EBOOK

How glass can contribute to more energy efficient buildings

Photo credit: Studio Connecta

GUARDIAN® GLASS

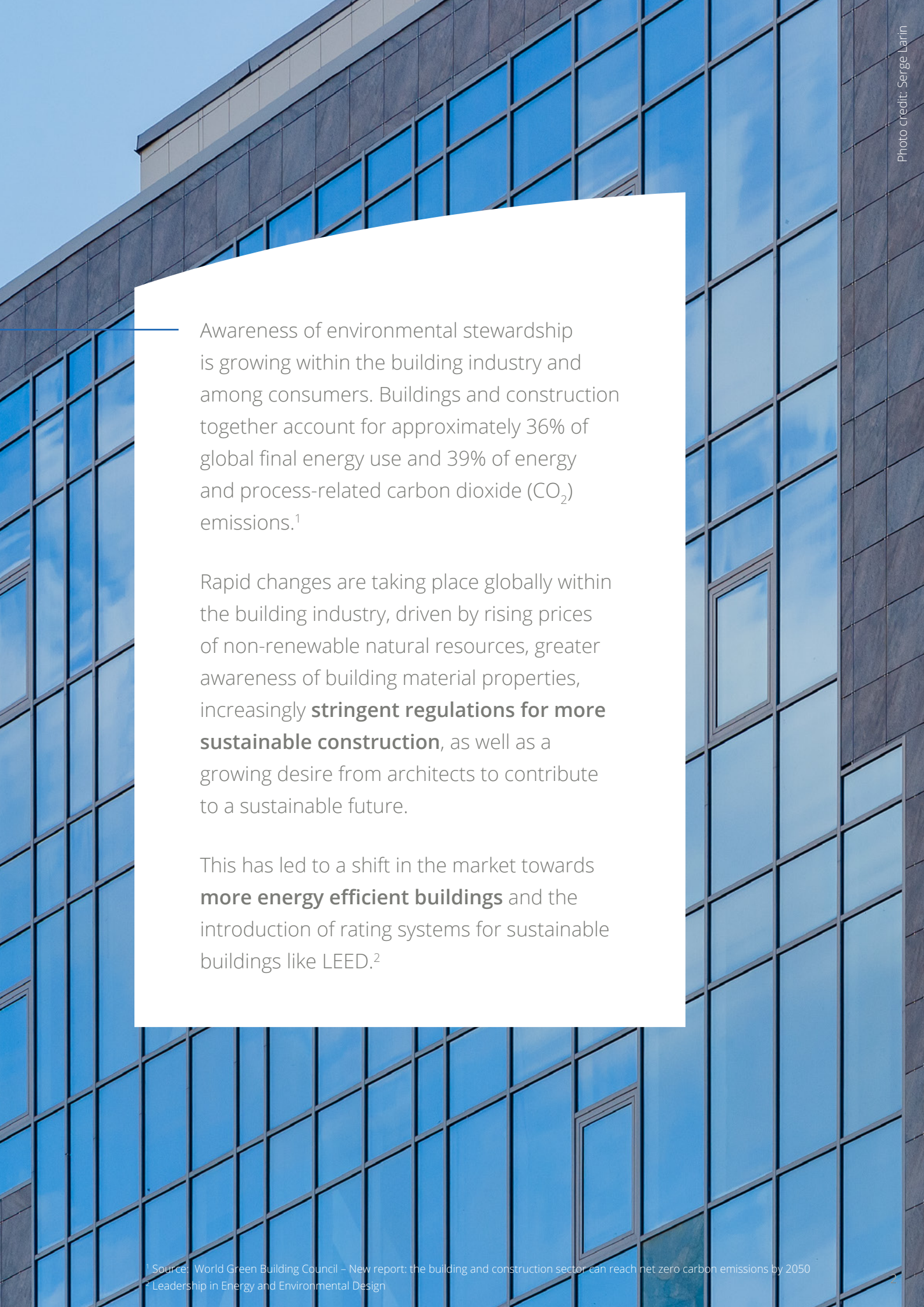


Photo credit: Serge Larin

Awareness of environmental stewardship is growing within the building industry and among consumers. Buildings and construction together account for approximately 36% of global final energy use and 39% of energy and process-related carbon dioxide (CO_2) emissions.[1]

Rapid changes are taking place globally within the building industry, driven by rising prices of non-renewable natural resources, greater awareness of building material properties, increasingly **stringent regulations for more sustainable construction**, as well as a growing desire from architects to contribute to a sustainable future.

