EUROPEAN WINDOW FILMS ASSOCIATION
STAZIONE SPERIMENTALE DEL VETRO SSV

Energy performances of window films in European Climates

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Purpose

This in-depth technical energy study was commissioned by the European Window Film Association (EWFA) to illustrate the energy saving benefit of installing various types of window films to European buildings. It has been undertaken by Stazione Sperimentale del Vetro of Murano Venezia (Italy). SSV has been operating since 1956 and is an independent research and testing body devoted, by its institutional deed, to dealing with the scientific and technological issues of glass industry (hollow, flat and technical glass, glass fibres, hand-made glass, raw materials, refractories, furnaces, etc.), and acts as a linkage between research on the one side, which it often develops in cooperation with Universities and other Italian and foreign centers, and industrial application of the obtained results on the other. SSV is a Notified body in the European Union (N. 1694) for the application of the EU Regulation n.305/2011 on architectural glazing.

Window Films have been used for decades as an effective solution to improve occupant comfort, and to reduce energy expenditure. The study considers a range of window films, glazing types, buildings and climates that would be typical across the region to demonstrate the energy saving impact the installation of window film can have across Europe.

Summary

- The European Window Film Association (EWFA) commissioned a technical energy study to illustrate the energy saving benefits of installing various types of window film to European buildings.

- Window film is composed of a polyester substrate to which a scratch resistant coating is applied on one side; a mounting adhesive layer and a protective release liner is applied to the other side. When the release liner is removed, the side of the film with the adhesive is applied to the surface of the glass. A standard window film might have eight layers and undergo up to seven manufacturing processes.

- The study covers three representative building sizes - Small (1000 square meters floor space), Medium (5000 square meters), and Large (10000 square meters) - for which the total building and cooling energy usage in kWh was calculated.

- The study concludes that installation of window films can significantly reduce the total commercial building energy usage, over a variety of European climates, window types, and building sizes. For all models considered, the average building energy savings was 18% with a global minimum of 2% and a maximum of 42%.

- In addition to this study, more research is available conducted by the International Window Film Association focusing on the Energy Analysis for Window Films Applications in New and Existing Homes and Offices.

Methods

The energy performances of window films were analysed by numerical simulation using one of the most advanced and commonly-used building-simulation programs: EnergyPlus software. It has its roots in both the BLAST and DOE–2 programs. BLAST (Building Loads Analysis and System Thermodynamics) (BLAST Support Office 1992) and DOE–2 (Winkelmann et al. 1993) which were both developed and released in the late 1970s and early 1980s as energy and load simulation tools by Department of Energy of the US Government. Lawrence Berkeley Laboratory of University of California -LBL - in the mid 1990s, as computing power continued to grow rapidly starting from BLAST and DOE-2 projected to improve in the flexibility and comprehensiveness of these tools and around 2000 EnergyPlus was released. At present time it is routinely used by energy engineers and architects in the design of new buildings and for designing energy-efficiency retrofits for existing buildings.

Many studies have been developed assessing the accuracy of EnergyPlus in evaluating the energy load and savings of buildings. Among other Henninger in 2003 (Henninger 2003) tested the software with the International Energy Agency HVAC BESTEST E100-E200 tests. EnergyPlus results generally agreed to within 1% of the analytical results. The software was also tested with good results using ANSI/ASHRAE Standard 140-2011 titled Standard Method of Test for the Evaluation of Building Energy Analysis Computer Programs (Henninger 2014). Moreover, the results of EnergyPlus are also compared with results from several other whole building energy analysis programs that simulated the same test cases (Henninger 2014).

The building energy performance in this study was evaluated applying window films to reference building. The reference building was defined considering previous research by the International Energy Agency (IEA) Task 27 “Performance of Solar Façade Components”, subtask A “Reference office for thermal, solar and lighting calculation”(Paltzer 2003). It was

defined by IEA in collaboration with the team of European project SWIFT -Optimisation of Control Strategies for Facade Systems - leaded by Fraunhofer ISE (Wienold 2004).

