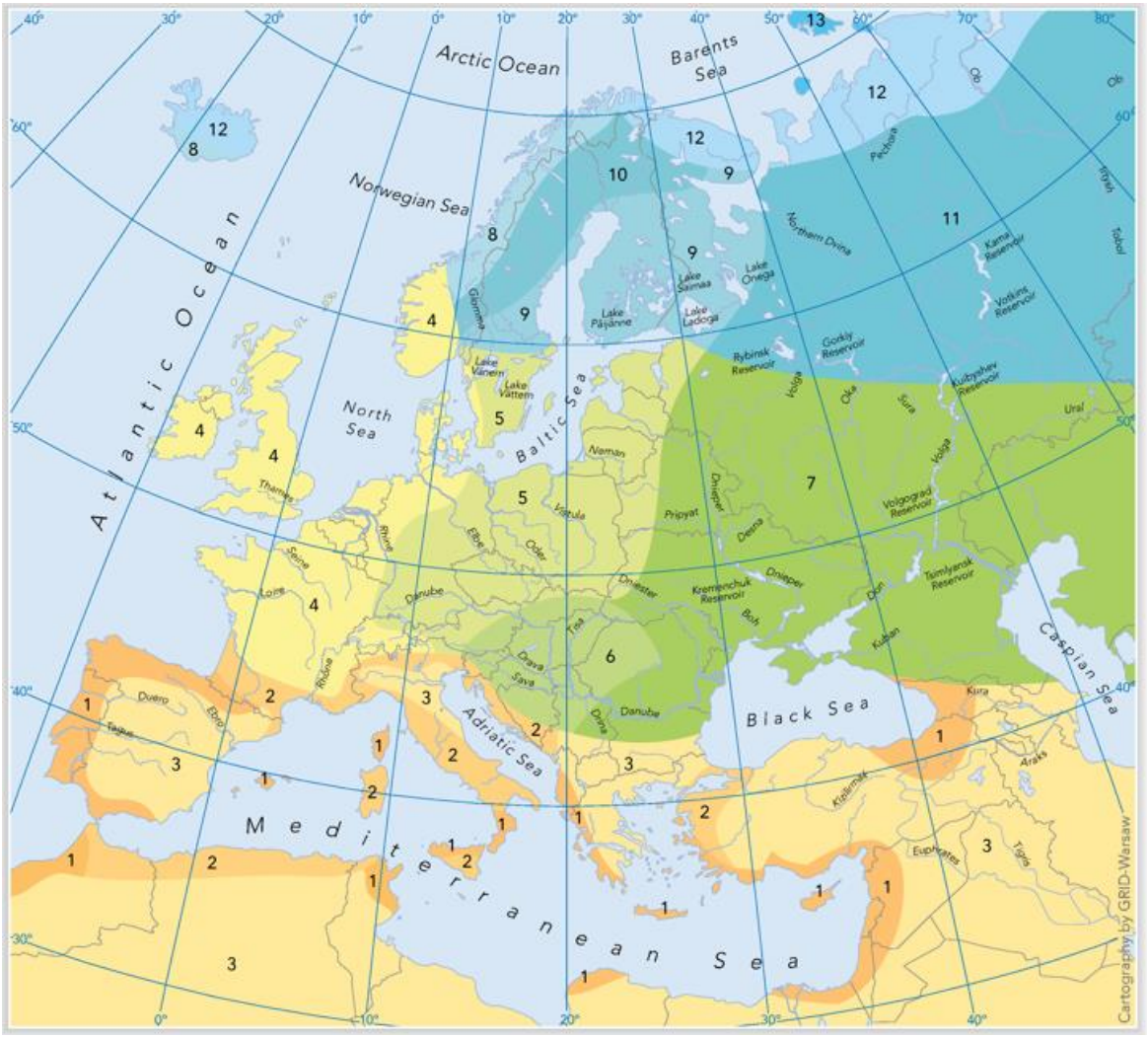
OVERHEATING CALCULATION METHODS IN EUROPEAN BUILDING ENERGY CODES



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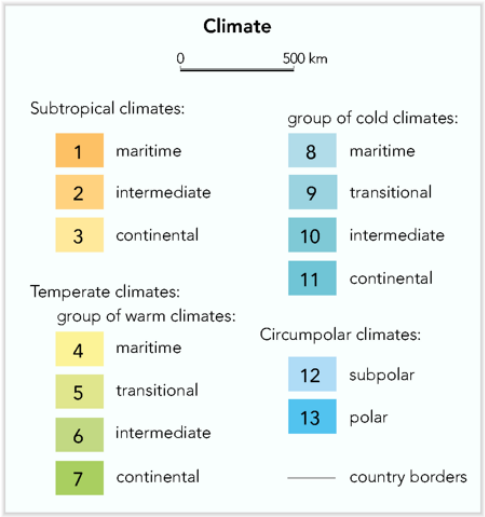

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OVERHEATING CALCULATION METHODS IN EUROPEAN BUILDING ENERGY CODES

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Overview of overheating calculation methods in European building energy codes and standards

ABSTRACT

The European Environment Agency predicts that the heatwaves will at least double between the first part of the century and the fifty last part. However, there are currently no standard European methods dealing with overheating. This study provides a review to understand the different regulations on overheating calculation methods for residential buildings to assure the well-being of people in residential buildings in European countries. It includes 26 European countries: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czechia, Denmark, Estonia, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Netherlands, Poland, Portugal, Romania, Slovakia, Spain, Sweden, Norway, Switzerland, United Kingdom. These countries have been analyzed based on a set of criteria defined in the study to propose a methodology on a European scale for thermal comfort in summer. Results show that most countries don't have strong regulations to fight thermal discomfort in summer. The study gives recommendations for European decision-makers, researchers, and industrialists to tackle the identified gaps to reach the European Commission's goal.

KEYWORDS

Renovation, New construction, Energy efficiency, Summer thermal comfort, Thermal discomfort, EPBD, Climate change, Heatwave, Dwelling

NOMENCLATURE

ANSI American National Standards Institute

ASHRAE American Society of Heating, Refrigerating and Air-Conditioning Engineers

CEN European Committee for Standardization;

CIBSE Chartered Institution of Building Services Engineers

DEAP Dwelling Energy Assessment Procedure

EPBD Energy Performance in Buildings Directive;

nZEB nearly Zero-Energy Building

PMV Predicted Mean Vote

PPD Predicted Percentage of Dissatisfied

UK United Kingdom

WHO World Health Organization

WWR Window to wall ratio

1. INTRODUCTION

Thermal comfort is an essential factor in the design and operation of buildings, especially in Europe, where the heatwave frequency will at least double compared to the first part of the century (*Number of Extreme Heat Waves in Future Climates under Two Different Climate Forcing Scenarios — European Environment Agency*, n.d.). Currently, 86% of deaths related to climate extremes in Europe are due to summer heat waves (*Cooling Buildings Sustainably in Europe*, n.d.). It becomes a matter of prime interest to deal with indoor thermal comfort during summer, especially as we spend more than 80% of our time indoors (*Cooling Buildings Sustainably in Europe*, n.d.). The new recast of the Energy Performance of Building Directive (EPBD) published in 2021 pays special attention to indoor thermal comfort asking for the members states to revise their national regulation link with the EPBD by the end of 2025 (*EPBD-Recast-New-Provisions-Need-Sharpening-to-Hit-Climate-Targets.Pdf*, n.d.). All new buildings in the European Union must be nearly zero-energy by the end of 2021, and all existing buildings must be renovated to this standard by 2050. It means that buildings must have a very high energy performance, with nearly zero or very low amounts of energy being covered by renewable energy sources. This requires a holistic approach to building design, taking into account factors such as human behavior insulation, airtightness, solar protection, and the use of energy-efficient systems and appliances (Attia, 2020; Attia, Lioure, et al., 2020; Attia, Shadmanfar, et al., 2020). The nearly zero energy building helps to increase energy comfort and efficiency but had to be defined and adapted for each country where it is implemented to be efficient (Piderit et al., 2019). It is also crucial to consider the cost optimality of the buildings to ensure the efficiency of the buildings in a financial way (Hamdy et al., 2017) with the well-being optimality. The EPBD gives calculation methods for residential and non-residential thermal parameters mainly based on the heat-balanced method of the norm named ISO 52016-1:2017. Countries' regulations are inspired by this standard, but each country has its own specific regulation with different parameters and thresholds to assure thermal comfort. Those differences lead to incoherent geographic discontinuity for thermal comfort, where the climatic condition is the same. A European consensus needs to be found to quickly and effectively improve regulation and well-being for summer thermal comfort.

The study, conducted between 2021 and 2023, provides an overview of overheating methods for residential buildings in European countries in the summer. The outcomes of this investigation are twofold:

1. A dataset of 3 documents, of which this document is part of
2. A scientific paper, which analyzes the dataset, published in an international journal: Energy Buildings

The dataset summarizes the interview that has been led in order to have a better understanding of the country's regulations regarding thermal comfort in residential

buildings. The scientific paper analyzes which methods are the more advanced and should be followed for the future of Europe. The study focuses on 26 European country thermal regulations, namely: Austria, Belgium, Bulgaria, Croatia, Czechia, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Netherlands, Poland, Portugal, Romania, Slovakia, Spain, Sweden, Norway, Switzerland, and the United Kingdom. This report excludes any financial landscape or social considerations. The aims of the study are to improve the well-being in residential buildings in European countries and to prepare buildings to be climate-proof against climate change. To follow these aims, the study based its research methodology on four research questions listed below:

1. What are the methodologies and criteria to assess thermal comfort and overheating in European building codes based on the EPBD?
2. How to characterize and compare different methodologies and criteria?
3. What are the main difference that distinguishes different methodologies? What are the most outstanding overheating national method?
4. What factors should be considered to advance the overheating assessments in future revisions of building regulations?

This report gives an answer to the first research methodology question. Then, the study answers the four research questions.

The originalities of this paper are multiple. It is the result of a 3-year-long study led between 2021 and 2023. It provides a broad general, and comprehensive overview of the overheating calculation methods in 26 European regulations for residential buildings, which was not done before on this scale. All these countries are members of the EPBD except for Switzerland.

Figure 1.1: The participating countries in the study on overheating calculation methods in European regulation for residential buildings

The methodology used consists of reviewing state-of-the-art thermal comfort calculations in Europe. Then, interviews were led based on a questionnaire that can be found in detail in Appendix 2. It is similar to a previous work conducted by the main author on Southern (Attia et al., 2017) and Eastern (Attia et al., 2022) Europe about nearly zero energy buildings. The questionnaire addresses five areas of study, listed below:

- The occupant representation in the method
- The thermal comfort model and overheating calculation
- The simulation model
- The mandatory envelope requirements

The information gathered is mainly qualitative. These countries have been analyzed based on a set of eight criteria defined in the study to propose a methodology on a European scale for thermal comfort in summer. Results show that most countries don’t have strong regulations to fight thermal discomfort in summer.

The study gives recommendations for European decision-makers, researchers, and industrialists to tackle the identified gaps to reach the European Commission's goal.

This report is organized into three sections. The first section introduces the research and identifies the issue, the objective, the knowledge gaps, and the framework of this study. The second section provides an overview of the information gathered during the investigation and the expert interview. The final section discusses and concludes the study outcomes, implications, and limitations while making useful recommendations.

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2.OVERVIEW OF NEARLY ZERO ENERGY BUILDINGS STATUS IN EASTERN EUROPE

2.1. AUSTRIA

Please fill out the following table regarding the status in your country. Feel free to develop the answers.

1. What is the thermal comfort limit for residential buildings in your country?

1.a.1. Explain shortly the reference standards used in your country to evaluate thermal comfort in residential buildings.

There are two relevant sources to be considered:

There is a national guideline that defines the comfort criteria, which is mandatory for both new buildings and for deep renovation (OIB RL 6).

Additionally, there is a national standard that defines the overheating calculation method that has to be applied (ÖNORM B 8110-3).

1..a.2. Cite the reference, and share the reference in pdf format if possible.

The comfort criteria is defined in
OIB Guideline Nr. 6 (2019): Energy saving and heat insulation

This guideline is one out of six national guidelines, which serve to harmonize the construction engineering regulations in Austria. They are published by the Austrian Institute of Construction Engineering. These OIB Guidelines are organized according to the basic requirements for construction works of the EU Construction Products Directive. Only one guideline is missing so far, this is the one for the basic requirement „Sustainable use of natural resources".

The overheating calculation method is defined in the national standard
ÖNORM B 8110-3 (2020): Thermal protection in building construction — Part 3: Determination of the operating temperature in summer (Prevention of summerly overheating).
This standard is one out of seven national standards on thermal protection in building construction. The calculation method of ÖNORM B 8110-3 is based on
EN ISO 52016-1 (2018): Energy performance of buildings — Energy needs for heating and cooling, internal temperatures and sensible and latent heat loads.

Part 1: Calculation procedures

1.a.3. Is the comfort assessed based on a static comfort model (like Fanger) or

adaptive comfort model (like EN 15251 / 16798)? Explain.

The comfort criterion is defined by the maximum indoor operative temperature, that may occur under the influence of an endlessly repeated warm and sunny design-day, which is defined as a July 15th. The allowed maximum indoor operative temperature depends upon the statistic daily mean outdoor temperature of this design-day. The daily mean outdoor temperature of this design-day depends upon the location of the site. Thus, the method follows the adaptive approach.

1.a.4. Please fill out the following table regarding overheating in your country. Feel free to elaborate with your answers.

Table 1: Overheating assessment

Criteria	Your Country
<u>Climate and weather data</u>	
Is comfort dependent on national geographic climate zones? If yes, list them.	Yes, it is. As described in 1.a.4: The allowed indoor operative temperature depends upon the location-sensitive statistic daily mean outdoor temperature on July 15th. This in turn is derived from a national climate data regression model, which takes the sea level of the site and its affiliation to one out of seven national climate regions into account. This climate data regression model is defined in the national standard ÖNORM B 8110-5 (2019).
Do you have a specific comfort calculation approach for heat waves?	The calculation method is based on an hourly simulation of an endlessly repeated summerly design day. So, it is, by definition, an heat wave approach. But it is an ongoing national discussion, if the basis of the climate data is still sufficient: The outdoor daily mean design temperature is defined as the one, that is statistically met or surpassed 13 times per year, based upon weather data from 1981 to 2000.
Do you take into account the urban heat island effect?	No, we don't.
Does your overheating methodology take into account future climate change weather files with extreme scenarios?	No, it doesn't, at least not mandatory. There is a method, defined in the same standard ÖNORM B 8110-3, how to not only fulfil (A) the summer comfort minimum criterion, but to fulfill enhanced criteria, which are (B) "good summer comfort" or (C) "very good summer comfort". For (B) the same calculation has to be processed with an outdoor design temperature that is raised by 1,5 K above the standard design temperature. For (C) it has to be processed with an outdoor design temperature that is raised by 3,0 K above the standard design temperature. In both cases the indoor comfort temperature that has to be met, stays at the level of the mandatory method.
<u>Occupant type and representation</u>	

What is your comfort standard?	OIB RL 6 for definition of comfort criteria. ÖNORM B 8110-3 for calculation method. Find detailed description above.
For which building types?	Residential Buildings only. For commercial buildings there is an alternative criterion, which defines a threshold for the annual specific cooling demand that is caused by solar radiation alone, given in kWh/(m^2_{GFA}.a)
Does your method embrace the four occupant categories (I, II, III, IV)? *	No, it does not. There's only one comfort limit, given in a threshold of the operative temperature in the room, which must not be passed under the given, periodically repeated diurnal series of outdoor temperature, solar irradiation, internal gains and ventilation rates.
How do you represent occupancy presence in the simulation model?	There are mandatory sets to take internal gains into account, given in hourly values of internal loads from people and equipment.
<u>Comfort model</u>	
What is your overheating indicator?	It is the daily maximum of the hourly operative temperature of the room.
Is your comfort model based on an adaptive or static method?	The threshold of the comfort limit of the operative temperature depends upon the site-specific outdoor design temperature, which is the daily mean temperature, that is statistically met or surpassed 13 times per year, with the abbreviation of $T_{NAT,13}$. The threshold of the comfort limit of operative temperature is defined as: $T_{limit} = 1/3*T_{NAT,13} + 21,8$ °C. So, it is an adaptive method.
What are your overheating thresholds? and according to which standard are those thresholds defined?	See above. The threshold is defined in OIB RL 6. The formula is taken from EN 16798, chapter B.2.2, Default acceptable indoor temperatures for buildings without mechanical cooling systems. It is the temperature definition formula for category II upper limit.
Is there a distinction between naturally ventilated, air-conditioned, and mixed mode buildings?	There is no destinction regarding the benchmarks of overheating indicator. But there is a destinction in the ventilation rates that may be taken into account: For mechanical ventilation, the ventilation rate is limited to 1,5 ACH (if people are in the room) resp. 2,5 ACH (if no people are in the room). For window ventilation the ventilation rate is calculated by simplified aperture flow formulas. .
Does your model take into account local personalized heating/cooling & ventilations systems (ceiling fans, air-conditioned chairs, electric heating mattresses…)?	No, it does not. There is no option to e.g. increase the operative temperature threshold for enhanced air movement.
<u>Simulation model</u>	
Is your calculation based on a static/quasi-dynamic/dynamic model? What is the calculation timestep?	The calculation is based on a dynamic, diurnally repeated simulation. Input parameters, both climate and internal gains, are given at a timesteps of one hour. There is no obligation

	which simulation software has to be used. The software has to fulfill the either the quality requirements of EN ISO 52016-1 or has to be validated with the example in ÖNORM B 8110-3 (2019), Appendix C.
Is your overheating calculation based on a single or multizone model?	Single Zone. More than one rooms may be calculated as one zone, if open doors may be assumed without compromising the functions of the rooms.
Does your calculation distinguish sleeping rooms from other living areas?	No, it does not. It did until the latest revision. But it was cancelled.
<u>Mandatory envelope requirements</u>	
Does your method oblige the installation of external shading?	No. It is fully a performance based method.
Does your method oblige the limitation of the window to wall ratio? If yes, what is the limit?	No. It is fully a performance based method.
Does your method recommend a g-value? If yes, what is the limit?	No. It is fully a performance based method.
* we are focusing on category II occupants for new and renovated buildings	

1b. Do you have fuel poverty problems in your country that might influence overheating risk in residential buildings? Explain.

We have 16% of our inhabitants being in danger of poverty. 8% may be addressed to be in energy poverty. There is a general connection between overheating risk and poverty: The poorer districts correlate significant with the areas of significant heat island effect. So, poverty is correlated with overheating risk by the location of the flats. Furthermore there might be no money to buy or run an AC. Furthermore there might be no interest of the landlord to install thermal improvements such as solar shading to houses with low return on investment.

1.c.1. What are the overheating criteria for residential buildings in your country?

This has been already explained above. It is the indoor maximum operative temperature that is reached within one day, to be calculated by diurnally repeated simulation runs, under given outdoor climate and given internal gains.

1.c.2. What is the overheating risk for residential buildings (highly insulated) in your climate?

The overheating risk is significant. Night ventilation together with thermal mass used to be sufficient. But this is now threatened by Urban Heat Island effect, by noise and dust in the dense areas of the cities. Another burden to overheating is coming from central domsetic hot water systems, which are run, due to hygienic reasons, at increasing temperature levels with full circulation. This is already a significant heat load to the flats.

1.c.3. How do you evaluate overheating risk in residential buildings in your country? Please share the calculation method and overheating hours limit threshold.

This has bee already discussed in detail.

1.d. Can we rely on passive cooling or must include active cooling systems for residential buildings in your country for residential buildings?

Cooling just is getting in the residential sector. Night ventilation alone is not enough anymore. But there is strong political consensus to avoid AC systems. There are good experiences with concrete core activation of ceiling slabs, being run with hydronic systems at constantly 21°C. The heat sinks of those systems are mainly passive, in most cases borehole heat exchangers. The excess heat serves as in input for efficient heat-pump operation in winter.

Add something ?

Relevant References / key publications:

- ÖNORM B 8110-3 (2020): Thermal protection in building construction — Part 3: Determination of the operating temperature in summer (Prevention of summerly overheating)
- OIB Guideline Nr. 6 (2019): Energy saving and heat insulation
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2.2. BULGARIA

2. Please provide a map of the climatic areas in your country. Cite the source and make sure to share a high-resolution document.

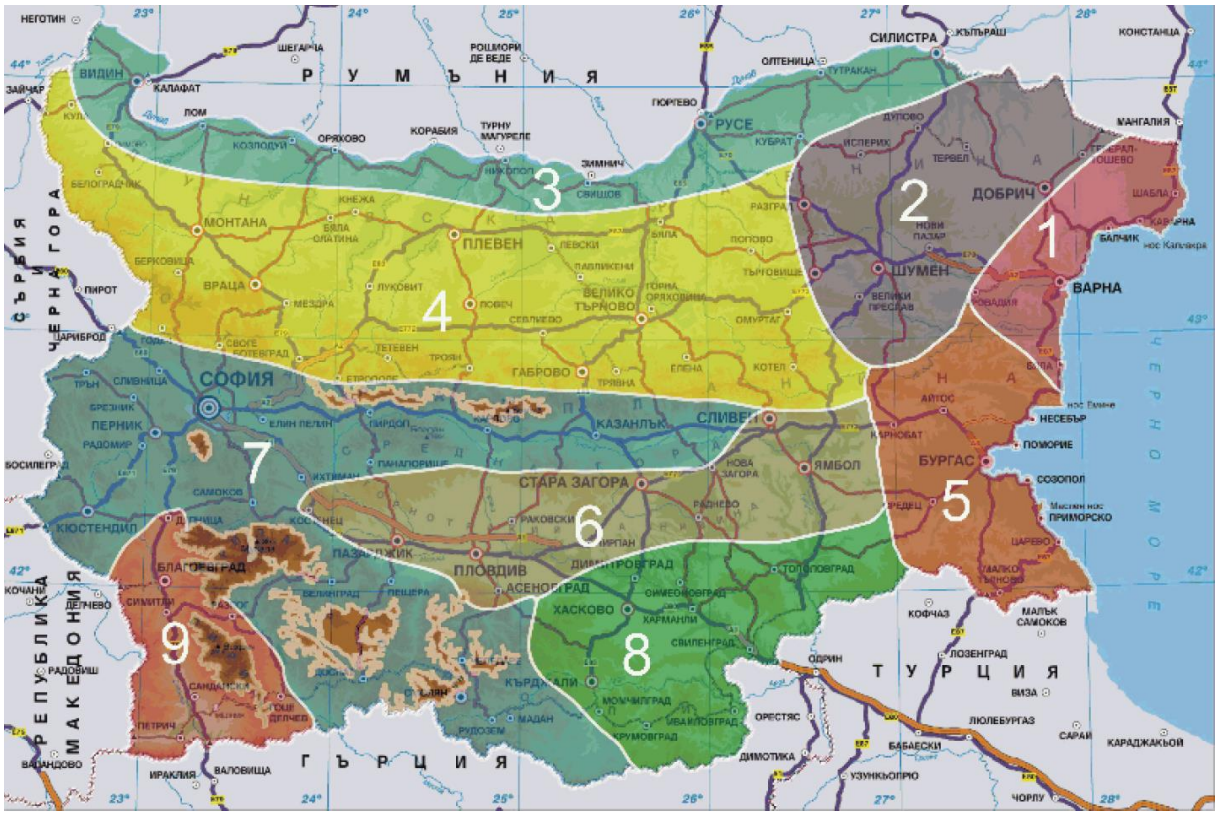


Figure 3.1.1: Climate zones of Bulgaria to calculate the energy efficiency of buildings

Source: Ordinance №7 of 2004 on the energy efficiency of buildings of the Ministry of Regional Development and Public Works, Bulgaria.

5. What is the thermal comfort limit for nZEBs in your country?

5.a.1. Explain shortly the reference standards used in your country to evaluate thermal comfort in nZEBS.

The thermal comfort standard is defined in “Ergonomics of the thermal environment - Analytical determination and interpretation of thermal comfort using calculation of the PMV and PPD indices and local thermal comfort criteria” (БДС EN ISO 7730: 2007) and in “Indoor environmental input parameters for design and assessment of energy performance of buildings addressing indoor air quality, thermal environment, lighting and acoustics” (БДС EN 15251:2007). Furthermore, the standard “Energy performance of buildings - Ventilation for buildings - Part 1: Indoor environmental input parameters for design and assessment of energy performance of buildings addressing indoor air quality, thermal environment, lighting and acoustics - Module M1-6” (БДС EN 16798-1:2019) is also in force.

5.a.2. Cite the reference, and share the reference in pdf format if possible.

1. https://www.bds-bg.org/bg/standard/?natstandard_document_id=47977

2. https://www.bds-bg.org/standard/?national_standard_id=62584

3. https://www.bds-bg.org/bg/standard/?natstandard_document_id=94080

5.a.3. Is the comfort assessed based on a static comfort model (like Fanger) or an adaptive comfort model (like EN 15251 / 16798)? Explain.

In Bulgaria, both standard EN 15251 and EN ISO 7730 are in force. However, the Bulgarian Ordinance №7 (last modified in 2017) for the energy efficiency of buildings does not recommend the application of a specific model.

5.a.4. Please fill out the following table regarding overheating in your country. Feel free to elaborate on your answers.

Table 3.1.2: Overheating assessment in Bulgaria

Country	Bulgaria
Climate and weather data	
Is comfort dependent on national geographic climate zones? If yes, list them.	In Bulgaria there are 9 climate zones (1,2,3,4,5,6,7,8,9). Civil engineers size the building thermal parameters according to Ordinance №7.
Do you have a specific comfort calculation approach for heatwaves?	No.
Do you take into account the urban heat island effect?	No.
Does your overheating methodology take into account future climate change weather files with extreme scenarios?	No.
Occupant type and representation	
What is your comfort standard?	БДС EN 15251 БДС EN ISO 7730
For which building types?	Residential and commercial.
Does your method embrace the four occupant categories (I, II, III, IV)? *	Yes.
How do you represent occupancy presence in the simulation model?	
Comfort model	
What is your overheating indicator?	The building's inside temperature.
Is your comfort model based on an adaptive or static method?	Static.
What are your overheating thresholds? and according to which standard are those thresholds defined?	For commercial spaces: - maximal 28 °C in normal cases and 26 °C in case of heavy physical work - minimal from 12 °C to 18 °C, depending on the type of activity Standard: БДС 14776:1987
Is there a distinction between naturally ventilated, air-conditioned, and mixed-mode buildings?	No.

Does your model take into account local personalized heating/cooling & ventilation systems (ceiling fans, air-conditioned chairs, electric heating mattresses…)?	No.
Simulation model	
Is your calculation based on a static/quasi-dynamic/dynamic model? What is the calculation timestep?	In practice different simulation software, which adopts different models. There are no requirements to use a specific methodology or software.
Is your overheating calculation based on a single or multizone model?	Multizone model.
Does your calculation distinguish sleeping rooms from other living areas?	No.
Mandatory envelope requirements	
Does your method oblige the installation of external shading?	No.
Does your method oblige the limitation of the window to wall ratio? If yes, what is the limit?	No.
Does your method recommend a g-value? If yes, what is the limit?	No.
* We are focusing on category II occupants for new and renovated buildings	

5.b. Do you have fuel poverty problems in your country that might influence the nZEB objective? Explain.

Bulgaria has fuel poverty problems, caused by: low income, low energy efficiency (inadequate insulation, old or inefficient heating systems), relatively high energy prices, under-occupancy (there is a tendency for a decrease in the population).

5.c.1. What are the overheating criteria for nZEBs in your country?

The room temperature is at least two consecutive days during the winter and summer seasons. There are no specifics for nZEB.

5.c.2. What is the overheating risk for nZEB (highly insulated) in your climate?

The overheating risk for nZEB depends on the climate zone. In some zones, there are extreme summer temperatures and therefore the overheating risk is high, while in other zones the risk is low.

5.c.3. How do you evaluate overheating risk in nZEBs in your country? Please share the calculation method and overheating hours limit threshold.

According to [8] (Ordinance № РД-07-3 from 18.07.2014 for the minimal requirements of microclimate at working places), the temperature is measured on equally spaced time intervals in at least two consecutive days during the winter and summer seasons. The temperature should be within the necessary range all the time.

5.d. Can we rely on passive cooling or must include active cooling systems for nZEBs in your country?

In some of the climate zones, passive cooling for nZEB is applicable. To the best of our knowledge, there are no experimental results for Bulgaria to assure that passive cooling is applicable in all zones.

Relevant References / key publications:

[1] БДС EN ISO 7730:2007. Ергономия на заобикалящата топлинна среда. Аналитично определяне и интерпретация на топлинния комфорт чрез пресмятане на индексите PMV и PPD и критерия за локален топлинен комфорт (ISO 7730:2005).

[2] БДС EN 15251:2007. Входящи параметри за качеството на вътрешния въздух, заобикалящата топлинна среда, осветлението и акустиката при проектиране и оценка на енергийната характеристика на сгради

[3] БДС EN 16798-1:2019. Енергийни характеристики на сгради. Вентилация на сгради. Част 1: Входни параметри на вътрешната околна среда за проектиране и оценяване на енергийните характеристики на сгради, насочени към качеството на вътрешния въздух, топлинната среда, осветлението и акустиката. Модул M1-6.

[4] БДС 14776:1987. Охрана на труда. Работни места в производствени помещения. Санитарно-хигиенни норми за температура, относителна влажност, скорост на въздуха и топлинно облъчване.

[5] National nearly zero-energy building plan 2015–2020, Sofia, Bulgaria, November 2015.

[6] Ministry of Regional Development and Public Works. Ordinance №7 of 2004 on the energy efficiency of buildings of the Ministry of Regional Development and Public Works, Bulgaria. Last modified on 21st of November, 2017.

[7] R. Savov, V. Maneva, D. Jordanov, D. Ivanov. Handbook for construction professionals (In Bulgarian: Савов Р., В. Манева, Д. Йорданов, Д. Иванов. Наръчник за строителни специалисти. https://www.bcci.bg/resources/files/RAKOWODSTWO.pdf)

[8] Minister of Labour and Social Policy and Minister of Health Care. Ordinance № РД-07-3 from 18.07.2014 for the minimal requirements of microclimate at working places (In Bulgarian: НАРЕДБА № РД-07-3 от 18.07.2014 г. за минималните изисквания за микроклимата на работните места).

2.3. CROATIA

The first official introduction of the term annual energy needs for heating, Q_h [kWh/a] in Croatia can be traced back to 2006 and a document titled Technical Regulation on the Rational Use of Energy and Thermal Insulation in Buildings [1]. This Regulation first allowed energy needs for heating for residential and non-residential buildings heated to a temperature of 18 °C or higher. Allowed energy needs were defined concerning the building shape factor f_0 [m^{-1}].

Croatia's entry into the European Union on July 1, 2013, marked the beginning of energy certification of buildings with the first Ordinance on energy audits and energy certification of buildings [2]. The calculation of energy required for cooling was later introduced in 2008.

And finally, the primary energy consumption limitation and definition of nearly zero energy buildings (nZEB) in Croatia was brought in 2014 by Technical Regulation on the Rational Use of Energy and Thermal Insulation in Buildings [3]. The regulation was written to align with the requirements of Directive 2010/31/EU of the European Parliament and of the Council of 19 May 2010 on the energy performance of buildings. Even before 2014, there have been many educational and promotional activities- from European projects where Croatia had a representative (i.e. IEE project SUSTAINCO, 2011) to local and regional events (nZEB Regional Conference in Dubrovnik, 2014) [4].

Regulation [3] stipulated that from December 31, 2020, all new buildings must be nZEB, and after December 31, 2018, also all new buildings used by public authorities or owned by public authorities. Regulation [3] was revised in 2015 but the definition of nZEB building stayed the same - Nearly zero energy building is a building with very high energy properties. This almost zero or very low amount of energy should be covered to a very significant extent by energy from renewable sources, including energy from renewable sources produced on or near the building, for which the requirements are laid down in Regulation.

2. Please provide a map of the climatic areas in your country. Cite the source and make sure to share a high-resolution document.

Table 3.2.2 shows how requirements for nZEB buildings are defined based on the type of building and building location, the continental part of Croatia, or the coastal part of Croatia. This division puts the whole of Croatia in two climate zones based on the mean monthly temperatures of the outdoor air of the coldest month of the year at the location of the building, graphically presented in Figure 1:

- Continental zone (when the mean monthly temperature of the coldest month at the location of the building is ≤ 3 °C according to meteorological data for the nearest meteorological station) and

- Coastal zone (when the mean monthly temperature of the coldest month at the location of the building is > 3 °C according to meteorological data for the nearest meteorological station).

The division of Croatia into two climate zones according to the network of climatological meteorological stations is presented in Figure 1 based on the data from the Croatian Meteorological and Hydrological Service [8]. Eastern from the blue line is the continental part of Croatia and western is the coastal part.

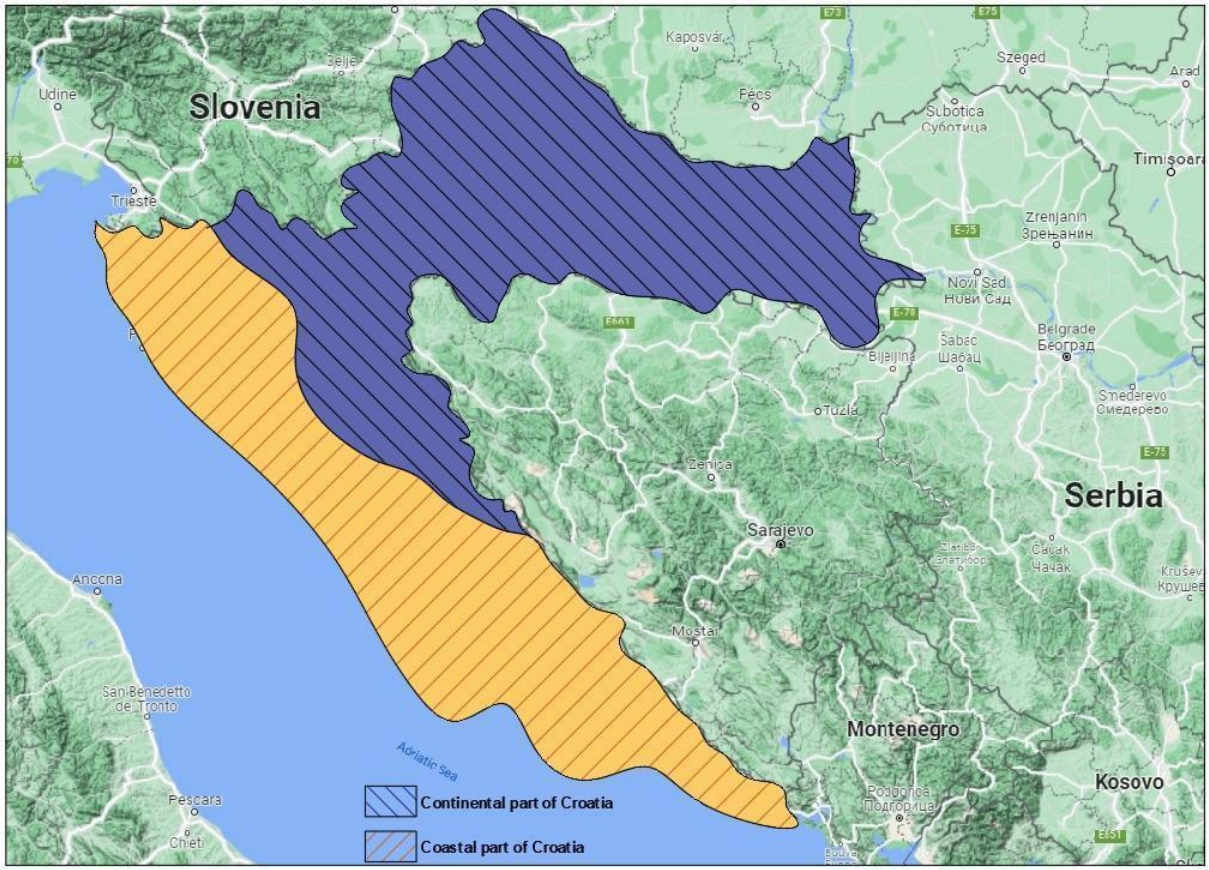


Figure 3.2.1: Two climate zones of Croatia

5. What is the thermal comfort limit for nZEBs in your country?

5.a.1. Explain shortly the reference standards used in your country to evaluate thermal comfort in nZEBs.

Guidelines for nZEB buildings for investors and design engineers are made by the Ministry of Physical Planning, Construction and State Assets, two sets of them:

- Guidelines for nearly zero energy buildings - Part ONE (intended for the general public concerned) and
- Guidelines for nearly zero energy buildings - Part TWO (intended for the professional public concerned).

But there are no special recommendations regarding thermal comfort in them. Regulation [5] refers to EN 15251:2008 when it comes to thermal comfort regardless of whether it is an nZEB or not. The comfort of the indoor area shall be ensured by fulfilling the conditions for heating, cooling, and ventilation, thermal stability and indoor surface temperatures, regulated humidity, proper lighting, and allowed noise level in the space. The recommended values are defined by EN 15251:2008 where microclimatic parameters of the buildings are related to the air quality, thermal comfort, lighting, and acoustics.

5.a.2. Cite the reference, and share the reference in pdf format if possible.

They are at the end of the section.

5.a.3. Is the comfort assessed based on a static comfort model (like Fanger) or an adaptive comfort model (like EN 15251 / 16798)? Explain.

Article 43, Regulation [5]: Recommended budget values are defined by HRN EN 15251:2008 containing input values of microclimatic parameters for the design and evaluation of the energy performance of buildings relating to air quality, thermal comfort, lighting, and acoustics.

5.a.4. Please fill out the following table regarding overheating in your country. Feel free to elaborate on your answers.

Table 3.2.3: Overheating assessment in Croatia

Country	Croatia
Climate and weather data	
Is comfort dependent on national geographic climate zones? If yes, list them.	No.
Do you have a specific comfort calculation approach for heatwaves?	No.
Do you take into account the urban heat island effect?	No.
Does your overheating methodology take into account future climate change weather files with extreme scenarios?	No.
Occupant type and representation	
What is your comfort standard?	Indoor environmental input parameters for design and assessment of energy performance of buildings addressing indoor air quality, thermal environment, lighting, and acoustics (EN 15251:2008).
For which building types?	All.
Does your method embrace the four occupant categories (I, II, III, IV)? *	No.
How do you represent occupancy presence in the simulation model?	No.
Comfort model	
What is your overheating indicator?	Yes, covered in [5], it is stated how overheating should be prevented by applying proper technical solutions. Building areas should not overheat more than 4°C due to solar radiation compared to the internal design temperature of the area.

Is your comfort model based on an adaptive or static method?	Static.
What are your overheating thresholds? and according to which standard are those thresholds defined?	We don't have them.
Is there a distinction between naturally ventilated, air-conditioned, and mixed-mode buildings?	Yes.
Does your model take into account local personalized heating/cooling & ventilation systems (ceiling fans, air-conditioned chairs, electric heating mattresses…)?	No.
Simulation model	
Is your calculation based on a static/quasi-dynamic/dynamic model? What is the calculation timestep?	Quasi-dynamic calculation based on monthly values.
Is your overheating calculation based on a single or multizone model?	-
Does your calculation distinguish sleeping rooms from other living areas?	No.
Mandatory envelope requirements	
Does your method oblige the installation of external shading?	No.
Does your method oblige the limitation of the window to wall ratio? If yes, what is the limit?	No.
Does your method recommend a g-value? If yes, what is the limit?	0.25 to 0.87 depending on the glazing and shading type.
* we are focusing on category II occupants for new and renovated buildings	

5.b. Do you have fuel poverty problems in your country that might influence the nZEB objective? Explain.

