

SuPeRBE Training Material

Macro Area of Expertise MAE 10:

Risk Assessment At Building Level

Hazard: Extreme Heat (C)

Area of Expertise AE 10.4:

Building Element: Facade (C4)

Risk Category: Facade opening (C4.2)

Level of competence: 3



Heatwaves and Urban Overheating

Heatwaves are prolonged periods of extreme heat that strain buildings and human health. Urban areas are particularly vulnerable due to the heat island effect and poor thermal comfort in buildings.

What makes it worse?

- Dark surfaces
- Lack of vegetation
- Poor buildings insulation or ventilation
- Urban heat island effect

What can we do?

- **Shading**
- Natural ventilation
- Green roofs and trees
- Reflective materials and thermal insulation





Heatwaves and Building Overheating

Facade openings

Why does it make it worse?



- Windows are the main entry point for solar gains
- Overheating is a combination of high solar gains and insufficient ventilation
- Solar shading becomes one of the key elements for limiting overheating
- Large, poorly shaded glazing dramatically increases overheating risk
- Facade openings are decisive for passive cooling
- Windows link the building to the outdoor microclimate

What can we do better?



- Reduce solar gains through glazing
 - optimise the size and orientation of glazing, appropriate solar factor
- Integrate effective external shading
- Prioritise external shading over internal
- Support passive cooling and safe night ventilation
- Encourage “good” user behaviour instead of maladaptation
- Design shading so that it does not kill daylight and views when in use



Heatwaves and Building Overheating

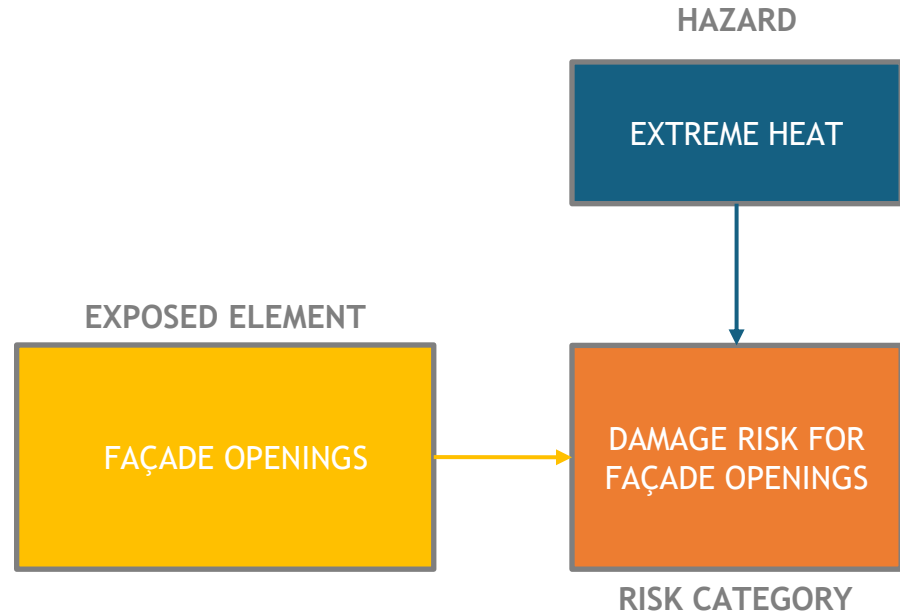
Facade openings

strongly influence the building's **exposure** and **vulnerability** and are a primary lever for **Extreme Heat adaptation measures**