The EnergyPlus models created as part of this study were of buildings with characteristics (building construction and geometry, window to wall ratio, heating and cooling system type and efficiency, and occupancy schedules) common to many European office buildings.

The study is comprised of 3 separate reports, each covering a representative building size: Small (1000 square meters floor space), Medium (5000 square meters), and Large (10000 square meters). For each of these building sizes the study considered common glazing types found throughout Europe, namely dual-pane clear and dual-pane low-e glazing. To be representative of European climates, three locations were used: (Stockholm-Northern climate, Amsterdam-Central Maritime climate, and Athens-Southern climate). Finally, to each building model a representative sample of seven internally and externally-installed window films (ranging from 20-70% visible light transmission) were applied to each building in the EnergyPlus models.

The result of the above combination of building sizes, locations, window types, and film types resulted in this study incorporating 126 separate EnergyPlus models.

Results

Total building heating and cooling energy usage in kWh was calculated for each model in the study. The following tables summarize the total building heating and cooling energy savings when solar-control window films were added to the building EnergyPlus models without window film. It should be noted, that while installation of window film to some buildings increased heating energy by reducing solar heat gain during the heating months (which can be used to offset the need for mechanical heating), the overall net effect from window film installation is shown in this summary, with cooling savings eclipsing any increases in heating energy. Furthermore, it should be noted that even though costs have not been considered in this study, on a kwh basis cooling energy costs are much higher than heating energy costs as well.

Dual-pane clear windows

Northern Climate

	Small Building	Medium Building	Large Building
Average Savings	17%	14%	18%
Range of Savings	9%-23%	8% - 20%	10%- 25%

Central Maritime Climate

	Small Building	Medium Building	Large Building
Average Savings	20%	18%	22%
Range of Savings	11%-28%	9%-25%	12%- 30%

Southern Climate

	Small Building	Medium Building	Large Building
Average Savings	31%	26%	30%
Range of Savings	15%-42%	13%-36%	15%-41%

Dual-pane low-e windows

Northern Climate

	Small Building	Medium Building	Large Building
Average Savings	11%	9%	12%
Range of Savings	2%- 9%	2% - 16%	2% - 22%

Central Maritime Climate

	Small Building	Medium Building	Large Building
Average Savings	13%	11%	16%
Range of Savings	2%- 25%	2% - 22%	3% - 30%

Southern Climate

	Small Building	Medium Building	Large Building
Average Savings	19%	15%	18%
Range of Savings	3%-38%	2%-30%	3%-36%

Conclusions

The study shows conclusively that installation of window films can significantly reduce total commercial building energy usage, over a variety of European climates, window types, and building sizes. For all models considered, the average building energy savings was 18% with a global minimum of 2% and a maximum of 42%.

It should be noted, that while this study only considered the effect of window films on modern, commonly-found types of glazing throughout Europe (dual-pane clear and dual-pane low-e glazing), it should be expected that the energy-savings effect of installing window films to single-pane glazing (equally common across Europe) would be even more pronounced. In this way the market for window films across Europe is extensive. Also of importance, this study has only focused on the energy-saving benefits of window films, and has not included a detailed discussion of the other varied benefits of window films when used in buildings, such as: significantly improved occupant comfort, reduced glare, opportunities to limit the use of blinds and shades connecting occupants with and enabling occupants a view to the outdoors, and reducing UV radiation impact on furnishings, carpets, fabrics and occupants themselves. Furthermore, there are combination solar-control/safety/security window films that offer all of the above mentioned and energy savings benefits while providing a variety of protection for building occupants from broken glass due to: bomb blast events, human impact against non-safety glass, windstorms, and providing added security against unwanted entry into buildings.

The study shows the effect of installing a variety of window films on typical European buildings. It should not be used to aid film specification, or to estimate film performance for individual projects. For individual projects a more customized energy analysis is required to give an indication of expected energy savings and film performance.

Please refer to a EWFA manufacturer member for a detailed analysis of your particular situation. EWFA members have access to advanced simulation software and can provide a more specific analysis of many building types (offices, hotels, universities, schools, retail). These analyses can take into account for your specific location, building geometry, building heating and cooling system type and efficiency, precise window area on each exposure, and the effect of any overhangs or adjacent buildings.

