FACT SHEET • Solar Control Window Film

*It has been estimated that the cost of the energy lost each year in the U.S. as a result of unwanted heat gain or loss through windows is comparable to the value of the oil delivered by the Alaska pipeline.**

The installation of window film on existing windows as part of retrofit projects can be a highly effective method to increase the energy efficiency of buildings and to reduce peak demand during summer months.

Many advanced window film products can also allow existing buildings to capture most of the same solar control and visible light transmission benefits offered by new "smart windows," without altering building appearance or diminishing views.

**"Success Stories: Energy Efficiency Windows." Lawrence Berkeley National Laboratory (http://eetd.lbl.gov/success/window.html)*

Keep the Heat Out, Let the Light In with Today's Window Film

According to the California Energy Commission, around 40% of a typical structure's cooling requirements are due to solar energy entering through glass. With proper selection and installation, window film measures can help reduce a building's energy use and increase the overall comfort and productivity level of its occupants.[1]

How Can Window Film Benefit My Facility?

Energy and non-energy benefits that can be realized through installing window film in existing buildings include:

- Lower energy costs (many films can reduce solar heat gain by as much as two thirds)
- Enhanced comfort from reduced glare, reduced radiant heat near windows, and increased daytime privacy
- Less fading and deterioration of building furniture, carpets, and fabrics
- Reduction of up to 99% of ultraviolet (UV) radiation
- Increased shatter resistance of windows.

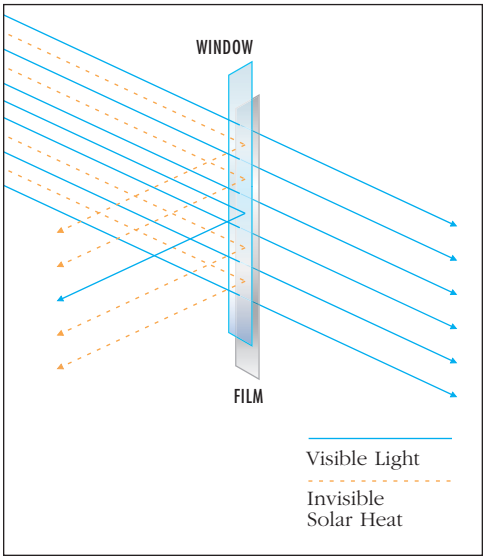
What Types of Film Are Available?

Window film is made of polyester layers that are transformed into a thin transparent plastic film or metallic laminate that adheres to all types of glass. A wide variety of window film products currently offered in the marketplace have differing effects on the optical and mechanical properties of the underlying glass. Applied window film products can be classified into two main categories: standard film (tinted and reflective) and spectrally selective film.

Pacific Gas and Electric Company®

[1] *Some window manufacturers do not recommend the use of window film due to the potential for increased thermal stress.*

Effect of Spectrally Selective Film



Standard Film: Standard products provide customers with a range of low-cost options for reducing their energy bills by lowering the level of solar heat gain. The total installed cost of standard window film products ranges from approximately $4 to $6 per square foot.[2] These products also provide non-energy benefits in the form of reduced glare, increased shatter resistance, and lower levels of ultraviolet (UV) radiation. However, they may accomplish these gains at the cost of reducing the level of daylight that enters the building and in some cases causing unwanted reflection.

Spectrally Selective Film: Spectrally selective films can generate significant increases in building energy efficiency since they block out (absorb or reflect) the infrared portion of sunlight that causes heat gain while allowing more visible sunlight to enter a building. These films are more expensive than standard products, costing approximately double the installed cost per square foot ($9 to $12 per square foot).

Because both types of products can be applied to the interior of most existing types of glass, window film can be an attractive energy efficiency retrofit opportunity; it is less costly to install than new chemically altered specialty glass and does not have the drawbacks of draperies or blinds.

How Can I Evaluate Different Products?

