TEC1.3

Quality of the building envelope

Objective

Our objective is to minimise the energy demand for air conditioning in buildings while at the same time ensuring high thermal comfort and preventing building damage.

Benefits

A well-planned building envelope is a prerequisite for achieving high user comfort and low energy costs.

Contribution to overriding sustainability goals

	CONTRIBUTION TO SUSTAINABLE DEVELOPMENT GOALS (SDGS) OF UNITED NATIONS (UN)		CONTRIBUTION TO GERMAN SUSTAINABILITY STRATEGY	
Significant	7.3	energy efficiency	7.1.a	Resource conservation
Moderate	8.4	Improve resource efficiency in consumption and production	7.1.b 8.1	Resource conservation Resource conservation
	12.2	Sustainable management and use of natural resources		

Outlook

The different levels of quality of the building envelope defined in the criterion will be adjusted to correspond to technical and, potentially, legislative developments in the medium term.

Share of total score

	SHARE	WEIGHTING FACTOR
Office **Education** **Residential** **Hotel**	**2.5%**	**4**
Consumer market **Shopping centre** **Department stores**	**2.1%**	**3**
Logistics **Production**	**2.7%**	**4**
Assembly buildings	**2.6%**	**4**

EVALUATION

The quality of the building envelope is evaluated using four indicators, which are intended to create the conditions required to ensure high thermal comfort with the lowest possible energy demand. The heat transfer coefficients (indicator 1), existing thermal heat bridges (indicator 2), airtightness (indicator 3) and summer heat protection (indicator 4) are evaluated depending on the specific use. In this criterion, a maximum of 100 points, or a maximum of 105 points including bonuses, can be achieved.

NO.	INDICATOR		POINTS
1	**Heat transfer**		
1.1	**Heat transfer coefficients**		
	Evaluation of the indicator is not possible (see Appendix A Detailed description)		**0**
	Office **Education** **Shopping centre** **Department stores** **Logistics** **Production** **Hotel** **Assembly buildings**	W/(m²·K)	**Max. 40**
	Consumer market		**Max. 45**
	Opaque exterior components *	≤ min. country	**20**
	Transparent exterior components *	specific	
	Curtain wall	mandatory	
	Glass roofs, strip lights, skylights	requirement	
	Opaque exterior components *	-15% of the	**30**
	Transparent exterior components *	min.	
	Curtain wall	mandatory	
	Glass roofs, strip lights, skylights	U-Value	
	Opaque exterior components *	-30% of the	**40**
	Transparent exterior components *	min.	
	Curtain wall	mandatory	
	Glass roofs, strip lights, skylights	U-Value -	
	For: **Consumer market**		**45**
	Note for **Logistics** **Production**: Building areas with the low heating levels must be evaluated via indicator 1.3		

Alternative: if no mandatory regulation exists, U-Values from **Appendix 1** can be used as min. requirements for the Heat transfer coefficients.

1.2	**Maximum value for the specific transmission heat loss H'_T**		
	Residential	W/(m²·K)	**Max. 40**
	Freestanding A_N < 350 m² of the façade area	≤ min. country	**20**
	Freestanding A_N > 350 m² of the façade area	specific	
	Semi-detached	mandatory	
	Other	requirement	

Freestanding A_N < 350 m² of the façade area	-15% of the	**30**
Freestanding A_N > 350 m² of the façade area	min.	
Semi-detached	mandatory	
Other	U-Value	
Freestanding an < 350 m² of the façade area	-30% of the	**40**
Freestanding an > 350 m² of the façade area	min.	
Semi-detached	mandatory	
Other	U-Value	

Alternative: if no mandatory regulation exists, U-Values from **Appendix 1** can be used as min. requirements for the specific transmission heat loss.

1.3 **Heat transfer coefficients**

Logistics **Production** W/(m²·K) **Max. 40**

The following U-values apply to the exterior components of building areas with low heating levels (target indoor air temperature between 12 °C and 19 °C).