For additional technical details about the EWFA Window Film Energy Study, please contact the EWFA secretariat at *info@ewfa.org*.

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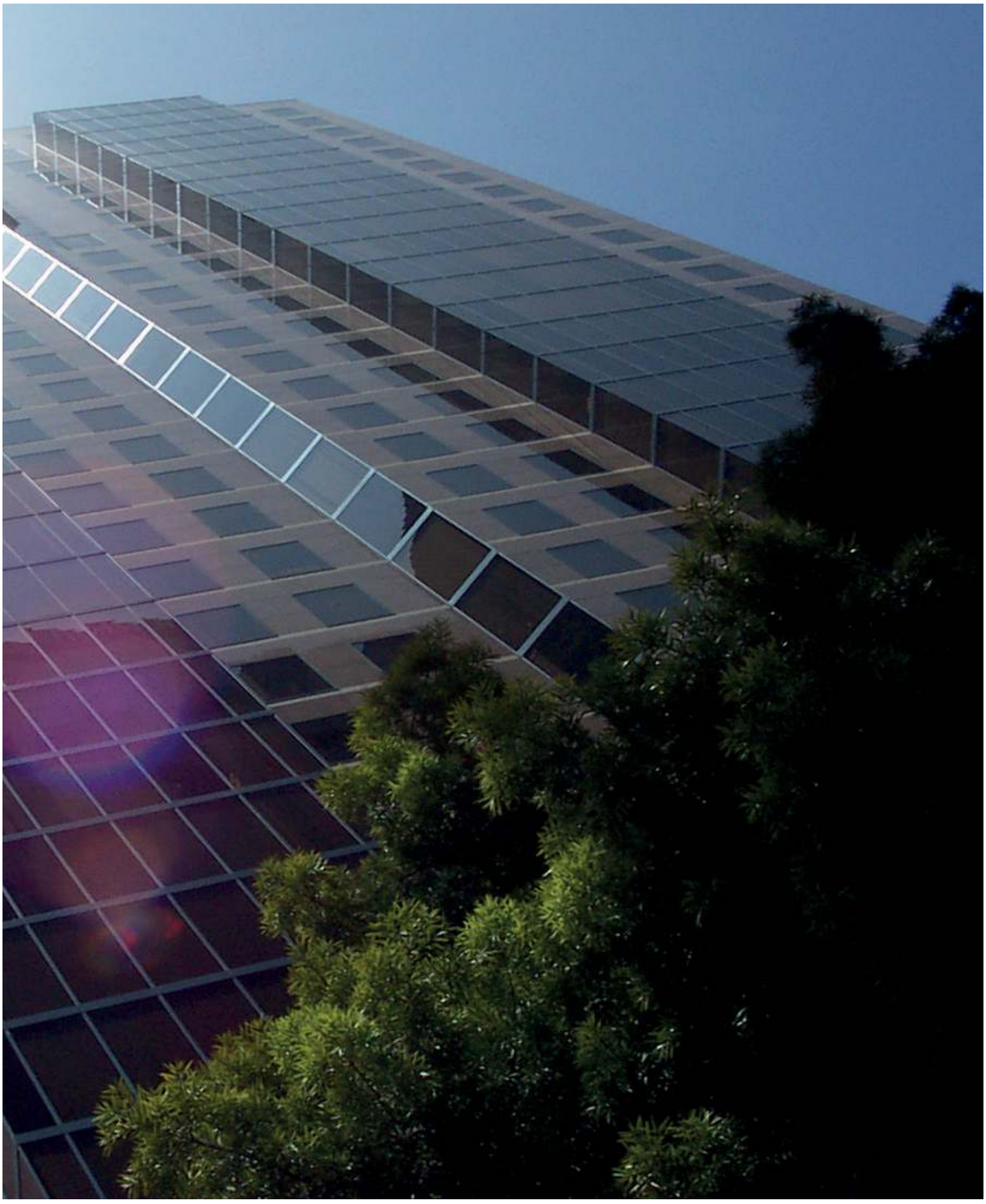

