologies and strategies for new and retrofit construction markets are essential for achieving near-term, broad market impacts. The recent study from LBNL focuses on innovative shading technologies that have the potential to significantly curtail annual cooling costs and reduce summer peak electric demand.

The building industry understands energy-efficiency potential does not always match actual, real world performance in the field due to a variety of mitigating factors. Third party verification of the energy savings potential of innovative technologies is important for market adoption. In the case of shading, new simulation tools have only recently been developed to improve modelling accuracy. Market acceptance is also, heavily dependent on how well the technology balances comfort and indoor environmental quality (IEQ) requirements (e.g., view, brightness, etc.).

Commercial product offerings for exterior coplanar shading include a variety of solutions:

a) fixed or operable louvered systems (15-91 cm, 0.5-3 ft wide louvers) that can withstand the weather elements.

b) lighter-weight, operable louver, venetian blind, or roller shade
systems that are retracted when wind speeds exceed a specified level or when ice and snow accumulation is expected (e.g., seasonal retraction during the winter)

c) thin, lightweight fixed solar screens held within a frame for low-rise applications

d) metal mesh screens that can be rolled up into a header rail.

Some of the more innovative systems are comprised of shading elements/slats whose geometry and surface reflectance properties have been engineered to address the challenges of delivering both solar control, daylight, and view. Each of these solutions have been used by the architectural/ engineering community in innovative ways to define the architectural character of the façade.

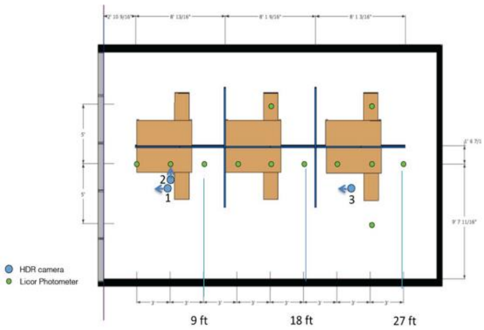
In California, simple coplanar exterior shading systems are needed to deliver significant, reliable energy savings to a wide variety of new and existing commercial buildings. Two types of systems have the potential to meet these criteria:

a) flexible, operable shading elements such as roller shades or screens whose side edges are held in an innovative structural rail (e.g., “zipper” roller shade) to withstand higher lateral loads from wind.

b) a light-weight but rigid, framed metal solar screen that can be mounted on existing windows using simple “snap-lock” fasteners, hinges or track systems.

Performance is dictated by both the shade type and material (e.g., fabric weave, openness, thermal properties, colour) and its operation. There have been significant advances in the development of building energy simulation tools that enable more accurate assessments of window heat gains, daylight, and comfort. Field measurements provide an opportunity to confirm findings from these tools.

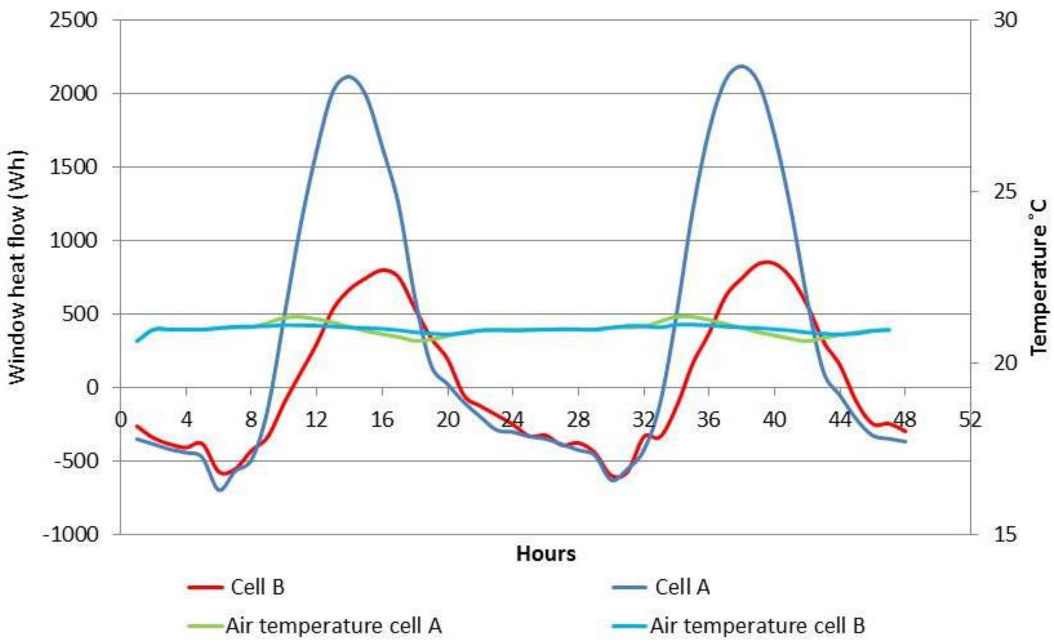
These two innovative shading technologies were evaluated through a controlled field monitoring program in the Lawrence Berkeley National Laboratory’s (LBNL) new Facility for Low Energy Experiments in Buildings (FLEXLAB) facility. The FLEXLAB facility consists of side-by-side, full-scale test rooms designed to emulate a 30 feet deep commercial office zone with open plan workstations. The two exteriors, coplanar (parallel to the face of the façade) shading systems were evaluated over a six-month, solstice-to-solstice period. Monitored data related to energy use, comfort, and indoor environmental quality (IEQ) were used to conduct a comprehensive assessment. The results are intended to provide utilities with vital, third-party information needed to plan energy efficiency incentive offerings for these two classes of technologies in California.