Opaque exterior components *	≤ min. country	**20**
Transparent exterior components *	specific	
Curtain wall	mandatory	
Glass roofs, strip lights, skylights	requirement	
Opaque exterior components *	-15% of the	**30**
Transparent exterior components *	min.	
Curtain wall	mandatory	
Glass roofs, strip lights, skylights	U-Value	
Opaque exterior components *	-30% of the	**40**
Transparent exterior components *	min.	
Curtain wall	mandatory	
Glass roofs, strip lights, skylights	U-Value	

Alternative: if no mandatory regulation exists, U-Values from **Appendix 1** can be used as min. requirements for the Heat transfer coefficients.

* If not included in the components curtain wall, glass roofs, strip lights and skylights.

Note: Results of a detailed calculation may be interpolated.

NO.	INDICATOR		POINTS
2	**Thermal heat bridges**[1]		
2.1	**Thermal heat bridge correction factors**		
	Evaluation of the indicator is not possible		0
	Office **Education** **Residential** **Hotel** **Assembly buildings**	W/(m²·K)	**10–15**
	Thermal heat bridge correction factor ΔU_{WB} in W/(m²·K)	≤ 0.05	10
		≤ 0.02	15
	Consumer market **Shopping centre** **Department stores**	W/(m²·K)	**5–15**
	Thermal heat bridge correction factor ΔU_{WB} in W/(m²·K)	≤ 0.1	5
		≤ 0.05	10
		≤ 0.02	15
	Logistics **Production**	W/(m²·K)	**10–30**
	Thermal heat bridge correction factor ΔU_{WB} in W/(m²·K)	0.1	10
		≤ 0.05	20
		≤ 0.02	30
	Note: Results of a detailed calculation may be interpolated.		

NO.	INDICATOR		POINTS
3	**Airtightness**		
3.1	**Airtightness measurement**		
	Air exchange rate (at a pressure difference of 50Pa) n50 in h-1		
	Note for the point calculation: a linear interpolation is possible (n50-value)		
	Office **Education** **Residential** **Hotel** **Assembly buildings**		**Max. 15**
	Buildings – interior volume ≤ 1500 m³	n_{50} ≤ 1.5	5
	Buildings – interior volume > 1500 m³ applies additionally:		
	Air exchange from external surfaces	q_{50}: 2,5	
	Buildings – interior volume ≤ 1500 m³	n_{50} ≤ 1.0	10
	Buildings – interior volume > 1500 m³ applies additionally:		
	Air exchange from external surfaces	q_{50}: 2,0	
	Buildings – interior volume ≤ 1500 m³	n_{50} ≤ 0.6	15
	Buildings – interior volume > 1500 m³ applies		

[1] Adaptation possible, project specific values must be agreed with DGNB in the project adaptation process. The local code/standard may be used as a reference value

additionally:		
Air exchange from external surfaces	q_{50}: 1,8.	
Consumer market		**Max. 25**
Buildings – interior volume ≤ 1500 m³	n_{50} ≤ 1.5	10
Buildings – interior volume > 1500 m³ applies additionally:		
Air exchange from external surfaces	q_{50}: 2,5	
Buildings – interior volume ≤ 1500 m³	n_{50} ≤ 1.0	15
Buildings – interior volume > 1500 m³ applies additionally:		
Air exchange from external surfaces	q_{50}: 2,0	
Buildings – interior volume ≤ 1500 m³	n_{50} ≤ 0.6	25
Buildings – interior volume > 1500 m³ applies additionally:		
Air exchange from external surfaces	q_{50}: 1,8	
Department stores **Shopping centre**		**Max. 30**
Buildings – interior volume ≤ 1500 m³	n_{50} ≤ 1.5	10
Buildings – interior volume > 1500 m³ applies additionally:		
Air exchange from external surfaces	q_{50}: 2,5	
Buildings – interior volume ≤ 1500 m³	n_{50} ≤ 1.0	20
Buildings – interior volume > 1500 m³ applies additionally:		
Air exchange from external surfaces	q_{50}: 2,0	
Buildings – interior volume ≤ 1500 m³	n_{50} ≤ 0.6	30
Buildings – interior volume > 1500 m³ applies additionally:		
Air exchange from external surfaces	q_{50}: 1,8	