This has led to a shift in the market towards **more energy efficient buildings** and the introduction of rating systems for sustainable buildings like LEED.[2]

[1] Source: World Green Building Council – New report: the building and construction sector can reach net zero carbon emissions by 2050
[2] Leadership in Energy and Environmental Design

Glass: Flexible and energy efficient

Photo Credit: Georges De Kinder Photographe sprk

As a building material, glass is surprisingly flexible. As part of an architect's overall solution, glass can help meet the most challenging **project performance requirements** and contribute to more energy efficient builds. As well as enhancing the appearance of a building, it can help protect from the sun's glare, keep its occupants insulated from the cold, while helping to improve comfort and well-being.

In terms of insulation, glass has improved significantly as a component of a high-performance building envelope. Modern glazing solutions offer energy efficiency through insulating value but also through free solar heat gains when these are desirable, while providing thermal insulation where needed. Improvements in glazings and low-e coatings contribute to reduced energy consumption of windows and facades. Selecting the most appropriate high performance glazing solution based on the building's use and orientation can help reduce the need for air conditioning in the warmer months and heating in the colder months. **Natural daylighting** can also be transmitted where needed, helping to reduce the need for artificial lighting.

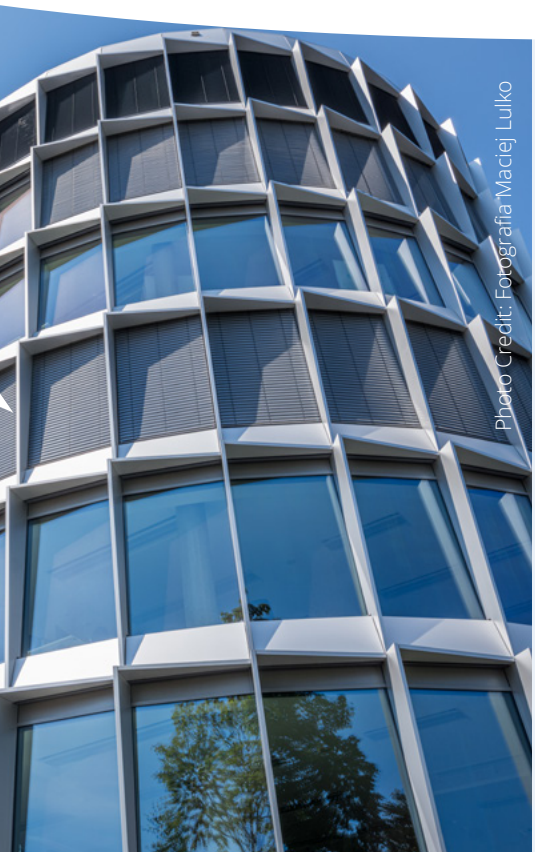


Photo Credit: Fotografia Maciej Lulko

Glass for every project

Architects are increasingly turning to advanced glazing solutions, not just to obtain the best all-round performance, but also to help overcome the challenges associated with meeting **local building codes**, or perhaps helping to achieve a **green building certification rating** for their project.

Architectural glazing enables building occupants to visually engage with outdoor environments, while enjoying indoor comfort. **Solar control and low-E coatings** can greatly contribute to the energy efficiency of windows and facades, using specialized coatings to improve performance and provide visual transparency.

How can glass contribute to performance and energy efficiency?

