ANNEX **5**

EBC
Energy in Building and Communities Programme

AIVC Technical Note 76

Overheating assessment & ventilative cooling in national building codes regarding indoor environmental quality and energy performance

May 2026

Main Authors

Hilde Breesch, KU Leuven, Belgium

Maria Kapsalaki, INIVE, Belgium

Published by INIVE, Sint-Pietersnieuwstraat 41, B-9000 Ghent, Belgium.

ISBN 978-2-930471-88-4

Participating countries in the EBC: Australia, Austria, Belgium, Brazil, Canada, P.R. China, Czech Republic, Denmark, Finland, France, Germany, Ireland, Italy, Japan, Republic of Korea, Netherlands, New Zealand, Norway, Portugal, Singapore, Spain, Sweden, Switzerland, Turkey, United Kingdom and the United States of America.

www.iea-ebc.org

essu@iea-ebc.org

Preface

The International Energy Agency

The International Energy Agency (IEA) was established in 1974 within the framework of the Organisation for Economic Co-operation and Development (OECD) to implement an international energy programme. A basic aim of the IEA is to foster international cooperation among the 30 IEA participating countries and to increase energy security through energy research, development and demonstration in the fields of technologies for energy efficiency and renewable energy sources.

The IEA Energy in Buildings and Communities Programme

The IEA co-ordinates international energy research and development (R&D) activities through a comprehensive portfolio of Technology Collaboration Programmes (TCPs). The mission of the IEA Energy in Buildings and Communities (IEA EBC) TCP is to support the acceleration of the transformation of the built environment towards more energy efficient and sustainable buildings and communities, by the development and dissemination of knowledge, technologies and processes and other solutions through international collaborative research and open innovation. (Until 2013, the IEA EBC Programme was known as the IEA Energy Conservation in Buildings and Community Systems Programme, ECBCS.).

The high priority research themes in the EBC Strategic Plan 2019-2024 are based on research drivers, national programmes within the EBC participating countries, the Future Buildings Forum (FBF) Think Tank Workshop held in Singapore in October 2017 and a Strategy Planning Workshop held at the EBC Executive Committee Meeting in November 2017. The research themes represent a collective input of the Executive Committee members and Operating Agents to exploit technological and other opportunities to save energy in the buildings sector, and to remove technical obstacles to market penetration of new energy technologies, systems and processes. Future EBC collaborative research and innovation work should have its focus on these themes.

At the Strategy Planning Workshop in 2017, some 40 research themes were developed. From those 40 themes, 10 themes of special high priority have been extracted, taking into consideration a score that was given to each theme at the workshop. The 10 high priority themes can be separated in two types namely ‘Objectives’ and ‘Means’. These two groups are distinguished for a better understanding of the different themes.

Objectives: The strategic objectives of the EBC TCP are as follows:

- reinforcing the technical and economic basis for refurbishment of existing buildings, including financing, engagement of stakeholders and promotion of co-benefits;
- improvement of planning, construction and management processes to reduce the performance gap between design stage assessments and real-world operation;
- the creation of ‘low tech’, robust and affordable technologies;
- the further development of energy efficient cooling in hot and humid, or dry climates, avoiding mechanical cooling if possible; the creation of holistic solution sets for district level systems taking into account energy grids, overall performance, business models, engagement of stakeholders, and transport energy system implications.

Means: The strategic objectives of the EBC TCP will be achieved by the means listed below:

- the creation of tools for supporting design and construction through to operations and maintenance, including building energy standards and life cycle analysis (LCA);
- benefitting from ‘living labs’ to provide experience of and overcome barriers to adoption of energy efficiency measures;
- improving smart control of building services technical installations, including occupant and operator interfaces;
- addressing data issues in buildings, including non-intrusive and secure data collection;
- the development of building information modelling (BIM) as a game changer, from design and construction through to operations and maintenance.

The themes in both groups can be the subject for new Annexes, but what distinguishes them is that the ‘objectives’ themes are final goals or solutions (or part of) for an energy efficient built environment, while the ‘means’ themes are instruments or enablers to reach such a goal. These themes are explained in more detail in the EBC Strategic Plan 2019-2024.

The Executive Committee

Overall control of the IEA EBC Programme is maintained by an Executive Committee, which not only monitors existing projects, but also identifies new strategic areas in which collaborative efforts may be beneficial. As the Programme is based on a contract with the IEA, the projects are legally established as Annexes to the IEA EBC Implementing Agreement. At the present time, the following projects have been initiated by the IEA EBC Executive Committee, with completed projects identified by (*) and joint projects with the IEA Solar Heating and Cooling Technology Collaboration Programme by (☼):

Annex 1: Load Energy Determination of Buildings (*)
Annex 2: Ekistics and Advanced Community Energy Systems (*)
Annex 3: Energy Conservation in Residential Buildings (*)
Annex 4: Glasgow Commercial Building Monitoring (*)
Annex 5: Air Infiltration and Ventilation Centre
Annex 6: Energy Systems and Design of Communities (*)
Annex 7: Local Government Energy Planning (*)
Annex 8: Inhabitants Behaviour with Regard to Ventilation (*)
Annex 9: Minimum Ventilation Rates (*)
Annex 10: Building HVAC System Simulation (*)
Annex 11: Energy Auditing (*)
Annex 12: Windows and Fenestration (*)
Annex 13: Energy Management in Hospitals (*)
Annex 14: Condensation and Energy (*)
Annex 15: Energy Efficiency in Schools (*)
Annex 16: BEMS 1- User Interfaces and System Integration (*)
Annex 17: BEMS 2- Evaluation and Emulation Techniques (*)
Annex 18: Demand Controlled Ventilation Systems (*)
Annex 19: Low Slope Roof Systems (*)
Annex 20: Air Flow Patterns within Buildings (*)
Annex 21: Thermal Modelling (*)
Annex 22: Energy Efficient Communities (*)
Annex 23: Multi Zone Air Flow Modelling (COMIS) (*)
Annex 24: Heat, Air and Moisture Transfer in Envelopes (*)
Annex 25: Real time HVAC Simulation (*)
Annex 26: Energy Efficient Ventilation of Large Enclosures (*)
Annex 27: Evaluation and Demonstration of Domestic Ventilation Systems (*)
Annex 28: Low Energy Cooling Systems (*)
Annex 29: ☼ Daylight in Buildings (*)
Annex 30: Bringing Simulation to Application (*)
Annex 31: Energy-Related Environmental Impact of Buildings (*)
Annex 32: Integral Building Envelope Performance Assessment (*)
Annex 33: Advanced Local Energy Planning (*)
Annex 34: Computer-Aided Evaluation of HVAC System Performance (*)
Annex 35: Design of Energy Efficient Hybrid Ventilation (HYBVENT) (*)
Annex 36: Retrofitting of Educational Buildings (*)
Annex 37: Low Exergy Systems for Heating and Cooling of Buildings (LowEx) (*)
Annex 38: ☼ Solar Sustainable Housing (*)
Annex 39: High Performance Insulation Systems (*)
Annex 40: Building Commissioning to Improve Energy Performance (*)
Annex 41: Whole Building Heat, Air and Moisture Response (MOIST-ENG) (*)
Annex 42: The Simulation of Building-Integrated Fuel Cell and Other Cogeneration Systems (FC+COGEN-SIM) (*)
Annex 43: ☼ Testing and Validation of Building Energy Simulation Tools (*)
Annex 44: Integrating Environmentally Responsive Elements in Buildings (*)
Annex 45: Energy Efficient Electric Lighting for Buildings (*)
Annex 46: Holistic Assessment Tool-kit on Energy Efficient Retrofit Measures for Government Buildings (EnERGo) (*)
Annex 47: Cost-Effective Commissioning for Existing and Low Energy Buildings (*)
Annex 48: Heat Pumping and Reversible Air Conditioning (*)
Annex 49: Low Exergy Systems for High Performance Buildings and Communities (*)
Annex 50: Prefabricated Systems for Low Energy Renovation of Residential Buildings (*)
Annex 51: Energy Efficient Communities (*)
Annex 52: ☼ Towards Net Zero Energy Solar Buildings (*)

Annex 53: Total Energy Use in Buildings: Analysis and Evaluation Methods (*)
Annex 54: Integration of Micro-Generation and Related Energy Technologies in Buildings (*)
Annex 55: Reliability of Energy Efficient Building Retrofitting - Probability Assessment of Performance and Cost (RAP-RETRO) (*)
Annex 56: Cost Effective Energy and CO_2 Emissions Optimization in Building Renovation (*)
Annex 57: Evaluation of Embodied Energy and CO_2 Equivalent Emissions for Building Construction (*)
Annex 58: Reliable Building Energy Performance Characterisation Based on Full Scale Dynamic Measurements (*)
Annex 59: High Temperature Cooling and Low Temperature Heating in Buildings (*)
Annex 60: New Generation Computational Tools for Building and Community Energy Systems (*)
Annex 61: Business and Technical Concepts for Deep Energy Retrofit of Public Buildings (*)
Annex 62: Ventilative Cooling (*)
Annex 63: Implementation of Energy Strategies in Communities (*)
Annex 64: LowEx Communities - Optimised Performance of Energy Supply Systems with Exergy Principles (*)
Annex 65: Long-Term Performance of Super-Insulating Materials in Building Components and Systems (*)
Annex 66: Definition and Simulation of Occupant Behavior in Buildings (*)
Annex 67: Energy Flexible Buildings (*)
Annex 68: Indoor Air Quality Design and Control in Low Energy Residential Buildings (*)
Annex 69: Strategy and Practice of Adaptive Thermal Comfort in Low Energy Buildings (*)
Annex 70: Energy Epidemiology: Analysis of Real Building Energy Use at Scale (*)
Annex 71: Building Energy Performance Assessment Based on In-situ Measurements (*)
Annex 72: Assessing Life Cycle Related Environmental Impacts Caused by Buildings (*)
Annex 73: Towards Net Zero Energy Resilient Public Communities (*)
Annex 74: Competition and Living Lab Platform (*)
Annex 75: Cost-effective Building Renovation at District Level Combining Energy Efficiency and Renewables (*)
Annex 76: ☼ Deep Renovation of Historic Buildings Towards Lowest Possible Energy Demand and CO_2 Emissions (*)
Annex 77: ☼ Integrated Solutions for Daylight and Electric Lighting (*)
Annex 78: Supplementing Ventilation with Gas-phase Air Cleaning, Implementation and Energy Implications (*)
Annex 79: Occupant-Centric Building Design and Operation (*)
Annex 80: Resilient Cooling (*)
Annex 81: Data-Driven Smart Buildings (*)
Annex 82: Energy Flexible Buildings Towards Resilient Low Carbon Energy Systems (*)
Annex 83: Positive Energy Districts
Annex 84: Demand Management of Buildings in Thermal Networks (*)
Annex 85: Indirect Evaporative Cooling
Annex 86: Energy Efficient Indoor Air Quality Management in Residential Buildings (*)
Annex 87: Energy and Indoor Environmental Quality Performance of Personalised Environmental Control Systems
Annex 88: Evaluation and Demonstration of Actual Energy Efficiency of Heat Pump Systems in Buildings
Annex 89: Ways to Implement Net-zero Whole Life Carbon Buildings
Annex 90: EBC Annex 90 / SHC Task 70 Low Carbon, High Comfort Integrated Lighting
Annex 91: Open BIM for Energy Efficient Buildings
Annex 92: Smart Materials for Energy-Efficient Heating, Cooling and IAQ Control in Residential Buildings
Annex 93: Energy Resilience of the Buildings in Remote Cold Regions
Annex 94: Validation and Verification of In-situ Building Energy Performance Measurement Techniques
Annex 95: Human-centric Building Design and Operation for a Changing Climate
Annex 96: Grid Integrated Control of Buildings
Annex 97: Sustainable Cooling in Cities
Annex 98: Flexibilization and Optimization of Heat Pump Systems in Existing Buildings through Secondary-Side Digitalization
Annex 99: Air Cleaning for Sustainable and Resilient Buildings

