A COMPARISON BETWEEN THE SPANISH AND AUSTRALIAN BUILDING ENERGY EFFICIENCY CODES. A CASE STUDY

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The main aim of this study is to compare the requirements established by Spanish and Australian Building Codes in terms of energy efficiency through a case study. In the first place, the BCA (Building Code of Australia) is analyzed in detail, studying its structure and finding the correlation of the sections with the CTE (Código Técnico de la Edificación) in Spain. Then, the contents in both regulations are identified, as well as the building classification, usages and the climatic zones, through climate severity defined for summer and winter using accumulated global radiation and degree per day average. Some other factors, such as solar heat gain coefficient, allow developing and facilitating the understanding of the comparison between both Building Codes. To illustrate the comparison, a detached house has been analyzed through the implementation of energy requirements for both Building Codes, providing constructive solutions using natural insulation. This enabled identifying the main points which present the most notable differences and which regulation is more restrictive in each aspect. Finally, a programmed software able to determine this data automatically has been developed, in order to facilitate the comparison for any other case study.

Keywords: *Building Code; Energy efficiency requirements; Climatic zone; Case study*

COMPARACIÓN ENTRE LA NORMATIVA DE EFICIENCIA ENERGÉTICA EN LA EDIFICACIÓN AUSTRALIANA Y ESPAÑOLA. UN CASO DE ESTUDIO

El principal objetivo de este estudio es la comparación de las exigencias establecidas por el Codigo Técnico de la Edificación Español y el Australiano en cuanto a eficiencia energética mediante un caso práctico. En primer lugar, se analiza detalladamente el Código de la Edificación en Australia (BCA), estudiando su estructura y relacionando sus secciones con el Código Técnico de la Edificación en España (CTE). A continuación se identifican los contenidos, así como la clasificación de edificios, sus usos y las zonas climáticas mediante las severidades definidas para verano e invierno, usando las medias de radiación solar global acumulada y temperatura diaria. Además, otros factores, permiten desarrollar y facilitar la comprensión de la comparación entre ambas normativas. Para ilustrar dicha comparación, se realiza un caso práctico sobre una vivienda en la que se aplican las exigencias energéticas de ambas normativas, aportando soluciones constructivas mediante aislamientos naturales. Esto posibilita la identificación de los puntos que presentan las diferencias más destacables y detectar cuál de las normativas es la más restrictiva en cada caso. Por último, se muestra un software programado para ser capaz de determinar dicha información automáticamente, que ha sido desarrollado para facilitar la comparación en cualquier otro caso.

Palabras clave: *Código de edificación; Requerimientos de eficiencia energética; Zona climática; Caso de estudio*

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1. Introduction

A current worldwide concern involves the efforts that are aimed at reducing energy consumption and CO_2 emissions (Rodríguez-Soria et al., 2014). The building sector is responsible for approximately 40% of the consumption and greenhouse gas emissions (European Commission, 2012) and two-thirds of these emissions result from residential buildings (Sharma et al., 2011), which exhibit the greatest potential for energy savings (Martínez de Alegría et al., 2009).

Many regulations related to energy efficiency entered into force in the last decades; however, the requirements vary greatly from one country to another. Energy efficiency is defined by the energy yield of the facilities and by the envelope energy losses. These energy losses depend on the morphology and characteristics of the building and are mainly conditioned by the thermal envelope transmittance, including walls, floors, roofs and windows.

Due to the lack of harmonization in the building energy efficiency requirements that are mandated by different countries, the interest of this paper is to present the variation in the requirements between two very different countries, which have similarities among some of their climatic zones: Spain and Australia.

The paper is focused on the requirements of the thermal envelope and also discusses the causes of the divergences in the requirements and their degrees of disparity. The results of the study would help to find strengths and weaknesses in the regulations and would allow improving the technologies and construction systems used.

2. Objectives

The main objective of this study is to compare the requirements established by Spanish and Australian Building Codes in terms of energy efficiency, focusing on the thermal envelope of the buildings, which is the most significant element in the energy performance.

As specific objectives, this study aim to present a comparison between the structure of both regulations, the building classification, usages and the climatic zones.

3. Comparison between Australian Building Codes and *Código Técnico de la Edificación*.

While in Spain, energy efficiency is regulated by *Código Técnico de la Edificación* (CTE) in the section *CTE-DB HE: Ahorro de Energía* (CTE, 2006), in Australia is regulated by National Construction Code (NCC).

The NCC comprises the Australian Building Code (BCA, 2011) published in “Volume One” for Class 2 to 9 buildings and “Volume Two” for Class 1 and Class 10 buildings and the Plumbing Code of Australia (PCA) in its “Volume Three”.

3.1 Usage building classification

Both in Spain and Australia, buildings are classified depending on its usage. The most common typology in Australia is the one-storey single dwelling which corresponds to Class 1. Commercial, educational, administrative buildings, hospitals, among others are included in Classes 2 to 9, and detached garages or additional structures are included in Class 10.

In Spain, the usages are presented in the section *CTE-DB-SI: Seguridad en caso de incendio*. Table 1 shows some examples of the correlation between the building use presented in both countries.

