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Innovative Solar Control Devices

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Advanced solar shading devices can include a redirection of daylight into the depth of the room.

Buildings are the EU's largest energy users, consuming over 40 % of Europe's total primary energy. One way of cutting this consumption is by avoiding or reducing cooling energy through proper solar shading. This paper presents examples of innovative solar control devices and emphasizes their relevance for the energy performance of buildings.

1 > The impact of solar control devices on the energy performance of buildings and indoor comfort

In its simplest form, solar shading is any device which excludes sunshine from a building, like a curtain or an awning for example. However, there is an extremely wide variety of solar shading products available which range in function and sophistication.

Solar shading controls the amount of heat and light admitted to a building. By doing so, solar shading devices contribute to saving energy in various areas. They can reduce the need for heating or air conditioning by maintaining a more even temperature despite varying climatic conditions. They can also cut the amount of energy required for lighting, by admitting more light during overcast conditions for example.

Besides the thermal and energy aspects, solar shading leads to better visual comfort. Glare reduction will improve working conditions in offices, reduce sick leave, increase productivity and contribute to health and safety at work. Solar control devices are also necessary on the North facade on certain buildings in order to prevent glare problems.

The Energy Performance of Buildings Directive *[1]* requests to include solar shading devices into the general framework for the calculation of the energy performance of buildings in the Annex as follows:

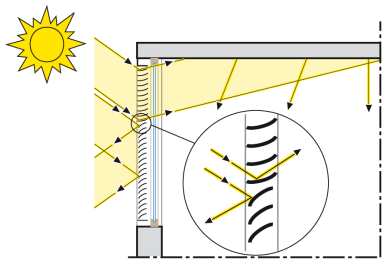
> *1. The methodology of calculation of energy performances of buildings shall include at least the following aspects:*
>
> ...
>
> *(g) passive solar systems and solar protection;*
>
> ...

2 > The range of solar shading products

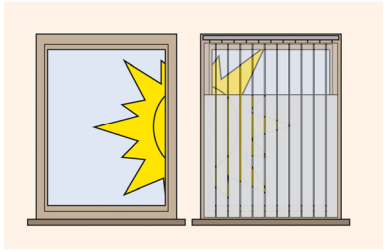
There is a wide range of solar shading products on the market. They're available for both external and internal installation and can be fitted to new buildings or retro-fitted to existing buildings during a renovation.

The best known exterior products include sun awnings, vertical roller blinds and roller shutters, but the industry makes other products to measure depending on the requirements of the individual application.

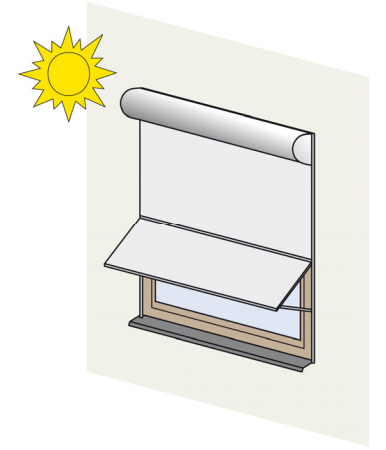
Intelligent Energy Europe



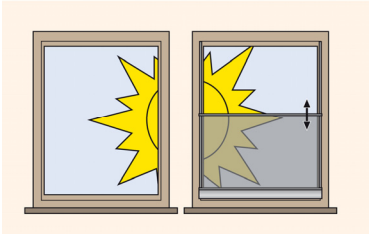
Scheme of blinds with daylight redirection function.



Scheme of a two-section vertical interior blind which allows daylight transmission in the upper part while shading in the lower part.



Markisolette, a combination of screen and awning, allows a direct view to the outside while the shading device is in function



Translucent foil closed from the bottom to the top to allow for daylight penetration.

Internal products come in an even wider variety of types and comprise venetian blinds, roller blinds, pleated and Roman shades and blackout blinds to name a few.

