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**Article**

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Energy Reports

**Provided in Cooperation with:**

Elsevier

*Suggested Citation:* Vaquero, Petra (2020) : Buildings Energy Certification System in Portugal: Ten years later, Energy Reports, ISSN 2352-4847, Elsevier, Amsterdam, Vol. 6, Iss. 1, pp. 541-547,  
<https://doi.org/10.1016/j.egyr.2019.09.023>

This Version is available at:

<https://hdl.handle.net/10419/243785>

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6th International Conference on Energy and Environment Research, ICEER 2019, 22–25 July,  
University of Aveiro, Portugal

# Buildings Energy Certification System in Portugal: Ten years later

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Received 24 July 2019; accepted 12 September 2019

Available online 25 September 2019

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## Abstract

Buildings Energy Certification System (SCE) was implemented in Portugal through the publication of the Decree-Law 78/2006 and due to the adjustment of national legislation imposed by EPBD 2002. Thus, since January 1, 2009 all residential and service buildings, new, refurbished or existing must have an Energy Certificate in any construction, purchase or lease process. During the last 10 years, and not only due to EPBD recast that occur in 2010, the legislation has undergone dozens of changes, interpretations and corrections being important to realize their impact on the main indicators of buildings energy efficiency. Through the application of the three calculation methodologies, adopted by SCE in these 10 years, to a single-family house that was certified in 2009, it was possible to verify that the main indicators of energy efficiency have changed drastically. © 2019 Published by Elsevier Ltd. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

Peer-review under responsibility of the scientific committee of the 6th International Conference on Energy and Environment Research, ICEER 2019.

*Keywords:* Energy efficiency; Energy certification; Buildings regulation; EPBD; SCE

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## 1. Introduction

In Portugal, the concern with energy consumption in buildings began in the early 90 s when Thermal Performance Building (RCCTE) and Air-Conditioning Energy Systems Codes (RSECE), were published [1]. Buildings Energy Certification System (SCE) was implemented through the publication of the Decree-Law (DL) 78/2006 [2] and, due to the obligation of adjust the national legislation imposed by Energy Performance in Buildings Directive (EPBD), published in 2002, [3], were approved the DL 79/2006 [4] and DL 80/2006 [5] that established the energy efficiency rules to which new and refurbished buildings must comply and the calculation methodologies to achieve several energy efficiency indicators and the energy efficiency class. These two Decrees-Law, RCCTE and RSECE, were the result of the actualization of the buildings regulation already existing in Portugal, as shown in Fig. 1.

Since 2006, there were numerous changes to those decrees arising from clarifications provided by the management entity [6], rectifications to the legislation itself and, in December 2013, a major change resulting from the transposition of EPBD's recast [7] to the national law, through the approval of DL 118/2013 [8].

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<https://doi.org/10.1016/j.egy.2019.09.023>

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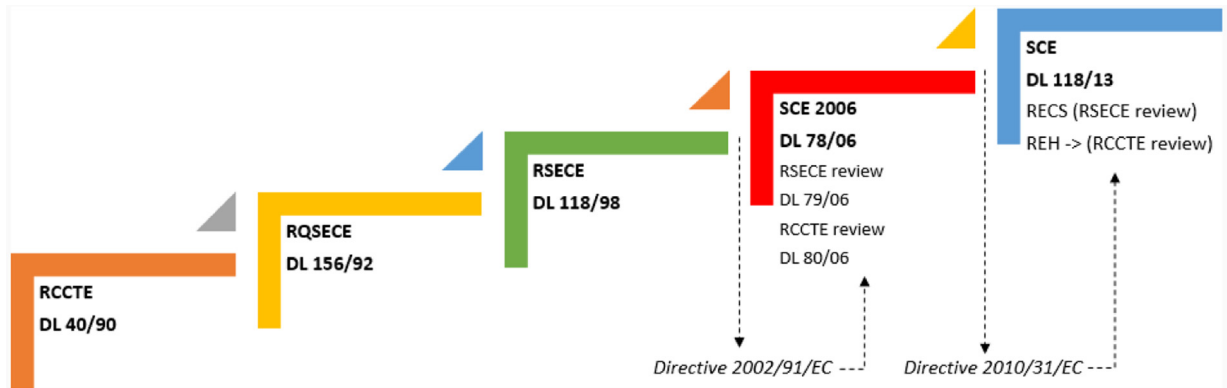


Fig. 1. Evolution of energy efficiency regulations in Portugal.