Table 1: Example of building classes defined by BCA and CTE.

BCA 2012			CTE-DB-SI
CLASS	Subclass	Description	Category assigned
1	Class 1a	A single dwelling being a detached house or one or more attached dwellings.	Residential (housing)
	Class 1b	A boarding house, guest house or hostel not exceeding 300 m2 and not more than 12 people reside.	Residential (public)
10	Class 10a	A non-habitable building being a private garage, carport, shed, or the like	Car park
	Class 10b	A structure being a fence, mast, antenna, retaining or free-standing wall, swimming pool, or the like.	Not provided

3.2 Structure of documents

Both regulations present some similarities in their structure. Focusing on the energy efficiency section, there has been done a connection from the BCA to the Spanish legislation in general (including CTE and others), being shown just a little demonstration in the Table 2.

Table 2: Example of similarities in the structure of energy efficiency sections BCA and CTE.

BCA 2012 (Volume II)	CTE 2006 (and other Spanish legislation)
3.12 Energy efficiency	
3.12.0 Application of Part 3.12	
3.12.0.1 Heating and cooling loads	CTE-DB-HE2: Regulations on thermal installations in buildings (RITE, 2007).
3.12.1 Building fabric	
3.12.1 Application	
3.12.1.1 Building fabric thermal insulation	CTE-DB-HE1-19: Required characteristics for external walls and interior partitions of the thermal envelope.
3.12.1.2 Roofs	
3. 12.1.3 Roof lights	
3.12.1.4 External walls	CTE-DB-SE-F-35: Type of walls.
3.12.1.5 Floors	CTE-DB-SE-C: Foundations.
3.12.1.6 Attached Class 10a buildings	
3.12.2 External Glazing	CTE DB-HE1-43: Windows and roof lights.
3.12.2 Application	
3.12.2.1 External glazing	
3.12.2.2 Shading	

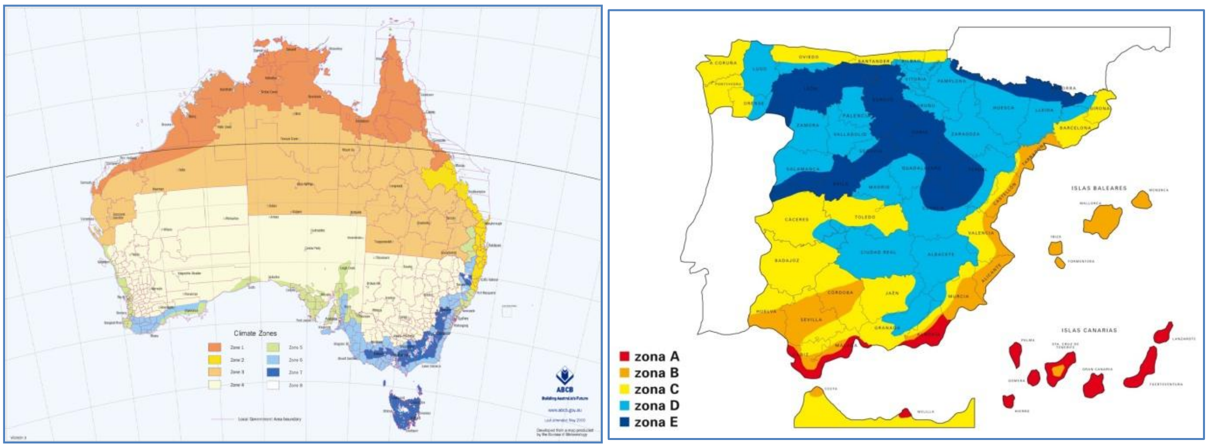
The main difference between Australian and Spanish legislation is that BCA comprises all the aspects involved in buildings in only one regulation, while Spanish legislation is a compendium of several documents, each one aimed at a different topic.

3.3 Climatic zones

Concerning climatic zones, the two countries involve several climates depending on the geographical point and the altitude above sea level. Both regulations separate in different climatic zones their territories so, to compare the requirements, first of all, this zones have to be linked (see Figure 1 and Table 3).

It is worth noting that, although Spain and Australia are located in the Northern Hemisphere and Southern Hemisphere, respectively, climates present many similarities and most of them can be matched to be compared.

Figure 1: Climatic zones by BCA and CTE codes.



In a first study, zones can be matched as follow in Table 3.

Table 3: Climatic zones.

AUSTRALIA	SPAIN
Zone 1: Equatorial & tropical Zone 2: Subtropical Zone 3: Northern dessert & grassland Zone 4: Southern dessert & grassland Zone 5: Subtropical	Zone A: Subtropical
Zone 6: Temperate (low altitude)	Zone B: Mediterranean or Zone D: Mediterranean-Continental
Zone 7: Temperate (high altitude)	Zone C: Oceanic
Zone 8: Alpine	Zone E: Highland

However, for more precise determinations, CTE- DB HE Annex D establishes a method to obtain the relative climatic zone of any place in the world by knowing the solar irradiation and the maximum and minimum temperatures in degrees. A practical application of this methodology is provided in the case study of this paper.

