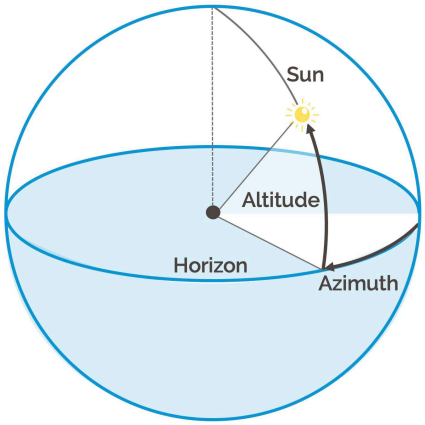
Angular dependency of MicroShade®, glass and shading solutions

In this document you can read more about the angle dependent performance of MicroShade®, glass products and other solar shading solutions.

Angular dependency

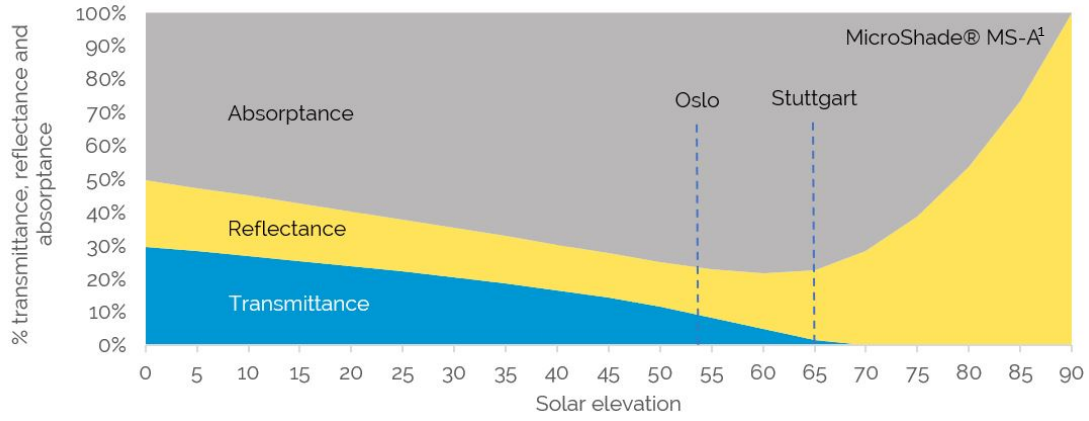
Usually only values perpendicular to the glazing are given, e.g. LT_o or g_o. But the performance always as an angular dependency. Angular dependency means that the performance varies with the position of the sun. The position of the sun varies both in the solar elevation direction and azimuth direction. In the figure below the two directions are illustrated.