Solar control glass

When you need plenty of natural daylight but want to reflect a high proportion of the sun's heat away from the glass – **the answer is solar control glass**. It helps reduce the 'greenhouse effect' that occurs in summer as rooms heat up to the point that they become unpleasant to be in. With solar control glass, indoor spaces can become brighter and cooler, while uncomfortable glare from the sun can be filtered out.

Depending on the climate, it can be more expensive to cool the interior of a building than to heat it. Solar control glass helps **minimize the amount of heat energy** that penetrates a building, thus helping to limit the use of air conditioning. Large window and facade surfaces can allow plenty of natural light to reach deep into the building's interior, which can also help reduce the need for artificial lighting.

What is solar energy?

The **sun's electromagnetic radiation** that reaches the Earth's surface is called solar energy (shortwave radiation). It consists of approximately 49% energy in the visible wavelength range, 49% energy in the near-infrared range, and 2% in the ultraviolet range. **Solar control coated glass blocks a significant amount of this energy.**

When a ray of electromagnetic energy strikes a glass pane, some of the energy may be reflected, some may be absorbed, and the remaining energy is transmitted. Depending on the region of the world, either the **solar heat gain coefficient (SHGC)** or the **solar factor (g-value)** is used to measure the solar energy that transfers indoors.

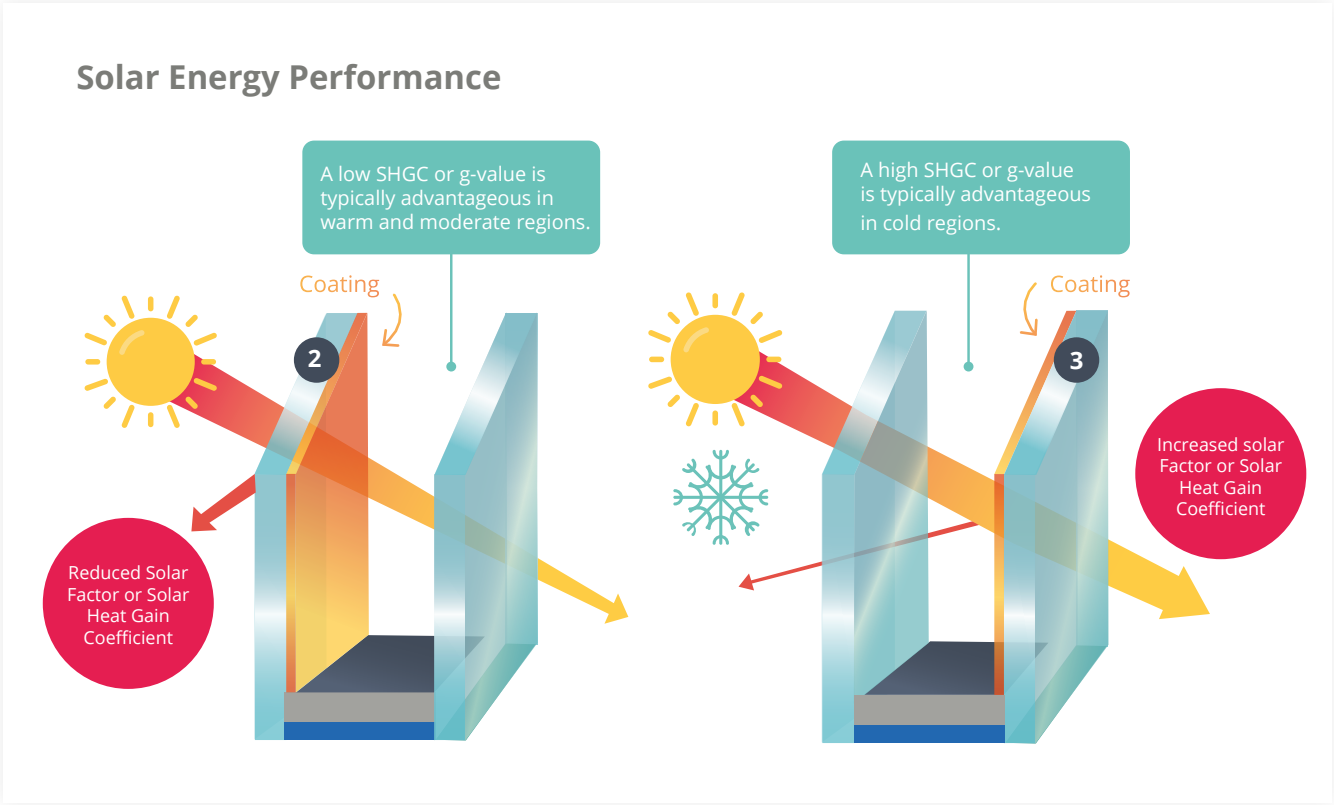
Photo Credit: Stanislas Ledoux


Photo Credit: Alexander Severin

Glazing for hot and cold climates

For architectural projects located in **warm or moderate climates**, a low SHGC or g-value is preferred. The number 2 surface placement of a solar control coating often facilitates the best performance because it partially **reflects away incoming solar energy** before it can enter the glazing.

In particularly **cold climates**, a higher SHGC or g-value could be beneficial to **allow passive heat gain**. The number 3 surface placement of a low-E coating can be ideal by **retaining the heat inside** the building or home.



Light coming inside the building, as well as coatings and their placement in the glazing, are crucial in **supporting occupant comfort**. The term '**spectral selectivity**' is used to address the amount of daylight transmission relative to solar energy blockage. Greater spectral selectivity is achieved when more visible light, and less overall solar energy, is transmitted.

Thermal insulating glass