4. Case study: Masonry veneer house

In order to compare the thermal requirements mandated by Spanish and Australian legislation, it has been selected a real building to implement both of them, as a case study.

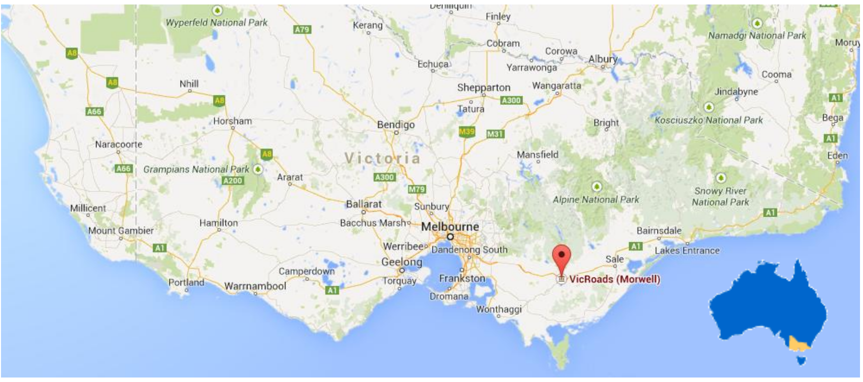
The development of the case study will allow comparing the requirements and identifying which regulation is more restrictive above the other one.

4.1 Case study description

The case study consists of a three bedroom masonry veneer house located in Morwell, the State of Victoria in Australia. It has cavity masonry walls in the lounge room, and the wall between the house and garage is a stud wall.

The usage of the building corresponds to Class 1a, so, Volume II should be applied. The location of Morwell in the country of Australia is shown in Figure 2.

Figure 2: Morwell's localion



The house is designed of a concrete slab-on-ground and will have a conventional pitched tiled roof with a roof upper surface solar absorptance value of more than 0.6 and a flat ceiling.

The house has 3 ceiling fans and 4 downlights penetrating the ceiling. An in-slab heating system will be installed under the bathroom. It will have a thermostat and time switch and the power load is 120 Wh/m^2.

A reverse-cycle air-conditioning system will be installed throughout the rest of the house (not the garage). The proposed lighting system totals 500 Watts for the house and 60 Watts for the garage. There are no lighting controls and the supply water heater is a 5 star gas unit. Star gas unit was established in Australia as an energy rating labels for many electric appliances and also water heaters or ducted heaters. It pretends to reduce the energy consumption and help customers to choose the most efficient installations to save on utilities cost (Australian Government, 2014).

The floor plan and a section of the house are presented in Figures 3 and 4.

Figure 3: Section of the masonry veneer house.

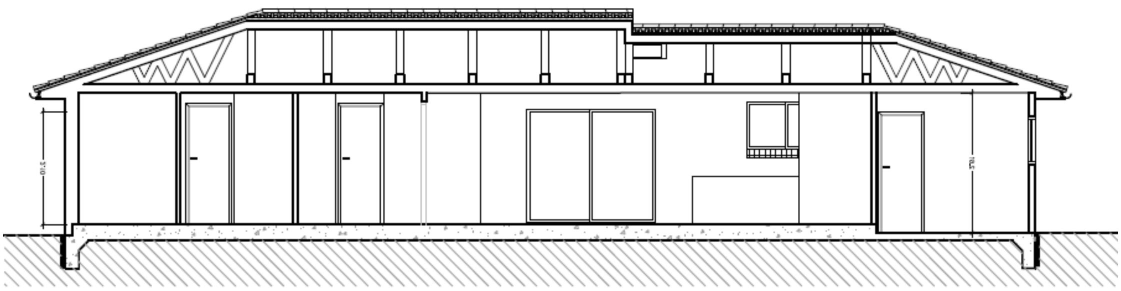
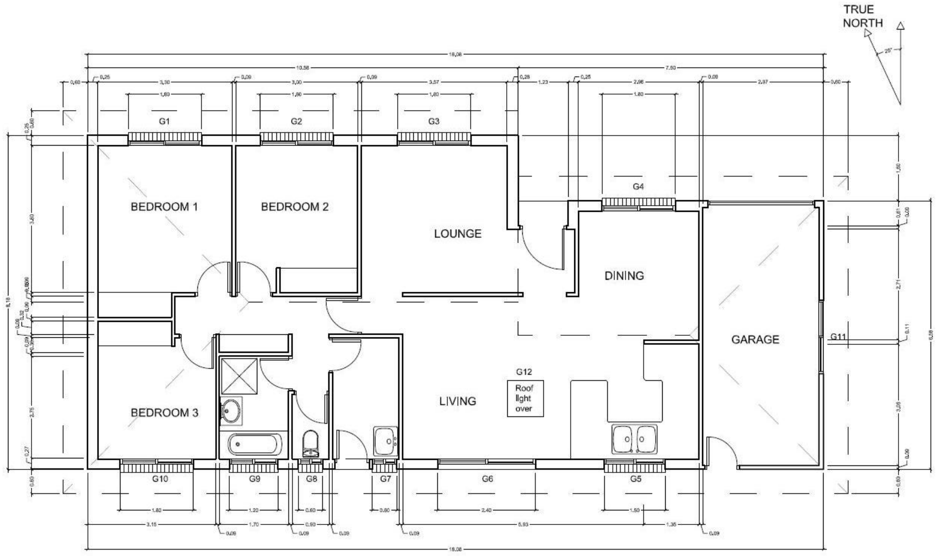


Figure 4 Floor plan of the masonry veneer house.



