# A Review and Examination of EnerLogic™ Window Film Performance Claims

*By Steve DeBusk, CEM, CMVP*
*Global Energy Solutions Manager*
*Solutia Inc., Performance Films Division*

## Abstract

Solutia Performance Films recently launched a new architectural window film with the brand-name EnerLogic™. Unlike most window films, that produce savings only during the cooling season, EnerLogic window film is an all-season, low-emissivity (low-e) film that produces both cooling and heating season savings. This paper will present details regarding the following claims being made about EnerLogic window film, which can be found at www.enerlogicfilm.com:

1. Other window film technologies can help you save energy. But because EnerLogic window film's patent-pending coating delivers excellent energy efficiency in every season, no other film can match its annual dollar or energy consumption savings.
2. EnerLogic window film is a low-cost, high-return technology that compares favorably to other popular energy-saving measures both in terms of energy efficiency and cost savings. In fact, EnerLogic window film typically outperforms most of the alternatives in terms of simple payback.
3. EnerLogic window film provides unparalleled glass insulating capabilities - no other window film even comes close. With its patent-pending low-e technology, EnerLogic window film has the best insulating performance of any film product available. The insulating power of EnerLogic window film gives single-pane windows the annual insulating performance of double-pane windows - and gives double-pane windows triple-pane insulating performance.

## Introduction

Window films have been used for decades for many reasons, but one primary benefit of architectural films are their ability to reduce energy costs in buildings and homes. Advances in the manufacturing of architectural window films, using all-metal films with no dyes to change color and innovative adhesive systems that securely adhere films to glass for many years, have enabled film manufacturers to typically offer 10-15 year warranties on many products used in non-residential settings, and often lifetime warranties in residential applications. Window films of today are durable products, protected by UV-absorbing layers that usually block 99% or more of the UV rays and a resilient scratch-resistant coating for easy cleaning and no maintenance. Many applications around the globe have been in service for more than 20 years providing long-term energy savings while maintaining a nearly-new appearance.

Most window films typically consist of a thin (0.025mm, 0.001 inch) polyester film substrate that has a micro-thin, transparent metal coating applied to one side that reflects and absorbs the sun's energy before it can be transmitted into a building space. By reducing the solar heat gain through windows and reducing the building cooling load, window films reduce the amount of time that a building's cooling equipment must run to maintain comfortable conditions, most often resulting in electricity savings. Savings of 5-15% in total building electricity costs, kilowatt-hour consumption, and kilowatt peak demand can often be achieved, with the savings amount dependent upon several factors, such as: glass type, window to wall ratio, presence of overhangs, climate, performance level of film used, and the efficiency of the building's cooling equipment.

While providing excellent cooling season savings, these "solar-control" window films often suffer from one drawback, in that they reduce solar gain through windows all year long, even when such heat gain may be desired (as during the heating season). So, in climates with prolonged heating seasons, on some buildings solar-control films may actually increase the amount of heat that must be supplied by the building's heating system. The gain of free solar heat during winter typically is not a large amount, as during winter there are considerably more days with cloudy weather and the hours of daylight during winter are less than during summer. Even when heating needs are slightly increased the overall net effect is still positive with cooling savings more than offsetting the loss of free solar heat in the winter and "solar-control" window films providing attractive returns on investment.

When desirable to produce improved annual savings and to overcome this minor drawback, low-e window films are available. Low-e films improve window insulating properties sufficiently to offset the loss of free solar heat during the heating season and typically provide both cooling and heating savings.

The low-e coating of these films (and for low-e windows) helps reduce the loss of room heat during the heating season. One way that heat is lost through windows during the heating season, is that objects within a room are warmer than the surrounding outdoors and the objects in the room will then radiate heat towards the cooler outdoors. For windows that are non low-e, much of this radiant heat is absorbed by the window glass as it attempts to escape to the outdoors causing the glass temperature to increase slightly. As the glass is warmer than the outdoors, this absorbed heat is still radiated to the outdoors. With a low-e film applied to the room side of a window, the room's heat attempts to radiate to the outdoors, but the low-e coating of the film does not absorb a significant portion of this radiant heat and reflects much of this heat back into the room. The degree to which percentage of heat is reflected back into the room in this manner (and how much of this radiant heat is absorbed and lost to the outdoors) is associated with the film's emissivity.

