HOW GLASS PLAYS A ROLE IN ENERGY CONSERVATION

Seringin Residences Kuchai Lama, Kuala Lumpur

The usage of coated glass and insulating glass units can have a significant impact on the energy consumption of commercial buildings. A reduction in HVAC (heating, ventilating and air conditioning) system reduces the initial investment, and annual savings from reduced energy consumption for heating and cooling requirements provides a return on glazing investment year after year. Studies have shown that over a 10-year period, the energy savings from high-performance coated glass can be several hundred thousand dollars for a typical six-story building, and the payback can be as little as two years.

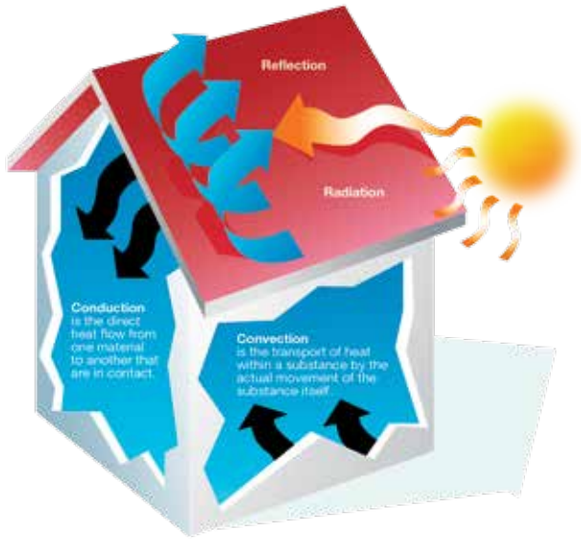
Performance Characteristic of Glass

Heat Flow

Heat flows through glazed elements such as a windows, glass doors or fixed glass panels is determined by the combined effect of the glass, frame and seals.

Heat flows through glazed systems in several ways:

1. Conduction
2. Convection
3. Radiation



01 Conduction

Conduction is the movement of heat energy through the glass and frame materials from the air on the warmest side to the air on the colder side. The greater the difference in temperatures – the more heat flow. Different frame and glass materials have varying ability to conduct heat, specified by the U-value. The lower the U-value, the less heat is transmitted.

There is a simple formula that can help you quantify the impact of improved U-value:

U x T x A = watts

- the amount of heat conducted through a glazed unit (in Watts) equals the U-value (U)
- multiplied by the number of degrees difference in air temperature on each side (T)
- multiplied by the area of the glazing unit (A)

How Low U-value helps save energy?

If a building has 45m^2 of windows and glazed door with aluminium frames, on sunny day when it is 10° hotter outside, the heat gain would be about:

6.0 x 10 x 45 = 2700 watts

That's almost equivalent to the total heat output of 1hp air conditioner running at full capacity (9000 btu/hr).

If you roughly halve the U-value of the window by selecting double glazing, you can halve the heat gain – in this example saving about 1350 watts of heat gain – equivalent to the energy use of twenty three unit of 60 watt incandescent light bulbs.

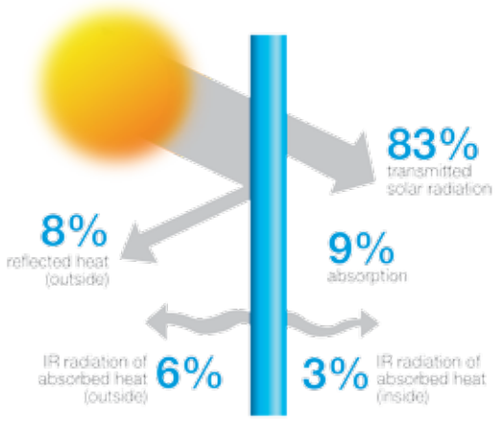
02 Convection

Convection is define as the movement of heat energy by air that passes over the surface of the glazing unit, taking heat away from the glass and frame. Higher air speed causes greater convection heat transfer. Minimising convective heat transfer can be achieved by reducing air movement adjacent to the surfaces of glazing units through shielding the exterior by walls, screens and plantings and by shielding the interior with curtains and pelmets. It can also be achieved through double glazing which creates a still gas layer between the panes.