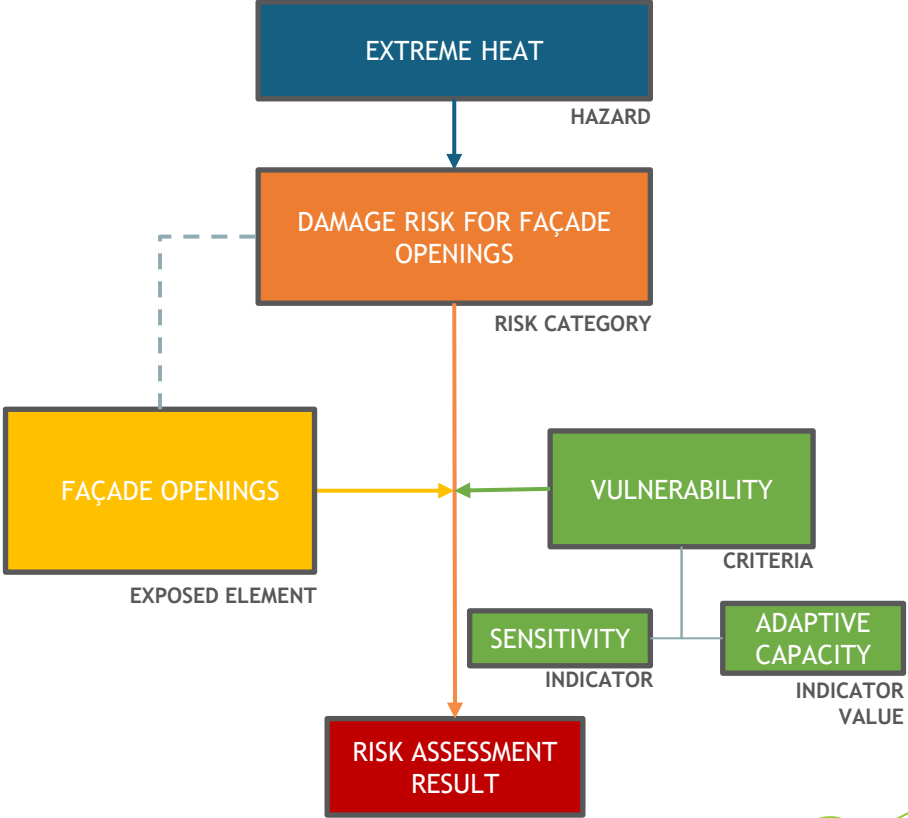
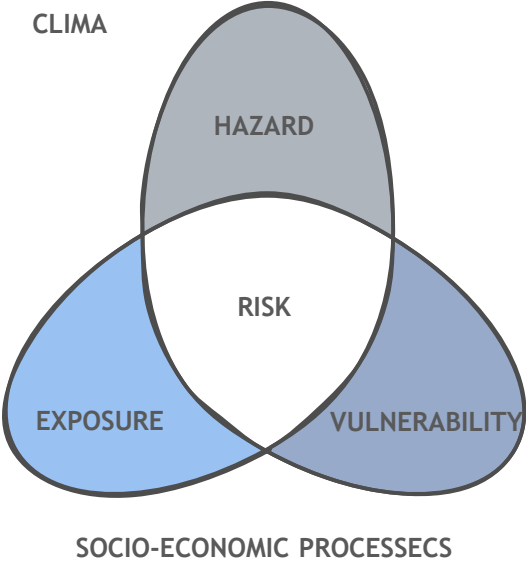
- **Exposure** - increase or reduce depending on how much solar energy and hot air enters the building
- **Vulnerability** - how facade openings support passive cooling and enable the building to maintain acceptable indoor comfort even during cooling or power outages
- **Adaptation measures** - focus on using facade openings for effective shading, natural and night ventilation, and automation strategies that reduce heat gains and enhance passive cooling

