LIGHT BALANCE

Glazing performance for Commercial Facades under the new NCC Section J

Photography by Trevor Mein

GLASSWORKS

INTRODUCTION

Modern architecture is characterised by glass like no other material. Initially used for its lightweight and transparent properties, designers and architects now use glass as a fundamental component of contemporary, sustainable buildings to provide natural light and a connection to the outdoors, both of which contribute to occupant health, comfort and wellbeing.

Buildings with a high percentage of glazing however must contend with the effects of heat gain during Australia's harsh summer. Solar protection devices compensate for a disadvantage that often goes hand-in-hand with the transparency of glass architecture – the undesirable build-up of room temperature in summer. In winter, these solar gains are desirable but in warmer months they can result in unpleasantly high indoor temperatures. The use of coated solar protection glass can substantially reduce but not entirely avoid this effect, with key trade-offs made between clarity and performance.

While the aesthetic appeal of glass structures is undeniable, the use of wide expanses of glass in modern architecture requires holistic and detailed planning. The goal for designers is to achieve the optimal indoor environment for any given climate by balancing insulation and heat gain without compromising natural lighting, all while meeting the demanding facade requirements of the new Section J in the National Construction Code (NCC) 2019.

In this whitepaper, we take a closer look at the design considerations that help architects, designers and specifiers achieve this balance. We also consider the impact of the new Section J on wall-glazing construction and the importance of the Light-to-Solar-Gain ratio in designing glazing systems.

"The LSG ratio can be calculated by dividing the VLT by the SHGC. If the ratio is greater than 1.0, the window transmits more light than heat."

Photography by Daniel Fuge

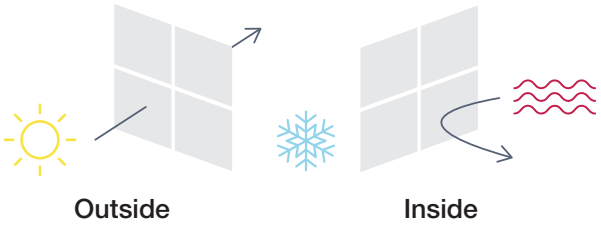
Photography by John Gollings

KEY TERMS AND DEFINITIONS

When considering wall-glazing design, designers need to be familiar with several concepts, technical terms and performance measurements. First is **passive heating and cooling**, which refers to solar design that seeks to use the sun's energy for the heating and cooling of living spaces through carefully managed sun exposure.

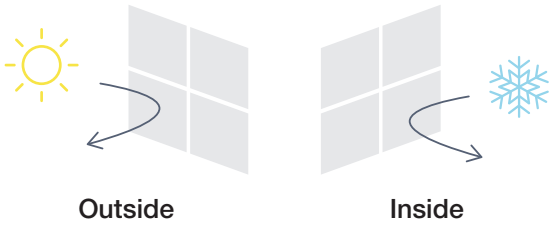
"Passive heating"[1] aims to capture the sun's heat within the building's elements, and gradually release that heat when the sun is absent while maintaining a comfortable interior temperature. Glass and the building's thermal mass work in combination to absorb, store and distribute solar heat.

Winter example



"Passive cooling"[2] works by implementing design solutions that reduce unwanted heat gain during the day, so minimal air-conditioning is required to cool a room. This is achieved through heat gain prevention, that is preventing heat from entering the interior, or by removing heat from the building via natural cooling processes.

Summer example



The challenge for architects and designers is allowing the greatest amount of light in, while rejecting excess solar heat gain through the glass. How is light and heat gain measured in terms of glazing performance? The NCC measures a window's thermal performance in terms of U-Value and Solar Heat Gain Co-Efficient (SHGC). Visible Light Transmission (or VLT) is the measurement for natural light transmission. These terms are explained below:

- **U-Value** measures the amount of heat transferred through a window. The lower the value, the higher the window's insulation performance or, in other words, the better the window is at preventing unwanted heat flow and heat escaping.
- **SHGC** measures how much solar radiation passes through the window. Windows with poor SHGC allow buildings to collect solar heat more readily.
- **VLT** is the measurement of the amount of visible light waves that transmit through a material. The higher the VLT value, the more light is entering through the window.

PERFORMANCE FACTORS FOR GLAZING

Now that we know how glazing performance is measured, the next question is what environmental and design factors impact glazing selection. Below are several factors outlined in more detail.