Some systems are designed to provide insulation as well as shading, and all can be automated to offer optimum performance.

3 > Innovative developments

Innovative systems are distinguished by their ability to optimally ensure the required solar protection in combination with other functions of the window, like supplying the rooms with daylight and allowing the view to the outside. Preferably, they also reliably protect the workplace from glare. In the following, a selection of innovative solutions is presented. The sample is not exhaustive but shall demonstrate the diversity of innovative solutions in practice.

Blinds with daylight redirection function

Using a two-section slatted blind, incident light can not only be excluded or reduced, it can also be controlled in a differentiated way and even be guided into a desired direction. On the one hand, these systems provide sun-free and glare-free zones, on the other hand they grant sufficient luminance. They combine privacy (protection from curious glances) with a view to the outside.

Blinds operated from the bottom to the top

Some manufacturers offer metallic external venetian blinds that push up from the bottom edge of the window instead of lowering from the top. The advantage of this system is that the upper part of the window, which is ideal for daylighting, is free of shading. Daylight access in the room can thus be optimized.

Markisolette

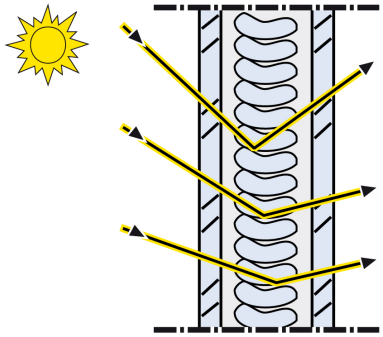
A markisolette combines the functions of a window awning with those of a screen. It drops vertically to the required height, then it is angled out from the facade. The advantage is that the upper part screens the disturbing light and heat, while the lower part allows open views to the outside. The system can be used with high windows, extends a short distance from the wall (usually about 60 cm) and is relatively wind resistant [2].

Translucent foils

High-reflectance embossed foils are mounted on the interior side of the window frame. The metallic coatings are so fine that it is possible to see through the material. The foils are operated from the bottom to the top. Thus the shading effect is perceived at first in the field of vision, which prevents glare effects (for office working spaces and similar). The upper part of the window can still be used for supplying daylight to the room. The foil systems are available with electric drives and controls or for manual operation. Sun shading and glare protection devices blend in with the panoramic view - despite effective solar and glare protection the panorama remains visible through the closed foil and the daylight can still be used.

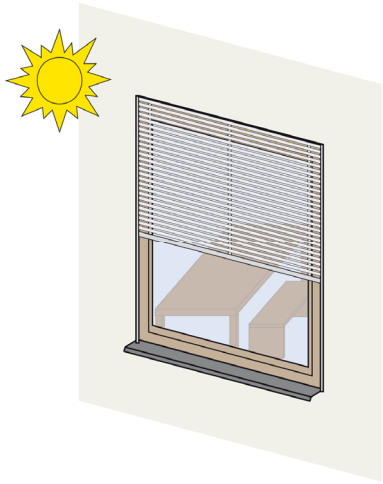
Solar control devices in combination with daylight redirecting glazing

In addition to the two-section blinds there are also other solutions, which combine blinds with a static daylight-redirection element. This is usually realised in a window element that is split in two parts. In the upper part (with about 50 cm height) daylight redirecting glazing is installed while the lower part is a regular window with a standard solar control device.



Schematic drawing of daylight redirecting glazing.

Photo of a combination of blinds with daylight redirecting glazing.



A semi-transparent shading system.

Semi-transparent shading systems

Semi-transparent blinds and shutters function in analogy with translucent foils. One application is a rollable curtain made of stainless steel with slits to let through the light, further applications are roller-shaped, double-walled aluminium sections with light and ventilation slots. Sunshade and roller shutters in one.