Working Group – Energy Efficiency in Educational Buildings (*)
Working Group – Indicators of Energy Efficiency in Cold Climate Buildings (*)
Working Group – Annex 36 Extension: The Energy Concept Adviser (*)
Working Group – HVAC Energy Calculation Methodologies for Non-residential Buildings (*)
Working Group – Cities and Communities (*)
Working Group – Building Energy Codes

IEA EBC Annex 5: Air Infiltration and Ventilation Centre

EBC Annex 5 was first established in 1979 under the name "Air Infiltration Centre" undertaking technical activities and providing information services with the task of minimizing air infiltration energy losses. In 1986, the name was changed to "Air Infiltration and Ventilation Centre" to reflect the importance of the coupling of a good airtightness with appropriate ventilation. Over time, the AIVC has been continuously evolving to respond to emerging concerns, challenges and opportunities. We have now entered the 46th year of the AIVC's existence and the Centre's main goal is to provide reference information on ventilation & air infiltration in the built environment with respect to efficient energy use and good Indoor Environmental Quality (IEQ).

In November 2025, the Executive Committee approved the continuation of the AIVC for the period 2027-2031. Peter Wouters and Arnold Janssens are on behalf of INIVE the operating agents for this period.

The AIVC holds a conference each year in September/October in one of the AIVC participating countries. More information can be found here: www.aivc.org/events/conferences

The AIVC organizes 1 to 2 workshops per year. More information can be found here: www.aivc.org/events/workshops

The AIVC organizes a number of webinars per year. More information can be found here: www.aivc.org/events/webinars

The AIVC has formal collaborations with the TightVent platform (https://tightvent.eu/), the venticool platform (https://venticool.eu/) and the IEQ-GA (https://ieq-ga.net/).

Moreover, there is a close interaction with several ventilation related annexes of IEA-EBC.

If you want to be kept informed on the activities of AIVC and related platforms, you can subscribe here.

venticool

venticool is the international ventilative cooling platform launched in October 2012 to accelerate the uptake of ventilative cooling by raising awareness, sharing experience and steering research and development efforts in the field of ventilative cooling. In 2020, venticool decided to broaden its scope towards resilient ventilative cooling

The platform supports better guidance for the appropriate implementation of resilient ventilative cooling strategies as well as adequate credit for such strategies in building regulations.

The platform philosophy is to pull resources together and to avoid duplicating efforts to maximize the impact of existing and new initiatives. venticool joins forces with international projects (in particular IEA EBC Annex 62 (ventilative cooling), IEA EBC annex 80 (Resilient cooling of buildings), IEA EBC annex 87 (Energy and Indoor Environmental Quality Performance of Personalised Environmental Control Systems) and more recently IEA EBC annex 97 (Sustainable Cooling in Cities)) as well as organizations with significant experience and/or well identified in the field of ventilation and thermal comfort like AIVC and REHVA.

venticool was initiated by INIVE (International Network for Information on Ventilation and Energy Performance) with the financial and/or technical support of the following partners: Agoria, Velux, Reynaers Aluminium, WindowMaster, Active House, CIBSE nvg, Eurowindoor and REHVA.

Table of content

1. Introduction

The world meteorological organization (WMO) reported that 2024 was the warmest year in the 175-year observational record, and likely the first to exceed 1.5°C above pre-industrial levels (WMO, 2025). That year also brought extreme heat in the world, with record-breaking temperatures above 50°C in regions including India and USA.

This accelerating warming trend highlights a shift in building practice in cold and moderate climates: from focusing on heating needs to addressing cooling demand, overheating risks, and thermal resilience. Designers typically rely on national building codes on indoor environmental quality (IEQ) and energy performance when assessing overheating risks. Yet key questions arise: Do current building codes adequately reflect the realities of climate change? What methods and requirements are in place, and how do they apply across residential and non-residential buildings?

Within this context, ventilative cooling is recognized as a key strategy (EC, 2025). It not only helps meet cooling demand in standard weather conditions but also reduces CO_2 emissions and enhances resilience during extreme scenarios such as heatwaves.

The purpose of this document is to provide practitioners with an overview of the current status of national building codes regarding indoor environmental quality (IEQ) and energy performance, with a focus on how they address overheating and ventilative cooling in buildings. The review focuses primarily on building codes applicable to new buildings in cold and moderate climates, where regulations have traditionally prioritized heating performance. To support this objective, we conducted a cross-country survey in 2024-2025, gathering insights into how different countries and regions are tackling both overheating and ventilative cooling.

The survey targeted 19 countries/regions - Australia, Austria, Flanders (Belgium), Canada, Denmark, France, Germany, Greece, Ireland, Italy, Japan, the Netherlands, Norway, Portugal, South Korea, Spain, Sweden, Switzerland and England & Wales (GB). This survey gathered detailed information on assessment methods, performance requirements, and the integration of passive cooling concepts in both residential and non-residential buildings in current regulations. All information provided reflects the interpretation and judgment of national experts based on their understanding of applicable regulations.

National experts were recruited through professional and academic networks and selected based on their expertise in national building regulations and building performance assessment (see Chapter 6 for the list of contributing experts). They were asked to provide data on the presence of overheating assessment, whether building codes specify requirements for limiting overheating, and the extent to which ventilative cooling is acknowledged as a mitigation strategy. The survey also explored technical modeling practices, such as the type of assessment methods used (e.g. simplified versus detailed), the use of climate data (current and future), modeling tools, zoning strategies, and time resolution.

In addition, the survey investigated the terminology and concepts referenced in national codes—such as "ventilative cooling," "free cooling," and "passive cooling"—as well as the degree to which resilience to overheating is explicitly addressed. For ventilative cooling specifically, the survey examined whether codes distinguish between natural and mechanical systems, manual and automated control, and different airflow strategies like single-sided or cross-ventilation.

All survey responses have been systematically compiled and presented in comparative tables and summary figures throughout the report, providing a comprehensive overview of regulatory practices across the participating countries.

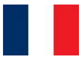
This report is based on regulatory frameworks as identified during the 2024-2025 data collection period. While some countries or regions have subsequently adopted revised building codes before publication in 2026, the analysis presented here refer to the code versions available at the time the survey was conducted.

2. Building Codes

2.1. Key Regulations

The survey gathered information on the national (or regional) building codes related to Indoor Environmental Quality (IEQ) and Energy Performance in each of the 19 participating countries. Respondents provided the names of the applicable codes, the year of their most recent version, and whether a revision is currently planned. Table 1 below presents this information.

Table 1:Overview of national (or regional) building codes regarding Indoor Environmental Quality (IEQ) and Energy Performance (EP) in each of the 19 participating countries

Country		National (or regional) building code regarding Indoor Environmental Quality and Energy Performance	Year	Revision planned? When?
Australia		National Construction Code 2022 (adopted by states and territories from May 1, 2023). Volume 1 (non-residential buildings) has energy efficiency requirements in Section J and health and safety in Section F. Subsection J6 relates to air-conditioning and ventilation. In Volume 2 (residential buildings), energy performance requirements are in Part H6, and Health and amenity in Part H4. Each state/territory has slightly different requirements, so these are presented in the respective schedules.	**2022**	**No**
Austria		There's a national framework for the regional building codes. It is published by the Austrian Institute of Construction Engineering. It consists of six guidelines. Relevant for ventilation are Guideline Nr.3 - hygiene, health and environmental protection (OIB-Richtlinie 3: Hygiene, Gesundheit und Umweltschutz) and Guideline Nr.6 - Energy conservation and heat insulation (OIB-Richtlinie 6: Energieeinsparung und Wärmeschutz)	**2023**	**YES - 2026**
Flanders (Belgium)		EPB (The EU EPBD requirements are translated into the Energy Decree of Flanders)	**2020**	**YES - 2027**
Canada		National Energy Code of Canada for Buildings (NECB) 2020 (Updated every 5 years)	**2020**	**YES - 2025**
Denmark		BR18 (Building Regulations 2018 - more info in English here)	**2025**	**YES - 2026**
France		RE2020 (Environmental Regulation 2020)	**2022**	**YES - 2030**
Germany		GebäudeEnergieGesetz (GEG) (The GEG aligns with the EU EPBD). ArbeitsStättenRichtlinie (ASR- Technical Rules for Workplaces - refers to a set of technical rules in Germany that provide detailed guidance on how to implement the Arbeitsstättenverordnung (ArbStättV) – the Workplace Ordinance)	**2024** **2018**	**YES - 2026**
Greece[1]		Regulation Of Energy Performance of Buildings - KENAK	**2017**	**NO**
Ireland		Building Regulations Technical Guidance Document Part L, and Building Regulations Technical Guidance Document Part F	**2022**	**YES - 2025** [2]
Italy		Italian Ministerial Decree 26th June 2015 on "Application of energy performance calculation methodologies and specification of prescriptions and minimum requirements" (more info in English here) - Decreto interministeriale 26 giugno 2015 - Applicazione delle metodologie di calcolo delle prestazioni energetiche e definizione delle prescrizioni e dei requisiti minimi degli edifici	**2015**	**YES - 2025**

[1] In Greece, the Energy Performance of Buildings Regulation (KENAK, 2017) does not include explicit requirements or a defined method to assess overheating. Cooling needs are only considered indirectly through energy performance calculations, but there are no specific thresholds or resilience criteria related to overheating.

