3.5. How to choose windows for passive building design?

Unfortunately, older window technology was one of the primary sources of unwanted heat loss and heat gain. The United States Department of Energy (DOE) finds that "heat gain and heat loss through windows are responsible for 25%–30% of residential heating and cooling energy use." Though that large bay window in the living room might offer a beautiful view and biophilic benefits, it might also be driving up your monthly energy bill (Roberts, T., Writer, R., 2021).

Upgrading to passive house windows will undoubtedly cut back on your energy use. However, the exact amount of savings will depend on the type of window they are replacing. According to one estimate, high-efficiency triple pane windows might improve up to 20-30 % on energy efficiency. Suppose you are replacing older, single-pane windows or windows with significant and noticeable air leaks around the frame. In that case, the energy savings will most likely be even more considerable (Roberts, T., Writer, R., 2021).

There is no such thing as a passive house window type. The Passive House standard is performance based, not a checklist of specific components to buy. In general, they are characterized by being thermally broken, airtight, and usually triple glazed with the gaps between glass panes filled with argon or krypton gas (WEB-1: *PASSIVE HOUSE WINDOWS: Revolutionary Energy Savings*).

South-facing solar glazing is a crucial element in the design of a passive solar system, as it allows sunlight to enter the home during the winter months, providing warmth and natural light. However, it is important to carefully consider the amount of solar glazing in the design of a passive solar home, as too much can lead to overheating during the summer months and compromise the home's cooling performance. The amount of solar glazing should be carefully balanced with the amount of thermal mass in the home to ensure optimal performance (Fig. 3.5.1).

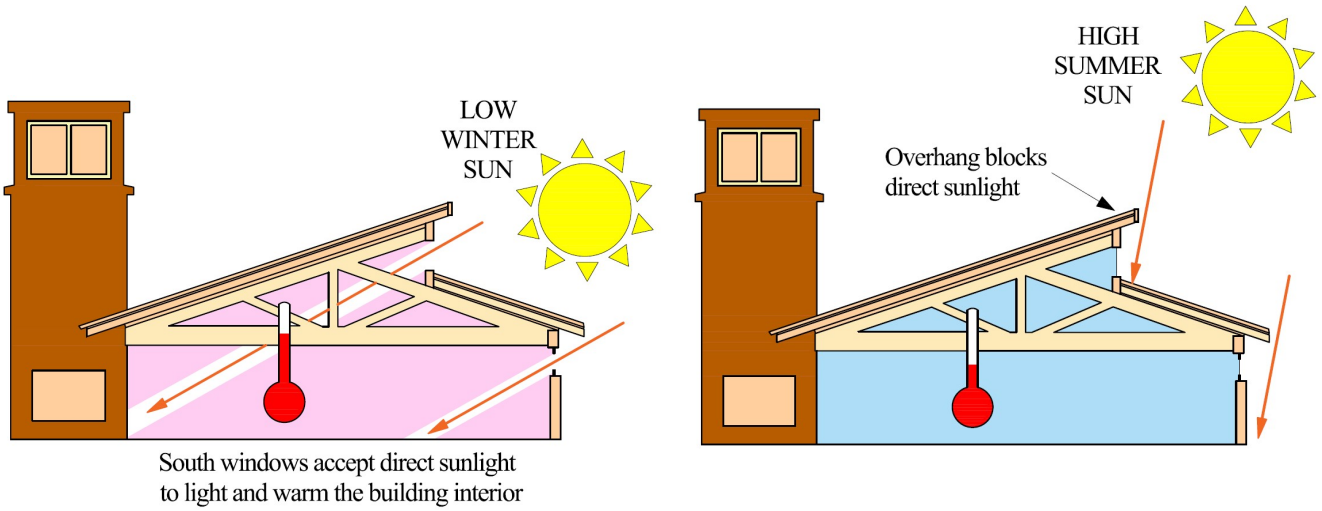

Fig.3.5.1. Sunlight through south-facing windows. (Source: own elaboration).

North-facing windows should generally be used sparingly in a passive solar home, as they receive relatively little direct sunlight in the summer and do not contribute significantly to heating the home. East-facing windows catch the morning sun, which can cause potential overheating issues in the summer if there are too many. West-facing windows can be particularly problematic, as they receive a lot of afternoon sun, which can lead to overheating. It is therefore important to consider the use of shading techniques, such as roof overhangs, trellises, awnings, and external shutters, to block the high summer sun and allow in the low winter sun.

Passive daylighting strategies promote the efficient use of natural light in a building by collecting and reflecting it into darker areas of the home. Clerestory windows, light shelves, and blinds are often used for this

purpose. Skylights should be avoided, as they are difficult to control and do not allow for the easy use of window coverings.