RISK ASSESSMENT FOR DAMAGE RISK FOR FAÇADE OPENINGS

- **Hazard:**
Extreme Heat
- **Exposed element:**
Façade openings

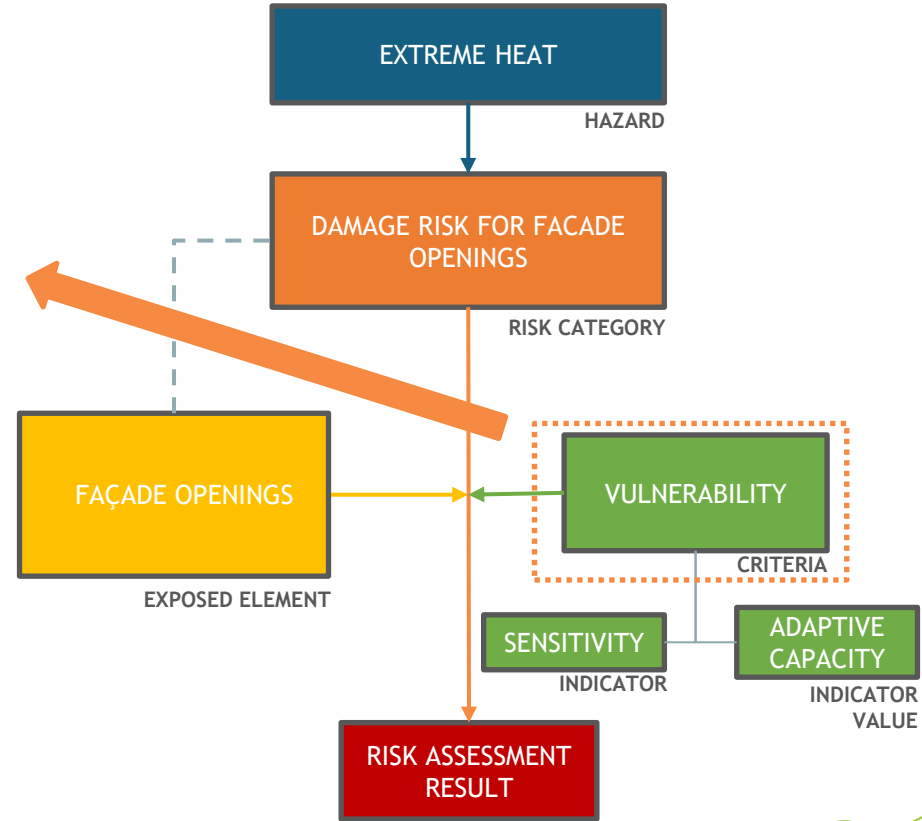


IMPACT CHAIN



CRITERIA

C4.2 Facade openings	INDICATOR
C4.2.1 High-Performance Window Glazing	U-value
C4.2.2 Optimized Window Orientation and Placement	Proper placement of windows
C4.2.3 Solar Shading Devices for Windows	Shading coefficient of the window with the shading device
C4.2.4 Automated Blind Systems	Share of regularly occupied rooms in the building equipped with automated blind systems
C4.2.5 Solar Radiation Control	Total solar factor of the window system



C4.2.1 HIGH-PERFORMANCE WINDOW GLAZING

Description:

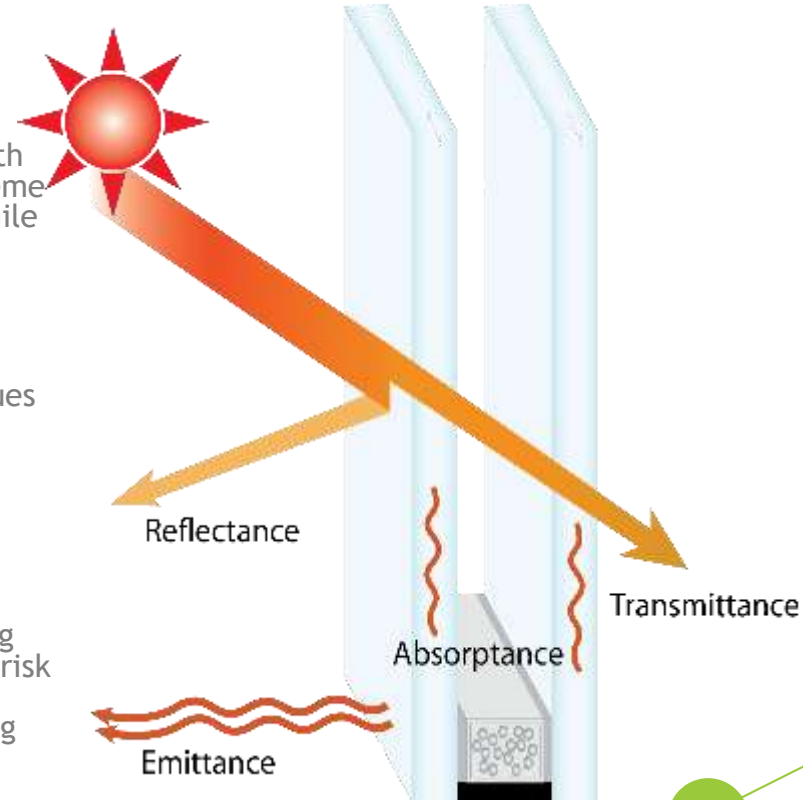
This criterion assesses the use of high-performance window glazing with low thermal transmittance (U-value) to reduce heat gains during extreme heat, improve indoor thermal comfort, and support passive cooling while maintaining adequate daylight availability.

Objective:

To promote the installation of window glazing systems with low U-values that limit unwanted solar and conductive heat gains in hot periods, thereby reducing cooling demand, avoiding overheating, and ensuring comfortable indoor conditions without compromising daylight access.