I would say when it comes to our position in GDP (PPP) per capita in Europe, we take position number 32 from 40 countries. We are the second last country in the EU when it comes to GDP per capita, consumption per capita, and price level indices: https://ec.europa.eu/eurostat/statistics-explained/index.php/GDP_per_capita,_consumption_per_capita_and_price_level_indices. So, poverty, low GDP are negatively influencing nZEB objective! But this year we also had a "Public call for financing energy renovation of family homes for vulnerable citizens at risk of energy poverty".

5.c.1. What are the overheating criteria for nZEBs in your country?

Except ones stated above in the text, we don't have any other.

5.c.2. What is the overheating risk for nZEB's (highly insulated) in your climate?

Glass facades. Large windows without shading mechanism. Or an inappropriate one.

5.c.3. How do you evaluate overheating risk in nZEBs in your country? Please share the calculation method and overheating hours limit threshold.

No. I did not find any in our regulations or guidelines for nZEBs.

5.d. Can we rely on passive cooling or must include active cooling systems for nZEBs in your country?

Since a significant part of the country is at the Adriatic coast, there are definitely active cooling systems for nZEB's. This probably wouldn't be necessary for one part of the country with a mountain climate, but that part of the country is sparsely populated anyway.

Add something ?

Relevant References / key publications:

[1] Tehnički propis o racionalnoj uporabi energije i toplinskoj zaštiti u zgradama (Translation: Technical Regulation on the Rational Use of Energy and Thermal Insulation in Buildings). „Narodne novine" broj 79/05.

[2] Pravilnik o energetskom pregledu zgrade i energetskom certificiranju (Translation: Ordinance on energy audits and energy certification of buildings). „Narodne novine" broj 81/12.

[3] Tehnički propis o racionalnoj uporabi energije i toplinskoj zaštiti u zgradama (Translation: Technical Regulation on the Rational Use of Energy and Thermal Insulation in Buildings). „Narodne novine" broj 97/14

[4] eCentral, Report on nZEB initiatives from the central Europe region. 2018.

[5] Tehnički propis o racionalnoj uporabi energije i toplinskoj zaštiti u zgradama (Translation: Technical Regulation on the Rational Use of Energy and Thermal Insulation in Buildings). „Narodne novine" broj 128/15, 70/18, 73/18, 86/18, 102/20.

[6] Ministry of Physical Planning, Construction and State Assets, Guidelines for nearly zero energy buildings - Part ONE. 2019, https://mgipu.gov.hr/UserDocsImages/dokumenti/EnergetskaUcinkovitost/Smjernice_1_dio_nZEB_mgipu.pdf.

[7] Ministry of Physical Planning, Construction and State Assets, Guidelines for nearly zero energy buildings - Part TWO. 2019, https://mgipu.gov.hr/UserDocsImages/dokumenti/EnergetskaUcinkovitost/Smjernice_2_dio_nZEB_mgipu.pdf.

[8] Croatian Meteorological and Hydrological Service. 2020; Available from: https://meteo.hr/infrastruktura.php?section=mreze_postaja&param=pmm&el=klimatoloske.

[9] Teni, M., K. Čulo, and H. Krstić, Renovation of Public Buildings towards nZEB: A Case Study of a Nursing Home. Buildings 2019. 9(153).

[10] Gumbarević, S., et al., Improving competencies of engineers and workers in the AEC industry for delivering NZEBs. Organization, Technology, and Management in Construction, 2020. 12: p. 19.

[11] Milovanović, B., et al., Innovative training schemes for retrofitting to nZEB-levels. 2019.

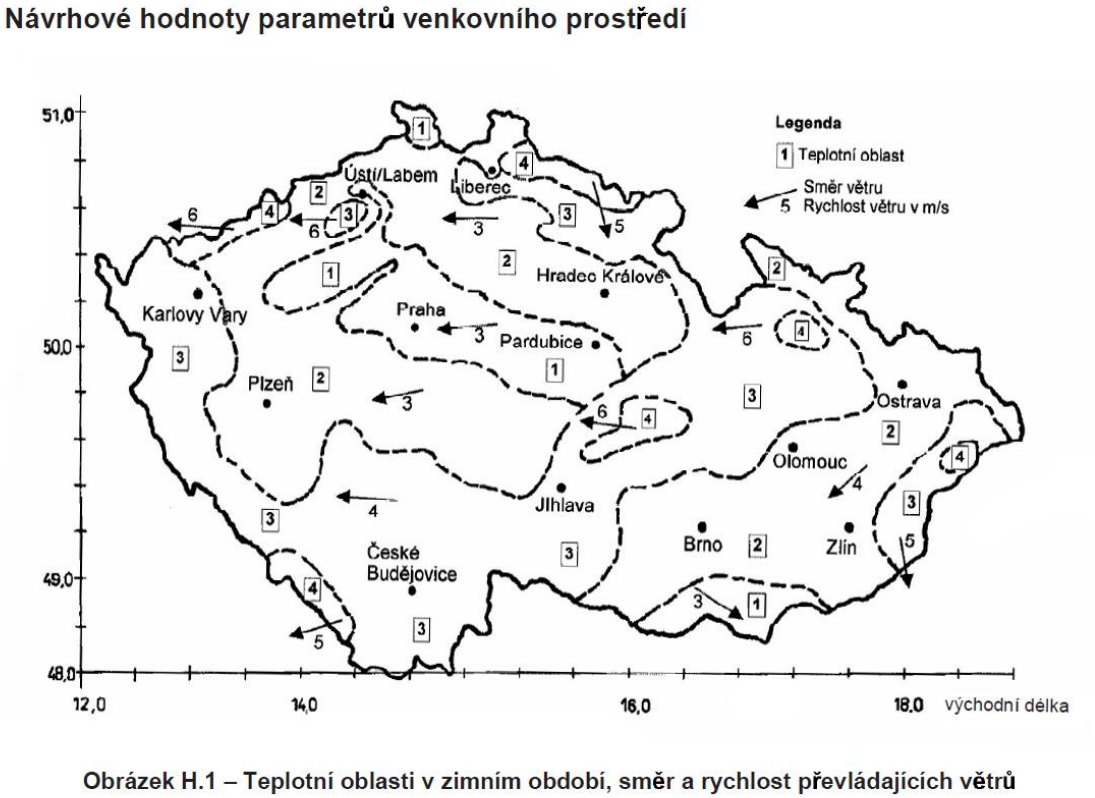
[12] Integrated National Energy and Climate Plan for the Republic of Croatia for the period 2021-2030. 2019, Ministry of Environment and energy, Republic of Croatia.

[13] Ministry of Physical Planning, Construction and State Assets - Programme for encouraging the construction of new and retrofitting existing buildings to nZEB standard 2018.

[14] Update/upgrade of the energy strategy and of the implementation program of the Republic of Croatia. 2008: Ministry of economy, labor and entrepreneurship and United nations development program (UNDP).

2.4. CZECHIA

2. Please provide a map of the climatic areas in your country. Cite the source and make sure to share a high-resolution document.



Obrázek H.1 – Teplotní oblasti v zimním období, směr a rychlost převládajících větrů

Figure 3.3.1: Climate zones of Czechia

5. What is the thermal comfort limit for nZEBs in your country?

5.a.1. Explain shortly the reference standards used in your country to evaluate thermal comfort in nZEBS.

We do not have standards designated specifically for nZEBs in Czechia. Thermal comfort (surface temperature limits, overheating, and temperature decrease) of all buildings is evaluated according to general standards such as ČSN 730540-2 (see 5.c.3).

It should be also noted that government regulation no. 41/2020, Coll. (describing health protection conditions at work) defines working conditions (e.g. indoor air temperatures). It permits higher temperatures at workplaces than ČSN 730540-2 if specific conditions are met (e.g. freshwater supply).

5.a.2. Cite the reference, and share the reference in pdf format if possible.

Government regulation no. 41/2020, Coll. In Czech: https://www.zakonyprolidi.cz/cs/2007-361/zneni-20200301 (available in Czech only)

(2011). Standard ČSN 730540-2 Tepelná ochrana budov – Část 2: Požadavky (Thermal protection of buildings – Part 2: Requirements), Prague: Czech Office for Standardization, Metrology, and Testing, 56 p. (available only in Czech and for a fee).

5.a.3. Is the comfort assessed based on a static comfort model (like Fanger) or an adaptive comfort model (like EN 15251 / 16798)? Explain.

ČSN EN 16798 standard series (localization of EN 16798) is valid in Czechia. Previously, the hourly calculations were performed according to other standards, such as ČSN EN ISO 52016-1 and ASHRAE 140-2017.

5.a.4. Please fill out the following table regarding overheating in your country. Feel free to elaborate on your answers.

Table 3.3.4: Overheating assessment in Czechia

Country	Czechia
Climate and weather data	
Is comfort dependent on national geographic climate zones? If yes, list them.	No. We have only one climate zone for the whole country in this regard.
Do you have a specific comfort calculation approach for heatwaves?	No.
Do you take into account the urban heat island effect?	No.
Does your overheating methodology take into account future climate change weather files with extreme scenarios?	No
Occupant type and representation	
What is your comfort standard?	ČSN EN ISO 52016-1 for summer stability ČSN 730540-4 for winter stability
For which building types?	"non-production" and others.
Does your method embrace the four occupant categories (I, II, III, IV)? *	No.
How do you represent occupancy presence in the simulation model?	It is possible (not mandatory) to include indoor energy gains from people, equipment, etc. into the calculations.
Comfort model	
What is your overheating indicator?	Maximum daily indoor air temperature in an assessed “critical room”.
Is your comfort model based on an adaptive or static method?	Static.
What are your overheating thresholds? and according to which standard are those thresholds defined?	ČSN 735040-2 Natural ventilation: 27°C indoor air temperature in a critical room in summer for non-production buildings (housing, offices, etc.), 29.5 (buildings with indoor heat sources ≤ 25 W/m3) or 31.5°C (buildings with indoor heat sources > 25 W/m3) for the rest of buildings. Air conditioning: 32°C indoor air temperature in a critical room in summer.
Is there a distinction between naturally ventilated, air-conditioned, and mixed-mode buildings?	In the calculation method no. In practice yes: it is possible to define air exchange rates to differentiate between natural and mechanical

	ventilation. It is also possible to define a cooling source (in hourly steps).
Does your model take into account local personalized heating/cooling & ventilation systems (ceiling fans, air-conditioned chairs, electric heating mattresses…)?	In general no, but it is possible to add heat energy gains from equipment or people, the air supply, and exchange rates to reflect the operation of such systems.
Simulation model	
Is your calculation based on a static/quasi-dynamic/dynamic model? What is the calculation timestep?	Dynamic model & hourly calculations.
Is your overheating calculation based on a single or multizone model?	Single zone. The assessment is performed only for a "critical room", (see 5.c.3. for definition).
Does your calculation distinguish sleeping rooms from other living areas?	No.
Mandatory envelope requirements	
Does your method oblige the installation of external shading?	No. However, it is difficult to comply with the indoor air temperature threshold without it.
Does your method oblige the limitation of the window to wall ratio? If yes, what is the limit?	No.
Does your method recommend a g-value? If yes, what is the limit?	No.
* we are focusing on category II occupants for new and renovated buildings	

5.b. Do you have fuel poverty problems in your country that might influence the nZEB objective? Explain.

According to a short report (https://www.tacr.cz/wp-content/uploads/2019/10/190531_TZ_energetickaChudoba.pdf), 4.7% of Czech households were endangered by energy poverty in 2019. Another report (https://bit.ly/3sqVhL2) from 2021 further elaborates this. It states that approx. 25 % of Czech households faced some sort of energy poverty in 2018.

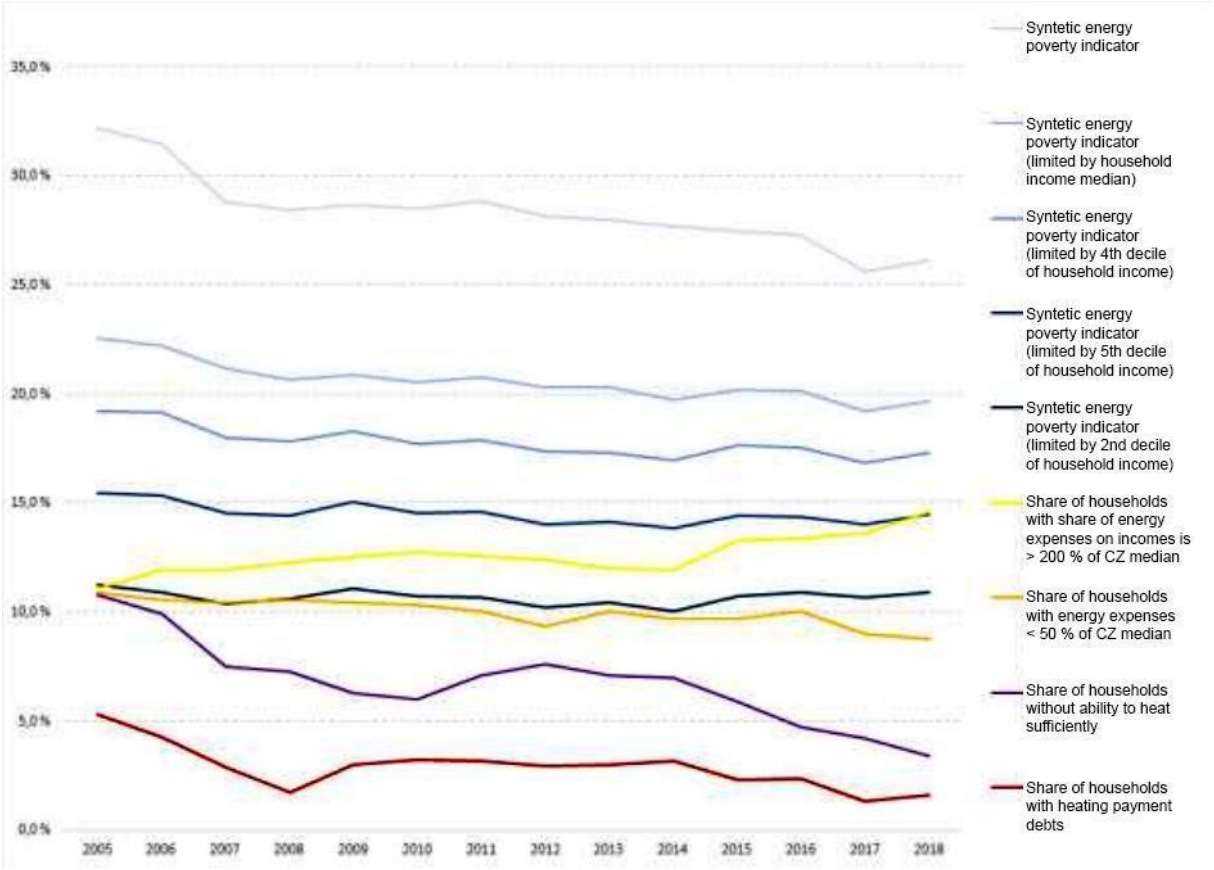


Figure 3.3.3: Percentage of households influenced by energy poverty in Czechia.

This could have a noticeable impact on the implementation of nZEB, especially if we consider the fact that housing in Czechia is the least affordable compared to most EU countries: Deloitte report states that own housing costs approx. 11.4 annual average gross income in Czechia (https://www2.deloitte.com/content/dam/Deloitte/cz/Documents/real-estate/Property_Index_2020.pdf).

5.c.1. What are the overheating criteria for nZEBs in your country?

There are no particular requirements on nZEBs in this regard. All buildings should comply with the "≤ 27°C indoor air temperature" requirement specified in ČSN 730540-2. It is not defined how this requirement should be met (air conditioning, shading, etc.).

5.c.2. What is the overheating risk for nZEB (highly insulated) in your climate?

We did not find any reliable (written) source on this matter; however, we think that the risk could be quite high if there is no change in approach towards building design and construction: A lot of Czech designers still focus on maximizing winter solar gains (to reduce heating demand), but neglect summer cooling (external shading, air conditioning). We found some old news articles stating that approx. 50% of existing Czech building stock is suffering from summer overheating and we presume that this issue will be further stressed by ongoing climate change.

5.c.3. How do you evaluate overheating risk in nZEBs in your country? Please share the calculation method and overheating hours limit threshold.

Summer thermal stability (overheating) is evaluated according to ČSN EN ISO 52016-1. This standard utilizes hourly dynamic calculations to assess maximum temperature in a critical room (room with the worst ratio between floor area and area of openings exposed to direct sunlight in E-SE-S-SW-W directions). The thresholds are defined in ČSN 730540-2:2011: 27°C indoor air temperature in summer for naturally ventilated "non-production" buildings (housing, offices, etc.), 29.5 or 31.5°C for the rest of buildings "with internal heat source" (depending on the output of the source). The standard says that the threshold can be increased to 29°C "... for periods shorter than 2 hours … in a residential building... if the investor agrees." The threshold for mechanically ventilated buildings is 32°C.

Overheating in winter is not evaluated. Indoor air temperature decrease in case of heat source failure is evaluated instead (according to ČSN 730540-4).

It should be noted that overheating is often omitted not only by designers (as stated in5.c.2) but by building authorities as well (authors' own experience). The exceptions are mostly buildings where its fulfillment is questionable (such as offices with transparent facades).

5.d. Can we rely on passive cooling or must include active cooling systems for nZEBs in your country?

So far, we can say that passive cooling is sufficient for buildings (especially residential) in the Czech climate. However, ongoing climate changes may change this in the following decades. We think (see 5.c.2)) that more attention should be paid to passive measures such as external shading instead of air conditioning systems that i. a. increase buildings' electricity consumption. The exception may be urbanized areas (urban heat islands), with above-average temperatures.

Add something ?

Relevant References / key publications:

- (2011). ČSN 730540-2 Tepelná ochrana budov – Část 2: Požadavky (Thermal protection of buildings – Part 2: Requirements). Prague: Czech Office for Standardization, Metrology and Testing. 56 p.
- (2005). ČSN 73 0540-4 Tepelná ochrana budovy - Část 4: Výpočtové metody (Thermal protection of buildings – Part 4: Calculation methods). Prague: Czech Office for Standardization, Metrology and Testing. 60 p.
- (2020). Vyhláška č. 264/2020 Sb. o energetické náročnosti budov (Ordinance no. 264/2020 Coll. on energy performance of buildings). Prague: Ministry of Industry and Trade. URL: https://www.zakonyprolidi.cz/cs/2020-264 (last visit 11th Feb. 2022)
- (2014). State energy policy of Czechia. Prague: Ministry of Industry and Trade. 159 p. URL: https://www.mpo.cz/assets/en/energy/state-energy-policy/2017/11/State-Energy-Policy-_2015__EN.pdf (last visit 11th Feb. 2022)

- Drábková, I. (2019) Energetická chudoba hrozí až pětině českých domácností (Energy poverty threatens up to a fifth of Czech households). Prague: Technology Agency of Czechia. URL: https://www.tacr.cz/wp-content/uploads/2019/10/190531_TZ_energetickaChudoba.pdf (last visit 11th Feb.. 2022)
- (2021). Zranitelný zákazník a energetická chudoba v ČR, Mapovací a plánovací studie (Vulnerable user and energy poverty in CZ, Mapping and planning study). Prague: Prague University of Economics and Business. URL: https://bit.ly/3sqVhL2 (last visit 11th Feb. 2022)
- Čejka, M. (2020). Novela vyhlášky č. 78/2013 Sb. – Část 2: Úprava parametrů referenční budovy (Novelization of ordinance no. 78/2013 Coll. – Part 2: Changing parameters of reference buildings). Prague: tzb-info.cz. URL: https://www.tzb-info.cz/energeticka-narocnost-budov/20685-novela-vyhlasky-c-78-2013-sb-cast-2-uprava-parametru-referencni-budovy (last visit 11th Feb. 2022)

2.5. DENMARK

Please fill out the following table regarding the status in your country. Feel free to develop the answers.

1. What is the thermal comfort limit for residential buildings in your country?

1.a.1. Explain shortly the reference standards used in your country to evaluate thermal comfort in residential buildings.

I think this question needs to be more precise. In principle you can use any reference standard you like as long as you fulfil the minimum requirement in the building code.

I suggest that the question is something like: “Explain shortly the reference standards used in your country to evaluate thermal comfort in residential buildings according to minimum requirements in national building code”.

The short answer for this question in Denmark is: None.

The guideline to our code refers to DS 474 and ISO 7730 for non-residential buildings

1..a.2. What is your comfort standard?

The Danish building regulation state minimum requirements formulated in general terms + more specific guidelines for suggestions on how to document the fulfilment of the minimum requirement.

Requirement:

“Chapter 19 Thermal indoor climate and installations for heating and cooling (Termisk indeklima og installationer til varme-og koleanlaeg) §386”: In rooms where people stay for a long time, it must be ensured that a satisfactory thermal indoor climate in terms of health and comfort can be maintained during the intended use and activity.

PCS. 2. Documentation of the thermal indoor climate must be done by calculation based on the conditions in the critical rooms and based on the Design Reference Year, DRY 2013 for the calendar year 2010. For homes, a simplified calculation can be used.

The guideline appended to this paragraph is:

For homes where it is possible to open windows and create ventilation, the requirement can normally be considered fulfilled when it can be shown through calculation that there are a maximum of 100 hours per years of use, where the room temperature exceeds 27 °C and 25 hours per years when the room temperature exceeds 28 °C. It is a prerequisite for using these temperature limits that it is possible to create venting, as venting makes it possible to accept higher temperatures. It is also recommended that the function of the rooms be taken into account when determining temperature levels.

For example, rooms that will typically be used as bedrooms can be problematic if most overheating hours occur in the evening.

1..a.3. On what your comfort model is based?

The guideline – and I cannot stress enough that it is ONLY a guideline – is a simplified approximation of the adaptive comfort model as described in EN 15251.

1.a.4. What are the overheating criteria for residential buildings in your country?

There are no criteria. Only a guideline. See above.

1..a.5. Cite the reference, and share the reference in pdf format if possible.

Requirement: https://bygningsreglementet.dk/Tekniske-bestemmelser/19/Krav

Guideline: https://bygningsreglementet.dk/Tekniske-bestemmelser/19/Vejledninger/Termisk-indeklima

For more details, see the papers and report I sent earlier.

1.a.6. Please fill out the following table regarding overheating in your country. Feel free to elaborate on your answers.

Table 2: Overheating assessment

Criteria	Your Country
Climate and weather data	
Is comfort dependent on national geographic climate zones? If yes, list them.	No. It is assumed that Denmark is one climatic zone.
Do you have a specific comfort calculation approach for heat waves?	No. It is not a requirement in the code. Denmark design buildings based on TMY.
Do you take into account the urban heat island effect?	No.
Does your overheating methodology take into account future climate change weather files with extreme scenarios?	No.
Occupant type and representation	
What type of building type does your comfort standard deal with?	All type are addressed in the building code.
Does your method embrace the four occupant categories (I, II, III, IV)? *	No
How do you represent occupancy presence in the simulation model?	Nothing is stated about this in the building code. However, common practice is to use a simplified thermal model implemented in the Danish national energy calculation tool for EPBD compliance where people are assumed to be home 24h/24, 7j/7. Heat load from persons

	are assumed to be 3.5 Watt per square meter floor area, and 1.5 Watt/m2 for equipment. Not in the building regulation, it is the part of how the industry does it : but it is the common way in Denmark to represent occupancy
Comfort model	
What is overheating provisions period coverage?	New buildings
What is your overheating indicator?	Operative temperature = room temperature
Is your comfort model based on an adaptive (like EN 15251 / 16798) or static (like Fanger) method?	A simplified approximation of the adaptive method as described in EN 15251
What are your comfort thresholds?	The guideline for residential building where it is possible to open windows and create venting: Maximum 100 hours in the time of use > 27°C Maximum 25 hours in the time of use > 28°C Time of use for residential buildings is 24/7.
What are your overheating thresholds? and according to which standard are those thresholds defined?	The guideline for residential building where it is possible to open windows: Maximum 100 hours > 27°C Maximum 25 hours > 28°C
Is there a distinction between naturally ventilated, air-conditioned, and mixed mode buildings?	No. Residential buildings have no mechanical cooling in Denmark.
Does your model take into account local personalized heating/cooling & ventilations systems (ceiling fans, air-conditioned chairs, electric heating mattresses…)?	No.
Simulation model	
Is your calculation based on a static/quasi-dynamic/dynamic model? What is the calculation timestep?	There is no requirement for using a specific tool or model in the building regulations. The requirement state that the requirement for residential buildings may be documented using a simplified method. The guideline suggest that the calculation method implemented in the Danish national tool for energy compliance could be used for the purpose. This method is a simplified implementation of the simple hourly method in EN 13790. The required timestep is therefore implicitly minimum hourly..
Is your overheating calculation based on a single or multizone model?	Must be documented for critical rooms(single zone). No guideline is provided on how to identify critical rooms.
Does your calculation distinguish sleeping rooms from other living areas?	No (but the guideline mention that warm bedrooms should be avoided)
Mandatory envelope requirements	
Does your method oblige the installation of external shading?	No

Does your method oblige the limitation of the window to wall ratio? If yes, what is the limit?	No (however, there is a minimum requirement for this ratio to fulfill minimum daylight requirements)
Does your method recommend a g-value? If yes, what is the limit?	No
* we are focusing on category II occupants for new and renovated buildings	

1b. Do you have fuel poverty problems in your country that might influence overheating risk in residential buildings? Explain.

No

1.c.2. What is the overheating risk for residential buildings (highly insulated) in your climate and your country? Please share the calculation method and overheating hours limit threshold.

It is not only highly insulated buildings that are overheated. Highly glazed older buildings also have this issue.

Newer buildings are designed with respect to a TMY file which means that the overheating criteria in average is overstepped every second year. Furthermore, , many designers use simple methods to calculate thermal comfort which probably increase the risk of overheating.

1.d. Can we rely on passive cooling or must include active cooling systems for residential buildings in your country for residential buildings?

In the current climatic conditions, ventilative cooling strategies like nighttime venting is sufficient to minimize overheating risks in residential buildings.

Add something ?

Relevant References / key publications:

2.6. ESTONIA

2. Please provide a map of the climatic areas in your country. Cite the source and make sure to share a high-resolution document.

No climatic zones in energy calculation. National test reference year.

5. What is the thermal comfort limit for nZEBs in your country?

We have EVS-EN 16798-1:2019+NA:2019, so it includes the Estonian national annex. For new buildings indoor climate Category II requirements apply, National Annex specifies some additional air velocity requirements and blocks the use of the adaptive comfort model.

5.a.1. Explain shortly the reference standards used in your country to evaluate thermal comfort in nZEBS.

5.a.2. Cite the reference, and share the reference in pdf format if possible.

5.a.3. Is the comfort assessed based on a static comfort model (like Fanger) or an adaptive comfort model (like EN 15251 / 16798)? Explain.

5.a.4. Please fill out the following table regarding overheating in your country. Feel free to elaborate on your answers.

Table 3.4.8: Overheating assessment in Estonia

Country	Estonia
Climate and weather data	
Is comfort dependent on national geographic climate zones? If yes, list them.	No.
Do you have a specific comfort calculation approach for heatwaves?	No (just simulation with TRY).
Do you take into account the urban heat island effect?	No.
Does your overheating methodology take into account future climate change weather files with extreme scenarios?	Yes / No (we expect to revise TRY in every 10 years).
Occupant type and representation	
What is your comfort standard?	EVS-EN 16798-1:2019 NA:2019
For which building types?	Residential and commercial.
Does your method embrace the four occupant categories (I, II, III, IV)? *	I, II, III (IV is not defined).
How do you represent occupancy presence in the simulation model?	Hourly occupancy profiles are defined in the regulation.
Comfort model	
What is your overheating indicator?	150 Kh > 27 °C in residential buildings 100 Kh > 25 °C in non-residential buildings
Is your comfort model based on an adaptive or static method?	The above criteria may be classified as adaptive, but cooling systems are sized with static.
What are your overheating thresholds? and according to which standard are those thresholds defined?	150 Kh > 27 °C in residential buildings 100 Kh > 25 °C in non-residential Apply for rooms with human occupancy

Is there a distinction between naturally ventilated, air-conditioned, and mixed-mode buildings?	No.
Does your model take into account local personalized heating/cooling & ventilation systems (ceiling fans, air conditioned chairs, electric heating mattresses…)?	Yes (whatever you have you can simulate if your simulation tool is capable of that – most common IDA-ICE is quite flexible).
Simulation model	
Is your calculation based on a static/quasi-dynamic/dynamic model? What is the calculation timestep?	Dynamic (for single-family, an Excel calculator may be used as an alternative)
Is your overheating calculation based on a single or multizone model?	Multizone. But an apartment may be simulated with open doors. Both single zone (one apartment as one zone) or multizone (main rooms modeled) approach is specified.
Does your calculation distinguish sleeping rooms from other living areas?	Upon energy modeler choice because two approaches are specified.
Mandatory envelope requirements	
Does your method oblige the installation of external shading?	No.
Does your method oblige the limitation of the window to wall ratio? If yes, what is the limit?	Rule of thumbs are provided for single-family: - WWRxg ≤ 0.2 - WWR ≤ 0.4 - window to floor ratio ≤ 0.15 - effective openable windows are fraction ≥ 0.1 If these four conditions are met for living rooms and bedrooms, no temperature simulation is needed.
Does your method recommend a g-value? If yes, what is the limit?	Yes. For single-family: WWRxg ≤ 0.2
* we are focusing on category II occupants for new and renovated buildings	

5.b. Do you have fuel poverty problems in your country that might influence the nZEB objective? Explain.

5.c.1. What are the overheating criteria for nZEBs in your country?

5.c.2. What is the overheating risk for nZEB (highly insulated) in your climate?

5.c.3. How do you evaluate overheating risk in nZEBs in your country? Please share the calculation method and overheating hours limit threshold.

5.d. Can we rely on passive cooling or must include active cooling systems for nZEBs in your country?

Add something ?

Relevant References / key publications:

[1] "REHVA nZEB Task Force and CEN EPBD. Technical definition for nearly zero energy buildings. REHVA Journal, (03)," 2013.

[2] Estonian Government Ordinance No. 63: "Hoone energiatõhususe miinimumnõuded" [Minimum requirements for buildings energy performance] (in Estonian), RT I, 2018, redacted 25.08.2019.

[3] Estonian Government Ordinance No. 58: “Hoone energiatõhususe arvutamise metoodika” [Calculation methodology for building energy efficiency] (in Estonian), RT I, 2015, redacted 25.08.2019.

2.7 FINLAND

Please fill out the following table regarding the status in your country. Feel free to develop the answers.

1. What is the thermal comfort limit for residential buildings in your country?

1.a.1. Explain shortly the reference standards used in your country to evaluate thermal comfort in residential buildings.

There is a building code asking for minimum requirements about thermal comfort: Decree of the Ministry of the Environment on the energy performance of new buildings (Ympäristöministeriön asetus uuden rakennuksen energiatehokkuudesta). In this building code, you need to note that it existed several categories of building according to the regulation:

Category 1) Small residential buildings: a) Detached single-family dwelling and building forming part of a block of flats with a net heated area (net) of 50-150 m2b) Detached single-family dwelling and building forming part of a block of flats with a net heated area (net) of more than 150 m2 but not exceeding 600 m2c) Detached single-family dwelling and building forming part of a block of flats, with a net heated area (net) of more than 600 m2 (d) Terraced houses and blocks of flats with no more than two storeys

Category 2) Apartment blocks with three or more residential floors

Class 3) Office building, health center

Class 4) Commercial building, department store, shopping center, retail building, except for grocery stores under 2,000 m2, shopping hall, theatre, opera house, concert hall, congress hall, cinema, library, archive, museum, art gallery, exhibition hall

Category 5) Accommodation building, hotel, dormitory, service building, retirement home, nursing home

Category 6) Educational building and kindergarten

Category 7) Sports hall, except swimming pools and ice rinks

Category 8) Hospital

Category 9) Other building, storage building, transport building, swimming pool, ice rink, grocery store unit less than 2000 m2, mobile building

A second way to calculate thermal comfort and overheating in Finland existed. It is a voluntary-based assistance method for indoor environments and new buildings. It is invented for the first time in 1995 for all types of buildings and updated for the last time in 2008. It is not a mandatory method. It is published as a RT standard sheet (Building Information Group RT) and as a separate publication (FISIAQ). The classification has been created together with:

- Building Information Foundation RTS
- RAKLI - The Finnish Association of Building Owners and Construction Clients
- Finnish Association of Architects
- The Finnish Association of Consulting Firms SKOL

It has target values based on three categories : S1 “individual”, S2 “comfortable”, S3 “satisfactory” – building code level

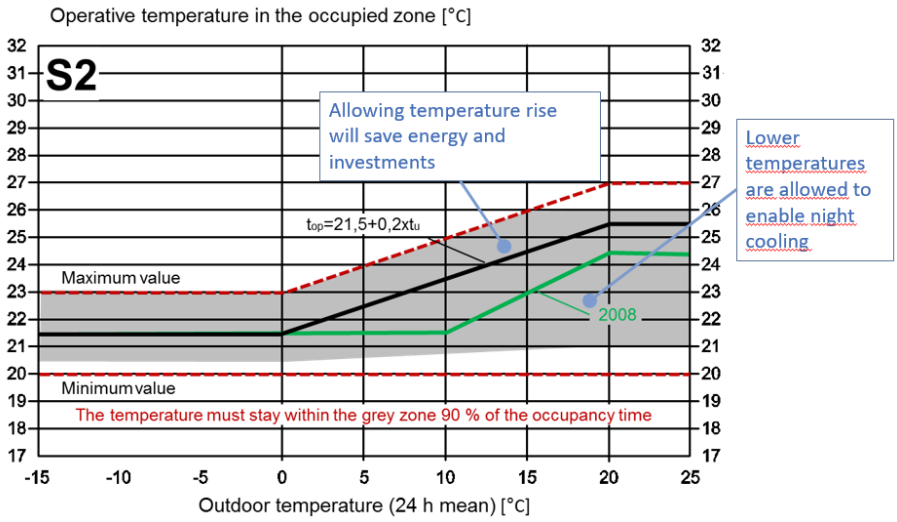
It has also technical target values about :

- Concentration on fine particles PM2,5 and in/out relation
- Operative temperature,
- Air velocity,
- Draught rate,
- Carbon dioxide,
- Radon

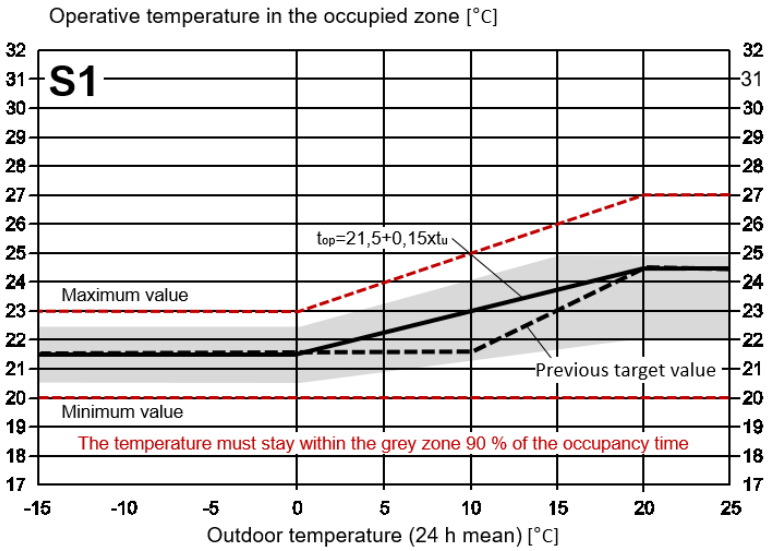
		S1	S2	S3
CO_2	ppm	<350	<550	<800
Radon	Bq/m³	<100	<100	<200
$PM_{2,5}$	µg/m³	<10	<10	<25
$PM_{2,5}$ in/out		0,5	0,7	-
*Above backround level				

- Lighting
- Acoustics

Target values for operative temperature



Target values for operative temperature



1..a.2. What is your comfort standard?

There is a building code asking for minimum requirements about thermal comfort: Decree of the Ministry of the Environment on the energy performance of new buildings (Ympäristöministeriön asetus uuden rakennuksen energiatehokkuudesta).

1..a.3. On what your comfort model is based?

There are both developed based on EN and ISO standards, applied to Finland.

Is it based on ISO 7730 ? EN15251 ? EN 16798 ?

1.a.4. What are the overheating criteria for residential buildings in your country?

In the building code the design summertime indoor temperature shall not exceed the cooling limit of 27 °C for use class 2 and 25 °C for use classes 3 to 8 by more than 150-degree hours between 1 June and 31 August at the design airflow rate. Compliance with the summer indoor temperature requirement shall be demonstrated by temperature calculations for the different space types. The calculation shall use the output data from the E-value calculation except for the airflow. The requirement for the summer-time indoor temperature shall not apply to buildings of Use Classes 1 and 9. A dynamic calculation tool shall be used to calculate the summer-time indoor temperature.1..a.5. Cite the reference, and share the reference in pdf format if possible.

1.a.5. Cite the reference, and share the reference in pdf format if possible.

Building code:
https://www.finlex.fi/fi/laki/alkup/2017/20171010#Pidm45053757945280

1.a.6. Please fill out the following table regarding overheating in your country. Feel free to elaborate on your answers.

Table 3: Overheating assessment

Criteria	Your Country
Climate and weather data	
Is comfort dependent on national geographic climate zones? If yes, list them.	No
Do you have a specific comfort calculation approach for heat waves?	No
Do you take into account the urban heat island effect?	No
Does your overheating methodology take into account future climate change weather files with extreme scenarios?	No. Weather is based on a test year which represents a typical year made in 2013
Occupant type and representation	
What type of building type does your comfort standard deal with?	New building Renovated building Occupied Building
Does your method embrace the four occupant categories (I, II, III, IV)? *	No
How do you represent occupancy presence in the simulation model?	One occupant profile: 24h/7j The daily and weekly building occupancy times, the average occupancy rates for lighting, consumer equipment, and occupant presence during the building occupancy period, and the internal heat loads per net heated area are used for the occupancy profile.
Comfort model	
What is overheating provisions period coverage?	From June to July
What is your overheating indicator?	Comfort based indicator are used for this : air temperature
Is your comfort model based on an adaptive (like EN 15251 / 16798) or static (like Fanger) method?	It is not related to any standard but it looks like a static method
What are your comfort thresholds?	The design summertime indoor temperature shall not exceed the cooling limit of 27 °C for use class 2 and 25 °C for use classes 3 to 8 by more than 150-degree hours between 1 June and 31 August at the design airflow rate. Compliance with the summer indoor temperature requirement shall be demonstrated

	by temperature calculations for the different space types. The calculation shall use the output data from the E-value calculation except for the airflow. The requirement for the summer-time indoor temperature shall not apply to buildings of Use Classes 1 and 9. A dynamic calculation tool shall be used to calculate the summer-time indoor temperature. Moreover, occupied buildings should not exceed a temperature of 32°C during summer.
What are your overheating thresholds? and according to which standard are those thresholds defined?	Same as the comfort thresholds
Is there a distinction between naturally ventilated, air-conditioned, and mixed mode buildings?	No in the regulation limitation but the simulation model can make a difference.
Does your model take into account local personalized heating/cooling & ventilations systems (ceiling fans, air-conditioned chairs, electric heating mattresses…)?	You can take it into account technically but it is not common to do it
<u>Simulation model</u>	
Is your calculation based on a static/quasi-dynamic/dynamic model? What is the calculation timestep?	The calculation is based on a dynamic model. It is common to use a time step of 1 hour. In fact, the logiciel, that is used, can have a smaller calculation time step. There is no mandatory value for the time step.
Is your overheating calculation based on a single or multizone model?	Overheating calculation method is based on a multi-zone model.
Does your calculation distinguish sleeping rooms from other living areas?	The multi-zone model differentiates each room: so also the sleeping room from the other. However, there is no specific limit for the calculation in the sleeping room compared to the other room.
<u>Mandatory envelope requirements</u>	
Does your method oblige the installation of external shading?	Yes
Does your method oblige the limitation of the window to wall ratio? If yes, what is the limit?	The benchmark for the total window area of a building is 15% of the total floor area of all or part of the ground floors of the building, up to a maximum of 50% of the building's façade area. The window area shall be calculated according to the external dimensions of the window perimeter. And regulation needs to be fulfilled after calculation. If not designer/architect/engineers, need to find a solution.
Does your method recommend a g-value? If yes, what is the limit?	No, but the regulation needs to be fulfilled after calculation. If not designer/architect/engineers, need to find a solution.
* we are focusing on category II occupants for new and renovated buildings	

1b. Do you have fuel poverty problems in your country that might influence overheating risk in residential buildings? Explain.

