

Minimum performance requirements for window  
replacement in the residential sector

Final report



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## Final report

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# 1 Aim of the project

The study developed a comprehensive list of minimum performance requirements (U-values and when appropriate g-values) for

- windows replacement
- in the residential sector
- in the 28 EU Member States, including sub-national legislation if relevant (e.g. Belgium, UK).

The following chapters present a brief outline of the executed research activities and the results thereof.

## 2 Brief overview of research

We followed a three-step approach, to go beyond existing studies and provide up to date information:

- 1) Interviews with contact persons from all Member States (including the three Belgium regions and the four UK regions).
- 2) In case of absence of data after the interviews we performed a critical review of well-known Ecofys literature and other literature from European sources that contain useful information on U-values:
  - a. Cost-optimality report assessment (Ecofys), (Grözinger et al. 2015)
  - b. EPBD Concerted Action reports, (CA EPBD 2015)
- 3) For the Member States, where this was still needed after step 1) and 2), based on the information retrieved during interviews, we identified and checked relevant legal national documents for verification of uncertain information from the interviews about required u-values for windows.

## 3 Results

This chapter outlines the results of a comprehensive list of minimum performance requirements for windows replacement in the residential sector in the 28 EU Member States.

The main result is a table showing an overview about legal requirements for replacement of windows in residential buildings by Member State. This table is followed by brief explanations allowing an unambiguous interpretation of the numbers in the table. A table informing about the interviewed person and the national regulation follows these explanations.

The abbreviations used in the following table are:

- $U_w$ -value: Heat transition coefficient for the whole window (glass and frame)
- $U_g$ -value: Heat transition coefficient for the transparent part of the window (glass)
- g-value: Total energy transmittance factor of a glazing system

**Table 1. Overview about legal requirements for replacement of windows in residential buildings by Member State.**

Member State	Legal requirements		
	U <sub>w</sub> – value	g - value	Last update
	W/m <sup>2</sup> K	-	-
Austria	1.2	-	2015
Belgium - Brussels	1.8 (U <sub>g</sub> : 1.1)		2014
Belgium - Flanders	1.5* (U <sub>g</sub> : 1.1)		2016
Belgium - Wallonia	1.5 (U <sub>g</sub> : 1.1)		2017
Bulgaria	1.4*	-	2015
Croatia	1.6 / 1.8*	-	2015
Cyprus	2.9*	-	2017
Czech Republic	1.5	-	2011
Denmark	-*	-	2015
Estonia	-*	-	2013
Finland	1.0*	-	2012
France	2.3 / 2.6*	-	2008
Germany	1.3	-	2014
Greece	2.6...3.2*	-	2010
Hungary	1.6*	-	2006
Ireland	1.6*	-	2011
Italy	1.7...3.2*	0.35*	2015
Latvia	1.3·k / 1.8·k*	-	2015
Lithuania	1.6·k*	-	2014
Luxembourg	1.5*	-	2016
Malta	4.0*	0.89	2015
Netherlands	2.2	-	2015
Poland	1.1*	-	2017
Portugal	2.2...2.8*	0.10...0.56*	2016
Romania	1.5*	-	2016
Slovak Republic	1.0	0.60	2016
Slovenia	1.3*	0.50	2010
Spain	2.5...5.7*	-	2013
Sweden	1.2*	-	2012
UK – England	1.6*	-	2016
UK – Wales	1.6*	-	2014
UK – Northern Ireland	1.6*	-	2013
UK – Scotland	1.6*	-	2016

## **Explanations of the above numbers:**

**Austria:** When performing a renovation in Austria either the above mentioned  $U_w$ -value ( $88\% \cdot 1.4 = 1.2 \text{ W/m}^2\text{K}$ ) needs to be fulfilled or a renovation concept needs to be developed ensuring the compliance with the energy balance requirements for the whole building. Building elements have not been investigated in the cost optimality report. The requirements also apply for single window replacements.

**Belgium-Brussels:** This requirement applies / is enforced solely in case of renovation with a town planning permit. There is no need of a permit if only single windows are replaced. Therefore, the requirements do not apply for single window replacements.