Not applicable for **Logistics** **Production**

3.2 Joint permeability of windows and doors

Office **Education** **Residential** **Hotel** **Assembly buildings**

Joint permeability Q in accordance with DIN EN 12207	**Max. 15**
■ Class 2	5
■ Class 3	10
■ Class 4	15

Not applicable for **Consumer market** **Shopping centre** **Department stores** **Logistics** **Production**

NO.	INDICATOR		POINTS
4	**Summer heat protection**		
4.1	**Simplified method**		
	Office **Education** **Residential** **Consumer market** **Hotel** **Assembly buildings**		
	Compliance with minimum national criteria to avoid overheating in summer, or with MIN_FAC*, whichever is stricter.	S ≤ x Shp,max	**5–15**
		x = 1	5
		x = 0.8	**15**
	Logistics **Production**		
	Compliance with minimum national criteria to avoid overheating in summer, or with MIN_FAC*, whichever is stricter.	S ≤ x Shp,	**10–30**
		x = 1	10
		x = 0.8	30
	Department stores **Shopping centre**		
	Compliance with minimum national criteria to avoid overheating in summer, or with MIN_FAC*, whichever is stricter.	S ≤ Shp	**15**
	Alternative (documentation according to DIN 4108-2:2013) Simulation		
	Office **Education** **Residential** **Consumer market** **Hotel** **Assembly buildings** **Department stores** **Shopping centre**		
	number of overheating / excess temperature hours	≤ x Kh/a	**5 – 15**
		x = 500	5
		x = 350	15
	Logistik **Produktion**		
	number of overheating / excess temperature hours	≤ x Kh/a	**10 – 30**
		x = 500	10
		x = 350	30

***Note: Definition of MIN_FAC see Table 2 under the Appendix 1**

4.2	**AGENDA 2030 BONUS – CLIMATE ADAPTATION** Resilient thermal comfort: The frequency of exceeding during the heating and cooling period is determined for buildings using climate data predictions for 2030 and 2050. The results are used in the decision-making process at the planning stage.		**+5**

SUSTAINABILITY REPORTING AND SYNERGIES

Sustainability reporting

Appropriate key performance indicators (KPI) include communicating information regarding heat transfer coefficients, thermal heat bridge correction factors, the results of the airtightness measurement, solar transmittance parameters and, if necessary, the number of exceeding temperature hours. The results of a thermal simulation can be used for reporting in accordance with the "Level(s) – Common EU framework of core environmental indicators"(for more details see chapter “Terms and Definitions”).

NO.	KEY PERFORMANCE INDICATORS (KPIS)	UNIT
KPI 1	Heat transfer coefficients, differentiated by different exterior components	[W/m²*K]
KPI 2	Thermal heat bridge correction factors	[W/m²*K]
KPI 3	Air exchange rate	[1/h]
KPI 4	Solar transmittance parameter	[-]
KPI 5	Number of exceeding temperature hours, corresponds to Level(s) indicator 4.2: Time outside of thermal comfort range – Time out of range	[kh/a]
KPI 6	Number of exceeding temperature hours in 2030 and 2050, corresponds to Level(s) indicator 5.1: Time outside of thermal comfort range – Time out of range 2030/2050	[kh/a]

Synergies with DGNB system applications

- **DGNB RENOVATED BUILDINGS:** Synergies exist with criterion TEC1.3 in the scheme for the renovated buildings.
- **DGNB INTERIORS:** Criterion PRO1.1 establishes an incentive for taking sustainability aspects of thermal comfort into account as well when choosing rental spaces.