[2] Revision only valid for residential buildings

Japan		Act on the Improvement of Energy Consumption Performance of Buildings (Building Energy Conservation Act)	**2022**	**YES - 2025**
Netherlands		NTA 8800 (Energy performance of buildings - Determination method)	**2024**	**YES - 2026**
Norway		Byggteknisk forskrift (TEK17) med veiledning (Building Technical Regulations (TEK17) with Guidance – aligns with the EPBD)	**2017**	**YES - 2022 (delayed)**
Portugal		Decreto-Lei 101-D/2020 de 7 de dezembro (Decrée-Law 101-D/2020 of December 7th) and associated complementary legislation (namely Portaria 138-I/2021 of July 1st; Despacho Despacho n.º 6476-H/2021 of July 1st in its most recent version).	**2020**	**NO**
South Korea		Building Energy Saving Design Code (national code overseen by Ministry of Land, Infrastructure and Transport) – Article 9 addresses economizer systems and heat recovery ventilation devices. Regulation on Building Facility Standards (national code overseen by Ministry of Land, Infrastructure and Transport)– Article 11 addresses the ventilation standards for multi-family housing and multi-use facilities from the perspective of indoor air quality.	**2024**	**NO**
Spain		"Documento Básico ahorro de Energía" (DB-HE) of the "Código técnico de la edificación" (CTE).	**2019**	**NO**
Sweden		Boverkets föreskrifter om skydd med hänsyn till hygien, hälsa och miljö samt hushållning med vatten och avfall (BFS 2024:8)[3]	**2026**	**NO**
Switzerland		Switzerland consists of 26 cantons, each of which has its own constitution and laws, ensuring a degree of autonomy within the Swiss Confederacy. The 26 cantonal building codes are based on the Mustervorschriften der Kantone im Energiebereich (MuKEn). The current version of MuKEn is from 2014; a revised version is expected in 2025. Standards are not part of the building codes.	**2014**	**YES - 2025**
England & Wales (GB)		Part F (indoor environmental quality related to ventilation), Part L (energy performance) and Part O (indoor environmental quality related to overheating). [Note: Scotland is covered by the Scottish Building Regulations: "Section 6 (Energy)" is equivalent to Part L in England and Wales and "Section 3 (Environment)" is equivalent to Part F and Part O in England and Wales.]	**2022**	**NO[4]**

2.2. Overheating Assessment and Ventilative Cooling in Regulations

This section analyzes the extent to which national (or regional) building codes from the 19 countries, included in this overview, address overheating in buildings. Specifically, it evaluates whether codes:

1. Include an **assessment method for** overheating.
2. Set **requirements for** overheating.
3. Include **ventilative cooling** as a mitigation strategy.
4. Include **resilience** to overheating concept and **cooling-related terminology**—such as ventilative, passive, and free cooling

The analysis covers both **residential** and **non-residential** building types. Replies to the survey are included in Table 2 & Table 3 and mapped in Figures 1 to 10 which follow.

[3] 2019 (BBR 26, BFS 2018:4) and 2024 (BFS) are used in parallel for the year 2025.

[4] There was a consultation in 2023 called "The Future Homes and Buildings Standards: 2023 consultation" - this was looking at options to update Part F and Part L, and seeking evidence of the use of Part O. The Future Homes Standard (FHS) was due to come into being in 2025. The FHS is likely to increase the requirements for energy efficient, airtight, well-ventilated dwellings, which can cope with overheating.

Table 2: Overheating Assessment-Requirements & Ventilative Cooling in national (or regional) building codes in each of the 19 participating countries

Country		Does the building code include **a method to assess overheating in buildings**?		Does the building code include **requirements for overheating**?		Does the building code include **ventilative cooling to mitigate overheating** in a building?	
		Residential	**Non-residential**	**Residential**	**Non-residential**	**Residential**	**Non-residential**
Australia		No		No		No	
Austria		Yes [5]		Yes		No	Yes
Flanders (Belgium)		Yes	No	Yes	No	Yes	
Canada		Yes [6]	No	Yes	No	No	
Denmark		Yes	No	Yes	No	Yes	
France		Yes		Yes		Yes	
Germany		Yes		Yes		No	
Greece		No		No		No	
Ireland		Yes		Yes		No	
Italy		No		Yes		Yes	
Japan		No		No		No	
Netherlands		Yes		Yes	No	Yes	
Norway		No		No	Yes	Yes	No
Portugal [7]		No		No		No	
South Korea		No		No		No	
Spain [8]		No		No		No	
Sweden		Yes		Yes		No	
Switzerland		No		No		No	
England & Wales (GB)		Yes	No	Yes	No	Yes	No
YES/NO		**10/9**	**6/13**	**11/8**	**7/12**	**7/13**	**6/14**

[5] In the overheating calculations of **residential buildings**, all windows have to be regarded as closed between 22:00 and 06:00.

[6] The current approach is to limit overheating by capping the peak cooling load, but this only applies to buildings following the performance compliance path. Since most buildings do not use this path, the method is not widely adopted

[7] The Portuguese code does not specify explicit requirements for overheating, however, there are requirements for the solar factor of the fenestration (including the effect of glazing, geometrical elements and both fixed and movable shading systems). Such limits indirectly aim at limiting the cooling needs related to solar gains, as well as the risk of overheating. In addition, ventilative cooling may be considered in the energy simulations when calculating the annual cooling (and heating) demand, only for non-residential buildings.

[8] The Spanish building code does not include a method to assess overheating or requirements for overheating. However, there are limits on the building cooling demand and mandatory requirements in terms of solar shading, windows g-values and maximum percentage of glazing for both residential and non-residential buildings. As regards ventilative cooling, it is not explicitly included as an overheating mitigation strategy in the Spanish code. However, the calculation method for the building cooling demand allows using a fixed nighttime ventilation rate (4 ach). Therefore, it acknowledges the cooling potential of nocturnal ventilation, albeit indirectly.

An analysis of the data in Table 2 reveals that a **method to assess overheating** in **residential buildings** is included in the building codes of more than half of the countries analyzed. Austria, Flanders (Belgium), Canada, Denmark, France, Germany, Ireland, the Netherlands, Sweden and England & Wales (GB)—have integrated such methods. In contrast, this number drops to six countries—Austria, France, Germany, Ireland, Netherlands and Sweden—when it comes to non-residential buildings. This may reflect a stronger regulatory focus on residential overheating, likely driven by the fact that residential buildings do not always include (active) cooling system in moderate climates while this is commonly used in non-residential buildings. An in-depth analysis can be found in chapters §3.1.1& §3.1.2.

When considering the presence of **requirements for overheating**, the figures are somewhat more encouraging. A total of eleven countries—Austria, Flanders (Belgium), Canada, Denmark, France, Germany, Ireland, Italy[9], the Netherlands, Sweden, and England & Wales (GB)—include requirements for overheating for **residential buildings**. For **non-residential buildings**, seven countries—Austria, France, Germany, Ireland, Italy, Norway, and Sweden—have established such requirements. This could indicate a growing acknowledgment of overheating risks and a willingness in many countries to enforce preventative measures, particularly in the residential sector. Still, only a few countries have aligned their requirements across both building types, suggesting room for improvement. An in-depth analysis can be found in chapters §3.2.1 & §3.2.2.

Ventilative cooling is addressed in residential building codes in seven countries: Flanders (Belgium), Denmark, France, Italy, Netherlands, Norway and England & Wales (GB). Its presence in non-residential codes is also limited. Only six countries—Austria, Flanders (Belgium), Denmark, France and the Netherlands—include ventilative cooling provisions in non-residential building codes. In Italy, the cost-effectiveness of adopting passive cooling strategies must be assessed (including but not limited to ventilation, green roofs); these assessments and evaluations must be fully documented in the technical report. An in-depth analysis can be found in chapters §4.1 & §4.2.

However, when asked whether the **term *"ventilative cooling"*** is explicitly mentioned in national or regional building codes, only two countries—Italy, and Netherlands—confirmed its inclusion (see Table 3); the majority do not reference the term directly. This discrepancy suggests that while ventilative cooling is not entirely overlooked, it still represents a less developed area of regulation and often lacks formal recognition.

Resilience to overheating as a concept is still not widely embedded in national regulatory frameworks. Only five countries—Austria, Germany, Netherlands, Norway and England & Wales (GB)—affirmed that their building codes explicitly consider resilience to overheating; the remaining fourteen countries, indicated that their codes do not.

Similarly, the use of **specific cooling-related terminology** in legislation remains limited. The term *"free cooling"* is explicitly mentioned in the building codes of five countries: Australia, Germany, Norway, Portugal[10], and Sweden (Germany notes that "Free cooling" is used in its standard DIN V 18599 Energy efficiency of buildings). In addition, *"passive cooling"* is mentioned in only five— Flanders (Belgium), Greece, Ireland, Norway and England & Wales (GB).

[9] In Italy, a detailed calculation of overheating is not required. The only legal requirements are to limit energy demand for summer cooling, maintain acceptable indoor temperatures, and reduce urban heat build-up.

[10] only possible to consider its contribution in non-residential buildings

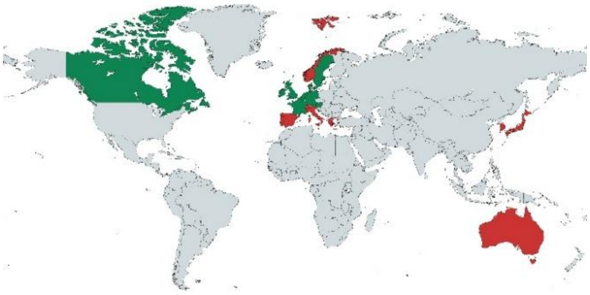


Figure 1a: Does the building code include a method to assess overheating in residential buildings? (Red = NO / Green = YES)

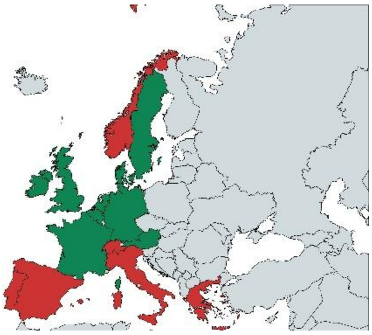


Figure 1b: Does the building code include a method to assess overheating in residential buildings? (Red = NO / Green = YES) – [EU focused map]

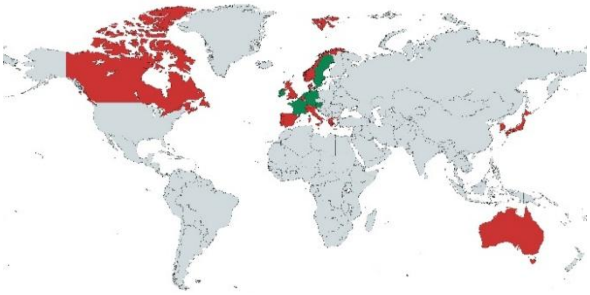


Figure 2a: Does the building code include a method to assess overheating in non-residential buildings? (Red = **NO** / Green = **YES**)