Traditionally Finish dwellings do not have any cooling system. People who rent a house may find it more difficult to have a cooling system because of the contract to rent from another individual or from the state if it is social housing.

1.c.2. What is the overheating risk for residential buildings (highly insulated) in your climate?

With climate change, overheating is becoming more and more of a risk to take into account in residential buildings.

1.c.3. How do you evaluate overheating risk in residential buildings in your country? Please share the calculation method and overheating hours limit threshold.

The overheating risk in residential buildings in Finland is high. A study has been conducted on monitoring measures in over 8500 apartments. This study shows that 100% of the dwelling overheat during hot summer.

1.d. Can we rely on passive cooling or must include active cooling systems for residential buildings in your country for residential buildings?

We can rely on passive cooling for cold summer. However hot summers are becoming more and more frequent and intense. In the case of extreme scenarios, active cooling is needed. During hot summer nights ventilation is not working become nights are very hot too (the morning temperature can be 23°C)

Add something ?

Based on the building code:

The calculated energy consumption of a building may be calculated on a monthly basis for a building where cooling is not required for indoor air temperature control or cooling is only required for spaces with a net heated area of less than 10 % of the net heated area of the building or with a net heated area of less than 50 m2 .

Where cooling is required to control the indoor air temperature in a building, the calculated energy consumption of the building shall be calculated using a calculation method which, in addition to the factors mentioned in paragraph 1, takes into account the thermal and electrical energy demand of the cooling system and whose heat transfer calculation takes into account the heat storage capacity of the structures as a function of time in time steps of up to one hour (dynamic calculation method).

Relevant References / key publications:

2.8 GERMANY

Anton Maas :

Please fill out the following table regarding the status in your country. Feel free to develop the answers.

1. What is the thermal comfort limit for residential buildings in your country?

1.a.1. Explain shortly the reference standards used in your country to evaluate thermal comfort in residential buildings.

There are two methods for verifying thermal insulation in summer: the solar input parameter method and the method of thermal building simulation.

The solar input parameter method is based on the requirement that the solar input parameter S_{vorh} must not exceed the maximum value S_{zul}, i.e .:

$S_{vorh} \leq S_{zul}$

The existing solar input value S_{vorh} results from the ratio of the window area to the floor area of the room multiplied by the total energy transmittance of the glass including sun protection.

The maximum value S_{zul} is determined as the sum of the proportional solar input parameters in DIN 4108-2 according to the bonus-malus principle. The climatic region, the type of construction, any possible night ventilation, the base area-related proportion of the window area, any existing sun protection glass, the installation situation of the window and any intended use of passive cooling are taken into account.

If the dynamic thermal building simulation is used as part of the verification, evaluations must be carried out with regards to the resulting overtemperature degree hours for a room. The reference value of the overtemperature degree hours is to be used depending on the climatic region. The reference values and the requirement values to be complied with depending on the use are included in the table below.

Summer climatic region	Reference value $\Theta_{b,op}$ of the internal temperature °C	Requirement value overtemperature degree hours Kh/a	
		Residential buildings	Non-residential buildings
A	25	1200	500
B	26		
C	27		

In particular, due to standardized boundary conditions, the calculation results only permit limited conclusions to be drawn about actual excess values. The following boundary conditions are to be used for the verification using thermal building simulations (at least on an hourly basis) for reasons of comparability with the aforementioned requirement values:

- Simulation environment (software)
- Usages / times of use
- Climate data for the calculations (test reference years)
- Beginning of the simulation calculations and the period for the evaluation
- Internal heat input
- Target room temperature for heating purposes (without night reduction)
- Basic air exchange
- Increased daytime air exchange
- Night air change
- Sun protection control
- Heat transfer coefficients
- Structural shading
- Passive cooling (if systems are used for room cooling in which energy is only required to transport the cooling medium)

Compared to the application of the solar input parameter method, which is based on a large number of standardized calculation boundary conditions, the simulation offers significantly more extensive possibilities to map certain influences and their effects on the summer heat behavior of a room

1..a.2. Cite the reference, and share the reference in pdf format if possible.

DIN 4108-2:2013-02 “Thermal protection and energy economy in buildings – Part 2: Minimum requirements to thermal insulation”

1.a.3. Is the comfort assessed based on a static comfort model (like Fanger) or adaptive comfort model (like EN 15251 / 16798)? Explain.

The reference values for the indoor temperature vary depending on the summer climate region. The reason for this is essentially that an adaptation of humans to the prevailing outside climate can be assumed.

1.a.4. Please fill out the following table regarding overheating in your country. Feel free to elaborate with your answers.

Table 4: Overheating assessment

Criteria	Your Country
Climate and weather data	
Is comfort dependent on national geographic climate zones? If yes, list them.	The area of the Federal Republic of Germany is divided into 3 summer climatic regions: Region A: coastal areas, mountains, high altitudes Region B: Middle altitudes, north German lowlands Region C: metropolitan areas, Upper and Middle Rhine
Do you have a specific comfort calculation approach for heat waves?	no
Do you take into account the urban heat island effect?	no
Does your overheating methodology take into account future climate change weather files with extreme scenarios?	no
Occupant type and representation	
What is your comfort standard?	maximum overtemperature degree hours (1.200 residential/500 non-residential)
For which building types?	Residential buildings, non-residential buildings
Does your method embrace the four occupant categories (I, II, III, IV)? *	The standard is based on category II
How do you represent occupancy presence in the simulation model?	For residential buildings, the presence time 24 h, 7 days. For non-residential buildings 11 h (7:00 a.m. to 6:00 p.m.), 5 days (Mon to Fri).
Comfort model	
What is your overheating indicator?	Overtemperature degree hours are used as an indicator
Is your comfort model based on an adaptive or static method?	static
What are your overheating thresholds? and according to which standard are those thresholds defined?	The reference values for the operative internal temperature are 25 ° C in climatic region A, 26 ° C in climatic region B, 27 ° C in climatic region C. The values are defined in the German standard DIN 4108-2 “Thermal protection and energy economy in buildings” 2013-02.
Is there a distinction between naturally ventilated, air-conditioned, and mixed mode buildings?	No

Does your model consider local personalized heating/cooling & ventilations systems (ceiling fans, air-conditioned chairs, electric heating mattresses…)?	No
Simulation model	
Is your calculation based on a static/quasi-dynamic/dynamic model? What is the calculation timestep?	The calculation is based on a dynamic model. The calculation timestep is one hour or smaller.
Is your overheating calculation based on a single or multizone model?	The calculation is based on a single zone model.
Does your calculation distinguish sleeping rooms from other living areas?	No
Mandatory envelope requirements	
Does your method oblige the installation of external shading?	No
Does your method oblige the limitation of the window to wall ratio? If yes, what is the limit?	No
Does your method recommend a g-value? If yes, what is the limit?	No
* we are focusing on category II occupants for new and renovated buildings	

1b. Do you have fuel poverty problems in your country that might influence overheating risk in residential buildings? Explain.

No. In German residential buildings, the energy consumption for cooling is around 0.1 % in relation to the energy consumption for heating and hot water.

1.c.1. What are the overheating criteria for residential buildings in your country?

Overtemperature degree hours are used as an indicator. The requirement values are 1200 Kh

1.c.2. What is the overheating risk for residential buildings (highly insulated) in your climate?

?

1.c.3. How do you evaluate overheating risk in residential buildings in your country? Please share the calculation method and overheating hours limit threshold.

New buildings have to fulfil the above mentioned requirements

1.d. Can we rely on passive cooling or must include active cooling systems for residential buildings in your country for residential buildings?

For residential buildings in Germany, passive measures are usually sufficient to achieve comfortable conditions in summer.

Add something ?

Relevant References / key publications:

- Schlitzberger, St.: Anpassung und Entwicklung von Planungswerkzeugen für den sommerlichen Mindestwärmeschutz und zur Komfortbewertung des Sommerfalls. Dissertation, Universität Kassel, 2014. Online available: http://nbn-resolving.de/urn:nbn:de:hebis:34-2014072345734
- Maas, A. und Schlitzberger, S.: Nachweisverfahren der Energieeinsparverordnung. In Bauphysik-Kalender 2015. Hrsg. N. A. Fouad. Ernst & Sohn Verlag Berlin (2015), S. 113-159.
- Ackermann; Feldmeier; Kießl; Steinbach: Mindestanforderungen an den baulichen Wärmeschutz. Kommentar zu DIN 4108-2:2013-02. Berlin: Beuth (Beuth Kommentar). Online available: http://gbv.eblib.com/patron/FullRecord.aspx?p=2033156.
- Spitzner, M.: Sommerlicher Wärmeschutz DIN 4108-2 und Energieeinsparverordnung EnEV. Mindestanforderungen und Nachweismöglichkeiten. Hg. v. ift Rosenheim, ift-Fachtagung Transparente Gebäudehülle 2013. Rosenheim.

Dr. Annekatrin Koch

Please fill out the following table regarding the status in your country. Feel free to develop the answers.

1. What is the thermal comfort limit for residential buildings in your country?

1.a.1. Explain shortly the reference standards used in your country to evaluate thermal comfort in residential buildings.

The general requirements concerning transmission heat losses and primary energy demand are regulated in the GEG. This law leads to the DIN 4108-2 where the detection methods against summer overheating are defined. You can choose between simplified static indicator method via the simplified solar transmittance indicator or thermodynamic simulation.

1.a.2. Cite the reference, and share the reference in pdf format if possible.

- Deutscher Bundestag (2020): GEG 2020: Gesetz zur Einsparung von Energie und zur Nutzung erneuerbarer Energien zur Wärme- und Kälteerzeugung in Gebäuden (Gebäudeenergiegesetz - GEG)
- Deutsches Institut für Normen (2013): DIN 4108-2:2013-02 - Wärmeschutz und Energie-Einsparung in Gebäuden -Teil 2: Mindestanforderungen an den Wärmeschutz

1.a.3. Is the comfort assessed based on a static comfort model (like Fanger) or adaptive comfort model (like EN 15251 / 16798)? Explain.

The simplified static method via the solar transmittance indicator doesn´t consider outdoor temperature. The thermodynamic simulation method represents a simplified

adaptive comfort model. The maximum admissible interior temperature for a period of 1200 h per year depends on the summer climate region A, B, C (A: 25°C, B: 26°C, C: 27°C).

1.a.4. Please fill out the following table regarding overheating in your country. Feel free to elaborate with your answers.

Table 5: Overheating assessment

Criteria	Your Country
Climate and weather data	
Is comfort dependent on national geographic climate zones? If yes, list them.	Both methods consider summer climate regions A “cool summer”, B “average”, C “hot summer”.
Do you have a specific comfort calculation approach for heat waves?	The detection method via the thermodynamic simulation calculates overtemperature hours over a whole year basing on test reference years published in 2011 by BBSR. The underlain weather data in TRY 2011 bases on measurements before 1980. In 2017 BBSR provided new, high-resolution data (TRY 2017: period from 1995 to 2012) where you can choose between 12 meteorological parameters out of which you can derive climate indexes such as heat waves. Actually, the TRY 2017 isn´t obligatory and in consequence the are no extra approaches for heat waves.
Do you take into account the urban heat island effect?	If you just meet the minimum legal requirements (TRY 2011) there are no extra accounts for urban heat island effects.
Does your overheating methodology take into account future climate change weather files with extreme scenarios?	If you just meet the minimum legal requirements (TRY 2011) you don´t take climate change weather files with extreme scenarios into account. The TRY 2017 also offers data for future scenarios (2031-2060).
Occupant type and representation	
What is your comfort standard?	DIN 4108-2
For which building types?	Residential and non-residential buildings
Does your method embrace the four occupant categories (I, II, III, IV)? *	No, it doesn´t.
How do you represent occupancy presence in the simulation model?	Residential buildings: - usage period: daily, 00:00 – 24:00 o´clock - internal gains: 100 Wh/(m_{NGF}^2d) Non-residential buildings: - usage period: Monday to Friday, 7:00 – 18:00 o´clock per day

	- internal gains: 144 Wh/(m_{NGF}^2d)
Comfort model	
What is your overheating indicator?	- simplified solar transmittance indicator method: the present indicator exceeds the admissible indicator - thermodynamic simulation method: the number of hours that exceed the reference indicator of the interior temperature depending on the climate region A, B or C
Is your comfort model based on an adaptive or static method?	- simplified solar transmittance indicator method: static - Thermodynamic simulation method: simplified adaptive method
What are your overheating thresholds? and according to which standard are those thresholds defined?	- simplified solar transmittance indicator method: the present and admissible indicator s take building specific characteristics into account (as per description) - thermodynamic simulation method: overtemperature hours per year maximum 1200 h/a in residential buildings, maximum 500 h/a in non-residential buildings - Standards: DIN 4108-2
Is there a distinction between naturally ventilated, air-conditioned, and mixed mode buildings?	- simplified solar transmittance indicator method: there is a distinction between "high night-time ventilation" ($n \geq 5\ h^{-1}$), „increased night-time ventilation" ($n \geq 2\ h^{-1}$) and „without night-time ventilation", but you can apply each without a specific type of ventilation - thermodynamic simulation method: the same regulations apply and it is possible to set the night-time ventilation indicator according to the capacity of the ventilation system
Does your model take into account local personalized heating/cooling & ventilations systems (ceiling fans, air-conditioned chairs, electric heating mattresses…)?	- No.
Simulation model	
Is your calculation based on a static/quasi-dynamic/dynamic model? What is the calculation timestep?	- simplified solar transmittance indicator method: static - thermodynamic simulation method: dynamic, minimum on an hourly basis
Is your overheating calculation based on a single or multizone model?	- simplified solar transmittance indicator method: residential buildings are considered as single zone models; you examine the room with the most unfavorable conditions concerning summer comfort

	- thermodynamic simulation method: residential buildings: single zone model, non-residential buildings: multizone buildings
Does your calculation distinguish sleeping rooms from other living areas?	- No
<u>Mandatory envelope requirements</u>	
Does your method oblige the installation of external shading?	- simplified solar transmittance indicator method: no - thermodynamic simulation method: no. If you apply increased or high night-time ventilation you must achieve an overall energy transmittance gtot ≤ 0,4.
Does your method oblige the limitation of the window to wall ratio? If yes, what is the limit?	No, it doesn´t. You can meet the requirements by various options. Limiting the window to wall ratio is only one option. There is no general limit indicator.
Does your method recommend a g-value? If yes, what is the limit?	No, it doesn´t.
* we are focusing on category II occupants for new and renovated buildings	

1b. Do you have fuel poverty problems in your country that might influence overheating risk in residential buildings? Explain.

Energy poverty is an increasing problem in Germany. One official indicator is the so called 10 %-indicator: people suffer from energy poverty when they spend more than 10 % of their net income on energy costs. There are various studies which record that about 10 to 12 % of all German households live in energy poverty. A further indicator is the number of power and gas cuts (more than 330 000 power cuts and about 40 000 gas cuts in 2017).

There could be a causal relation between energy poverty and overheating risk in residential buildings concerning the investments in improving the overheating protection. German people mostly rent their homes. The so called landlord-tenant-dilemma expresses the resulting problem. For one thing, in contrast to the tenants, the landlords don’t benefit directly from their invest. Further the landlords don´t benefit monetarily because investments in overheating protection doesn´t save (heating-) energy costs so they couldn´t transfer a part of the investment costs to the rent.

Concerning the described facts and with regard to the increasing energy costs one further relation could be the lack of disposable income to both buy an own air conditioning system and pay the operating costs.

1.c.1. What are the overheating criteria for residential buildings in your country?

- simplified solar transmittance indicator method: the present indicator exceeds the admissible indicator
- thermodynamic simulation method: the number of hours that exceed the reference indicator of the interior temperature depending on the climate region A, B or C: overtemperature hours per year maximum 1200 h/a in residential buildings, maximum 500 h/a in non-residential buildings

1.c.2. What is the overheating risk for residential buildings (highly insulated) in your climate?

Progressive global warming and the urban heat island effects (due to higher density of buildings and traffic, expanding soil sealing etc.) in big cities lead to increasing night time temperatures which in turn reduce the effects and possibility of night time ventilation.

1.c.3. How do you evaluate overheating risk in residential buildings in your country? Please share the calculation method and overheating hours limit threshold.

We evaluate overheating either by the simplified solar transmittance indicator method or by the thermodynamic simulation method. Both methods are explained in DIN 4108-2.

The simplified solar transmittance indicator method considers the summer climate region A, B and C. You compare an admissible solar transmittance indicator with the present solar transmittance indicator. The admissible indicator considers summer climate region (A, B, C), building construction (light, middle, heavy), proportion of window area, night ventilation, sun protection, window slope and orientation, use of passive cooling. The present indicator considers the window are, the overall energy transmittance (gtot) and the net floor space of the room.

The method via thermodynamic simulation represents a simplified adaptive comfort model. The maximum admissible interior temperature for a period of 1200 h per year depends on the summer climate region A, B, C (A: 25°C, B: 26°C, C: 27°C).

1.d. Can we rely on passive cooling or must include active cooling systems for residential buildings in your country for residential buildings?

With regard to increasing exterior temperatures and increasing comfort claims and if German Government continues the “business-as-usual-way” concerning tangent regulations - for example in the agriculture, traffic or building sector- we have to include active cooling systems in the foreseeable future. There is still a great potential in passive measures to exploit. Extensively roof and façade greening and sun-reflecting light-colored façades, revitalizing green spaces and rivers, adiabatic air cooling, passive cooling by ground water or by geothermal heat are only a few examples we should address firstly.

Add something ?

Relevant References / key publications:

- Deutscher Bundestag (2020): GEG 2020: Gesetz zur Einsparung von Energie und zur Nutzung erneuerbarer Energien zur Wärme- und Kälteerzeugung in Gebäuden (Gebäudeenergiegesetz - GEG)
- Deutsches Institut für Normen (2013): DIN 4108-2:2013-02 - Wärmeschutz und Energie-Einsparung in Gebäuden -Teil 2: Mindestanforderungen an den Wärmeschutz
- Deutscher Bundestag (2019): Kleine Anfrage der Abgeordneten Sven Lehmann, Dr. Julia Verlinden, Dr. Wolfgang Strengmann-Kuhn, Markus Kurth, Beate Müller-Gemmeke, Corinna Rüffer, Katharina Dröge, Sven-Christian Kindler, Claudia Müller, Stefan Schmidt, Oliver Krischer, Lisa Badum, Stefan Gelbhaar, Sylvia Kotting-Uhl, Christian Kühn (Tübingen), Stephan Kühn (Dresden), Steffi Lemke, Ingrid Nestle, Markus Tressel, Daniela Wagner und der Fraktion BÜNDNIS 90/DIE GRÜNEN. Ausmaß und Auswirkungen der Energiearmut
- Öko-Institut (2018): Policies and measures to alleviate energy poverty in Germany - learning from good practices in other European countries

2.9 GREECE

In Greece, current adaptation status of nearly zero energy buildings is still at early stage. The energy performance of buildings was initially introduced in Greek legislation with the Greek Law 3661/2008 “Measures to reduce energy consumption in buildings and other provisions”, which integrates the European Directive 2002/91/EC. Based on this law, in 2010 the Regulation for Energy Efficiency of Buildings was issued, which established the implementation of inspections in buildings for issuing the Energy Performance Certificates and the methodology for the conduction of inspection. The recast Energy Performance of Buildings Directive (EPBD, 2010/31/EU) was integrated in the Greek legislation under the Greek Law 4122/2013 “Energy Performance of Buildings – Transposition of Directive 2010/31/EU” (WP2 – Deliverable 2.1, 2014). In this law, terminology is provided mainly as per the European Directive, whereas no thresholds and concrete definitions are set. More specifically, the minimum energy efficiency threshold regarding nZEBs has not been defined yet either regarding end use or primary energy. Moreover, no thresholds have been defined for CO2 emissions. According to the Greek Law 4122/2013 a National Plan is to be developed which will include the technical characteristics of the nearly Zero-Energy Buildings, targets so as to improve the energy performance of the new buildings till 2015 and information concerning the promotion of the nearly Zero-Energy Buildings. However, the National Plan has not been defined yet. It should be mentioned that according to the New Building Regulation (Greek Law 4067/2012) a category of buildings named “low energy buildings” is defined, which includes all buildings displaying annual primary energy 10kWh/m2 including heating, cooling, lighting, ventilation and DHW (Domestic Hot Water). Though this target seems quite optimistic.

Regarding the renovations of the residential buildings in Greece to nZEBs it should be stated that no records exist till now, taking into account the fact that the term nZEB has not been official defined. Regarding the renovations in general in the residential buildings, the following Figure 3.3.1 presents the energy class per percentage of total renovations and new buildings and per year of renovation. It is highlighted though that the Figure 3.3.1 refers to both the radically renovated and new-built residences, whereas a discrimination between them could not be detected based on the available relevant statistics.

New/radically renovated buildings

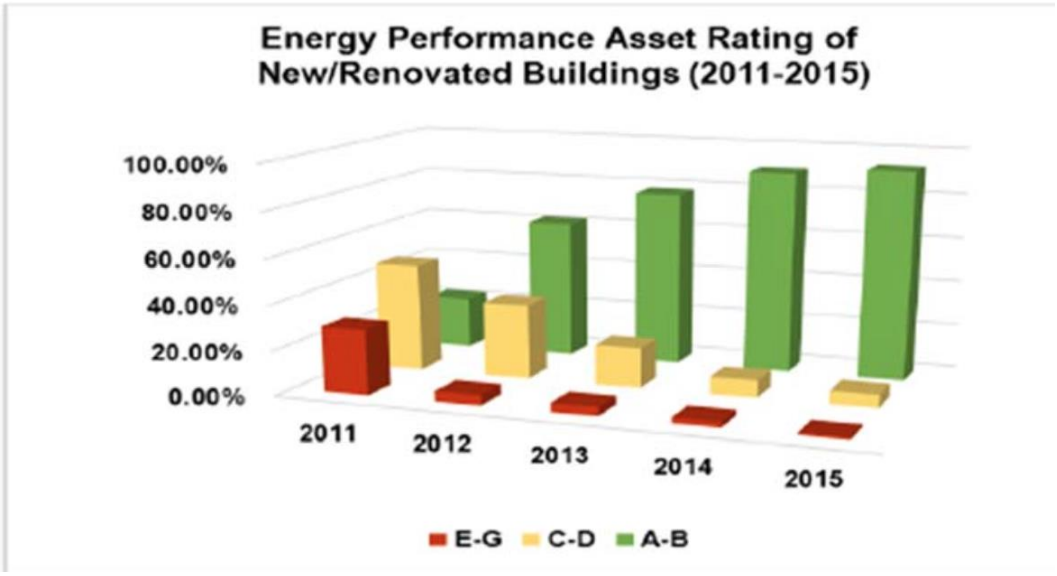


Figure 3.3.1: Energy class of new/radically renovated buildings per year (G.D.E.C.E.M.I, 2016)

As per the recast EPBD (2010/31/EU) the minimum energy performance requirements should be set based on cost-optimal levels, which should be calculated by each Member State based on a comparative methodology provided by the Commission. Currently, Greece has not proceeded to a cost-optimal analysis. Therefore, it is proposed to refer to the thresholds set by Cyprus for nZEBs. This approach is mainly justified due to the climate of Cyprus, which bears more similarities to the Greek climate since the Mediterranean climate is the dominant climate in both countries than the climate of the other countries - Member States of the European Union which have defined the minimum energy requirements for nZEBs. Based on the indicators of Cyprus it is recommended for nZEB residential buildings a maximum primary energy of 100 kWh/m^{2}y and for non-residential buildings 125 kWh/m^{2}y. For several European countries the PassiveHaus Standard is followed in order to guarantee a minimum performance threshold of 15 kWh/m^2/a for heating demand. According to the Passive House Institute, 11 buildings have received the relevant certification in Greece. Most of the passive houses are detected in Volos. One example is a semi- detached house, consisting of 3 apartments, which was constructed in 2012. The building is of masonry construction and it achieved an annual heating demand of 12 kWh/m2a. Another case- study is a detached single family house in Penteli (Attica) of mixed construction type, constructed in 2011. The building achieved an annual heating demand of 15 kWh/m2a.[2]

In Greece under ideal circumstances the threshold of 15 kWh/m2a could be achieved, taking into account the fact that the climate of Greece during winter is mainly mild. However, it should be noted that the materials used in buildings in order to achieve PassivHaus Standard are not in common use in Greece but are mainly used in Northern Europe (e.g. wood). Moreover, the achievement of this threshold depends highly on the orientation of the building and its surroundings, whereas in Greece the urban area does not provide most of the time ideal design conditions.

Thus, the PassivHaus Standard is not proposed to be followed in Greece as supplementary or guidance for nZEBs. Other main issues regarding the implication of the passive house are the insulation of the envelope, the openings, the air-tightness, the thermal bridges and the ventilation systems with heat recovery. The main issue is the insulation of the building's envelope, which should be appropriately designed combined with the ventilation of the building, so as to prevent any overheating or uncomfortable indoor conditions. In general, modifications should be done in order the principles to be properly adjusted in the Mediterranean climate, thus this Standard is not proposed to be followed. A major factor in a nZEB is the heating and cooling balance in a building. Based on the Greek Regulation for Energy Efficiency of Buildings, issued as the Ministerial Decision Official Gazette Bulletin B' 407/09-04-2010 4 different climate zones (A, B, C and D) are defined based on heating degree days (HDD) dividing the country in 4 regions. Climate Zone A corresponds to regions in South Greece, whereas Climate Zone D to regions in Northern Greece. The rest of the regions are classified respectively to Climate Zone B and C. Figure 3.3.2 presents the climate zones in Greece.

Based on the aforementioned map, it is stated that the largest cities per climatic zone (in terms of its population based on the population census conducted on 2011) are the following:

- Climatic Zone A: Iraklio
- Climatic Zone B: Athens
- Climatic Zone C: Thessaloniki
- Climatic Zone D: Kozani

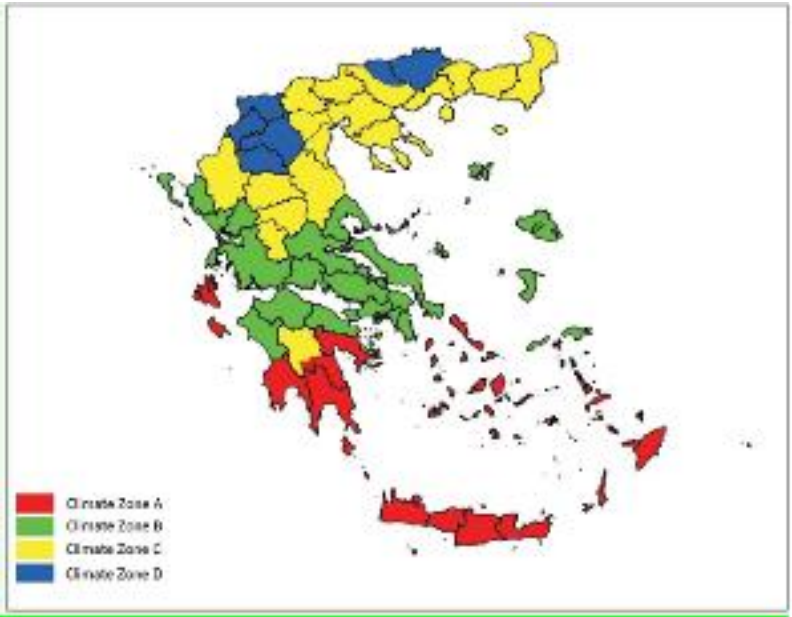


Figure 3.3.2: Climate zones in Greece (www.Microboiler.eu 2013)

Regarding the Mediterranean climate of Greece, it is mentioned that the summers are usually hot and dry, and the winters can be quite cold and wet. The northern part of Greece can be very cold during the winter and snow is not uncommon. However, for the south of Greece and the islands, the winters can be milder. During the winter a big part of Greece may have snow, and much snowfall can be expected in the

higher mountains of Greece. As per Koeppen-Geiger classification, the climate of Greece is classified as Csa, which is translated to a warm temperate Mediterranean climate with dry, warm summers and moderate, wet winters with the warmest month above 22°C on average. Thus, it is most likely that the heating demand to be relative low in nZEBs, however cooling demand would be greater. It should be noted that till now no cost- benefit analysis has been implemented in Greece regarding nZEBs and relevant studies also have not been issued, thus it is not possible to provide any recommendations on the heating-cooling balance of nZEBs in Greece.

In Greece the guidelines for the construction and the full renovation of existing buildings, developed based on European standards, have been set in force under Ministerial Decisions and complete the Regulation for Energy Efficiency of Buildings, issued on 2010. The European standard EN 15251 on thermal comfort has already been taken into account to provide design conditions for each type of building during the design of a new building. Thus, it is considered that the adaptive comfort model should be used for the development of nZEBs, since thermal comfort is a major concept in the nZEBs. The comfort levels set through legislation in Greece refer to the combination of temperature and relative humidity during summer and winter time. The levels are different based on the use of the building. Thus, for example for the residences during winter time the defined temperature and relative humidity is 20oC and 40% respectively, whereas during the summer time the defined temperature and relative humidity is 26oC and 50% respectively. These values refer to the majority of the cases studied, whereas differentiations are detected in specific buildings, such as hospitals. Thermal comfort is also strongly related to fuel poverty. In Greece, due to the financial crisis fuel poverty indicators are quite high. The following Figure 3.3.3 present the situation in Greece in 2012.

35

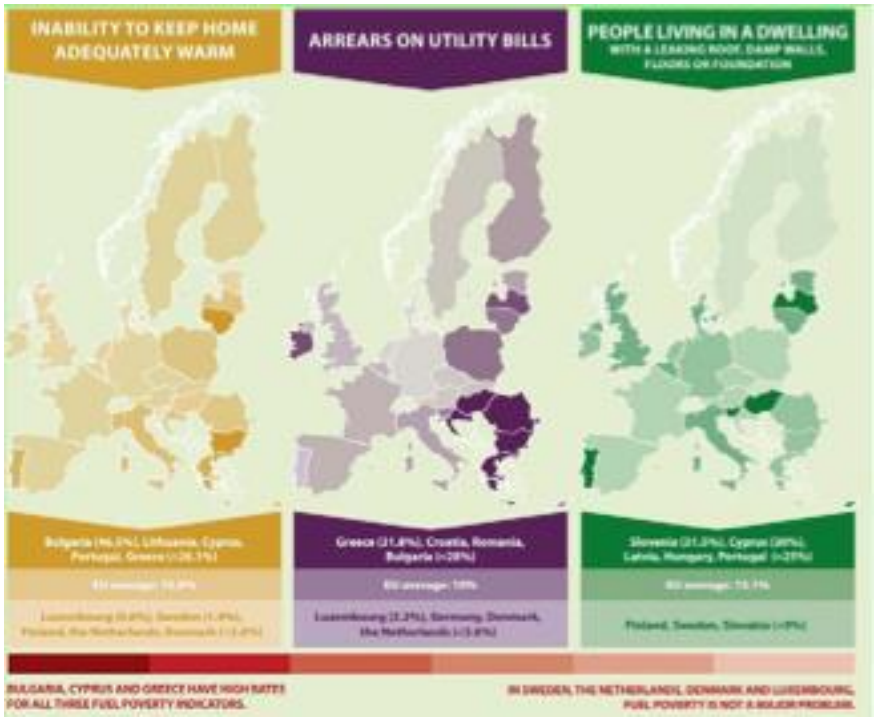


Figure 3.3.3: Fuel Poverty in Europe in 2012

Fuel poverty (BPIE, 2015) can have strong impact and may act as a barrier on the implementation of nZEBs. Therefore, the government already has provided a quite big amount of subsidy in order to enhance actions on the improvement of the energy efficiency of buildings. Another issue that should be taken into account and influences the thermal comfort in the southern European countries, such as Greece is the risk of overheating. Overheating refers not only to high temperatures in the inside of the buildings but also to a combination of lack of air movement and sustained exposure to high temperatures. Overheating is highly related to the insulation of a building as well as its airtightness, since improved airtightness and high insulation may lead to the retention of unwanted heat gains inside the building during the summer (NHBC Foundation, 2012). Both though factors are quite important for a nZEB, thus it is most important to highlight the necessity of proper insulation and ventilation design of the building. As mentioned beforehand, the climate of Greece, especially during summer, is characterized as hot and dry, thus cooling is a major factor for achieving thermal comfort. Passive cooling could be used in nZEBs, however it should be properly designed taking into account not only the building's characteristics but also the climate of the surroundings. Especially in urban areas passive cooling may not be as efficient as in rural areas and thus adequate for achieving thermal comfort inside the building, due to the effect of heat island. For instance, one way of implementing passive cooling is through natural night-time ventilation, which however would not be so effective in case the air temperature of the surrounding air during night remains high, which is the result of the effect of heat island, due to the type of construction materials and the great number of buildings. In Greece the majority of the population lives in urban areas thus active cooling in designing nZEBs in these areas may be imperative in order to achieve thermal comfort. The levels are proposed to remain the same as already stated in Greek legislation for the design of the buildings according to the Energy Efficiency Regulation.

According to the aforementioned, till now no indicators for renewables on the characterization of a nZEB have been provided for Greece. However, investing in renewables is not considered to be quite easy in Greece. The construction of buildings is mainly focused on multi-store buildings (block of flats) in urban areas, thus the implementation of renewables is not facilitated due to the available space and legislative obstacles. More specifically, the harvesting of the geothermal and solar thermal energy requires space which most of the times is not available. Regarding wind energy, the potential is not adequate for the wind energy to be effective in financial terms (e.g. payback period). Moreover, the potential is highly associated with the topography of the area and the obstacles that exist (e.g. buildings). Furthermore, there are yet legislative guidelines to be issued (Technical Chamber of Greece, 2014). CHP (Cogeneration Heat and Power) in Greece is not considered to be economically feasible for space heating due to short winter period, thus tri-generation (Power, Heat and Cooling) would be necessary for an economic operation (Small-scale CHP Factcheet Greece, 2007). For this operation an absorption chiller is mainly used. However, this application is effective mostly on tertiary buildings, in which there is great need in simultaneous production of electricity and heating/cooling. As a consequence, solar energy is mainly used as the most effective RES technology. However, barriers regarding the available space in urban areas still exist especially in multi-family buildings. Thus, the investment in

energy efficiency might be easier to be achieved, taking into account the subsidy programs promoted by the government.

For a nZEB there should be a minimum threshold on energy production for onsite renewable sources, which is proposed to be 25%, following the indicators set by Cyprus. However, in case this minimum threshold cannot be achieved then it should be possible to be lower, but the interested person/owner should provide adequate justification (e.g. cost-benefit analysis based on the capabilities of the building) to support this request. Current policy and existing relevant regulation encourage the energy production in the building. However, legislation exists only for the implementation of PV installations through the net-metering scheme, whereas the legislation was defined on 2014 with the Greek Official Gazette 3583/2014. Regarding small-scale wind generation legislation is yet to be defined.

The energy grid of Greece presents some peculiarities. The continental grid consists of the interconnected electricity system, whereas in the majority of the islands a local grid system exists, based on diesel generators and RES, thus these islands are referred as non-interconnected islands. Consequently, regulations set defining the maximum power of the PV installations differentiated for each type of connection and taking into account the capability of each system. Especially in the non-interconnected islands, as well as in specific regions of interconnected system in which the grid is considered to be saturated (e.g. in regions of Evia) the maximum power to be installed in lower than in other regions. Also, studies have been conducted by RAE (Regulatory Authority for Energy) in order to examine whether the energy grid is capable of connecting RES and the pace that should be followed in order to achieve the targets set by European Directives for the reduction of CO2 emissions and the enhancement of RES percentage in the energy grid (e.g. as per Technical University of Athens, 2011).

A major concern for the development of nZEBs in Greece is the construction quality of these buildings. Barriers have been identified in the market of high-tech components and new construction technologies but mostly in the know-how of professionals responsible for the design and construction of nZEBs. It should be mentioned that this lack has been observed in the southern European countries, thus a European-funded project initiated on March 2014 called “SouthZEB project” and aims to develop training material on proper designing of nZEBs and train professionals in the building sector in order to be capable of designing nZEBs, taking into account the climate and building regulations in each country. In the project the target countries in which it is estimated that 1500 professionals will be trained are: Greece, Italy, Cyprus and Portugal (http://www.southzeb.eu/el). In nZEB the use of high-tech components is crucial in order to achieve the minimum energy requirements, since they can provide higher efficiency, whereas low- tech nZEB solutions (e.g. RES technology) are quite difficult to achieve the targets of an nZEB. In order to address more efficiently high-tech components professionals in the design section should be properly trained, since these are the driving force for the implementation of high efficient buildings. Moreover, key-persons in rest positions, such as evaluators or policy-makers in order to enhance the financial support of energy efficiency measures. In Greece, as mentioned before, the main barriers of high quality nZEB construction is the gap in the know-how of the professionals at the design phase and the lack of investing interest mainly due to the lack of awareness in

the general public. Furthermore, the real estate market, which affects the construction of new buildings in general has also shrunk considerably over the past years and is characterized by low demand, against a background of high rates of unemployment, heavy taxes on real property and a shortage of liquidity, thus posing a barrier in the construction of nZEBs in Greece (Bank of Greece, 2016).

Add something ?