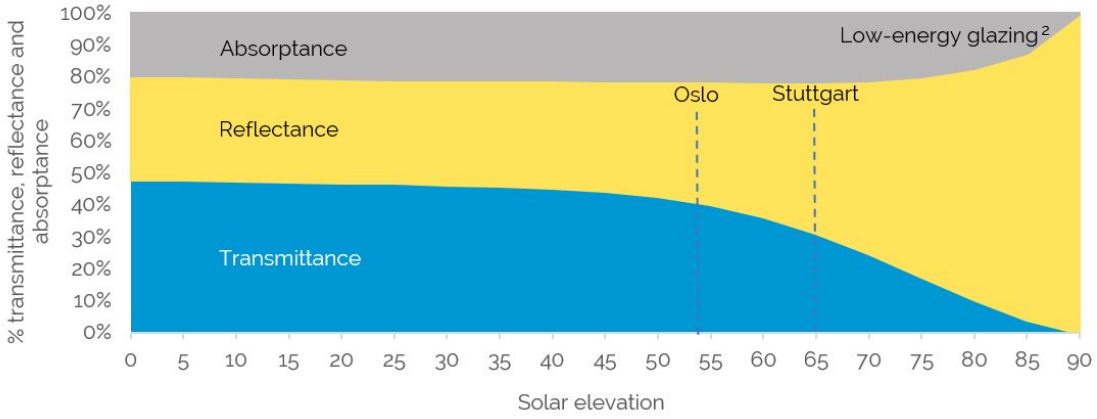


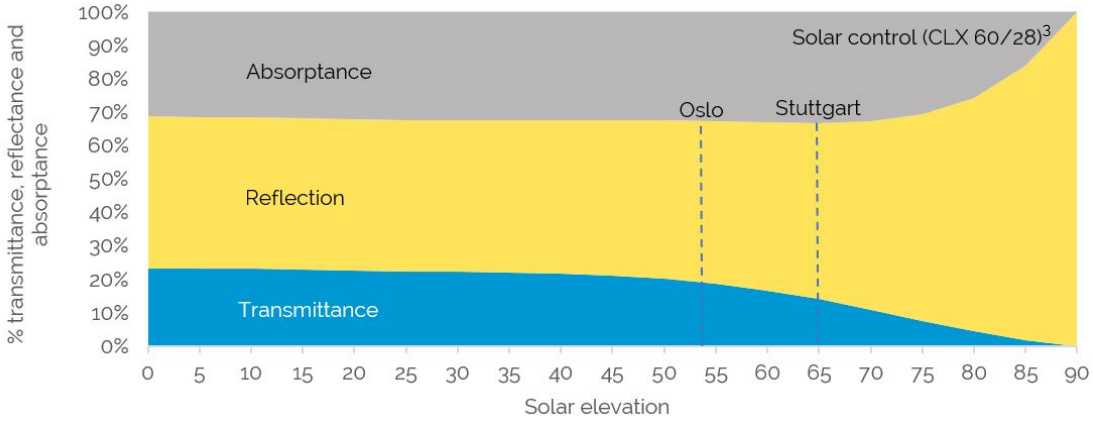
The angular dependency in the solar elevation direction is the most important of the two directions. However, the angle dependency in the azimuth direction can in some cases also be significant. Therefore, it will give the most accurate results if both directions are considered.

Transmittance of glass and shading solutions

The basic characteristic of products is the transmittance, reflection and absorptance. In the figures below the angle dependent transmission, reflection and absorptance of a 3-layer MicroShade® glazing, solar control glazing (Cool-Lite Xtreme 60/28) and a low energy glazing in the solar elevation direction is shown.







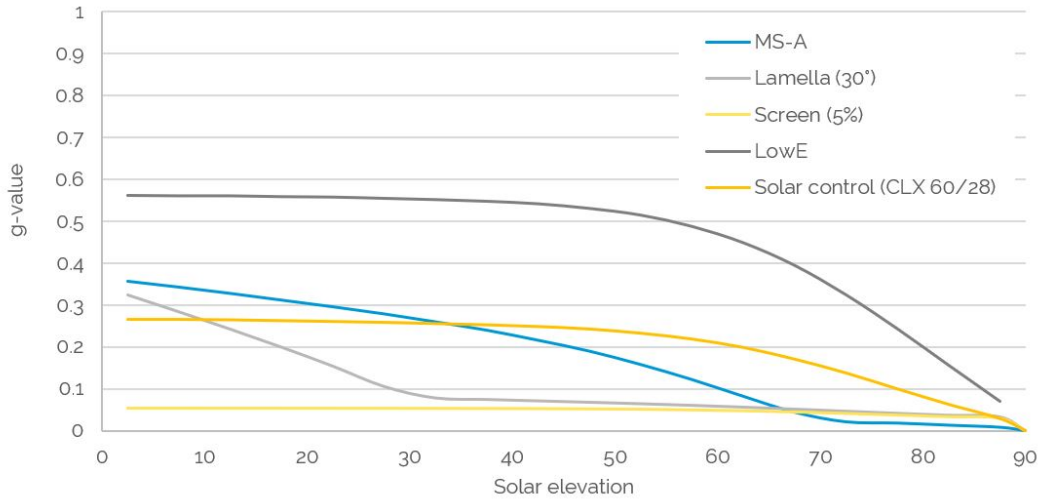
The three figures clearly show that the low energy glazing and solar control glazing has almost no angular dependency in the typical solar elevation range, e.g. from 0˚ and up to 54˚ in Oslo or 65˚ in Stuttgart. However, the MicroShade® glazing is varying within the typical solar elevation range.

This is the reason for g_0-value and LT_0 (perpendicular to the glazing) being good performance metrics for glazing product, but not for a MicroShade® glazing. The angle dependency of MicroShade® is more comparable to venetian blinds/lamellas, as MicroShade® consist of micro lamellas.

[1] MicroShade® glazing build-up: 4 mm float + MS-A - 12 mm argon 90% - 4 mm low-e - 12 mm argon 90% - 4 mm low-e
[2] Low-energy glazing build-up: 4 mm float - 12 mm argon 90% - 4 mm low-e - 12 mm argon 90% - 4 mm low-e
[3] Solar control glazing build-up: 4 mm Cool-lite Xtreme 60/28 - 12 mm argon 90% - 4 mm float - 12 mm argon 90% - 4 mm low-e