03 Radiation

Solar radiation is heat that is transmitted as electromagnetic waves. They can pass through space, in the same way as visible light moves through space, until reflected or absorbed by materials.

The sun transmits solar radiation which is comprised of ultraviolet (2% of the total solar energy), visible (47%) and solar near-infrared (IR) (51%). Warm objects like people and buildings, radiate the longer wavelengths of infrared heat. When sunlight strikes a sheet of glass, some of the solar radiation is transmitted straight through, some is reflected and some is absorbed by the glass. The heat energy absorbed by the glass is then radiated to both the inside and outside as infrared radiation. The sum of reflected, absorbed and transmitted heat always equals 100%.



For example, 3mm clear glass: 83% of solar radiation is transmitted, 8% reflected and 9% is absorbed. 3% is then radiated inside and 6% outside.

The total amount of solar heat that passes through the glass is the sum of the heat transmitted plus that part of the heat absorbed in the glass which is subsequently re-radiated and convected inside. For the above example this equals 86%. This proportion of solar energy that passes through the window, both directly and indirectly, is called the Solar Heat Gain Coefficient (SHGC). Therefore, 3mm clear glass has a SHGC of 0.86.

The amount of infrared heat energy radiated from the surface of glass depends on its emissivity (also known as emittance). A 'perfect radiator' has an emissivity of 1.0. Untreated (uncoated) glass, whether clear or tinted, has an emissivity of 0.84. It is almost a perfect radiator. Low emissivity (low-e) glass has a coating on its surface which minimises the amount of heat, absorbed by the glass, being subsequently radiated into the building. It can also be designed to block some of the solar radiation transmitted through glass. Low-e glass is available with an emissivity as low as 0.03.

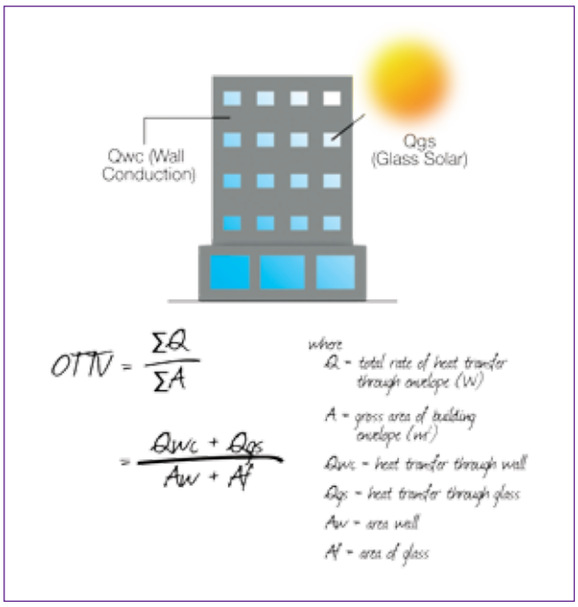
Double glazing is an effective way to reduce U-value, but its impact on solar heat gain depends on the type of glass. One layer of clear glass has a SHGC of 0.86. Two layers have a combined SHGC of about 0.76.

Building Envelope, Window Design & OTTV

Heat conduction through the overall building envelope can be computed by calculating its overall thermal transfer value (OTTV). The OTTV requirement aims to achieving the design of adequately insulated building envelope so as to cut down external heat gain and hence reduce the cooling load of the air-conditioning system.

The OTTV concept takes into consideration the three basic elements of heat gain through the external envelope of a building, as follows.

1. Heat Conduction through opaque walls
2. Heat Conduction through glass windows
3. Solar Radiation through glass windows



Principles of OTTV

The Capers Sentul

How solar control glass contribute to OTTV

1. Heat conduction through opaque walls, the first part of the formula typically accounts for; in the range of 0.5 % to 5% of the overall OTTV. This will have a bigger impact if the window areas are small, such as in shopping complexes.