Complementary information have been found in KENAK:

- https://ypen.gov.gr/energeia/energeiaki-exoikonomisi/ktiria/kenak/
- https://ypen.gov.gr/wp-content/uploads/2020/11/KENAK_FEK_B2367_2017.pdf
- http://www.kenak.gr/e-library.htm
- https://www.taxheaven.gr/law/4122/2013

Relevant References / key publications:

- Bank of Greece. (June 2016). Development and prospects in the real estate market. Retrieved from http://www.bankofgreece.gr/BogDocumentEn/Monetary_policy_2015-2016_June%202016,Chapter%20IVSection_2.pdf
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- Hellenic Statistical Authority (2012). Survey on Energy Consumption in Household.
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- Papakostas, K.T., Zagana-Papavasileiou, P., & Mavromatis, T. (n.d.). Analysis of 3 decades temperature data for Athens and Thessaloniki, Greece-Impact of temperature changes on energy consumption for heating and cooling of buildings.
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- WP2 – Deliverable 2.1 (2014). Report on the Current Situation Regarding nZEB in the Participating Countries. Retrieved from http://www.southzeb.eu/wp-content/uploads/2016/07/SouthZEB_WP2_Deliverable_D2.1.pdf http://www.southzeb.eu/el/

2.10. HUNGARY

1.Please provide a map of the climatic areas in your country. Cite the source and make sure to share a high-resolution document.

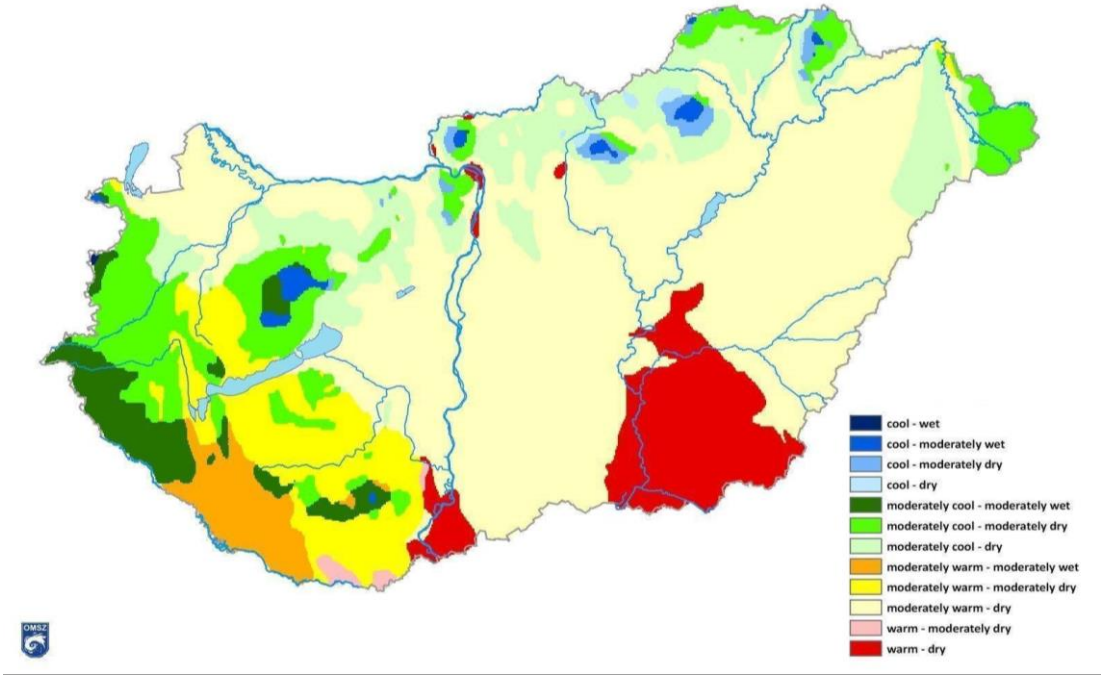

Figure 3.5.1 - The climatic regions in Hungary (after György Péczely)

https://www.met.hu/en/eghajlat/magyarorszag_eghajlata/altalanos_eghajlati_jellemzes/altalanos_leiras/

2.What are the Thermal comfort limits for nZEB in your country?

In 2019, the European Committee for Standardization (CEN) introduced the European standards EN 16798, which suggests the adoption of the Fanger's PMV/PPD model for mechanically heated and/or cooled buildings and Humphreys and Nicol's adaptive model for buildings without mechanical cooling systems. In 2008, the PassivHaus standard required comfort levels complying with the static model of EN 15251 / 16798 respecting the following rule: the number of hours over 25°C may not exceed 5% of the time working. This criterion is verified by using a dynamic simulation. In Eastern Europe, there are no studies that investigated the correlation between the variations of minimum performance threshold and suitable or fit to purpose comfort models in continental climates.

a.1. Explain shortly the reference standards used in your country to evaluate thermal comfort in nZEBS.

Indoor temperatures (operative) are required to comply with EN 15251 in both heating and cooling seasons.

Table 3.5.2: basic data that can be taken into account for the design of the building technology system

1. táblázat: Az épülettechnikai rendszer tervezéséhez figyelembe vehető légállapot adatok *

Az épület vagy a helyiség funkciója	A minimális belső hőmérséklet fűtésnél, °C	Hőmérséklet tartomány fűtésnél, °C	A maximális belső hőmérséklet hűtésnél, °C (amennyiben van gépi hűtés)	Hőmérséklet tartomány hűtésnél, °C
Lakóépület, huzamos tartózkodásra szolgáló helyiségek (szobák, étkező hálószoba stb.)	20	20-25	26	23-26
Lakóépület: egyéb helyiségek (konyha, tároló stb.)	16	16-25	-	-
Iroda (cellás vagy egyterű) Konferenciaterem Előadó, osztályterem Étterem/büfé	20	20-24	26	23-26
Óvoda	22	22-24	26	23-26
Áruház	16	16-22	25	21-25

Megjegyzés: A táblázatban levő hőmérsékletek operatív hőmérsékletet jelentenek.

a.2. Cite the reference, and share the reference in pdf format if possible.

The standard is cited here in the regulation: [1] Annex 1, V. Table 1. (online version available: https://net.jogtar.hu/jogszabaly?docid=a0600007.tnm)

a.3. Is the comfort assessed based on a static comfort model (like Fanger) or an adaptive comfort model (like EN 15251 / 16798)? Explain.

The static model is used and only for indoor operative temperature. The relative humidity is not mentioned in the decree. Fresh air volume is determined by the decree, no standards are referenced.

a.4. Please fill out the following table regarding overheating in your country. Feel free to elaborate on your answers.

Table 3.5.3: Thermal comfort and overheating requirements in Hungary

Country	Hungary	France	Belgium
Climate and weather data			
Is comfort dependent on national geographic climate zones? If yes, list them.	No	Yes: H1a, H1b, H1c, H2a, H2b, H2c, H2d, H3	Yes: Brussels, Flanders, Wallonia
Do you have a specific comfort calculation approach for heatwaves?	No	No	No
Do you take into account the urban heat island effect?	No	No	No
Does your overheating methodology take	No	No	No

into account future climate change weather files with extreme scenarios?			
Occupant type and representation			
What is your comfort standard?	EN 15251	ISO 7730 EN 15251	EN 15251
For which building types?	Residential, commercial, education, dining, kindergarten, sales	Residential and commercial	Residential and commercial
Does your method embrace the four occupant categories (I, II, III, IV)? *	No	Yes	No
How do you represent occupancy presence in the simulation model?	No simulation required		Deterministic (living and sleeping zones and schedules)
Comfort model			
What is your overheating indicator?	q_b: average internal heat gains for occupied periods	DIES (durée d'inconfort d'été statistique): statistical summer discomfort duration	$I_{overh} = \sum_{m=1}^{12} Q_{excess\ norm,m}$ where $Q_{excess\ norm,\ m}$ is the excess of heat gains in relation to the indoor set-point temperature for the month m.
Is your comfort model based on an adaptive or static method?	Static	Mixed: adaptive and static for sleeping rooms	Static
What are your overheating thresholds? and according to which standard are those thresholds defined?	qb < 10 W/m^2 AND Δtb,summer < 3 K (heavy bldg.) Δtb,summer < 2 K (lightweight bldg.)	● all living spaces except sleeping rooms depend on an adaptive model ● maximum 28°C operative temperature in sleeping rooms & EN 15251	Recommended range: 1000 Kh < I_{overh} < 6500 Kh & EN 15251
Is there a distinction between naturally ventilated, air-conditioned, and mixed-mode buildings?	No	I don't know	No
Does your model take into account local personalized heating/cooling & ventilation systems (ceiling fans, air conditioned chairs, electric heating mattresses…)?	No	No	No
Simulation model			
Is your calculation based on a	Static. A dynamic, hourly model is	Dynamic model & hourly calculations	Brussels: Static (Passive House Standard)

static/quasi-dynamic/dynamic model? What is the calculation timestep?	optional.		Flanders and Wallonia: quasi-dynamic with 12 simulation steps (ISO 13790)
Is your overheating calculation based on a single or multizone model?	The static calculation for relevant zones.	Multizone model	Multizone model
Does your calculation distinguish sleeping rooms from other living areas?	No	Yes	Yes
Mandatory envelope requirements			
Does your method oblige the installation of external shading?	No, only recommended.	No	No
Does your method oblige the limitation of the window to wall ratio? If yes, what is the limit?	No	No	No
Does your method recommend a g-value? If yes, what is the limit?	Active cooling can be used only in case g<0,3 at non-north-facing and roof windows.	No	No
* We are focusing on category II occupants for new buildings and renovated buildings			

b. Do you have fuel poverty problems in your country that might influence the nZEB objective? Explain.

Fuel poverty is sadly still a very relevant issue in Hungary. Many research projects have been conducted on the topic in recent years. A local energy policy institute and methodological center, Energiaklub among many other energy-related topics, has focused on fuel poverty problems locally for more than 30 years now. Their recent research was published online [3] and states that it is difficult to estimate the share of households in a country that are affected by the problem because there is neither a national nor EU-level definition for the term yet. In 2020, the EU published a report on the topic [4] which estimated the number of EU citizens affected to be 82 million. According to the 2019 utility data in Hungary, 10.2% of households had unpaid energy bills and approximately 5,4% of the households were not able to reach the desired heating set point in their home. [5]

c.1. What are the overheating criteria for nZEBs in your country?

The energy code sets a maximum threshold to avoid overheating which is the average internal heat gains for occupied periods (qb). The requirement is that the internal heat gains for occupied periods cannot exceed 10 W/m^2 and the daily average temperature

difference between indoor and outdoor should be below 3 K in case of heavy buildings and 2 K for lightweight buildings.

c.2. What is the overheating risk for nZEB (highly insulated) in your climate?

In Hungary, predominantly heavy-weight buildings are built for residential purposes, therefore, overheating risk is estimated to be lower. However, external shading use is not prescribed in the local energy code, therefore, designers should pay attention to using appropriate window-to-wall ratio and shading systems.

c.3 How do you evaluate overheating risk in nZEBs in your country? Please share the calculation method and overheating hours limit threshold.

See above.

d. Can we rely on passive cooling or must include active cooling systems for nZEBs in your country?

Historically, no buildings required active cooling systems in Hungary as summer night temperatures reached free cooling levels and nocturnal ventilation was applied which ensured passive cooling of the buildings. However, with climate change, summers became warmer and at the same time, there was a tendency to increase window sizes without appropriate shading. Therefore, recently, active cooling has started to be a standard feature of new-built residential and also commercial buildings to ensure comfort during summer periods.

Add something ?

Relevant References / key publications:

[1] Hungarian transposition of EPBD: TNM Ministry Decree No. 7/2006 (V.24); Government Decree 176/2008 (VI. 30.) on The Determination of Building Energy Parameters; Governmental Decree 264/2008. (XI. 6.), (n.d.).

[2] F. Kft., Report on the Electricity Supply Network Climate-Specific Evaluation in Hungary - A MAGYARORSZÁGI VILLAMOSENERGIA-ELLÁTÁS ÉGHAJLATI SZEMPONTÚ ÉRTÉKELÉSE, MBFSZ Serv. (2019).

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[8] TNM Ministry decree 176/2008 on The Certification of Building Energy Parameters - TNM, 176/2008. (VI. 30.) Korm. rendelet az épületek energetikai jellemzőinek tanúsításáról, (2008) https://net.jogtar.hu/jogszabaly?docid=a0800176.kor

2.11 IRELAND

Please fill out the following table regarding the status in your country. Feel free to develop the answers.

1.What is the thermal comfort limit for residential buildings in your country?

1.a.1. Explain shortly the reference standards used in your country to evaluate thermal comfort in residential buildings.

1.a.2. What is your comfort standard?

The Health, Safety and Environment (HSE) Sustainability Office of Ireland indicates the temperature of 18-23 °C is the comfortable range. Room temperature should be about 20 °C.

The Irish building regulations do not specifically define comfort limits, however throughout Part L (conservation of fuel and energy) they make reference to CIBSE TM52: The Limits of Thermal Comfort: Avoiding Overheating in European Buildings; CIBSE 2013

The Irish normal operating temperatures as defined within the national building energy rating methodology DEAP, are 21C in living areas and 18C in bedrooms. These are not comfort limits, but expected operating conditions. Research by Colclough et al (2021) has shown that in reality dwellings often operate at indoor temperatures well above these values.

1.a.3. On what your comfort model is based?

There is no specific comfort model.

CIBSE TM52 is referenced throughout the building regulations and designers are advised to abide by it

The values used in the national building energy rating calculation methodology (DEAP) derive from those limits set by the WHO. The WHO recommends a minimum temperature of 18°C [2], with increases of 2-3°C for those more vulnerable to the effects of cold strain including the elderly.

1.a.4. What are the overheating criteria for residential buildings in your country?

The CIBSE definition of overheating:

The current Irish building regulations reference TM52 but the Sustainable Energy Authority of Ireland commissioned AECOM to undertake a “Research report on Overheating risk in dwellings” using TM59, hence it is likely to be incorporated into future regulations. The criteria for TM52 are first outlined followed by those of TM59.

TM52:

According to TM52, CIBSE recommends that new buildings should conform to Category II in BS EN 15251, which sets a maximum acceptable temperature (T_{max}) of 3°C above the comfort temperature for buildings in free-running mode (i.e. without use of mechanical cooling). For such buildings, T_{max} can be calculated as $T_{max} = 0.33\ T_{rm} + 21.8$ where T_{rm} is the running mean of the outdoor temperature. TM52 sets out three criteria for overheating on the basis that they "provide a robust yet balanced assessment of the risk of overheating of buildings in the UK". The criteria are all defined in terms of ΔT, the difference (rounded to the nearest °C) between operative temperature (T_{op}) in the room at any given time and T_{max} ($\Delta T = T_{op} - T_{max}$). A room or building that fails any two of the three criteria is classed as overheating.

- Criterion 1 - Hours of exceedance: The number of hours (He) during which ΔT is greater than or equal to 1°C during the occupied hours of a typical non-heating season (1 May to 30 September) shall not be more than 3% of occupied hours. If data are not available for the whole period (or if occupancy is only for a part of the period) then 3% of available hours should be used.
- Criterion 2 - Daily weighted exceedance: This criterion represents the severity of overheating within any one day, as a function of temperature rise and its duration, which can be as important as its frequency.
- Criterion 3 - Upper limit temperature (T_{upp}): The value of ΔT shall not exceed 4°C. This criterion, the absolute maximum daily temperature, covers the extremes of hot weather conditions and future climate scenarios. TM52 (and therefore the above criteria) apply to buildings in general but are based largely on evidence from the occupants of non-domestic buildings.

TM59:

It requires that the internal temperature between 10 pm and 7 am does not exceed 26 °C for more than 1% of annual hours. (The Sustainable Energy Authority of Ireland (SEAI) TM59 sets out two compliance criteria for dwellings that are predominantly naturally ventilated.

- Criterion A for living rooms, kitchens and bedrooms. It requires that the internal temperature in these rooms does not exceed a defined comfort temperature by 1 °C or more for more than 3% of occupied hours over the summer period (1 May to 30 September).
- Criterion B for bedrooms only. It requires that the internal temperature between 10 pm and 7 am does not exceed 26 °C for more than 1% of annual hours.)

For homes that are predominantly mechanically ventilated (MEV) (i.e. with significantly limited opportunity to open windows), TM59 applies a single criterion that Top should not exceed 26˚C for more than 3% of occupied hours in any occupied rooms. The criterion for mechanically ventilated homes is however not relevant to this project

because most homes in England are not of this type. A significant minority of new homes (particularly flats) have mechanical ventilation but typically they would also have openable windows. (Research report on Overheating risk in dwellings, Sustainable Energy Authority of Ireland)

1.a.5. Cite the reference, and share the reference in pdf format if possible.

1. Research report on Overheating risk in dwellings, Sustainable Energy Authority of Ireland, Project number: 60591901, December 2019 [13, 14].
2. Research report on Overheating risk in dwellings, Sustainable Energy Authority of Ireland, September 2019, AECOM, Ministry of Housing, Communities and Local Government
3. Research into overheating in new homes, September 2019, Ministry of Housing, Communities and Local Government.
4. Monahan, E. (2014) Thermal Comfort, Energy Usage and Fuel Poverty in a Sample of Older Person's Households in Dublin, Master's Thesis, Technological University Dublin, 2014 [12].
5. Conservation of Fuel and Energy – Buildings other than Dwellings- part L-Building Regulations 2020
6. The limits of thermal comfort: avoiding overheating in European buildings-TM52: 2013

1.a.6. Please fill out the following table regarding overheating in your country. Feel free to elaborate on your answers.

Table 6: Overheating assessment

Criteria	Your Country
Climate and weather data	
Is comfort dependent on national geographic climate zones? If yes, list them.	No, because it considers just one climatic zone in Ireland. Ireland's climate is defined as a temperate oceanic climate, or Cfb on the Köppen climate classification system, a classification it shares with most of northwest Europe.
Do you have a specific comfort calculation approach for heat waves?	The definition of a heat wave in Ireland is shaded air temperatures reaching highs of above 25˚ C on five or more consecutive days at the same location (Met Eireann).
Do you take into account the urban heat island effect?	No
Does your overheating methodology take into account future climate change weather files with extreme scenarios?	No
Occupant type and representation	
What type of building type does your comfort standard deal with?	Dwellings (Residential buildings) and Buildings other than dwellings (Non-Residential buildings)

<table>
<tr><td>Does your method embrace the four occupant categories (I, II, III, IV)? *</td><td>No</td></tr>
<tr><td>How do you represent occupancy presence in the simulation model?</td><td>Occupancy is not included amongst parameters in the assessment method for risk of overheating in Irish dwellings, as outlined in the building regulations.</td></tr>
<tr><td colspan="2"><u>Comfort model</u></td></tr>
<tr><td>What is overheating provisions period coverage?</td><td>Not specified. Overheating thresholds are not specifically defined rather the risk of overheating is defined in terms of indoor temperatures, and the likelihood of those to lead to overheating.The calculation is related to the factors that contribute to internal temperature: solar gain (taking account of orientation, shading and glazing transmission); ventilation (taking account of window opening in hot weather), thermal capacity and mean summer temperature for the location of the dwelling.</td></tr>
<tr><td>What is your overheating indicator?</td><td>It is based on TM52.</td></tr>
<tr><td>Is your comfort model based on an adaptive (like EN 15251 / 16798) or static (like Fanger) method?</td><td>CIBSE TM52 is an adaptive comfort theory that accepts that the occupants can adapt to the surrounding thermal environment because of the behavioral, physiological, and psychological actions.</td></tr>
<tr><td>What are your comfort thresholds?</td><td>CIBSE Guide A (2006) specifies a threshold value denoted as ‘‘benchmark peak temperature” for free-running buildings which is 3 ℃ higher than the summer comfort temperature. It defines 25 ℃ as the summer comfort temperature in the living room at which few people feel uncomfortable. For bedrooms, however, it assigns the summer comfort temperature of 23 ℃ since sleep may be impaired above 24 ℃. Accordingly, the prescribed benchmark peak temperature is 28 ℃ for the living room and 26 ℃ for the bedrooms. CIBSE Guide A (2015) and CIBSE TM59 also commonly suggest 26 ℃ for the bedrooms in naturally ventilated buildings. The Passive House standard sets a maximum threshold value of 25 ℃ for all living areas in buildings without active cooling or with passive cooling. It is suggested that the effect of other comfort parameters such as relative humidity, clothing factor, metabolic rate, and air velocity should be considered in defining comfort [15].</td></tr>
<tr><td>What are your overheating thresholds? and according to which standard are those thresholds defined?</td><td>Overheating thresholds are not specifically defined rather the risk of overheating is defined in terms of indoor temperatures, and the likelihood of those to lead to overheating. These are shown in the table below.
<table>
<tr><th>$T_{threshold}$</th><th>Likelihood of high internal temperature during hot weather</th></tr>
<tr><td>< 20.5°C</td><td>Not significant</td></tr>
<tr><td>≥ 20.5°C and < 22.0°C</td><td>Slight</td></tr>
<tr><td>≥ 22.0°C and < 23.5°C</td><td>Medium</td></tr>
<tr><td>≥ 23.5°C</td><td>High</td></tr>
</table></td></tr>
<tr><td>Is there a distinction between naturally</td><td>Yes. There is a distinction with different methods of calculation for mechanical and natural cross ventilation outlined.</td></tr>
</table>

ventilated, air-conditioned, and mixed mode buildings?	
Does your model take into account local personalized heating/cooling & ventilations systems (ceiling fans, air-conditioned chairs, electric heating mattresses…)?	No
Simulation model	
Is your calculation based on a static/quasi dynamic/dynamic model? What is the calculation timestep?	static
Is your overheating calculation based on a single or multizone model?	single
Does your calculation distinguish sleeping rooms from other living areas?	No
Mandatory envelope requirements	
Does your method oblige the installation of external shading?	It does not oblige it but does enable inclusion of it within calculations for risk of overheating
Does your method oblige the limitation of the window to wall ratio? If yes, what is the limit?	There is no limit on window to wall ration but the building regulations specify that total window and door openable area can be assumed to be 1/20th of the floor area of each habitable room (as per TGD Part F requirements)
Does your method recommend a g-value? If yes, what is the limit?	No recommendation. The solar factor is expressed as a number between 0 and 1. A lower solar factor means less heat gain. It has been reported that 0.6 should be a reasonable g-value. (NSAI Standard Recommendation S.R. 54:2014)
* we are focusing on category II occupants for new and renovated buildings	

1b. Do you have fuel poverty problems in your country that might influence overheating risk in residential buildings? Explain.

Yes. According to the Government's most recent strategy to tackle energy poverty 'A Strategy to Combat Energy Poverty 2016-2019' up to 28% of households in Ireland are in or at risk of energy poverty (equivalent to 475,000 households in 2016). More recent research published by the Economic and Social Research Institute (ESRI) in October 2020 'Carbon Taxes, Poverty and Compensation Options' estimates a

measure of ‘core’ energy poverty at 17.5% of households (approximately 297,500 households).

1.c.2. What is the overheating risk for residential buildings (highly insulated) in your climate?

CIBSE TM52 defines as

- Criterion 1 - Hours of exceedance: The number of hours (He) during which ΔT is greater than or equal to 1°C during the occupied hours of a typical non-heating season (1 May to 30 September) shall not be more than 3% of occupied hours. If data are not available for the whole period (or if occupancy is only for a part of the period) then 3% of available hours should be used.
- Criterion 2 - Daily weighted exceedance: This criterion represents the severity of overheating within any one day, as a function of temperature rise and its duration, which can be as important as its frequency.
- Criterion 3 - Upper limit temperature (T_{upp}): The value of ΔT shall not exceed 4°C. This criterion, the absolute maximum daily temperature, covers the extremes of hot weather conditions and future climate scenarios. TM52 (and therefore the above criteria) apply to buildings in general but are based largely on evidence from the occupants of non-domestic buildings.

1.c.3. How do you evaluate overheating risk in residential buildings in your country? Please share the calculation method and overheating hours’ limit threshold.

Low, overheating is not common in Ireland. It is an Island nation, close to the Atlantic and with many breezes and no continental issue: oceanic climate.

1.d. Can we rely on passive cooling or must include active cooling systems for residential buildings in your country for residential buildings?

Yes in Ireland we can rely on passive cooling. In Ireland, there are many breezes and even in summer, there is no high temperature.

Add something ?

Relevant References / key publications:

[1] A. M. Coggins et al., "Indoor air quality, thermal comfort and ventilation in deep energy retrofitted Irish dwellings," Building and Environment, p. 109236, 2022.

[2] K. Collins, "Low indoor temperatures and morbidity in the elderly," Age and Ageing, vol. 15, no. 4, pp. 212-220, 1986.

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[4] J. D. Healy and J. P. Clinch, "Fuel poverty, thermal comfort and occupancy: results of a national household-survey in Ireland," Applied Energy, vol. 73, no. 3-4, pp. 329-343, 2002.

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- HSE Website: Thermal Comfort. Detailed guidance on workplace temperature and thermal comfort is available on HSE's website. See www.hse.gov.uk/temperature/thermal

2.12. ITALY

Please fill out the following table regarding the status in your country. Feel free to develop the answers.

1. What is the thermal comfort limit for residential buildings in your country?

1.a.1. Explain shortly the reference standards used in your country to evaluate thermal comfort in residential buildings.

In Italy, there is a legislative instrument D.Lgs. 81/2008 on the protection of health and safety in the workplace that, among different aspects, also specifies the standards to refer to regarding the thermal comfort requirements in (i) moderate environments (UNI EN ISO 7730), (ii) severe hot environments (UNI EN ISO 27243:1996 and UNI EN ISO 7933:2005), and (iii) severe cold environments (UNI EN ISO 11079:2008 and UNI EN ISO 13732-3:2009).

For residential units, the Presidential Decree (DPR) n. 74, issued on April 16, 2013, establishes the general criteria regarding the operation, management, control, maintenance and inspection of thermal systems for winter and summer air conditioning, provides for residential buildings that the weighted average of the air temperatures, measured in the individual rooms of each building unit, during operation of the winter conditioning system, must not exceed 20°C +2°C tolerance; during operation of the summer air conditioning system, it must not be lower than 26°C –2°C tolerance. However, due to the energy crisis provoked by the Russian/Ukrainian war, the Ministry for ecological transition recently issued the Decree n. 383 on 6 October 2022, implementing the National Plan for the containment of natural gas consumption for the year 2022. It amends Presidential Decree 74/2013 with respect to the:

- Reduction of the operation period for heating systems (i.e. 15 days less over the entire season)
- Reducing the maximum allowed number of hours of operation per day (i.e. 1 h less every day)
- Reducing the maximum internal temperature to 17°C + 2°C tolerance for buildings used for industrial, craft and similar activities; the maximum internal temperature of 19°C + 2°C tolerance for all other buildings (including residences) (1 ºC less of the indoor setpoint temperature).

Furthermore, the Standard UNI TS 11300-1 (which is the national application of the EN ISO 13790:2008) assumes that (for energy calculation purposes) the indoor air temperature is 20 ºC for winter climatization and 26 ºC for summer climatization for standard or design applications. This standard also provides indications on the duration of the heating period (Prospetto 3).

Decree 11/10/2017 refers to ISO 7730, but it also prescribes that, for new buildings or renovations larger than 15% of the previous treatment volume or larger than 500 m3,

to provide adequate thermal comfort conditions, every component of the building envelope should have periodic areal thermal capacity of at least 40 kJ/m2K OR the summer operative temperature and the absolute value of the deviation have to be calculated with the UNI EN 15251 (superseded by EN 16798-1 in 2018).

1..a.2. What is your comfort standard?

The D.Lgs. 81/2008 explicitly refer to ISO 7730.

The Decree 11/10/2017 refers to the EN 15251 and hence the EN 16798-1

1..a.3. On what your comfort model is based?

The D.Lgs. 81/2008 explicitly refers to the Fanger comfort model, and the European adaptive comfort model is also available for free-running buildings.

1.a.4. What are the overheating criteria for residential buildings in your country?

There are no specified overheating criteria to use during eighter design or assessment phases.

1..a.5. Cite the reference, and share the reference in pdf format if possible.

I added hyperlinks

1.a.6. Please fill out the following table regarding overheating in your country. Feel free to elaborate on your answers.

Table 7: Overheating assessment

<table>
<tr><th>Criteria</th><th>Your Country</th></tr>
<tr><td colspan="2"><u>Climate and weather data</u></td></tr>
<tr><td>Is comfort dependent on national geographic climate zones? If yes, list them.</td><td>Yes, climate one based on heating degree days. They were established by the Annex A of the Presidential decree of 26 August 1993, n. 412.
<table>
<tr><th>Zona climatica</th><th>Periodo di accensione</th><th>Orario consentito</th></tr>
<tr><td>A</td><td>1° dicembre – 15 marzo</td><td>6 ore giornaliere</td></tr>
<tr><td>B</td><td>1° dicembre – 31 marzo</td><td>8 ore giornaliere</td></tr>
<tr><td>C</td><td>15 novembre – 31 marzo</td><td>10 ore giornaliere</td></tr>
<tr><td>D</td><td>1° novembre – 15 aprile</td><td>12 ore giornaliere</td></tr>
<tr><td>E</td><td>15 ottobre – 15 aprile</td><td>14 ore giornaliere</td></tr>
<tr><td>F</td><td>nessuna limitazione</td><td>nessuna limitazione</td></tr>
</table>
</td></tr>
<tr><td>Do you have a specific comfort calculation approach for heat waves?</td><td>No. Since 2004, the Italian Ministry of Health has launched a series of initiatives for the prevention of the impact of heat waves on the health of the population and has appointed a small group of experts, coordinated by the General Directorate of Health Prevention of draw up guidelines to deal effectively with the heat emergency.
Heat waves are extreme meteorological conditions that occur when very high temperatures are recorded for several consecutive days,</td></tr>
</table>

	often associated with high humidity rates, strong solar radiation and lack of ventilation; these conditions represent a risk to the health of the population. A heat wave is defined in relation to the climatic conditions of a specific city and it is therefore not possible to identify a temperature-risk threshold valid at all latitudes. The Italian national forecast and alarm system, managed by the Ministry of Health with the technical-scientific contribution of the National Competence Center (CCN), Department of Epidemiology SSR of the Lazio Region, guarantees the monitoring of meteorological conditions associated with a health risk. This system is operational in 27 cities covering all Italian regions: Ancona, Bari, Bologna, Bolzano, Brescia, Cagliari, Campobasso, Catania, Civitavecchia, Florence, Frosinone, Genoa, Latina, Messina, Milan, Naples, Palermo, Perugia, Pescara, Reggio Calabria, Rieti, Rome, Turin, Trieste, Venice, Verona, and Viterbo.
Do you take into account the urban heat island effect?	In the National plan for the prevention of the effects of heat on health – Guidelines For Prevention, the UHI is mentioned and recommendations are provided for urban planning, building renovation and adaptation strategies are listed.
Does your overheating methodology take into account future climate change weather files with extreme scenarios?	About Heat waves, Italy uses the Euroheat tool for medium range forecast (3-10 days). Pluss during the period with high rist there are daily Bulletins.
Occupant type and representation	
What type of building type does your comfort standard deal with?	DPR 74/2013 provides indications for all buildings types.
Does your method embrace the four occupant categories (I, II, III, IV)? *	Not related, but the Decree 11/10/2017 allows referring to EN 15251 superseded by EN 16798-1 that refer to comfort categories
How do you represent occupancy presence in the simulation model?	UNI TS 1130-1, for design or standard evaluations, occupation data and use of the building refer to a conventional user. Schedule and internal gains are provided in Prospetto 9 (residential) and 10 (offices). For energy performance certification purposes, it is assumed that occupation is constant over the 24 hours per day.
Comfort model	
What is overheating provisions period coverage?	DPR 74/2013 provides the duration of the heating operation period for each climate zone; therefore, the complementary can be considered the cooling season
What is your overheating indicator?	Not mentioned explicitly
Is your comfort model based on an adaptive (like EN 15251 / 16798) or static (like Fanger) method?	Decree 11/10/2017 allows referring to EN 15251 superseded by EN 16798-1 D.Lgs. 81/2008 mentions the UNI EN ISO 7730 and refer to the Fanger model.
What are your comfort thresholds?	Those mentioned by DPR 74/2013 (currently superseded by Decree 383/2022 due to the Russia/Ukraine war)
What are your overheating	No overheating thresholds.

<table>
<tr><td>thresholds? and according to which standard are those thresholds defined?</td><td>But it is possible to refer to EN 16798-1</td></tr>
<tr><td>Is there a distinction between naturally ventilated, air-conditioned, and mixed mode buildings?</td><td>Yes. It depends on the adopted standard</td></tr>
<tr><td>Does your model take into account local personalized heating/cooling & ventilations systems (ceiling fans, air-conditioned chairs, electric heating mattresses…)?</td><td>No.</td></tr>
<tr><td colspan="2"><u>Simulation model</u></td></tr>
<tr><td>Is your calculation based on a static/quasi-dynamic/dynamic model? What is the calculation timestep?</td><td>No specific simulation for overheating calculation</td></tr>
<tr><td>Is your overheating calculation based on a single or multizone model?</td><td>No specific simulation for overheating calculation</td></tr>
<tr><td>Does your calculation distinguish sleeping rooms from other living areas?</td><td>No specific simulation for overheating calculation</td></tr>
<tr><td colspan="2"><u>Mandatory envelope requirements</u></td></tr>
<tr><td>Does your method oblige the installation of external shading?</td><td><u>D.Lgs. 311/2006</u> introduces the obligation to check the existence of suitable sunshields already in the design phase, and recognizes the (outdoor or indoor) awning a fundamental role in reducing the solar load in the summer months</td></tr>
<tr><td>Does your method oblige the limitation of the window to wall ratio? If yes, what is the limit?</td><td><u>L. 90/2013</u> implements the EPBD recast. It introduces the principle of the minimum requirements assessed with respect to a reference building. In this regard, this law introduces a limit of the “summer equivalent solar area per unit of useful surface” that must be lower than the limit values shown in Table 11 appendix A (Paragraph ii, 2b), paragraph 3.3) of the Law.
Tabella 11 - Valore massimo ammissibile del rapporto tra area solare equivalente estiva dei componenti finestrati e l’area della superficie utile $A_{sol,est}/A_{sup\ utile}$ (-)
<table>
<tr><th>#</th><th>Categoria edificio</th><th>Tutte le zone climatiche</th></tr>
<tr><td>1</td><td>Categoria E.1 fatta eccezione per collegi, conventi, case di pena, caserme nonché per la categoria E.1(3)</td><td>≤ 0,030</td></tr>
<tr><td>2</td><td>Tutti gli altri edifici</td><td>≤ 0,040</td></tr>
</table></td></tr>
<tr><td>Does your method recommend a g-value? If yes, what is the limit?</td><td>L. 90/2013 indicates a total solar transmission factor for windows and mobile shading of max 0.35 for all the climate zones</td></tr>
<tr><td colspan="2">* we are focusing on category II occupants for new and renovated buildings</td></tr>
</table>

1b. Do you have fuel poverty problems in your country that might influence overheating risk in residential buildings? Explain.

I cannot answer

1.c.2. What is the overheating risk for residential buildings (highly insulated) in your climate?

In Italy, there are very different climate conditions from the Polar climate on the Alps to the subtropical on the southern shore of Sicily; therefore, in the northern regions, it is quite limited, while it may be a sensitive issue in the southern regions.

1.c.3. How do you evaluate overheating risk in residential buildings in your country? Please share the calculation method and overheating hours limit threshold.

No standard procedure.

1.d. Can we rely on passive cooling or must include active cooling systems for residential buildings in your country for residential buildings?

L.90/2013, in order to limit the energy requirements for summer air conditioning and to contain the internal temperature of the rooms, as well as to limit overheating on an urban scale, requires that, for the roof structures of buildings, it is mandatory to verify the effectiveness, in terms of cost-effectiveness benefits of using:

a) materials with high solar reflectance for roofs (cool roofs), assuming for the latter a solar reflectance value not lower than:

- 0.65 in the case of flat roofs;

- 0.30 in the case of pitched roofs;

b) passive air conditioning technologies (by way of example but not limited to: ventilation, green roofs).

Add something ?

Relevant References / key publications:

2.13. LATVIA

2. Please provide a map of the climatic areas in your country. Cite the source and make sure to share a high-resolution document.

Latvian building code on building climatology does not provide climate division in climatic areas. It provides average data on climate parameters for 22 cities. The main provided data includes average heating temperature, length of the heating season, and data on relative humidity, winter and summer design temperatures.

Figure 1 Cities with available climatic data for calculation of energy performance

5. What is the thermal comfort limit for nZEBs in your country?

5.a.1. Explain shortly the reference standards used in your country to evaluate thermal comfort in nZEBs.

- EN ISO 7730:2006-05 – Ergonomics of the thermal environment - Analytical determination and interpretation of thermal comfort by calculating the PMV and PPD index and criteria for local thermal comfort.
- EN 15251:2012-12 – Input parameters for the indoor climate for the design and evaluation of the energy efficiency of buildings - indoor air quality, temperature, light and acoustics.

5.a.2. Cite the reference, and share the reference in pdf format if possible.

5.a.3. Is the comfort assessed based on a static comfort model (like Fanger) or an adaptive comfort model (like EN 15251 / 16798)? Explain.

It should be used when cooling loads are not considered for building energy certification.

5.a.4. Please fill out the following table regarding overheating in your country. Feel free to elaborate on your answers.

Table 3.6.3: Overheating assessment in Latvia

Country	Latvia
Climate and weather data	
Is comfort dependent on national geographic climate zones? If yes, list them.	No.
Do you have a specific comfort calculation approach for heatwaves?	No.
Do you take into account the urban heat island effect?	No.
Does your overheating methodology take into account future climate change weather files with extreme scenarios?	No
Occupant type and representation	
What is your comfort standard?	EN ISO 7730:2006 EN 16798-1:2019
For which building types?	All.
Does your method embrace the four occupant categories (I, II, III, IV)? *	Yes
How do you represent occupancy presence in the simulation model?	It is not defined.
Comfort model	
What is your overheating indicator?	Kelvin hours (K · h)
Is your comfort model based on an adaptive or static method?	Static.
What are your overheating thresholds? and according to which standard are those thresholds defined?	for various types of single-family houses, apartment buildings, and office buildings, the operating temperature above 27 ° C shall not exceed 150 Kelvin hours (K · h) in the period from 1 May to 30 September; the operating temperature of social housing and hospitals of various social groups above 25 ° C shall not exceed 100 Kelvin hours (K · h) in the period from 1 May to 30 September; The operating temperature of the premises in the buildings of educational institutions above 25 ° C shall not exceed 150 Kelvin hours (K · h) in the period from 1 May to 15 June and from 15 August to 30 September.
Is there a distinction between naturally ventilated, air-conditioned, and mixed-mode buildings?	No.
Does your model take into account local personalized heating/cooling & ventilation systems (ceiling fans, air conditioned chairs, electric heating mattresses…)?	No.
Simulation model	

Is your calculation based on a static/quasi-dynamic/dynamic model? What is the calculation timestep?	Static, in some cases quasi-dynamic. Calculation time step: monthly or hourly.
Is your overheating calculation based on a single or multizone model?	Multizone (but not mandatory).
Does your calculation distinguish sleeping rooms from other living areas?	It is possible but not mandatory
Mandatory envelope requirements	
Does your method oblige the installation of external shading?	No.
Does your method oblige the limitation of the window to wall ratio? If yes, what is the limit?	No.
Does your method recommend a g-value? If yes, what is the limit?	No.
* We are focusing on category II occupants for new and renovated buildings	

5.b. Do you have fuel poverty problems in your country that might influence the nZEB objective? Explain.

Till the end of 2021, there wasn't any sign of possible fuel poverty. However, late uncertainties in natural gas supply and electricity import from Belarus and Russia have caused revision on current support to install local renewable energy systems.

5.c.1. What are the overheating criteria for nZEBs in your country?

It was overheating hours.