APPENDIX A – DETAILED DESCRIPTION

I. Relevance

–

II. Additional explanation

–

III. Method

The required values are defined below and serve as comparison values for the implemented design. The following methods are used for the evaluation of the implemented design:

Indicator 1: Transmission and diffusion via envelope surface components
This indicator is evaluated based on the selected energy performance certificate (EPC) for more details regarding the EPC refer to the criterion ENV1.1 and [T&D_03]. The worst average value must be used for the evaluation in each case.

Indicator 1.1: Diffusion via envelope surface components
In order to prevent damage in the long term, the building envelope must always be designed to ensure that only non-critical amounts of condensation water occur in the envelope surface components. Verification is carried out via an informal declaration by the specialist planner. If the specialist planner does not classify structural components as fundamentally non-critical, documentation of the vapour diffusion must be carried out for these components using static or dynamic calculation. This also applies to enveloping surfaces of building zones with highly different indoor climates
(e.g. cold storage rooms). If this verification is not carried out, no points can be awarded in this indicator.

Indicator 1.2: Transmission via envelope surface components
When calculating the average value of each component category (no. 1–4, see evaluation), the components must be taken into account based on the proportion of the total area they represent. The heat transfer coefficients of components against unheated rooms or soil must additionally be weighted with a factor of 0.5. When calculating the average value of the floor slabs immediately adjacent to the soil, surfaces more than 5 m away from the outer edge of the building may be disregarded.

Indicator 2: Transmission via thermal heat bridges
Indicator 2.1: Minimum heat insulation on thermal heat bridges
The thermal heat bridges must always be designed to ensure that the structural minimum heat insulation (moisture protection) is complied with throughout the entire area to provide long-lasting protection against damage. Verification is carried out via an informal declaration by the specialist planner. If the specialist planner does not classify thermal heat bridges as fundamentally non-critical, a two-dimensional isothermal calculation must be carried out for these design details in accordance with the ISO 13788:2012 “Hydrothermal performance of building components and building elements”. If this verification is not carried out, no points can be awarded in this indicator. The thermal heat bridge correction factor ΔU_{WB} is determined in accordance with ISO 10211:2017 “Thermal bridges in building construction“.

Indicator 3: Airtightness of the building envelope

Indicator 3.1: Airtightness measurement

The measurement must include all building areas that are to be heated.

Buildings with an interior volume ≤ 1500 m³:

- Assessment of the air exchange rate n_{50} in H^{-1} at a pressure difference of 50 Pa in accordance with DIN EN 13829 (Method A or Method B).

For buildings with an interior volume > 1500 m³, the following also applies:

- Assessment of the air exchange from external surfaces q_{50} in accordance with DIN EN 13829 (Method A or Method B).

Indicator 3.2: Joint permeability of windows and doors

Documentation of the joint permeability Q in accordance with DIN EN 12207. The worst value of the components installed is used here. If there are differences in classes, deviations up to a 10% of the total area (area of the windows and doors) can be ignored.

Indicator 4: Summer heat protection

Documentation on summer heat protection must be carried out in accordance with the version of DIN EN 13363. As an alternative, documentation of the summer heat protection can be created in accordance with a newer version of ISO 52022-3:2017 standard.

Indicator 4.1: Simplified method

Assessment of the solar transmittance parameter S in the simplified calculation method of the solar and daylight characteristics for solar protection devices combined with glazing ISO 52022-1:2017. The documentation must include the rooms specified as relevant in the valid version of the EPC.

Alternative: **simulation**

If it is not possible to carry out documentation in accordance with the simplified method, a dynamic thermal simulation calculation can be carried out to assess the number of exceeding temperature hours for the purposes of evaluating the thermal conditions. This applies in particular if rooms or spatial areas suitable for the assessment exist in conjunction with the following structural facilities:

- Double façades or
- Transparent thermal insulation (TTI) systems.

In such cases, the thermal simulation must be carried out with consistent calculation boundary conditions in accordance with the norms described in criterion ENV1.1.