Most films have an emissivity equal to that of glass of 0.84. So, when objects in the room try to radiate heat to the outdoors during the heating season, the film (or plain glass) absorbs 84% of this heat, most of which as described above is subsequently lost to the outdoors. Likewise, only 16% of the room heat is reflected back into the room. When a low-e film is applied to the glass on the room side of the window, with an emissivity of say 0.35, then only 35% of the room's radiant heat is absorbed by the glass and lost outdoors, and 65% is reflected back into the room, resulting in heating energy savings. Windows with low-e coated glass work in a similar manner to reduce heat loss during the winter.

One key point is that low-e coatings help to reduce the flow of radiant heat from the warmer side of a window to the cooler side. In winter low-e films (and windows) reduce heat loss, but in summer they help to reduce heat gain, so low-e coatings help to provide year-round savings.

A second key point is that the lower the emissivity of the film (or window glass), the more improvement in reducing the flow of heat through a window (during winter and summer). As you can see from the example above, a film with an emissivity of 0.07 (such as EnerLogic window film) is reflecting 93% of the room's heat back into the room during winter, which is significantly better than the level of room heat reflected back into the room by most low-e films (65%) with emissivities of about 0.35, and far greater than most standard window films with emissivities of 0.84 (only 16% of room heat reflected back into the room).

A final point concerns low-e window film appearance. While conventional low-e films help reduce energy costs in all seasons, they can display an unpleasant iridescence or "oil slick" appearance when installed near certain types of energy-efficient lighting, such as compact fluorescents. EnerLogic window film's low-e coating was developed in such a way to minimize this iridescence, providing for a more aesthetically-pleasing film (see Table 1).

## EnerLogic 35 Window Film Claims

**Claim 1** - *Other window film technologies can help you save energy. But because EnerLogic window film's patent-pending coating delivers excellent energy efficiency in every season, no other film can match its annual dollar or energy consumption savings.*

As outlined in the Introduction, unlike solar-control-only films, low-e films such as EnerLogic window film provide for both summer and winter savings. Therefore, low-e films typically produce the greatest overall annual savings when comparing films with similar solar-control properties. With its patent-pending low-e coating that produces an emissivity of 0.07 (versus the 0.35 of most other low-e window films); EnerLogic window film will produce superior energy savings to all other films.

To validate this claim, an energy study was conducted on a typical large office building in a variety of climates (one city from each of the ENERGY STAR© climate zones in Figure 1), with four buildings in each city, and with each building using a different common existing building glass type (single-pane clear, dual-pane clear, single-pane gray, and dual-pane gray). The study utilized the U.S. Department of Energy's DOE-2 energy analysis methodology.

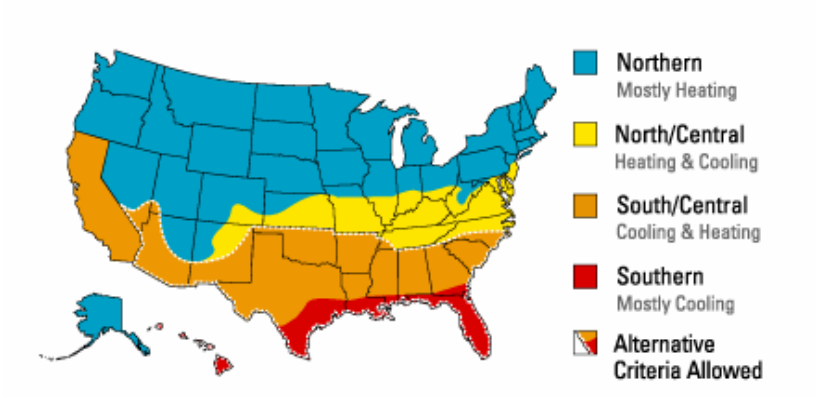


**Figure 1 – ENERGY STAR® Climate Map**

Before window film was added to any of the models in the study, the energy usage data from these buildings was evaluated using the ENERGY STAR Portfolio Manager software to ensure that the buildings created were not energy-inefficient buildings which might favorably-skew savings resulting from window film installation. The Portfolio Manager results showed scores ranging from 53 to 59, which is above the national median of 50, indicating that the models created are slightly more efficient than the typical office building. Following this model validation, several window films were added to each model and annual energy savings were determined as shown in Figure 2. Table 1 provides a comparison of the performance and other characteristics and benefits of these films.