5.c.2. What is your climate's overheating risk for nZEB (highly insulated)?

The overheating risk for nZEBs is moderate.

5.c.3. How do you evaluate overheating risk in nZEBs in your country? Please share the calculation method and overheating hours limit threshold.

Bot any specific tool is directly mentioned. Usually, the use of a Passive house planning package uses IDA-ICE in some rare cases.

5.d. Can we rely on passive cooling or must we include active cooling systems for nZEBs in your country?

Mechanical cooling is included for all types of buildings. However, dynamic energy simulation can be used to prove the efficiency of passive cooling.

In practice, dynamic energy simulation is not widely used for single-family houses. Thus energy performance certificates usually include mechanical cooling. It should be noted that mechanical cooling doesn't critically impact overall performance.

Add something ?

Relevant References / key publications:

- Latvian building code “Building climatology” https://likumi.lv/ta/id/307966-noteikumi-par-latvijas-buvnormativu-lbn-002-19-eku-norobezojoso-konstrukciju-siltumtehnika
- Latvian building code “heating and ventilation of residential and public buildings” https://likumi.lv/ta/id/274815-noteikumi-par-latvijas-buvnormativu-lbn-231-15-dzivojamo-un-publisko-eku-apkure-un-ventilacija-
- Labour Protection Law https://likumi.lv/ta/id/26020-darba-aizsardzibas-likums
- Baranova, D., Sovetnikov, D., & Borodinecs, A. (2018). The extensive analysis of building energy performance across the baltic sea region. Science and Technology for the Built Environment, 24(9), 982-993. doi:10.1080/23744731.2018.1465753
- Baranova, D., Sovetnikov, D., Semashkina, D., & Borodinecs, A. (2017). Correlation of energy efficiency and thermal comfort depending on the ventilation strategy. Paper presented at the Procedia Engineering, 205 503-510. doi:10.1016/j.proeng.2017.10.403 Retrieved from www.scopus.com
- Borodinecs, A., Geikins, A., & Prozuments, A. (2020). Energy consumption and retrofitting potential of Latvian unclassified buildings doi:10.1007/978-981-32-9868-2_27 Retrieved from www.scopus.com
- Borodinecs, A., Prozuments, A., Zajacs, A., & Zemitis, J. (2019). Retrofitting of fire stations in cold climate regions. Magazine of Civil Engineering, 90(6), 85-92. doi:10.18720/MCE.90.8
- Borodinecs, A., Zemitis, J., Sorokins, J., Baranova, D. V., & Sovetnikov, D. O. (2016). Renovation need for apartment buildings in Latvia. Magazine of Civil Engineering, 68(8), 58-64. doi:10.5862/MCE.68.6
- Odineca, T., Borodinecs, A., Korjakins, A., & Zajecs, D. (2019). The impacts of the exterior glazed structures and orientation on the energy consumption of the building. Paper presented at the IOP Conference Series: Earth and Environmental Science, 290(1) doi:10.1088/1755-1315/290/1/012105 Retrieved from www.scopus.com
- Prozuments, A., Borodinecs, A., Odineca, T., & Nemova, D. (2020). Long-term buildings’ space heating estimation method doi:10.1007/978-3-030-42351-3_47 Retrieved from www.scopus.com
- Tihana, J., Odineca, T., Borodinecs, A., Gendelis, S., & Jakovics, A. (2019). Optimal properties of the external building envelope for minimization of overheating. Paper presented at the IOP Conference Series: Earth and Environmental Science, 390(1) doi:10.1088/1755-1315/390/1/012046 Retrieved from www.scopus.com
- Zemitis, J., & Borodinecs, A. (2019). Energy-saving potential of ventilation systems with exhaust air heat recovery. Paper presented at the IOP Conference Series: Materials Science and Engineering, 660(1) doi:10.1088/1757-899X/660/1/012019 Retrieved from www.scopus.com.

2.14. LITHUANIA

2. Please provide a map of the climatic areas in your country. Cite the source and make sure to share a high-resolution document.

Lithuania has only one climate zone (see Figure 3.7.1).

Figure 3.7.1: Climate zone of Lithuania

5. What is the thermal comfort limit for nZEBs in your country?

5.a.1. Explain shortly the reference standards used in your country to evaluate thermal comfort in nZEBS.

During the preparation of the first Lithuanian methodology for calculating the energy performance of buildings (2005), data on room temperatures in winter and summer periods were taken and used from Annex C of the working document of the new draft standard EN ISO 13790: 2004. These temperatures complied with the limits set by the Lithuanian Hygiene Standards Methodology HN 42: 2004 for the standard values of the ambient temperature of thermal comfort in the premises of residential and public buildings. Subsequently, to ensure the continuity and stability of the methodology for assessing the energy performance of buildings, these temperatures were not changed. Although Lithuania's various hygiene standards have been constantly improved since 2004 and the limits of indoor ambient temperature values have been adjusted, the calculated indoor temperatures in the winter and summer periods set in the methodology for calculating the energy performance of buildings remained within the comfort limits set by new hygiene standards.

In Lithuanian climatic conditions, it is possible to design buildings in such a way that there was a very low energy demand for cooling. Therefore, when setting the regulatory requirements for the energy performance of buildings, it was assumed that there should be no need for cooling in buildings. The EN ISO 13790: 2008 standard is used to calculate the energy demand for cooling in Lithuania. The calculation methodology in this standard for calculating the thermal energy demand for cooling a building has

been transferred to Annex 2 of the Lithuanian Construction Regulation STR 2.01.02: 2016. If the average building temperature calculated under this standard rises above 24 ° C, the energy consumption for cooling the building shall be calculated. These consumptions are calculated regardless of whether the building has cooling equipment or not. If there is no cooling equipment, the cooling unit with EER = 2.8 is estimated in the calculations. If cooling equipment is available, the EER of this equipment shall be assessed. The energy consumption of cooling a building increases the consumption of non-renewable primary energy and total primary energy in the building and therefore reduces the energy performance of the building. Meanwhile, the consumption of renewable primary energy by refrigeration equipment, which could improve the ratio between the consumption of renewable and non-renewable energy in the building, is not included in the calculation of this ratio.

5.a.2. Cite the reference, and share the reference in pdf format if possible.

The requirements of the following Lithuanian hygiene norms were taken into account when assessing the overheating of the premises:

- HN 42-2009 “Microclimate of residential and public premises”
- HN 69: 2003 “Thermal comfort and sufficient thermal environment in work premises. Parameter normative values and measurement requirements ”
- HN 21: 2011 “School implementing general education programs. General Health Safety Requirements ”
- HN 123: 2013 “Health safety requirements for sports club services”
- HN 111: 2001 “Boarding school for children with special needs. Hygiene norms and rules ”

The calculation methodology used in Lithuania to assess the overheating of premises and to calculate the energy demand for cooling buildings (this methodology corresponds to EN ISO 13790: 2008) can be found in the construction technical regulation STR 2.01.02: 2016 in Annex 2.

5.a.3. Is the comfort assessed based on a static comfort model (like Fanger) or an adaptive comfort model (like EN 15251 / 16798)? Explain.

5.a.4. Please fill out the following table regarding overheating in your country. Feel free to elaborate on your answers.

Table 3.7.3: Overheating assessment in Lithuania

Country	Lithuania
Climate and weather data	
Is comfort dependent on national geographic climate zones? If yes, list them.	No. Lithuania has one climate zone.
Do you have a specific comfort calculation approach for heatwaves?	No
Do you take into account the urban heat island effect?	No

Does your overheating methodology take into account future climate change weather files with extreme scenarios?	No
Occupant type and representation	
What is your comfort standard?	ISO 7730, but this standard is used for design purposes only. Comfort standards are not taken into account in the energy performance calculations of buildings. These calculations assume that the average indoor temperature of most buildings should be 20 C during the heating season and not higher than 24 C during the non-heating season.
For which building types?	For all building types.
Does your method embrace the four occupant categories (I, II, III, IV)? *	Yes
How do you represent occupancy presence in the simulation model?	This is left to the discretion of the designers.
Comfort model	
What is your overheating indicator?	Building zones (when individual building zones are excluded from the calculations) or the average indoor temperature of the whole building during the non-heating season. This temperature must not exceed 24 C for most buildings.
Is your comfort model based on an adaptive or static method?	Static
What are your overheating thresholds? and according to which standard are those thresholds defined?	Maximum 24°C for most.
Is there a distinction between naturally ventilated, air-conditioned, and mixed-mode buildings?	No
Does your model take into account local personalized heating/cooling & ventilation systems (ceiling fans, air conditioned chairs, electric heating mattresses…)?	No
Simulation model	
Is your calculation based on a static/quasi-dynamic/dynamic model? What is the calculation timestep?	Static. The calculation timestep is one month.
Is your overheating calculation based on a single or multizone model?	Single zone for all buildings.
Does your calculation distinguish sleeping rooms from other living areas?	No
Mandatory envelope requirements	
Does your method oblige the installation of external shading?	No
Does your method oblige the limitation of the window to wall ratio? If yes, what is the limit?	No
Does your method recommend a g-value? If yes, what is the limit?	No, g-values depend on the type of glazing.
* we are focusing on category II occupants for new and renovated buildings	

5.b. Do you have fuel poverty problems in your country that might influence the nZEB objective? Explain.

There is no shortage of fuel in Lithuania. NZEB can be achieved by using energy from heating networks, using renewable electricity, using biofuels, using high-efficiency heat

pumps. The use of natural gas is widespread in Lithuania, but with them, NZEB can be achieved only by using efficient gas boilers with absorption heat pumps.

5.c.1. What are the overheating criteria for nZEBs in your country?

Comfort standards are not taken into account in the energy performance calculations of buildings. We are using EN ISO 13790:2008. The calculation methodology in this standard for calculating the thermal energy demand for cooling a building has been transferred to Annex 2 of the Lithuanian Construction Regulation STR 2.01.02: 2016. If the average building temperature calculated following this standard rises above 24 ° C, the energy consumption for cooling the building shall be calculated. These consumptions are calculated regardless of whether the building has cooling equipment or not. If there is no cooling equipment, the cooling unit with EER = 2.8 is estimated in the calculations. If cooling equipment is available, the EER of this equipment shall be assessed. The energy consumption of cooling a building increases the consumption of non-renewable primary energy and total primary energy in the building and therefore worsens the energy performance of the building. Meanwhile, the consumption of renewable primary energy by refrigeration equipment, which could improve the ratio between the consumption of renewable and non-renewable energy in the building, is not included in the calculation of this ratio.

5.c.2. What is the overheating risk for nZEB (highly insulated) in your climate?

The risk of overheating in the Lithuanian climate arises if large glazing areas are installed in buildings without sun protection.

5.c.3. How do you evaluate overheating risk in nZEBs in your country? Please share the calculation method and overheating hours limit threshold.

We are using ISO 13790 to calculate the overheating. If the temperature exceeds the one specified in the Lithuanian regulation, the primary energy consumption for cooling the building is automatically estimated. In Lithuania, the normative requirement is that there must be no energy demand for cooling the building.

5.d. Can we rely on passive cooling or must include active cooling systems for nZEBs in your country?

Passive cooling is not evaluated yet.

Add something ?

In Lithuania, the energy performance class of a building is determined according to compliance with the following regulatory requirements:

1. the values of the energy efficiency indicators C1 (describing the energy efficiency of the building for heating, cooling and electricity for indoor lighting) and C2 (describing the energy efficiency of the hot water system) of the building (part thereof);

2. compliance of the specific heat loss of the building partitions with the regulatory requirements;

3. compliance of the technical indicators of recuperators with the regulatory requirements;

4. compliance of structures separating parts of the building with autonomous heating systems to the standard level of insulation;

5. compliance with the tightness of the building with the regulatory requirements;

6. compliance of thermal energy consumption for heating the building with regulatory requirements;

7. compliance of the primary energy consumption of the building with the regulatory requirements;

8. compliance of the share of energy from renewable sources with regulatory requirements (this requirement only applies to NZEB buildings).

None of these requirements take precedence. The building of the relevant energy performance class must meet all the established requirements. If a building does not meet any of the regulatory requirements, it is assigned a lower energy performance class.

The standard heat and primary energy consumption depend on the heated area of the building. The standard cost in each case is calculated according to the formulas specified in the norms by estimating the heated area Ap (m²) of the building. E.g. For 1-2 apartment buildings, the thermal energy consumption must not exceed the values indicated in Table 3.7.5:

Table 3.7.5: Thermal energy consumption threshold in Lithuania

B	A	A+	A++
$864 \cdot A_p^{-0,36}$	$568 A_p^{-0,37}$	$516 \cdot A_p^{-0,39}$	$451 \cdot A_p^{-0,39}$

Also, e.g. For 1-2 apartment buildings, the primary energy consumption must not exceed the values given in Table 3.7.6:

Table 3.7.6: Primary energy consumption threshold in Lithuania

C	B	A	A+	A++
$1237 \cdot A_p^{-0,25}$	$821 \cdot A_p^{-0,22}$	$665 \cdot A_p^{-0,21}$	$622 \cdot A_p^{-0,21}$	$546 \cdot A_p^{-0,2}$

Relevant References / key publications:

- Construction technical regulation STR 2.01.02: 2016 “Design and certification of the energy performance of buildings” (STR 2.01.02: 2016 “Pastatų energinio naudingumo projektavimas ir sertifikavimas“).
- Šadauskienė, Jolanta; Šeduikytė, Lina; Paukštys, Valdas; Banionis, Karolis; Gailius, Albinas. The role of airtightness in the assessment of building energy performance: a case study of Lithuania // Energy for sustainable development. Amsterdam: Elsevier. ISSN 0973-0826. 2016, vol. 32, p. 31-39. DOI: 10.1016/j.esd.2016.02.006. [Science Citation Index Expanded (Web of Science); Scopus;

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- Bliudzius, R.; Banionis, K.; Levinskyte, A.; Geleziunas, V. Experience of implementation of energy performance requirements for buildings in Lithuania // International conference on sustainable materials, systems and structures – SMSS 2019: Energy efficient building design and legislation: Rovinj, Croatia, 20-22 March 2019 / edited by Marina Bagarić, Ivana Banjad Pečur, Hartwig M. Künzel. Paris : RILEM, 2019. ISBN 9782351582176. eISBN 9782351582183. p. 188-195. (RILEM proceedings (PRO) ; vol. 128).
- Jonkutė, G.; Norvaišienė, R.; Banionis, K.; Monstvilas, E.; Bliūdžius, R. Management of carbon dioxide emissions in residential buildings through energy performance certification in Lithuania // 14th conference on sustainable development of energy, water and environment systems, (SDEWES), October 1-6, 2019, Dubrovnik, Croatia: book of abstracts. Zagreb : Faculty of Mechanical Engineering and Naval Architecture. ISSN 1847-7186. eISSN 1847-7178. 2019, SDEWES2019.0941, p. 455.

2.15. NERTHELANDS

Please fill out the following table regarding the status in your country. Feel free to develop the answers.

1. What is the thermal comfort limit for residential buildings in your country?

1.a.1. *Explain shortly the reference standards used in your country to evaluate thermal comfort in residential buildings.*

EN 13790. (2008)and Netherlands Technical Agreement (NTA) 8800 (2020)

1..a.2. What is your comfort standard?

ISSO 74 (2014) (not used in overheating compliance) & EN 15251

1..a.3. On what your comfort model is based?

1.a.4. What are the overheating criteria for residential buildings in your country?

There are two criteria based on two metrics 1) TO_{juli}<1 and 2) GTO<450

1..a.5. Cite the reference, and share the reference in pdf format if possible.

1.a.6. Please fill out the following table regarding overheating in your country. Feel free to elaborate on your answers.

Table 8: Overheating assessment

Criteria	Your Country
Climate and weather data	
Is comfort dependent on national geographic climate zones? If yes, list them.	No
Do you have a specific comfort calculation approach for heat waves?	No
Do you take into account the urban heat island effect?	No
Does your overheating methodology take into account future climate change weather files with extreme scenarios?	No
Occupant type and representation	
What type of building type does your comfort standard deal with?	New buildings & refurbishments – Almost Energy Neutral Buildings (in Dutch ‘‘Bijna Energie Neutrale Gebouwen” (BENG))
Does your method embrace the four occupant categories (I, II, III, IV)? *	Yes (A, B, C, & D)
How do you represent occupancy presence in the simulation model?	correction factor for occupancy time

Comfort model	
What is overheating provisions period coverage?	New and refurbishments
What is your overheating indicator?	(Static) The overheating evaluation requires the determination of dimensionless index TO_{juli}. The value is calculated depending on the façade surface per orientation. For instance, a terraced house has two outcomes, and a corner house has three outcomes. The TO_{juli} should be calculated for the month of July (Dynamic) NTA 8800 also provides a method based on the weighted limit temperature (GTO) to calculate the risk of overheating more accurately when the TO_{juli} slightly exceeds its limit value. In the GTO method, the hours of when the actual or calculated PMV exceeds the limit value of 0.5 are weighted proportional to the PPD.
Is your comfort model based on an adaptive (like EN 15251 / 16798) or static (like Fanger) method?	Static for overheating calculation (EN 15251) – but they also have hybrid ISSO 74 comfort model
What are your comfort thresholds?	ISSO 74 thresholds (but not in overheating calculation: EN 15251 static is used as thresholds while calculating GTO)
What are your overheating thresholds? and according to which standard are those thresholds defined?	● Criterion 1 (static): TOjuli < 1K ● Criterion 2 (dynamic): GTO < 450h
Is there a distinction between naturally ventilated, air-conditioned, and mixed mode buildings?	Yes
Does your model take into account local personalized heating/cooling & ventilations systems (ceiling fans, air-conditioned chairs, electric heating mattresses…)?	No
Simulation model	
Is your calculation based on a static/quasi-dynamic/dynamic model? What is the calculation timestep?	static & dynamic
Is your overheating calculation based on a single or multizone model?	Multizone
Does your calculation distinguish sleeping rooms from other living areas?	No
Mandatory envelope requirements	
Does your method oblige the installation of external shading?	No
Does your method oblige the limitation of the window to wall ratio? If yes, what is the limit?	No
Does your method recommend a g-value? If yes, what is the limit?	Yes factors determine by calculation need to be respected

* we are focusing on category II occupants for new and renovated buildings

1b. Do you have fuel poverty problems in your country that might influence overheating risk in residential buildings? Explain.

1.c.2. What is the overheating risk for residential buildings (highly insulated) in your climate?

1.c.3. How do you evaluate overheating risk in residential buildings in your country? Please share the calculation method and overheating hours limit threshold.

You can find the calculation methods in https://doi.org/10.1016/j.enbuild.2021.111463

(please check 3.2.2 for the Netherlands)

1.d. Can we rely on passive cooling or must include active cooling systems for residential buildings in your country for residential buildings?

Add something ?

Relevant References / key publications:

- https://www.nen.nl/nta-8800-2022-nl-290717

2.16. NORWAY

Please fill out the following table regarding the status in your country. Feel free to develop the answers.

1. What is the thermal comfort limit for residential buildings in your country?

1.a.1. Explain shortly the reference standards used in your country to evaluate thermal comfort in residential buildings.

In Norway, building regulations do not have quantified requirements for thermal indoor climate. The developer or users should set their own requirements, preferably by referring to categories in NS-EN 15251 with a national supplement and stating the expected activity and clothing (i.e., ‘’Air temperature is adapted to the room's function and use, and possibilities for individual control options should be strived for’’, Byggteknisk-Forskrift-TEK17). The requirements should include operating temperature, vertical temperature difference, radiation asymmetry, and air speed. As an aid to structuring user requirements, the standards NS-EN 15251 with national addition and NS 8175 have established categories for buildings. The categories (The requirement for operating temperature in

Table 10 is a calculated temperature measure that combines the effect of air temperature and radiation exchange with surrounding surfaces. The different temperature requirements between summer and winter is due to seasonal differences in clothing and that there is a certain physiological adaptation to seasonal temperature variations. In addition, it will be easier to achieve good perceived air quality and appropriate relative humidity if the indoor temperatures in winter are lower than in summer. In well-insulated buildings, the operating temperature is approximately equal to the air temperature, which is easier to measure. According to category II and III (Table 9), recommends temperature limits for different activity levels, including 19–26 ºC for light work. If individual control is possible, the interval for adjustment should be specified.

Table 9) express different expectation levels with criteria for thermal indoor climate.

Table 10**Error! Reference source not found.** shows examples of requirements that can be set for a thermal indoor climate for summer and winter. The figures are taken from categories in NS-EN 15251 with national addition. The requirement for operating temperature in

Table 10 is a calculated temperature measure that combines the effect of air temperature and radiation exchange with surrounding surfaces. The different temperature requirements between summer and winter is due to seasonal differences in clothing and that there is a certain physiological adaptation to seasonal temperature variations. In addition, it will be easier to achieve good perceived air quality and appropriate relative humidity if the indoor temperatures in winter are lower than in summer. In well-insulated buildings, the operating temperature is approximately equal to the air temperature, which is easier to measure. According to category II and III (Table 9), recommends temperature limits for different activity levels, including 19–26

ºC for light work. If individual control is possible, the interval for adjustment should be specified.

Table 9 Categories for thermal indoor climate\ air quality in NS-EN 15251 with national supplement

Category	Equivalent
in	High level of expectations. Recommended in rooms where very sensitive and vulnerable people with special needs are staying, such as the sick, infants and the elderly
ii	Normal level of expectation. Should be used in new and upgraded buildings
iii	Moderate level of expectation. Corresponds to minimum requirements from building regulations for new buildings. Can be used in existing buildings
(iv)	Does not meet any of the categories above. Should only be accepted for limited periods.

Table 10 Examples of requirements for various thermal factors. Applies to sedentary activities.

Thermal factor		Category [1)]	
		in	ii – iii
Operating temperature	Winter	21-22.5 ° C	19-24 ° C
	Summer	23.5–25.5 ° C	23-26 ° C
Interval manual temperature control		± 2 ° C	± 1 ° C
Air speed	Winter	<0.15 m / s	<0.18 m / s
	Summer	<0.18 m / s	<0.22 m / s
Vertical temperature difference		<2 ° C	<3 ° C
Radiation asymmetry	Warm roof	<5 ° C	<5 ° C
	Cold thanks	<14 ° C	<14 ° C
	Cold wall	<10 ° C	<10 ° C
	Warm wall	<23 ° C	<23 ° C
Floor temperature		19.5-28 ° C	19.5-28 ° C

[1]Category refers to NS-EN 15251

The Norwegian Technical Building Works Regulations (TEK17) recommends the operating temperatures (total effect of air temperature and thermal radiation) in Table 11 for comfortable thermal indoor climate. With the exception of situations with plant faults or other operational disturbances, it should always be possible to keep the lowest limits. On days with high outdoor temperatures, it is difficult to avoid the indoor temperature being higher than the recommended values. Exceeding the maximum limit should therefore be acceptable in hot summer periods with an outdoor air temperature above that exceeded by 50 hours in a normal year. For instance, it is accepted to deviate from these values for hot summer periods with an outdoor temperature that is exceeded by 50 hours in a normal year (TEK17, 2017).

Table 11 Recommended range of operative temperatures by Norwegian Building Regulations (TEK17).

Activity group	Easy work	Medium work	Heavy work
Temperature ° C	19-26	16-26	10-26

TEK 17 recommends the passive measures below to help in avoiding unacceptable overtemperature. The measures include:

- reduced window area in sun-exposed facades
- exposed thermal mass
- exterior sun protection
- openable windows that allow for ventilation and
- location of air intake / design of ventilation system so that temperature rise in the system due to high outdoor temperature is minimal (<2 ° C).

For residential buildings without installed cooling, a slightly higher indoor temperature should be acceptable for short periods. This is justified by the fact that residential buildings have a usage pattern that gives the user greater personal influence and the opportunity to adapt to high indoor temperatures, e.g. for lighter clothing and ventilation in the living zone. For residential construction, the requirement for a thermal indoor climate will usually be met if at least two of the above-mentioned passive measures have been implemented. Air temperature difference above 3-4 ° C between feet and head gives unacceptable discomfort, as well as daily or periodic temperature variation beyond approx. 4° C.

In Norway, the recommended relative humidity in residential building is in the range from 20-70% during summer, and 20- 40% during winter(Asphaug,Silje Kathrin. Time, Berit. Vincent Thue,Jan. Geving,Stig .Gustavsen,Arild. Mathisen,Hans Martin . Uvsløkk, 2015).

In buildings with other activities (commercial buildings), other laws and regulations (besides TEK17) are also important. See Table 12 for an overview. The overview does not include industrial jobs. The Norwegian Labour Inspection Authority, Arbeidstilsynet, states that operating temperature in the workplace should be within 19-26 °C. Furthermore, it is stated that exceedances of the highest limit should be acceptable during hot summer periods at outdoor air temperatures above 22 °C, it should not exceed 50 hours per years within the workhours (Arbeidstilsynet, 2016).

Table 12 Overview of laws, regulations and guidelines that set requirements and provide recommendations on thermal indoor climate for companies (commercial buildings)

Lover	Contains

- The Working Environment Act - Public Health Act - The Education Act	- Obliges owners of businesses and facilities to ensure that they are operated in accordance with the regulations - Gives the Norwegian Labor Inspection Authority and the municipality authority to conduct inspections, respectively
The Planning and Building Act (pbl)	- Regulates construction matters - Sets a general requirement for proper operation of technical facilities in buildings
Regulations	**Contains**
- Workplace regulations - Regulations on environmental health care - Regulations on environmental health care in kindergartens and schools etc.	Supplementary provisions on thermal indoor climate and work to ensure requirements in the laws
Internal control regulations	Instructs companies to conduct systematic HSE work
TEK17	- Requirements for thermal indoor climate for new construction, change of use and major alterations - Requirements for FDV documentation
Supervisors [1)]	**Contains**
Climate and air quality in the workplace	Norm values and recommendations for thermal indoor climate
Guide to TEK17	Guidance and pre-accepted solutions prepared by the Directorate for Building Quality (DiBK)

1) The guidelines are not legally binding, but if you choose to deviate from the benefits and recommendations provided, you must document that legal and regulatory requirements have nevertheless been met.

The requirements of TEK17 apply to new construction, change of use and major rebuilding. In older buildings, one cannot expect the indoor climate performance to be better than what the requirements were for new construction or for the last major change. When buying or renting, there is thus a risk that the premises do not satisfy the requirements that the company is obliged to meet in accordance with other regulations.

1..a.2. Cite the reference, and share the reference in pdf format if possible.

https://www.byggforsk.no/dokument/193/termisk_inneklima_betingelser_tilrettelegging_og_maalinger#i2

energies-13-00658-v2 (2).pdf

1.a.3. Is the comfort assessed based on a static comfort model (like Fanger) or adaptive comfort model (like EN 15251 / 16798)? Explain.

It should be adaptive according to EN 15251. For residential buildings without installed cooling, the Norwegian building regulations (TEK17) accept slightly higher indoor temperature than it recommends in Table 11 for short periods. This is justified by the fact that residential buildings have a usage pattern that gives the user greater personal influence and the opportunity to adapt to high indoor temperatures, e.g. for lighter clothing and ventilation in the living zone. For residential construction, the requirement for a thermal indoor climate will usually be met if at least two of the passive measures below (recommended by TEK17) have been implemented. The measures include:

- reduced window area in sun-exposed facades
- exposed thermal mass
- exterior sun protection
- openable windows that allow for ventilation and
- location of air intake / design of ventilation system so that temperature rise in the system due to high outdoor temperature is minimal (<2 ° C).

Notice: Air temperature difference above 3-4 ° C between feet and head gives unacceptable discomfort, as well as daily or periodic temperature variation beyond approx. 4° C.

1.a.4. Please fill out the following table regarding overheating in your country. Feel free to elaborate with your answers.

Table 13: Overheating assessment

Criteria	Your Country
Climate and weather data	
Is comfort dependent on national geographic climate zones? If yes, list them.	No
Do you have a specific comfort calculation approach for heat waves?	No
Do you take into account the urban heat island effect?	No
Does your overheating methodology take into account future climate change weather files with extreme scenarios?	No.
Occupant type and representation	
What is your comfort standard?	NS-EN 15251 is recommended.
For which building types?	Commercial and residential. (no industrial)

Does your method embrace the four occupant categories (I, II, III, IV)? *	Yes.
How do you represent occupancy presence in the simulation model?	Static assumptions, according to NS3031-2014 (Calculation of buildings' energy performance - Method and data), see
Comfort model	
What is your overheating indicator?	Number of hours above 26 C operative temperature
Is your comfort model based on an adaptive or static method?	Adaptive or static according to NS-EN 15251
What are your overheating thresholds? and according to which standard are those thresholds defined?	Approximately 50 hours
Is there a distinction between naturally ventilated, air-conditioned, and mixed mode buildings?	Naturally ventilated and air-conditioned, but not mixed mode.
Does your model consider local personalized heating/cooling & ventilations systems (ceiling fans, air-conditioned chairs, electric heating mattresses…)?	If possible. TEK 17 recommend the designer to follow the user requirements in line with the standard NS-EN 15251.
Simulation model	
Is your calculation based on a static/quasi-dynamic/dynamic model? What is the calculation timestep?	Dynamic
Is your overheating calculation based on a single or multizone model?	Multi-zone only if the dwelling is larger than 50m2 and have significantly different orientations for living spaces.
Does your calculation distinguish sleeping rooms from other living areas?	No. Even the new standard NS-EN 16798:2019 does not distinguish between thermal comfort adaption in different rooms in residential buildings, see.
Mandatory envelope requirements	
Does your method oblige the installation of external shading?	No. But recommended.
Does your method oblige the limitation of the window to wall ratio? If yes, what is the limit?	No. But as energy saving measure, the percentage ≤ 25% of the gross internal area is recommended by TEK17, see.
Does your method recommend a g-value? If yes, what is the limit?	No. However, the daylight requirement should be achieved. This could influence the decided g-value.
* we are focusing on category II occupants for new and renovated buildings	

1b. Do you have fuel poverty problems in your country that might influence overheating risk in residential buildings? Explain.

No

1.c.1. What are the overheating criteria for residential buildings in your country?

Number of hours that exceed the recommended upper limit temperature 26C Operative

temperature.

1.c.2. What is the overheating risk for residential buildings (highly insulated) in your climate?

The overheating risk of a typical Norwegian residential building under present-day, 2050 and 2080 weather conditions was evaluated in this study. Two different overheating evaluation criterial guidelines (the Passive House Planning Package and CIBSE TM 59) were compared, see. The following conclusions could be drawn:

Large window-to-wall ratios (WWR) are not recommended for Norwegian residential buildings. Too large WWR will result in overheating risk in the summer, particularly in the future extreme weather conditions. In the north-western oriented bedrooms with windows faced north, the use of a large WWR is not recommended.

In very airtight residential buildings, overheating risk can take place in the future climate scenarios analyzed.

1.c.3. How do you evaluate overheating risk in residential buildings in your country? Please share the calculation method and overheating hours limit threshold.

See Study 1 and study 2 as an examples.

1.d. Can we rely on passive cooling or must include active cooling systems for residential buildings in your country for residential buildings?

For residential construction, the requirement for a thermal indoor climate will usually be met if at least two of the passive measures below (recommended by TEK17) have been implemented. The measures include:

- reduced window area in sun-exposed facades
- exposed thermal mass
- exterior sun protection
- openable windows that allow for ventilation and
- location of air intake / design of ventilation system so that temperature rise in the system due to high outdoor temperature is minimal (<2 ° C).

Add something ?

Study 1, study 2, and study 3

The building regulation does not specify a correct conditions (weather file and\or use patern, etc) to evaluate the overheating.

The thermal comfort criteria is not defined well.

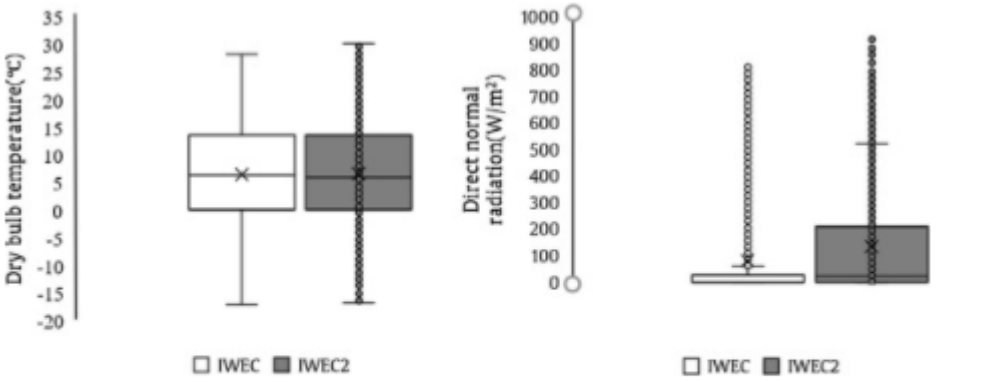

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Fig. 6. Temperature and radiation differences in the IWEC and IWEC2 weather files.

https://www.sciencedirect.com/science/article/pii/S0306261920303809#f0030

Relevant References / key publications:

2.17. POLAND

2. Please provide a map of the climatic areas in your country. Cite the source and make sure to share a high-resolution document.

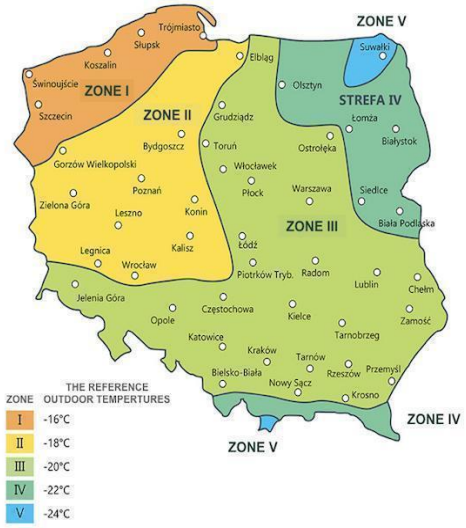

Figure 3.8.1: Climate zones of Poland

Source: https://ebrdgeff.com/poland/poradnik/modernizacja-systemu-grzewczego/

5. What is the thermal comfort limit for nZEBs in your country?

5.a.1. Explain shortly the reference standards used in your country to evaluate thermal comfort in nZEBs.

In 2019, the standards EN 16798 were implemented in Poland. In Poland, standards are not mandatory, but the guidelines described therein must be met. It means that EN 16798 rules are now obligatory. There is no national annex to these standards, which means that we are at the very beginning of using them.

Every Polish building must fulfill the criteria of the government document called ‘Warunki techniczne jakim powinny odpowiadać budynki oraz ich usytuowanie’ (Eng. ‘Technical conditions to be met by buildings and their location’). There are described the requirements for max. total energy transmittance of solar radiation of windows and glass and transparent elements.

5.a.2. Cite the reference, and share the reference in pdf format if possible.

Technical conditions to be met by buildings and their location: ‘Obwieszczenie Ministra Inwestycji i Rozwoju z dnia 8 kwietnia 2019 r. w sprawie ogłoszenia jednolitego tekstu rozporządzenia Ministra Infrastruktury w sprawie warunków technicznych, jakim powinny odpowiadać budynki i ich usytuowanie. Dz.U. 2019 poz. 1065’: https://isap.sejm.gov.pl/isap.nsf/download.xsp/WDU20190001065/O/D20191065.pdf

5.a.3. Is the comfort assessed based on a static comfort model (like Fanger) or an adaptive comfort model (like EN 15251 / 16798)? Explain.

We usually use the Fanger model. EN 15251 was implemented and obligatory only for a short period, so from 2019 the rules of EN 16798 are obligatory and it means that we should use the adaptive comfort model. The implementation of EN 16798 is very new, so Polish engineers have to meet the criteria and methods from this standard to start using them.

5.a.4. Please fill out the following table regarding overheating in your country. Feel free to elaborate on your answers.

Table 3.8.2: Overheating assessment in Poland

Country	Poland
Climate and weather data	
Is comfort dependent on national geographic climate zones? If yes, list them.	No.
Do you have a specific comfort calculation approach for heatwaves?	No.
Do you take into account the urban heat island effect?	No.
Does your overheating methodology take into account future climate change weather files with extreme scenarios?	No.
Occupant type and representation	
What is your comfort standard?	ISO 7730 EN 16798
For which building types?	Residential and non-residential.
Does your method embrace the four occupant categories (I, II, III, IV)? *	If you mean the categories of occupant expectations of the indoor environmental quality: yes, it is implemented in EN 16798.
How do you represent occupancy presence in the simulation model?	Deterministic (living and sleeping zones and schedules).
Comfort model	
What is your overheating indicator?	We do not have any.
Is your comfort model based on an adaptive or static method?	Static / Adaptive It looks like both after implementation of EN 16798.
What are your overheating thresholds? and according to which standard are those thresholds defined?	We do not have any.
Is there a distinction between naturally ventilated, air-conditioned, and mixed-mode buildings?	No
Does your model take into account local personalized heating/cooling & ventilation systems (ceiling fans, air conditioned chairs, electric heating mattresses…)?	No.
Simulation model	
Is your calculation based on a static/quasi-dynamic/dynamic model? What is the calculation timestep?	-
Is your overheating calculation based on a single or multizone model?	-

Does your calculation distinguish sleeping rooms from other living areas?	-
Mandatory envelope requirements	
Does your method oblige the installation of external shading?	External or internal – both are allowed.
Does your method oblige the limitation of the window to wall ratio? If yes, what is the limit?	We have the limitation for the minimal fenestration: in a room intended for people purposes, the ratio of the window area to the floor area should be at least 1: 8, while in another room, where daylighting is required for reasons of use - at least 1:12.
Does your method recommend a g-value? If yes, what is the limit?	Yes. No more than 0.35 during summertime.
* we are focusing on category II occupants for new and renovated buildings	

5.b. Do you have fuel poverty problems in your country that might influence the nZEB objective? Explain.

Due to official data from 2016 14.1% of Polish households in single family houses met fuel poverty. It was 3% less than in 2013, but due to actual energy prices in the market (Feb 2022), the problem may be higher again.

(https://www.gov.pl/attachment/6c6e6567-5f87-4e7a-bf5b-03861670888c)

At least 600 000 Polish pensioners have no more than 270 EUR per month. We should also include unemployment and those who work with the lowest wage. It will give the group of at least 2 500 000 adult people (add children) who have a big problem deciding if they can buy food, medicaments or fuel. If they do not have money on the base needs, they will not think about the nZEB renovation of homes.

5.c.1. What are the overheating criteria for nZEBs in your country?

We do not have overheating criteria.

5.c.2. What is the overheating risk for nZEB (highly insulated) in your climate?

The risk is the biggest in the new buildings, highly insulated and not massive (Attia et al. 2021). Poland is still dominated by large fenestration of buildings. Even in the North of Poland it influences overheating of the highly insulated buildings. The risk is lower in the massive constructions due to thermal load, the lowest risk is in single-family houses where the floors on the ground influence thermal inertia.

I live in a block of flats, made of concrete with 12 cm EPS insulation on the walls. Windows directed to North and South. The block is equipped only with natural ventilation. In the hottest period of the year (usually no longer than 2 weeks) our temperature inside is 28-32°C. A similar problem is in almost every insulated block of flats, doesn't matter if it is a new or old one.

5.c.3. How do you evaluate overheating risk in nZEBs in your country? Please share the calculation method and overheating hours limit threshold.

We do not evaluate overheating risk of any building in Poland.

5.d. Can we rely on passive cooling or must include active cooling systems for nZEBs in your country?

