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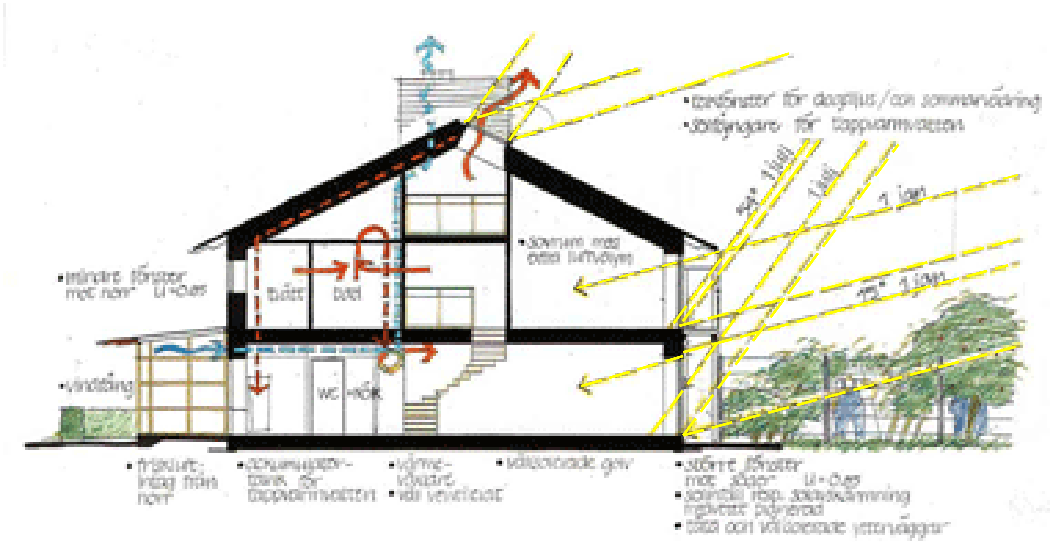
Passive solar heat gain



Getting sustainable summer comfort

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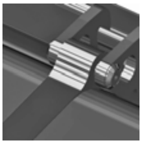
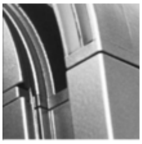




Glossary


TS: solar transmission as a %
RS: solar reflection as a %
AS: solar absorption as a %
TS + RS + AS = 100% of solar energy
TV: visual light transmission as a %
g-value: solar heat gain factor, a measure of how much solar energy overall passes through the material including what has been absorbed and re-radiated towards the window. As a % or fraction.
U-value: in W/m^2K is the heat transfer coefficient or thermal transmittance: a measure of how well the glass or shade insulates.
e-value is equivalent to U-value

References:

Pilkington Glass: Solar control range
European Commission, Energie: Solar Shading for European climates
Rehva journal, September 2008: Synergies between solar shading and HVAC technologies
Sattler AG
Ferrari AG
Lund University: Performance of Energy Efficient Windows and Solar Shading Devices

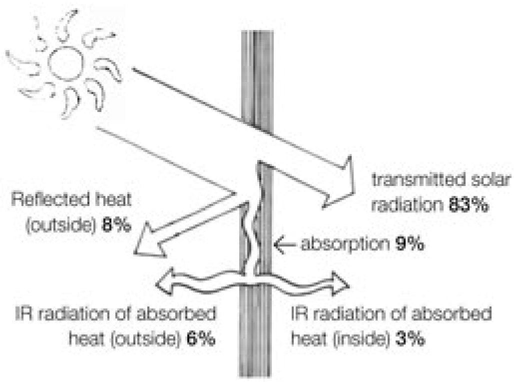
The greenhouse effect.

When a glazed surface is exposed to the sun, a “greenhouse effect” takes place: the suns energy has a short wavelength and travels easily through the glass.

Once inside the building, this energy is absorbed by wall and floors, by furniture and all sorts of objects, and transformed into a higher wavelength, infrared radiation. It becomes heat and these heat waves do not travel as easily through the glass. Therefore heat will accumulate and a greenhouse effect happens.

That’s why inside a car parked in the glaring sun, the temperature will rapidly rise far beyond the outside temperature.

It is also the reason why it is more efficient to stop the passive solar heat gain (energy from the sun passing through the glass) than to remove unwanted heat build-up from inside the building by expensive mechanical means.





Passive solar heat gain in buildings


Today's increased use of glass in architecture and the ever growing focus on energy efficiency are driving building developers, owners and occupants to demand higher performing products than ever before.

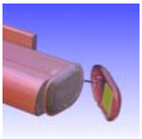
Buildings are increasingly becoming the focus of energy saving initiatives because, not only are they a significant energy consuming sector, but the technologies and products to make buildings more energy efficient have already been developed.

Causes of passive solar heat gain in summer include:

- Size of windows relative to the structure.
- Orientation of the windows.
- Type of glass in windows.
- No shading of the windows in summer.

Negative solar heat gain in winter can be caused by overshadowing of the windows by other tall buildings.

