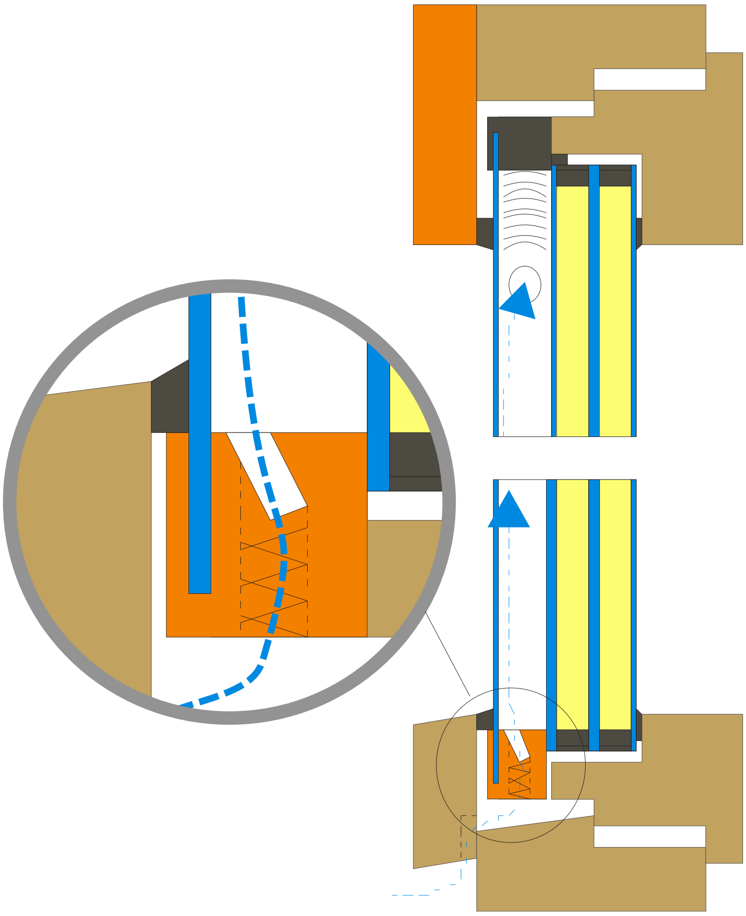
EuroPHit



D5.1.3_Window_integrated_shading

INTELLIGENT ENERGY – EUROPE II

Energy efficiency and renewable energy in buildings

IEE/12/070

EuroPHit

[Improving the energy performance of step-by-step refurbishment and integration of renewable energies]

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Abstract

Regardless whether it is up to retrofits or new builds, shading- and glare-protective elements have a high share on the overall costs of windows.

Cost effective solutions are most desired therefor. A promising concept is integrated shading, a shading element in between an inside low-e-coated glazing, acting as insulation layer of the window and a weather protection glazing on the outside.

This solution promises to be very cost effective in both, investment and maintaining- as well as energy costs.

This solution was carried out as the most cost effective and easiest to apply in the Component Award 2015, co-founded by the EuroPHit project. As an example, smartwin shading by pro Passivhausfenster was developed with guidance of the passive house institute.

1 Passive House suitable windows

1.1 Requirements

The requirements for transparent components are set according to the climate zone for which the component is designed. The criteria is included in Table 1.

The basis of this criteria, in terms of the functional requirement for hygiene is:

- **Maximum water activity (interior building components): $a_w \leq 0.80$**

  Water activity is the relative humidity either in a material's pores or directly on its surface. This requirement restricts the minimum temperature at the window surface for health reasons. Mould growth may occur if water activity exceeds 0.80. Such conditions should therefore be consistently avoided.

  The $f_{Rsi=0.25}$ temperature factors given in Table 1 result as acceptable certification criteria for different climates. This f_{Rsi} is the temperature factor at the coldest point of the window frame. Criteria for other climate zones are currently being determined.

Regarding comfort, the functional requirement is the following:

- **Minimum temperature of volume enclosing surfaces: $|\theta_{si}-\theta_{op}| \leq 4.2K$**

  This temperature difference requirement limits the minimum average temperature of a window for reasons of comfort; it may deviate by a maximum of 4.2K. A greater difference may lead to unpleasant cold air descent and perceptible radiant heat deprivation.