**Belgium-Flanders:** In addition to the average  $U_w$ -value requirement of  $1.5 \text{ W/m}^2\text{K}$  a  $U_g$ -value of  $1.1 \text{ W/m}^2\text{K}$  needs to be fulfilled. From 2015, all major building renovations (residential, offices and schools) involving 75% or more of the building shell or replacement of the whole HVAC system will have to meet a whole building energy performance requirement. This requirement applies / is enforced solely in case of renovation with a town planning permit. There is no need of a permit if only single windows are replaced. Therefore, the requirements do not apply for single window replacements.

**Belgium-Wallonia:** U-value requirement might be updated in 2020. This requirement applies / is enforced solely in case of renovation with a town planning permit. There is no need of a permit if only single windows are replaced. Therefore, the requirements do not apply for single window replacements.

**Bulgaria:** Valid for windows with PVC frame (further requirements: 1.6 / 1.8 – wood (walls / roofs), 1.7 – Aluminium, 1.75 / 1.9 – glazing facades / with higher requirements). The legal requirement is supposed to become  $U_w = 0.6$  in 2020. An intermediate step of  $U_w 1.1$  is discussed for 2018. It is unclear whether the requirements apply also for replacement of single windows.

**Croatia:** Building specific requirements (first figure: buildings up to 2 floors; second figure: buildings with more than 2 floors). The existence of air tightness requirements was mentioned but not specified. In case where only certain building elements of the envelope of a heated part of the building covering a surface area over 25% are renovated, the U-value of the entire building element (for all types of buildings) shall fulfil the prescribed requirements. In case of external walls and transparent elements of the envelope of a heated part of the building covering an area over 25% of that building component or element, the provision from the previous sentence relates to each individual geographic orientation of that building part (Exception: Requirements related to the max. Allowed U-values are not applied to a glass window with a large surface up to  $4 \text{ m}^2$  or if there is an additional barrier between such window and the heated indoor area of the building). Therefore, the requirements do not apply for single window replacements.

**Cyprus:** As from 1st of January 2017 all buildings that undergo major renovation should reach at least energy class B as far this is technically and financially feasible. The requirements apply for single windows that are replaced in existing and new buildings.

**Czech Republic:** It is unclear whether the requirements apply also for replacement of single windows.

**Denmark:** Danish energy requirements to windows in the Buildings Regulations are to the energy balance of the window not to the U-value and g-value separately. This is set to create possibility for manufacturers to focus on the total energy performance optimisation of windows instead of focusing on sub-optimisation of the U-value and g-value separately. The requirements concerning the energy gain are  $E_{ref} > -17 \text{ kWh/m}^2\text{a}$  (windows) and  $E_{ref} > 0 \text{ kWh/m}^2\text{a}$  (roof windows). This approach is compliant with EU regulation and welcomed by the industry but it makes it impossible to provide definite numbers in this report. Therefore, the requirements apply even if only a single window is replaced.

**Estonia:** Estonian legislation do not set any requirements for the window's thermal properties. No component based requirements exist. Energy efficiency of buildings is assessed through primary energy and requirements are set to the primary energy consumption. The minimum energy performance requirements are expressed as a primary energy performance indicator calculated for the building according to its standardised use, and applied to the building as a whole. Therefore, no requirements exist for single window replacements.

**Finland:** The U-value of new windows and external doors must be  $1.0 \text{ W/(m}^2\text{K)}$  or better. This requirement applies / is enforced solely in case of renovation with a town planning permit. A permit is needed if you exchange so many windows that the measure has a significant effect on the energy efficiency of the building. The threshold for an effect to be considered "significant" was not reported. Yet, in practice almost 100% of the renovation market were reported to fulfil the given U-values, as manufacturers reportedly don't produce windows above these U-values just for "non-permit" cases. Yet, officially the requirements do not apply for single window replacements.

**France:** The first value ( $2.3 \text{ W/m}^2\text{K}$ ) is valid for shallow renovations (also for single window replacements) or for buildings below  $1000 \text{ m}^2$ , the second one ( $2.6 \text{ W/m}^2\text{K}$ ) for deep renovations or buildings above  $1000 \text{ m}^2$  (and for sliding windows). In addition to the  $U_w$ -value requirement, a  $U_g$ -value of  $2.0 \text{ W/m}^2\text{K}$  needs to be fulfilled in every case. All requirements are only valid for windows  $\geq 0.5 \text{ m}^2$ . The values are under revision and an adaption is planned for 2018.