4.2 Spanish climatic zone determination

Morwell is located in the climatic zone 6: Temperate - low altitude, according to Australian climatic zones. In order to implement the Spanish regulation in the building, it should be known the matched climatic zone in Spain. Through the method described in the CTE, Morwell matches zone D1 and one of the Spanish cities in this zone is Pamplona. Figure 5 shows the methodology to calculate the relative climatic zone, according to the degree days (GD) and the solar irradiation of location.

Figure 5: Determination of the relative climatic zone for any Spanish city

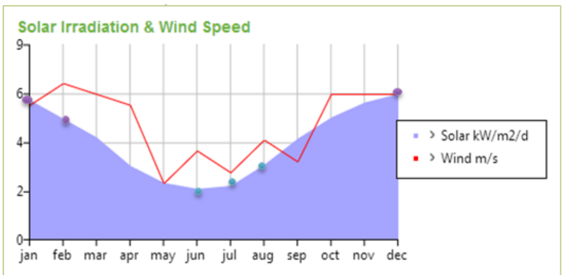
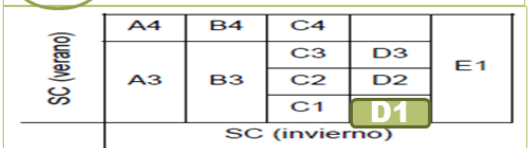


Tabla D.2a - Severidad climática de invierno

A	B	C	D	E
SCI ≤0,3	0,3 <SCI ≤0,6	0,6 <SCI ≤0,95	0,95 <SCI ≤1,3	SCI>1,3

Tabla D.2b - Severidad climática de verano

1	2	3	4
SCV ≤0,6	0,6 <SCV ≤0,9	0,9 <SCV ≤1,25	SCV>1,25



Statistics	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	Years	
Temperature															
Mean maximum temperature (°C)	26.5	26.5	24.2	20.5	16.8	14.1	13.6	14.9	16.9	19.4	22.0	24.0	20.0	29	1984 2013
Mean minimum temperature (°C)	12.6	12.9	11.2	8.7	6.5	4.4	3.7	4.3	5.9	7.4	9.5	11.1	8.2	29	1984 2013

$$SCI = a \cdot RAD + b \cdot GD + c \cdot RAD \cdot GC + d \cdot (RAD)^2 + e \cdot (GD)^2 + f = 1{,}2187$$

a	b	c	d	e	f
$-8{,}35 \cdot 10^{-3}$	$3{,}72 \cdot 10^{-3}$	$-8{,}62 \cdot 10^{-6}$	$4{,}88 \cdot 10^{-5}$	$7{,}15 \cdot 10^{-7}$	$-6{,}81 \cdot 10^{-2}$

$$SCV = a \cdot RAD + b \cdot GD + c \cdot RAD \cdot GC + d \cdot (RAD)^2 + e \cdot (GD)^2 + f = 0{,}1135$$

a	b	c	d	e	f
$3{,}724 \cdot 10^{-3}$	$1{,}409 \cdot 10^{-2}$	$-1{,}869 \cdot 10^{-5}$	$-2{,}053 \cdot 10^{-6}$	$-1{,}389 \cdot 10^{-5}$	$-5{,}434 \cdot 10^{-1}$

	TB	T_{max}	T_{min}	N_i	X_c	GD	RAD
June	20	14,1	4,4	30	1	322,5	2,2
July	20	13,6	3,7	31	1	351,85	2,2
August	20	14,9	4,3	31	1	322,4	3,2
						332,25	2,533

$$GD = \sum_{n=0}^{n=i} \left(TB - \frac{T_{max} + T_{min}}{2} \right) \cdot N_i \cdot X_c$$

	TB	T_{max}	T_{min}	N_i	X_c	GD	RAD
December	20	24	8,2	31	1	120,9	6
January	20	26,5	12,6	31	1	13,95	5,8
February	20	26,5	12,9	28	1	8,4	5
						47,75	5,60

As it is presented in the Figure 5, firstly the temperatures of Morwell among every month of the year are identified according to official meteorological data, as well as the solar irradiation, which depends on the latitude of the place. Both data are introduced in the mathematical expressions presented in Figure 5, which mean:

SCI: Severidad climática de invierno (Climate severity in Winter)
SCV: Severidad climática de verano (Climate severity in Summer)
GD: Grados Día (Degree Days)

The degree days are also calculated and introduced in the expressions, for both summer and winter. Finally, it is obtained the values for SCI and SCV which are checked in the *Tabla D.2a-Severidad climática de invierno* and *Tabla D.2b-Severidad climática de verano* from CTE-DB HE.