  The maximum thermal transmittance coefficients (U-values) of installed certified transparent Passive House building components under heating dominated situations are calculated from this temperature difference criterion. The heat transfer coefficients given in Table 1 result as acceptable certification criteria for different climates.

- **Limiting the risk of draughts: $v_{Air} \leq 0.1$ m/s**

  The air velocity in the living area must be less than 0.1m/s. This requirement restricts the air permeability of a building component as well as cold air descent.

Table 1: Adequate certification criteria and U-values of the recommended glazing for vertical elements.

Climate zone	**Hygiene criterion** $f_{Rsi=0.25\ m^2K/W} \geq$	**Component U-value** [W/(m²K)]	**U-value installed** [W/(m²K)]	**Recommended glazing** (low-e-coated)
1 Arctic	0.80	**0.40**	**0.45**	High end quadruple
2 Cold	0.75	**0.60**	**0.65**	High end triple or quadruple
3 Cool-temperate	0.70	**0.80**	**0.85**	Triple
4 Warm-temperate	0.65	**1.00**	**1.05**	Triple
5 Warm	0.55	**1.20**	**1.25**	Double
6 Hot	none	**1.20**	**1.25**	Double anti sun
7 Very hot	none	**1.00**	**1.05**	Triple anti sun

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1.2 Calculation method

The thermal transmittance coefficients (U-values) and the thermal bridge loss coefficients (ψ-values) are determined based on DIN EN ISO 10077, EN 673 and DIN EN 12631. Passive House suitability should be determined for the specified dimensions of the products to be certified. Verification of the hygiene criterion is provided using 2-dimensional heat flow calculations of the standard cross-sections.

The detailed information on the requirements and calculation can be found in the criteria for certified Passive House transparent components (click here).

2 Design principles

The submissions of the component award included a wide range of shading options, including roller shutters, blinds, screens, pane-integrated shading, sliding shutters, fixed elements, and even electrochromic glass. For an incremental retrofit, shading cost an average of 425 euros per window, with the windows themselves costing an average of 690 euros each. Besides special solutions (electrochromic glazing, sliding shutters with PV), the blinds were the most expensive option at about 500 euros. The least expensive options were those with shading elements in between the panes of coupled windows, which came out to an average of 180 euros per window, although the windows themselves cost more than average at 790 euros per window. So the savings of investment costs are 220 Euros per window compared to the outside blinds. In addition, the additional pane in such a window reduces energy costs as well as maintenance costs, since the shading element is protected between two panes of glass, and improves soundproofing.

2.1 Glazing

As already mentioned, the additional air gap, which should be around 32 mm, improves the glazing. This effect can be increased by a adding a hard coating in the air gap. A hard coating is resilient to mechanical stress and weather. But it is a bit expensive than a low e-coating and the emissivity is higher, so that it has a minor effect on the U-value as a hard coating. On the other hand, the some hard coatings are working like kind of an anti-reflexive coating, that is improving the g-value.

Table 2 shows some glazing configurations, their thermal data and, thickness and recommendation for the use in the different climate zones. According to the experience of many passive house window producers, the overall thickness of the sealed gas gaps in a pane should not extend 36 mm in sum. Higher volumes may damage the panes or the edge bond because of the so-called pumping effect caused by temperature driven volume changes of the gas.

That means, that the gap in which the shutter works, should not be sealed. The other reason for not seal the air gap is the maintenance of the shutter. If a shutter is damaged in a sealed gap, the complete glazing unit has to be changed, producing high costs. In unsealed gaps it is possible to maintain the shutter unit without changing the whole glazing.

A not sealed glazing unit has to be slightly ventilated to avoid fogging inside the glazing. This concept is well known in coupled windows. To avoid dust in the airgap, filters should be used.

The use of pretightened glazing should be considered to avoid cracks because of thermal tension.