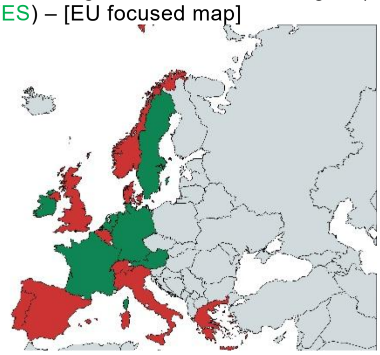


Figure 2b: Does the building code include a method to assess overheating in non-residential buildings? (Red = **NO** / Green = **YES**) – [EU focused map]

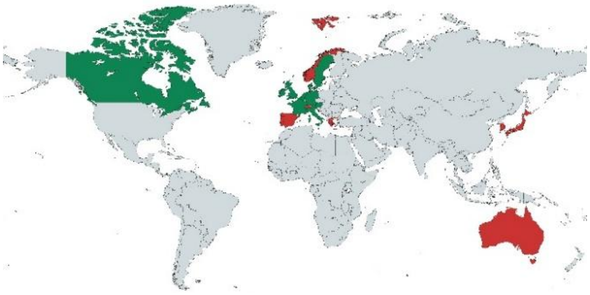


Figure 3a: Does the building code include requirements for overheating in residential buildings? (Red = **NO** / Green = **YES**)

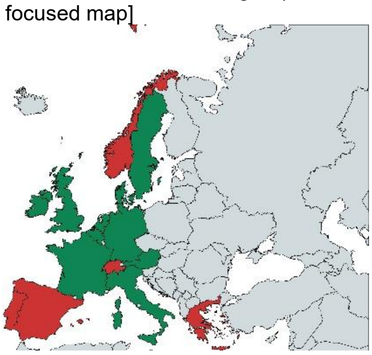


Figure 3b: Does the building code include requirements for overheating in residential buildings? (Red = **NO** / Green = **YES**) – [EU focused map]

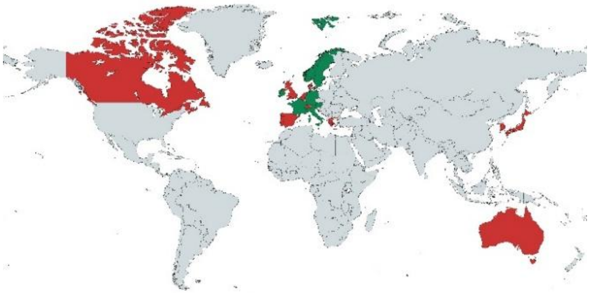


Figure 4a: Does the building code include requirements for overheating in non-residential buildings? (Red = **NO** / Green = **YES**)

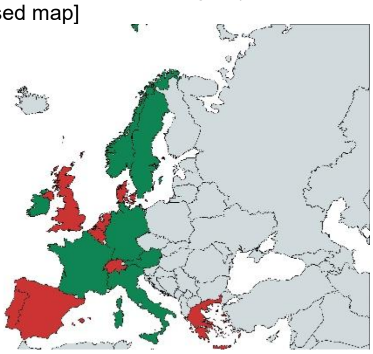


Figure 4b: Does the building code include requirements for overheating in non-residential buildings? (Red = **NO** / Green = **YES**) – [EU focused map]

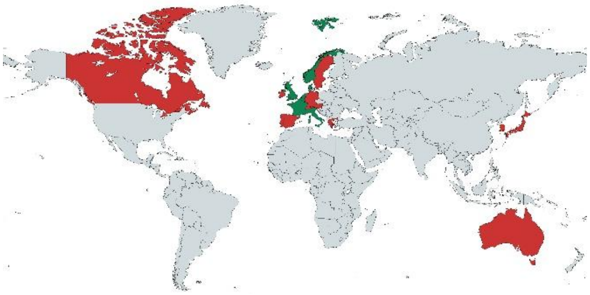


Figure 5a: Does the building code include ventilative cooling to mitigate overheating in a residential building? (Red = **NO** / Green = **YES**)

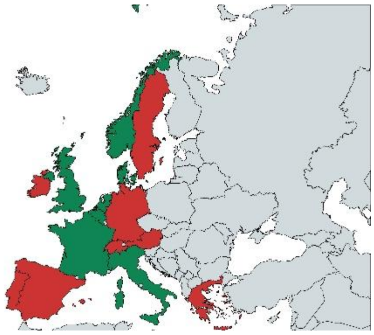


Figure 5b: Does the building code include ventilative cooling to mitigate overheating in a residential building? (Red = **NO** / Green = **YES**) – [EU focused map]

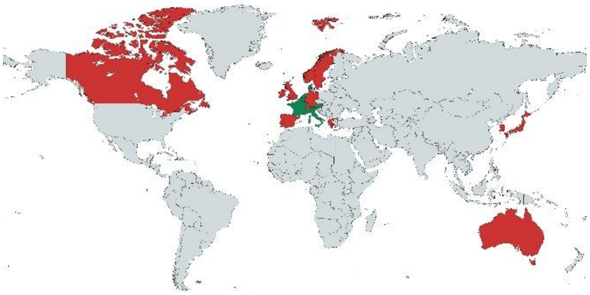


Figure 6a: Does the building code include ventilative cooling to mitigate overheating in a non-residential building? (Red = **NO** / Green = **YES**)

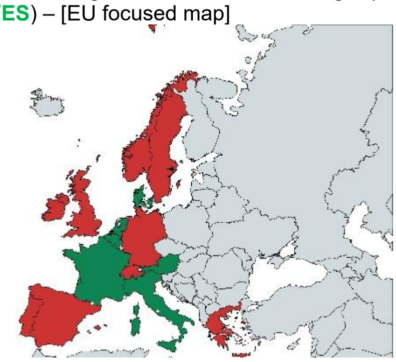


Figure 6b: Does the building code include ventilative cooling to mitigate overheating in a non-residential building? (Red = **NO** / Green = **YES**) – [EU focused map]

Beyond standard terminology, several countries refer to unique or regionally relevant concepts in their codes, reflecting a diversity of approaches:

- **Flanders (Belgium)** mentions “Intensive (night) ventilation”.
- **France** states “Windows opening in summer” and “Intensive (night) ventilation”.
- **Japan** references “Cross ventilation” as a design consideration for reducing the cooling load (by shortening the running time of cooling devices).
- **Portugal** includes the terms “Passive building” and “Hybrid building”. More specifically: The Portuguese legislation defines “passive building” and “hybrid building” only for non-residential buildings. The definitions are based on the ability of the building to keep its temperature within a certain range, without the need of heating and cooling, as follows:
    - “Passive building”, the building that presents a percentage of less than 10% of the annual occupancy hours in which heating and/or cooling are required, to maintain the comfortable indoor temperature within the range of 19 ºC to 27 ºC;
    - “Hybrid building”, the building that presents a percentage of 10% to 30%, inclusive, of the annual occupancy hours in which there are heating and/or cooling needs, to maintain the comfortable indoor temperature within the range of 19 ºC to 27 ºC;
- **England & Wales (GB)** refers to “purge ventilation”, “passive means”[11] and “cross ventilation”
- **Ireland** also refers to “purge ventilation”
- **The Spanish code** does not mention ventilative cooling. However, the technical document for calculations (Condiciones Técnicas De Los Procedimientos Para La Evaluación De La Eficiencia Energética) does mention “night ventilation”.

[11] Part O uses the term “passive means”. Passive means: “Any means of cooling a building which is not mechanical cooling (e.g. air conditioning). Openable windows or mechanical ventilation fans are considered to be passive means of cooling”

Table 3: Resilience to Overheating and Cooling Terminology in national (or regional) building codes in each of the 19 participating countries

Country		**Is resilience to overheating taken into account in the building code?**	**Is ventilative cooling mentioned as a specific word in the building code?**	**Is one of the following terms mentioned in the building code?**		
				free cooling	**passive cooling**	**Other?**
Australia		No	No	Yes	No	No
Austria		Yes	No	No		
Flanders (Belgium)		No	No	No	Yes	Intensive (night) ventilation
Canada		No	No	No		
Denmark		No	No	No		
France		No	No	No	No	Windows opening in summer and Intensive (night) ventilation
Germany		Yes	No	Yes	No	No
Greece		No	No	No	Yes	No
Ireland		No	No	No	Yes	Stack ventilation, cross ventilation, mechanical ventilation, passive stack ventilation, Single-sided
Italy		No	Yes	No		
Japan		No	No	No	No	Cross ventilation
Netherlands		Yes	Yes	No		
Norway		Yes	No	Yes	Yes	No
Portugal		No	No	Yes [12]	No	Passive building & hybrid building (only for non-residential buildings)
South Korea		No	No	No		
Spain		No	No [13]	No		
Sweden		No	No	Yes	No	No
Switzerland		No	No	No		
England & Wales (GB)		Yes	No	No	Yes	Purge ventilation, cross ventilation, passive means
YES/NO		**5/14**	**2/17**	**5/14**	**5/14**	

[12] free cooling by window opening and operation of ventilation systems (only for non-residential buildings)

[13] CONDICIONES TÉCNICAS DE LOS PROCEDIMIENTOS PARA LA EVALUACIÓN DE LA EFICIENCIA ENERGÉTICA

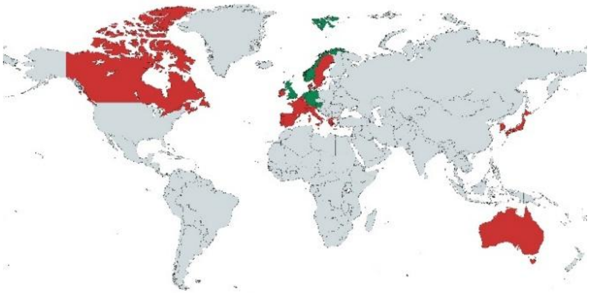


Figure 7a1: Is resilience to overheating taken into account in the building code? (Red = **NO** / Green = **YES**)

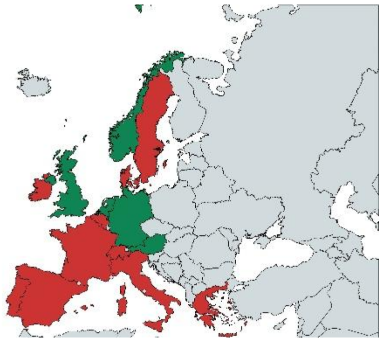


Figure7b: Is resilience to overheating taken into account in the building code? (Red = **NO** / Green = **YES**) – [EU focused map]