Longwave radiation from the sun interacts with solids and molecules, and the initiated motion transfers heat. Glass with thermal insulating properties is able to block a significant proportion of this radiation.

Heat transfer takes place through 3 mechanisms:

- **radiation** (heat transfer by electromagnetic radiation),
- **conduction** (heat transfer through direct contact),
- **convection** (heat transfer through currents of moving air or gas caused by temperature differences).

Example of the oven

When you consider the example of an oven, longwave radiation is emitted from the interior of the oven; conduction means that if you touch the oven, you may get burned; and through convection, if you open the oven, the hot air will escape and rise.

All 3 types of heat transfer occur within an insulating glass unit (IGU). During a cold night, for example, heat migrates outwards in 3 ways:

- **By radiation**, where longwave radiation is transmitted through the glazing assembly.
- **By conduction**, where heat is transferred within the glass and the IGU interspace and through direct contact between the glass and the surrounding air.
- **By convection**, whereby the air within the IGU slowly circulates, transferring the heat.

Keeping you warm

Insulating performance of glass refers to the reduction of heat transfer associated with **exterior-versus-interior air temperature differences**. Insulating performance is particularly beneficial in cold climates, where the glazing may allow incoming shortwave solar radiation to enter and retain the heat inside of the building. Longwave heat radiation is reflected inside.

Changing temperatures during the day, between different seasons and across different climates, make it difficult to maintain a comfortable indoor environment. Thermal insulating glass welcomes natural light into a room, while helping to reduce the negative effects of cold outside temperatures. The glass reflects heat back into the room to keep inside spaces warmer during the colder seasons.

Photo Credit: Architectuurfotograaf Lucas van der Wee

How do we describe insulating performance?

Insulating performance is described with a parameter known as the 'U-value'. This describes the **heat transfer per unit time**, i.e. the duration required for heat transfer per unit of glazing area and per degree of temperature difference between the exterior and interior conditions.

If a glazing assembly has strong insulating performance, only a small amount of energy will be transferred and the **U-value** will be low. Or it may take more time, more glazing area, and/or more of a temperature difference for the same amount of energy transfer to take place. Again, these circumstances would result in low U-values.