**Germany:** Alternatively, to the above mentioned  $U_w$ -value also meeting a whole building energy requirement (140% of new building's primary energy and overall shell transmission coefficient) is possible to meet the requirement. No requirements if less than 10% of the building component area is concerned (building component area for windows consists of: windows, roof windows, window doors and window roofs). Therefore, no requirements exist for single window replacements.

**Greece:** Climate zone specific requirements exist (A: 3.2, B: 3.0, C: 2.8, D: 2.6, see Annex: Maps of climate zones). There are no specific requirements for renovated buildings. For deep renovations (>25% of building envelope) however these values apply and the total energy class of the building should comply with Class B (100-75% of primary energy consumption of reference building). Therefore, the requirements do not apply for single window replacements.

**Hungary:** In case of a shallow renovation (< 25% of the building shell is replaced) the shown  $U_w$ -value of  $1.6 \text{ W/m}^2\text{K}$  is valid. Therefore, the requirements apply even if only a single window is replaced. In case of a major renovation the following

requirement concerning the specific heat loss coefficient  $q_m \leq 0,079+0,27*(A/V)$  is valid since 2017. The existence of air tightness requirements was mentioned but not specified.

**Ireland:** For extensions and material change of use, windows, doors and roof lights should have a maximum U-value of 1.6 W/m<sup>2</sup>K when their combined area is 25% of floor area. The requirements apply even if only a single window is replaced.

**Italy:** Climate zone specific requirements exist (2015-2020: A & B: 3.2, C: 2.4, D: 2.1, E: 1.9, F: 1.7; by 2021: A & B: 3.0, C: 2.0, D: 1.8, E: 1.4, F: 1.0, see Annex: Maps of climate zones). The climate zones are defined as follows: Zone A = up to 600 HDD; Zone B = from 601 to 900 HDD; Zone C = from 901 to 1400 HDD; Zone D = from 1401 to 2100 HDD; Zone E = from 2101 to 3000 HDD; Zone F = more than 3000 HDD). The g-value of 0.35 includes movable shading devices. Additionally, the g-value (=0.35) is only for orientation from East to West, passing through South: there is no limit for North-facing sides. This requirement applies / is enforced solely in case of renovation with a town planning permit. A building permit is needed by exchanging all windows of a property unit.

**Latvia:**  $U_{norm}$  = normative value /  $U_{max}$  = maximal allowed value. The term "k" is the temperature correction factor ( $k = 20/(\Phi_i - \Phi_e)$ ), where  $\Phi_i$  - indoor air temperature and  $\Phi_e$  - outdoor air temperature). It is unclear whether the requirements apply also for replacement of single windows.

**Lithuania:** The term "k" is the temperature correction factor ( $k = 20/(\Phi_i - \Phi_e)$ ), where  $\Phi_i$  - indoor air temperature and  $\Phi_e$  - outdoor air temperature). The requirements apply even if only a single window is replaced. If the total area of windows and other transparent building elements exceeds 25 % of total external wall area, the U-value of transparent elements even shall not exceed 1.3 W/(m<sup>2</sup>K). The existence of air tightness requirements was mentioned but not specified. By 2018 the requirement will change to 1.4-k.

**Luxembourg:** The requirements apply even if only a single window is replaced.

**Malta:** Buildings undergoing major renovation will be required to have a maximum yearly overall energy demand per square metre not exceeding that for the dwelling typology with the highest maximum overall energy demand requirement. Building extensions of 14 m<sup>2</sup> or less as well as major renovation project, to existing dwellings may be assumed to fulfil all the overall energy requirements (as before) provided that this construction is similar to the un-extended building. Where a building element forming part of the building envelope is being replaced or a building is being extended to a degree which may not be described as a major renovation, the building shall not be required to have a minimum overall energy performance level. Each new element forming part of the building envelope shall however not be exempted from compliance with maximum thermal conductivity requirements for that element. Therefore, the requirements apply even if only a single window is replaced. The U-value requirement only applies when windows and glazed door surface is  $\geq 20\%$  of exposed wall.