Morwell corresponds to the D1 climatic zone in Spain, within which it is selected Pamplona.

Figure 6: Climatic zones in Spain according to CTE

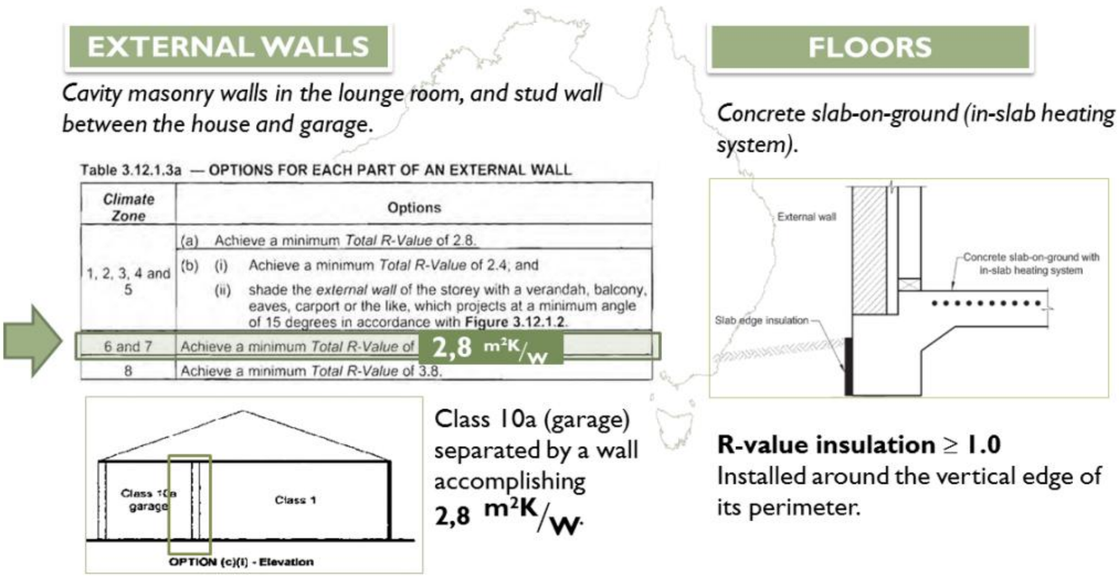
Capital de provincia	Capital	Altura de referencia (m)	Desnivel entre la localidad y la capital de su provincia (m)				
			≥200 <400	≥400 <600	≥600 <800	≥800 <1000	≥1000
Albacete	D3	677	D2	E1	E1	E1	E1
Alicante	B4	7	C3	C1	D1	D1	E1
Almería	A4	0	B3	B3	C1	C1	D1
Ávila	E1	1054	E1	E1	E1	E1	E1
Badajoz	C4	168	C3	D1	D1	E1	E1
Barcelona	C2	1	C1	D1	D1	E1	E1
Bilbao	C1	214	D1	D1	E1	E1	E1
Burgos	E1	861	E1	E1	E1	E1	E1
Palencia	D1	722	E1	E1	E1	E1	E1
~~Palma de Mallorca~~	~~B3~~	~~1~~	~~B3~~	~~C1~~	~~C1~~	~~D1~~	~~D1~~
Palmas de Gran Canaria (las)	A3	114	A3	A3	A3	B3	B3
Pamplona	D1	456	E1	E1	E1	E1	E1
Pontevedra	C1	77	C1	D1	D1	E1	E1
Salamanca	D2	770	E1	E1	E1	E1	E1
Santa Cruz de Tenerife	A3	0	A3	A3	A3	B3	B3
Santander	C1	1	C1	D1	D1	E1	E1
Segovia	D2	1013	E1	E1	E1	E1	E1
Sevilla	B4	9	B3	C2	C1	D1	E1
Soria	E1	984	E1	E1	E1	E1	E1
Tarragona	B3	1	C2	C1	D1	D1	E1
Teruel	D2	995	E1	E1	E1	E1	E1

4.3 BCA requirements determination

BCA establishes some tables for each thermal envelope element that allow knowing the energy efficiency limitations, through some data of the case.

Thermal envelope is formed by the building fabric and external glazing. As an example, the determination of the external walls as a part of the building fabric depends just of the climatic zone; however, floors depend on the construction system used.