### 1.1. EPBD 2002 to national law

EPBD 2002 established that the Member States of the European Union had to implement an energy certification system in order to, among other objectives, inform the citizens about the thermal quality of buildings when constructing, selling or renting them. The EPBD also states that this certification system should cover all residential and service buildings, public or private. The transposition into national law was carried out through a legislative package as schematically presented in Fig. 2.

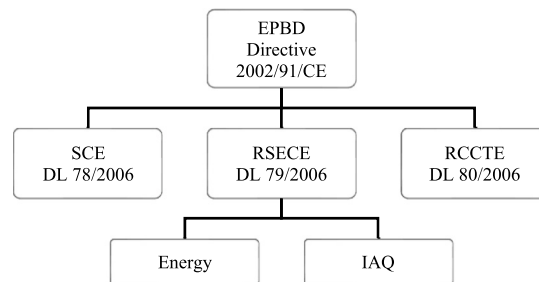


Fig. 2. Transposition of the EPBD 2002 into national law.

The entry into force of these three decrees completely transformed the energy efficiency industry in Portugal. In new buildings or buildings subject to major refurbishments, there has been an effective application of requirements in the opaque and glazed envelope, HVAC systems were analyzed in what comes to dimensioning, characteristics, installation and maintenance and, additionally, requirements for Indoor Air Quality (IAQ) through the mandatory introduction of fresh air into the occupied spaces. Through the Qualified Expert, an SCE technician trained and recognized by ADENE, the entity managing the system, there was a verification of the compliance with the regulations in the project execution phase, as attested by the Regulatory Compliance Statement (DCR), and at the end of the building construction, proven by the Energy Certificate and the IAQ (CE).

In RCCTE, applicable to residential buildings and small service buildings with HVAC systems under 25 kW, the calculation methodology was based on the EN ISO 13790, making the adaptations allowed by this standard to fit the reality of Portuguese construction. The building or fraction was treated as a single zone maintained, permanently, at the same reference temperature (20–25°C). It was a seasonal calculation made on reference climatic data and assuming that, contrary to what is the Portuguese reality, the dwelling was always heated or cooled [9]. The results obtained by this methodology allowed to “test” the constructive characteristics and compare buildings among themselves, though they are quite different of the real energy consumption.

In RSECE, valid to residential buildings and small service buildings HVAC systems higher 25 kW and large service buildings (GES), the calculation methodology was based on hourly dynamic simulation. For small services

there was a simplified monozone simulation tool and in GES, simulation should be performed using a software compliant with ASHRAE 140-2004. Here too, the buildings were placed under nominal conditions of operation in terms of air conditioning systems, occupation, use of lighting or equipment's within the building. Once again, the results obtained in terms of energy consumption have nothing to do with the reality of the building although in the existing GES the dynamic simulation model is calibrated based on energy audits and invoice analysis.

For the existing buildings, there were established rules for situations where it was not possible to verify the real characteristics of a building element, for instance, the wall or roof composition. Additionally, and, only for the large service buildings, energy and IAQ audits were mandatory with a periodicity of 6 years. Note that, the inclusion of the IAQ component associated with the Energy Certification process was a national initiative. Since energy performance and IAQ are interconnected by HVAC systems, SCE intended to capitalize synergies and consolidate inspections, audits and certifications into a single coherent system.

The energy certificate was the end of methodologies application imposed by these two regulations which always placed the buildings in standard operating conditions. The energy label (9 levels from A+ to G) obtained came from the combination of several characteristics of the building, such as envelope behavior, solar orientation, lighting, HVAC systems, water heating, among others.

### 1.2. EPBD 2010 to national law

The European Union, with new energy and environmental targets set for 2020, publishes on 19 May 2010, the EPBD's recast [7] which has been transposed into national law through DL 118/2013, on August 20, 2013 [8].

In Portugal, associated to DL 118/2013, several ordinances and normative orders were published, shifting the structure of the legislation in this area, but simplifying the changes that have been implemented in recent years. This new decree also includes (Fig. 3) the amendments to RCCTE, which is renamed REH — Regulation of Energy Performance of Residential Buildings and to RSECE, which is renamed RECS — Regulation of Energy Performance of Trade and Services Buildings. REH, contrary to what happened with the RCCTE, is only applied to residential buildings and RECS only to services buildings, regardless of their area or installed power of air conditioning.

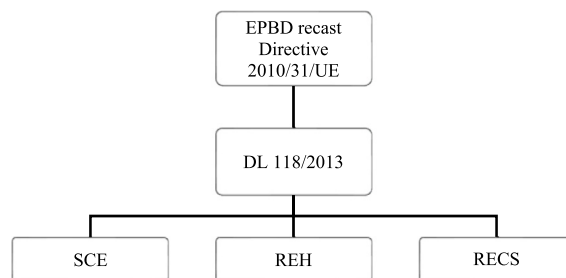


Fig. 3. Transposition of the EPBD 2010 (recast) into national law.