**Netherlands:** It is unclear whether the requirements apply also for replacement of single windows.

**Poland:** Please note that the value applies to new buildings or replacement when you need a town planning permit. Without such a permit, for window retrofitting, no minimum performance requirement is enforced. Therefore, the requirements do not apply for single window replacements. By 2021 the requirement will change to 0.9 W/m<sup>2</sup>K. The existence of air tightness requirements was mentioned but not specified.

**Portugal:** This requirement applies / is enforced solely in case of renovation with a town planning permit. There is no need of a permit if only single windows are replaced. Therefore, the requirements do not apply for single window replacements. Climatic zones in Portugal are distinguished by three levels (1, 2 and 3) for winter (I) and also three levels for summer (V) according to the temperature, radiation and altitude (see Annex: Maps of climate zones). I3 refers to the areas with higher energy needs for heating (heating degree days for a 18°C base above 1800) and V3 refers to the areas with higher energy needs for cooling (average temperatures during summer above 22°C). As an example, climatic zone I1V3 refers to a location with mild winters and hot summers. Nevertheless, the heating needs are always significantly more relevant than the cooling needs. Therefore, in many situations the climatic zones are nominated by their winter designation. Concerning the g-value the maximum value for the window system (glass + frame + shading device) is shown. Furthermore, the value depends on the thermal mass of the building.

**Romania:** By 2018 the current  $U_w$ -value requirement for new buildings ( $U_w = 1.3$  W/m<sup>2</sup>K) will be enforced for existing buildings. The requirements apply even if only a single window is replaced.

**Slovak Republic:** From 2021 onwards stricter requirements are expected. The existence of air tightness requirements was mentioned but not specified. It is unclear whether the requirements apply also for replacement of single windows.

**Slovenia:** In case of metal frames, the requirement is set at 1,6 W/m<sup>2</sup>K. In spring 2017 an update of the Building Code is planned, that will introduce cost-optimal levels for windows. It is unclear whether the requirements apply also for replacement of single windows.

**Spain:** In Spain the maximum U-value for windows for renovation (when these are replaced, if they are not replaced there is not such a requirement) is the same that for new buildings. In the case that more than 25% of the envelope is renovated, the heating demand should be lower than the reference building (the same building but with an envelope that comply with the previous normative from 2006). The requirements apply even if only a single window is replaced. A combination of building specific requirements (distinction between isolated blocks, terraced houses, block within adjacent buildings, semi-detached house) and climate specific (climate zones are defined as a combination of the severity of winter: a (warmest region:  $U_w = 5.7$  W/m<sup>2</sup>K), A, B, C, D, E (coldest region,  $U_w = 2.5$  W/m<sup>2</sup>K) and the severity of the summer (1, 2, 3, 4; mild to extreme)) requirements exist (see Annex: Maps of climate zones). The existence of air tightness requirements was mentioned but not specified.

**Sweden:** The building shall primarily fulfil the energy requirements for new buildings. If not, U-value requirements for the various building parts shall be fulfilled. It is unclear whether the requirements apply also for replacement of single windows.

UK-England: In England either a U-value of 1.6 W/m<sup>2</sup>K or a Window Energy Rating (WER) of Band C or better is required. The calculation of the WER is set out in the Glass and Glazing Federation (GGF) Guide to the Calculation of Energy Ratings for Windows, Roof Windows and Doors. The requirements apply even if only a single window is replaced.

UK-Wales: See description of UK-England. Wales follows the relevant standards of England's Building Regulations in their Building Regulation. The requirements apply even if only a single window is replaced.

UK-Northern Ireland: See description of UK-England. Northern Ireland follows the relevant standards of England's Building Regulations in their Building Regulation. The requirements apply even if only a single window is replaced.

UK-Scotland: See description of UK-England. Scotland follows the relevant standards of England's Building Regulations in their Building Regulation. For extensions to existing dwellings, where the dwelling has poor levels of wall and roof insulation, the requirements are a U<sub>w</sub> of 1.4 W/m<sup>2</sup>K or a Window Energy Rating A. The requirements apply even if only a single window is replaced.

The following table informs about the contacted institutions and the national regulation / guide per Member State (if applicable).