U-values are described as either:

- British thermal units transferred per hour, per square foot of glazing, and per degree Fahrenheit (Btu/hr.ft^2.°F).
- Units of Watts per square meter of glazing area per Kelvin (W/m^2.K).

Photo Credit: by Max Touhey

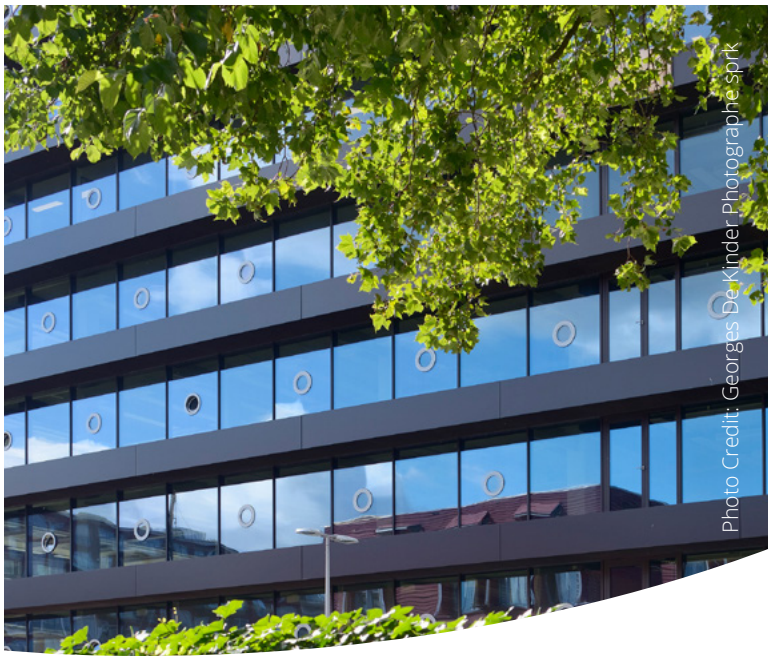


Photo Credit: Georges De Kinder Photographe sprl

Ways to improve insulating performance of an IGU

The insulating performance of an IGU can be improved in a variety of ways:

- **A low-e coating** can be used that performs well in reflecting longwave radiation.
- Rather than air, **argon gas** can be used within the cavity of the IGU to reduce conduction. The cavity width can also be optimized.
- A **warm edge spacer** can be used to help minimize thermal conductivity at the perimeter of the glazing assembly.
- Another pane of glass can be added so that **multiple cavities and coated surfaces** can provide increased insulating performance.

Windows can be made more energy efficient by using thermal insulating **double- or triple-glazing**. It means your living or workspace can become more comfortable all year round, with **fewer cold spots and drafts**, as well as **less condensation**. The glass can be made to look neutral or beautifully transparent, while giving you the freedom to use larger windows that help flood home and office interiors with natural daylight. All this helps people feel more comfortable.