Relevance:

Under more frequent and intense heatwaves, poorly performing glazing can significantly increase indoor temperatures, cooling loads, and the risk of overheating. Selecting glazing with low U-value and appropriate coatings is a key passive design measure that supports resilient building operation, lowers energy use, and enhances occupant comfort while maintaining visual connection to the outdoors.



C4.2.1 HIGH-PERFORMANCE WINDOW GLAZING

Indicator:

U-value of the installed window glazing systems (including frame, spacer, and glass), expressed in $\text{W}/\text{m}^2\text{K}$, representing the rate of heat transfer through the glazing per unit area per degree of temperature difference between indoor and outdoor air. The indicator is represented by the characteristic U-value of the glazing systems used in the building.

Benchmarks:

Critical value (1): $U \geq 1.41 \text{ W}/\text{m}^2\text{K}$

Optimal value (0): $U \leq 0.80 \text{ W}/\text{m}^2\text{K}$

Calculation:

The indicator is determined as the representative U-value ($\text{W}/\text{m}^2\text{K}$) of the window glazing systems installed in the building, typically expressed as an area-weighted average of the U-values of all glazing types or, where required by the method, as the U-value of the dominant glazing system.

C4.2.1 HIGH-PERFORMANCE WINDOW GLAZING

CALCULATION STEP-BY-STEP

- Obtain the manufacturer-declared U-value for each installed glazing system (including frame, spacer, and glazing) or calculate it according to ISO 10077-1.
- Confirm the glazing build-up, coatings (e.g. low-emissivity or solar-control), gas fill and frame characteristics used in the project.
- Calculate the representative U-value for the building as the area-weighted average U-value of all glazing types, or use the U-value of the dominant glazing system if specified by the assessment method.
- Verify the resulting U-value against construction documentation and product data (manufacturer product data sheets, window system EPDs, building plans and specifications, U-value calculation reports, Energy Performance Certificate or energy models).

C4.2.2 OPTIMIZED WINDOW ORIENTATION AND PLACEMENT

Description:

This criterion assesses the design and placement of windows to optimise solar gains and daylight while minimising overheating risks during extreme heat events, taking into account building orientation, room function, shading potential, and natural ventilation strategies.

Objective:

To promote window layouts that reduce the risk of overheating during extreme heat while maintaining adequate daylight and enabling effective natural ventilation, by considering orientation, size, distribution, and shading already in the early design stages.

Relevance:

In a warming climate with more frequent and intense heatwaves, inappropriate window orientation and placement can lead to excessive solar gains, increased cooling demand, and poor thermal comfort. Well-designed window layouts that balance daylight access, solar control, and cross-ventilation are a key passive strategy for resilient and energy-efficient buildings.



C4.2.2 OPTIMIZED WINDOW ORIENTATION AND PLACEMENT

Indicator:

Proper placement of windows assessed qualitatively based on their orientation, size, and distribution in relation to local climate conditions, passive cooling potential (cross-ventilation), and shading opportunities (overhangs, surrounding structures, vegetation) to prevent overheating in regularly occupied rooms.

Benchmarks:

Critical value (1): poor window placement with high overheating risk and no effective mitigation strategies

Optimal value (0): windows predominantly oriented to optimise daylight while minimising direct solar gains in summer (e.g. north, shaded east/west, well-controlled south), with placement supporting cross-ventilation and thermal comfort during extreme heat

Calculation:

The indicator is expressed as a qualitative rating of window orientation and placement performance, derived from an expert review of architectural documentation and site conditions. The rating reflects how effectively the window design limits overheating risk while maintaining daylight and natural ventilation, according to the qualitative scale defined in the assessment method.

C4.2.2 OPTIMIZED WINDOW ORIENTATION AND PLACEMENT

CALCULATION STEP-BY-STEP

- Review architectural drawings and building plans to identify the orientation, size, and position of windows in all regularly occupied rooms.
- Assess the window-to-wall ratio, shading potential (overhangs, balconies, external shading devices, surrounding buildings, vegetation) and orientation in the context of local climate data and sun path diagrams.
- Evaluate the potential for natural ventilation and cross-ventilation based on window placement, opening type, and layout of adjacent spaces.
- Determine the overall effectiveness of the window design in reducing overheating risk during extreme heat while ensuring adequate daylight, and assign a qualitative performance level according to the method (from “poor window placement with high overheating risk” to “optimised orientation and placement”).
- Document the qualitative judgement, key design features, and any identified mitigation measures (e.g. external shading, vegetation, adjustable blinds) as part of the assessment record.