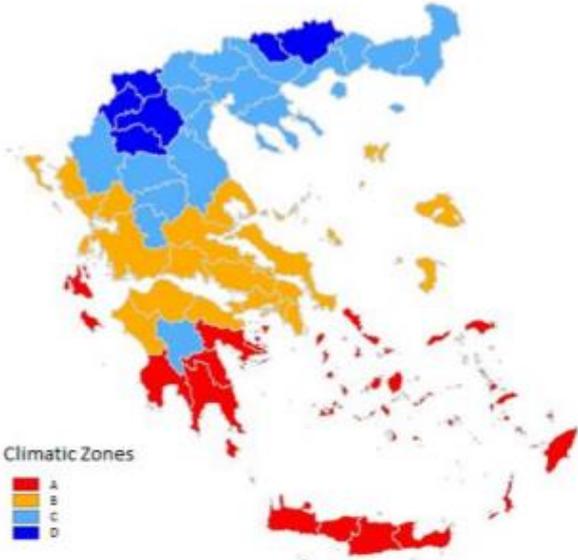
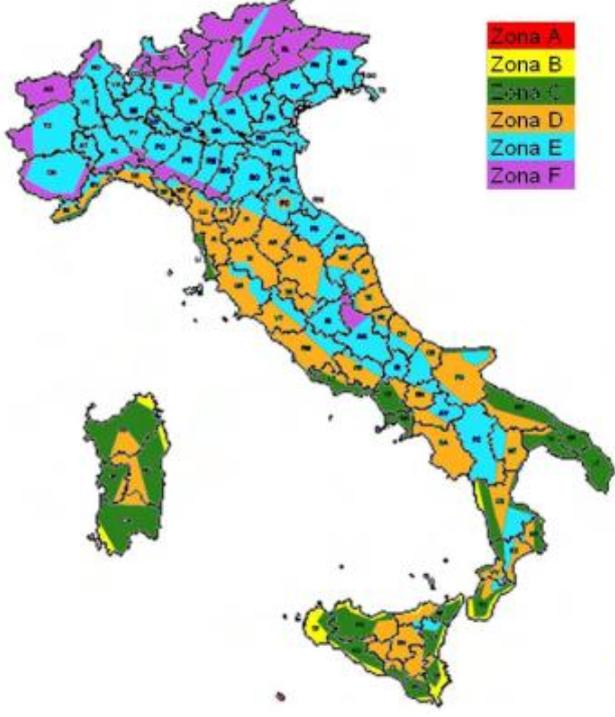
**Table 2. Overview of contacted institutions and national regulation**