They both provide direct sun control with some diffusion of daylight to the interior. Views to the outdoors are filtered by the fabric or metal screen. Both systems reduce solar heat gains primarily by shading the exterior façade from direct sun. In the case of the metal solar screen, which is composed of horizontal slats, the cut-off angle of the slats blocks direct sunlight transmission to the indoors for moderate to high solar altitudes. For the automated roller shade, the shade height is adjustable, so the owner can allow some direct sun into the space for increased daylighting and unobstructed views by specifying the desired depth of sunlight penetration into the room.

The dynamic automated exterior shading system, on clear sunny days, the daily cooling loads due to the window were reduced by up to 24% and peak summer cooling demand was reduced by 26%. Glare was well managed during the summer but unacceptable on sunny days during the winter period near the window. When lowered, the 5% openness of the fabric roller shade inadequately blocked direct sun. Depending on the climate and layout of the interior space, a denser weave fabric or an indoor shade may need to be provided. The dynamic system was less successful at maintaining acceptable daylight levels in the centre zone

When MicroLouvre was assessed, daily cooling loads due to the window were reduced by up to 68% on sunny days (8 AM to 6 PM) and effectively controlled admission of direct sunlight compared to the same Title-24 2013 compliant, dual-pane, low-emittance window (SHGC=0.27, U-value=0.28 Btu/h-ft2-°F) with an indoor venetian blind. Peak cooling demand due to the window was reduced by up to 62% (for noncoincident peak periods). An indoor shade may be required to control glare during sunny winter periods. Microlouvre was able to maintain daylight levels within the "acceptable" range in the centre zone (10-20 ft) for greater than 80% of the tested period.



COOLING LOAD (WH) DUE TO THE REFERENCE (ROOM A) VERSUS THE MICROLOUVRE SYSTEM (ROOM B) FOR A 48-HOUR PERIOD. INDOOR AIR TEMPERATURE IS ALSO SHOWN ON THE GRAPH. DATA ARE GIVEN FOR OCTOBER 21-22, 2015

The “Title 24 2013” reference solar control low-e windows installed, considered to be a “high performance” solar glazing, are marketed with a low solar heat gain coefficient and U-value (SHGC=0.27, U-value=0.28 Btu/h-ft2-°F). On paper this solar low-e glazing has been considered a highly effective solution for solar heat gain reduction. This test, however brief, does show that there may be some real questions regarding the veracity of this “high performance” claim.

In conclusion, exterior, coplanar shading systems solve some of the structural and wind loading challenges of exterior shading and maintains a façade appearance, that is to some degree, architecturally within character of the original facade design. The dynamic roller shade with side rails offers a solution that can withstand moderate wind loads. It may, however, allow for individual screens to be fully retracted, partially or fully deployed across a façade creating an uneven aesthetic to the building. Modest solar control benefits would need to be balanced by the cost of installation, operation and maintenance. The static MicroLouvre solution is light-weight and avoids some of the problems of its macro-louvered counterparts which can encourage nesting birds, snow and ice accumulation, etc. A uniform aesthetic can be achieved as the screen is static in operation. High winds are not a problem with MicroLouvre as the wind loading is not significant (3lbs/ft^2 @ 60mph) and the assembly has been tested by the manufacturer to wind speeds up to 100mph without failure. Both systems are applicable to south-, east-, and west-facing facades (northern hemisphere) with significant exposure to direct sun (i.e., unshaded by nearby buildings and other obstructions). Benefits would be greater in hotter climates and for facades with moderate-to large-area windows.

The exterior shading systems may require use of interior shades to control glare and direct sun. In the case of the dynamic system, use of a fabric with a 1%- or 3%-openness factor on the exterior would likely be sufficient to control glare from direct sunlight. If a more open fabric is used, an interior shade would likely still be needed. Note that using a second roller shade fabric with the exterior dynamic system could produce a moiré (interference) pattern which could be visually distracting; an interior venetian blind is recommended. In the case of the MicroLouvre, the cut-off angle of the louvers was ~40°, which balanced the need for solar occlusion and daylight admission. For further glare control, use of a roller shade is recommended with this system.

Both systems were recommended for adoption by LBNL for various reasons. MicroLouvre exterior shading especially as a simple low-cost option given reductions in operating cost and the potential to downsize the capacity of the central chiller and air distribution system in deep retrofit applications. Because exterior shading can significantly reduce cooling peak demand, both systems are particularly applicable to low energy buildings that are reliant on innovative cooling strategies such as radiant cooling, night-time ventilation, and thermal mass to achieve very low energy use. To achieve the best balance between daylight, glare, and solar control, the existing conditions should be modelled to evaluate performance. Human factors studies are needed to better understand user interactions with respect to visual and thermal comfort and their impact on actual performance.