Figure 7: External walls and floors BCA requirements determination



Note that BCA provides the requirements as a minimum R-value (thermal resistance) instead of maximum a U-value (thermal transmittance) as CTE does. The same happens for roof lights or glazing, where it is necessary a conversion equaling factors, for instance, the Solar Heat Gain Coefficient in (1):

$$SHGC = F_{sm} \cdot (1\text{-}FM) \cdot g_{\perp} + FM \cdot 0{,}04 \cdot Um \cdot \alpha \cdot 0{,}8 \qquad (1)$$

Table 4: External glazing BCA requirements determination

Table 3.12.2.1 CONSTANTS FOR CONDUCTANCE AND SOLAR HEAT GAIN

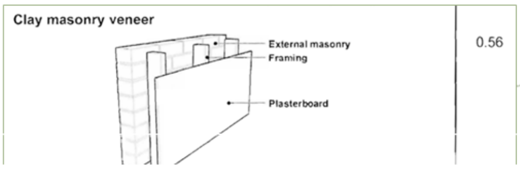
Floor construction	Air Movement (refer notes)	Constant	Climate zone 1	2	3	4	5	6	7	8
Floor in direct contact with the ground	Standard	C_u	1.650	18.387	14.641	7.929	13.46	6.418	86	3.987
		C_{SHGC}	0.063	0.074	0.062	0.097	0.122	0.153	89	0.234
	High	C_U	1.650	18.387	14.641	7.929	13.464	6.418	5.486	3.987
		C_{SHGC}	0.069	0.081	0.068	0.107	0.134	0.168	0.208	0.257
Suspended floor	Standard	C_U	1.485	16.548	13.177	7.136	12.118	5.776	4.937	3.588
		C_{SHGC}	0.057	0.067	0.056	0.087	0.110	0.138	0.170	0.211
	High	C_U	1.485	16.548	13.177	7.136	12.118	5.776	4.937	3.588
		C_{SHGC}	0.063	0.074	0.062	0.096	0.121	0.152	0.187	0.232

For the external glazing, it has to be considered the solar radiation depending on the hemisphere where the city is located. Being the north façade the most radiated for the Southern Hemisphere and the south façade the most radiated for the Northern Hemisphere.

4.4 Insulation calculations

Constructive solutions would be proposed through natural insulation to satisfy not only energy efficiency criteria, but also, sustainable criteria.

Figure 8: Example of insulation calculation (External walls)



BCA Min R-value insulation = 2,8 – 0,56 = **2.24** m^2K/W

CTE Min R-value insulation = 1,16 – 0,56 = **0,63** m^2K/W

INSULATION TYPE	DISTRIBUTION L x W x T (m)		ρ (kg/m³)	λ (W/m° C)	€/m²	MORWELL e_{min} ins (m)	MORWELL OBSERVATIONS Need	exce ss	Sol (€/m²)	PAMPLONA e_{min} ins (m)	PAMPLONA OBSERVATIONS Need	exce ss	Sol (€/m²)
WOOL	PANEL (0,6x1,2x0,05m)		30	0,035	8,5	0,08	2	2cm	17,00	0,02	1	3cm	8,50
	LAYER (0,6x10x0,05-0,1m)			0,043	6,2 - 11,7	0,10	0 – 1	-	11,70	0,03	1 - 0	2cm	6,20
	BULK	Filling	12	3,8	3,8 €/kg	0,13	-	-	5,82	0,04	-	-	1,64
		Injected	20	3,8	3,8 €/kg	0,09	-	-	7,15	0,03	-	-	2,01
STANDARD WOOD FIBRE	PANEL (2,5x1,2x 0.08-0,095-0,12m)		350	0,05	2,25 - 2,45 -2,85	0,11	0 - 0 – 1	1cm	2,85	0,03	1-0-0	5cm	2,25
HEMP	LAYER (0,6x8-10x0.05-0,1m)		30	0,041	6.75-12,9	0,09	1	1cm	12,9	0,03	1-0	2cm	6,75
THERMO WOOD FIBRE	PANEL (1,2x0,6x 0.02-0.08m)		170	0,04	4,95–9,6-18,9-23,2	0,09	1-0-0-1	1cm	23,90	0,03	0-1-0-0	1cm	9,60
CORK	PANEL (0,5x1x0.02-0.1m)		110	0,04	From 6,61 to 27,89	0,09	0-0-1-1-0-0	1cm	25,05	0,03	0 – 1 - 0-0-0	-	8,61
COTTON	PANEL (0,6x1,2x0,05m)		30	0,036	6,8	0,08	2	2cm	13,60	0,02	1	3cm	6,80
	LAYER(0,6x10x0,05-0,1m)		30	0,034	5,8 - 10,4	**0,08**	0 -1	2cm	**10,40**	**0,02**	1-0	3 cm	**5,80**
	BULK	Filling	20	2,2	2,2 €/kg	0,11	-	-	4,93	0,03	-	-	1,39
		Injected	30	2,2	2,2 €/kg	0,09	-	-	6,21	0,03	-	-	1,75

Note: Insulation prices (RMT, 2013) are considered the same in both countries to conduct this study.

First of all, several natural insulation materials have been selected and their thermal characteristics are presented in Figure 8: dimensions, density, conductivity and price.

Depending on the city (Morwell or Pamplona) the Figure 8shows the required thickness of insulation, the number of panels needed and/or the excess of thickness, as well as the final price. According to this criteria, it has been selected panels of insulation made of cotton, as it is highlighted in the Figure 8.