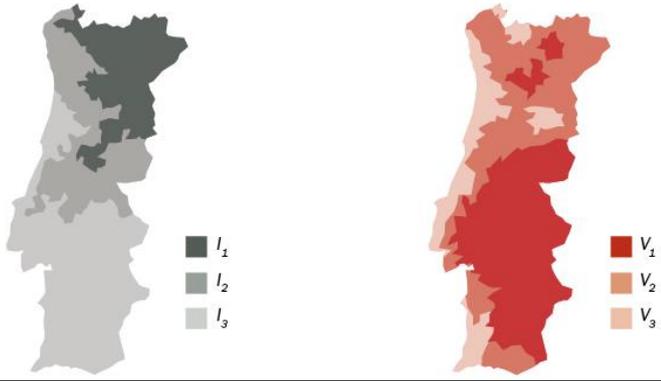
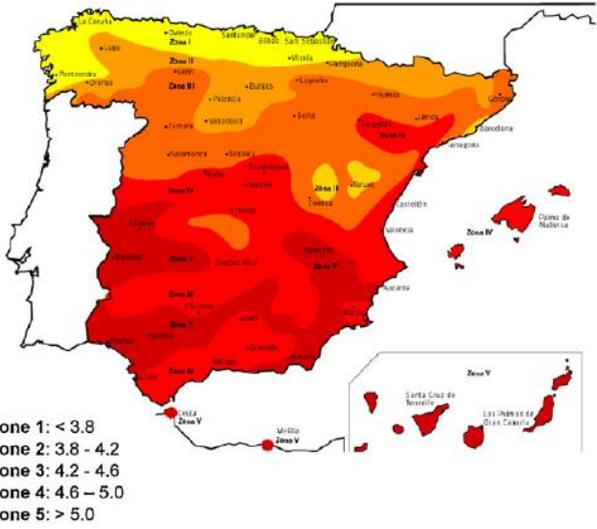
Member State	Institute	National regulation
Austria	Ecofys Germany GmbH	OIB-Richtlinie 6 Energieeinsparung und Wärmeschutz
Belgium - Brussels	Brussels Energy Agency	-
Belgium - Flanders	Flemish Energy Agency	Energy law (Energiebesluit) of November 19, 2010, Annex VII
Belgium - Wallonia	EE buildings department	Réglementation PEB du 01/01/2017 au 31/12/2020
Bulgaria	Sofia Energy Agency - SOFENA	Ministry of Regional Development - Ordinance 7 of the Energy Efficiency of Buildings
Croatia	Ministry of Construction and Physical Planning	Technical regulation on rational energy consumption and thermal protection in buildings (OG 128/2015)
Cyprus	Ministry of Energy, Commerce, Industry and Tourism	Ministerial Order for Minimum Energy Performance Requirements 2013 (ΚΔΠ 244/2013, ΚΔΠ 432/2013, ΚΔΠ 119/2016)
Czech Republic	Building Engineering-Consultants Prague	CSN 730540-2
Denmark	Danish Ministry of Climate, Energy and Buildings, Danish Energy Agency	Executive Order on the Publication of the Danish Building Regulations 2015 (BR15)
Estonia	Tallinn University of Technology	Concerted Action 2014 / Minimum energy performance requirements
Finland	Ministry of the Environment	4/13 Ministry of the Environment degree on improving the energy performance of buildings undergoing renovation or alternation
France	ADEME/DTVD/SB	Arrêté du 3 Mai 2007 relatif aux caractéristiques thermiques et à la performance énergétique des bâtiments existants

Member State	Institute	National regulation
		Arrêté du 13 Juin 2008 relatif à la performance énergétique des bâtiments existants de surface supérieure à 1000 m <sup>2</sup> lorsqu'ils font l'objet de travaux de rénovation importants
Germany	Ecofys Germany GmbH	Energieeinsparverordnung zur Zweiten Verordnung zur Änderung der Energieeinsparverordnung vom 18. November 2013 (BGBl. I S.3951) (Energieeinsparverordnung 2014)
Greece	Laboratory of Building Construction and Building Physics Civil Engineering Department, Aristotle University of Thessaloniki	Ministerial Decision 5825/30-03-2010 FEK B' 407
Hungary	Building Energetics Affiliation of the Hungarian Chamber of Engineers	7/2006. (V. 24.) TNM the definition of the energy characteristics of buildings, Annex 1 & Annex 5
Ireland	Sustainable Energy Authority	Building Regulations 2011: Technical Guidance Document L - Conservation of Fuel and Energy - Dwellings Section 2.1.2.4 - Table 5
Italy	Politecnico di Milano	National Ministerial Decrees (D.M. 26/06/2015)
Latvia	Ministry of Economics Latvia	Construction Law & Regulations Regarding Latvian Construction Standard LBN 002-01 Thermotechnics of Building Envelopes
Lithuania	Ministry for Environment of the Republic of Lithuania	STR 2.05.01:2013 "Design of Energy Performance of Buildings"
Luxembourg	Ministry of Economy	Règlement grand-ducal concernant la performance énergétique des bâtiments d'habitation - Annexe p.15 & p.34
Malta	Malta Intelligent Energy Management Agency	Doc F - Technical Guidance Conservation of Fuel and Natural Resources Part A energy performance of : Minimum requirements on the buildings – Malta, 2015
Netherlands	National Enterprising Netherlands Sustainable Construction and Services, Team Housing	Bouwbesluit 2015, Richtlijn energieprestatie gebouwen
Poland	National Energy Conservation Agency	"Regulation on the technical conditions that should be met by buildings and their location" issued by the Minister of Infrastructure of 12 April 2002 (updated in 2008 and 2015)
Portugal	University of Minho, Department of Civil Engineering	Decree-law nº 28/2016; Ordinance nº 319/2016; Ordinance nº 379A/2015; Ordinance nº15793-k/2013.