Indicator 4.2: Agenda 2030 bonus: Thermal comfort climate adaptation

The frequency of exceeding during the heating and cooling period is determined for buildings using climate data predictions for 2030 and 2050. The results are used in the decision-making process at the planning stage. The climate data used should be based on the UN IPCC "Mitigation" (SRES E1) emissions scenario. The "Medium-high" (SRES A1B) emissions scenario can be used as a second "worst-case scenario". Information regarding the assessment methodology and the possible areas of focus in the planning process can be found in the "Level(s) framework" published by the European Commission (Source: "Level(s) – A common EU framework of core sustainability indicators for office and residential buildings", Draft Beta v1.0, Brussels, August 2017).

IV. Usage-specific description

Assembly buildings

Evaluation of the seasonal / irregularly used buildings i.e. buildings which are not operating the whole year, such as exhibition halls, will be performed only for operational (in use) time, without consideration of the building's vacant periods.

Appendix 1: Worldwide climatic zones and U-Values for orientation

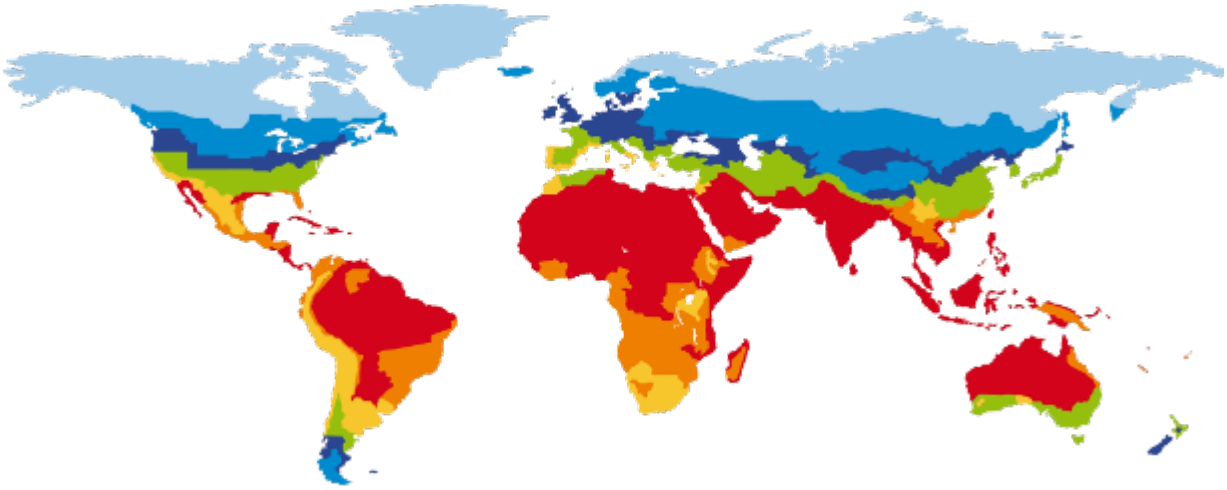

Figure 1: World climate map according to the Passive House Institute (PHI)

DGNB offers the PHI climate map with certain U-Values as an alternative solution for the regions and countries where no mandatory regulations exist. The following 7 climatic zones are considered as the most influential zones:

