Information, Criteria, and Algorithms for Certified Passive House Components: Insulated Glass Units and Solar Protection Glazing

2022-02-24

Note: Currently, certificates are only issued for the climate regions Arctic, Cold, Cool-temperate, Warm-temperate and Warm, Hot and Very Hot. The criteria are in a trial phase, therefore a special reservation of change applies.

Certificate: tested thermal quality

The market for highly energy-efficient buildings is experiencing rapid growth, and demand for reliable, high-performance components is increasing. However, requirements and ways to achieve them are often unclear, and some manufacturers report characteristic values that they cannot guarantee.

The Passive House Institute certifies highly energy-efficient components according to international criteria to meet requirements for comfort, hygiene and efficiency. As part of the certification process, the Institute advises manufacturers on how to improve their products. The result is future-proof products and reliable thermal parameters for input into the PHPP and other energy balance calculation software programs.

Benefits of certification:

- Advice on product development for high-efficiency buildings
- Entry into a growing market
- Increased market visibility and product recognition
- Independently tested & certified: Use of the Passive House Component Seal.
- Representation in the Passive House Institute's component database
- Integration into the building energy balance calculation program PHPP

Passivhaus Institut

The **Passive House Institute** (PHI) is an independent research institute that has played a decisive role in the development of the Passive House concept. The Passive House Standard is the only globally recognized energy standard for buildings that represents concrete, verifiable efficiency values.

www.passiv.de

The **Passive House component database** presents all PHI-certified products in an appealing way and makes them accessible to the international public. Integrated tools offer a high added value for builders, planners and manufacturers. **database.passivehouse.com**

PHPP

The **Passive House Project Planning Package** (PHPP) is a cost-effective energy balancing tool for highly energy-efficient buildings. It is validated against measured projects, provides accurate results, and can be used reliably by all stakeholders. **www.passiv.de**

iPHA

The **International Passive House Association** is a competence network of the PHI that promotes the passive house and disseminates relevant knowledge and information. It unites architects, planners and manufacturers as well as scientists and builders. **www.passivehouse-international.org**

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1 Preface

Passive House buildings provide optimal thermal comfort with minimum energy expenditure; they lie within the economically profitable range with reference to their life-cycle costs. To achieve this level of comfort and low life-cycle costs, the thermal quality of the components used in Passive Houses must meet stringent requirements. These requirements are directly derived from the Passive House criteria for hygiene, comfort and efficiency as well as from feasibility studies. The Passive House Institute has established component certification in order to define quality standards, facilitate the availability of highly efficient products and promote their expansion, and to provide planners and building owners with reliable characteristic values for input into energy balancing tools.

2 Certification criteria

2.1 *Verification of Passive House suitability, certificate*

The certifiability of glazing is verified by the thermal transmittance (U_g-value, W/(m²K)) of the glazing and by an efficiency criterion, which includes U_g and the total energy transmittance (g-value) for insulated glass units. For solar control glazing, the g-value and the light transmission in the visible spectrum (T_{vis}) are used. The above characteristic values are determined in accordance with ISO 15099.

2.2 *Thermal comfort criterion (U_g-value)*

The climate zone-specific maximum U-values are derived from the comfort criterion for Passive Houses. The maximum U-values are justified and defined in the criteria for transparent building components. In order to take into account the additional heat losses due to installation and glazing edge thermal bridges, we assume the maximum U-value required in this region for the installed window and subtract a standard value of 0.05 W/(m²K) from this. According to practical experience, this also gives a reliable requirement for the U_g-value of the glazing. The values to be achieved, or the maximum permissible values in each case, can be found in Table 1 and Section 2.4.
Furthermore, the U_g-values of glazing depend on the temperature difference between inside and outside and are therefore climate-specific. To take this into account, climate-specific boundary conditions are used to determine the U_g, see Table 3.

