



Short communication

Assessment of Portuguese thermal building legislation in an energetic and environmental perspective

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ABSTRACT

The aim of this study is to assess the consistency of Portuguese thermal building legislation in terms of energy and environmental performance.

To illustrate this, a case study has been carried out for different scenarios of a dwelling home located in an extreme climate zone (I3, V1 north) in Portugal with a T3 typology: four occupants and net floor area of 150 m², modelled according to Regulation Thermal Performance Characteristics of Buildings and a Life Cycle Assessment approach.

The results show that the Portuguese thermal building legislation can be considered consistent in terms of energy efficiency and environmental performance if we take the damage categories into account – “human health” or “ecosystem quality” or the impact category – “emission into air”. It cannot be considered consistent if we take the damage category into account – “resources” or the impact category – “CO₂ eq” (equivalent carbon dioxide emissions)/“climate change”/“global warming”.

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1. Introduction

In 2008 in Portugal, the share of final energy consumption in the main sectors of economic activity was 16.8% in domestic and 11.5% in services [1]. In the domestic sector, there was a decrease in electricity consumption per unit of accommodation (2510 kW h/accommodation in 2008 compared to 2611 kW h/accommodation in 2007), with buildings in 2006 representing 62% of electricity consumption. According to the same source, electricity consumption in houses for heating purposes represented 15% of total consumption [1]. Worldwide, 30–40% of all primary energy is used for buildings which are also responsible for 40–50% of green house gas emissions [2].

Despite the fact that energy intensity in recent years has reversed in Portugal, the value of 181.53 kgoe/10³ EUR of GDP reached in 2008 remains well above the European (EU15) average of 149.98 kgoe/10³ EUR of GDP [3].

Under the Kyoto Protocol and in conjunction with the commitments of the European Union, Portugal has also assumed responsibilities for controlling Greenhouse Gas Emissions (GGE), but in 2008 total GGE (in CO₂ equivalent) had increased by 32.2% compared to 1990 which contrasts with the 27% assumed for the period 2008–2012 [3].

In the period 1995–2006 GHG emissions grew the most in the construction sector (nearly 60%); however, its reduced weight in

the economy (only 3.8% in 2006) mitigates much of its contribution to overall growth of these emissions [4].

Recently, Portugal has shown a great willingness to meet its commitments on emission control (GGE), since in recent years the share of Renewal Energy Sources (RES) in gross electricity consumption for the purposes of Directive 2001/77/EC was 45% in 2009 and total production of electricity from renewable sources increased by 59% from January to November 2010 compared to the same period in 2009 [5].

By DL 78/2006 (SCE) “National System for Energy and Indoor Air Quality Certification of Buildings” [6] and DL 80/2006 (RCCTE) “Regulation Thermal Performance Characteristics of Buildings” [7], Portugal transposed Directive No. 2002/91/EC [8] of the European Parliament and Council of 16 December on the Energy Performance of Buildings (EPBD). The purpose of the (SCE) is to certify the energy performance and indoor air quality in buildings. Its management was entrusted to the Energy Agency (ADENE), which approved the energy performance and indoor air quality in buildings certificate model, wherein the energy performance label is divided into nine classes (from A+ to G) [9] as shown in Fig. 1.

According to the energy classification adopted by the SCE and represented in Fig. 1 the most efficient building (class A+) may consume less than 1/4 of the energy consumed by a “reference building”¹ while the least efficient (class G), can consume more

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¹ “Reference building” – is a building where N_{tc} (nominal needs of global primary energy) = N_t (maximum allowable primary energy).

Energy class	Ntc/Nt
A+	≤ 0.25
A	>0.25-0.5
B	>0.5-0.75
B-	>0.75-1
Reference Consumption	
C	>1-1.5
D	>1.5-2
E	>2-2.5
F	>2.5-3
G	> 3

Fig. 1. Portuguese building energy certification scheme.

Adapted from [9].

than 300% of that. The energy label is based on calculations in terms of primary energy, and nominal CO₂ emissions are also listed on front page of the Energy Performance Certificate (EPC). In some Member States both calculated and measured energy performance ratings are used, depending on building typology and age [10].

In 2008, approximately 90% of new buildings/dwellings started the process of energy certification. Almost half (45%) of all new buildings/dwellings were certified class A followed by class B (28%), class A⁺ (14%) and class B⁻ (12%). Almost three quarters of existing buildings/dwellings have been certified: class B (29%), B⁻ (11%) and C (32%) [9].

Portugal must evaluate its national requirements for the energy performance of new buildings by 2011 [8] and ensure that by 31 December 2020, all new buildings are nearly zero-energy buildings (NZEB) [11]. Following the cost-optimality principle of the directive, “nearly net zero energy” building definition was proposed by REHVA Task Force [12], as “national cost optimal energy use of >0 kWh/(m² year) primary energy”. The “nearly-zero energy” requirement in the new EPBD should help to move faster towards a more renewable and other energy-efficient solutions (urban networks, heat pumps, etc.) [13].