In massive constructions, not highly insulated, passive cooling is rather enough, but in light active cooling is needed.

Add something ?

Relevant References / key publications:

- Attia, S., Kosiński, P., Wójcik, R., Węglarz, A., Koc, D., & Laurent, O. (2021). Energy efficiency in the polish residential building stock: A literature review. Journal of Building Engineering, 103461.
- Obwieszczenie Ministra Inwestycji i Rozwoju z dnia 8 kwietnia 2019 r. w sprawie ogłoszenia jednolitego tekstu rozporządzenia Ministra Infrastruktury w sprawie warunków technicznych, jakim powinny odpowiadać budynki i ich usytuowanie.
- Zimny J. 2006. Potential of geothermal energy in Poland and Germany - state for the year 2005. Environment Protection Engineering Vol. 32 (1), pp. 209-217.

2.18. PORTUGAL

Please fill out the following table regarding the status in your country. Feel free to develop the answers.

1. What is the thermal comfort limit for residential buildings in your country?

1.a.1. Explain shortly the reference standards used in your country to evaluate thermal comfort in residential buildings.

In Portugal, thermal comfort is evaluated following ASHRAE 55, ISO 7730 or EN 16798 standards.

1..a.2. What is your comfort standard?

There is no Portuguese Thermal Comfort Standard but in the Portuguese Buildings Thermal Code, thermal comfort is considered based on maintaining the internal temperature of the house at a temperature of 18 °C for 24 hours during the entire heating season and 25 °C for 24 hours throughout the cooling season.(Ref: Despacho n.º 6476-H/2021 - Manual SCE). The Portuguese Buildings Thermal Code include the requirements of EPBD.

The Portuguese Buildings Thermal Code aims to ensure thermal comfort conditions, indoor air quality and energy efficiency of buildings. The assessment of the energy performance of buildings is carried out, taking into account the energy needs related to space heating and cooling, ventilation, domestic hot water preparation, lighting, which are determined in order to optimize, directly or indirectly, indoor air quality and health and thermal comfort of building occupants.

It is important to mention that LNEC (National Laboratory for Civil Engineering) developed an Adaptive Thermal Comfort Methodology, adapted to the Portuguese context (based on ASHRAE 55 and EN15251). This Methodology was published, in 2010, by LNEC as TPI1 65 - Desenvolvimento de um modelo adaptativo para definição das condições de conforto térmico (Development of an adaptive model to define thermal comfort conditions) (http://livraria.lnec.pt/php/livro_ficha.php?cod_produc_tirag=5372575

http://repositorio.lnec.pt:8080/jspui/bitstream/123456789/1001274/1/ENBRI%2042_LM.pdf). The use of this methodology is not mandatory and, unfortunately, not widely used.

1..a.3. On what your comfort model is based?

[1] TPI - Teses e Programas de Investigação LNEC - Theses and Research Programs LNEC

The Adaptive Thermal Comfort Methodology from LNEC was adapted to the Portuguese context based on ASHRAE 55 and EN15251. However, the use of this methodology is not compulsory. Moreover, in general, the methodology is not widely used in Portugal. Generally, ASHRAE 55, EN 16798 or ISO 7730 standards are used.

In the Portuguese Buildings Thermal Code, comfort conditions are based on a set of parameters that, when combined, express the energy performance of the building, such as:

- Location, surroundings, and climate;
- Building characterization (e.g., typologies, boundary conditions and surroundings, and dimensional survey);
- Opaque envelope (e.g., thermal transmission coefficient, thermal inertia, and solar obstruction factor);
- Glazed envelope (e.g., thermal transmission coefficient, glazed fraction, g-value, and solar radiation obstruction factor);
- Ventilation (natural, mechanical or mix-mode);
- Air conditioning and domestic hot water;
- Lighting;
- Lifting installation (elevators, escalators, moving walks);
- Other energy-consuming equipment;
- Building automation and control systems;
- Electric energy production systems.

Ref: Despacho n.º 6476-H/2021 - Manual SCE

1.a.4. What are the overheating criteria for residential buildings in your country?

In the Portuguese Buildings Thermal Code there are no specific overheating criteria.

The Portuguese Buildings Thermal Code establishes nine climate zones (I1-V1, I1-V2, I1-V3, I2-V1, I2-V2, I2-V3, I3-V1, I3-V2, I3-V3) from the different combinations of climatic severity in winter (I1, I2, and I3) and summer (V1, V2, and V3), from least severe (I1, V1) to most severe (I3, V3).

Depending on the climate zone, the Portuguese building code establishes two conditions for preventing overheating during the summer season: 1) control of the cooling needs by imposing limits according to the climatic zone; 2) Imposing a maximum value for the solar shading factor (g) in the cooling season. Mobile solar protection devices are considered to be fully activated part of the time, depending on the orientation (0 – north, 0.4 – NE/NW, 0.6 – S/E/W, 0.7 – SE/SW, 0.9 – Horizontal).

When the risk of overheating is minimized, that is, when the thermal gain utilization factor (ηv) is higher than the respective reference factor ($\eta v ref$), it is assumed that the energy needs for cooling are zero.

The reference thermal gain utilization factor in the cooling season ($\eta v ref$) varies as a function of the difference between the reference indoor temperature (θref, = 25ºC) and the average outdoor temperature (θext,), $\Delta\theta$. Taking, in general, values of 0.30 or 0.45. The utilization factor of thermal gains in the cooling season (ηv), depends on the relationship between the thermal gains (due to solar gains from the glazing and the opaque envelope and gains due to internal loads in the building) and the sum of heat transfers by transmission through the envelope and by ventilation.

1..a.5. Cite the reference, and share the reference in pdf format if possible.

The Portuguese Building Thermal Regulation is available in Decreto-Lei n.º 101-D/2020 (available at: https://files.dre.pt/1s/2020/12/23701/0002100045.pdf), Despacho n.º 6476-B/2021 and Despacho n.º 9067/2021 (available at: https://files.dre.pt/2s/2021/09/182000000/0013800188.pdf and https://files.dre.pt/2s/2021/07/126000002/0006600316.pdf).

The Manual SCE (Building Energy Certification System Manual) has all the Portuguese Building Thermal Regulation (available for download at: https://www.sce.pt/wp-content/uploads/2021/07/Manual-SCE.pdf or at: https://files.dre.pt/2s/2021/07/126000002/0006600316.pdf)

1.a.6. Please fill out the following table regarding overheating in your country. Feel free to elaborate on your answers.

Table 14: Overheating assessment

Criteria	Your Country
<u>Climate and weather data</u>	
Is comfort dependent on national geographic climate zones? If yes, list them.	Portuguese Building Thermal code defines nine climate zones, from the different combinations of climatic severity in winter (I1, I2, and I3) and summer (V1, V2, and V3), from least severe (I1, V1) to most severe (I3, V3), for the calculation of buildings energy needs. - Heating season climate zones: I1: GD ≤ 1300 ºC I2: 1300 ºC < GD ≤ 1800 ºC I3: GD > 1800 ºC - Cooling season climate zones: V1: Θext,v ≤ 20 ºC V2: 20 ºC < Θext,v ≤ 22 ºC V3: Θext,v > 22 ºC **Before Ref: Despacho n.º 6476-H/2021 - Manual SCE** GD – Degree-day for heating based on 18ºC indoor temperature

	Θext,v – average outdoor temperature in the conventional cooling season (four months: June, July, August and September) The reference indoor temperature for all the climatic zones is 18ºC in winter and 25ºC in summer. There is also some variation about the limitation concerning the altitude and the proximity of the seacoast (these variations are included in the calculation of the simulation)
Do you have a specific comfort calculation approach for heat waves?	No
Do you take into account the urban heat island effect?	No
Does your overheating methodology take into account future climate change weather files with extreme scenarios?	There is no overheating methodology in the Building Thermal Performance Legislation.
<u>Occupant type and representation</u>	
What type of building type does your comfort standard deal with?	There is no Portuguese Thermal Comfort Standard but the buildings thermal code deals with comfort issues in all types of buildings, residential and non-residential.
Does your method embrace the four occupant categories (I, II, III, IV)? *	There is no Portuguese Thermal Comfort Standard. LNEC Thermal Comfort Methodology considers two situations when the heating/cooling system is ON or OFF.
How do you represent occupancy presence in the simulation model?	In the Portuguese Building Thermal Code for residential buildings, occupancy is considered as an internal heating load (occupancy, lighting and equipment correspond to a heating load of 4 W/m^2).For non-residential buildings this value is 7 W/m^2
<u>Comfort model</u>	
What is overheating provisions period coverage?	There are no overheating periods considered in the Portuguese Building Thermal Code. New buildings must follow the limitation about the comfort thresholds. When there is a renovation the regulation is less demanding about the limitations based on building characteristics (age, climate zone, …)
What is your overheating indicator?	There is no Portuguese Thermal Comfort model. In the Portuguese Buildings Thermal Code, the reference value for the indoor temperature in summer is 25ºC.Whenever the temperature goes up this value, a cooling need is assumed and calculated. The cooling needs are limited to a maximum value depending on the climatic zone and on the thermal inertia of the building.
Is your comfort model based on an adaptive (like EN 15251 / 16798) or static (like Fanger) method?	The non-official LNEC methodology, that is not mandatory, is based on ASHRAE 55 and EN 15251. The official is based on a static model (Fanger)
What are your comfort thresholds?	Portuguese Building Thermal Code Residential buildings:

	- Heating season: 18 ºC - Cooling season: 25 ºC and 50% of relative humidity **Ref: Despacho n.º 6476-H/2021 - Manual SCE** + minimum requirements for the residential building envelope (maximum U-values, maximum g-value, windows, .. see below)
What are your overheating thresholds? and according to which standard are those thresholds defined?	There are no overheating thresholds considered in the Portuguese Building Thermal Code unless the one related to the maximum cooling needs allowed that depend on the climatic zone and on the thermal inertia of the building.
Is there a distinction between naturally ventilated, air-conditioned, and mixed mode buildings?	In the Portuguese Building Thermal Code, are considered naturally and mechanically ventilated mix-mode, acclimatized and non-acclimatised buildings. Most residential buildings don't have cooling or mechanical ventilation systems LNEC adaptive thermal comfort methodology, not compulsory and non-official, considers situations when the heating/cooling system is ON or OFF.
Does your model take into account local personalized heating/cooling & ventilations systems (ceiling fans, air-conditioned chairs, electric heating mattresses…)?	No.
<u>Simulation model</u>	
Is your calculation based on a static/quasi-dynamic/dynamic model? What is the calculation timestep?	The energy performance of residential buildings is calculated using a steady-state methodology based on EN ISO 13790, with a seasonal calculation method. It is used for residential buildings. We do calculations for both winter and summer. The winter calculations are done for a period that depends on the severity of the climatic conditions, varying from 2.9 months in the Azores islands (mildest climate) to 7.5 months in Serra da Estrela (coldest climate). The summer calculations are done, for the whole territory, for a period of 4 months (June, July, August and September, corresponding to 2928 hours). The calculation of the energy performance of office and commercial buildings must be done, for one year (8760 hours), with dynamic simulation (single or multi-zone) according to the methodology defined in the standard EN 15232-1, using programs accredited by ASHRAE 140, with an hourly or lower time step.
Is your overheating calculation based on a single or multizone model?	There is no overheating calculation in the Portuguese Building Thermal Code.
Does your calculation distinguish sleeping rooms from other living areas?	Not in residential buildings
<u>Mandatory envelope requirements</u>	

Does your method oblige the installation of external shading?	External shading systems are not mandatory but, shading systems (external or internal) or special glazing (except for north-facing windows or when $A_{window} \leq 55\ A_{floor}$).will be required to comply with the maximum g-value defined in the Portuguese Building Thermal Code (Portaria n.º 138-I/2021(Portaria n.º 138-I/2021 https://files.dre.pt/1s/2021/07/12602/0001200053.pdf), which defines the minimum energy performance requirements for the building envelope), depending on the climate zone, thermal inertia and orientation.
Does your method oblige the limitation of the window to wall ratio? If yes, what is the limit?	No, but when the windows area is greater than 15% of the floor area they serve, there are special requirements regarding shading.
Does your method recommend a g-value? If yes, what is the limit?	Maximum admissible g-value of glazing for residential buildings: - Low thermal inertia: 0.15 for V1 climate zone 0.10 for V2 climate zone 0.10 for V3 climate zone - Medium or high thermal inertia: 0.56 for V1 climate zone 0.56 for V2 climate zone 0.50 for V3 climate zone **Ref:** Portaria n.º 138-I/2021
* we are focusing on category II occupants for new and renovated buildings	

1b. Do you have fuel poverty problems in your country that might influence overheating risk in residential buildings? Explain.

Portugal has a high level of Energy Poverty (around 17% of the population, and this figure is expected to increase due to the current energy crisis and climate changes). However, in general, this influences mostly the heating season.

In Portuguese climate conditions, traditional and passive architecture shows reduced cooling energy needs, due to the high thermal inertia, use of shading devices and the use of night cooling. However, in 2022, during the summer heat waves, the traditional technics and thermal inertia were not enough to prevent thermal discomfort, thus the risk of increasing use of cooling systems and fuel poverty during summer might increase.

However, most of the Portuguese residential buildings do not have cooling systems (and the oldest ones also do not have heating systems, or thermal insulation in the envelope, and inhabitants use portable electric heaters during short periods). Wood-burning fireplaces (most of them open ones) are common throughout the country.

1.c.2. What is the overheating risk for residential buildings (highly insulated) in your

climate?

Most of the Portuguese building stock was built before the first Building Thermal Code became into force (1991), thus does not have thermal insulation in the envelope. The more recent and retrofitted buildings have thermal insulation in the envelope but are not highly insulated. The Building Thermal Code considers and imposes requirements for both the heating and cooling seasons.

Portuguese Building Thermal Code limits cooling energy needs and the total solar energy transmittance for windows with active shading devices, established as maximum values that are a function of thermal inertia and climatic zones, which could not be adequately preventive to avoid indoor overheating conditions. Nevertheless, for Portuguese climate conditions, traditional and passive architecture shows reduced cooling energy needs and thermal comfort conditions are ensured for most of the occupied period of residential buildings.

Non-residential buildings, with high internal loads, high glazing areas, and some with medium or low thermal inertia present a risk of overheating.

1.c.3. How do you evaluate overheating risk in residential buildings in your country? Please share the calculation method and overheating hours limit threshold.

There is no overheating risk evaluation methodology being used in Portugal. The cooling needs are very small when compared with the heating needs and usually the risk of overheating is small mainly due to the high thermal inertia of the traditional buildings and night ventilation techniques. However, this may change due to the more frequent and intensive heat waves.

1.d. Can we rely on passive cooling or must include active cooling systems for residential buildings in your country for residential buildings?

Portuguese thermal building code limits cooling energy needs and the total solar energy transmittance for windows with active shading devices established as maximum values that are a function of thermal inertia and climatic zones.

These techniques might not be enough to prevent indoor overheating conditions during heat waves and in climate change scenarios. Nevertheless, for Portuguese climate conditions, traditional and passive architecture shows reduced cooling energy needs, and thermal comfort conditions are ensured for most of the occupied periods of residential buildings.

Add something ?

Overheating used not to be an issue in Portugal (cooling needs represent less than 10% of the demand) because the buildings have generally high thermal inertia, shading devices are generally used together with good night ventilation techniques (usually

there is no mechanical system at home for cooling or ventilation). Regulations are also very demanding regarding windows performance and shading.

In the previous regulation, the reference indoor temperature for all the climatic zones was 20ºC in winter.

Thermal calculations in office and in residential buildings are strongly different.

The price of electricity is one of the most expensive prices in Europe, which intensifies issues about energy poverty (and the capacity of families to cool and heat)

Relevant References / key publications:

2.19. ROMANIA

2. Please provide a map of the climatic areas in your country. Cite the source and make sure to share a high-resolution document.

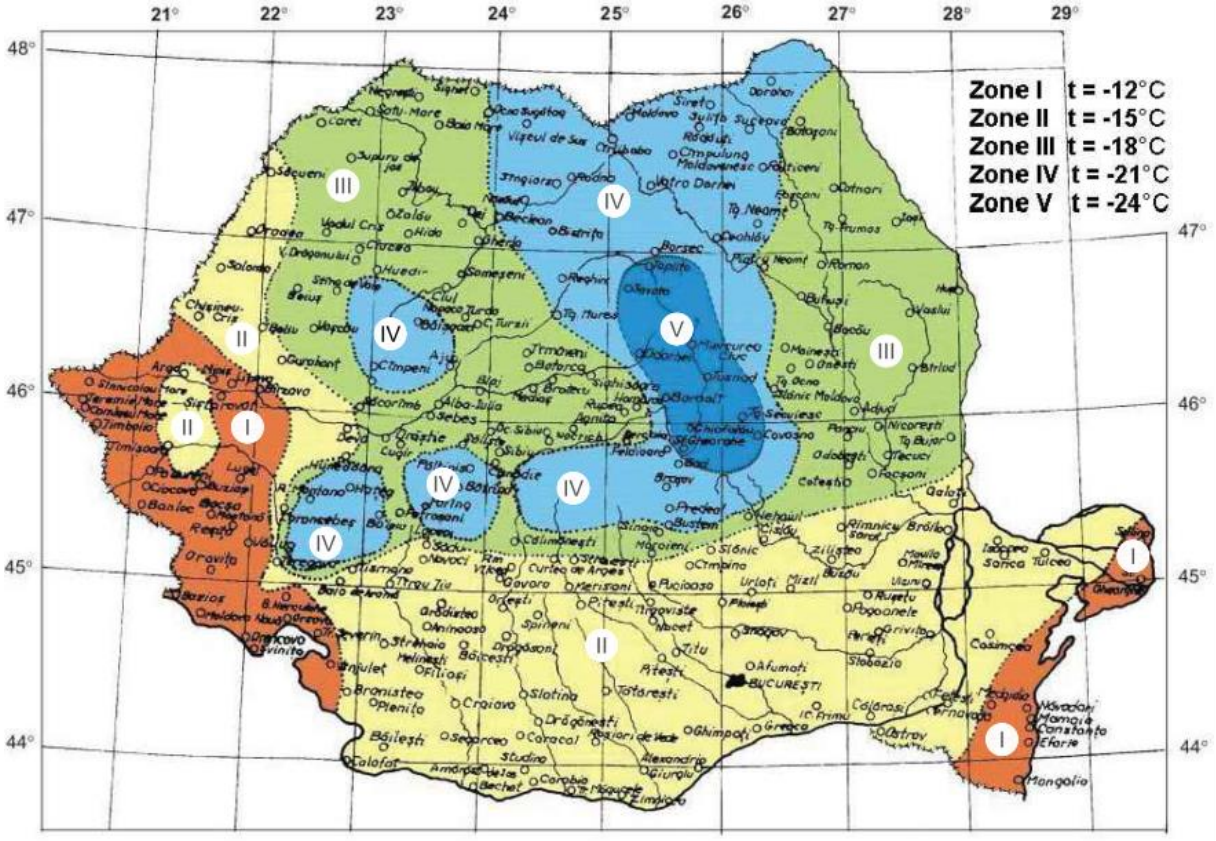

Figure 3.9.1: Climate zones of Romania

Source : Ministerul Dezvoltarii Regionale si Administratiei Publice, 2016.

5. What is the thermal comfort limit for nZEBs in your country?

5.a.1. Explain shortly the reference standards used in your country to evaluate thermal comfort in nZEBs.

In Romania, thermal comfort is addressed in several standards and normative:

- SR EN ISO 7730:2006 establishes the methodology for the analytical determination and interpretation of thermal comfort by calculating the PMV and PPD indices and specifying the local thermal comfort criteria based on the room characteristics (surfaces, thermal insulation), the thermal resistance of the clothing, and metabolic heat (Asociatia de Standardizare din Romania, 2006)
- Normative I5-2010 for the design, execution, and operation of ventilation and air conditioning installations establishes, based on the calculated values off PMV and PPD indices, four ambient categories: I - High level recommended for occupied spaces very sensitive and fragile, which have specific requirements,

such for example sick, disabled, young children, people in age; II - Normal level recommended for new or renovated buildings; III - Moderately acceptable level, recommended in existing buildings and IV - Level other than the above; recommended to be accepted for limited periods

- SR EN 16798-1:2019 is the most recent development in the field of the energy performance of buildings. This standard focuses on setting new rules and requirements for indoor environmental parameters for the thermal environment, indoor air quality, lighting, and acoustics and explains how to use these parameters for building system design and energy performance calculations. In terms of thermal comfort, it relies on ASHRAE 55 and ISO 7730 standards.

5.a.2. Cite the reference, and share the reference in pdf format if possible.

The Standards cannot be shared. The Normative is attached.

5.a.3. Is the comfort assessed based on a static comfort model (like Fanger) or an adaptive comfort model (like EN 15251 / 16798)? Explain.

The assessment methodology is based on Fanger static comfort model

5.a.4. Please fill out the following table regarding overheating in your country. Feel free to elaborate on your answers.

Table 3.9.5: Overheating in Romania

Country	Romania
Climate and weather data	
Is comfort dependent on national geographic climate zones? If yes, list them.	Yes: I, II, III, IV and V.
Do you have a specific comfort calculation approach for heatwaves?	No.
Do you take into account the urban heat island effect?	No.
Does your overheating methodology take into account future climate change weather files with extreme scenarios?	No.
Occupant type and representation	
What is your comfort standard?	SR EN 7730:2006 SR EN 16798-1:2019
For which building types?	Residential and commercial.
Does your method embrace the four occupant categories (I, II, III, IV)? *	No.
How do you represent occupancy presence in the simulation model?	The entire building is considered either continuously or intermittently used.
Comfort model	
What is your overheating indicator?	Only through PMV indices calculated through SR EN 7730:2006.
Is your comfort model based on an adaptive or static method?	Static.
What are your overheating thresholds? and according to which standard are those thresholds defined?	Operating temperature values between 20 and 27°C for different destinations and ambient categories according to SR EN ISO 16798-1:2019.

Is there a distinction between naturally ventilated, air-conditioned, and mixed-mode buildings?	Yes.
Does your model take into account local personalized heating/cooling & ventilation systems (ceiling fans, air-conditioned chairs, electric heating mattresses…)?	No.
Simulation model	
Is your calculation based on a static/quasi-dynamic/dynamic model? What is the calculation timestep?	Static / Quasi-dynamic / Dynamic Hourly simulations.
Is your overheating calculation based on a single or multizone model?	Single zone / Multizone
Does your calculation distinguish sleeping rooms from other living areas?	Yes.
Mandatory envelope requirements	
Does your method oblige the installation of external shading?	The installation of external/internal shading devices is recommended but not mandatory.
Does your method oblige the limitation of the window to wall ratio? If yes, what is the limit?	No, a window to floor ratio is imposed to ensure a minimum level of natural light with values between 1/3 and 1/14 according to the room destination (STAS 6221-89).
Does your method recommend a g-value? If yes, what is the limit?	Yes. Values range between 0.30 and 0.68 W/m3 K depending on the number of floors of the building (between 10 or higher and 1) and the envelope surface to building volume ratio (between 0.15 and higher than 1.10) according to C107-2005.
* we are focusing on category II occupants for new and renovated buildings	

5.b. Do you have fuel poverty problems in your country that might influence the nZEB objective? Explain.

According to EU Energy Poverty Observatory (2020), Romania's concerted effort to improve existing building stock through programs partially funded by the European Union may have contributed to a decrease in energy poverty in recent years. Thus, the population unable to keep the home adequately warm has significantly decreased since 2008 from 24.4% to 9.6% in 2018, comparable with the EU average (7.3%). Meanwhile, the arrears on utility bills increased between 2008 and 2013, reaching 29.7%, followed by a considerable decrease to 14.4% in 2018, while the respective EU average is significantly lower at 6.6%. The population share that spends a high part of their income on energy expenditure is 16.9%, slightly higher than the EU average which is 16.2%. In this context, the willingness to pay for nZEB may be reduced, incentives from the government being required.

5.c.1. What are the overheating criteria for nZEBs in your country?

There are no specific overheating criteria for nZEBs in Romania. SR EN ISO 16798-1:2019 establishes operating temperature values between 20 and 27°C depending on the building destination and ambient categories.

5.c.2. What is the overheating risk for nZEB (highly insulated) in your climate?

An experimental assessment of the overheating in an nZEB, the Laboratory building L7 of the R&D Institute of the Transilvania University of Brasov (cold mountain area), was performed by Moldovan et al. (2017). A 228 m2 open office with Eastern and western curtain walls was kept without any cooling in 2013 to evaluate the overheating. To measure the indoor temperature, 31 wireless temperature sensors were installed, and the measurements were performed every five minutes. The results showed that the indoor temperatures exceeded the comfort threshold of 24°C in the period May – to September. Given the occurrence of the overheating of nZEB in a cold mountain area, it is expected that this will happen in areas with higher temperatures.

5.c.3. How do you evaluate overheating risk in nZEBs in your country? Please share the calculation method and overheating hours limit threshold.

TRNSYS simulations performed to evaluate the overheating occurring in an NZEB, the Laboratory building L7 of the R&D Institute of the Transilvania University of Brasov were experimentally validated (Moldovan et al., 2017). Thus, TRNSYS simulations based on in-field climatic data are recommended.

5.d. Can we rely on passive cooling or must include active cooling systems for nZEBs in your country?

In the above study (Moldovan et al., 2017), natural night ventilation allowed significant savings in cooling energy consumption during 2014, as high as 97% in June, 73% in July, 33% in August, and 82% in September, proving that passive cooling could be effective three months in the Summer but active cooling must be included.

Add something ?

Relevant References / key publications:

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- Ministerul Mediului. (2018a). “Ordinul 1287/2018 pentru aprobarea Ghidului de finantare a Programului privind instalarea sistemelor de panouri fotovoltaice pentru producerea de energie electrica, in vederea acoperirii necesarului de consum si livrarii surplusului in reteaua nationala”. Monitorul Oficial nr. 1061 din 14 decembrie 2018
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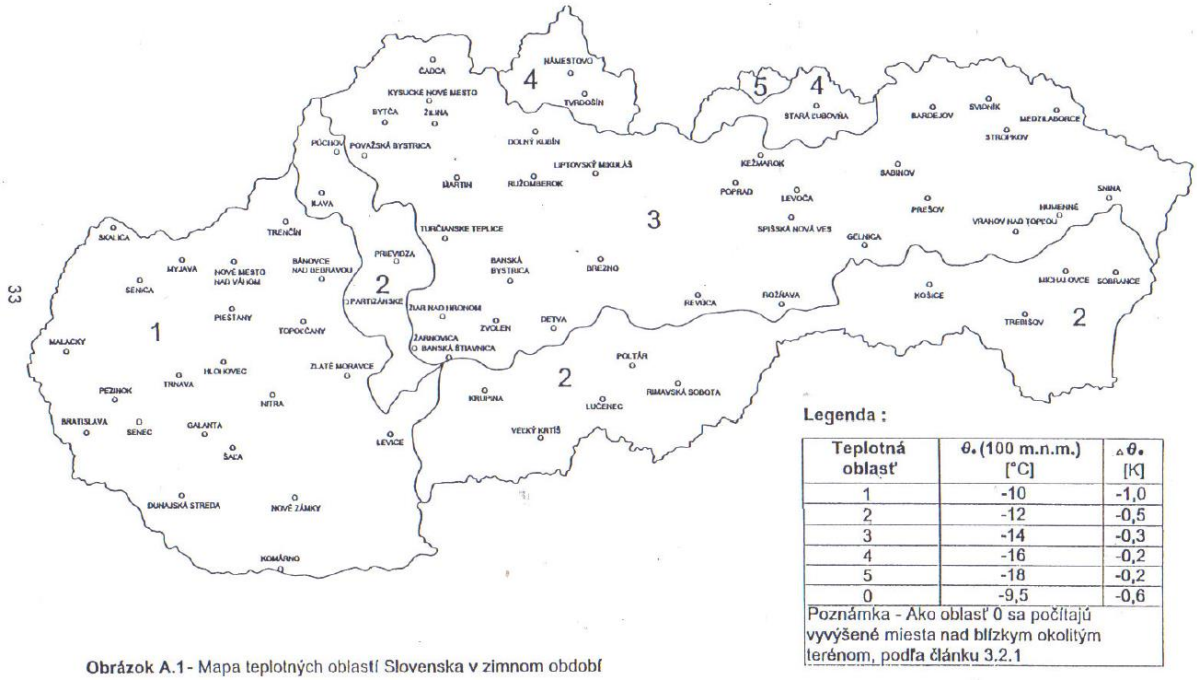
2.20. SLOVAKIA

2. Please provide a map of the climatic areas in your country. Cite the source and make sure to share a high-resolution document.

There are different approaches for the climatic areas in Slovakia that depend on the purpose of particular building physics, thermal, and/or energy evaluation. Depending on the purpose, various input parameters can be used in this regard.

Slovakia is divided into five (six) zones depending on outdoor winter design temperature, e.g. when assessing building envelope structures. This is not applied for energy performance calculations, where normalized values are used for the whole country (see. 4.a.).



Obrázok A.1 - Mapa teplotných oblastí Slovenska v zimnom období

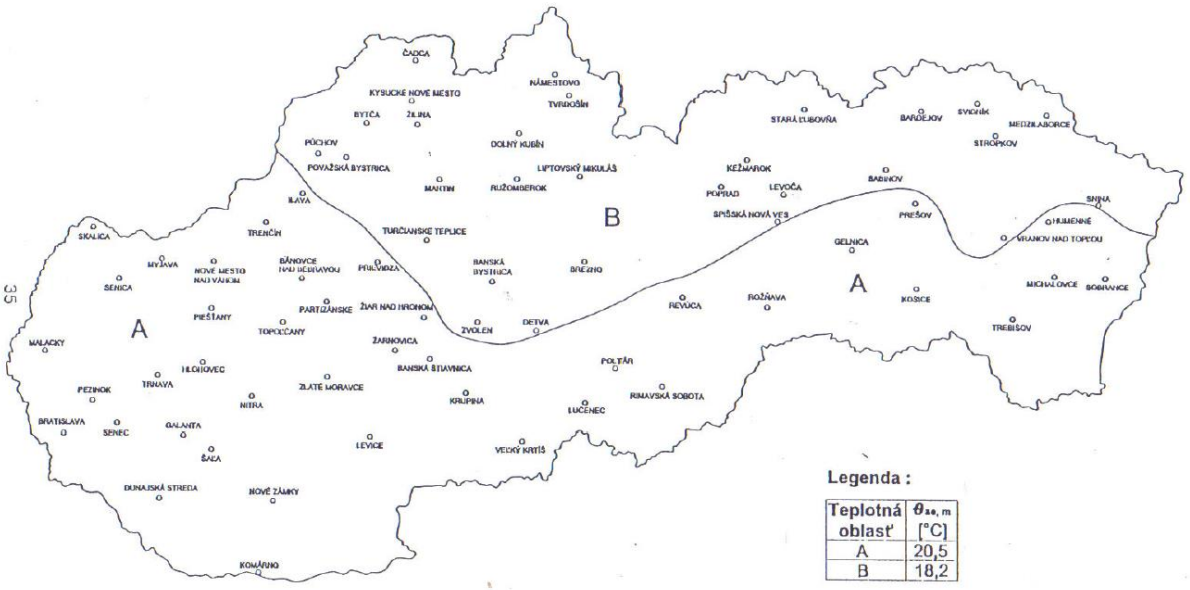
Figure 3.10.1: Temperatures areas in Slovakia in winter

Here is the translated legend:

Table 3.10.2: Temperatures areas in Slovakia in winter (legend)

Climatic zone	θ_e (100 MSL) [°C]	gradient $\Delta\theta_e$ [K] above 100 MSL
1	- 10.0	- 1.0
2	- 12.0	- 0.5
3	- 14.0	- 0.3
4	- 16.0	- 0.2
5	- 18.0	- 0.2
0	- 9.5	- 0.6
0 - elevated slope and mountain ridge areas (50 m above the plain, valley or basin)		

The thermal stability of a room in the summer period is based on a standard related to the thermal protection of buildings (STN 73 0540-3) [4].



Obrazok A.3 - Mapa teplotných oblastí Slovenska v letnom období

Figure 3.10.2: Temperature areas in Slovakia in summer

The average daily air external temperature $\Delta\theta_{ae,m}$ = 20.5°C for climatic zone A, $\Delta\theta_{ae,m}$ = 18.2°C for climatic zone B [4].

5. What is the thermal comfort limit for nZEBs in your country?

5.a.1. Explain shortly the reference standards used in your country to evaluate thermal comfort in nZEBS.

There is no particular standard specifically focused on nZEB. In Slovakia, for all buildings, the mandatory indoor air quality and temperature-humidity microclimate requirements are defined in Decree no. 259/2008 Coll [7] (residential building or housing). It defines the required ventilation rate in rooms without harmful pollutants and with smoking restrictions, with long-term occupation by people with metabolic activity within the classes 0 to 1a (relaxed lying or sitting or standing with minimum activity). For non-residential or work, Decree no. 99/2016 Coll [8] applies (describing health protection conditions at work), which defines working conditions (e.g., in the range of optimal and minimum/maximum temperature values) based on the work classes (1 to 4).

5.a.2. Cite the reference, and share the reference in pdf format if possible.

STN EN 16798-1: 2019 Energy performance of buildings - Ventilation for buildings - Part 1: Indoor environmental input parameters for design and assessment of energy performance of buildings addressing indoor air quality, thermal environment, lighting,

and acoustics - Module M1-6 [9]

STN 73 0540-2 – Thermal protection of buildings. Thermal performance of buildings and components.

STN EN ISO 13790/NA: 2010 – Energy performance of buildings

Legislation: Decree no. 259/2008 Coll. [7] and Decree no. 99/2016 Coll. [8]

Standards: STN EN 16798-1 [9], TNI CEN/TR 16798-2 [10], STN EN ISO 7730 [11]

5.a.3. Is the comfort assessed based on a static comfort model (like Fanger) or an adaptive comfort model (like EN 15251 / 16798)? Explain.

STN EN 16798 standard series (localization of EN 16798) is valid and applicable in Slovakia. According to STN EN 16798-1 [9], both static and adaptive models can be used. However, national regulations consider only the PMV/PPD model.

5.a.4. Please fill out the following table regarding overheating in your country. Feel free to elaborate on your answers.

Table 3.10.4: Overheating assessment in Slovakia

Country	Slovakia
Climate and weather data	
Is comfort dependent on national geographic climate zones? If yes, list them.	Yes. Mild climate zone - most of the Slovak Republic. 3 Climate areas: - warm region - south (Danubian Lowland) - cold area - north (high mountains) - mild area
Do you have a specific comfort calculation approach for heatwaves?	No.
Do you take into account the urban heat island effect?	No.
Does your overheating methodology take into account future climate change weather files with extreme scenarios?	No.
Occupant type and representation	
What is your comfort standard?	ISO 7730 STN EN 16798-1
For which building types?	Residential and commercial.
Does your method embrace the four occupant categories (I, II, III, IV)? *	Yes.
How do you represent occupancy presence in the simulation model?	It is possible (not mandatory) to include occupants' schedules for energy calculations (e.g. Annex C STN EN 16798-1).
Comfort model	
What is your overheating indicator?	If the room operative temperature is above the limits as defined in relevant standards and national regulations: IoH;ztc,m ISO 52016-1
Is your comfort model based on an adaptive or static method?	Static.

What are your overheating thresholds? and according to which standard are those thresholds defined?	Based on Decree no. 259/2008 Coll. and 99/2016 Coll. The limit depends on the type of activity (several categories of activity are defined) as optimal and maximum values (more details see Figure 3.10.4 below).
Is there a distinction between naturally ventilated, air-conditioned, and mixed-mode buildings?	Yes, if STN EN 16798-1 is used. No, if a national regulation is used.
Does your model take into account local personalized heating/cooling & ventilation systems (ceiling fans, air-conditioned chairs, electric heating mattresses…)?	No.
Simulation model	
Is your calculation based on a static/quasi-dynamic/dynamic model? What is the calculation timestep?	Dynamic model & hourly calculations.
Is your overheating calculation based on a single or multizone model?	Single zone. The assessment is performed only for a "critical room".
Does your calculation distinguish sleeping rooms from other living areas?	Yes.
Mandatory envelope requirements	
Does your method oblige the installation of external shading?	No. However, specific conditions may apply (see c.2.).
Does your method oblige the limitation of the window to wall ratio? If yes, what is the limit?	No. However, specific conditions may apply (see c.2.).
Does your method recommend a g-value? If yes, what is the limit?	No
* We are focusing on category II occupants for new and renovated buildings	

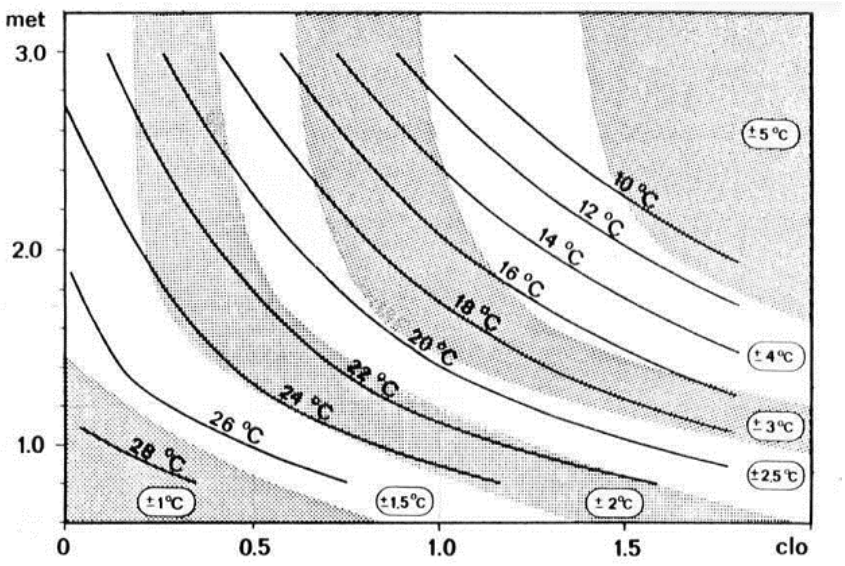


Figure 3.10.4: Areas of optimal and maximum operative temperature depending on clothing (clo) and activity (met) - 1 met = 58.2 W.m^{-2}; 1 clo = 0.155 m^2.W.K^{-1}

5.b. Do you have fuel poverty problems in your country that might influence the nZEB objective? Explain.

A definition of energy poverty is already established under Act No. 250/2012 Coll. [12] as a status when average monthly expenditures of household on the consumption of electricity, gas, heating, and hot water production represent a substantial share of the

household's average monthly income. According to EU SILC 2017, there were 12.4 % of the population in Slovakia at-risk-of-poverty (more than 650 thousand persons) [13]. In addition, according to qualified estimates, more than 20% of household income is spent on housing, which is just below the European Union average [14]. A large part of the cost is energy. In 2019, the last discussed government document on the protection of consumers in energy poverty suggested 10% of the energy expenditure from the average household income. Based on a recently published report on this matter, the Regulatory Office for Network Industries recommends some suggestions [15]. It is necessary to deal with the insufficient degree of thermal performance of residential and family houses. The provision of adequate housing for certain social groups, such as pensioners, is equally important as well. Social changes have led to retirees living alone in two-generation households today. The costs in such houses represent a really large part of their expenses. In particular, the support of energy efficiency should be the preferred approach. This should reflect lower energy bills as well as better energy availability for low-income groups long term.