2.3 *Passive house efficiency classes*

Insulated glass units are divided into efficiency classes on the basis of the g/Ug ratio, see Table 2 (left). The g-value is normally almost the same for all climatic zones. **The Ug values used to determine the efficiency class are established on the basis of the boundary conditions for climate zone 3, cool-temperate.**

Solar control glazings are divided into efficiency classes on the basis of the selectivity, i.e. the T_{vis}/g ratio, cf. table 2 (right). Different minimum requirements for achieving an efficiency class apply for each climate zone, see table 1. For the boundary conditions of the calculations, see section 3.

2.4 *Certification categories*

Certified thermal and solar control glazings are categorized according to the type of glazing, the number of panes and the filling gas.

Table 1: Sufficient certificate criteria (limit values)
for U-values and efficiency classes for each climatic region respectively

Climate zone	Type of glazing	U_g-value [W/(m²K)]	Eff. class (g/U_g)	Eff. class (T_{vis}/g)
1 arctic	Insulated glass unit	0,40	phA	
2 cold		0,60	phB	
3 cool-temperate		0,80	phC	
4 warm-temperate		1,00	phD	
5 warm		1,20	phE	
6 hot	Solar control glazing	1,20		phC
7 very hot		1,00		phC

Table 2: Passive house efficiency classes for insulating and solar control glazing

Th. insulation $g/U_g \geq$	Passive House Efficiency class
1,10	phA+
0,95	phA
0,80	phB
0,65	phC
0,50	phD
0,30	phE

Solar control $T_{vis}/g \geq$	Passive House efficiency class
2,8	phA+
2,4	phA
2,0	phB
1,6	phC
1,2	phD
0,8	phE

2.5 *Minimum requirements for the climate zones*

The following minimum requirements for each of the seven climate zones are derived from Tables 1 and 2:

Arctic climate:	$U_g \leq$ 0,40 W/(m²K);	$g/U_g \geq$ 0,95
Cold climate:	$U_g \leq$ 0,60 W/(m²K);	$g/U_g \geq$ 0,80
Cool-temperate climate:	$U_g \leq$ 0,80 W/(m²K);	$g/U_g \geq$ 0,65
Warm-temperate climate:	$U_g \leq$ 1,00 W/(m²K);	$g/U_g \geq$ 0,50
Warm climate:	$U_g \leq$ 1,20 W/(m²K);	$g/U_g \geq$ 0,30
Hot climate:	$U_g \leq$ 1,20 W/(m²K);	$T_{vis}/g \geq$ 1,6
Very hot climate:	$U_g \leq$ 1,00 W/(m²K);	$T_{vis}/g \geq$ 1,6