According to Maldonado [13] and Paulo Santos et al. [14] even with excellent “zero-energy” new buildings from now on, the building sector will continue to be inefficient if nothing is done to improve a large number of existing buildings.

In order to accommodate the requirements of the recast of the EPBD in 2010 and to improve the certification process, the revision process of the current legislation in Portugal has recently been launched, based on the experience gained over the last 3 years [14]. In that report, an overview of the current status of implementation and of the plans for the evolution of the implementation of the EPBD in Portugal is presented.

Many new targets and measures were introduced recently [15]: Roadmap for moving to a competitive low-carbon economy in 2050 – Energy Efficiency Plan 2011, 20% EE reduction will correspond to 25% reduction in CO₂ by 2020 and a crucial role of the building sector where the emissions could be reduced by 90% by 2050.

With this study the authors intend to assess the consistency of Portuguese building regulations (RCCTE) and (SCE) in terms of energy efficiency and environmental performance when applied to a dwelling home located in an extreme climate zone (I3, V1 norte) in Portugal – Manteigas, in the north-central region.

2. Case study

To evaluate the Portuguese legislation the dwelling home which we intended to study was a T3 typology: four occupants, a net floor

Table 1
Parametric variations according to Portuguese legislation (RCCTE).

Parameters	Possible solutions
Energy source and heating system efficiency	Electric resistor ($\eta_i = 1$); gas fuel boiler ($\eta_i = 0.87$); liquid fuel boiler ($\eta_i = 0.8$); solid fuel boiler ($\eta_i = 0.6$); heating pump (heating) ($\eta_i = 4$)
Energy source and cooling system efficiency	Heating pump (cooling) ($\eta_v = 3$); refrigerating machine (compression cycle) ($\eta_v = 3$); refrigerating machine (absorption cycle) ($\eta_v = 0.8$)
Energy source and DHW system efficiency	Electric heater with accumulation with at least 100 mm insulation ($\eta_a = 0.95$); electric heater with accumulation with 50–100 mm insulation ($\eta_a = 0.90$); electric heater with accumulation with less than 50 mm insulation ($\eta_a = 0.80$); gas heater with accumulation with at least 100 mm insulation ($\eta_a = 0.80$); gas heater with accumulation and 50–100 mm insulation ($\eta_a = 0.75$); gas heater with accumulation with less than 50 mm insulation ($\eta_a = 0.70$); gas wall boiler with accumulation and at least 100 mm insulation ($\eta_a = 0.87$); gas wall boiler with accumulation and 50–100 mm insulation ($\eta_a = 0.82$); gas wall boiler with accumulation and less than 50 mm insulation ($\eta_a = 0.65$); gas heater ($\eta_a = 0.5$)

area of 150 m² and shape factor (FF = 1), located in Manteigas, considered an extreme climatic zone in Portugal, i.e. the municipality with the greatest demand for heating in winter (I3) (3000 °C day) and lowest demand for cooling in summer (V1-north).

All the possible combinations of dwelling home heating, cooling and domestic heat water (DHW) conventional systems, were studied as shown in Table 1, which ensured the same indoor conditions required by the building regulation (RCCTE): indoor air temperature of 20 °C for the heating season and 25 °C and 50% relative humidity for the cooling season, consumption of 40 L of hot water at 60 °C per person per day for 365 days/year. Solar thermal collector systems (or other forms of renewable energy) for DHW were not considered.

3. Methodology

There is consistency in Portuguese building regulations (RCCTE) if the best and worst case scenarios of the dwelling home studied in terms of energy corresponds respectively to the best and worst case scenarios in terms of environmental performance.

To compare the various dwelling home scenarios from the perspective energy consumption, we used the models proposed in the Portuguese legislation, RCCTE and SCE. It was assumed that the nominal values of the net energy need for heating (N_{ic}) and cooling (N_{vc}) were met by conventional systems specified in the RCCTE and equal to the threshold values, i.e. (N_{ic} = N_i) and (N_{vc} = N_v), thus ensuring equal thermal comfort in the various scenarios. The net energy need for hot water (N_{ac}) was met by conventional systems using the model:

$$N_{ac} = \frac{Q_a}{\eta_a \cdot A_p} = M_{AQs} \cdot 4187 \cdot \Delta T \cdot \frac{n_d}{3,600,000 \cdot \eta_a \cdot A_p}$$

$$N_{ac} = \frac{20.38}{\eta_a} \text{ (kW h/m}^2 \text{ year) for this study}$$

where η_a is the net efficiency of DHW system.

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