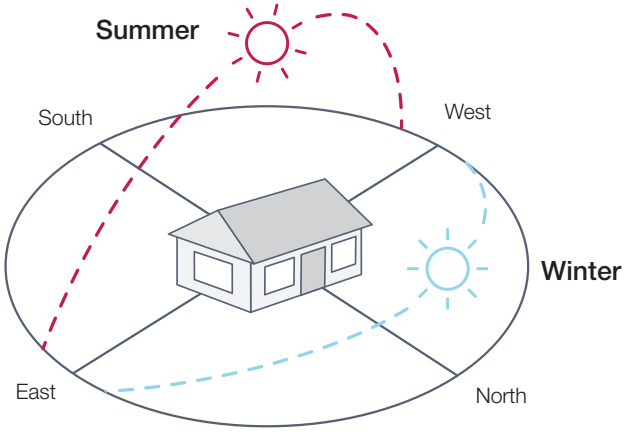
Climate

Different climatic conditions have different performance demands. In warmer climates, the priority is to keep solar radiation and ultraviolet light out, while retaining the coolness of air-conditioned air indoors. Compare this to cooler climates, which typically demand windows and glazing to maximise desirable solar heat gain for most of the year, while insulate against excess heat loss. Mixed climates require a balance – provide the benefits of solar heat gain during winter, while keeping buildings cool during summer.

Building Orientation

Building orientation, referring to the positioning of a building in relation to seasonal variations in the sun's path, is another key consideration. North-elevated windows receive sun in winter and little sun in summer. East and west facing windows can be a major source of heat gain during summer. For east and north-east facing windows, this occurs predominantly in the morning, west and north-west facing windows more so in the afternoon. South-facing windows receive little to no sunlight in summer and almost none in winter.

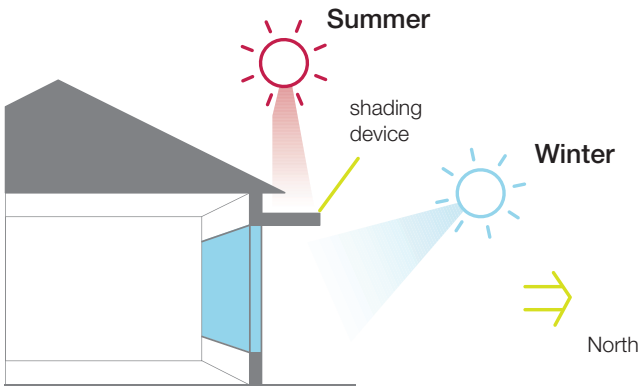
Summer vs Winter Sun
(credit: https://www.sustainability.vic.gov.au)



Building Considerations

In addition to climate and building orientation, the use of shading devices, eaves, pergolas and verandahs all impact the amount of sun a window receives during the day. In addition, building elements such as ventilation, wall insulation and other building materials can impact a building's overall thermal performance.

Shade North Facing Windows
(credit: https://www.sustainability.vic.gov.au)



The Role of Glass Coatings

Depending on the needs of the building, the right type of glass can either block out excessive heat gain or re-radiate escaping heat back into a room as required. Glass coatings can also be used to enhance the thermal performance of a building. Low Emissivity (Low-E) glass is an invisible metallic coating applied to the glass surface to enhance its solar control and insulating ability.

Not all Low-E is the same – some types of Low-E glass promote passive heating and are more suitable for cooler climates, while others are better for passive cooling in warmer climates. The different types of Low-E glass are covered in more detail in the following whitepaper: https://www.glassworksaust.com/wp-content/uploads/2018/10/Whitepaper-Low-E-Glass-Coatings-explained.pdf

Photography by Dylan James

SECTION J CONSIDERATIONS

The new provisions under Section J in NCC Vol 1 impact commercial buildings in Classes 2 to 9, and took effect in most states from 1 May 2020. What do architects, designers and specifiers need to know?

Performance Requirements

The NCC Performance Requirements relating to energy efficiency have changed significantly, with measurable objectives introduced to limit total energy usage for conditioned spaces within prescribed limits depending on the building classification.[3] The usage patterns of a building serve as the primary factor in determining its energy usage. A building that is occupied 24 hours a day, such as an aged care facility (Class 9c), will have different facade performance requirements than a building that is occupied during certain hours only, such as an office building (Class 5).

Climate Zones and Building Classes determine which performance requirements apply with various levels of stringency set as a function of how a building is used and occupied. The whole facade is considered and is required to achieve specified thermal performance figures, expressed in terms of Total U-Value (see Specification J1.5) and Solar Admittance (see Tables J1.5b and Table J1.5c).

Calculating Total Facade Performance (Walls and Glazing)

The method for calculating facade performance has also changed with wall and glazing now calculated together. The performance of glazing and walls are combined to get single values for a "wall-glazing construction system".

Under the new calculation methodology, the glazed area becomes a key metric in determining the overall performance of the facade. Low-performing components may potentially reduce the allowable wall-to-glazing ratio of the building. Using low-performing glazing means that the performance of adjacent walls must increase in terms of U-Value and SHGC to compensate. In this scenario, the glazing ratio (referring to the area of the facade that is comprised of glazing) may need to be reduced, limiting the amount of natural light and outdoor views in the building.

Facade Calculator

The NCC 2019 Facade Calculator applies to Classes 3 to 9 buildings, as well as the common areas of Class 2 buildings and mixed-use buildings. It incorporates the new calculation methodology and can be used by architects and designers to calculate the thermal resistance of the facade as a whole, rather than having separate requirements for walls and windows.

A concise explanation of each building classification is provided by the Australian Building Codes Board at https://www.abcb.gov.au/-/media/Files/Resources/Education-Training/UTNCC_Building_Classifications.PDF.