5. Results

CTE requirements are taken from CTE-DB HE document and converted to the units used by BCA, in order they can be compared as follows in the expressions:

BCA

$$\boldsymbol{C_U} = \frac{\sum_{i=0}^{i=n}(\boldsymbol{A_i} * \boldsymbol{U_i})}{\sum_{i=0}^{i=n}(\boldsymbol{A_i} * \boldsymbol{SHGC_i} * \boldsymbol{E_w})} \quad (2)$$

$$\sum_{i=0}^{i=n}(A_i * SHGC_i * E_w) = 12{,}44 \quad (3)$$

$$U_H = 0{,}503 * C_U \quad (4)$$

CTE

$$U_H = \frac{\sum_{i=0}^{i=n}(A_i * U_i)}{\sum_{i=0}^{i=n} A_i} \quad (5)$$

$$\sum_{i=0}^{i=n} A_i = 24{,}75 \quad (6)$$

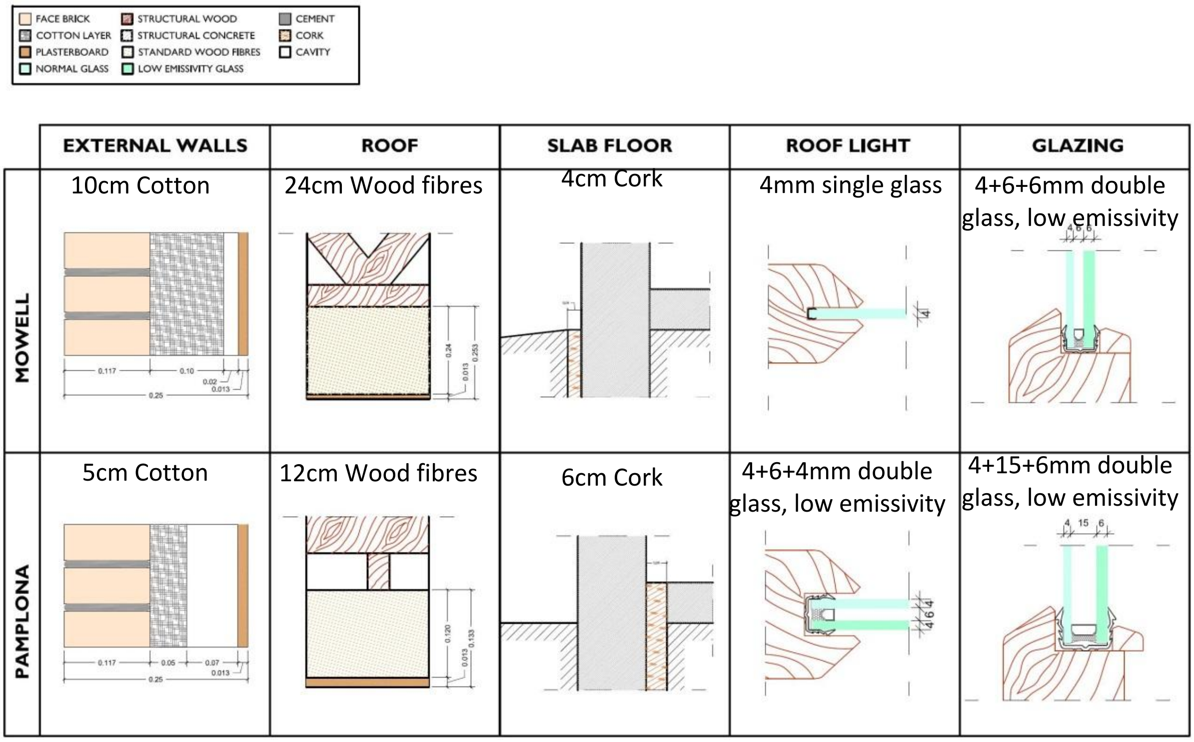
Table 5 present in bold letters the strictest values:

Table 5: Comparison of thermal limitations

	BCA – Part 3.12	**CTE DB-HE1**	
		Original units	**Unit conversion**
Roofs	Total R-value ≥ 5.1 m^2K/W	U-value ≤ 0.49 W/m^2K	R-value ≥ 2,04 m^2K/W
Roof lights	SHGC ≤ 0.72 Total U-value ≤ 5.7 W/m^2K	$F_{L\ luc}$ = 0.36 $U_{rl\ max}$ = 3,5 W/m^2K	SHGC ≤ 0.568
External walls	R-value ≥ 2.8 m^2K/W	U-value ≤ 0.86 W/m^2K	R-value ≥ 1,16 m^2K/W
Floors	Total R-value ≥ 2.176 m^2K/W	U-value ≤ 0.64 W/m^2K	R-value ≥ 1,56 m^2K/W

The constructive solutions selected as results of the study, using natural insulation, are summarized graphically in the Figure 9.

Figure 9: Constructive solutions selected for the building thermal envelope.



Analyzing the results of the case study, requirements for opaque thermal envelope elements are more restrictive in BCA, while for glazing and transparent parts of the thermal envelope, CTE is more restrictive. CTE limits more the conditions because takes into consideration the solar orientation of the facades, whereas that BCA limitations are only based on climate zone, air movement type and floor typology.