C4.2.3 SOLAR SHADING DEVICES FOR WINDOWS

Description:

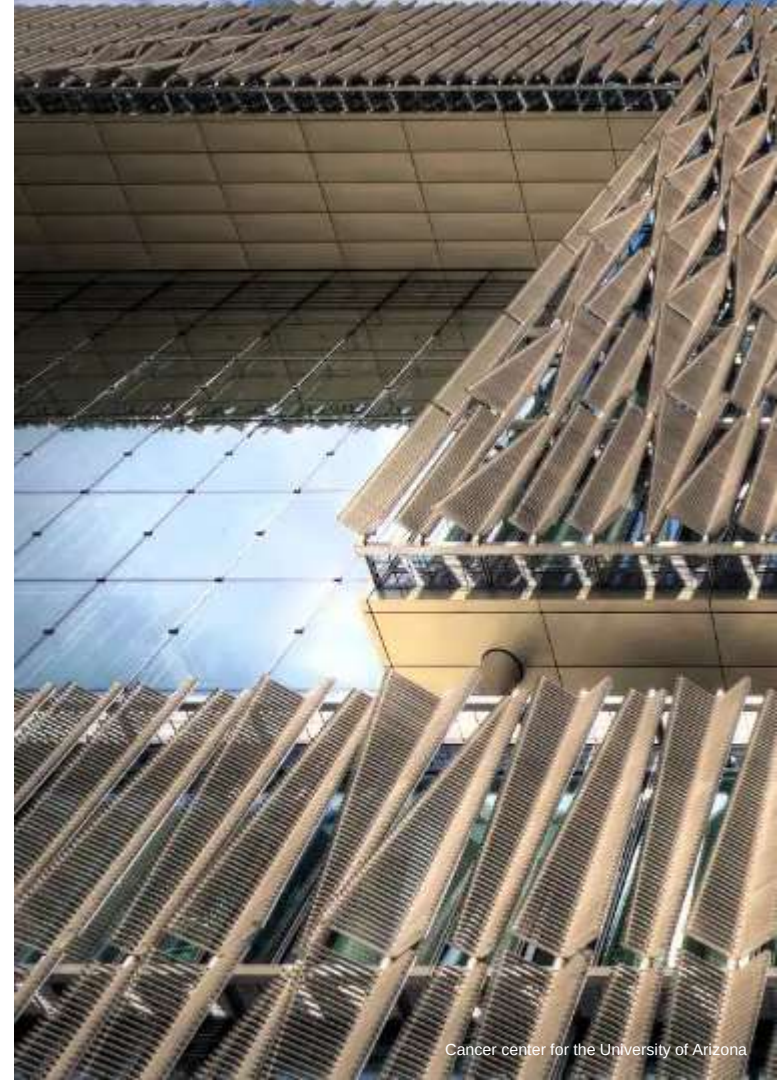
This criterion assesses the installation and use of external or integrated solar shading devices (e.g. louvers, overhangs, blinds) on windows to reduce solar heat gains during extreme heat events while maintaining daylight availability and occupant comfort.

Objective:

To encourage the design and installation of effective solar shading devices that significantly reduce unwanted solar heat gains through windows during extreme heat, thereby limiting overheating, reducing cooling demand, and ensuring comfortable indoor environments while preserving daylight and views.

Relevance:

In a warming climate, windows without adequate shading can lead to high solar gains, increased cooling loads, glare, and thermal discomfort, especially during heatwaves. Appropriately designed and operated solar shading devices (fixed, movable, or dynamic) are a key passive measure to control solar radiation, support thermal comfort, and improve the resilience and energy performance of buildings.



C4.2.3 SOLAR SHADING DEVICES FOR WINDOWS

Indicator:

Shading coefficient of the window with the shading device, expressed as a percentage, representing the relative solar performance of the shaded window compared to the same window without shading. The indicator can be interpreted as the percentage reduction of solar heat gain achieved by the shading device under defined conditions (0-100%, where higher values correspond to more effective shading).

Benchmarks:

Critical value (1): $\leq 30\%$

Optimal value (0): $\geq 60\%$

Calculation:

The indicator is determined as the shading coefficient (or equivalent solar shading performance value) of the window-shading system, obtained from manufacturer data, dynamic simulation results, or geometric/optical calculations. Where necessary, the ratio of solar gains with and without shading is converted into a percentage reduction to allow comparison with the benchmark values.