5.c.1. What are the overheating criteria for nZEBs in your country?

Overall, there are no particular requirements on nZEBs in this relation in terms of Slovak legislation. Overheating criteria are valid for all building types, independently on the nZEB. Again, it should be noted that from 1 January 2021, nZEB will be standard in Slovakia. The valid and relevant standards are STN EN 16798-1 and STN EN ISO 7730. However, the most important documents are national regulations. The comfort limit is based on these regulations' PMV/PPD model. The limit depends on the type of activity (several categories of activity are defined). This means, for instance, that for sleeping and reclining, the upper limit in occupied rooms is 26°C in winter and 28°C in summer. It is 24°C in winter and 27°C in summer for light activity.

5.c.2. What is the overheating risk for nZEB’s (highly insulated) in your climate?

There is no reliable source on this matter; however, it can be considered in general that the more thermal protection used, the higher the overheating risk may occur. The risk could be quite high because designers and stakeholders (especially residential buildings) still focus on maximizing the thermal protection of a building and winter solar gains (to meet heating demand). However, completely neglect summer thermal comfort (external shading, passive cooling, air conditioning, etc.). Therefore, summer overheating is considered a highly relevant issue and will be further emphasized by ongoing climate change. There are currently various initiatives, even at the level of strategic government documents, addressing this by promoting green infrastructure, green roofs and facades, greenery in general, etc.

5.c.3. How do you evaluate overheating risk in nZEBs in your country? Please share the calculation method and overheating hours limit threshold.

Overall, overheating/cooling is not commonly and adequately addressed in Slovak

buildings during the designing process. Under Decree no. 259/2008 Coll., the evaluation of the temperature-humidity microclimate must be objective either based on measured values or if the following conditions are reached:

- a) the calculation proves compliance with the requirements for thermal performance of building structures and for the thermal stability of the room according to the relevant technical standards,
- b) in the winter season, the heating system ensures optimal microclimatic conditions,
- c) the total area of the building openings does not exceed 40% of the area of the envelope structures of the room,
- d) openings oriented to the Sun shall have an installation of external shading.

This means that buildings are not necessarily subjected to more detailed analysis, and the conditions mentioned above can be applied to address this issue easily and be simplified.

5.d. Can we rely on passive cooling or include active cooling systems for nZEBs in your country?

Following Slovak regulation [7], in areas intended for the long-term stay of people, optimal conditions of the thermal-humidity microclimate need to be ensured in the warm and cold periods of the year. The assumption of optimal microclimatic conditions should be achieved by the proper building design; if the design (solution) of the building does not allow it, these conditions must be ensured by technical equipment (heating and/or cooling system). Generally speaking, a concept of no cooling system installed should be preferred.

Add something ?

Relevant References / key publications:

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[2] Vyhláška č. 364/2012 Z.z. ktorou sa vykonáva zákon č. 555/2005 Z. z. o energetickej hospodárnosti budov a o zmene a doplnení niektorých zákonov v znení neskorších predpisov (the Decree no. 364/2012 Coll. implementing Act No. 555/2005 Coll. on the energy performance of buildings and on the amendment of certain laws as amended by Decree no. 35/2020 from 11 February 2020), Bratislava, Ministry of Transport and Construction of the Slovak Republic

[3] Standard STN 73 0540-2/Z1+Z2. (2019). Tepelná ochrana budov Tepelnotechnické vlastnosti stavebných konštrukcií a budov Časť 2: Funkčné požiadavky (Thermal protection of buildings. Thermal performance of buildings and components. Part 2: Functional requirements), Bratislava: Slovak Office for Standardization, Metrology and Testing, 36 p. (not available without a fee) (in Slovak)

[4] Standard STN 73 0540-3. (2012) Tepelná ochrana budov Tepelnotechnické vlastnosti stavebných konštrukcií a budov Časť 3: Vlastnosti prostredí a stavebných výrobkov (Thermal protection of buildings. Thermal performance of buildings and components. Part 3: Properties of the building environment and products), Bratislava: Slovak Office for Standardization, Metrology and Testing, 68 p. (not available without a fee) (in Slovak)

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[6] Standard STN EN ISO 13790/NA. (2010) Energetická hospodárnosť budov. Výpočet potreby energie na vykurovanie a chladenie (Energy performance of buildings. Calculation of energy use for space heating and cooling)

[7] Vyhláška č. 259/2008 Z.z. o podrobnostiach o požiadavkách na vnútorné prostredie budov a o minimálnych požiadavkách na byty nižšieho štandardu a na ubytovacie zariadenia (Decree no. 259/2008 Coll. About the details of the requirements for the indoor environment of buildings and of the minimum requirements for lower standard dwellings and accommodation), Bratislava, Ministry of Health of Slovak Republic, from 18. June 2008

[8] Vyhláška č. 99/2016 Z.z. o podrobnostiach o ochrane zdravia pred záťažou teplom a chladom pri práci (Decree no. 99/2016 Coll. About the details on details of the protection of health against heat and cold at work), Bratislava, Ministry of Health of Slovak Republic, from 27. January 2016

[9] Standard STN EN 16798-1. (2019). Energetická hospodárnosť budov. Vetranie budov. Časť 1: Vstupné údaje o vnútornom prostredí budov na navrhovanie a hodnotenie energetickej hospodárnosti budov – kvalita vzduchu, tepelný stav prostredia, osvetlenie a akustika. Modul M1-6 (Energy performance of buildings - Ventilation for buildings - Part 1: Indoor environmental input parameters for design and assessment of energy performance of buildings addressing indoor air quality, thermal environment, lighting and acoustics - Module M1-6)

[10] TNI CEN/TR 16798-2. (2019) Energetická hospodárnosť budov. Vetranie budov. Časť 2: Interpretácia požiadaviek v EN 16798-1. Vstupné údaje o vnútornom prostredí budov na navrhovanie a hodnotenie energetickej

hospodárnosti budov – kvalita vzduchu, tepelný stav prostredia, osvetlenie a akustika. (Modul M1-6), (Energy performance of buildings - Ventilation for buildings - Part 2: Interpretation of the requirements in EN 16798-1 - Indoor environmental input parameters for design and assessment of energy performance of buildings addressing indoor air quality, thermal environment, lighting and acoustics (Module M1-6))

[11] Standard STN EN 7730. (2005) Ergonómia tepelného prostredia. Analytické určovanie a interpretácia tepelnej pohody pomocou výpočtu ukazovateľov PMV a PPD a kritérií miestnej tepelnej pohody. (Ergonomics of thermal environment – Analytical determination and interpretation of thermal comfort using calculation of the PMV and PPD indices and local thermal comfort criteria).

[12] Zákon č. 250/2012 Z. z. o regulácii v sieťových odvetviach (Act. no 250/2012 Coll. on regulation in network industries), from 31 August 2012.

[13] R. Vlačuha, Y. Kováčová. (2018). EU SILC 2017 Indikátory chudoby a sociálneho vylúčenia EU SILC 2017 Poverty indicators and social exclusion Štatistický úrad Slovenskej republiky 2018. ISBN 978-80-8121-624-4 (online)

[14] R.Filčák, D.Dokupilová. (2019). Concept of Energy Poverty in Slovakia. Prognostické práce – Foresight, Analysis and Recommendations / PP – FAR, 11 (1), 21-45. DOI: https://doi.org/10.31577/PPFAR.2019.11.002

[15] Energetická chudoba a zraniteľní odberatelia v energetickom sektore v Európe. Prehľad výskumných projektov v európskych štátoch. (2016) (Energy poverty and vulnerable consumers in the energy sector in Europe. Overview of research projects in European countries). Odbor regulácie kvality a analýz, Úrad pre reguláciu sieťových odvetví (Regulatory Office for Network Industries) http://www.urso.gov.sk/sites/default/files/Energeticka-chudoba-a-zranitelni-odberatelia-vEU_2016.pdf

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2.21. SPAIN

Please fill out the following table regarding the status in your country. Feel free to develop the answers.

1. What is the thermal comfort limit for residential buildings in your country?

1.a.1. Explain shortly the reference standards used in your country to evaluate thermal comfort in residential buildings.

1..a.2. What is your comfort standard?

The Energy saving part of the Spanish Building Code (CTE, DB HE), was updated in 2019 and for tertiary buildings, the Regulation of thermal systems in buildings (RITE), was updated in 2021.

1..a.3. On what your comfort model is based?

Based on the Fanger model (ISO 7730) in general with simplified temperature and humidity limits

1.a.4. What are the overheating criteria for residential buildings in your country?

OH is not included in the Spanish regulation for now. There is a parameter of solar control in CTE 2019 that limits the solar gains in July with solar shading devices activated ($Q_{sol;jul;lim}$), in kWh/m^2).

1..a.5. Cite the reference, and share the reference in pdf format if possible.

https://www.codigotecnico.org/pdf/Documentos/HE/DBHE.pdf

1.a.6. Please fill out the following table regarding overheating in your country. Feel free to elaborate on your answers.

Table 15: Overheating assessment

Criteria	Your Country
<u>Climate and weather data</u>	
Is comfort dependent on national geographic climate zones? If yes, list them.	Yes: 12 with 5 levels of winter from the most temperate A to the coldest E, and 3 levels of summer from the mildest 1 to the warmest 3.
Do you have a specific comfort calculation approach for heat waves?	No
Do you take into account the urban heat island effect?	No
Does your overheating methodology take into account future climate change weather files with extreme scenarios?	No. The data used for calculation are taken from the 2005 database in fact today.

Occupant type and representation	
What type of building type does your comfort standard deal with?	All, residential and low internal gains uses in CTE 2021 and tertiary buildings in RITE 2021
Does your method embrace the four occupant categories (I, II, III, IV)? *	Levels I and II
How do you represent occupancy presence in the simulation model?	Yes, heat gains because of equipment, lightning, occupation (sensitive and latent) are taken into account based on an hourly schedule 0:00 to 6:59 7:00 to 14:59 15:00 to 17:59 18:00 to 18:59 19:00 to 22:59 23:00 to 23:59
Comfort model	
What is overheating provisions period coverage?	New buildings & substantial refurbishments
What is your overheating indicator?	Solar gains indicator q(sol;jul) in kWh/m2·month considering all the solar shading activated Maximum cumulative heat in July with shading fully close: but not reflecting well the reality (there is no verification in free-running mode)
Is your comfort model based on an adaptive (like EN 15251 / 16798) or static (like Fanger) method?	Static
What are your comfort thresholds?	q(sol;jul) < 2.00 for residential buildings (private) and <4.00 for other uses, as the maximum cumulative heat in July with shading fully close. Between June and September : From 3:00pm to 10:59pm < 25°C From 11:00 pm 6:59 am< 27°C Maximum 4% of total annual hours can exceed the setpoints, mandatory for new and substantial refreshment buildings
What are your overheating thresholds? and according to which standard are those thresholds defined?	There is a temperature limit that must not be exceeded only between June and September : From 3:00pm to 10:59pm < 25°C From 11:00 pm 6:59 am< 27°C Maximum 4% of total annual hours can exceed the setpoints, mandatory for new and substantial refreshment buildings. q(sol;jul) < 2.00 for residential buildings (private) and <4.00 for other uses, as the maximum cumulative heat in July with shading fully close
Is there a distinction between naturally ventilated, air-conditioned, and mixed mode buildings?	Yes, regarding the ventilation sizing and justification, but thermal comfort limits are the same. The current regulation doesn't allow to

	build new naturally ventilated buildings (new constructions)
Does your model take into account local personalized heating/cooling & ventilations systems (ceiling fans, air-conditioned chairs, electric heating mattresses…)?	No in general. Some of these local room scale systems could be justified by the designers, but it is not common
<u>Simulation model</u>	
Is your calculation based on a static/quasi-dynamic/dynamic model? What is the calculation timestep?	1 hour timestep Spanish government has approved some tools which either apply dynamic calculations or simplified statistical models based on a dynamic justification of the tool. You need to use officially recognized tools (there are 6 or 7 in Spain which are free)
Is your overheating calculation based on a single or multizone model?	Multizone model, but the limitations must be justified with the global average results.
Does your calculation distinguish sleeping rooms from other living areas?	No, but indirectly with the limitation of temperate during the night. However, this temperature limit is applied for all the dwelling rooms.
<u>Mandatory envelope requirements</u>	
Does your method oblige the installation of external shading?	No, but indirectly yes: the limitation of solar heat gains must be respected
Does your method oblige the limitation of the window to wall ratio? If yes, what is the limit?	No, but indirectly yes: the limitation of solar heat gains must be respected
Does your method recommend a g-value? If yes, what is the limit?	No, but indirectly yes: the limitation of solar heat gains must be respected
* we are focusing on category II occupants for new and renovated buildings	

1b. Do you have fuel poverty problems in your country that might influence overheating risk in residential buildings? Explain.

Last year, Spain had the highest exceed of death because of the high temperature in Europe. In the summer climatic zones 2 and 3 people are exposed to very high temperatures (>40 ºC during many weeks in summer) and because of the high electricity costs, they can't afford using the cooling system enough or having one.

1.c.2. What is the overheating risk for residential buildings (highly insulated) in your climate?

1.c.3. How do you evaluate overheating risk in residential buildings in your country? Please share the calculation method and overheating hours limit threshold.

There is nothing to evaluate this kind of risk in Spain. Designers use non-mandatory tools or international methods (CIBSE, UNE-EN 16798-1:2020, PH standard,…).

1.d. Can we rely on passive cooling or must include active cooling systems for residential buildings in your country for residential buildings?

Rely on passive and active cooling for now, but there is a limitation to this consideration. In fact, reglamentation considers a high level of natural ventilation during summer nights (4 ACH for 8 h), and this overestimates the users bioclimatic capacity (location noise levels, security about opening windows, outer air particles, insects,...). In fact, this consideration hides the problem by minimizing the cooling need with natural night time ventilation to great extent.

Add something ?

Cooling doesn‘t need to be calculated in Spain for north areas (summer climate zones 1). It is only necessary for the summer climate of Spain (zones 2 and 3).

Definition (translated by me) and formula to calculate the Solar Control parameter, as defined in the Spanish Building Technical Code, DB-HE of 2019 Annex A Terminology ($q_{sol;jul}$):

It is the ratio between the solar gains for the month of July (Qsol;jul) of the windows and openings of the thermal envelope with its mobile solar protections activated (closed), and the useful area of the living spaces included within the thermal envelope (A_{util}). It can be applied to the building or part of it.
It is a simplified calculation, the energy reradiated to the sky is considered null.

$$q_{sol;jul} = Q_{sol;jul} / A_{util} = (\Sigma_k F_{sh;obst} \cdot g_{gl;sh;wi} \cdot (1 - F_F) \cdot A_{w;p} \cdot H_{sol;jul}) / A_{util}$$

Where:

$F_{sh;obst}$ is the reduction factor for shading by external obstacles (includes all the elements outside the window gap such as overhangs, lateral protections, setbacks, obstacles, etc.), for the month of July, of the gap k, and represents the reduction in received solar radiation in the opening due to permanent shading of fixed obstacles.

$g_{gl;sh;wi}$ is the total solar energy transmittance of the glazing with the mobile shading device activated (closed), for the month of July and for gap k;

F_F is the frame fraction of the gap k (in a simplified way the value of 0.25 can be adopted)

$A_{w;p}$ is the area (m2) of the opening k;

$H_{sol;jul}$ is the average accumulated solar irradiation for the month of July (kWh/m² month) in the studied location considering the inclination and orientation of the opening k;

A_{util} is the useful area of the living spaces in accordance with the definition of the section 4.6 of HE0.

Relevant References / key publications:

2.22. SWEDEN

Please fill out the following table regarding the status in your country. Feel free to develop the answers.

1. What is the thermal comfort limit for residential buildings in your country?

<<< R1 – The guidelines for the specification of indoor climate requirements>>>

R1 is a guideline developed by the Swedish Society of HVAC Engineers (SWEVAC) to consider Swedish norms, best practice, knowledge and harmonization with guidelines of EU standards. It lays the fundamentals for specifying and evaluating indoor climates quality and is a reference within planning, design and procurement of HVAC systems in new buildings. It is therefore an aid acting as a common basis for the collaboration between the property developer/contractor and consultants responsible for designing the building and HVAC systems. Also, it is used for assessment of indoor climate in existing buildings, serving as a template for communication and understanding between the developer, tenants, architect, consultants, contractors and facility managers. Thermal comfort is one of many parts in indoor climate of R1. R1 defines two thermal climate classes for residential buildings (TQ1 or TQ2 (TQ=thermal quality) is based on the purpose, use and activities and clothing within the buildings).

Based on SS-EN 7730, operative temperatures are estimated such that TQ1 gives PPD < 10 % and TQ2 = 10 % during design conditions. In residences, the following targets are suggested (operative temperatures) for both TQ1 and TQ2:
Winter (1.0 clo at 1.2 Met): 20-24 °C
Summer (0.5 clo at 1.2 Met): 23-26 °C
Moreover, R1 has several more specifications:
Floor temperatures: TQ1 22-26 °C and TQ2 20-26 °C
Vertical temperature gradient (0.1-1.1 m): for TQ1 < 2 °C and for TQ2 < 3 °C
Radiation temperature asymmetry: both TQ1 and TQ2: warm ceiling < 5 °C cold wall < 10 °C.

R1 defines the limitation for the draught rate (DR %)

air velocity < 0.1 m/s at t_{air}= 20 ˚ C

For TQ1: DR ≤ 10% with or

air velocity < 0.15 m/s at t_{air}= 26 ˚ C

air velocity < 0.15 m/s at t_{air}= 20 ˚ C

For TQ2: DR ≤ 20% with or

air velocity < 0.25 m/s at t_{air}= 26 ˚ C

In conclusion, the similarities and differences between TQ1 and TQ2 are as follows:

TQ1: (1) Operative temperature is kept in the acceptable range (2) the occupants have the possibility to control the room temperature (3) operative temperatures outside the acceptable range must be STRONGLY LIMITED, even higher temperatures in summertime (4) VERY little risk for disruptions in the form of draught, high thermal radiation.

TQ2: (1) Operative temperature is kept in the acceptable range (2) the occupants have the possibility to control the room temperature (3) operative temperatures outside the acceptable range must be ACCEPTED in summertime (4) little risk for disruptions in the form of draught or high thermal radiation.

In residential buildings, TQ2 is most common.

<<<**The Swedish National Board of Housing, Building and Planning (Boverket, BBR, section 6:4)**>>>

BBR is the national building regulation which define the minimum criteria (i.e the poorest acceptable conditions and buildings should perform better than this). These minimum values are already considered in R1.
The minimum acceptable operative temperature= 18 ˚ C
The maximum acceptable operative temperature difference at different points in the space= 5 K
16 ˚ C ≤ floor surface temperature ≤ 26 ˚ C
Maximum acceptable air velocity in the space during heating season: 0.15 m/s
Maximum acceptable air velocity from ventilation system during other periods of the year: 0.25 m/s

<<< **The National Board of Health and Welfare (Socialstyrelsen)** >>>

The Public Health Agency stipulates norms (values) so that occupants' health is not affected negatively. These are also explicitly or implicitly considered within R1 already.

- The recommended range for relative humidity (RH): 30 % ≤ RH (%) ≤ 70
- Limitations for different temperatures which create the requirement for further investigation:

  Air temperature < 20 ˚ C or air temperature > 24 ˚ C

  Air temperature > 26 ˚ C, during summer

  Floor surface temperature < 18 ˚ C

- Recommended values for different temperatures
  Operative temperature 20 ˚ C - 23 ˚ C (for sensitive groups 22 ˚ C - 24 ˚ C)

Vertical temperature difference (between 0.1 m & 1.1 m over floor) ≤ 3 ˚ C

Radiant temperature asymmetry ≤ 10 ˚ C for (Window – Opposite wall)

Radiant temperature asymmetry ≤ 5 ˚ C for (Ceiling – Floor)

The average air velocity ≤ 0.15 m/s

Floor surface temperature: 20 ˚ C - 26 ˚ C

- Guideline values for assessment of inconvenience for people's health
  Operative temperature < 18 ˚ C (OT < 20 ˚ C for sensitive groups)
  Operative temperature (permanently) > 24 ˚ C (during summer, maximum 26 ˚ C)
  Operative temperature (short-term) > 26 ˚ C (during summer, maximum 28 ˚ C)
  Floor surface temperature < 16 ˚ C (OT < 18 ˚ C for sensitive groups)

1.a.1. Explain shortly the reference standards used in your country to evaluate thermal comfort in residential buildings.

1. **R1 – The guidelines for specification of indoor climate requirements (Svensk Byggtjänst)**
   R1 Guidelines for specification of indoor climate requirements" are guidelines that should form the basis for specifying and evaluating the quality of the indoor climate, as a reference document in connection with the design and procurement of indoor climate systems.
   The guidelines must also be a tool for assessing the quality of the indoor climate in existing buildings. The R1 should simply serve as a template for air quality, thermal climate, Sound level and lighting requirements. A template that facilitates communication between the actors of the construction process.
   The fourth edition of the R1 has been updated mainly with regard to changed authority requirements and standards such as the Swedish Housing Agency's building regulations (BBR), the standard SS EN 25268 regarding noise classification of premises and the air quality regulation (luftkvalitetsförordningen) SFS 2010:477 that caused the changes.
   Source is SWEDVAC (2013) R1- Riktlinjer för specifikation av inneklimatkrav (eng : Guidelines for specification of indoor climate requirements), Stockholm, Energi- och miljötekniska föreningen, SWEDVAC In English | Energi- och Miljötekniska Föreningen (emtf.se)

2. **The Swedish National Board of Housing, Building and Plannig (Boverket, BBR) – Section 6:4**
   Boverket's building regulations, BBR, is valid when you build a new building and when you alter an existing building. Swedish laws and regulations apply to new buildings and substantial refurbishments (some exception is allowed for historical, artistic, architecturally and environmentally interesting and important buildings). BBR consists of details on how to fulfill 8 of the 10 technical

characteristic of construction works. BBR also consists of details on how to fulfill the design requirements of buildings (parts of chapter 3 in BBR).
BBR consists of mandatory provisions that you have to fulfill and general recommendations that state how you may fulfill the mandatory provisions. You can choose other solutions then the ones stated in the general recommendations but the verification that you need to do to make sure that the mandatory provisions are fulfilled will be more extensive.
Please note that the Building Regulations (BBR) are often updated and the link above, (Boverket, BBR), is only for information and available in English. There are newer versions in Swedish.
The building regulation divided into its 9 chapters:

1. Introduction
2. General rules for buildings
3. Accessibility, dwelling design, room height, and utility rooms
4. Mechanical resistance and stability
5. Safety in case of fire
6. Hygiene, health and environment
7. Protection against noise
8. Safety in use
9. Energy management

3. **The Public Health Agency's general advice on indoor temperature FoHMFS 2014:17**

   It is a part of HSLF-FS recommendation issued by The Public Health Agency of Sweden (Folkhälsomyndigheten) and The National Board of Health and Welfare (Socialstyrelsen) and etc. HSLF-FS primarily covers the areas of health care, social services, pharmaceuticals and public health. The collection of constitutions contains regulations, general advice and announcements. Regulations are binding rules, while general advice is general recommendations for how laws, ordinances and regulations can or should be applied.

1..a.2. What is your comfort standard?

The recommendations in “R1 – The guidelines for specification of indoor climate requirements” are based on “SS-EN ISO 7730. In being guidelines, these are recommended but not compulsory.

1..a.3. On what your comfort model is based?
We follow and refer mainly to R1 in our studies.

1.a.4. What are the overheating criteria for residential buildings in your country?
Included in the answer to question 1, on page 1.

1..a.5. Cite the reference, and share the reference in pdf format if possible.
Please cite the attached references here (attached pdf files of the references and link for Arbetsmiljöverket, The book/hard copy format of R1 was used)

1.a.6. Please fill out the following table regarding overheating in your country. Feel free to elaborate on your answers.

Table 16: Overheating assessment

Criteria	Your Country
Climate and weather data	
Is comfort dependent on national geographic climate zones? If yes, list them.	No (these energy requirements have been changed as to be local (city level).)
Do you have a specific comfort calculation approach for heat waves?	The Swedish Meteorological and Hydrological Institute (SMHI) defines the heat wave as a continuous period of 24 hours when the temperature at some point during the 24-hour period exceeds 25 ˚C and this happens for at least 5 consecutive days. The Swedish Work Environment Agency (Arbetsmiljöverket) considers the period of about 1 week as a short-term heat wave
Do you take into account the urban heat island effect?	Nothing was found in the main Swedish references!
Does your overheating methodology take into account future climate change weather files with extreme scenarios?	SMHI offers a service called" Climate of the Future" where a simple climate scenario service with future scenarios at county level in Sweden is available for download. The information from this service only shows the consequence for "air temperature" and "precipitation" for some different scenarios of climate change. In research projects in Sweden, the future climate change weather files with typical scenarios are also applied, but not extreme scenarios!!! However, usually typical meteorologic climate data is used, based on historic records. Moreover, the definition of the normal year is based on a data file that is defined every 30 years by SMHI. This normal year will be used for calculation. The regulation use data file from the SMHI of 1990, the 2020 reference should be included and used soon in the regulation.
Occupant type and representation	
What type of building type does your comfort standard deal with?	"R1 – The guidelines for specification of indoor climate requirements" deals with both "premises" and "Residential Buildings" "The Swedish Work Environment Agency (Arbetsmiljöverket)" deals with "premises": These can be applicable to areas/volumes in the residential building where work has to be perfomed (ususally temporarily) but also in for example technical rooms. "The National Board of Health and Welfare (Socialstyrelsen)" deals with all types of buildings for the whole Swedish population "The Swedish National Board of Housing, Building and Plannig (Boverket, BBR)" deals with "Residential Buildings", "Working Premises", "sanitary Rooms", "healthcare facilities",

	Kindergartens and ”Nursing Homes for Elderly People”.
Does your method embrace the four occupant categories (I, II, III, IV)? *	“R1 – The guidelines for specification of indoor climate requirements” focuses on Category II occupants with PPD < 10%, according to SS-EN ISO 7730, with an air velocity of maximum 0.1 m/s
How do you represent occupancy presence in the simulation model?	The usual input data for occupancy presence in the simulation model is used from two sources/standards: 1. Sveby: which is an industry standard for energy in buildings: it is written in the Swedish National Board (in the BEN) that the Sveby standard must be used 2. The Swedish National Board of Housing, Building and Planning (Boverket), from documents called “BEN” Represent normal occupancy with a constant value of heat gains due to equipment and lighting (kWh/m²·year), and people (the number of people depending on apartment size), occupancy presence (14 hrs per day) and emitting on average 80 W/person.
Comfort model	
What is overheating provisions period coverage?	R1 indicates that in working premises (e.g. office buildings), it is logical to allow higher operative temperatures than the defined higher limits for 80 working hours per year.
What is your overheating indicator?	operative temperature
Is your comfort model based on an adaptive (like EN 15251 / 16798) or static (like Fanger) method?	R1 is according to SS-EN ISO 7730, using Static (Fanger Model) (I could not find out whether or not the adaptive method is used in local Swedish standards or guidelines!!!)
What are your comfort thresholds?	Limitations/acceptable ranges for the operative temperature for different building types/activity levels/clothing insulations Law (The Swedish National Board of Housing, Building and Planning) says that : The minimum acceptable operative temperature= 18 ˚ C The maximum acceptable operative temperature difference at different points in the space= 5 K 16 ˚ C ≤ floor surface temperature ≤ 26 ˚ C Maximum acceptable air velocity in the space during the heating season: 0.15 m/s Maximum acceptable air velocity the room ventilation system during other periods of the year: 0.25 m/s However, R1 are recommended, which give better thermal comfort than minimum requirements above.

	In guideline R1 there are 2 categories that can be followed: TQ1 and TQ2. But there is no law for maximum temperature just guidelines.
What are your overheating thresholds? and according to which standard are those thresholds defined?	We refer to R1 data as maximum acceptable levels, i.e., Operative temperature (short-term) > 26 ˚ C (during summer, maximum 28 ˚ C) (guideline). In fact, the cooling building is a new issue: there is no specific regulation for cooling and for summer.
Is there a distinction between naturally ventilated, air-conditioned, and mixed mode buildings?	Not as we far as we know. ~~Since 1990 it is mandatory to install heat recovery ventilation in buildings with at least an airflow of 0.5 per second per square meter of floor~~. However, in terms of ventilation systems, there is a correlation with age of building due to historic regulations. All residential buildings have to be ventilated with at least 0.35 l/(s·m²) corresponding to approx. 0.5 ach. After energy crisis in mid-1970's, larger multifamily buildings had to impose heat recovery if ventilation losses were greater than 50 MWh/year, implying mechanical ventilation. In 1988, all new residential buildings (single- and multifamily buildings) had to recover at least 50% of exhaust ventilation energy – only possible with mechanical ventilation. Even today, residential buildings ordinarily have mechanical ventilation systems with heat recovery in order to fulfill energy requirements. The regulations allow natural ventilation, provided that ventilation flows are validated and that heat losses are compensated by other means (heating with low primary energy factors/preheating air with ambient heat, etc.).
Does your model take into account local personalized heating/cooling & ventilations systems (ceiling fans, air-conditioned chairs, electric heating mattresses…)?	No.
<u>Simulation model</u>	
Is your calculation based on a static/quasi-dynamic/dynamic model? What is the calculation timestep?	Dynamic model – IDA Indoor Climate and Energy (IDA-ICE) simulation tool Hourly calculation timestep
Is your overheating calculation based on a single or multizone model?	Multiple zone model
Does your calculation distinguish sleeping rooms from other living areas?	No, but generally the indoor temperature is kept slightly lower in bedrooms to help people to have better sleep.
<u>Mandatory envelope requirements</u>	
Does your method oblige the installation of external shading?	No!
Does your method oblige the limitation of the window to wall ratio? If yes, what is the limit?	No. For residential buildings, window to floor ratio is recommended (rule of thumb) as 10 – 15 % in residential buildings. For daylight vs energy requirements.

	A regulation from the late 2000s demands that all apartments in multifamily buildings have to have at least one room that gets direct daylighting.
Does your method recommend a g-value? If yes, what is the limit?	No technical requirement on the g-value of the window. However, when simulating, the shading should be (unless « skyline » is known, set as 0.5). Sveby recommends usual input data for g-value for calculation/simulation purposes (0.5 for office and residential buildings and 0.65 for educational buildings)
* we are focusing on category II occupants for new and renovated buildings	

1b. Do you have fuel poverty problems in your country that might influence overheating risk in residential buildings? Explain.

Probably not in a level that affects the thermal comforts. But in general the residential buildings are not equipped with any cooling systems in Sweden and for instance in case the heat waves of, e.g. summer 2018, many people get shocked as they were not ready for that and there were no cooling machine or fans available in the market, neither.

1.c.2. What is the overheating risk for residential buildings (highly insulated) in your climate?

The overheating risk is engaged mainly with eventual heat waves, and it does affects the elderly houses as well as Kindergarten schools especially if there are equipped with any cooling system. There is quite a high risk if residential building is not designed to cope with heat waves. This is what Sana has been studying. Shading is important as well as using mechanical ventilation system strategy of forcing ambient air if cooling potential is available, i.e. VAV instead of CAV. (Building regulation requires we have mechanical ventilation in residential buildings).

1.c.3. How do you evaluate overheating risk in residential buildings in your country? Please share the calculation method and overheating hours limit threshold.

According to R1 documents as mentioned above.

1.d. Can we rely on passive cooling or must include active cooling systems for residential buildings in your country for residential buildings?

May be a hybrid system is the best option as for instance when the outdoor temperature is too high or in case of long-lasting heat waves (which are not that common, but has happened for instance during summer 2018), an active cooling method is needed. New buildings, residential or non-residential, are obliged to have mechanical ventilation (with heat recovery since 1988).Though most of these buildings have CAV (constant air volume flow), these have the option of being converted to VAV (variable air volume flow) to make use of space cooling with ambient air having lower temperature than indoor air, and could be upgraded with a cooling unit. Before this, most have natural ventilation.

It is important to have shading devices, but these have to be seasonally controlled since solar gains during spring and autumn have a possitive influence on the heating demand. The combination of shading devices and using increased ventilation rates (using cooler ambient air) seem to be enough during today‘s typical climate. However, the role of airing (opening windows – a form of passive) is difficult to assess. Simulations often assume closed windows, which is common in offices, but not evident in residences. Yet, simulations suggest that future residential buildings exposed to climate change ought to be equipped with active cooling. Given that the buildings will have a mechanical ventilation system, the distribution system is already there but need a cooling source.

Add something ?

The Swedish Work Environment Authority (ARBETSMILJÖVERKET) has the following recommentions for the workplaces:

In winter, the air temperature, for light and sedentary work, should normally be in the range of 20-24 °C. In summer, it should be between 20-26 °C. If the air temperature is outside these ranges for a longer period of time, the thermal climate should be investigated more closely.

We also have an environmental certification system in Sweden called Miljöbyggnad (Miljöbyggnad - Sweden Green Building Council (sgbc.se)), no English homepage, please see 10.5772/intechopen.100699

Though seldom applied on residential buildings, it has to some extent set the level of quality that a building owner wishes to build (gold, silver or bronze).

Concerning heating, cooling and thermal comfort, the following aspects are considered:

- Primary energy use as a whole for the building
- Solar heat lead (as measure to reduce overheating/cooling need)
- Thermal climate, winter (PPD at design winter outdoor conditions)
- Thermal climate, summer (PPD during hot and sunny day, in building’s most critical rooms 20% of floor area)
- Daylight criteria.

Relevant References / key publications:

2.23. SWITZERLAND

Please fill out the following table regarding the status in your country. Feel free to develop the answers.

1. What is the thermal comfort limit for residential buildings in your country?

1.a.1. Explain shortly the reference standards used in your country to evaluate thermal comfort in residential buildings.

…

1..a.2. What is your comfort standard?

SIA-180 (Swiss Engineers and Architects)

1..a.3. On what your comfort model is based?

ISO 7730 Fanger Standard indirectly: The ISO standard was used to set the threshold for the SIA standard.The static method SIA 380/1 can only be used for heating energy calculation

1.a.4. What are the overheating criteria for residential buildings in your country?

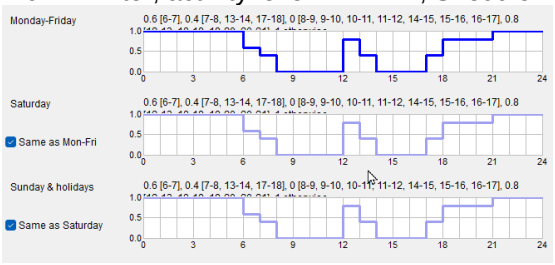
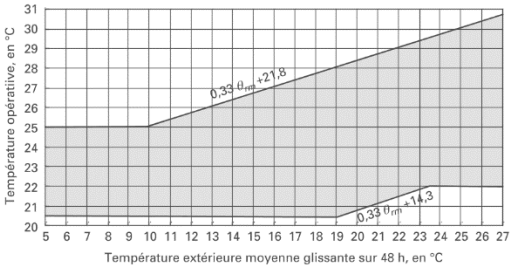
Based on Fanger model and with well defined internal and external loads, the operative temperature must stay under a certain limit that depends on the mean ambient temperature during the last 48 hours.

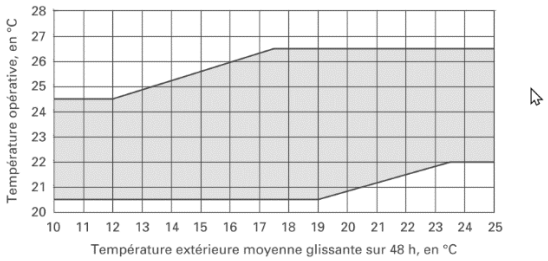
1..a.5. Cite the reference, and share the reference in pdf format if possible.

1.a.6. Please fill out the following table regarding overheating in your country. Feel free to elaborate on your answers.

Table 17: Overheating assessment

Criteria	Your Country
<u>Climate and weather data</u>	
Is comfort dependent on national geographic climate zones? If yes, list them.	No, but library of 40 stations: SIA 2028 calculates DRYs according to EN ISO 15927-4 (European Standard) which indicates how to calculate thermal comfort with 20 years of climate data
Do you have a specific comfort calculation approach for heat waves?	We calculate with the summer period of a Design Reference Year that includes average heat waves.
Do you take into account the urban heat island effect?	No
Does your overheating methodology take into account future climate change weather files with extreme scenarios?	No incorporate into the standard but planned soon with 2 scenarios (2035 and 2050). The data is available, but not yet mentioned in the standard.
<u>Occupant type and representation</u>	

What type of building type does your comfort standard deal with?	Residential, commercial, and public building
Does your method embrace the four occupant categories (I, II, III, IV)? *	No, but different has been set for different usage (activity, clothing)
How do you represent occupancy presence in the simulation model?	Depending on number of occupants, position, clothing, activity, hourly occupancy schedule, both sensible and latent heat is calculated after ISO 7730. For residential buildings: 35 m2/Person, Position in the center of the room, clothing 0.5 in Summer and 1.0 in Winter, activity level 1.2 MET, Shedule: 
Comfort model	
What is overheating provisions period coverage?	Mid-April to mid-October
Comfort regulation is applied for each generation of building ? (all existing building, renovate, new ?)	Yes.
What is your overheating indicator?	Operative temperature
Is your comfort model based on an adaptive (like EN 15251 / 16798) or static (like Fanger) method?	Based on the static Fanger method to define a curve
What are your comfort thresholds?	Define by a curve (SIA-180 annex C.1) 1.maximum for mechanic system 24,5°C under 12°C mean running T°C ; 26,5 over 17,5; 0,33 T°C (mean running)+ 20 between 12 and 17,5°C of mean running T°C **Exigences pour les locaux à ventilation naturelle, lorsqu'ils sont ni chauffés, ni refroidis** Dans les locaux à ventilation naturelle où les fenêtres sont ouvrantes et où les occupants peuvent adapter leur habillement saisonnier selon 2.1.3, la température intérieure acceptable, pendant qu'ils sont ni chauffés, ni refroidis, est en relation avec la température extérieure moyenne glissante selon la figure 3. Figure 3 Domaine admissible pour la température opérative à l'intérieur des locaux à ventilation naturelle, lorsqu'ils sont ni chauffés, ni refroidis, en fonction de la température extérieure moyenne glissante  2. minimum for mechanic system 20,5°C under 19°C mean running T°C ; 22 over 23.5; 0,33 T°C (mean running)+ 14.2 between 19 and 23,5°C of mean running T°C

	Température opérative En admettant la variation saisonnière de l'habillement selon la figure 2, la température opérative dans les locaux d'habitation et les bureaux lorsqu'ils sont chauffés, refroidis ou ventilés mécaniquement doit se situer à l'intérieur du domaine de la figure 4. Figure 4 Domaine admissible de la température opérative dans les espaces d'habitation ou administratifs lorsqu'ils sont chauffés, refroidis ou à ventilation mécanique, en fonction de la température extérieure moyenne glissante 
What are your overheating thresholds? and according to which standard are those thresholds defined?	Define by a curve (SIA-180 annex C.1) for residential building with mechanic system 1.maximum for mechanic system 24,5°C under 12°C mean running T°C ; 26,5 over 17,5; 0,33 T°C (mean running)+ 20 between 12 and 17,5°C of mean running T°C 2. minimum for mechanic system 20,5°C under 19°C mean running T°C ; 22 over 23.5; 0,33 T°C (mean running)+ 14.2 between 19 and 23,5°C of mean running T°C
Is there a distinction between naturally ventilated, air-conditioned, and mixed mode buildings?	Yes, the maximal temperature limit is higher in naturally ventilated buildings
Does your model take into account local personalized heating/cooling & ventilations systems (ceiling fans, air-conditioned chairs, electric heating mattresses…)?	Yes, temperature depend on the position of people on the room (near radiator, underfloor heating) will influence the model
<u>Simulation model</u>	
Is your calculation based on a static/quasi-dynamic/dynamic model? What is the calculation timestep?	Fully dynamic method. Calculation timestep is adaptive during the simulation (second to 1 hour)
Is your overheating calculation based on a single or multizone model?	Multizone
Does your calculation distinguish sleeping rooms from other living areas?	Not included in the standard (but you can as a user)
<u>Mandatory envelope requirements</u>	
Does your method oblige the installation of external shading?	No but you can as a user
Does your method oblige the limitation of the window to wall ratio? If yes, what is the limit?	No but you can as a user
Does your method recommend a g-value? If yes, what is the limit?	No, but designer can choose one
* we are focusing on category II occupants for new and renovated buildings	

1b. Do you have fuel poverty problems in your country that might influence overheating risk in residential buildings? Explain.