Member State	Institute	National regulation
Romania	Ministry of Regional Development and Public Administration, Technical Directorate	Code for thermal calculation of building elements: C 107-2005 with further amendments in 2010, 2012 and 2016, Methodology for calculating energy performance of buildings: Mc 001-2006 with further amendments in 2010 and 2013
Slovak Republic	Building Testing and Research Institute Bratislava	STN 73 0540-2; STN 73 0540-3
Slovenia	Building and Civil Engineering Institute ZRMK	Building code PURES 2010 and TSG-1-004:2010 URE (Technical guideline for construction: TSG-1-004:2010 Efficient use of energy)
Spain	Hochschule Luzern, Technik & Architektur Zentrum für Integrale Gebäudetechnik ZIG	Código Técnico de la Edificación (CTE). Documento Básico de Ahorro de Energía (DB-HE), 2013
Sweden	Boverket - National Board of Housing, Building and Planning	BBR Swedish Building code, section 9:92
UK – England	Department for Communities and Local Government	Building Regulations 2010 (SI 2010/2214), Building (Approved Inspectors etc.) Regulations 2010* (SI 2010/2214 and 2010/2215) Energy Performance of Buildings (England and Wales) Regulations (SI 2012/3118) incl. amendments from 2013
UK – Wales	Welsh Government	<u>See UK - England</u> Amendments compared to England: - Building (Amendment) (Wales) Regulations 2014 SI 2014/110 (W. 10); - Building (Amendment) (Wales) Regulations 2014 SI 2013/747 (W. 89).
UK – Northern Ireland	Department of Finance and Personnel Northern Ireland	<u>Own building regulation:</u> Building Regulations (Northern Ireland) 2012 (SR 2012 No. 192) Building (Prescribed Fees) Regulations (Northern Ireland) 1997 (SR 1997 No. 482); Energy Performance of Buildings (Certificates and Inspections) Regulations (Northern Ireland) 2008 (SR 2008 No. 170). Incl. amendments from 2014
UK – Scotland	Local Government and Communities Directorate (Scotland)	<u>Own building regulation:</u> Building (Scotland) Regulations 2004 and Energy Performance of Buildings (Scotland) Regulations 2008 Incl. amendments from 2013

## 4 Annex: Maps of climate zones

Member State	Map of climate zones
Greece	 <p data-bbox="491 1030 630 1142">Climatic Zones A B C D</p> <p data-bbox="470 1198 821 1232"><b>Figure 1: Climatic Zones.</b></p>
Italy	 <p data-bbox="949 1288 1037 1456">Zona A Zona B Zona C Zona D Zona E Zona F</p>

Member State	Map of climate zones
<p>Portugal</p>	<p><b>Zonamento climático de Portugal Continental</b></p> <p>Zonas climáticas inverno      Zonas climáticas verão</p> 
<p>Spain</p>	 <p> <b>Zone 1:</b> &lt; 3.8  <b>Zone 2:</b> 3.8 - 4.2  <b>Zone 3:</b> 4.2 - 4.6  <b>Zone 4:</b> 4.6 - 5.0  <b>Zone 5:</b> &gt; 5.0         </p> <p>Source: Spanish National Meteorological Institute. Note: Average daily irradiation in kWh/m<sup>2</sup> generated from annual global solar radiation isolines on horizontal surface.</p>

## 5 Publication bibliography

CA EPBD (Ed.) (2015): 2016 Implementing the Energy Performance of Buildings Directive (EPBD). Featuring country reports. Co-funded by the Intelligent Energy - Europe Programme of the European Union. Concerted Action Energy Performance of Buildings (CA EPBD). Lisbon.

Grözinger, Jan; Manteuffel, Bernhard von; Boermans, Thomas; Surmeli-Anac, Nesen; Ashok John; Bachner, Daniela; Leutgöb, Klemens (2015): Assessment of cost optimal calculations in the context of the EPBD (ENER/C3/2013-414). Final report. By order of the European Commission. ECOFYS; e7 Energie Markt Analyse GmbH. Berlin, Cologne (BUIDE13705).





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