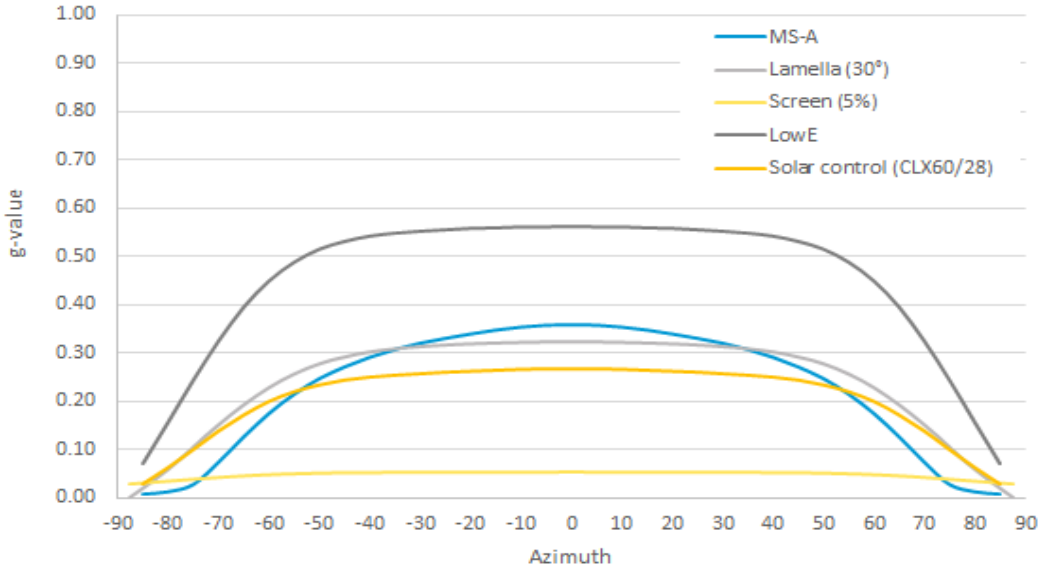
g-value and effective g-value

In the figure below the angle dependent g-value is shown for 3-layer glazings with MicroShade®, low energy glazing with external lamellas (tilted 30˚), low energy glazing with external screen (transmission of 5%), low energy glazing without shading and a solar control glazing (Cool-Lite Xtreme 60/28 from Saint Gobain).



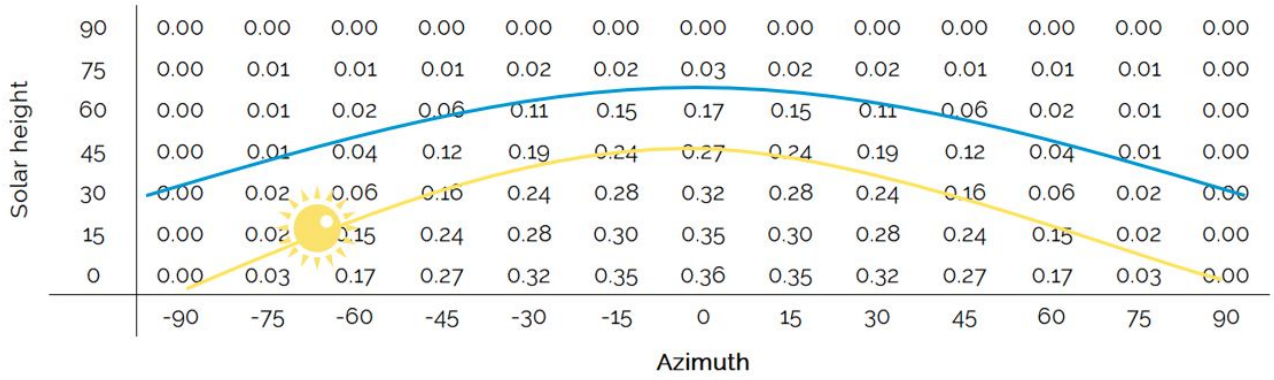
For the low energy glazing, solar control glazing and the external screen the g-value is not angle dependent in the typical solar elevation range, as also seen for the transmission. However, for MicroShade® and the external lamellas the g-value is highly angle dependent.

The angle dependency also apply in the horizontal plane (azimuth). And the corresponding graph can be seen below.



The angle dependent behaivor in the azimuth plane is the same as in the solar elevation plane for all solution.

The g-values of a MicroShade glazing varies over the course of a day/year with the position of the sun both in terms of solar elevation and azimuth. This is illustrated in the figure below. The figure shows a g-value table for MicroShade® MS-A with the blue curve being the sun position of summer solstice, June 21st, and the yellow curve being the sun position on spring equinox, March 21st for a south façade in Stuttgart.



The angular dependent performance can be described with the effective g-value as it considers the angle dependency in both solar elevation and azimuth direction. The effective g-value is calculated as a weighted average based on irradiation levels on the glazing each hour of the year considering the position of the sun. It means that the g-value in hours with high solar irradiance is weighted more heavily than in hours with low solar irradiance. An effective g-value for each month is a typical resolution to describe the performance.

Light transmittance and spatial daylight autonomy

The light transmission has the same angle dependency as the g-value.

For light transmittance no metric exists, that can take angle dependency into account. There is no such "effective light transmittance".

Light transmittance is used to evaluate the daylight performance of a product. For angle dependent products it is necessary to turn to daylight evaluation in buildings to describe the actual performance. It is necessary to use climate-based daylight simulations of Spatial Daylight Autonomy (sDA). Spatial Daylight Autonomy (sDA) is a description of how much of a space receives sufficient daylight, e.g. the percentages of the floor area that receives at least 300 lux for at least 50% of the daylight hours. Weather data and hourly sun position are used in combination with angle dependent light transmittance values to calculate sDA.

In SimShade it is possible to calculate the performance of MicroShade®, glass products and external shading products using all mentioned metrics (g_0-value, effective g-value, LT_0 and sDA).