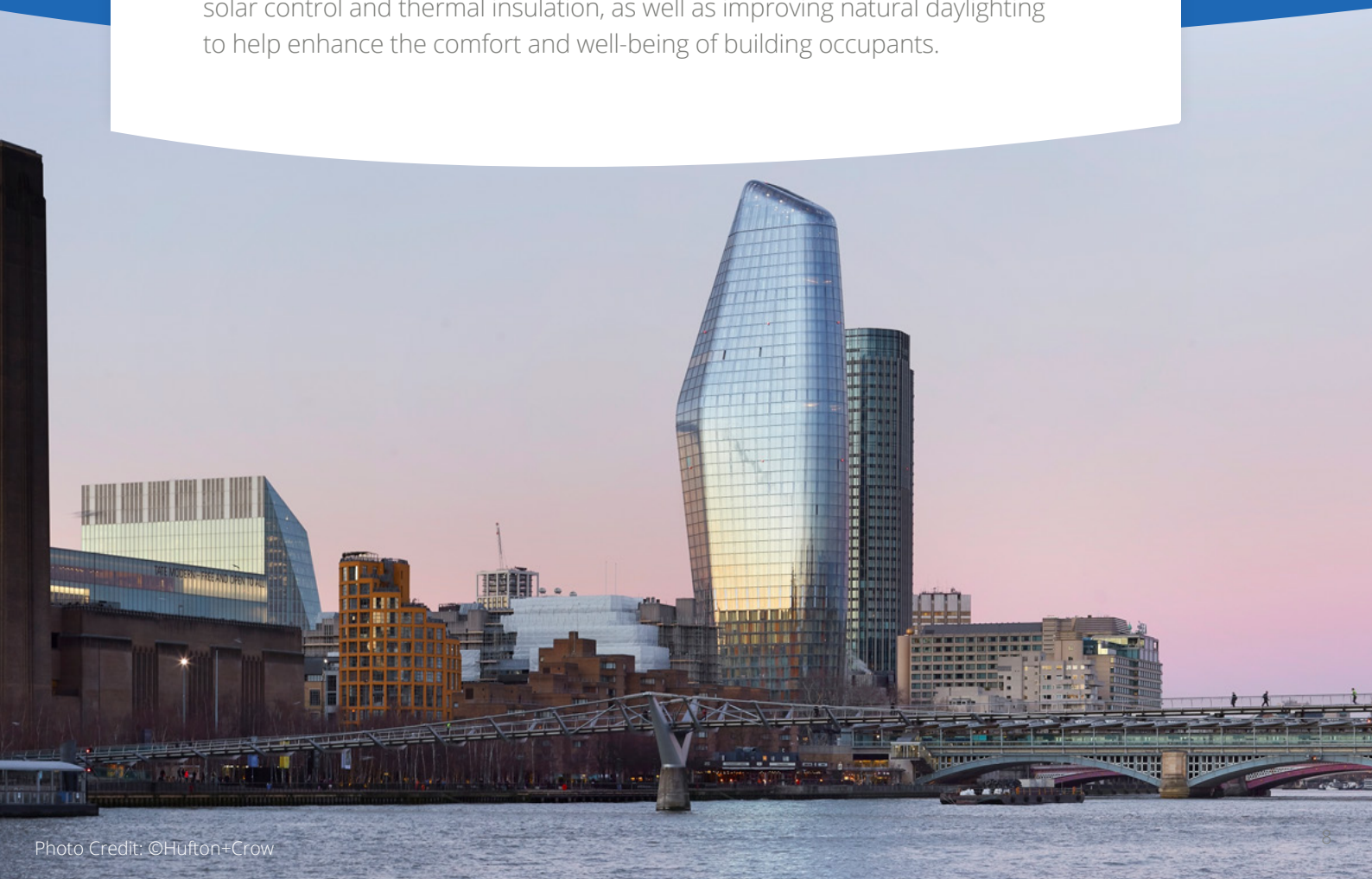
Make a difference

Glass is playing an increasingly important role in contributing to more sustainable, energy efficient buildings. From commercial skyscrapers to residential new builds, advanced glazing solutions can achieve very high levels of energy performance and help reduce operational carbon. Glass manufacturers are working to continuously improve their products and research innovative methods to minimize the glazing solutions' environmental impact throughout the lifecycle.

Glass is a flexible building material.

Coatings and properties can be combined to work in different ways to suit a variety of projects, providing architects with more options and opening up **new design opportunities** they thought wouldn't be possible in order to meet regulations and their own energy performance criteria for buildings.

Although more needs to be done to raise the awareness of the benefits of high-performance glass for buildings, **advanced glazing solutions** exist today and are ready to use. Ultimately, selecting the right glass can contribute to maximize a building's appearance and its energy performance in terms of solar control and thermal insulation, as well as improving natural daylighting to help enhance the comfort and well-being of building occupants.