To improve the energy efficiency of windows in a passive solar home, it is important to use low SHGC (solar heat gain coefficient) glass on east and west-facing windows, as this will reduce solar heat gain and improve shading. An SHGC rating of 0,25 or less is generally recommended for efficient energy performance. Increasing or reducing the SHGC for rooms that lack or allow too much natural sunlight into the home can have a significant impact on energy efficiency. During winter, an increased SHGC allows more heat to be transmitted into the home (Fig. 3.5.2). It is a cost-effective and convenient means of stabilizing indoor temperatures (WEB-2: *PASSIVE HOUSE WINDOWS: How do Passive House windows reduce your energy expenses?*).

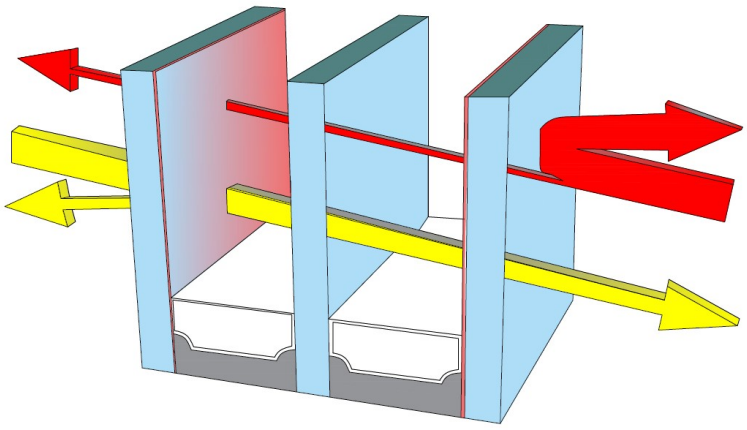

Fig.3.5.2. Passive building window. (Source: own elaboration).

It is also recommended to use windows with triple or super-efficient double glazing and low thermal conductivity materials, such as specially coated glass and argon-filled cavities, in the frames. The U-value, or measure of heat transfer, should be below 0,8 W/(m^2K) according to Passive House standards. The vinyl, aluminum, or fiberglass frames are also highly durable and less likely to warp or damage with time than wood. A passive house window should last at least 20 years when properly installed, but it could last for up to 40 years if well maintained (Roberts, T., Writer, R., 2021).

Even though passive house windows don't have specifications of required components or elements, they generally have **the following characteristics:**

1. **Thermally broken:** This refers to a specific manufacturing technique wherein the window frame (most often constructed from aluminum) contains a barrier between the inside and outside frames. This energy efficiency technique helps to limit the conductive thermal energy loss from the window (Roberts, T., Writer, R., 2021).
2. **Extremely Airtight:** Windows and their frames also contribute to unwanted heat loss and heat gain via gaps and fissures that lead to drafts. Passive house windows will have a strong focus on airtightness as a tight building envelope is a core principle of the passive house standard (Roberts, T., Writer, R., 2021).
3. **Triple Glazed Windows:** Passive house windows will also opt for the most energy-efficient window technology available. In today's market, triple-glazed windows with the gaps between the individual glass panes filled with argon or krypton gas are widely thought to be the most efficient option (Roberts, T., Writer, R., 2021).
4. **Low-E Glass:** Low-emissivity (low-E) glass is the industry standard. This type of glass has a thin coating of metal oxide on one internal glass surface. The metal oxide coating improves the window's thermal performance by reflecting heat into the home while not affecting the incoming external light. Windows with low-E glass allow homeowners to enjoy the warmth and light of the sun in the winter without losing interior heat (Roberts, T., Writer, R., 2021).

5. **U-Value and R-Value Measurements:** A window's energy efficiency is measured by its U-Value and R-value. A U-value is a precise calculation of the conduction properties of the different elements that make up the window. The U-Value of a window will measure the insulating ability of the window and act as an indicator of heat transfer. The R-value of a window, in contrast, measures the amount of heat retained by the window. Passive house windows will have a low U-value and high R-value. They will also be designed to maximize solar gain and minimize heat loss (Roberts, T., Writer, R., 2021).

In summary, the design of windows in a passive solar home should carefully consider the orientation of the windows, the use of shading techniques, the type of glass and materials used, and the U-value. By taking these factors into account, it is possible to create a home that makes efficient use of natural light and solar energy, while minimizing overheating and heat loss.

References

1. Roberts, T., Writer, R. (2021). *Passive House Windows: Your Complete Guide*. [Online] Available from: https://www.buildwithrise.com/stories/passive-house-windows [Accessed 05.01.2023].

2. WEB-1: *PASSIVE HOUSE WINDOWS: Revolutionary Energy Savings*. [Online] Available from: https://www.neuffer-windows.com/passive-house-windows.php [Accessed 04.01.2023].

3. WEB-2: *PASSIVE HOUSE WINDOWS: How do Passive House windows reduce your energy expenses?* [Online] Available from: https://neufenster.com/how-passive-house-windows-reduce-energy-bills/ [Accessed 04.01.2023].