- Arctic
- Cold
- Cool, temperate
- Warm, temperate
- Warm
- Hot
- Very hot

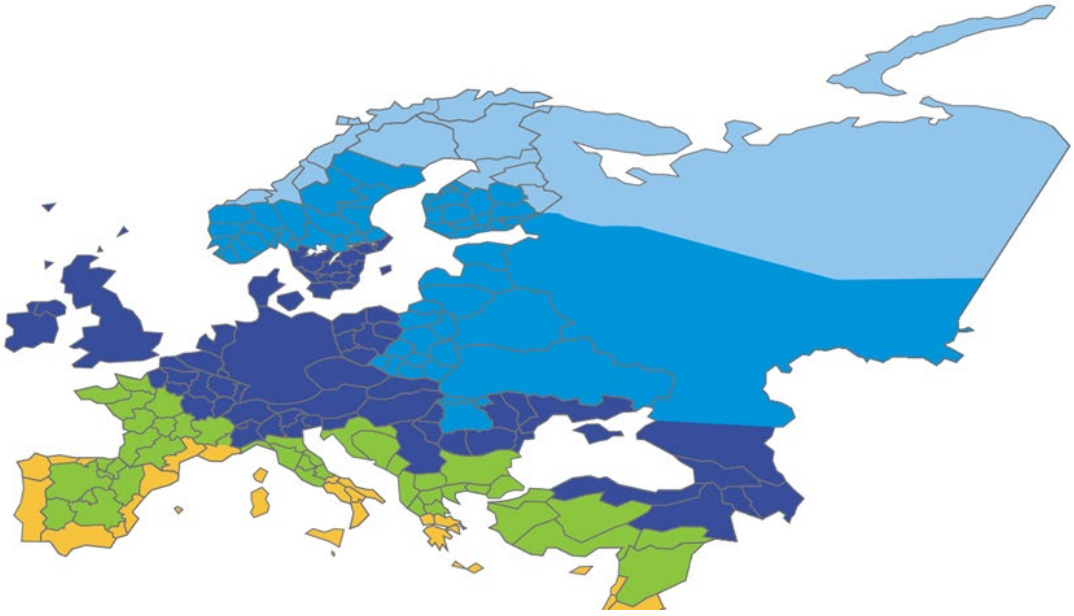

Figure 2: Climate map of Europe (source: PHI)

Table 1: Optional **U - Values** (minimum requirement) for the various climatic zones

	Climate Zones:						
	Arctic	Cold	Cool, temperate	Warm, temperate	Warm	Hot	Very hot
Heat transfer Non-residential W/(m²·K)							
Opaque exterior components	0.25	0.30	0.35	0.50	0.75	0.75	0.50
Transparent exterior components	0.90	1.30	1.70	2.00	2.30	2.30	2.00
Curtain wall	0.90	1.30	1.70	2.00	2.30	2.30	2.00
Glass roofs, skylights etc.	1.50	2.00	2.80	3.00	3.30	3.30	3.00
Transmission heat loss H'_T Residential W/(m²·K)							
Freestanding A_N < 350 m² of the façade area	0.35	0.40	0.45	0.60	0.90	0.90	0.60
Freestanding A_N > 350 m² of the façade area	0.45	0.50	0.55	0.80	1.20	1.20	0.80
Semi-detached	0.40	0.45	0.50	0.70	1.10	1.10	0.70
Other	0.50	0.60	0.70	1.05	1.50	1.50	1.05
Heat transfer (indoor air temperature between 12 °C and 19 °C) Logistic/Production W/(m²·K)							
Opaque exterior components	0.40	0.50	0.55	0.80	1.20	1.20	0.80
Transparent exterior components	1.65	2.35	3.00	3.50	4.00	4.00	3.50
Curtain wall	1.70	2.40	3.30	3.70	4.10	4.10	3.70
Glass roofs, skylights etc.	1.90	2.50	3.40	3.90	4.25	4.25	3.90

Table 2: Definition of MIN_FAC

	MECHANICALLY HEATED BUILDING (OFFICES AND SIMILARLY USED SPACES)	BUILDING WITHOUT ACTIVE COOLING OR WITHOUT AIR CONDITIONING
MIN_FAC	$S_{HP,} = W_{WR} \cdot g_t \leq 0.16 = S\ hp,_{max}$	$SHP = W_{WR} \cdot g_t \leq 0.16 = S\ hp,_{max}$

where:

W_{WR} is the window to wall ratio = window area / wall area

window area = sum of all windows (including window frames and mullions)

wall area = area of the exterior wall (width * floor to ceiling height) including all transparent and opaque parts of the wall

g_t is the combined total shading coefficient of window system, glazing and sun protection.

S_{HP} (Solar Heat Protection) is the factor to avoid overheating for office rooms according to DIN EN 13363

Alternative: Thermal, solar and daylight properties of building components and elements according to either detailed calculation method ISO 52022-3:2017 or Simplified calculation method of the solar and daylight characteristics for solar protection devices combined with glazing ISO 52022-1:2017.

