	Höppe, P. (1999). The physiological equivalent temperature – a universal index for the biometeorological assessment of the thermal environment. International Journal of Biometeorology, 2466, 71-75.

2.9.4 *Predicted Mean Vote-Predicted Percentage Dissatisfied (PMV-PPD)*

Project Name: UNaLab (Grant Agreement no. 730052)

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Mean or peak daytime temperature – Predicted Mean Vote-Predicted Percentage Dissatisfied	**Climate Resilience** **Natural and Climate Hazards**
Description and justification	Green urban infrastructure can significantly affect climate change adaptation by reducing air and surface temperatures with the help of shading and through increased evapotranspiration. Conversely, green urban infrastructure can also provide insulation from cold and/or shelter from wind, thereby reducing heating requirements (Cheng, Cheung, & Chu, 2010). By moderating the urban microclimate, green infrastructure can support a reduction in energy use and improved thermal comfort (Demuzere et al., 2014). The cooling effect of green space results in lower temperatures in the surrounding built environment (Yu & Hien, 2006)
Definition	Mean or peak daytime local temperature by PMV-PPD calculation (unitless value)
Strengths and weaknesses	+ Mathematical expression of a person's thermal comfort under indoor steady-state conditions - Subjective evaluation of thermal sensations - The output is **not** expressed in any temperature units, e.g., °C.
Measurement procedure and tool	The model aims to estimate the mean thermal sensation of a group of individuals and their respective percentage of dissatisfaction with the thermal environment, expressed in terms of Predicted Mean Vote-Predicted Percentage Dissatisfied (PMV-PPD). The practical

	application of the PMV equation and associated variables has been described by Ekici (2016). PMV provides a score that relates to the Thermal Sensation Scale (Fanger, 1970). If the score is zero, the occupant satisfaction regarding the environment is at the maximum level (Ekici, 2016). Thermal Sensation Scale (Fanger, 1970): **Scale** – **Description** – **How it feels** **3** – Hot – Intolerably warm **2** – Warm – Too warm **1** – Slightly warm – Tolerably uncomfortable, warm **0** – Neutral – Comfortable **-1** – Slightly cool – Tolerably uncomfortable, cool **-2** – Cool – Too cool **-3** – Cold – Intolerably cool
Scale of measurement	Building scale
Data source	
Required data	Metabolism, clothing, indoor air temperature, indoor mean radiant temperature, indoor air velocity and indoor air humidity (Rupp, Vásquez, & Lamberts, 2015).
Data input type	Semi-quantitative
Data collection frequency	Annually
Level of expertise required	High – requires the ability to apply the mathematical model and evaluate the results
Synergies with other indicators	Directly related to *Incorporation of environmental design in buildings* indicator
Connection with SDGs	SDG 3 Good health and well-being, SDG 11 Sustainable cities and communities, SDG 13 Climate action
Opportunities for participatory data collection	Participatory data collection is feasible through direct participation in the indicator assessment
Additional information	
References	Ekici, C. (2016). Measurement uncertainty budget of the PMV thermal comfort equation. International Journal of Thermophysics, 37, 48 Ekici, C. (2013). Review of Thermal Comfort and Method of Using Fanger's PMV Equation. Proceedings of the 5th International Symposium on Measurement, Analysis and Modelling of

Thermal Sensation Scale (Fanger, 1970):

Scale	Description	How it feels
3	Hot	Intolerably warm
2	Warm	Too warm
1	Slightly warm	Tolerably uncomfortable, warm
0	Neutral	Comfortable
-1	Slightly cool	Tolerably uncomfortable, cool
-2	Cool	Too cool
-3	Cold	Intolerably cool

	Human Functions, 27-29 June 2013, Vancouver, Canada. 4 pp. Fanger, P. (1970). Thermal comfort. Analysis and applications in environmental engineering. Copenhagen: Danish Technical Press. Rupp, R. F., Vásquez, N. G., & Lamberts, R. (2015). A review of human thermal comfort in the built environment. Energy and Buildings, 105, 178–205.

2.10. Urban Heat Island Effect

2.10.1. Urban Heat Island (UHI) incidence

Project Name: UNaLab (Grant Agreement no. 730052)

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Urban Heat Island (UHI) effect	**Climate Resilience** **Natural and Climate Hazards**
Description and justification	The UHI effect is caused by the absorption of sunlight by (stony) materials, reduced evaporation and the emission of heat caused by human activities. The UHI effect is greatest after sunset and reported to reach up to 9°C in some cities, e.g., Rotterdam (Van Hove et al., 2015). Because of the UHI effect, citizens living in urban areas experience more heat stress than those living in the countryside.
Definition	Urban Heat Island (UHI) effect denotes an urban area that is significantly warmer than its rural or undeveloped surrounding areas. Expressed and evaluated as temperature (°C).
Strengths and weaknesses	+ Fairly easy and straightforward assessment of temperature differences - Requires a rather large amount of temperature measurement stations to holistically identify the effect within the urban area - May require modelling expertise