2. Heat conduction through windows typically accounts for; in the range of 10% to 20% of the overall OTTV, depending on the amount of glazing and if they are single (higher U-value) or double glazed (lower U-value).

3. Solar radiation through glass windows is the greatest contributor to the OTTV typically accounting for; in the range of 70% to 85% of the overall OTTV, depending on the glazing area. The large constant of 194 already hints that this is a major factor in the overall OTTV. In order to keep the OTTV contribution for exceeding 50 w/m^2, the shading coefficient is a major contributor to the overall OTTV as it can change this component by 30% to 80% of OTTV.

IJM Gallery @ Bangsar South

Why choosing Glass with Low Shading Coefficient (SC) value is better than Low U-value glass in Tropical Country

The total heat gain by a window glass pane is given by the following equation:

Total heat gain (or Relative Heat Gain, RHG)
= Solar Heat + Thermal Heat

What is solar heat?

It is heat generated when the sunlight directly transmits through the window and some is absorbed and re-radiated in and out. It is governed by the glass property Solar Factor (SF) or we call SHGC.

What is thermal heat?

It is the heat transfer through the window, by conduction (temp diff) or convection (air flow). When the sun heats up objects or glass, the heat will be conducted through the window. It is governed by the U-value of the window.

By ASHRAE standard, the RHG formula is written as follow:

RHG = 630 (sunlight energy near earth given by ASHRAE) x SF (or SHGC) + U x 8°C (temp diff in/out)

For example:
Using Clear float glass 6mm (FL 6) VS St. Gobain Solar Control Low- E Glass ET 125 (in short ET 125)

> For FL 6, with sunlight energy = 630, SF = 0.87, U-value = 5.9W/m^{2}K, and temperature difference between indoor and outdoor = 8°

Relative Heat Gain for FL6
= Solar heat + Thermal heat
= (630 × 0.87) + (5.9 × 8)
= 548.1 + 47.2
= 595.3 W

From the sum, we convert into percentage, solar heat contributes 92% whereas thermal heat contribute 8%.

> For St. Gobain Solar control Low-E Glass ET 125, sunlight energy = 630, SF = 0.31, U-value 3.9 W/ m^{2}K and temperature difference between indoor and outdoor = 8°

Relative Heat Gain for ET 125
= Solar heat + Thermal heat
= (630 × 0.31) + (3.9 × 8)
= 195.3 + 31.2
= 226.5 W

From the sum, we convert into percentage, solar heat contributes 86% whereas thermal heat contribute 14%.

Compare both FL6 and ET 125 – RHG reduction
= RHG of FL6 – RHG of ET 125
= 595.3 – 226.5 = 368.8 W / 62%
> Solar contribution = 548.1 - 195.3
= 352.8 or 64%
> Thermal contribution = 47.2 - 31.2
= 15.9 or 34%

The total heat gain has been reduced by 62% switching from FL6 to ET 125. This is mainly due to the 64% contribution from the solar heat reduction.

Hence we should focus on the SHGC value instead of U-value because it is more value you get per money invested. Bear in mind that the U-value of 3.9 is approaching the limit for a single glazing coated glass.

To further reduce the U-value, we need to go to the next level which is DGU. But even we can reduce the U-value to below 2W/m^{2}K or even 1W/m^{2}K with the EXTREME product, the reduction is not significant because we are addressing the averaged 20% of the thermal portion but the cost of investment may increase significantly.

This is because in tropical country like Malaysia, the temperature difference between outdoor and indoor is not big (averaged at 8°C) compared to seasonal countries where temperature difference may vary up to 30°C!

Glass for Energy Efficient Building

Sierra Puchong

Green Building Index Rating System

Non Residential Existing Building (NREB), Non Residential New Construction (NRNC), Residential New Construction (RNC) and Residential Existing Building (REB).