**Figure 2 – Typical Large Office Building Savings from Window Film Installation (Cost Savings per Square Foot of Floor Space)**

| Film Type | Appearance | Visible Light Trans-mission (VLT) | Solar Heat Gain Coefficient (SHGC)* | Emissivity | Aesthetic Concerns | Benefits |
|---|---|---|---|---|---|---|
| Neutral | Gray | 28% | 0.36 | 0.81 | Minimal | Provide good solar heat rejection with somewhat lower visible reflectance |
| Reflec-tive | Silver | 18% | 0.21 | 0.71 | Low VLT, High Visible Reflectance | Best solar heat rejection |
| Conven-tional Low-e | Silver or Amber, Reflective | 31% | 0.27 | 0.33 | High Visible Reflectance, Iridescence under certain lighting | Excellent solar heat rejection, good improvement in window insulating properties |
| EnerLogic 35 | Earth-tone, less reflective than conventional low-e | 33% | 0.24 | 0.07 | Higher visible reflectance than Neutral films (but less than comparable VLT reflective films) | Excellent solar heat rejection, best improvement in window insulating properties |

* Film applied to 3mm (1/8 inch) clear glass

**Table 1 – Comparison of Window Films Shown in Figure 2**

Each of these films were added to the 16 different models without film (4 cities, 4 glass types in each city), total energy savings noted, and total energy savings divided by the square footage of the 16 buildings involved. The resulting total energy savings per square foot of floor space is noted in Figure 2, which clearly shows the advantage of the low-e films over solar-control only films, and the advantage of EnerLogic 35 window film over a similar VLT and SHGC low-e film that has a significantly higher (poorer) emissivity.

Due to the improvement in insulating properties of the glass to which it is attached, the EnerLogic 35 window film produced both superior heating and cooling savings. Annual cooling and heating savings for all 16 buildings are shown in Table 2:

| Film Type | Annual Cooling Savings | Annual Heating Savings |
|---|---|---|
| Neutral | 3.6% | -0.2% |
| Reflective | 5.2% | 3.1% |
| Conventional Low-e | 5.7% | 12.7% |
| EnerLogic 35 | 7.0% | 22.2% |

**Table 2 – Comparison of Energy Savings from Window Films Shown In Figure 2 and Table 1**

It is important to note that while the reflective film used in the above study has a better (lower) SHGC than EnerLogic 35 window film, meaning the reflective film is better at reducing solar heat during the cooling season, with EnerLogic window film's lower emissivity and added insulating performance a greater overall cooling savings can be achieved (7.0% savings vs. 5.2% is a 35% improvement). Both reflective films and EnerLogic window film provide cooling savings by blocking solar heat gain, but EnerLogic window film provides an additional reduction in the total need for cooling by reducing radiant heat flow through the window not related to solar heat gain due to the warmer outdoor objects attempting to radiate heat to the cooler indoors. Also, note that EnerLogic window film produced over 7 times the heating season savings of a standard reflective film, and nearly twice the heating savings of other available low-e films. With greater energy savings during both the cooling and heating seasons, compared to all other film types the study visibly demonstrates that no other film can provide the year-round energy savings of EnerLogic window film.

**Claim 2** – *EnerLogic window film is a low-cost, high-return technology that compares favorably to other popular energy-saving measures both in terms of energy efficiency and cost savings. In fact, EnerLogic window film typically outperforms most of the alternatives in terms of simple payback.*

The following graphic is used to illustrate this claim:


**Figure 3 – Typical Simple Payback for Energy-Efficiency Upgrades**

The simple payback numbers shown in Figure 3 for Lighting and Non-Lighting Upgrades were taken from LBNL Report 52320, Table 7 [(1)]. This table shows simple payback for many Energy Service Company (ESCO) related projects in both the Institutional (Public) and Private sectors. The figures used in the graphic above are the averages for all such projects (445 in total).

The DOE-2 study referenced in the discussion of Claim 1 was used to determine the overall average simple payback for EnerLogic 35 window film (2.75 years) over a variety of climates and glass types. The simple payback range for Window Replacement is obtained using energy savings estimates from a national window manufacturer, which states annual energy savings "up to $465", and from within that study a total of 300 square feet of windows are involved. Surveys of typical installed prices for replacement windows, 3 feet by 4 feet in size, show prices ranging from $200 to $400. Using the average price of $300 for a 3 foot by 4 foot window, or $25 per square foot, would indicate an installed price of $7,500 for the 300 square feet of windows in a typical home. With a $7,500 installed price and $465 in annual savings, the simple payback is then $7500/$465 or 16.1 years. Noting that the window manufacturer gave an "up to" savings of $465 indicates that savings in some locations would be less than this, and as such a range for Window Replacement simple payback is shown in Figure 3 as 15-20+ years.