Table 2: Glazing configurations

Inner glazing	Hard coating	U-value	g-value	Thick-ness	Recommended for climate zone				
[W/(m²K)]		[W/(m²K)]	[%]	[mm]	Warm	Warm, temp.	Cool, temp	Cold	Arctic
Double 16 mm Argon U_g= 1,13	Non	0,86	59	58			Comfort criterion not achieved		
	Inside	0,72	61						
	In + out	0,67							
Triple 18 mm Argon Ug= 0,53	Non	0,47	51	81					
	Inside	0,42	53						
	In + out	0,40			Might be too expensive				
Triple 12 mm Krypton Ug= 0,50	Non	0,43	51	69					
	Inside	0,38	53						
	In + out	0,36							

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2.2 Frame

Frames, especially designed for passive houses are deeper than standard frames used in the specific climate zones. This is necessary because of the low u-values to be achieved and to hold the thicker glazing. However, if it comes to integrated shading with the airgap of more than 30 mm, even passive house frames are coming to their limit. An argon special frame designs are required e.g. for a triple argon glazing with 33 mm airgap, that results in sum in a glazing thickness of more than 80 mm. So, for the cool, temperate climate zone a two plus one glazing could be taken into account, as long as frames able to include such thick glazing are not widely spread on the market.

Regarding the thickness of the glazing, it comes to three tasks to be solved: 1. The glazing does not fit into the frame. 2. If the frame is made deeper, the opening curve has to be fitted to the deeper design. That means either a thicker frame or a limited smallest size of the window. 3. To develop a new frame only for integrated shading might not make sense in an economic way, so the frame has to be flexible enough to serve for glazing without shading as well as for integrated shading.

A first approach might be an additional profile holding the single pane and additionally a filter avoiding dust in the glazing, see Figure 1. Such a profile can make the frame flexible for both, normal glazing and integrated glazing. It enables adapted opening-curves too.

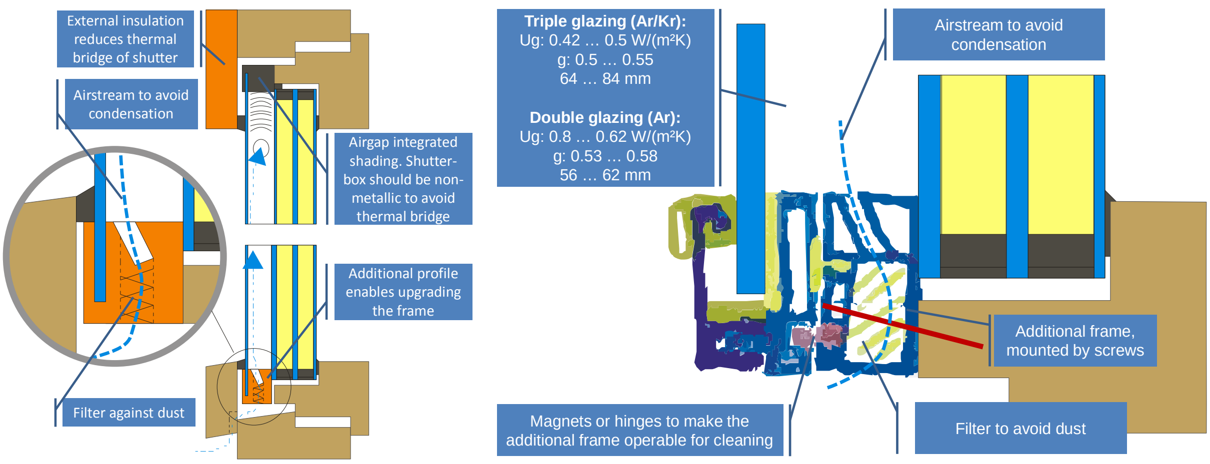

Figure 1: Left: Airgap integrated shading in principle. Right: Schematic solution for an additional frame.

Such integrated solutions are known well for operable windows. A real chance for a deep impact on the marked is only given, if the solution works for fixed frames too. The minimum solution should be, that the shutter case can be removed from the inside of the building without destroying anything, see . In that case, the panes in the airgap can mot be cleaned. So it might be a good idea to design “fixed frames” too as operable elements, but only for cleaning and maintaining, so the hardware can be simple and cheap. Than the solution is similar to the principle shown in Figure 1.