A similar effect can be achieved with stainless steel woven mesh. Due to its micro-texture the mesh blocks solar rays with a much smaller incident angle (at angles of around 30° to normal position) as compared to a standard glass pane (typical for standard glass types a drop of transmission is observed at angles of around 60° to normal position). This allows for selecting a glass type with a high light transmission coefficient while still keeping solar energy transmission low.

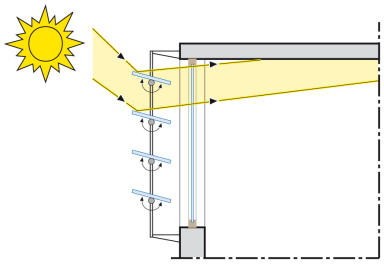
During the day, it is possible to have a good view to the outside through the fabric, reducing the feeling of being shut in. Remember, however, that this works the other way round at night. With the lights switched on, people can look inside just as well.

Photo of the Berlaymont building; headquarter of the EU Commission in Brussels. The façade of the building features glass slats that can be arranged similar to a double glazed façade.

Coated glass slats

Another type of transparent shading device are coated glass slats (lamellas), which are mounted in front of the facade. The coatings can be used for different functions. Depending on the inclination of the slats, the reflective coatings can exclude direct solar radiation or redirect it to the ceiling of the room behind the device. This allows for a variable control of the daylight in the room. Additionally, the slats can be used to save energy by adjusting them to a vertical position, thus creating an air buffer space similar to a double skin façade. By applying infrared-coating on the second surface of the glass slat, this effect can be significantly increased during cold winter nights as the heat emission to the cold outer space is reduced.

Photovoltaic foils can also be used for glass slat coatings. Using this option, part of the incident solar radiation can be converted into electricity. However, this usually results in a considerable heating of the glazing. Therefore the glass lamellas have to be ventilated well in order to ensure a



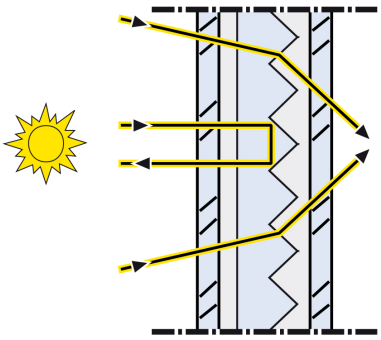
Schematic drawing of movable glass slats.

high efficiency of the PV elements and to prevent an indirect heat load of the rooms behind the shading device.

Thermotropic and photochromic glazings

The flow of radiation energy and lighting within the glazing can be dynamically adapted to the user-dependent requirements by using actively switchable layers. Self-acting switchable glazings fulfill their protective function without complex control equipment. So-called thermotropic or thermochromic materials change their optical properties when a certain temperature threshold is exceeded. With most systems, the clear layer at low temperatures will become white and light dispersive and reflects the incident radiation in a diffuse way. When integrating a thermotropic layer into a glazing it is possible to adapt the transmission of the glazing to the climatic situation. In a situation with undesirably high solar radiation and heat, the transmission property of the glazing is self-actively reduced. Themotropic layers can be realised with multiple different materials.

Electrochromic glazing represents a different type of switchable glazing. It is one of the best examples of "glass of the future". In just a few seconds, it becomes either completely transparent or darkens in order to protect from the sun or to give a more subdued light. Switching is realised by a voltage change applied to a special foil on the glazed pane. Thus the systems require electrical power supply. When performing an energy efficiency assessment of the system, the necessary electrical energy has to be part of the balance.



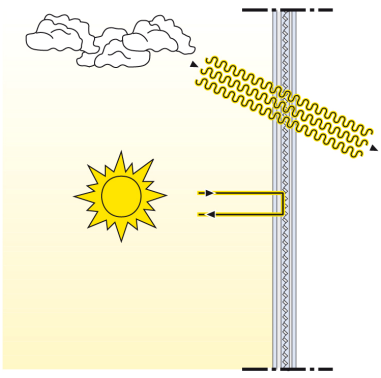
Schematic drawing of prismatic glazing.