Most of these cannot be easily rectified after building completion. It is forecast that 90% of the buildings that will exist in 50 years time are already standing.
Buildings last for decades, sometimes centuries, it is important that all buildings be energy efficient, whether newly built or renovated.


GLASS


The capacity of glass to manage energy is measured by its e-value (also known as U-value) and g-value.

What is seen as the main characteristic is the e-value, the capacity to insulate from conduction. But e-value is not about radiation, its about what happens when there is a temperature differential between outside and inside. The e-value should be high in summer to allow internal heat to escape but in winter this means that paid for heating tends to escape through the glass. Conversely low-e glass will retain heat, summer and winter from occupants, computers etc.

For the suns radiation, however, the g-value is far more representative, a dimensionless figure that indicates how much of the solar radiation will travel through the glass towards the inside of the building. “High performance” glass has a g-value in the low twenties. This means that, summer and winter, the glass will block up to 80% of the heat passing through. But in winter only about 20% of the solar energy will pass through, resulting in additional heating costs over what they could have been with the free solar energy. Low g-value glass also tends to have a lower light transmittance, requiring the use of artificial light at a distance from the window.

Where both heating and cooling are needed, they require a larger air-conditioning unit than could otherwise be necessary.

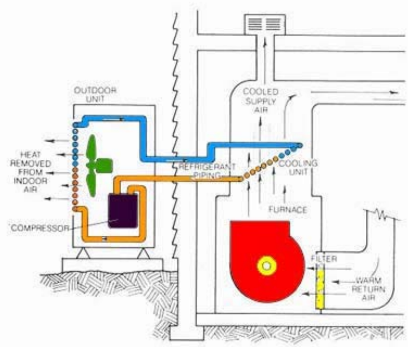
AIR-CONDITIONING

Air-conditioning systems move heat, either from outside the building to the inside in winter or from the inside to the outside in summer. How do you know that the plant that you install is appropriate for your needs, neither so large that it is rarely running or too small and unable to perform its task. Unless it is the right size it will cost you more either in capital or running costs. Saving energy in buildings is usually identified with: insulate more, use high-performance double glazing and use more energy-efficient installations for air-conditioning.

Insulation of walls and roofs, helps keep the cold out. But the problem is more often to keep the heat out in summer conditions, especially in buildings with lots of glass.
Solar control glass will prevent the sun's energy entering the buildings when it is welcome, in winter time, requiring extra heat be pumped in

As we become more demanding of our comfort, air conditioning moves from luxury to standard equipment in offices and also in residences. This creates an extra need for electric power and often causes peak demand problems that our electricity grids are not equipped for.

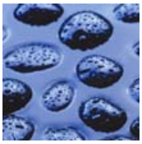
How do you optimise the size of the air-conditioning plant with regard to capital and running costs, no bigger than necessary but adequate for the task.
There are other ways.



Central Air-Conditioning & Heating System
Graphic courtesy: Air-Conditioning & Refrigeration Institute

NIGHT VENTILATION

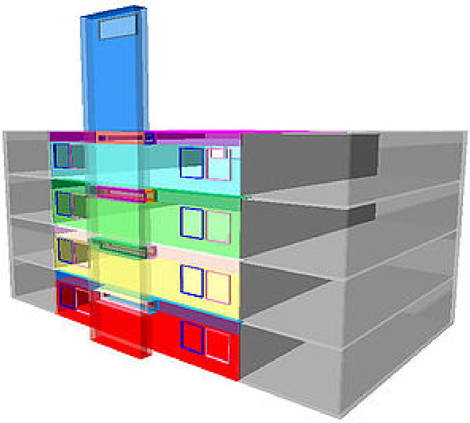


Summer heat accumulates in the structure of the building.
The greater the mass of the building, the greater the thermal inertia. This means that the day *after* the structure of the building has become heated it can be warmer inside than the outside air temperature even if the air temperature outside is lower than before.

Combining automated external solar shading with natural night ventilation will avoid excessive heat build-up during the day.
Removing some of the heat during the cooler night time reduces the need for artificial cooling during the following day. It also allows a reduction in the size of cooling plant.

A study by the University of Delft in the Netherlands shows that the application of advanced solar shading systems combined with motorised windows for natural night ventilation can reduce the carbon emissions of a building by as much as 28%.

Purging the air from the building at night also gives the sensation of a much fresher feel to the air in the morning as it removes VOC (volatile organic compounds) released from carpets, furnishings, people etc.





MOBILE SOLAR CONTROL

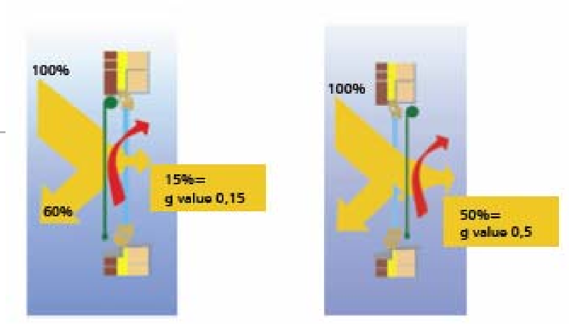

Mobile solar shading (blinds, awnings, shutters etc) adds a dynamic capacity to glass.