One of the first major amendments introduced by the transposition of the new directive was the dissolution of the obligation to carry out periodic audits of the IAQ in the GES during the Energy Certification process. From 2009 to 2013, hundreds of audits were carried out on public and private buildings and, as a rule, the problems detected were serious and their resolution would carry large investments to the public purse as it would be necessary to install or reformulate existing ventilation systems. Following the transposition of the EPBD 2010, these audits were withdrawn from the scope of SCE, reducing them to inspections to be performed by public institutions. Some consequences of this decision are being reported in the numerous cases of Legionella and bacteriological contaminations in several Portuguese buildings.

With the new decree, there are only 8 energy classes (A + to F) and there is an obligation to exhibit the energy certificate in all non-residential buildings with areas greater than 500 m<sup>2</sup> or, as of July 1, 2015, areas greater than 250 m<sup>2</sup> and the obligation to certify all public buildings with areas over 500 m<sup>2</sup> and, as of July 1, 2015, with areas greater than 250 m<sup>2</sup>. In addition, any residential or service building that initiates a process or intention to sell or lease must have a valid Energy Certificate and indicate the energy class in the advertisement.

Regarding the requirements to be applied in the building envelope and HVAC systems, they become more demanding than in SCE 2006. Additionally, they were introduced requirements to interior lighting systems, lifting equipment and management systems.

In residential buildings, the seasonal calculation was maintained and the permanent climatization maintained but the required temperature interval was changed (18–25 °C). However, there were adjustments in the determination of several parameters, simplification in the accounting of linear thermal bridges and, of great impact in the calculation process, the decrease of HVAC weight in the obtained energy class.

In service buildings, nominal profiles were replaced by real profiles which could have been an opportunity to near the energy consumption announced in the Energy Certificate to actual consumption, but the operation of the HVAC systems remained under nominal conditions distorting the obtained results.

As of January 1, 2016, according to what DL 118/2013 provided, the requirements to be fulfilled were altered [10], which gave rise to a change in the calculation parameters of the energy classes. This new SCE moment was designated as Roadmap 2016 replacing what was in effect between December 1, 2013 and December 31, 2015, Roadmap 2013.

The reviews to which SCE was subject have given rise to three major moments in terms of the calculation methodology and requirements to fulfill: SCE 2006, Roadmap 2013 and Roadmap 2016.

If you are going to certificate a building today, it is therefore necessary to define what type of building is under analysis which is summarized in Table 1.

**Table 1.** Regulatory and methodological framework for buildings under the SCE.

New building Roadmap 2016	New building Roadmap 2013	New building SCE 2006	Existing building
Architectural design after December 31, 2015.	Architectural design between December 1, 2013 and December 31, 2015.	Architectural design between July 4, 2006 and November 30, 2013.	Architectural design prior to July 3, 2006.
Must comply with the requirements of the DL 118/2013 with all the changes that have been published since December 31, 2015.	Must comply with the requirements that were in force at that date, that is, DL 118/2013 with all the amendments that have been published until December 31, 2015.	Must comply with the requirements that were in force at that date, that is, DL 79/2006 or DL 80/2006, as applicable.	It does not have any type of requirement to fulfill unless it is subject to an intervention.
Will be classified considering the calculation methodology of Roadmap 2016.	Will be classified considering the calculation methodology of Roadmap 2013.	Will be classified considering the calculation methodology of Roadmap 2016.	Will be classified considering the calculation methodology of Roadmap 2016.

It should be noted that, consequently, there is a set of buildings, those of Roadmap 2013, which, if certified today, will adopt a calculation methodology different from that adopted by all the others. This was the option taken to prevent that new buildings, after the entry into force of the legislation resulting from the EPBD 2010, obtain a class below B — (minimum class for new buildings). However, it distorts one of the major objectives of the Energy Certification: “Inform consumers about the thermal quality of the product, allowing objective comparisons between various offers and cost-benefit assessments”. As the calculation basis will be distinct between a building of Roadmap 2013 and one of Roadmap 2016 and, despite being data provided in the Energy Certificate, the consumer does not have enough information or knowledge to understand its scope.

The last major change occurred in May 2017 with the mandatory accounting, in energy certificates, of the contribution of renewable energy obtained from heat pump systems. Although this accounting has no impact on the energy class, it significantly changes the share of renewable energy in a building, with a direct and relevant impact on the fulfillment of the Europe 2020 strategy targets: a 20% reduction in GHG emissions, a 20% increase in the share of renewable energy in final energy consumption and a 20% reduction in total EU primary energy consumption (all compared with 1990).