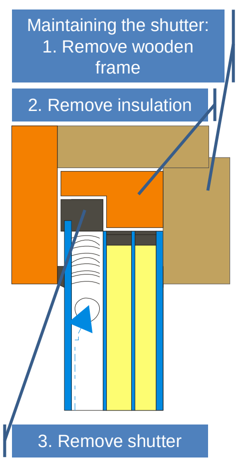

Figure 2: Principle solution for fixed frames

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3 Solutions from the Component Award 2015 (samples) | similar products

As part of the EuroPHit project, the Passive House Institute focused its 2015 Component Award on energy efficient windows for retrofits. The main challenge was that the product had to be flexible enough to work both during the transition period and when the insulation was put in place and that it was cost-effective, considering the life cycle costs. Some of the participants delivered solutions with integrated shading, which turned out as very cost effective. The solutions presented here, illustrations included, were presented by the participants.

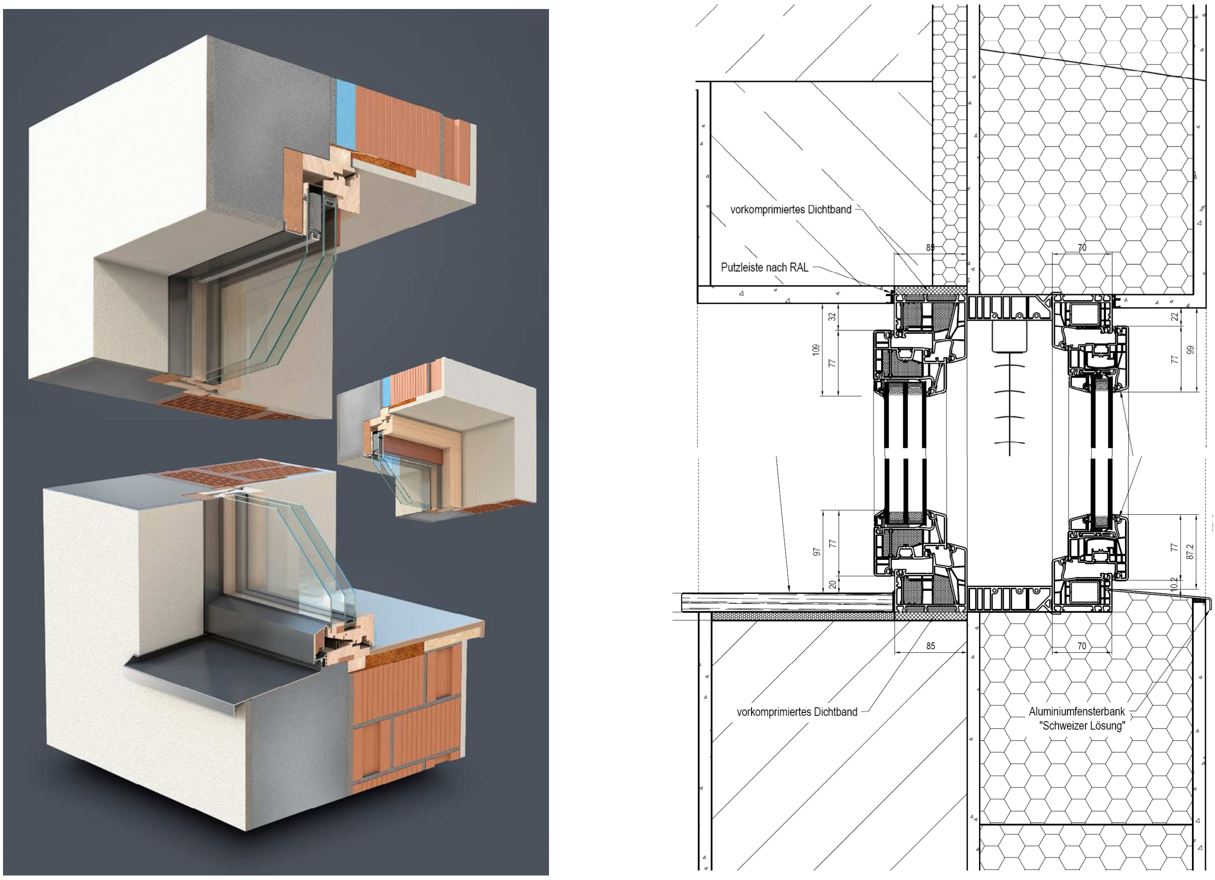

Figure 3: Left: Smartwin compact S by pro Passivhausfenster: Solution with air gap integrated shading as proposed in this document. Right: Aluplast: Casement window.