Common sense dictates that external systems will be more efficient for controlling the admittance of solar energy. The shading device will stop the vast majority of the suns energy.

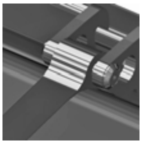
For a well designed external solar shading system, the g-value is usually between 0.1 and 0.2, which means that 80 to 90% of the suns energy will be stopped by the combination of glazing plus awning.

For internal blinds, the g-value covers a greater range and could be anywhere from 0.3 to 0.7, depending on the type of blind and colour. Paler colours give a lower figure as do opaque fabrics.
In general it will double the passive solar gain compared with an external system and also block the view to the outside.

In both cases - external or internal - the solar control should be easily mobile. Ideally motorized and automated so that the full benefits are reaped even if the building is not occupied or the occupants are asleep.



Exterior vs interior solar shading: typical values

Lets consider external shading and assume a g-value of 0.15. that means that 85% of the suns energy will be stopped by the combination of shading and glazing and only 15% will penetrate the window and be converted into heat.

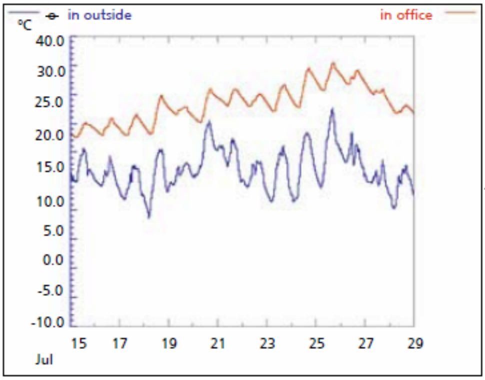
If the system is automated, a solar sensor will bring the shade down as soon as the sun is present, even if the buildings occupants are absent, and keep it down until the sun is no longer present.

A thermostat can keep the shade in the “up” position as long as the desired indoor temperature is not reached, bringing in some welcome, free solar energy as a contribution to the heating needs. A positive solar heat gain.

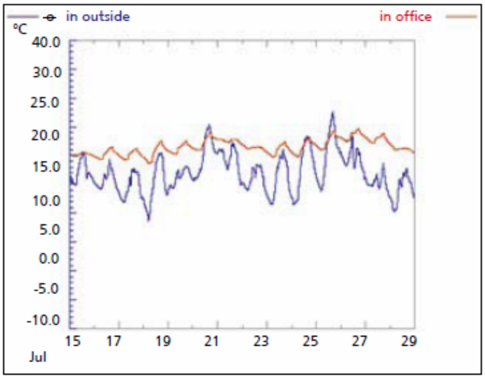
These will change the energy consumption of the building. Often the energy demand for cooling will drop by over 30% in some climates.

Building in Brussels without air-conditioning

Without awnings

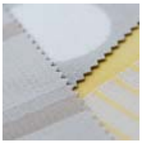


With awnings





FABRIC SELECTION

The type of fabric selected for the external solar shading will also influence the solar energy gain and the comfort factor inside the building.

There are fabrics which

- still allow an external view.
- still allow light transmission.
- block all light transmission.
- change the colour of the light.

These different types of fabric will involve compromises between solar heat gain, light transmission and view of the external world.

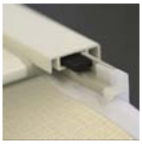
Typical values are

	Light transmittance	g-value
Sattler 314910 white	27.00%	.2931
Sattler 364638 black	0.32%	.2399
Sattler Reflect 355221	4.84%	.1647
Sattler Reflect Air 355221	7.72%	.1876
Soltis 86 2044 white	32.00%	.21
Soltis 86 2053 black	15.00%	.14

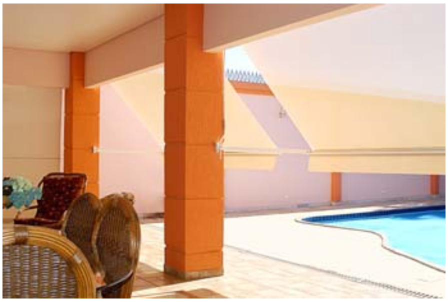
The Sattler fabrics represent a standard acrylic awning fabric, Reflect has a special clear coating to reflect solar radiation. Reflect Air has micro perforations to maintain visibility.

Soltis 86 fabric is a PVC coated polyester mesh fabric with 15% openness to maintain the view.





TYPES OF EXTERNAL MOBILE SHADING



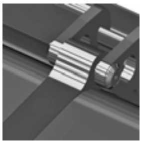
METRO drop arm awning
Provides shade without blocking ventilation

VERTICAL-BOX awning
Provides shade without blocking view or pathways

ARCADA awning system
Provides shade for overhead and low sun angles and reflected glare

SELECT Folding Arm awning.
Provides shade for windows and terraces





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