PV coated slats

A further innovative development in the field of solar shading devices are slatted blinds with photovoltaic elements on the outside. The excluded solar energy is utilised for electricity production. Similar to the coated glass slats attention has to be paid that the slats are well ventilated in order to ensure high efficiency of the PV elements and to prevent the rooms from overheating.

Prismatic glazing

Prismatic glazing allows the total reflection, the redirection or the transmission of light depending on the radiation angle. To ensure the desired function, these systems have to be tracked according to the position of the sun. Due to the light refraction within the prism a shift of the colours of light may happen.



Total reflection of direct radiation with holographic optical elements.

Holographic films

The use of holography makes it possible to transform solar shading devices into foil constructions that result in total reflection, redirection or transmission of sunlight, depending on the angle of incidence angle. The systems can only be applied in a static way and therefore have to be tracked according to the position of the sun.

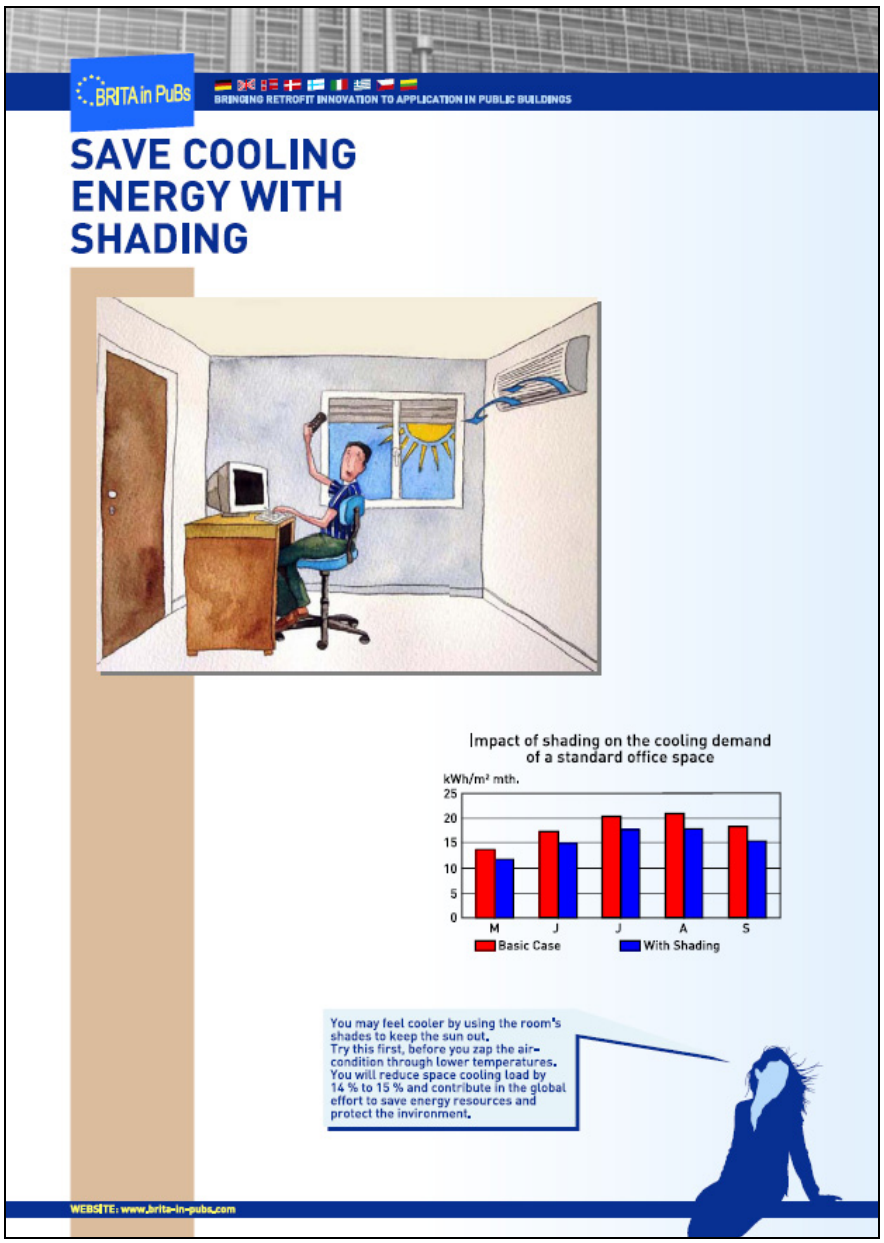
4 > Motivation of the building users to operate shading systems correctly