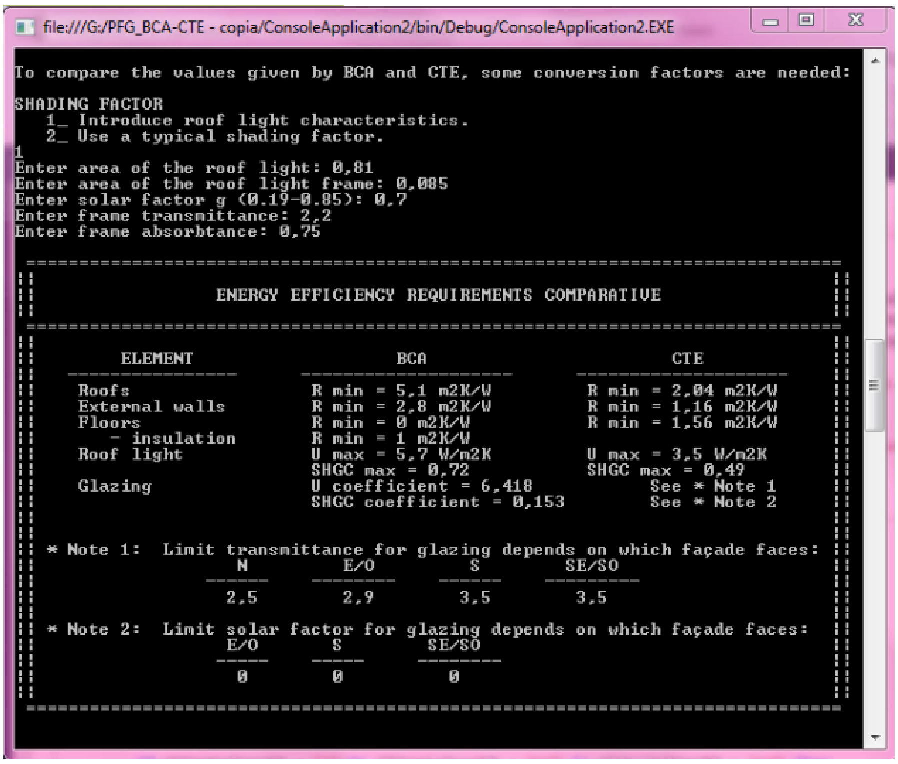
However, CTE in Spain also introduces the concept of U_{lim} for each thermal envelope element, that should be accomplished and it is always more restrictive than U_{max} values, which refers to each independent element of the thermal envelope. Then, for some specific cases CTE could become more restrictive.

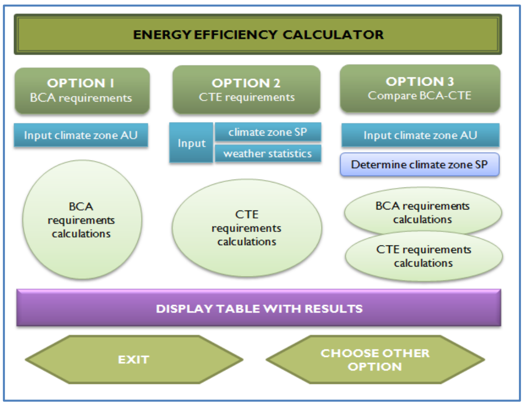
It also worth noting that BCA considers, in most of cases, more factors to determine the minimum R-values while for CTE just considers the relative climate zone. Some of the reasons which could explain BCA higher restrictions could be the extremer climate (due to the natural disasters, extreme weather, etc.), dwelling typical typologies and its specific legislation for each building type.

6. Software

All the methodology presented to achieve this comparison between the BCA and CTE have been automated by creating a software based on Visual Basic programming language. This tool allows the users to check the requirements for any city. Figure 10 shows the interface of the software.

Figure 10: Visual Basic program scheme functionality and appearance.





7. Conclusions

The study presented in this paper allowed comparing the requirements of the Spanish and Australian regulations, CTE (Código Técnico de la Edificación) and BCA (Building Code of Australia) respectively, concerning energy efficiency. The BCA was analyzed in detail, studying the structure and finding the correlation of the sections with the CTE. In some cases, some aspects included in BCA are not directly found in CTE and, therefore, it was necessary to resort to other regulations, such as the RITE. The building classification according the usages and the climatic zones are also compared between both countries. The usages of Australian buildings are more divided, finding then, more building types.

To illustrate the comparison, a detached house has been analyzed through the implementation of energy requirements for both building codes, providing constructive solutions using natural insulation. The major interest of the comparison lies in the findings, which show that while BCA is more restrictive for opaque thermal elements than CTE, CTE is more restrictive for glazing and transparent parts of the envelope.

Nevertheless, CTE not only work through a maximum U-value/R-value for each independent element typology of the thermal envelope, as for BCA, but also requires accomplishing U_{lim} for groups of elements which take part in the same constructive element of the envelope, introducing then more restrictive values than BCA in some elements.

In conclusion, this case study enabled identifying the main points which present the most notable differences and which regulation is more restrictive in each aspect.

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