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The role of solar control glazing in passive cooling of buildings

Preventing overheating, optimising thermal comfort and preserving daylight

1. Executive Summary

The **European building stock is becoming increasingly vulnerable to overheating** due to rising global temperatures, more frequent and intense heatwaves and insufficient adaptation of existing structures.

Buildings that are not designed or retrofitted to cope with these conditions face significant **decline in thermal comfort** and **increased public health risks** for their occupants which also suffer from **reduced productivity**. These buildings experience **higher energy consumption** as demand for active cooling grows.

Active cooling is already the fastest-growing source of energy use in buildings and is projected to rise sharply by mid-century. This trend **increases the operational carbon**[1] emissions of buildings, placing a **strain on electricity systems**[2] during peak summer periods. It also increases the **embodied carbon emissions** in buildings when additional materials are used for shading purposes.

To mitigate these risks policymakers must prioritise solutions such as **high-performance solar control glazing** which is a **critical and robust enabler of passive cooling.**

- Glazed surfaces must be considered a strategic asset as they can filter and reduce unwanted solar heat gains, while **maintaining natural daylight.**
- To support the simplification of building envelope design, **solar control glazing must be considered at the earliest stages of works** to determine thermal loads reliably.
- Solar control glazing offers an **efficient and cost-effective solution** to reduce overheating risks, improve resilience, and ensure summer comfort[3].

Given Europe's rapidly changing climate and commitment to improving energy efficiency, it is crucial that **buildings are designed or renovated without delay to withstand higher temperatures.** European legislations such as the revised Energy Performance of Buildings Directive and the forthcoming Heating and Cooling Strategy must further encourage Member States to implement measures that strengthen the resilience of the building stock.

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[1] Assuming that no European Member States currently has a 100% renewable electricity generation.

[2] The Future of Cooling – Analysis, International Energy Agency, 2018

[3] There is no official definition of summer comfort, but it can be described as a satisfactory physical and mental state felt by people in a defined building in summertime. For more details, refer to Glass for Europe's informative paper: *"Glazing contribution to summer comfort"*, available here.

2. Contribution of glazing in mitigating overheating

Glazing is an essential construction material that directly impacts a building's thermal performance. Glazed surfaces are the **primary interfaces between indoor and outdoor** environments and therefore have a profound impact on comfort, daylight availability, and overall energy performance.

In addition to **letting daylight in**, high-performance windows significantly **improve insulation and reduce heat loss** during colder periods. While these insulating benefits are widely recognised, glazing's **contribution to preventing overheating and reducing active cooling demand is far less understood** and incorporated into policies.

Solar control glazing specifically is a technology that **selectively filters solar radiation**, thereby reducing internal heat loads. Solar glass is typically used in double or triple insulating glass units and comes in a wide range of solar heat gain levels, allowing the **free energy of the sun to be exploited** in cold climates or **reflected in warm ones**. This technology is easily **combined with low emissivity glazing** further reinforcing the thermal efficiency of windows.

The amount of solar heat that passes through the glazing is expressed with the g-value. A high g-value means the glazing will capture more free solar heat gains, while a lower g value indicates most solar heat gains will be repealed to avoid over-heating.

These glazing **unique characteristics are explicitly recognised in the revised Energy Performance of Building Directive** (EPBD). In a dedicated guidance[4] from the recast Directive, it is acknowledged that, across the European Union, minimum energy performance requirements are almost entirely based on thermal transmittance properties.

This means that **national calculations tend to disregard the substantial energy impact of solar heat gains**, resulting in an inaccurate picture of glazing energy performance.

The guidance therefore emphasises the need to **improve energy calculation methods** to support the deployment of the most cost-effective solutions. The European Commission also encourages Member States to prioritise effective passive solar heat protection *"to minimise the energy required for cooling as far as possible".* Solar control glazing falls into the category, as part of the most effective passive strategies.

3. Solar control glazing: an indispensable passive solution

Today, heating and cooling represent more than 60% of the energy consumed by households[5] and cooling demand continues to rise sharply. Growing demand for **cooling is therefore becoming a major energy security concern for both citizens and the wider energy system**.

Reliance on active cooling systems entails **additional costs in the form of installation and maintenance fees**, as well as increased energy bills, which decrease households' disposable

[4] *General framework for the calculation of the energy performance of buildings (Annex I)*, available here, 2025. Additional details on the European Commission's recommendations can be found in Annex I of this document, available below.
[5] European Commission's Call for Evidence on the Heating and Cooling Strategy, 2025

income. It also endangers grid stability by increasing congestion and reliance on expensive peak power plants.

Before resorting to active systems (if needed), the first step is to **minimise the need for mechanical cooling through passive design solutions with limited embodied carbon.**

Solar control glass is a **mature** and **reliable technology whose performance is independent of consumer behaviour**, **user intervention** or **additional window components**. It is available in **highly transparent** versions that are hardly distinguishable from other types of thermal insulation glass. Despite its low g-value, solar control glass allow plenty of daylight to pass through.

Consequently, its use allows active cooling equipment to be smaller, more efficient and less costly to operate.

Solar control glass delivers tangible results in terms of energy savings and temperature reduction **regardless of external factors such as building orientation or shadowing[6].** This is particularly true for buildings with high window-to-wall ratios.

According to a recent UN report, the Global Cooling Watch 2025[7], solar control glazing can deliver an **average energy savings of ~20% and indoor temperature reductions of ~3°C**. These impacts illustrate how strategic choices at the building-envelope are.