The performance of window film is typically measured using the following key criteria:

- **Shading Coefficient.** The ratio of the solar heat gain through a given window system to the solar heat gain under the same conditions for clear, un-shaded 1/8" single-pane glass. A lower shading coefficient denotes increased sun control capability. Although shading coefficients will vary according to the type of window film and glass that is being utilized, most products currently offered in the marketplace have a coefficient within a range of 0.3 to 0.7.
- **Solar Heat Gain Coefficient (SHGC).** A measure of how well a product blocks heat. A lower coefficient indicates superior performance. SHGC values for a highly reflective film can be as low as 0.26, while values for standard tinted and spectrally selective films can range from 0.4 to 0.6.
- **Visible Light Transmittance.** The percentage of visible light transmitted through a window relative to the total visible light incident on its surface. Visible light transmittance levels can reach 65% to 70% for spectrally selective films, compared to 18% to 50% for other window film products. Films with similar visible light transmission may exhibit considerable differences in solar heat gain, depending upon their composition and method of manufacture.

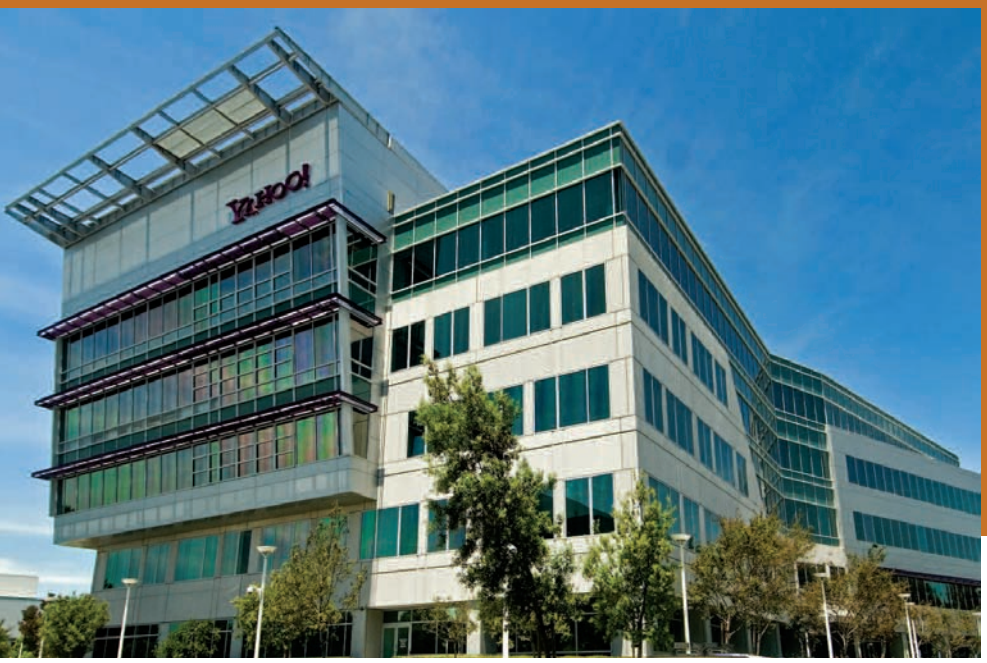
Additional elements for customers to consider when evaluating different window film products include: exterior and interior appearance, reflectance levels, energy impact, glare reduction, installation requirements, product life cycle, safety and security, durability, and scratch resistance.

How Attractive Are Investments in Window Film?

In California, where significant levels of solar heat gain during the summer can generate large cooling loads, the installation of window film at an existing facility can generate significant monetary savings. Although the payback on window film measures is highly dependent upon the film type and building-specific conditions, payback periods for most commercial buildings are less than 5 years. The average life of window film is 10 years, but some manufacturers claim that products have a life of up to 20 years.

For information about incentives for window film from PG&E, visit www.pge.com/biz/rebates or call the Business Customer Service Center at 800-468-4743.

[2]Actual prices depend upon the specifics of a given building, geographic area, and square feet of film applied.



Case Study

Yahoo! Inc., Sunnyvale

"The energy impact of this retrofit will be substantial. Across the six treated buildings we expect to save about 1.4 million kWh per year. With incentives from PG&E, the payback period will be a little over one year."