The rating system for all 4 building categories is as follows:

Points	GBI Rating
> 86	Platinum
76 to 85	Gold
66 to 75	Silver
50 to 65	Certified

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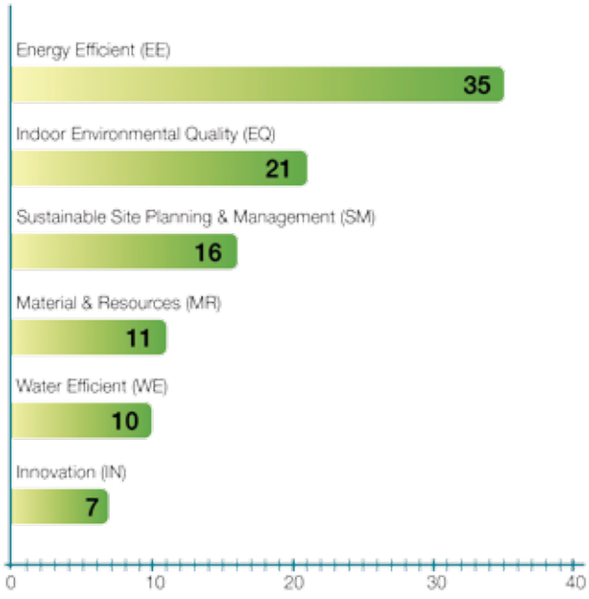
How CSG products can help to achieve green points?

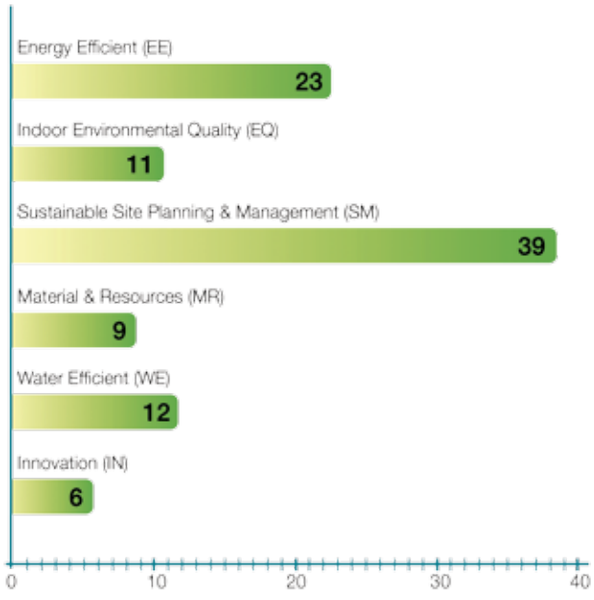
One of the most prominently recognized architectural standards in green or sustainable building design is the Green Building Index (GBI) Rating System developed by Malaysia Institute of Architects (PAM) and Association of Consulting Engineers Malaysia (ACEM). GBI provides a set of standards for the design, construction and operation of high performance green buildings. GBI was developed specifically for the Malaysia tropical weather, environmental and development context, cultural and social needs. It defines "green building" by establishing a common standard of measurement and Recognizing environmental leadership in the building industry through a certification process of buildings on a point-system for specific building projects. While GBI does not certify specific building (glass) products, it does recognize that the selection of products play a significant role in fulfilling GBI point requirements. CSG is committed to helping architects, builders, contractors and others to construct greener building by achieving GBI certification for their projects in a number of areas noted below:-

GBI Points Allocation Chart (Non-Residential)



Part	Item	Maximum Points
1	Energy Efficiency	35
2	Indoor Enviromental Quality	21
3	Sustainable Site Planning & Management	6
4	Material & Resources	11
5	Water Effciency	10
6	Innovation	7
	Total Score	**100**

GBI Points Allocation Chart (Residential)