Figure 8a: Is ventilative cooling mentioned as a specific word in the building code? (Red = **NO** / Green = **YES**)

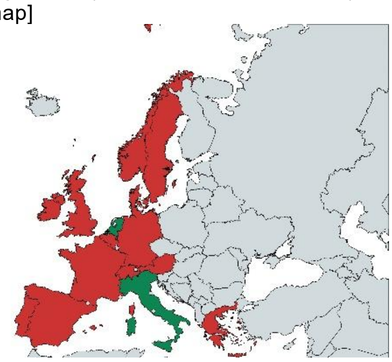


Figure 8b2: Is ventilative cooling mentioned as a specific word in the building code? (Red = **NO** / Green = **YES**) – [EU focused map]

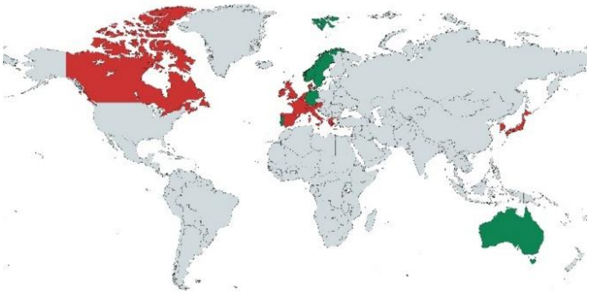


Figure 9a3: Is free cooling mentioned as a specific word in the building code? (Red = **NO** / Green = **YES**)

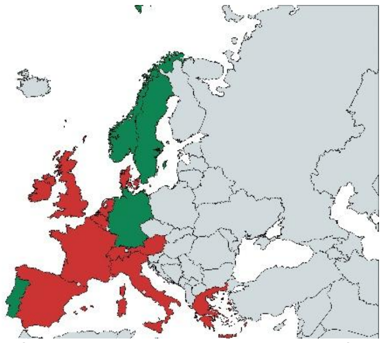


Figure 9b: Is free cooling mentioned as a specific word in the building code? (Red = **NO** / Green = **YES**) – [EU focused map]

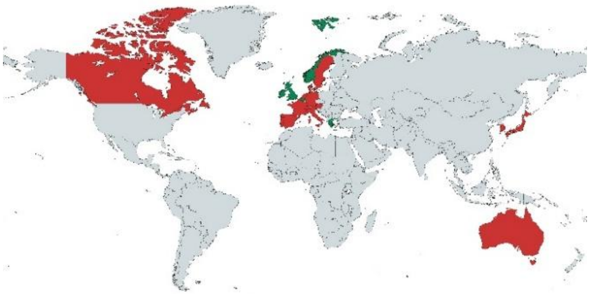


Figure 10a: Is passive cooling mentioned as a specific word in the building code? (Red = **NO** / Green = **YES**)

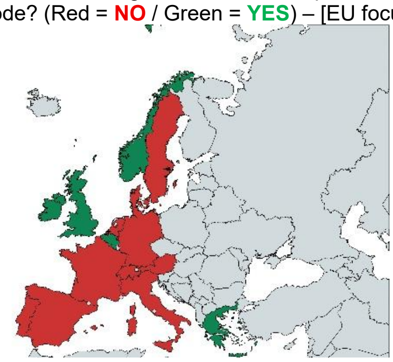


Figure 10b4: Is passive cooling mentioned as a specific word in the building code? (Red = **NO** / Green = **YES**) – [EU focused map]

This analysis reveals a building regulatory landscape that is slowly evolving to meet the demands of a warming climate but remains uneven. Overheating is more commonly addressed in residential than non-residential buildings, and while assessment methods and requirements are gaining ground, full regulatory alignment is lacking. Ventilative cooling and passive cooling strategies are implemented in practice and are referenced in the terminology of many national regulations, with most countries mentioning concepts such as free cooling, passive cooling or other. Some countries show relatively consistent and forward-looking approaches, while others lag in policy language.

3. Overheating

3.1. Assessment of overheating

3.1.1. Assessment of overheating in residential buildings

Assessment approach

As part of the survey, participants were asked to describe the type of assessment approach used to evaluate overheating. They could select from three categories: *Simplified* (e.g. monthly calculations with assumptions on ventilative cooling), *Detailed* (e.g. full dynamic simulations or simplified hourly calculations), or *Intermediary* (a method between Simplified and Detailed). Table 4 presents a summary of the responses.

Table 4: Type of assessment approach used to evaluate overheating (residential buildings)

Country	How should you describe the assessment approach for overheating?		
	Simplified (e.g. based on monthly calculations with assumptions on input air flows for ventilative cooling)	**Intermediary** (a method that falls between Simplified & Detailed).	**Detailed** (e.g. based on full dynamic simulations or simplified hourly calculations)
Austria	√	√	
Flanders (Belgium)	√		
Canada	√		
Denmark			√
France			√
Germany			√
Ireland	√		√
Netherlands	√		
Sweden	√		√
England & Wales (GB)	√		√

- **Flanders (Belgium)** applies a **Simplified method**, based on the excess heat gains.
- **Canada** described it as "**Simplified**" and noted: *"To reduce the risk that houses built under the tiered energy performance compliance path will overheat in the summer, the peak cooling load criteria is used. The proposed house must achieve a peak cooling load that is no more than that of the reference house. Since most buildings do not use this path, the method is not widely adopted"*.
- The **Netherlands** uses a **Simplified approach** based on cooling demand in July.

In contrast**, Denmark, France and Germany** reported using **Detailed methods**.

- **Denmark** reported using a **detailed approach** based on a Simplified hourly calculation.
- **France** relies on **hourly dynamic calculations** to determine an annual overheating indicator.
- **Germany** applies full dynamic simulations with **at least an hourly timestep**.

Austria reported using an **Intermediary approach** for buildings without cooling, based on a periodically oscillating method and a simplified method for buildings with cooling.

Regarding **England and Wales** (**GB**), **both simplified and detailed approaches** are mentioned. England & Wales (GB) uses the simplified approach and more specifically tables of glazing areas (various parameters) for spaces with and without cross-ventilation & tables of minimum free-areas of windows. The detailed approach (Section 2 of AD_O) details a dynamic thermal modelling method for demonstrating compliance with overheating mitigation requirements. It provides a standardised approach to predicting overheating risk for residential buildings using dynamic thermal modelling as an alternative to the simplified method it provides in Section 1 of AD_O.

Ireland's building code mentions **both the simplified (static) and detailed approach**. However, the detailed approach is only needed when there is a risk of overheating as a result of the simplified method. Moreover, Ireland referenced DEAP as national energy assessment tool that include some estimates of overheating risk in residential buildings; however, it was noted that this tool does not follow the approach described in the Building Regulations, which instead refer to CIBSE TM52 and TM59 as alternative methods.

Sweden also mentioned **both simplified and detailed approaches** and noted that SS-EN 16798-1:2019 & SS-EN ISO 7730:2006 are being followed.

<u>Software tools</u>

Participants were also asked whether specific software tools are available to assess overheating in accordance with their national or regional building codes. Eight countries—Austria, Flanders (Belgium), Denmark, France, Germany, Ireland, the Netherlands and England & Wales (GB)—responded "yes", indicating that tools are in place to support regulatory compliance (Table 5).

- **Austria** reported that **the validated national Building Physics and Energy Performance tools** include the standardized overheating calculations as part of their functionality.
- **Flanders (Belgium)** referred to the **EPB compliance tool** which calculates the overheating risk indicator in residential buildings
- **Denmark** uses a dedicated tool called **"Sommer comfort" modul** (Summer Comfort Module) for this purpose.
- In **France**, the **core regulatory calculation engine is developed by CSTB**, while various commercial developers provide the software interfaces.
- **Germany** noted that overheating assessment is generally incorporated within **commercial energy calculation software**.
- **Ireland** cited the **DEAP software**, "*which includes an overheating component, though it is considered not robust; the regulations instead recommend designers consult CIBSE TM59"*.
- The **Netherlands** mentioned **VABI Elements** as a commonly used tool. This is a software tool for dynamic (hourly) calculations. For the NTA 8800 calculations another software is used: for example, VABI NTA 8800 or Uniec3 software.
- In **England & Wales (GB)**, **any software is permitted provided it complies with the requirements of CIBSE AM11**: Building performance modelling (2015).

Table 5 outlines the collected replies.

Table 5: Overheating assessment tools, timestep and model (residential buildings)

Country		Are there specific software tools to assess overheating in accordance with the national (or regional) building code?	What is the timestep of the overheating assessment?			How should you describe the model for the overheating assessment?		What is the scale of the single zone in the overheating assessment?	
			Monthly	Hourly	Other	Single zone	Multizone	Whole building	1-room
Austria		√	√	√		√			√
Flanders (Belgium)		√	√			√		√	
Canada							√		
Denmark		√		√		√			√
France		√		√			√		√
Germany		√		√		√			√
Ireland		√			√	√		√	

Netherlands		√	√			√		√	
Sweden			√	√			√		
England & Wales (GB)		√		√			√		

Timestep for calculation

The survey also inquired about the timestep used in overheating assessments, specifically whether calculations are performed on a monthly, hourly, or other basis (see Table 5).

- **Flanders (Belgium)** and **Netherlands** indicated the use of **monthly timesteps**.
- **Denmark, France, Germany and England & Wales (GB)** reported using **hourly timesteps**.
  - England & Wales (GB) reported using hourly calculations (for the detailed method-dynamic thermal modelling).
- **Ireland** noted that the assessment for residential dwellings is a static assessment using threshold temperatures, so it is **neither hourly nor monthly**. It calculates a worst-case scenario using predefined inputs based on the building and opening design.
- **Austria & Sweden** reported using **both monthly and hourly timesteps**.

Single zone or multizone approach?

The survey included a question on the type of model used for overheating assessment—specifically, whether it is based on a single-zone or multizone approach (see Table 5).

With the exception of Canada, France, Sweden, and England & Wales (GB), the other six countries reported using a **single-zone model** for overheating assessments in residential buildings. **In contrast, respondents from the aforementioned countries** reported the use of **multizone models**.

The survey also explored the scale of the single-zone model used in overheating assessments—specifically, whether it represents the whole building, a single room, several rooms together, or another configuration (Table 5).

Denmark, France, Germany and Ireland indicated that the assessment is based on a **single room**. **Austria** noted a conditional approach: "*several rooms together can be assessed as a single zone, provided it can be demonstrated that doors between rooms are expected to remain open in normal operation*". **Flanders (Belgium), Ireland, and the Netherlands** reported using the **whole building** as the scale for assessment.

Weather files

The survey also addressed the **type of weather files used for overheating assessment**, asking whether current (e.g. 2001-2020), future mid-term (e.g. 2041–2060), or future long-term (e.g. 2081–2100) climate data are included.