C4.2.3 SOLAR SHADING DEVICES FOR WINDOWS

CALCULATION STEP-BY-STEP

- Identify the type of shading devices installed on each relevant window (e.g. fixed overhangs, external louvers, external blinds, dynamic or automated systems).
- Obtain the manufacturer-declared shading coefficient or equivalent solar shading performance value for the combined window-shading system under relevant conditions (orientation, glazing type, control strategy).
- If manufacturer data are not available, use building energy modelling software (e.g. EnergyPlus, IES VE) or dedicated shading coefficient / geometry calculation tools to simulate the solar heat gain through the window with and without shading.
- Derive the shading coefficient as a percentage representing the reduction of solar heat gain due to the shading device, and calculate a representative value for the building (e.g. area-weighted average for all assessed windows).
- Compare the resulting value with the benchmark thresholds (critical $\leq 30\%$; optimal $\geq 60\%$) and document the methods, data sources, and assumptions used, including references to manufacturer product data sheets, window system EPDs, dynamic simulation outputs, and any on-site measurements if performed.

C4.2.4 AUTOMATED BLIND SYSTEMS

Description:

This criterion assesses the implementation of automated blind systems that respond to solar radiation, indoor temperature, or time schedules to reduce heat gains and improve thermal comfort during extreme heat events, while maintaining daylight availability and supporting passive cooling strategies.

Objective:

To increase the use of automated blind systems in regularly occupied rooms so that blinds respond reliably to overheating and solar gains, thereby limiting internal heat loads, reducing cooling demand, and improving thermal and visual comfort without relying solely on occupant behaviour.

Relevance:

During extreme heat events, manually operated blinds are often used inconsistently, leading to persistent solar gains, glare, and overheating. Automated blind systems that respond to solar radiation, indoor temperature, or schedules provide predictable control of solar gains, support passive cooling and natural ventilation strategies, and enhance the resilience and energy performance of the building, especially in spaces that are regularly occupied.



C4.2.4 AUTOMATED BLIND SYSTEMS

Indicator:

Share of regularly occupied rooms in the building equipped with automated blind systems capable of reducing solar gains during extreme heat conditions, expressed as a percentage of all regularly occupied rooms (0-100%).

Benchmarks:

Critical value (1): < 50%

Optimal value (0): $\geq 90\%$

Calculation:

The indicator is expressed as the percentage of all regularly occupied rooms that are equipped with automated blind systems meeting the defined control criteria (response to solar radiation, indoor temperature, or time schedules). It is calculated as the percentage of regularly occupied rooms that are equipped with automated blind systems.

C4.2.4 AUTOMATED BLIND SYSTEMS

CALCULATION STEP-BY-STEP

- Conduct a building audit, using architectural drawings and building management system (BMS) documentation, to determine the total number of regularly occupied rooms in the building.
- Identify, room by room, which of these regularly occupied rooms are equipped with blind systems.
- For each room with blinds, confirm from control system specifications, BMS documentation, and manufacturer information that the blinds are automated and can respond to at least one of the following: solar radiation, indoor temperature, or predefined time schedules.
- Count the number of regularly occupied rooms that meet the above automation criteria.
- Calculate the indicator as:
$$\text{Share of rooms with automated blinds} = \frac{\text{Number of regularly occupied rooms with qualifying automated blinds}}{\text{Total number of regularly occupied rooms}} \times 100\%$$
- Document the result, data sources used (BMS documentation, building plans, control system specifications, on-site verification, manufacturer documentation), and any assumptions or exclusions applied in the assessment.

C4.2.5 SOLAR RADIATION CONTROL

Description:

This indicator assesses whether the building can limit overheating during heatwaves by controlling the total solar energy transmittance of window systems, i.e. glazing in combination with any fixed or operable solar shading.

Objective:

To promote window and shading designs with low total solar energy transmittance so that solar gains are effectively controlled in summer, reducing overheating risk and cooling demand while maintaining adequate daylight and views.

Relevance:

Under more frequent and intense heatwaves, excessive solar gains through poorly designed glazing and shading can cause high indoor temperatures, discomfort, and increased cooling loads. Controlling the total solar factor of window systems is therefore a key passive design strategy for climate-resilient and energy-efficient buildings.



