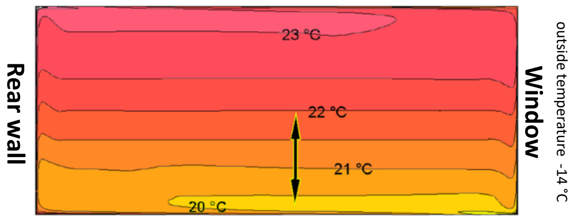
Comfort criteria for windows in PHPP 10

A high level of thermal comfort is one of the most important traits of a Passive House building. The first prerequisite is an adequate operative room temperature of 21 to 22 °C. In addition, the external surfaces, especially the windows, must meet certain minimum requirements in order to prevent

- cold air pockets
- unpleasant draughts
- excessive spatial or temporal temperature differences in a room
- undesired radiation heat losses on cold winter days.

This can be achieved either by means of heating devices near the windows or with good thermal insulation.



External component conforms to $\Delta\vartheta_{si}$ < 4.2 K

Low air temperature stratification in the room of a Passive House building. © Passive House Institute

Based on the ISO 7730 and ASHRAE 55 norms, the following was already concluded at the beginning of the Passive House development: If all surfaces in the room fulfill the requirement that their average surface temperature does not deviate by more than 4.2 K from the average operative temperature in the room, then a high level of thermal comfort will always be achieved. This benchmark has generally worked well; if it is met, the room offers a high level of thermal comfort in the entire living space (> 0.5 m from the outer walls). There are then no longer any restrictions regarding the way how heat is introduced into the room. This simplifies planning and reduces investment costs. In particular, radiators are no longer required under the windows. The Passive House window certification's frame and glazing requirements also consider this correlation.

For individual small windows, such a high level of thermal protection is difficult to achieve because the influence of the edge seal and installation is more impactful. However, it is also not necessary to the same extent, as smaller windows have a weaker impact on the situation than curtain walls. In principle, this has already been taken into account in PHPP 9; the requirements for the U-value of small windows are lower here than for large glazing areas. However, this was a somewhat cautious estimate in the previous version of the PHPP.

From PHPP 10 onwards, the tool calculates the comfort criteria for windows more precisely. In preliminary studies, the radiation temperature measured in the direction of the window proved to be the dominant influencing factor. If this remains sufficiently high, we can also meet the requirements for temperature stratification, air velocities and temperature differences in the living space.

The radiation temperature is calculated from a point 0.50 m in front of the center of the window. A few centimeters in front of the window we would measure lower radiation temperatures, lower air temperatures and higher air velocities, but all this is not relevant for thermal comfort.

The view factor $F_{1,2}$ describes the share of the window surface in the radiation temperature measured towards the exterior wall. For the window, $F_{1,2}$ results from the geometry:

$$F_{1,2} = \frac{2}{\pi}\left(\frac{\tilde{a}}{\sqrt{\tilde{a}^2+1}}\tan^{-1}\frac{\tilde{b}}{\sqrt{\tilde{a}^2+1}} + \frac{\tilde{b}}{\sqrt{\tilde{b}^2+1}}\tan^{-1}\frac{\tilde{a}}{\sqrt{\tilde{b}^2+1}}\right)$$

$$\tilde{a} = \frac{a}{2d}, \tilde{b} = \frac{b}{2d}$$

*View factor of a window with the size **a** times **b** at a distance **d***

For the rest of the half-space, the surrounding wall's U-value is considered.

On this basis, the maximum U-value of the window that is required to maintain a high level of thermal comfort is calculated for any given geometric configuration. Windows adjacent to one another have to be considered as one large window. Automatic assessment of thermal comfort without any excessive safety margins is facilitated by the new input method for windows in PHPP 10. With this new method a complete opening in the wall is entered in each row instead of just one glazing area as was done previously.