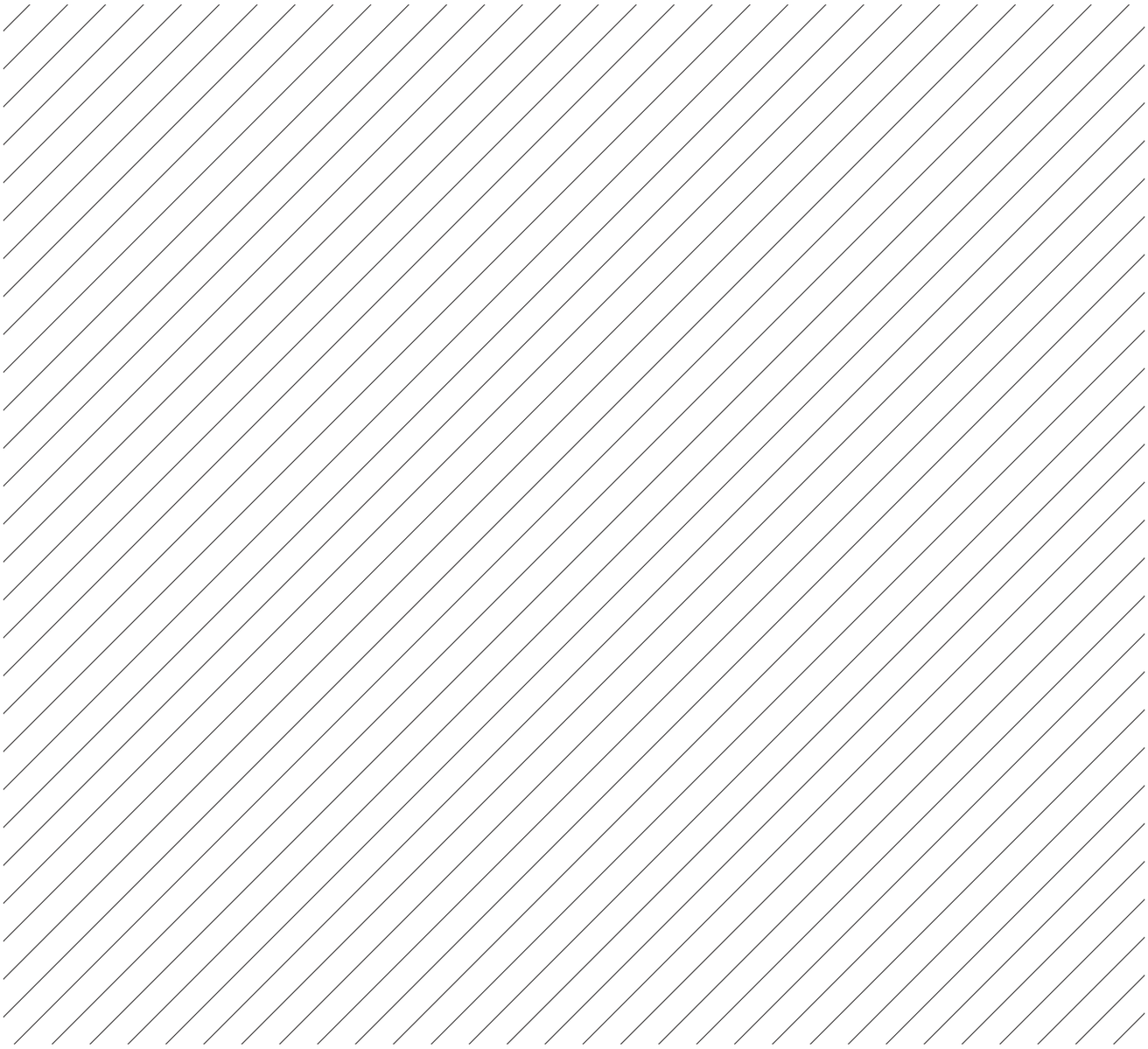

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