- **Historical climate data**:
  - **Austria, Flanders (Belgium), Canada, Denmark, France, Germany, the Netherlands, and Sweden** reported using current climate data, typically based on historical periods.
  - **England & Wales (GB)** specified using current climate data, typically based on historical periods such as 1984-2013 that represents the climate from 2011 to 2040 (a warm, but not extreme, summer).
  - **Denmark** specifically referred to the period 2001–2010.
  - To calculate the risk of overheating **France** does not use "average climatic data over past years" (as for Winter calculation) but a specific set of data (from past years) that have been reworked to include heatwaves; it is not really a projection but it does take into account that heatwaves will be "the standard" in a few years.
- **Future climate data:**
  - **Germany** noted that it plans to include future mid-term data in a forthcoming standard update, expected by 2025.

Ireland also reported that for the screening on overheating no weather file is used, but 15 ºC is used in the static approach unless information about the dwelling location for June-August is available, whereby a different mean external temperature is used.

The survey also asked whether national (1 per country) or regional (more than 1 per country) weather files are used for overheating assessments.

- **Regional weather data:**
  - **Austria, Canada, France, Germany and England & Wales (GB)** reported using **regional weather data**, tailored to multiple zones or climatic conditions within the country.
  - **Austria** specified a national model divided into **seven climatic zones**, with additional adjustments for altitude.
  - **Germany** uses **three regional weather files**, while **France** also bases its assessments on **regional differentiation**.
- **National weather files**
  - **Flanders (Belgium), Denmark, the Netherlands and Sweden** indicated the use of **national weather files**.
  - For example, **Denmark** applies the **DRY2013 file as a national reference**, while **Ireland** generally uses **Dublin as the default location**.

A summary of these responses is presented in Table 6 below.

Table 6: Weather files used for the overheating assessment (residential buildings)

Country	Which weather files are included for the overheating assessment in a residential building?				
	Current (e.g. 2001-2020)	**Future mid-term (e.g. 2041-2060)**	**Future long-term (e.g. 2081-2100)**	**National (1 per country)**	**Regional (more than 1 per country)**
Austria	√				√
Flanders (Belgium)	√			√	
Canada	√				√
Denmark	√			√	
France	√				√
Germany	√				√
Netherlands	√			√	
Sweden	√			√	
England & Wales (GB)	√				√

3.1.2. Assessment of overheating in non-residential buildings

Assessment approach

The survey also explored the assessment approach used to evaluate overheating in non-residential buildings, with participants selecting again from the three categories: Simplified, Intermediary, or Detailed methods. The responses reveal variation in national practices.

- **Austria** noted that for **buildings with cooling**, a **simplified method** is applied, while for **buildings without cooling** an **Intermediary method** based on a periodically oscillating model is applied.
- **France** and **Germany** reported using a **Detailed approach**.
  - **France** specified it as "*Hourly dynamic calculation to estimate a year indicator*"
  - **Germany** described it as *"Full dynamic simulation with at least hourly timestep"*.
- **Netherlands** indicated using a **simplified** approach.
- **Ireland and Sweden** mentioned **both simplified** and **detailed** approaches.
  - **Sweden** noted that SS-EN 16798-1:2019 & SS-EN ISO 7730:2006 are being followed.

A summary of these responses is presented in Table 7 below.

Table 7: Type of assessment approach used to evaluate overheating (non-residential buildings)

Country		How should you describe the assessment approach of overheating?		
		Simplified (e.g. based on monthly calculations with assumptions on input air flows for ventilative cooling)	**Intermediary** (a method that falls between Simplified & Detailed).	**Detailed** (e.g. based on full dynamic simulations or simplified hourly calculations)
Austria		√	√	
France				√
Germany				√
Ireland		√		√
Netherlands		√		
Sweden		√		√

Software tools

As with residential buildings, the survey investigated whether specific software tools are available to assess overheating in non-residential buildings in line with national or regional building codes. Four countries—Austria, France, Germany and Ireland—responded **"yes"**, indicating that such tools are in use to support compliance.

- **Austria** reported that the validated national Building Physics and Energy Performance tools include the standardized overheating calculations as part of their functionality.
- **Germany** similarly reported that overheating assessments are typically embedded within most commercial energy calculation software.
- In **France**, the calculation tool is developed by *CSTB*, with commercial software developers creating the user interfaces.
- **Ireland** cited the **SBEMie software** using the NEAP methodology.
- The **Netherlands** identified **VABI Elements** as a commonly used tool also used for residential buildings

The results of the survey reveal that the availability of specific software tools for assessing overheating in buildings is consistent across both residential and non-residential buildings in Austria, France, Germany, Netherlands and Ireland.

Similar to the residential context, the survey collected information on the technical parameters of overheating assessment in non-residential buildings, with a focus on aspects such as timestep, zoning models, assessment scale, and the use of weather files.

Timestep for calculation

As regards the **timestep** used in calculations:

- **France** reported that assessments are conducted using an **hourly timestep**
- **Germany** indicated that the timestep is at least **hourly**
- **Netherlands** indicated the use of **monthly timesteps**
- **Austria** reported that two calculations are required, a simplified one with **monthly** timesteps and a detailed one with **hourly** timesteps.
- **Ireland & Sweden noted the use of both hourly and monthly timesteps**

These responses indicate a preference for more precise methods that can capture temperature variations throughout the day and better reflect actual indoor conditions.

Single zone or multizone?

Regarding the model:

- **Austria**, **Germany**, and **Netherlands** reported using a **single-zone model** for overheating assessments in non-residential buildings, which simplifies the assessment by treating the building as one uniform thermal space.
- In contrast, **France, Ireland & Sweden** reported using a **multizone model**, indicating a more detailed assessment that accounts for thermal differences between various zones within a building.

When asked about the **scale of the single-zone model**, responses varied.

- **Austria** provided a **conditional approach**: The assessment covers the whole building to calculate cooling demand; Additionally, when no cooling is applied, the assessment focuses on one problematic room to evaluate overheating.
- **France** noted that the designer decides how to divide the building, usually based on what's known at the design stage—since internal partitions are often not defined yet.
- **Germany** reported using a 1-room.
- **Netherlands and Ireland** noted using a whole building scale.

A summary of these responses is presented in Table 8.

Table 8: Overheating assessment tools, timestep and model (non-residential buildings)

Country		**Specific software tools** to assess overheating in accordance with the national (or regional) building code?	**Timestep for overheating assessment?**		**Type of the model for the overheating assessment**		**What is the scale of the single zone in the overheating assessment?**		
			Monthly	**Hourly**	**Single zone**	**Multizone**	**Whole building**	**1-room**	**Several rooms together (e.g. day zone)**
Austria		√	√	√	√		√	√	
France		√		√		√		√	√
Germany		√		√	√			√	
Ireland		√	√	√		√	√		
Netherlands		√	√		√		√		
Sweden			√	√		√			

Weather files

In relation to the **weather files** used for residential overheating assessments—all countries i.e. Austria, France, Germany, Ireland, Netherlands and Sweden reported that current weather files are used for assessments.

- **France** reported that while a precise time period is not defined, the summer scenarios used in calculations include more frequent and intense heatwaves than current conditions, suggesting an implicit consideration of future climate impacts.
- **Germany** noted that the scope will be expanded to include future mid-term scenarios in the next update of its standard, expected around 2025. Standard DIN 4108-2 is currently in the final enquiry - shall be published in 2025. It includes a sentence, that future weather files (maybe also local differentiated for postal code) can be used in individual calculations.
- **Ireland** clarified that no specific weather files are defined in the Building Regulations; instead, designers typically follow CIBSE TM52 guidance, selecting weather files accordingly.

These responses show that most countries currently rely on historical or present-day climate data, though there are efforts to gradually integrate future climate projections into regulatory practice.

As for the **geographic resolution of weather files**, **Austria, France and Germany** reported using **regional weather files**, while **Ireland & Netherlands** indicated the use of **national files**.

- **Austria** explained that it applies a national weather calculation model subdivided into seven climatic zones, with additional adjustments based on altitude.
- **Germany** uses three regional weather files to reflect climatic variation across the country.

- In contrast, **Ireland** uses Dublin as the national reference location as a default.
- In the case of **Sweden**, the regulation does not propose any national or regional weather file nor current or future. The designers are free to use whatever they wish provided that it is declared.

Table 9 includes the main points from the replies.

Table 9: Weather files used for the overheating assessment (non-residential buildings)

Country		Which weather files are included for the overheating assessment?			Which weather files are included for the overheating assessment?	
		Current (e.g. 2001-2020)	**Future mid-term** (e.g. 2041-2060)	**Future long-term** (e.g. 2081-2100)	**National** (1 per country)	**Regional** (more than 1 per country)
Austria		√				√
France		√				√
Germany		√				√
Ireland		√			√	
Netherlands		√			√	
Sweden		√			√	√

3.2. Requirements for overheating

3.2.1. Requirements for overheating in residential buildings

The survey investigated whether national building codes include a **separate indicator** for overheating in residential buildings. **Austria, Flanders (Belgium), France, Denmark, the Netherlands, and England & Wales (GB)**—reported that their national building codes **include a separate indicator for overheating** in residential buildings. Canada, Germany, Ireland, Italy & Sweden, however, indicated that its code does not contain such an indicator.

When asked about the **thermal comfort model** upon which their overheating indicators are based, Austria & Denmark reported using the adaptive comfort model. In contrast, Flanders (Belgium), the Netherlands, France and England & Wales (GB) selected “other” and provided clarifications; the Netherlands uses a metric called “TOjuli,” which represents the temperature exceeding hours in July. England & Wales (GB) noted that for the dynamic method there is an adaptive criterion (Criterion A) and a static criterion (criterion B - which only applied to bedrooms as people are assumed to be unable to adapt here). Notably, none of the countries reported explicitly using the PMV-PPD (Fanger) model.

The survey also explored the **type of approach** used for assessing overheating—whether performance-based, prescriptive, or otherwise. Most countries described their methods as performance-based, meaning they rely on quantifiable metrics such as the number of hours indoor temperatures exceed certain thresholds. Austria, Flanders (Belgium), Denmark, France and Netherlands all fell into this category. As regards England & Wales (GB) the simplified method could fall under prescriptive while the detailed/dynamic method under performance based.

Regarding the **parameters** on which these indicators are based, Austria identified operative temperature as the primary metric. Flanders (Belgium) chose “other” and referenced excess heat gains. Denmark, France and the Netherlands reported the % of hours of exceedance of indoor temperature as the parameter. The reference temperature for France varies between 26 to 28°C during the day (contained adaptation), and 26°C during the night. England & Wales (GB) noted both the operative temperature and the % of hours of exceedance of indoor temperature as parameters.