Part	Item	Maximum Points
1	Energy Efficiency	23
2	Indoor Enviromental Quality	11
3	Sustainable Site Planning & Management	39
4	Material & Resources	9
5	Water Effciency	12
6	Innovation	6
	Total Score	**100**

greenbuildingindex

GREEN BUILDING INDEX POINTS & CRYSTAL SAFETY GLASS PRODUCT

Category	Intent	Requirements	Examples of CSG Products
GBI Category: Energy Efficiency (EE)			
EE1 **Minimum EE Performance** **(1 point)**	To create energy efficiency (EE) awareness and promote the use of MS1525.	OTTV ≤ 50 (Calculation using BEIT software) and provision of Energy Management Control system where air-condtioned space ≥ 4000m2.	For instance, achieving of CSG "spectrally selective" tinted or CSG Low-E glass with luminous efficacy of 1.0 or higher.
EE5 **Advance EE Performance** **(1-15 points)**	To encourage enhancement of building EE performance thereby reducing C02 emission.	Exceed EE Performance better than the baseline minimum to reduce energy consumption in the building. Achieve improvement of Building Energy Intensity (BEI) as defined under GBI reference.	For instance, CSG Laminated or CSG Double Glazing unit with Low-E products provide excellent solar and thermal control while allowing significant visible and natural light into buildings.
GBI Category: Indoor Enviromental Quality (EQ)			
EQ8 **Daylighting** **(1-2 points)**	To encourage use of diffused daylighting into interior of building.	Demonstrate that ≥ 30% (1 point) or ≥ 50% (2 points) of the NLA (Nett Lettable Area) has a Daylight Factor in the range of 1.0 – 3.5% as measured at the working plane, 800mm from floor level, OR	CSG provides a wide array of clear, tinted and coated glass with varying levels of visible light transmittance combined with solar and thermal control. For example, CSG DGU Low-E glass provides 50% or more visible light transmittance for areas requiring daylight transmittance.
EQ9 **Daylight Glare Control** **(1 point)**	To reduce discomfort of glare from natural light.	Reduce discomfort of glare from natural light. Where blinds or screens are fitted on glazing and atrium as a base building, incorporate provisions to meet the following criteria; 1. Eliminate glare from all direct sun penetration and keep horizontal workspace luminance level below 2000 lux; 2. Eliminate glare from diffused sky radiation for occupant workspace at viewing angles of 15° to 60° from the horizontal at eye level (typically 1.2m from floor level); 3. Control with an automatic monitoring system (for atrium and windows with incident direct sun light only – not applicable for fixed blinds/ screens); AND 4. Equip with a manual override function accessible by occupants (not applicable for fixed blinds/screens).	CSG offers lustrous colour of high performance tinted and coated glass with varying levels of glare control. For example, CSG Laminated Blue Reflective Low-E glass helps to control glare and subsequently reduces the need for blinds or shades.
EQ12 **External Views** **(1-2 points)**	To reduce eyestrain for building occupants by providing long distance views and visual connection to the outdoor.	Demonstrating that ≥ 60% (1 point) or ≥ 75% (2 points) of the NLA has a direct line of sight through vision glazing at a height of 1.2m from floor level.	CSG provides a wide array of clear, tinted and coated glass with varying levels of visible light transmittance combined with solar and thermal control. For example, CSG DGU Low-E glass provides 50% or more visible light transmittance for areas requiring daylight transmittance.
EQ13 **Internal Noise Levels** **(1 point)**	To ensure building is designed to maintain a comfortable acoustic environment for occupants.	Demonstrate that 90% of the NLA do not exceed the following ambient internal noise level: 1. Within the entire building general office, space noise does not exceed 40dBAeq OR 2. Within the baseline building office space, the sound level does not exceed 45dBAeq for open plan and does not exceed 40dBAeq for closed offices.	CSG offers various glass thicknesses and glazing methods (CSG Laminate, CSG IGU or combinations of the two) that is effective at controlling the sounds transmit.
GBI Category: Material & Resources (MR)			
EQ13 **Internal Noise Levels** **(1 point)**	To encourage designers to specify the usage of recycled content materials in new buildings. Increase demand for building products that incorporate recycled content materials in production.	Where use of materials with recycled content is such that the sum of post-consumer recycled plus one-half of the pre-consumer content constitutes ≥ 10% (1 point) or at least 30% (2 points) based on cost of the total value of the materials in the project.	CSG always monitor the quantum and value of the recycled content of the glass purchased from our suppliers.