2.6 Delineation of climate zones –regions of equal requirements

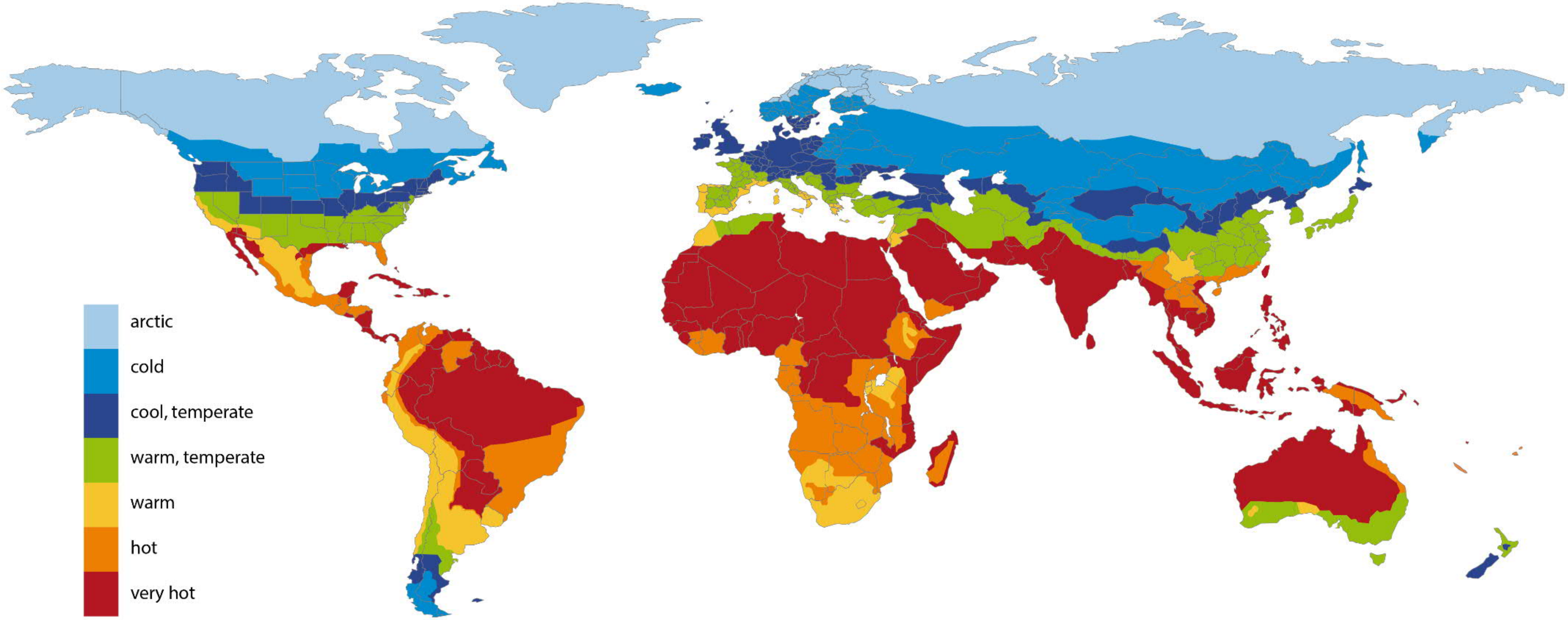


Figure 1: Delineation of the regions of equal requirements

3 Calculation, boundary conditions, data

The calculation is performed according to ISO 15099 using the WINDOW software of the Lawrence Berkeley National Laboratory. Data for fillings and thermal conductivities are taken from these sources. The spectral data are to be supplied by the manufacturer.

3.1 Heat transfer coefficient U_g

The climate-specific boundary conditions for determining the U_g values can be taken from Table 3.

Table 3: Boundary conditions for determining U_g

Climate zone	**Temperature** [°C]		**Heat transfer coefficient** [W/(m²K)]	
	inside	outside	inside	outside
1 arctic	20	-15	7,69	26
2 cold		-5		25
3 cool-temperate		0		
4 warm-temperate		5		
5 warm		10		
6 hot	22	15		
7 very hot		20		

3.2 Total energy transmittance g, light transmittance T_{vis}

The solar reference spectrum ASTM G197-08 is used to determine the total energy transmittance g and T_{vis}.

Table 4 lists the climate-specific boundary conditions for calculating the g-values. The winter conditions are used for the cold climate zones and the summer conditions for the warm climate zones. Within the scope of calculation accuracy, the g-value is generally almost the same for all climate zones, despite the different boundary conditions. Therefore, only one g-value is shown in the certificate as an average value.

Table 4: Boundary conditions for determining the g-value

Climate zone	**Temperature** [°C]		**Heat transfer coefficient** [W/(m²K)]		**Solar radiation**
	inside	ouside	inside	outside	W/m²
1 arctic	20	-15	7,69	25	200
2 cold	20	-5		25	200
3 cool-temperate	20	0		25	500
4 warm-temperate	25	20		25	500
5 warm	25	25		15	500
6 hot	25	26		15	500
7 very hot	25	30		15	500