A Practical Example: Aged Care vs Office Building

An office building (Class 5) that is occupied only during the day will have very different target performance values than an aged care facility (Class 9c) that is occupied around the clock. Given the lower targets for the aged care facility, the wall-to-glazing ratio will be less (more wall, less glazing) than an office building for the same performing glass. The better the glass performance, the higher the wall-to-glazing ratio. Below is a table showing how building target values and window performance relate to the wall-to-glazing ratio.

Table 1. Wall-to-Glazing Ratio Example

	Example Target Values		Glazing-to-Wall Ratio by Window Performance		
Building Type	Target U-Value	Target SHGC	Good	Better	Best
Aged care facility	1.1	2.0	10%	30%	60%
Commercial office building	0.7	0.16	30%	60%	100%

The table provides a hypothetical example of how the glazing area of a facade can increase when window performance increases. Exact values will depend on the specific performance of individual window and glazing systems.

Addressing the Light-to-Solar-Gain Ratio

Continuing with the aged care example, if the target is a U-Value of 1.1 for an aged care facility then the glass performance needs to be outstanding if glazing is to make up more than half of the total facade. If the glass area needs to be specified smaller due to poor U-Value and SHGC performance, there is a key trade-off – natural lighting becomes limited.

If opting for a predominantly glass facade with good SHGC performance, there is another inherent trade-off, this time between solar gain and natural light. When keeping the SHGC down, the VLT is often inadvertently compromised – a glass that blocks out more heat also blocks out more light.

A good rule-of-thumb is to aim for a solution where SHGC is around half the VLT – this is known as the Light-to-Solar-Gain ratio (LSG ratio). The LSG ratio is a less-commonly used value across the industry, but is valuable in measuring how much a window transmits light relative to heat.

The LSG ratio can be calculated by dividing the VLT by the SHGC. If the ratio is greater than 1.0, the window transmits more light than heat. Windows with low LSG are more conducive for passive heating applications, whereas high LSG windows are used to help prevent heat gain. Note that any window system that achieves a LSG ratio approaching 2.5 is considered favourable, striking the perfect balance or the "best of both worlds".

ACHIEVE BALANCE WITH HIGH PERFORMANCE GLAZING

by Glassworks

Very few glazing solutions on the market address the LSG ratio. While considered good, a typical single silver Low-E IGU in a 6mm/12 Argon/6mm Low-E in a reasonably performing aluminium frame might achieve a VLT of 70% with an SHGC of 0.54, leaving a LSG ratio of 1.3, considerably short of the recommended 2.5. By upgrading to a triple silver Low-E in the same configuration, such as Glassworks' LoE^3-366®, the VLT may achieve 63% with an SHGC of 0.27 equalling a more favourable ratio of 2.33.

For fully-glazed commercial building facades, LoE^3-340® in the same configuration produces an exceptionally low SHGC of 0.18 with a commercially acceptable VLT of 38%, resulting in a LSG of 2.11.

Providing world-leading glass solutions, Glassworks products combine the most sophisticated technology and machinery to produce superior performing glass solutions with Australian market demands and climate conditions top of mind. Glassworks has you covered with a Low-E glass type for all building requirements, budgets and climates.

LoE^3-366: The all-round highest performing Low-E

Manufactured with a triple layer of silver that supersedes ordinary Low-E glass and is neutral in colour from the outside, clear from the inside, LoE^3-366 has the unique ability to reject solar heat without compromising visibility, unlike tinted glass. LoE^3-366 blocks the harshness of the sun with a low SHGC of 0.27 on clear compared with the 0.67 of regular Low-E double glazed. LoE^3-366® also boasts a Visible VLT figure of 63% in certain IGU make-ups, meaning natural light is able to enter the building and allowing architects, designers and specifiers to achieve a favourable LSG ratio.

LoE^3-340: Superior solar control glass

The ultimate sun-blocking Low-E glass, LoE^3-340 produces an SHGC figure of 0.18, the lowest of any stocked glass in Australia, including dark tints, and is perfect for commercial buildings seeking green ratings. Unlike dark tints, it achieves a VLT figure of 38%, well within the desired range of 30-40% for commercial projects. The use of Glassworks' LoE^3-340 eliminates the need for screens or overhangs regardless of the climate or elevation, enabling complete architectural freedom. The external reflectivity of only 11% makes it highly beneficial for obtaining building permits.

Photography by Kane Jarrod

REFERENCES

1 Australian Government. “Passive solar heating.” YourHome. https://www.yourhome.gov.au/passive-design/passive-solar-heating (accessed 23 June 2021).

2 Australian Government. “Passive cooling.” YourHome. https://www.yourhome.gov.au/passive-design/passive-cooling (accessed 23 June 2021).

3 Australian Window & Glass Association. “Technical Fact Sheet: NCC 2019 – Section J.” AGWA. https://awa.associationonline.com.au/documents/item/2095 (accessed 23 June 2021).

All information provided correct as of July 2021

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