Rick Cuevas,
Senior Facilities Manager

AN ENERGY AUDIT LEADS TO SAVINGS

Yahoo!'s headquarters in sunny Silicon Valley consists of seven low buildings with extensive windows looking out on a landscaped campus.

A PG&E audit in 2004 measured temperature spikes in building perimeter zones on the east, west, and south as a result of solar heat gain through the large windows—a finding consistent with employees' experience. Using DOE-2 modeling of one of the buildings, PG&E engineers estimated the effect of applying film to selected windows. The results suggested substantial potential cost and energy savings.

Yahoo! then performed a physical test, applying film to the windows of one of two similar conference rooms in the same building with the same solar exposure and measuring the temperature difference between the two rooms with data loggers. The average difference of 2°F to 4°F during the hottest part of the day persuaded Yahoo! that window film would indeed reduce the heat gain and thus lower the cooling needs of the campus. The test also demonstrated that there were no aesthetic drawbacks, and that maintaining a more consistent temperature would increase employees' comfort.

INSTALLATION Yahoo! opted to apply film on all sides of six of its buildings (excluding the double-paned cafeteria), ultimately covering nearly 130,000 square feet of single-pane glazing in a project completed in mid 2006. To accommodate Yahoo! employees, work was carried out in the late afternoon and evening, over a period of approximately five months.

RESULTS According to Facilities Manager Rick Cuevas, "Before we applied the film, a conference room with a southwest exposure was a source of consistent complaints. The AC system simply could not keep the room comfortable on a hot day." With the film in place, it became possible to maintain the desired set-point temperature. The difference was clearly noticeable. Reduced solar heat gain has enabled the facilities staff to adjust temperature set points throughout the buildings. In individual work areas, employees can now open shades that were previously kept closed because of the intense heat.

A few months after the installation, this sizable project is meeting the needs of both those who work in the buildings and those who manage the building systems.

Case Study

Embarcadero Center, San Francisco

"We met all of our goals and more. We were pleased with the energy savings, which will contribute to lower operating expenses for the tenants. But the non-energy benefits were an especially important outcome for our tenants, and thus were, and are, important for our business."

Danny Murtagh,
Director of Engineering for
Boston Properties

GREAT VIEWS, TENANT COMFORT, AND ENERGY COST SAVINGS

Stunning views of the city and San Francisco Bay are one of the reasons why tenants chose the Embarcadero Center's office towers for their businesses. Not surprisingly, when offices and meeting rooms heated up or became too bright on sunny days, these tenants did not wish to close off their views with draperies or blinds. Further, different solar exposures made it difficult and expensive for the Center's facilities team to maintain an even temperature across floors and throughout its buildings.

The latest window film technology appeared to offer a solution that would reduce solar heat gain and glare, allow clear views, and reduce the buildings' air conditioning load without altering the Center's external appearance. On-site testing and a survey of buildings already using film technology revealed additional benefits—a significant reduction in ultraviolet (UV) radiation, which would reduce the fading and deterioration of tenants' carpets and furnishings.

INSTALLATION In late 2004 and early 2005, film was installed on three sides of the office towers, covering approximately 400,000 square feet of single- and double-pane glazing. Because the chosen film was designed to complement the tint of the Center's windows, the treated windows look essentially the same as the untreated (North-facing) windows. The center's floor-to-ceiling window line and shallow window pockets posed an installation challenge, as did built-in furnishings incorporating electrical, telephone, and computer wiring and equipment. Installers primarily worked at night and on weekends to minimize any inconvenience to the tenants.

RESULTS Although the eight-month installation was complex and costly, the results have been rewarding. Tenants noticed an improvement in comfort right away—especially those nearest the windows, who were no longer affected by radiant heat. Some tenants even asked that the air conditioning settings be turned *up*, leading to adjustments in temperature set points throughout the buildings.

With a large number of commercial tenants, the Center finds that its energy load is constantly changing. Nevertheless, it estimates that the window film project is saving over 2.4 million kWh per year. Given the accompanying financial savings, along with a substantial incentive from PG&E, the payback period is estimated to be three to five years.

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