If one chooses to use EnerLogic window film rather than replacing windows and wanted to account for the fact that EnerLogic window film would most likely need to be replaced during the expected longer lifetime of the replacement windows, window film would still provide a far greater lifetime savings to investment ratio. As seen in Figure 3, doubling the payback for EnerLogic window film, in the event of film replacement, would still provide a 5.5 year payback (by doubling the 2.75 year payback), compared to the 15-20+ years for window replacement. In addition, use of window film such as EnerLogic window film is a much less disruptive project for building occupants compared to window replacement and can be accomplished in much less time.

The information in Figure 3 clearly indicates that EnerLogic window film takes its place alongside other major energy-saving measures such high-efficiency lighting, new control systems, and HVAC upgrades, that are the backbone of the energy-efficiency industry.

**Claim 3** - *EnerLogic window film provides unparalleled glass insulating capabilities - no other window film even comes close. With its patent-pending low-e technology, EnerLogic window film has the best insulating performance of any window film available. The insulating power of EnerLogic window film gives single-pane windows the annual insulating performance of double-pane windows - and gives double-pane windows triple-pane insulating performance.*

As outlined earlier, emissivity is the driving factor for improvement in the insulating property (U-value) of windows when adding films. The lower the emissivity of a window film, the more improvement in insulating performance obtained. Most solar-control only films (Neutral, Reflective, and Bronze type films) have emissivities in the range of 0.70 to 0.84. Most conventional low-e films are in the range of 0.30 to 0.35. EnerLogic window film's emissivity is 0.07, which is approaching the emissivity of low-e coatings on high-performance solar-control low-e glass (0.02 to 0.04).

To determine the improvement in insulating performance of windows the fenestration industry utilizes the Lawrence Berkeley National Labs (LBNL) Window Program (see http://windows.lbl.gov/software/window/window.html). Using this software, the insulating value or U-value was determined for the four film types shown in Figure 4, with these films applied to 6mm (1/4 inch) clear glass. As many people are more familiar with the term R-value, these U-values (in English units) were converted to R-values for each film and glass combination (R-value = 1 divided by U-value). Figure 4 and Table 3 illustrate the percentage improvement in 6mm (1/4 inch) glass average annual R-value with various films applied, compared to the R-value without film.

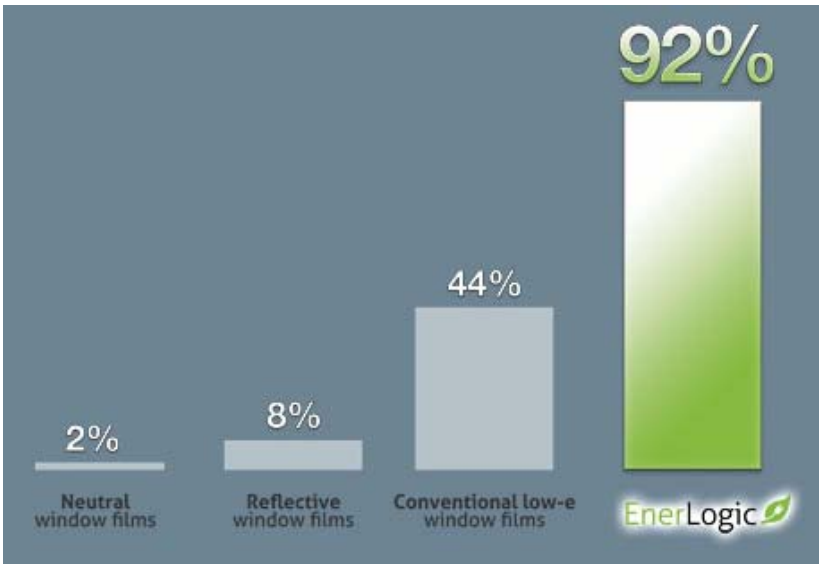


**Figure 4 – Improvement in Average Annual Insulating Properties for 6mm (1/4 inch) Glass With Various Films Compared to the Same Glass Without Film**

| Film Type | Winter U-value [1] | Summer U-value[2] | Annual Average U-value[3] | Annual Average R-value[4] | Percent Improvement Over No Film |
|---|---|---|---|---|---|
| None | 1.025 | 0.925 | 0.975 | 1.0256 | - |
| Neutral | 1.004 | 0.904 | 0.954 | 1.042 | 2% |
| Reflective | 0.952 | 0.85 | 0.901 | 1.1099 | 8% |
| Conventional Low-e | 0.743 | 0.614 | 0.679 | 1.4738 | 44% |
| EnerLogic 35 | 0.589 | 0.424 | 0.507 | 1.9743 | 92% |