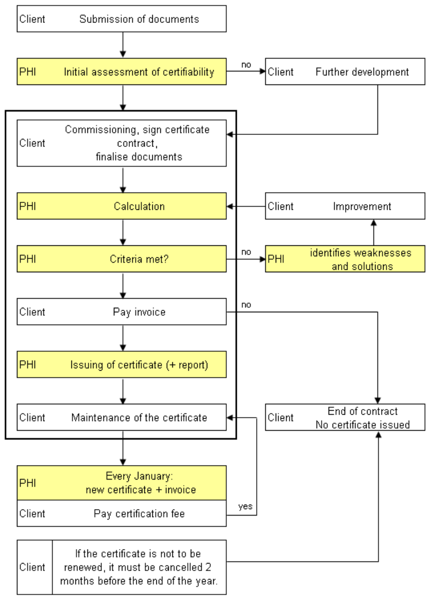
3.3 Special procedure for the certification of vacuum glazing

For certification of vacuum glazing, measured values of the U-value of the pane must be submitted. The measurements are to be carried out by a recognized institute (notified body) after consultation with the PHI, using a guarded hot plate measuring device. The measurements are to be carried out on panes with a minimum size of 80 x 80 cm on at least 5 different samples at a temperature difference of 20 K between the plates. The conditioning time to reach the thermal equilibrium of the samples for a 2-fold vacuum plate is at least 5 hours. The nominal U-value is determined following the statistical method according to EN ISO 10456.

The measured values are checked for plausibility at PHI by calculation according to ISO 15099 and 3D heat flow simulation to determine the influence of the supports.
It will be noted in the certificate that vacuum glazing in Passive House windows should be used only in frames designed for this purpose. It is strongly recommended to certify an exemplary window frame in addition to the glazing, if necessary in cooperation with a window manufacturer.

4 Formalities, Services of the Passive House Institute

4.1 Certification procedure



4.2 Required documentation

In detail, the following data (preferably as ASCII or excel file) are required for each of the certified glazings in order to perform a calculation of the U_g-values and the g-values according to ISO 15099:

1. Thicknesses of the panes and the spaces between the panes
2. Glas pane material(s) and thermal conductivity of materials
3. Filling gas and nominal (minimum) gas filling fraction in the inter-pane spaces
4. Normal emissivity ε_n for all surfaces
   (including those not facing the inter-pane cavity),
5. Unique and clear designation and type of coating
6. Regular performance of external monitoring (yes/no)?
7. For calculation of g-values according to ISO 15099
   - spectral transmittance of the panes $\tau(\lambda)$
   - spectral reflectance of the panes (in both directions) $\rho(\lambda)$ und $\rho'(\lambda)$

4.3 Services of the Passive House Institute

Determination of the above mentioned characteristic values:

1. Calculation of U_g-values according to ISO 15099 for the glazing configurations requested by the client. As a rule, triple glazing is calculated for a coating of 3 and 5 with inter-pane spaces of 12, 14, 16 and 18 mm. For all 7 climate zones, U_g-values are calculated and documented with the corresponding boundary conditions according to Table 4. Only those results that meet the above criteria are shown in the certificate. The results are given to the nearest two decimals.
2. Calculation of g-values and T_{vis}-values according to ISO 15099 for the glazing configurations requested by the client.

The cost of calculating variants will be invoiced after prior consultation with the client.

Documentation is provided with the certificate.

Certification:

1. Client will maintain the certificate as contractually agreed
2. Implementation of the thermal parameters of the product in the Passive House Project Planning Package PHPP.
3. Use of the seal "Certified Passive House Component" and, if applicable, "EnerPHit Component" by the client.

Representation in the component database of the Passive House Institute.
The component is displayed with certificate in the component database of the Passive House Institute. The availability of the component in different countries can be communicated and displayed. In addition, for a surcharge on the yearly certification fee, it is possible to show other production or distribution locations as a map in addition to the headquarters of the certificate holder.

4.4 Coming into effect, temporary provisions, further development

The certification criteria and calculation rules for transparent components suitable for Passive House come into force in full with the publication of this document. With the entry into force of these provisions, the relevant previous criteria lose their validity. Existing certificates are protected until further notice. The Passive House Institute reserves the right to make future changes.