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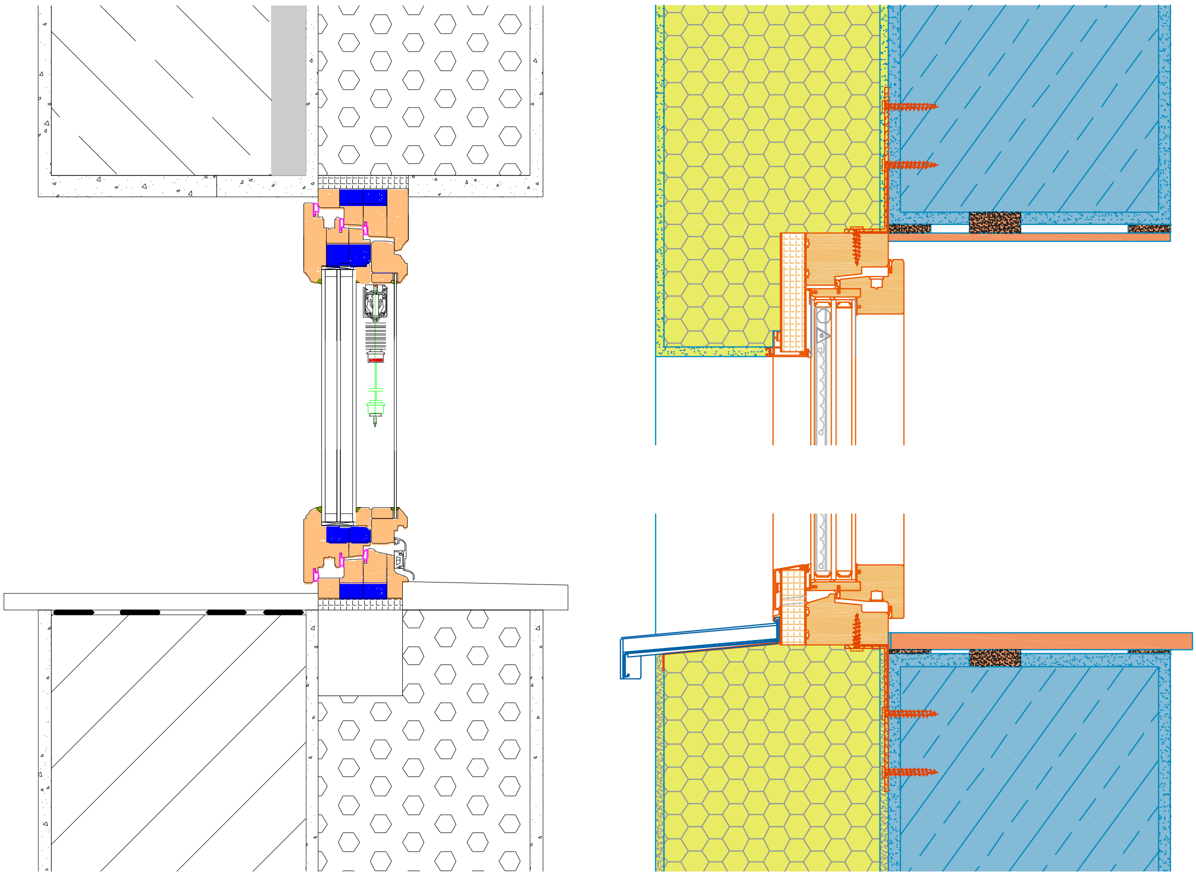

Figure 4: Left: Rukna 1 by Bitri: Coupled window with air gap integrated shading. Right: ENERsign plus by Pazen Fenster und Technik: With gas gap integrated roller blind.

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