(1) BTU/hour/square foot/degree F, based on: Outdoors -18 deg C (-0.4 deg F), Indoors 21 deg C (69.8 deg F), no sun, 5.5 m/s wind speed (12.3 mph)
(2) BTU/hour/square foot/degree F , based on: Outdoors 32 deg C, 89.6 deg F, Indoors 24 deg C (75.2 deg F), full sun, 2.8 m/s wind speed (6.2 mph)
(3) Average of Winter and Summer U-values
(4) Annual Average R-value = 1 divided by Annual Average U-value

**Table 3 – Illustration of How Percentages in Figure 4 Were Determined**

As seen in figure 4, Neutral and Reflective films provide a small improvement in window insulating properties while conventional low-e films offer substantially greater improvement. However, EnerLogic window film provides more than twice the improvement in insulating performance of conventional low-e films and many times the improvement of standard films.

While this improvement in insulating performance with EnerLogic window film provides obvious heating season savings, it is important to remember that during the cooling season EnerLogic 35 window film provides superior cooling savings versus a reflective film with a lower (better) SHGC (see Claim 1 study

results of 5.2% cooling season savings for the Reflective film with a 0.21 SHGC versus 7.0% cooling season savings for EnerLogic 35 window film with a 0.24 SHGC).

A secondary claim is that EnerLogic window film improves window insulating performance sufficiently to give single-pane windows dual-pane performance. Likewise, adding EnerLogic window film to dual-pane produces triple-pane insulating performance. Since we are now talking about whole-window performance, U-value must be used, rather than R-value, as R-value is specific only to a single layer of a multi-layer product. Using the same method as outlined above for determining U-value, and using different frame types (aluminum without a thermal break, aluminum with a thermal break, wood, and vinyl), one can compute the annual average U-value of EnerLogic window film added to single-pane glass with a specific frame type, and compare this value to the annual average whole-window U-value of a dual-pane window of the same frame type. If the U-value with EnerLogic window film is lower (better) than the dual-pane U-value without film then this secondary claim is valid.

Performing this analysis for various windows (single, double, and triple-pane glass types), with different frame types, EnerLogic window film indeed lives up to this claim. For example, EnerLogic window film added to single-pane 6mm (1/4 inch) clear glass, for a 914 mm x 1219 mm (36 inch x 48 inch) window with an aluminum frame with no thermal break, produces an annual average U-value of 4.78 (0.842). The same frame with dual-pane clear glass of the same thickness, with a 12 mm (1/2 inch) air-space and no film applied has an annual average U-value of 4.905 (0.864). So, adding EnerLogic window film to a single-pane window improves the insulating performance as if one replaced the existing glass with dual-pane glass with an air-space. Similar results are obtained using different frame types. Using these methods, the same can be said for adding EnerLogic window film to dual-pane glass and obtaining triple-pane insulating performance.

## Conclusions

As claimed, EnerLogic window film produces a pleasing improvement in low-e window film appearance and more importantly from an energy-savings standpoint a significant improvement in window insulating performance, giving single-pane glass dual-pane glass insulating performance, and giving dual-pane glass triple-pane glass insulating performance. This improvement in insulating performance, coupled with the film's solar-control properties, result in unequalled energy savings compared to other standard solar-control and conventional low-e films. With such a high level of energy savings, EnerLogic window film is able to provide for simple paybacks and returns on investment on a level comparable to other commonly used energy-efficiency measures.

## About the Author

Steve DeBusk, Global Energy Solutions Manager, Solutia Performance Films. With more than 25 years in the energy-efficiency industry, Steve developed energy-savings programs for the State of Virginia and Hercules Aerospace prior to joining Solutia in 1995 as the Technical Marketing Manager for Commercial and Residential Films. Since 2003, he has developed Solutia's Energy Solutions Program globally and has worked with Energy Service Companies (ESCOs), Performance Contractors, property management companies, energy management companies, and energy efficiency consultants to promote and implement the energy savings benefits of window film. Steve is a Certified Energy Manager (CEM) and Certified Measurement and Verification Professional (CMVP) through the Association of Energy Engineers.

## References

(1) LBNL Report 52320, "Review of U.S. ESCO Industry Market Trends: An Empirical Analysis of Project Data", Charles Goldman, Nicole Hopper, Julie Osborn, Lawrence Berkeley National Labs, January 2005.