The specific **overheating thresholds and requirements** vary considerably among the countries. Austria stated that operative temperature must remain below a maximum permissible temperature which depends on the regional climate data. Flanders (Belgium) referenced a limit of 6,500 Kh for the indicator. Denmark applies a dual threshold: overheating is not permitted for more than 100 hours above 27 °C and more than 25 hours above 28 °C. The Netherlands allows two methods for compliance—a monthly calculation where the indicator must not exceed 1.2 K (TOjuli indicator).), and a dynamic calculation that caps overheating at 450 weighted degree hours above PMV exceeding 0.5. England & Wales (GB) mentions two criteria: Criterion A: Fails if operative temperature exceeds the Category II threshold for over

3% of occupied hours (3672 hr in bedrooms, 1989 hr in living rooms) from May to September. Criterion B: Fails if bedroom temperature exceeds 26°C for more than 1% of annual nighttime hours (3285 hr, 22:00–07:00). France refers a general limit of cumulative overheating DH of 1250 K.h which can go up to 2600 K.h in case of acoustics constraints for small multifamily dwellings.

In **summary,** almost 1/4 of the countries surveyed have incorporated overheating indicators into their residential building codes. However, the models, parameters, and thresholds used to define and assess overheating differ widely. This reflects both the varied climatic contexts and national regulatory frameworks. Canada stands out as an exception, having not yet formalized overheating criteria in its code. The responses are summarized in Table 10,Table 11 & Table 12 for comparison.

Table 10: Overheating indicators and associated thermal comfort model (residential buildings)

Country	Describe the approach of the overheating indicator			
	Does the building code include a separate indicator for overheating?	On which thermal comfort model is the overheating indicator based on?		
		PMV-PPD (Fanger)	Adaptive comfort	Other
Austria	Yes		√	
Flanders (Belgium)	Yes			√
Canada	No			
Denmark	Yes		√	
France	Yes			√
Germany	No			
Ireland	No			
Italy	No			
Netherlands	Yes			√
Sweden	No			
England & Wales (GB)	Yes			√

Table 11: Overheating Indicator approach (residential buildings)

Country	Describe the approach of the overheating indicator	
	Performance based (e.g. less than "a certain number of" degree hours)	Prescriptive (e.g. minimum window opening to floor area)
Austria	√	
Flanders (Belgium)	√	
Denmark	√	
France	√	
Netherlands	√	
England & Wales (GB)	√	√

Table 12: Parameter & threshold for overheating indicator (residential buildings)

Country		**On which parameter is the overheating indicator based on?**				**What is the overheating requirement and threshold?** e.g. 150-degree hours exceeding an operative temperature of 26°C
		Operative temperature	**Air temperature**	**(% of) hours of exceedance of indoor temperature**	**Other**	
Austria		√				Max. operative temperature in room must stay below maximum permissible temperature[14]
Flanders (Belgium)					√	Maximum of 6500 Kh for the overheating indicator
Denmark				√		Max 100 hours above 27°C and Max 25 hours above 28°C [This is only valid if you have Natural Ventilative Cooling (normally manually controlled). Stricter requirements should be used if people don't have access the NVC]
France				√		Max 1250 K.h above 26 °C night or adaptative 26-28°C day. Tolerances take into account climate zone, acoustics constraints and size of dwellings
Netherlands				√		Maximum value of the indicator is 1,2 K This is based on the monthly calculation. In addition, there is a dynamic calculation possible with a max. of 450 degree hours exceeding a PMV of 0.5.
England & Wales (GB)		√		√		Criterion A: adaptive threshold in living rooms and bedrooms. Fails if indoor operative temperature is greater than the Category II upper temperature threshold for more than 3% of occupied hours (3672 hours in bedrooms; 1989 hours in living rooms) between the months of May and September (inclusive). Criterion B: static threshold in bedrooms only. Failed if operative temperature in bedrooms exceeds 26°C for more than 1% of annual hours between 22:00 and 07:00 (3285 hours).

3.2.2. Requirements for overheating in non-residential buildings

As part of the survey, the same set of questions regarding overheating indicators was extended to non-residential buildings. No respondent provided an answer.

Denmark applies a guidance of a recommended threshold: overheating should not occur in non-residential buildings for more than 100 occupied hours above 26 °C and more than 25 occupied hours above 27 °C, although it is left to the builder/owner of the project to set the overheating requirements, the recommended levels usually are used.

The limited response highlights a potential gap in the integration of overheating indicators for non-residential buildings across countries.

[14] This temperature is calculated from the regional climate data.

4. Ventilative cooling

4.1. Ventilative cooling in residential buildings

The survey included a series of questions focused on how ventilative cooling is addressed within the building codes in residential buildings.

When asked whether the building code **differentiates between ventilative cooling during the day and at night**, Denmark, France and England & Wales (GB) responded "yes" indicating that their codes account for the varying effectiveness of ventilation strategies based on time of day. In contrast, Flanders (Belgium), Netherlands and Norway answered "no", suggesting that their regulations treat ventilative cooling as a general measure.

Regarding **manual versus automated control**, Flanders (Belgium), Denmark, France and Netherlands reported that their codes do differentiate between these modes of operation. Norway and England & Wales (GB) stated that they do not.

When asked **how ventilative cooling is accounted for in calculations**, Denmark, France and England & Wales (GB) responded that it is considered in relation to both overheating and energy performance. In contrast, Flanders (Belgium), Netherlands and Norway reported that ventilative cooling is considered only in relation to overheating suggesting a narrower application in their regulatory frameworks.

On a question on whether **manual operation of windows is permitted** for ventilative cooling, all six countries—Flanders (Belgium), Denmark, France, Netherlands, Norway and England & Wales (GB)—answered "yes", showing broad acceptance of occupant-controlled ventilation strategies. Similarly, all countries (except Norway), indicated that their codes differentiate between natural and mechanical ventilative cooling, acknowledging the distinct characteristics and impacts of these two approaches.

An overview of the responses is presented in Table 13.

Table 13: Ventilative cooling criteria (residential buildings)

Country	Does the building code differentiate between ventilative cooling during the day and at night?	Does the building code differentiate between manual and automated control of ventilative cooling?	Your building code calculates the effect of ventilative cooling on:		Does the building code allow manual operation of windows for ventilative cooling?	Does the building code differentiate between natural and mechanical ventilative cooling?
			Overheating	Energy Performance		
Belgium (Flanders)	No	Yes	√		Yes	Yes
Denmark	Yes	Yes	√	√	Yes	Yes
France	Yes	Yes	√	√	Yes	Yes
Netherlands	No	Yes	√		Yes	Yes
Norway	No	No	√		Yes	No
England & Wales (GB)	Yes	No	√	√	Yes	Yes

The survey examined how national and regional building codes define airflow rates for natural ventilative cooling and whether they distinguish between different ventilation strategies.

Flanders (Belgium), France, and the Netherlands reported using a **variable airflow rate** approach:

- **Belgium** explained that there are 6 different levels which are proportional with the ventilative cooling potential that is determined per building, based on ventilation strategy (single-sided vs. cross or stack ventilation), opening area, burglary protection, and automatic control.

- **France** noted that the flowrate depends on wind speed, temperature difference, size of openings, repartition of windows (single sided and cross). The calculation is quite similar to the one proposed in EN 16798-7 §6.4.3.5.4 but the equations are more like those in the former EN 15241.
- **Netherlands** stated that the air flow is calculated in NTA 8800, and depends on the size of the opening, single/multi sided, height etc.

Denmark indicated that they apply a variable airflow rate approach. The input value for ventilative cooling is a fixed airflow rate based on either simple assumption (depending on the percentage of floor to opening area or a value which can be entered from a simple manual calculation estimating the project specific airflow rate.

England & Wales (GB) use both fixed and variable airflow rate approaches**.** More specifically:

- Fixed: For Part O simplified method, where the minimum operable window opening area is specified along with whether cross ventilation is present.
- Variable: For Part O detailed (dynamic) method where a dynamic airflow rate can be selected or simulated using DTM software.

When asked whether their codes **differentiate between single-sided, cross, and stack ventilation**, Flanders (Belgium), Denmark, France, the Netherlands and England & Wales (GB) answered "yes", while Norway reported “no”.

A summary of the replies is shown in Table 14.

Table 14: Ventilative cooling criteria (residential buildings)

Country		**How does the building code determine the airflow rate for natural ventilative cooling?**		**Does the building code differentiate between single-sided, cross and stack natural ventilative cooling?**
		Fixed airflow rate	**Variable airflow rate (e.g. based on extra calculations)** **Other**	
Belgium (Flanders)			√	Yes
Denmark		√		Yes
France			√	Yes[15]
Netherlands			√	Yes
Norway				No
England & Wales (GB)		√	√	Yes

4.2. Ventilative cooling in non-residential buildings

In the case of non-residential buildings, when asked whether the code differentiates between ventilative cooling during the day and at night, Netherlands—responded "no", indicating that their regulations do not distinguish between daytime and nighttime strategies. Austria, Flanders (Belgium), Denmark and France however, responded "yes", indicating that its building code takes into account the distinct cooling needs and strategies between day and night. Austria reported “yes”, limited to non-residential buildings without technical cooling.

Regarding the control mechanism of ventilative cooling, Denmark, France and the Netherlands reported that their codes do differentiate between manual and automated control, while Austria and Flanders (Belgium) do not.

When asked whether the building code calculates the effect of ventilative cooling on overheating, energy performance, or both, Austria stated that both are considered. Conversely, Flanders (Belgium), Denmark, and the Netherlands consider only energy performance, whereas France focuses exclusively on overheating.

[15] same logic as in EN16798-7

In response to whether manual operation of windows is permitted for ventilative cooling, all five countries—Austria, Flanders (Belgium), Denmark, France, and the Netherlands—answered "yes", indicating that occupant-controlled ventilation is an accepted practice.

For Austria, there's severe restriction to this: Ventilative cooling is only accounted for between 06:00 and 22:00. During the nights, no ventilative cooling may be accounted for, due to conflict with noise protection and others.

Similarly, all five countries confirmed that their building codes differentiate between natural and mechanical ventilative cooling, acknowledging the performance and design differences between passive and active systems.

A breakdown of the responses can be found in Table 15.