No right now but perhaps with the war (2020) between Ukraine and Russia.

1.c. What is the overheating risk for residential buildings (highly insulated) in your climate? Please share the calculation method and overheating hours limit threshold.

Highly insulated buildings exist which can lead to overheating risk for residential buildings.

There is highly glaze & isolate residential which can lead to a certain risk of overheating.

1.d. Can we rely on passive cooling or must include active cooling systems for residential buildings in your country for residential buildings?

Passive cooling: you can use dynamic simulation to include it in residential building.

Add something ?

Same software Germany Austria Sweden Finland and to a lower extend in other countries.

Relevant References / key publications:

- https://www.equa.se/en/ida-ice

2.24. UNITED KINGDOM (UK)

Please fill out the following table regarding the status in your country. Feel free to develop the answers.

1. What is the thermal comfort limit for residential buildings in your country?

1.a.1. Explain shortly the reference standards used in your country to evaluate thermal comfort in residential buildings.

1..a.2. What is your comfort standard?

1..a.3. On what your comfort model is based?

1.a.4. What are the overheating criteria for residential buildings in your country?

https://www.cibse.org/knowledge-research/knowledge-portal/technical-memorandum-59-design-methodology-for-the-assessment-of-overheating-risk-in-homes

Based on:

https://www.cibse.org/knowledge-research/knowledge-portal/tm52-the-limits-of-thermal-comfort-avoiding-overheating-in-european-buildings

Included in the new Building Regulations:

https://www.gov.uk/government/publications/overheating-approved-document-o

1..a.5. Cite the reference, and share the reference in pdf format if possible.

1.a.6. Please fill out the following table regarding overheating in your country. Feel free to elaborate on your answers.

Table 18: Overheating assessment

Criteria	Your Country
Climate and weather data	
Is comfort dependent on national geographic climate zones? If yes, list them.	Local weather file should be used.
Do you have a specific comfort calculation approach for heat waves?	Indirectly through the use of DSY files.
Do you take into account the urban heat island effect?	https://www.cibse.org/knowledge-research/knowledge-portal/technical-memorandum-49-design-summer-years-for-london-2014-pdf
Does your overheating methodology take into account future climate change weather files with extreme scenarios?	The weather file used for the methodology should be the DSY1 (design summer year) file most appropriate for the site location for the 2020s, high emissions, 50% percentile scenario.

	Other files including the more extreme DSY2 and DSY3 files, as well as future files (i.e. 2050s or 2080s), should be used to further test designs of particular concern, as described below, but a pass is not mandatory for the purposes of the simpler test presented in this document. Design summer years (DSYs) should always be used for analysis of overheating, and it is good practice to take into account future weather files (see CIBSE TM48: Use of climate change data in building simulation: the CIBSE Future Weather Years(2009), TM49: Design Summer Years for London (2014a) and CIBSE's Probabilistic Climate Profiles (ProCliPs) (2014b) for further advice).
Occupant type and representation	
What type of building type does your comfort standard deal with?	Homes, care homes, student accommodation.
Does your method embrace the four occupant categories (I, II, III, IV)? *	Care homes and accommodation for vulnerable occupants, which are predominantly naturally ventilated (see definition above), should use criteria (a) and (b) from section 4.2 above but should assume Type I occupancy (see CIBSE TM52 (2013) for description).
How do you represent occupancy presence in the simulation model?	Standard profiles should be applied for occupancy, lighting and equipment gains. Based on CIBSE Guide A (2015a), a maximum sensible heat gain of 75 W/person and a maximum latent heat gain of 55 W/person are assumed in living spaces. An allowance for 30% reduced gain during sleeping is based on Addendum g to ANSI/ASHRAE Standard 55-2010: Thermal environmental conditions for human occupancy (ASHRAE, 2013), Table 5.2.1.2 'Metabolic rates for typical tasks'.
Comfort model	
What is overheating provisions period coverage?	May-September.
What is your overheating indicator?	Criteria for homes predominantly naturally ventilated: Compliance is based on passing both of the following two criteria: (a) For living rooms, kitchens and bedrooms: the number of hours during which DT is greater than or equal to one degree (K) during the period May to September inclusive shall not be more than 3 per cent of occupied hours. (CIBSE TM52 Criterion 1: Hours of exceedance). (b) For bedrooms only: to guarantee comfort during the sleeping hours the operative temperature in the bedroom from 10 pm to 7 am shall not exceed 26 °C for more than 1% of annual hours. (Note: 1% of the annual hours between 22:00 and 07:00 for bedrooms is 32

	hours, so 33 or more hours above 26 °C will be recorded as a fail). Criteria for homes predominantly mechanically ventilated: For homes with restricted window openings, the CIBSE fixed temperature test must be followed, i.e. all occupied rooms should not exceed an operative temperature of 26 ℃ for more than 3% of the annual occupied annual hours (CIBSE Guide A (2015a)).
Is your comfort model based on an adaptive (like EN 15251 / 16798) or static (like Fanger) method?	Adaptive.
What are your comfort thresholds?	As above.
What are your overheating thresholds? and according to which standard are those thresholds defined?	TM59/52.
Is there a distinction between naturally ventilated, air-conditioned, and mixed mode buildings?	Yes.
Does your model take into account local personalized heating/cooling & ventilations systems (ceiling fans, air-conditioned chairs, electric heating mattresses…)?	Operative temperature calculations (used within CIBSE TM52 (2013)) require assumptions on air speed. The modelled air speed in a space must be set at 0.1 m/s where the software provides this option unless there is a ceiling fan or other means of reliably generating air movement. Where fixed ceiling fans are installed as part of the new- build or refurbishment the assumed elevated air speed assumptions must be reported. Typically this should not exceed 0.8 m/s.
Simulation model	
Is your calculation based on a static/quasi-dynamic/dynamic model? What is the calculation timestep?	Hourly dynamic simulation modelling/
Is your overheating calculation based on a single or multizone model?	Multizone.
Does your calculation distinguish sleeping rooms from other living areas?	Yes (please see above).
Mandatory envelope requirements	
Does your method oblige the installation of external shading?	Blinds and shading devices can be used for the analysis only if specifically included in the design, provided in the base build and explained within associated home user guidance. Blinds cannot be used properly if they clash with the opening of windows. If blinds are used to pass the overheating test, the report must either demonstrate that there are no clashes with the opening of windows, or the reduction in air flow due to the clashes must also be calculated and

	included in the model. These calculations must be explained in the compliance report. The assumed solar transmittance/reflectance properties and usage profiles for blinds will need to be justified and well described in the compliance report. Where blinds are used to enable a pass, the analysis results without blinds must also be provided for reference.
Does your method oblige the limitation of the window to wall ratio? If yes, what is the limit?	In order to allow the occupants to 'adapt', each habitable room needs operable windows with a minimum free area that satisfies the purge ventilation criteria set in Part F of the Building Regulations for England (NBS, 2010), and equivalent regulations in other countries, i.e. the window opening area should be at least 1/20th of the floor area of the room (different conditions exist for windows with restricted openings, and the same requirement applies for external doors). Control of overheating may require accessible, secure, quiet ventilation with a significant openable area. Homes that are predominantly mechanically ventilated because they have either no opportunity or extremely limited opportunities for opening windows (e.g. due to noise levels or air quality) should be assessed for overheating using the fixed temperature method based on CIBSE Guide A (2015a), as described in section 4.3 below.
Does your method recommend a g-value? If yes, what is the limit?	The methodology recommends a full written report that documents the following details for the assessment: information on the construction type with layers of construction (used to determine U-values and g-values) for all external and internal building elements, plus any additional shading features (including any blinds, and demonstrating that the blinds do not clash with opening windows if blinds are used to contribute to a pass)
* we are focusing on category II occupants for new and renovated buildings	

1b. Do you have fuel poverty problems in your country that might influence overheating risk in residential buildings? Explain.

https://commonslibrary.parliament.uk/research-briefings/cbp-8730/

https://www.sciencedirect.com/science/article/abs/pii/S0378778818321327

1.c.2. What is the overheating risk for residential buildings (highly insulated) in your climate?

https://researchportal.bath.ac.uk/en/studentTheses/does-improving-the-building-fabric-increase-the-risk-of-overheati

1.c.3. How do you evaluate overheating risk in residential buildings in your country? Please share the calculation method and overheating hours limit threshold.

1.d. Can we rely on passive cooling or must include active cooling systems for residential buildings in your country for residential buildings?

https://journals.sagepub.com/doi/full/10.1177/0143624414566242

Add something ?

May be of interest: https://www.buildingsandcities.org/calls-for-papers/alternatives-air-conditioning.html

Relevant References / key publications:

3.DISCUSSION AND CONCLUSION

In this report, thermal comfort in residential buildings in European countries has been examined in detail through the questionnaire addresses five areas of study listed below:

- The occupant representation in the method
- The thermal comfort model and overheating calculation
- The simulation model
- The mandatory envelope requirements

It gathers information to identify the key findings and develop recommendations to drive significant and robust improvement in overheating thermal comfort during summer in European countries. The recommendations can provide future perspectives for researchers, policymakers, funding agencies, and building stakeholders.

This is an alarming conclusion because we can confirm that most European countries are not ready to tackle climate change for overheating thermal comfort in residential buildings during summer. Most European countries haven't upgraded their regulation in a modern way to fit with the new and future challenges of climate exigence. More than 50% of European countries study considering single-zone calculation methods, which gives a poor quality of accuracy in the calculation. Only two countries have mandatory regulations about thermal comfort during the night and during the day. Moreover, there is a lack of sharing between European countries about thermal comfort led to no common approach which rigorously addresses overheating in residential buildings. It is disquieting because overheating and heatwaves during summer can be multiplied by ten for most European regions before 2100. This is a pressing issue to build today's long-term buildings to be ready to preserve the well-being and health of European people during the heatwaves of today and tomorrow's future.

The study provides recommendations to help improve thermal comfort on a National and European scale. It recommends harmonizing actions between European countries regarding thermal regulations, especially for countries with the same climate or issues as mountains or seacoast. EPBD needs to be more holistic in its regulations, taking into account climate specificity according to the geographic zone, for example, and more precise, giving limitations for the g-values, for example. It should have more mandatory rules to ensure minimal thermal comfort for every citizen of Europe, as a clear criterion for acceptable thresholds for minimum comfort.

The strength of this study is that it gathers information on most European countries. It provides an opportunity to easily compare overheating calculations in Europe to improve in faster way thermal regulation of European countries, which can take an example of what is already applied in other parts of Europe. The limitation of the report is twofold. It works in 25 countries out of 28 European countries of the EPBD.

It focuses on thermal comfort in residential buildings only through regulations and expert knowledge in a qualitative way. The methodology used was based on questioning 15 active national experts on the thermal comfort of their country from 13 European countries and linked to IEA 80. Group discussions have also been led to propose solutions through existing and newly developed criteria.

APPENDIX 1: SUMMARY OF OVERHEATING REGULATIONS & CRITERIA'S FOR EU COUNTRIES

Austria

In Austria, comfort criteria are defined in OIB RL 6 and the overheating calculation method in ÖNORM B 8110-3. Both of these national documents are mandatory. Thermal comfort is defined by the maximum indoor operative temperature that is defined by an endlessly diurnally warm and sunny day in summer. It is a heat wave approach. It depends on the national geographic climate zone with a climate data regression model defined in the national standard. The threshold of the comfort limit of operative temperature is based on an adaptive method that is site-specific: it is the daily mean temperature that is statistically met or surpassed 13 times per year. The threshold of the comfort limit of operative temperature is defined as Tlimit = 1/3*TNAT,13 + 21,8 °C. They have a non-mandatory method that takes into account a temperature increase up to 3.0K above the standard design. Moreover, the calculation is based on an hourly dynamic and single-zone method. Occupancy presence is represented in the simulation model considering internal gains from people and equipment each hour. Overheating indicator is the daily maximum of the hourly operative temperature of the room, and its threshold is a formula taken from EN 16798, chapter B.2.2.

Belgium

In Belgium, the overheating indicator applies to new buildings and residential buildings. The regulations and guidelines are implemented by PEB Wallonia, EPB Flanders, and PEB Brussels. It is dependant on the comfort climatic zone and it is calculated on the basis of thermal inertia and the ratio between solar and internal contributions to the transmission and ventilation ratio, which is expressed as the unit of kelvin hour [Kh]. Recommended range of overheating thresholds is 1000 Kh < I_{overh} < 6500 Kh. The internal air temperature should be maintained in the range of 18 to 23 ℃. Therefore, the overheating indicator is the excess of heat gains in relation to the indoor set-point temperature for the considered month. According to this overheating indicator, it is definitely a conventional probability that an active cooling installation is effectively placed and this probability is between 0 and 1. The correct orientation of the glazed surfaces leads to energy savings thanks to solar gains. However, it is necessary to avoid overheating in the summer.

Bulgaria

The thermal comfort standard is defined in "Ergonomics of the thermal environment - Analytical determination and interpretation of thermal comfort using calculation of the PMV and PPD indices and local thermal comfort criteria" (БДС EN ISO 7730: 2007)

and in “Indoor environmental input parameters for design and assessment of energy performance of buildings addressing indoor air quality, thermal environment, lighting and acoustics” (БДС EN 15251:2007). Furthermore, the standard “Energy performance of buildings - Ventilation for buildings - Part 1: Indoor environmental input parameters for design and assessment of energy performance of buildings addressing indoor air quality, thermal environment, lighting, and acoustics - Module M1-6” (БДС EN 16798-1:2019) is also in force. Bulgaria considers nine climatic zones to calculate the energy efficiency of buildings and uses a static method: based on the indoor set-point temperature, Tset-point based on a multi-zone model. According to the БДС 14776: 1987 the indoor building spaces must be between 18°C and 25 °C. Moreover, the calculation takes into account the gains or losses due to the metabolic heat of the inhabitants and the equipment. There are no requirements to use a specific model: in practice, there are different simulation software, that adopts different models. Overheating criteria for Bulgaria is the room temperature for at least two consecutive days during the winter and summer seasons. In some zones, there are extreme summer temperatures and therefore the overheating risk is high, while in other zones the risk is low.

Croatia

In Technical Regulation on the Rational Use of Energy and Thermal Insulation in Buildings, which refers to EN 15251:2008, it is stated how overheating should be prevented by applying proper technical solutions. The building areas should not overheat more than 4°C due to the solar radiation compared to the internal design temperature of the area. The static comfort standard is used, based on EN 15251 (2008). The calculation base on a single zone is a quasi-dynamic model based on monthly values. The occupancy presence is not defined in the simulation model. The methods recommend a g-value between 0.25 to 0.87 depending on the glazing and shading type.

Cyprus

However, no legislation or regulations exist regarding thermal comfort in buildings. The majority of construction engineers take into consideration the ASHRAE 55 standard whenever needed. Most of the time, no strict thermal comfort calculations are applied. All buildings should comply with the indoor air temperature ≤ 25°C requirements, which is specified in EN 15251, and the number of hours in excess of 25°C, should be ≤ 5% of work time.

Czechia

A lot of Czech designers still focus on maximizing winter solar gains to reduce the heating demand but neglect the summer cooling measures, such as external shading, air conditioning, etc. Some news articles have stated that approximately 50% of

existing Czech building stock is suffering from summer overheating and we presume that this issue will be further stressed by ongoing climate change.

The summer thermal stability (overheating) is evaluated according to ČSN EN ISO 52016-1. This standard utilizes hourly dynamic calculations to assess the maximum temperature in a critical room. It is a room with the worst floor area and area of openings exposed to direct sunlight ratio in the East-South East-South-South West-West directions. The thresholds defined in ČSN 730540-2:2011 are an indoor air temperature of 27°C in summer for naturally ventilated non-production buildings, like housing, offices, etc., and an indoor air temperature of 29.5 or 31.5°C for the rest of the buildings with an internal heat source depending on the source output. The standard says that the threshold can be increased to 29°C for periods shorter than 2 hours in the residential building if the investor agrees. The threshold for mechanically ventilated buildings is 32°C. Energy gains from people, equipment, and lightning can be included in the calculations but it is not mandatory. The overheating calculation is based on a single-zone model only for the critical room. It should be noted that overheating is often omitted not only by the designers but also by the building authorities as well as from the author‘s own experience.

Denmark

In Denmark regulations about thermal comfort which can be found in “Chapter 19 Thermal indoor climate and installations for heating and cooling (Termisk indeklima og installationer til varme-og koleanlaeg) §386 are soft and concern only new buildings. The comfort model is based on a guideline, which is a simplified approximation of the adaptive comfort model as described in EN 15251. This guideline specifies that room temperature in a residential building where it is possible to open windows, and have natural venting should comply with a maximum of 100 hours over 27°C and 25 hours over 28°C. The calculation of the thermal indoor climate is based on the conditions in the critical rooms and on the Design Reference Year, DRY 2013 for the calendar year 2010. For homes, a simplified calculation can be used. There is no requirement for using a specific tool or model in the building regulations but time step is therefore implicitly minimum hourly. Most of the thermal comfort rules aren’t mandatory and are based on guidelines in order to help designers.

Estonia

Estonia uses EVS-EN 16798-1:2019 & NA:2019 regulations as comfort standards to assess the comfort levels in the building. The regulations define a dynamic model with hourly occupancy profiles. The indoor air temperature is the overheating indicator. The buildings should comply with 150 Kh above 27 °C in residential buildings, for the indoor temperature. The model considers local personalized heating/cooling & ventilation systems. Moreover, depending on the energy modeler’s choice, the dynamic calculation can distinguish the sleeping room from the other living area. These criteria

may be classified as adaptive, but the cooling systems are sized with static. (EVS-EN 16798-1 (2019) & NA (2019)). The method

- obliges the limitation of the window-to-wall ratio for a single family: WWRxg ≤ 0.2 WWR ≤ 0.4 window-to-floor ratio ≤ 0.15 effective openable window are fraction ≥ 0.1
- recommends a g-value of WWRxg ≤ 0.2, for single family

Finland

Finland has a building code asking for minimum requirements about thermal comfort: Decree of the Ministry of the Environment on the energy performance of new buildings (Ympäristöministeriön asetus uuden rakennuksen energiatehokkuudesta). In this building code, you need to note that it existed 9 categories of building according to the regulation, especially the category:

- 1) Small residential buildings: a) Detached single-family dwelling and building forming part of a block of flats with a net heated area (net) of 50-150 m2b) Detached single-family dwelling and building forming part of a block of flats with a net heated area (net) of more than 150 m2 but not exceeding 600 m2c) Detached single-family dwelling and building forming part of a block of flats, with a net heated area (net) of more than 600 m2 (d) Terraced houses and blocks of flats with no more than two storeys
- 2)Apartment blocks with three or more residential floors

In the building code, the design summertime indoor air temperature shall not exceed the cooling limit of 27 °C for use class 2 by more than 150-degree hours between 1 June and 31 August at the design airflow rate. Compliance with the summer indoor temperature requirement shall be demonstrated by temperature calculations for the different space types with a multi-zone and dynamic simulation. Where cooling is required to control the indoor air temperature in a building, the simulation time steps are up to one hour with the dynamic method.

The envelop requirement is more strict: it obliges the installation of external shading and the benchmark for the total window area of a building is 15% of the total floor area of all or part of the ground floors of the building, up to a maximum of 50% of the building's façade area. The window area shall be calculated according to the external dimensions of the window perimeter. There is no recommendation about the g-value however if regulation about thermal comfort is not fulfilled a solution need to be find modifying, for example, the envelope.

France

The French building thermal regulation RE2020 is based on standard EN 15251 concerning adaptive comfort and ISO 7730 standard with a focus on summer comfort. According to R 131-29 of law no. 2007-363, the temperature should not be below 26

°C for air-conditioned buildings for the hottest of the 8 climatic zones. The multi-zone model is applied with the PMV/PPD model for bedrooms and adaptive for the rest. The calculation is based on a dynamic model with a time step at least of one hour. If the building cannot meet the limit of 25°C: the designer is obliged to install an active cooling system. The overheating indicator is the DIES: the statistical summer discomfort duration.

Germany

Germany's comfort standard, DIN-4108-2, is dependent on 3 summer climatic regions. Region A for coastal areas mountains, and high altitudes with an operative internal temperature that should be above 25°C. Region B for middle altitudes, north German lowlands with an operative internal temperature that should be above 26°C. Regions C for metropolitan areas, upper and the middle Rhine with an operative internal temperature that should be above 27°C. It is defined that over-temperature hours per year have to be under 1200 Kh. In order to simulate these thresholds, the comfort model distinguished 2 calculations. A simplified solar transmittance static indicator method and an adaptive method for the thermodynamic simulation method. It considers a full schedule occupancy with an internal gain of 100 Wh/m²NFA d for residential buildings that are considered as a single zone. A dynamic model with hourly or fewer calculation time steps is used.

Greece

Greece has four climatic zones. Legislation on thermal comfort is based on the European standard EN 15251, which includes the adaptive comfort model. The calculation model is based on a single-zone or multi-zone model but it is strongly recommended to use the multi-zone model in order to be more precise in the calculation. It can be mandatory for some specific cases. The calculation is based on a quasi-static model with monthly time steps (ISO 13790) The comfort levels set through legislation in Greece refer to the combination of temperature and relative humidity during summer and winter time. The summer temperature has to be under 26°C and humidity less than 50% (EN 15251). The levels are different based on the use and function of the building. However, for residential buildings a full schedule is described: people are at home 18h a day all week all year and internal gains are added. The average shading coefficient during the summer period had to be at least 0.70 for south faces and 0.75 for the west and east-façade. There is a high overheating risk in case of not having the proper design of ventilation and building insulation.

Hungary

In Hungary, the comfort standard, based on EN 15251, defines the operative temperature in residential buildings as an indicator of thermal comfort. It should not exceed 26°C when a mechanic cooling system is activated. The comfort model is based on a static method. The overheating thereholds are based on the average of

internal heat gains for occupied hours. The requirement is that the internal heat gains for occupied periods cannot exceed 10W/m2 and the average temperature difference between indoors and outdoor in summer should be below 3K (heavy buildings) and 2K (lightweight buildings). The calculation is based on a static model where only overheating in relevant zone are considered, a dynamic hourly model can be used but it is optional. According to the expert, overheating risk in Hungary is low and no buildings require active cooling. However, with climate change, new buildings begin to use active cooling.

Ireland

Ireland do not have a specific comfort model. CIBSE TM52 is referenced throughout the building regulations and designers are advised to abide by it. It is an adaptive model The values used in the national building energy rating calculation methodology (DEAP) derive from those limits set by the WHO. The WHO recommends a minimum temperature of 18°C, with increases of 2-3°C for those more vulnerable to the effects of cold strain including the elderly. The definition of a heat wave in Ireland is shaded air temperatures reaching highs of above 25˚ C on five or more consecutive days at the same location (Met Eireann). The overheating indicators are based on the 3 criteria of TM52 (criterion 1: Hours of exceedance, criterion 2: Daily Weighted Exceedance, criterion 3: Upper Limit Temperature). Moreover, a distinction between naturally ventilated, and air-conditioned is outlined. The simulation model based the calculation on a static and single-zone model.

Italy

The thermal comfort is dependent on 6 national geographic climate zone. Indoor air temperature should not exceed 26°C to assure thermal comfort in summer. However, they don’t have an explicit overheating indicator and there is no specific simulation for overheating calculation. The comfort model is based on the decree 11/10/2017 allows referring to EN 15251 superseded by EN 16798-1. Moreover, D.Lgs. 81/2008 mentions the UNI EN ISO 7730 and refers to the Fanger model. D.Lgs. 311/2006 introduces the obligation to check the existence of suitable sun shields already in the design phase, and recognizes the (outdoor or indoor) awning a fundamental role in reducing the solar load in the summer months. L. 90/2013 implements the EPBD recast and introduces the principle of the minimum requirements assessed with respect to a reference building. In this regard, this law introduces a limit of the “summer equivalent solar area per unit of useful surface” that must be lower than the limit values shown in Table 11 Appendix A (Paragraph ii, 2b), paragraph 3.3) of the Law which is 0,040 for residential building. L. 90/2013 indicates a total solar transmission factor for windows and mobile shading of max 0.35 for all the climate zones.

Latvia

EN ISO 7730:2006 and EN 16798-1 are used as comfort standards in Latvia. The comfort model is based on a static method that considers a schedule occupancy presence in the model. The comfort thresholds for new buildings of category II is a maximum for cooling in the summer of 26°C and for category III a maximum for cooling in the summer of 27°C according to the standard LVS EN 16798-1:2019 Annex B. The calculation is based on a static model or a quasi-dynamic model with a monthly or hourly time step. The overheating indicator in the kelvin hours. The overheating calculation is based on a single-zone calculation, multi-zone can be possible but it is not mandatory. The overheating threshold, for residential buildings, is that the operative temperature above 27 °C shall not exceed 150 K.h (from 1 May to 30 September). The distinction of sleeping rooms from other living areas is possible but not mandatory.

Lithuania

In Lithuania, comfort standards are not taken into account in the energy performance calculations of the buildings. ISO 7730 is the recognized comfort standard which assumes that the indoor temperature of buildings must be below 24°C during the non-heating season. Lithuanian Construction Regulation STR 2.01.02: 2016. (Annex 2), based on EN ISO 13790:2008, provides the methodology to calculate overheating. It is a static model using a calculation based also on static with a monthly time step. The calculation is based on a single zone. These consumptions are calculated regardless of whether the building has cooling equipment or not.

The risk of overheating in the climate scenario of Lithuania arises if large glazing areas are installed in the buildings without any solar protection. If the temperature exceeds the one specified in the Lithuanian regulation, the primary energy consumption for cooling the building is automatically estimated. In Lithuania, the normative requirement is that there must be no energy demand for cooling the building.

Netherlands

The NTA 8800 is the main regulatory document related to building energy codes based on EPBD. The comfort standard is based on ISSO 74 (2014) which is a private standard and EN 15251. It embraces the occupant and building categories (A, B, C, D). Moreover, a correction factor allows their methods to represent the occupancy schedule. A hybrid method is implemented in the comfort model with an overheating indicator based on monthly mean overheating temperature. The simulation model is based on a quasi-steady state and multi-zone. The overheating indicator is the average indoor temperature of the whole building during the non-heating season. During summer, the temperature shouldn’t exceed 24°C. However, if the limitation isn’t respected, the installation of a cooling system isn’t mandatory.

There is two overheating thresholds. The first criterion is static. It uses a dimensionless index TOjuli which is calculated only for July and depending on the façade surface per

orientation. It must be below 1K. The second criterion is based on the weighted limit temperature name GTO. It is a dynamic method that must be above 450h. When TOjuli is exceeded, it calculates the risk of overheating more accurately.

Norway

In Norway, there is no requirement for quantified value in the building regulation. It is common to embrace the four occupant categories (I, II, III, IV) or to choose a static or adaptive method for thermal comfort according to the NS-EN-15251. The Norwegian Technical Building regulations (TEK 17) is used to determine the main factors that should be studied: operating temperature, vertical temperature difference, radiation asymmetry, and airspeed. The operative temperature should be above 26°C to assure thermal comfort. For residential buildings without installed cooling, a slightly higher indoor temperature should be acceptable for short periods. During hot summer periods, these temperatures can be exceeded if the outdoor air temperature is exceeded by 50 hours the temperature of a normal year. Moreover, if the number of hours above 26°C of the operative temperature is higher than 50 the overheating threshold of the indicator is exceeded. The simulation model based its calculation on a dynamic, with no specific time step, and multi-zone or single-zone model. The multi-zone is used only if the dwelling is larger than 50m2 and has significantly different orientations for living spaces.

Poland

Poland uses ISO 7730 and EN 16798 as comfort standards. The comfort model can be based on a static or adaptive method. In Poland, the overheating criteria are yet to be defined. The simulation model for the comfort model represents the occupancy presence with a schedule depending on if it is the living room or the sleeping room zone. The overheating risk is more in the new buildings, which are highly insulated and not massive. Poland is still dominated by large window arrangements in the buildings. However, the g-value in summer must be above 0.35. Even in the North of Poland, this influences overheating of the highly insulated buildings. The risk is lower in massive constructions due to the thermal load, and the lowest risk is in single-family houses, where the floors on the ground influence the thermal inertia. In the hottest period of the year, which is usually no longer than 2 weeks the internal air temperature varies between 28 to 32°C. There is a similar problem in almost every insulated block of flats, new or old. There are no defined methods to neither evaluate nor calculate the overheating risk of any building in Poland.

Portugal

In the Portuguese Buildings Thermal Code, comfort conditions are based on a set of parameters that, when combined, express the energy performance of the building. There is no Portuguese Thermal Comfort model and no overheating indicator. In the Portuguese Buildings Thermal Code, the reference value for the indoor temperature in

summer (June, July, August, and September are the conventional cooling month) is 25ºC. Whenever the temperature goes up this value, a cooling need is assumed and calculated. The cooling needs are limited to a maximum value depending on the climatic zone and on the thermal inertia of the building. Portuguese Buildings Thermal Code defines nine climate zones, from the different combinations of climatic severity in winter and summer. There is a maximum admissible g-value of glazing for residential buildings according to the climate zone. External shading isn't mandatory but shading systems (external or internal) or special glazing will be required to comply with the maximum g-value defined in the Portuguese Building Thermal Code (Portaria n°138-I/2021). There is no obligation about the limitation of the window all ratio but if the area of the window is greater than 15% of the floor area they serve, there are special requirements regarding shading. The simulation model is based on a steady-state methodology based on EN ISO 13790.

Romania

Romania divided its country into five climatic zones. The overheating thresholds are defined by the operating temperature values, which are set by SR EN ISO 16798-1:2019 between 20 and 27°C, depending on the building destination and ambient categories. It is a static model. For the occupancy presence, it is considered a continuous or intermittent use. The calculation is based on a static or quasi-dynamic with hourly time step. It uses a multi-zone or single-zone calculation. The sleeping room is distinguished from the other area. The installation of external shading is recommended but not mandatory. The G-value must be between 0.30 to 0.68 W/m3K depending on the floor's envelope surface to building volume ratio: ≤ 0.15 & ≥ 1.10 (C 107-2005). Therefore, the TRNSYS simulations based on in-field climatic data are recommended to evaluate overheating risk.

Slovakia

Slovakia divide its country into three climate zones. The overheating criteria are valid for all building types. Using the standards STN EN 16798-1 and STN EN ISO 7730. However, the most important documents are the national regulations. In these regulations, the comfort limit is based on PMV/PPD model. The limit depends on the type of activity and several categories of activity are defined. This means for instance, that for activities like sleeping the upper limit in the occupied rooms is 26°C in winter and 28°C in summer. For light activity, it is 24°C in winter and 27°C in summer. Representing the occupancy presence have to be according to the C STN EN 16798-1, but it i not mandatory. The comfort model is based on static, and the simulation model is based on a dynamic and single zone model with hourly calculation. The calculation distinguished sleeping rooms from other living areas

It can be considered in general, that more thermal protection used in the building, higher the overheating risk. The risk could be quite high because the designers and stakeholders still focus on maximizing thermal protection of a building as well as winter

solar gains to meet with the heating demand, however completely neglecting the summer thermal comfort, such as the external shading, passive cooling, and/or air conditioning etc., especially for residential buildings. Therefore, summer overheating is being considered as a highly relevant issue and will be further emphasized by ongoing climate change. There are currently various initiatives, even at the level of government strategies addressing these issues by promoting green infrastructure, green roofs and facades, greenery in general, etc.

Overall, overheating/cooling is not commonly and adequately addressed in the Slovak buildings during the design process. In accordance to the Decree no. 259/2008 Coll., the evaluation of the temperature-humidity microclimate must be objectivized either on the basis of measured values or if the following conditions are reached:

a) the calculation proves compliance with the requirements for the thermal performance of the building structures and for the thermal stability of the room according to the relevant technical standards;

b) in the winter season, the heating system ensures optimal microclimatic conditions;

c) the total area of the building openings does not exceed 40% of the area of the envelope structures of the room;

d) openings oriented to the sun shall be installed with an external shading.

This means, that the buildings are not necessarily subjected to a more detailed analysis and above mentioned conditions are allowed to be applicable for it to address this issue in a simplified manner.

Spain

Spain’s regulations come from the Spanish Building Code (CTE 2019). Comfort models use the Fanger model and the ISO 15251. However, cooling doesn’t need to be calculated in Spain for most of the area. Spain had divided its country into 12 parts with 5 levels of winter from the most temperate A to the coldest E and 3 levels of summer from the mildest 1 to the warmest 3. The calculation is only mandatory for the summer climate zone and is based on the data file of 2005. Only solar gains, which are calculated considering all the solar shading activated is used as an overheating indicator during July and must not exceed 2.00 kWh/m2.month. Moreover, between June and September, the temperature of the rooms must not exceed more than 4% of total annual hours for new and substantial refreshment buildings at 27°C (from 11:00 pm to 6:59 am) and 25°C (from 3:00 pm to 10:59 pm). The current regulation doesn’t allow to build new naturally ventilated buildings. The calculation is based on a dynamic model with a 1-hour calculation time step Overheating calculation is based on a single zone model, which takes each room separately for the calculation. It needs to use a recognized simulation tool, in Spain 6 of them are available freely.

Sweden

The Swedish National Board of Housing, Building and Planning (Act) states that 18°C is the minimum acceptable operating temperature, which is the indicator for overheating. Since 1990, it has been mandatory to install heat recovery ventilation in buildings. Cooling of buildings in summer is a new issue in Sweden and there was no specific law to combat overheating. However, some guidelines, which are in common use, set limits that are more precise. The guidelines for specifying indoor climate requirements, called R1, define two thermal climate classes for residential buildings, to be chosen by the designers: the more restrictive one and TQ2, which is used for most residential buildings. Both limit the acceptable range for operating temperature to between 23°C and 26°C. R1 is in accordance with SS-EN ISO 7730, using statics. Sweden has based its calculation on what it calls a normal year. The Swedish Meteorological renews the data file of this normal year every 30 years and the Hydrological Institute based on a real year. These are constant values of heat gains due to equipment, lighting, and people depending on the type of people and activity inside the building. The calculation is based on a multi-zone and dynamic model with an hourly calculation time step.

Switzerland

Switzerland uses a comfort standard called SIA-180 for Society for architectural engineering 180. In annex C1, adaptive curves define the comfort thresholds for naturally ventilated buildings and others. The temperature must stay under a certain limit that depends on the mean ambient temperature during the last 48 hours. The maximal temperature limit is higher in naturally ventilated buildings. It takes into account the proximity of people to local heating, cooling, and ventilation systems, and the occupancy schedule. The simulation model is fully dynamic and its time step is adaptive during the simulation ranging from one hour to a few seconds. It is based on a multi-zone model.

UK

The UK have TM 59 and the CIBSE 59 for domestic building which are guideline using adaptive thermal comfort. It is dependent on local weather. There is no clear definition for heat waves but they have a calculation approach that deals with extreme temperatures in summer. Hours of exceedance and operative temperature are the two overheating indicators used in a different way according if it is a naturally ventilated or a predominantly ventilated home. The calculation is made with multi-zone with an hourly dynamic simulation modeling which distinguished sleeping rooms from the other. The thermal comfort in sleeping rooms deals with a static model during the night and an adaptive model during the day. Moreover, based on CIBSE Guide A (2015a), a maximum sensible heat gain of 75 W/person and a maximum latent heat gain of 55

W/person are assumed in living spaces. An allowance for 30% reduced gain during sleeping is based on Addendum g to ANSI/ASHRAE Standard 55-2010.

APPENDIX 2: QUESTIONNAIRE

Please fill out the following table regarding the status in your country. Feel free to develop the answers.

1. What is the thermal comfort limit for residential buildings in your country?

1.a.1. Explain shortly the reference standards used in your country to evaluate thermal comfort in residential buildings.

1..a.2. What is your comfort standard?

1..a.3. On what your comfort model is based?

1.a.4. What are the overheating criteria for residential buildings in your country?

1..a.5. Cite the reference, and share the reference in pdf format if possible.

1.a.6. Please fill out the following table regarding overheating in your country. Feel free to elaborate on your answers.

Table 19: Overheating assessment

Criteria	Your Country
Climate and weather data	
Is comfort dependent on national geographic climate zones? If yes, list them.	
Do you have a specific comfort calculation approach for heat waves?	
Do you take into account the urban heat island effect?	
Does your overheating methodology take into account future climate change weather files with extreme scenarios?	
Occupant type and representation	
What type of building type does your comfort standard deal with?	
Does your method embrace the four occupant categories (I, II, III, IV)? *	
How do you represent occupancy presence in the simulation model?	
Comfort model	
What is overheating provisions period coverage?	
What is your overheating indicator?	
Is your comfort model based on an adaptive (like EN 15251 / 16798) or static (like Fanger) method?	

What are your comfort thresholds?	
What are your overheating thresholds? and according to which standard are those thresholds defined?	
Is there a distinction between naturally ventilated, air-conditioned, and mixed mode buildings?	
Does your model take into account local personalized heating/cooling & ventilations systems (ceiling fans, air-conditioned chairs, electric heating mattresses…)?	
<u>Simulation model</u>	
Is your calculation based on a static/quasi-dynamic/dynamic model? What is the calculation timestep?	
Is your overheating calculation based on a single or multizone model?	
Does your calculation distinguish sleeping rooms from other living areas?	
<u>Mandatory envelope requirements</u>	
Does your method oblige the installation of external shading?	
Does your method oblige the limitation of the window to wall ratio? If yes, what is the limit?	
Does your method recommend a g-value? If yes, what is the limit?	
* we are focusing on category II occupants for new and renovated buildings	

1b. Do you have fuel poverty problems in your country that might influence overheating risk in residential buildings? Explain.

1.c.2. What is the overheating risk for residential buildings (highly insulated) in your climate?

1.c.3. How do you evaluate overheating risk in residential buildings in your country? Please share the calculation method and overheating hours limit threshold.

1.d. Can we rely on passive cooling or must include active cooling systems for residential buildings in your country for residential buildings?

Add something ?

Relevant References / key publications:

APPENDIX 3: SUMMARY OF OVERHEATING REGULATIONS IN A TABLE

To download the table please click here on the Table_V2.xlsx:
https://doi.org/10.7910/DVN/LCBTNX

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