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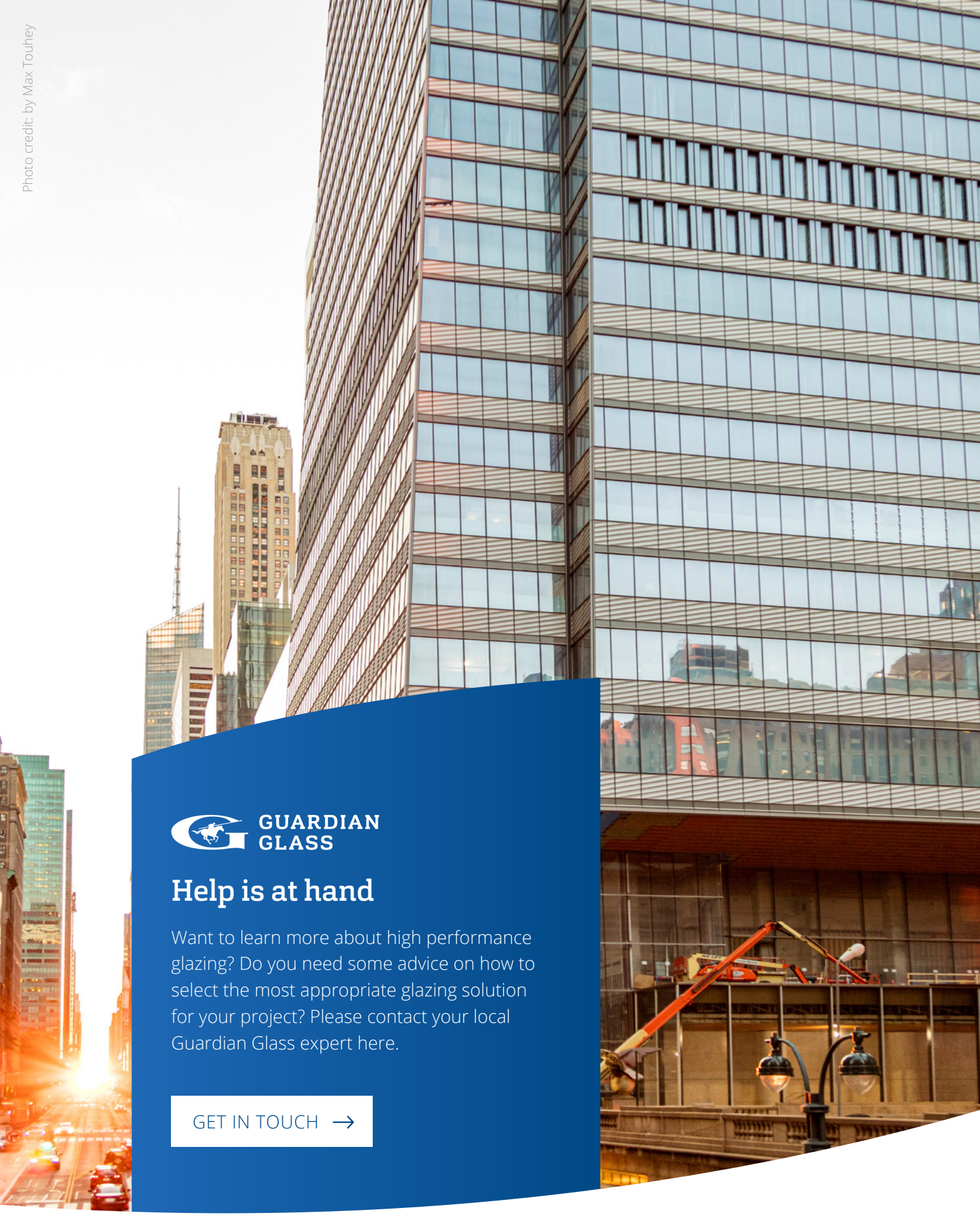

GUARDIAN GLASS

Help is at hand

Want to learn more about high performance glazing? Do you need some advice on how to select the most appropriate glazing solution for your project? Please contact your local Guardian Glass expert here.

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