It is useful to provide information on the correct handling of the shading system to the staff/tenants who will be using the building. If this is not done, experience shows that there is a real risk of complaints [2]. People do not always understand why the system behaves in a particular way, and this can cause irritation. But if people know why the system does certain things and that the reason is to save energy and improve the indoor climate, their criticism can usually be overcome. People can be informed in a meeting or by putting the information on an intranet. An effective

longterm strategy is to use blackboard information sheets to inform everyone who may be affected.

The blackboard information sheet (BISH) on the next page was developed within the EU FP6 demonstration project BRITA in PuBs [3] and shall guide the building users to improve their behaviour in order to save cooling energy. A similar BISH is available for the use of daylight in combination with solar shading.

Bringing Retrofit Innovation to Application – BRITA in PuBs. An EU FP6 ecobuildings project that among other things developed blackboard information sheets to support the improvement of users' behaviour. Website: www.brita-in-pubs.eu



5 > Requirements for energy performance assessment methods

In order to deliver a reliable result, but also to allow for a bigger market penetration of innovative and high performance shading devices it is important that the national energy assessment methods can correctly assess innovative solar control devices, not only regarding the impact on the cooling energy need, but also regarding the influence on the available daylight and therefore the electrical lighting. A holistic approach within the energy performance assessment method is therefore required.

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6 > Summary and recommendations

Innovative solar shading and anti-glare protection can make an important contribution to energy saving in modern private and commercial buildings, whilst simultaneously improving the well-being of the occupants. Intelligent control systems ensure comfort and maximum benefits [4].

While designing a building (new or retrofitted) it is fundamental to analyse the users' needs and the building's necessities concerning solar protection. Then the shading device that fits best to the requirements has to be chosen from the available systems, either conventional or innovative. Is it possible to combine the shading element with other functions? Does it have to be a switchable system? Is an automatic system, a self-active control or manual operation to be preferred? Which system proved to be efficient under a certain climate?

National policy makers and standardisation bodies have to ensure that the energy performance calculation methods allow for correctly assessing high performance shading devices in terms of cooling energy need and over-heating problems, but also regarding the available daylight and the necessary electrical lighting.

It is recommended to provide information on the correct handling of the shading system to the staff/tenants who will be using the building in order to reduce the risk of complaints and to tap the full potential of energy saving and indoor comfort improvement of shading devices. Blackboard information sheets are a good example for user information and motivation.

7 > References

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2. Hall, A.: Planning, purchasing and installing solar shading in public buildings. Gothenburg April 2008. Available for download at *http://www.es-so.eu/documents/HandbooksolarshadingAH08.pdf*.
3. Blackboard information sheets – BISHes for improving the buildings' user behaviour. EU FP6 Ecobuildings project "Bringing Retrofit Innovation to Application in Public Buildings – BRITA in PuBs" (TREN/04/FP6EN/S07.31038/503135). Available for download in several languages at *www.brita-in-pubs.eu*.
4. ES-SO: Solar shading – Energy savings and comfort. Brochure, 2005. Available for download at *http://www.es-so.org/documents/ES-SO-Flyer.pdf*.

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