APPENDIX B – DOCUMENTATION

I. Required documentation

Examples of possible documentation include the following items. The documentation submitted for the evaluation of individual indicators should comprehensively and clearly demonstrate compliance with the relevant requirements

Indicator 1: Transmission and diffusion via envelope surface components:

- Declaration by the specialist planner that there are non-critical amounts of condensation water in the envelope surface components, documentation of the vapour diffusion if necessary.
- List of the heat transfer coefficients for:
- Opaque exterior components
- Transparent exterior components
- Curtain wall
- Glass roofs, strip lights, skylights

Indicator 2: Transmission via thermal heat bridges

- Declaration by the specialist planner that the structural minimum heat insulation for thermal heat bridges has been complied with, documentation via isothermal calculations if necessary.
- Details of the selected thermal heat bridge correction factor ΔU_{WB}.
- Catalogue of the thermal heat bridges in accordance with DIN EN ISO 10211.

Indicator 3: Airtightness of the building envelope

- Documentation of the airtightness measurement results. Assessment of the air exchange rate n_{50} in h-1 and, if applicable, calculation of the air exchange from external surfaces q_{50} in m³/(h m²) at a pressure difference of 50 Pa in accordance with DIN EN 13829.
- Documentation of the joint permeability Q in accordance with DIN EN 12207 and details of the class calculated on the basis of the EPC.
- The details must be taken from the relevant technical data sheet for the windows and doors as test bench values.

Indicator 4: Summer heat protection:

- Documentation of the solar transmittance parameter S in accordance with DIN EN 13363 or ISO 52022-3:2017 and/or ISO 52022-1:2017.
- Dynamic thermal simulation with calculation boundary conditions in accordance with standards described in criterion ENV1.1.

Indicator 4.2: Agenda 2030 bonus: Thermal comfort climate adaptation

- Results of the thermal simulation/calculation which are done using climate data predictions for 2030 and 2050

APPENDIX C – LITERATURE

I. Version

Change log based on version 2020

PAGE	EXPLANATION	DATE
all	General, evaluation and usage specific description: scheme “Assembly buildings” has been added	16.09.2021
500	Shares of total score have been corrected	16.09.2021
505	Indicator 4: alternative assessment option – simulation has been added	16.09.2021
509	Editorial: method, indicator 4.2 climate scenario name from UN IPCC has been corrected SRES A1B	16.09.2021

II. Literature

- ISO 13788:2012 Hydrothermal performance of building components and building elements - Internal surface temperature to avoid critical surface humidity and interstitial condensation - Calculation methods Berlin: Beuth Verlag. May 2013
- ISO 10211:2017 Thermal bridges in building construction - Heat flows and surface temperatures - Detailed calculations
- ISO 14683:2017 Thermal bridges in building construction - Linear thermal transmittance - Simplified methods and default values.
- DIN EN 15026. Hygrothermal performance of building components and building elements – Assessment of moisture transfer by numerical simulation. Berlin: Beuth Verlag. July 2007
- ISO 52022-3:2017Energy performance of buildings -- Thermal, solar and daylight properties of building components and elements -- Part 3: Detailed calculation method of the solar and daylight characteristics for solar protection devices combined with glazing
- ISO 52022-1:2017 Energy performance of buildings -- Thermal, solar and daylight properties of building components and elements -- Part 1: Simplified calculation method of the solar and daylight characteristics for solar protection devices combined with glazing
- DIN EN 13363-1:2007-09 Solar protection devices combined with glazing - Calculation of solar and light transmittance - Part 1: Simplified method; Beuth Verlag. Sep. 2007
- Sustainable Development Goals icons, United Nations/globalgoals.org
- World climate map according to the Passive House Institute (PHI): https://passiv.de/en/03_certification/01_certification_components/02_certification_criteria/01_transparentcomponents/01_transparentcomponents.html