Table 15: Ventilative cooling criteria (non-residential buildings)

Country	Does the building code differentiate between ventilative cooling during the day and at night?	Does the building code differentiate between manual and automated control of ventilative cooling?	The building code calculates the effect of ventilative cooling on:		Does the building code allow manual operation of windows for ventilative cooling?	Does the building code differentiate between natural and mechanical ventilative cooling?
			Overheating	Energy Performance		
Austria	Yes	No	√	√	Yes	Yes
Flanders (Belgium)	Yes	No		√	Yes	Yes
Denmark	Yes	Yes		√	Yes	Yes
France	Yes	Yes	√		Yes	Yes
Netherlands	No	Yes		√	Yes	Yes

The survey also addressed how national or regional building codes determine **airflow rates** for natural ventilative cooling and whether they **differentiate between types of ventilation strategies**.

All countries, i.e. Austria, Flanders (Belgium), Denmark, France, and the Netherlands reported using a **variable airflow rate** approach.

- **Austria** explained that its code includes formulas to calculate airflow through windows under worst-case conditions, assuming single-sided or stack ventilation, no wind, and temperature difference as well as height as the sole driving forces.
- **Flanders (Belgium)** calculates an average airflow rate based on window opening area and type of window (bottom hung or turn windows)
- **Denmark** explained that its code allows for two methods: one depending on the percentage of window opening area, and another involving manual calculations to estimate potential airflow rates.
- **The Netherlands** stated that airflow calculations are based on window openings, height, and whether ventilation is single-sided or cross.

When asked whether their codes **differentiate between single-sided, cross, and stack ventilation**, Austria, France, Denmark, and the Netherlands answered "yes", while Flanders (Belgium) reported "no", indicating that most regulations recognize the differences in ventilation effectiveness based on the type of natural airflow strategy employed. Austria reported to differentiate only between single sided and stack ventilation.

An overview of the replies is shown in Table 16.

Table 16: Airflow rate assessment and ventilation strategy differentiation (non-residential buildings)

Country		**How does the building code determine the airflow rate for natural ventilative cooling?**		**Does the building code differentiate between single-sided, cross and stack natural ventilative cooling?**
		Fixed airflow rate	**Variable airflow rate (e.g. based on extra calculations)**	
Austria			√	Yes
Flanders (Belgium)			√	No
Denmark			√	Yes
France			√	Yes
Netherlands			√	Yes

5. Conclusions

This document reviewed how overheating assessment and ventilative cooling are addressed in national building codes with respect to indoor environmental quality and energy performance across 19 countries and regions: Australia, Austria, Flanders (Belgium), Canada, Denmark, France, Germany, Greece, Ireland, Italy, Japan, the Netherlands, Norway, Portugal, South Korea, Spain, Sweden, Switzerland and England & Wales (GB).

The analysis shows that approximately half of the surveyed countries/regions include an assessment method and/or requirements for overheating in buildings. Both simplified and detailed assessment approaches are applied, both single-zone and multi-zone models are used. Among these, 50% of the building codes specifies a separate indicator for overheating in residential buildings, with a significant variation in calculation models and thresholds. Notably, none of the countries reported using the PMV-PPD model of Fanger explicitly, all indicators are performance based, relying on operative temperature or exceedance hours.

Regarding ventilative cooling, fewer than 50% of the studied countries explicitly include ventilative cooling as a mitigating strategy, having an effect on overheating and on the energy performance of the building. Where ventilative cooling is considered, building codes typically provide multiple options for design and control, distinguishing between automated and manual control, mechanical and natural ventilation and various natural ventilation strategies. Most building codes also allow for variable flow rate.

A clear distinction exists between residential and non-residential buildings: overheating assessment methods as well as requirements are more common in residential buildings. The inclusion of ventilative cooling varies by building type differs between the different countries.

Finally, current building codes do not account for climate change impact. Future weather files are absent, with Germany being the only (known) country planning to incorporate mid-term future weather data in its upcoming standard update. Resilience to overheating is mentioned in only one-third of the reviewed buildings codes.

6. Acknowledgements

The authors gratefully acknowledge the national experts and contributors listed below for their time, knowledge, and valuable input to this survey. Their contributions were essential in preparing, interpreting, and validating the information presented in this report.

- Wendy Miller – Queensland University of Technology – Australia
- Peter Holzer – Institute of Building Research & Innovation – Austria
- Ivan Pollet – Renson – Belgium
- Lili Ji – National Research Council Canada – Canada
- Dahai Qi – Université de Sherbrooke – Canada
- Christoffer Plesner – Velux – Denmark
- Jannick Roth – Window Master – Denmark
- Ben Jones – University of Nottingham – UK
- Ben Roberts – Loughborough University – UK
- Valerie Leprince – Cerema – France
- Thomas Hartmann – Institut für Technische Gebäudeausrüstung Dresden – Germany
- Theo Tountas – FUV Group – Greece
- Paul O' Sullivan – Munster Technological University – Ireland
- Adam O' Donovan– Munster Technological University – Ireland
- Vincenzo Corrado – Politecnico di Torino – Italy
- Toshihiro Nonaka – ABI Institute of Building Environment – Japan
- André Kruithof – Nieman Consulting Engineers – Netherlands
- Hans Martin Mathisen – Norwegian University of Science and Technology – Norway
- Maria Lerel – NaturalWorks – Portugal
- Dong Hwa Kang – University of Seoul – South Korea
- Agnese Salvati – Universitat Politècnica de Catalunya – Spain
- Eva Crespo Sanchez – Universitat Politècnica de Catalunya – Spain
- Oriol Muntané Raich – Universitat Politècnica de Catalunya – Spain
- Jan-Olof Dalenbäck – Chalmers University of Technology – Sweden
- Theofanis Psomas – Munster Technological University – Sweden
- Beat Frei – FREI WÜEST EXPERT – Switzerland.

7. References

Australian Building Codes Board. (2022). *National Construction Code 2022*. Australian Building Codes Board. https://ncc.abcb.gov.au/editions/ncc-2022

Bundesanstalt für Arbeitsschutz und Arbeitsmedizin. (2018). *Technische Regeln für Arbeitsstätten (ASR)*. https://www.baua.de/DE/Angebote/Regelwerk/ASR/ASR

Bundesministerium für Wirtschaft und Klimaschutz. (2024). *Gebäudeenergiegesetz (GEG)*. https://www.gesetze-im-internet.de/geg/

Canadian Commission on Building and Fire Codes. (2020). *National Energy Code of Canada for Buildings 2020*. National Research Council of Canada. https://nrc.canada.ca/en/certifications-evaluations-standards/codes-canada/codes-canada-publications/national-energy-code-canada-buildings-2020

Department of Housing, Local Government and Heritage. (2020, December 4). *Technical Guidance Document F – Ventilation* [PDF]. Government of Ireland. https://www.gov.ie/en/publication/938bf-home-ventilation/

Department of Housing, Local Government and Heritage. (2022). *Technical Guidance Document L – Conservation of Fuel and Energy – Dwellings*. Government of Ireland. https://assets.gov.ie/static/documents/technical-guidance-document-l-conservation-of-fuel-and-energy-dwellings-2022.pdf

Direktoratet for byggkvalitet. (2017, June 19). *Forskrift om tekniske krav til byggverk (Byggteknisk forskrift – TEK17)*. https://www.dibk.no/regelverk/byggteknisk-forskrift-tek17/

EC. (2025). Technical building systems, indoor environmental quality and inspections (Articles 13, 23 and 24) — Annex 10. European Commission. Retrieved from https://energy.ec.europa.eu/document/download/77a9516d-8579-4c5b-af65-236f0029e7f1_en?filename=Technical%20building%20systems%2C%20indoor%20environmental%20quality%20and%20inspections%20%28Articles%2013%2C%2023%20and%2024%29%20-%20annex%2010.pdf

Governo de Portugal. (2020, December 7). *Decreto-Lei n.º 101-D/2020, de 7 de dezembro — Desempenho Energético de Edifícios e Sistema de Certificação Energética (SCE)*. Diário da República, 1.ª série, n.º 237. https://files.dre.pt/1s/2020/12/23701/0002100045.pdf

Ministère de la Transition écologique. (2022). *Réglementation environnementale RE2020*. https://www.ecologie.gouv.fr/politiques-publiques/reglementation-environnementale-re2020

Ministry of Land, I. T. (2016, April). Overview of the Act on the Improvement of Energy Consumption Performance of Buildings (Building Energy Efficiency Act). Retrieved August 26, 2025, from Ministry of Land, Infrastructure, Transport and Tourism: https://www.mlit.go.jp/common/001134876.pdf

Ministero dello Sviluppo Economico; Ministero dell'Ambiente e della Tutela del Territorio e del Mare; Ministero delle Infrastrutture e dei Trasporti; Ministero della Salute; Ministero della Difesa. (2015, June 26). *Decreto interministeriale 26 giugno 2015 – Applicazione delle metodologie di calcolo delle prestazioni energetiche e definizione delle prescrizioni e dei requisiti minimi degli edifici*. Gazzetta Ufficiale. https://www.mimit.gov.it/it/normativa/decreti-interministeriali/decreto-interministeriale-26-giugno-2015-applicazione-delle-metodologie-di-calcolo-delle-prestazioni-energetiche-e-definizione-delle-prescrizioni-e-dei-requisiti-minimi-degli-edifici

NEN Netherlands Standardisation Institute. (2024). *Bepalingsmethode – Energieprestatie van gebouwen (EPG)*. https://www.gebouwenergieprestatie.nl/bepalingsmethode/

Österreichisches Institut für Bautechnik. (2023). *OIB-Richtlinien*. Österreichisches Institut für Bautechnik. https://www.oib.or.at/kernaufgaben/oib-richtlinien/

Social- og Boligstyrelsen. (2025). *Bygningsreglementet*. https://www.bygningsreglementet.dk/

Technical Chamber of Greece (TEE). (2017). *KENAK – Regulation on the Energy Performance of Buildings*. https://www.kenak.gr/

The Energy Conservation Center, Japan. (2022, July 20). The government enacted the revised Building Energy Conservation Act. Retrieved August 26, 2025, from The Energy Conservation Center, Japan: https://www.asiaeec-col.eccj.or.jp/policynews-202207/

The Energy Conservation Center, Japan. (2024, September 26). MLIT expands support for energy-efficient buildings / Revised law to take effect. Retrieved August 26, 2025, from The Energy Conservation Center, Japan: https://www.asiaeec-col.eccj.or.jp/policynews-202408-1/

venticool. (2024). Enhancing thermal comfort and reducing cooling energy through resilient ventilative cooling - venticool's position. venticool. Retrieved from https://venticool.eu/wp-content/uploads/2024/07/2024.06_venticool-position-paper.pdf

Vlaanderen. (2020). *Energiebesluit en bijlagen*. https://www.vlaanderen.be/epb-pedia/epb-regelgeving/energiebesluit-en-bijlagen

WMO. (2025). State of the Global Climate 2024. Geneva: WMO. Retrieved from https://library.wmo.int/records/item/69455-state-of-the-global-climate-2024

.

www.iea-ebc.org