Wooden butterfly shutters

C4.2.5 SOLAR RADIATION CONTROL

Indicator:

Total solar factor of the window system (g_{tot}), dimensionless, representing the fraction of incident solar radiation that enters the interior as heat through the combined effect of glazing and any fixed or operable shading.

Benchmarks:

Critical value (1): $g_{tot} \geq 0.55$

Optimal value (0): $g_{tot} \leq 0.35$

Calculation:

The indicator is expressed as the representative total solar factor g_{tot} of the window systems, calculated for each relevant façade and orientation based on glazing properties and shading configuration, using standardised methods and typical summer operating positions of the shading devices.

C4.2.5 SOLAR RADIATION CONTROL

CALCULATION STEP-BY-STEP

- Collect detailed product data for all window systems, including glazing build-up (layers, coatings, thicknesses, spectral data), frame fraction and type of external or integrated shading devices.
- For each glazing type, determine the solar factor g according to EN 410 using manufacturer spectral data or equivalent certified values.
- For each combination of glazing and shading device, calculate the total solar factor g_{tot} according to EN ISO 52022-3, considering relevant façade orientation, angle of incidence and typical seasonal/operational shading positions (e.g. summer daytime configuration).
- Determine a representative g_{tot} value for each façade or window group (e.g. by area-weighted averaging of g_{tot} for all windows of the same orientation and use).
- If available, cross-check the adequacy of g_{tot} values using simplified dynamic simulations of peak-day indoor temperatures in key rooms.
- Document the final representative g_{tot} value used in the assessment together with all key assumptions (spectral data sources, incidence angles, shading schedules and control strategies).

HAZARD LIKELIHOOD

Hazardous event		Slow-on set process		Hazard Value (HV)
Frequent	Likely to occur often in a life time (every 10 years)	Very likely	Very likely to occur in the next 10 years	1 - 0,9
Probable	Likely to occur several times in a lifetime (every 25 years)	Likely	Likely to occur in the next 10 years	0,89 - 0,66
Occasional	Likely to occur some times in a lifetime (every 50 years)	As likely as not	As likely as not to occur in the next 10 years	0,65 - 0,33
Remote	Unlikely but still possible to occur in a lifetime (every 100 years)	Unlikely	Unlikely to occur in the next 10 years	0,32 - 0

Hazard Value (HV) = This information is provided by SECAPs or by experts' judgment

For example, Hazard Value (HV) = **0.8 (Probable)**

NORMALISATION

Once all indicator values for the selected criterion are calculated, normalization converts them to a common 0-1 scale. This ensures each indicator contributes proportionately to the overall resilience score, regardless of its original unit. Normalization enables meaningful data synthesis, cross-context benchmarking, and more transparent, objective decision-making in resilience assessments.

EXAMPLE:

For C4.2.5 Solar Radiation Control with an indicator value of $g_{tot} = 0,45$

Where:

$x_i = 0,45$

$x_{max} = 0,55$

$x_{min} = 0,35$

$$x_{norm} = \frac{x_{max} - x_i}{x_{max} - x_{min}}$$

$x_{norm} = (0,55 - 0,45) / (0,55 - 0,35) = 0,50$ (Neutral)

NORMALISATION INTERVAL

Normalisation values	Description
0,0 - 0,2	Optimal (no improvement necessary)
> 0,2 - 0,4	Rather positive
> 0,4 - 0,6	Neutral
> 0,6 - 0,8	Rather negative
> 0,8 - 1,0	Critical (could lead to severe consequences)

OVERALL VULNERABILITY (VULNERABILITY VALUE - VV)

CRITERION	Normalised value	Weight
C4.2.1 High-Performance Window Glazing	0,5	0,20
C4.2.2 Optimized Window Orientation and Placement	0,21	0,15
C4.2.3 Solar Shading Devices for Windows	0,35	0,15
C4.2.4 Automated Blind Systems	0,95	0,10
C4.2.5 Solar Radiation Control	0,50	0,10

Normalised score  Weight 

$$VV = \sum_{i=1}^n (I_i \times W_i)$$

$$VV = 0,50 \times 0,20 + 0,21 \times 0,15 + 0,35 \times 0,15 + 0,95 \times 0,10 + 0,50 \times 0,1 = 0,33$$

Vulnerability Value (VV) = 0,38

Vulnerability Level =
RATHER POSITIVE