Table 7-1 Energy and temperature improvements from passive cooling strategies

	Average energy savings (%)	Average indoor temperature reduction (°C)
Roof pond	58	2.8
Evaporative cooling	56	7.4
Trombe wall	44	5.2
Radiant cooling	32	3.4
Solar chimney	21	6.9
Solar control glazing	20	3.0
Wind-driven ventilation	20	6.4
Phase change materials	19	4.0
Vegetation	16	6.0
Shading	15	1.1
Nighttime cooling	11	5.1

Source: Bhamare et al. 2019; Al-Absi et al. 2020; Fereidani et al. 2021; Hu et al. 2023

Within this context, **glazed surfaces** (windows, façades and other transparent elements) must be considered a key part of **energy-efficient building design** rather than a secondary consideration in terms of passive cooling. Its **effectiveness is inherent in the material itself**, ensuring reliable energy savings and indoor comfort.

[6] The design of the building, its orientation and the local climate will only influence the magnitude of energy savings and temperature reductions reached.

[7] Global Cooling Watch 2025: The free degrees: How sustainable, passive first-cooling can save lives, money and food, United Nations Environment Programme, 11 November 2025

As a basic window component, the optimal glazing configuration should be the first decision in a **simplified yet accurate sequence of energy-efficiency upgrades**. High-performance glazing can provide a reliable baseline throughout its lifespan upon which other solutions can be evaluated and refined.

Carefully selecting the type of glass at the outset of a project enables designers and architects to **maximise energy performance with minimal complexity**. Once the glazing parameters are set, they establish clear boundary conditions for the rest of the design process. If this is not the case, mechanical and other add-on systems (such as shading solutions) are often oversized to compensate for excessive solar gains that could have been mitigated at the envelope level.

Data show that improving the energy envelope of buildings contribute to savings on grid investments of €44.2B, reduces congestion by 75%, lower electricity prices and reduce energy bills for households and industries alike[8].

Once passive solutions are maximised, the next steps can include adopting low-energy cooling technologies, implementing the highest-efficiency active systems and facilitating the transition to refrigerants with low Global Warming Potential (GWP).

4. Conclusion

To conclude, high-performance glazing such as solar control solutions acts as a **critical enabler of passive cooling** in European buildings. By effectively **limiting unwanted solar heat gains** while maintaining adequate daylight access, such glazing directly **improves indoor thermal comfort** and significantly **reduces dependence** on mechanical air-conditioning. This, in turn, lowers overall energy demand and associated carbon emissions.

Prioritising the building envelope at the earliest stages of design or renovation is therefore a rational and technically sound approach. An **optimised glazing establishes realistic thermal loads**, allowing heating and cooling systems to be correctly sized, to operate closer to their optimal performance range, and to avoid **unnecessary oversizing and energy waste**.

In this context, integrating passive measures, such as solar control glass, into both new construction and retrofit strategies is not optional but essential. It represents a cost-effective and scalable pathway to delivering a resilient, sustainable, and climate-adapted European building stock.

Glass for Europe is the trade association for Europe's flat glass sector. Flat glass is the material that goes into a variety of end products, primarily in windows and facades for buildings, windscreens and windows for automotive and transport as well as solar energy equipment, furniture and appliances.

Glass for Europe brings together multinational firms (AGC Glass Europe, Guardian, NSG-Group, Saint-Gobain Glass Industry and Şişecam) and thousands of SMEs across Europe gathering thousands of building glass processors and transformers, to represent the entire building glass value-chain.

[8] Akhmetov, Fedotova, and Frysztacki, Flattening the peak demand curve through energy efficient buildings: A holistic approach towards net-zero carbon, 2025

Annex I

European Commission recommendations on requirements for transparent building elements

As part of the recast of the Energy Performance of Buildings Directive (EPBD), the European Commission was mandated under Article 4 to develop guidance for calculating the energy performance of transparent building elements.

The resulting document emphasises that *"windows and glazing systems greatly influences both heating and cooling demands and indoor environmental quality".* Its objective is to **ensure consistent and accurate energy performance calculations** across the EU and **promote cost-optimal performance requirements.**

The Commission encourages **Member States to establish minimum performance requirements for glazing**, while maintaining an *"overall approach that prioritises optimising the building performance as a whole".* Considering the EPBD's provisions on reducing whole-life carbon, this whole-building perspective reinforces the relevance of integrated passive solutions such as high-performance solar control glazing that simultaneously **improve thermal comfort**, **reduce energy needs** and **limit emissions throughout the building's lifecycle[9].**

The proposed guidance introduces **differentiated requirements depending on building category** (single-family residential, multi-family residential, and non-residential) and **type of intervention**, whether new construction, major renovation, or window/glazing replacement.

Overall, across all building types, the European Commission's guidance document recommends:

- **Introducing U_w-value requirements** (thermal transmittance) to limit heat losses through transparent building elements,
- **Introducing g-value requirements** (solar heat gains or protection) for residential buildings and small non-residential buildings either simplified or based on energy balance calculations.

While Uw-value requirements are already widely applied across Member States to significantly reduce heating demand during winter, the introduction of **g-value requirements marks a substantial step forward**. Member States that are serious about addressing unwanted solar heat gains and wish to demonstrate ambition must consider introducing a maximum g-value.

By explicitly addressing unwanted solar heat gains, these requirements would support more accurate energy performance assessments, strengthen overheating protection, and encourage the uptake of glazing solutions that reduce cooling needs and enhance summer comfort.

[9] For more details on the embodied carbon of high-performance glazing, refer to Glass for Europe paper *"Calculations of embodied and operational carbon of double and triple glazed windows*", available here.