## 2. Methodology

In this brief description it is possible to confirm that the SCE is not static and has been adapted, transformed and changed over time. In order to carry out the calculation resulting from the application of the SCE 2006 methodology,

a software developed by LNEG [11] will be used. For the application of the methodologies of Roadmap 2013 and Roadmap 2016, a calculation tool, PTnZEB [12], currently used by the Qualified Experts will be considered.

Using a single-family house, built and certified in 2009, the three methods will be applied and indicators, such as energy needs, final and primary energy consumption, CO<sub>2</sub> emissions and share of renewable energy, will be evaluated. It is important to note that no changes were made to the building or its systems.

The single-family house is in Vila Nova de Gaia, it has four floors, five rooms, a floor area of 417 m<sup>2</sup>, average height of 2.6 m and average inertia. The main entrance of the building is facing south. The building has a VRF system with external air exchange and a heating and cooling power of 25 kW and 22.4 kW, respectively, with a COP of 3.63 and an EER of 3.21. The production of sanitary hot water (SHW) is carried out by a forced circulation solar water heating system with a surface area of 6.8 m<sup>2</sup> supported by a natural gas boiler in 90% efficiency.

### 3. Results and discussion

By applying the three calculation methodologies, it is concluded that, as expected, the energy class of the building deteriorates over the 10 years that have passed over its construction, from A to B.

However, the main energy efficiency indicators changed, over the years, without consistency. The certificate issued in January 2009 showed that the useful energy needs were 42% higher as those resulting from the current methodology (Fig. 4), final energy consumption was 37% higher than the same building certified in 2013 which, in turn, are 52% lower than those resulting from the methodology to be applied since 2016 (Fig. 4).

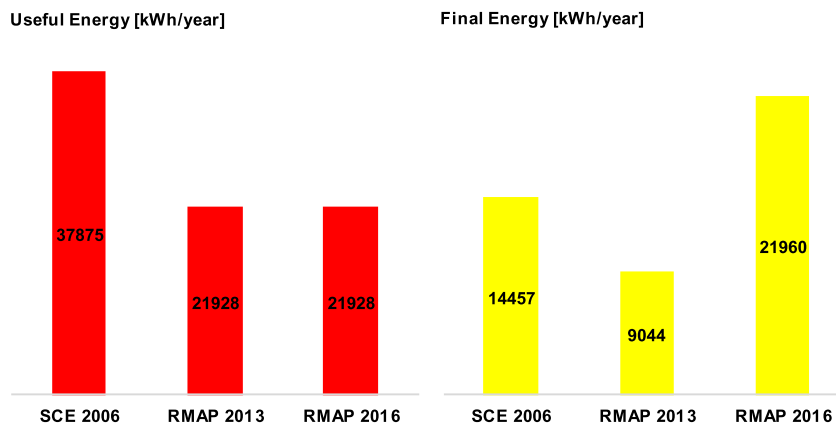


Fig. 4. Evolution of useful (left) and final (right) energy due to changes in methodologies.

In what comes to primary energy use, the results show that in SCE 2006 the consumption is 40% higher than in Roadmap 2013 which, in turn, is 75% lower than those resulting from Roadmap 2016 (Fig. 5). CO<sub>2</sub> emissions have quadrupled (Fig. 5) between 2006 and 2013, clearly contradicting the reduction of primary energy. Finally, with the accounting for the share of renewable energy from heat pump equipment, the renewable energy contribution of this building has gone from Roadmap 2013 to 2016, from 36% to 74% (Fig. 5).

The reason for these changes is due to the difference in calculation methodology, but it is not consistent. The same building, in the same location, with the same technical and constructive characteristics should not have a variation in useful, final and primary energy consumption and CO<sub>2</sub> emissions. Although there is an obviously deterioration of the building elements and the characteristics of the equipment, these parameters are not counted in the calculation and are not reflected here.

As for CO<sub>2</sub> emissions, which quadrupled from SCE 2006 to Roadmap 2013, it is not understandable how a reduction of primary energy matches to an increase in emissions of this greenhouse gas. One reason for these results is possibly due to the change in the primary energy conversion factors for CO<sub>2</sub> emissions, concluding that they were either being poorly accounted for in 2006 or are now overvalued. In fact, in 2006, CO<sub>2</sub> emissions were accounted with a unique conversion factor not having a concern with the type of energy being used and, in 2013, they were imposed different factors for the conversion depending on the type of energy source. This, as showed, has a great impact in the obtained results.

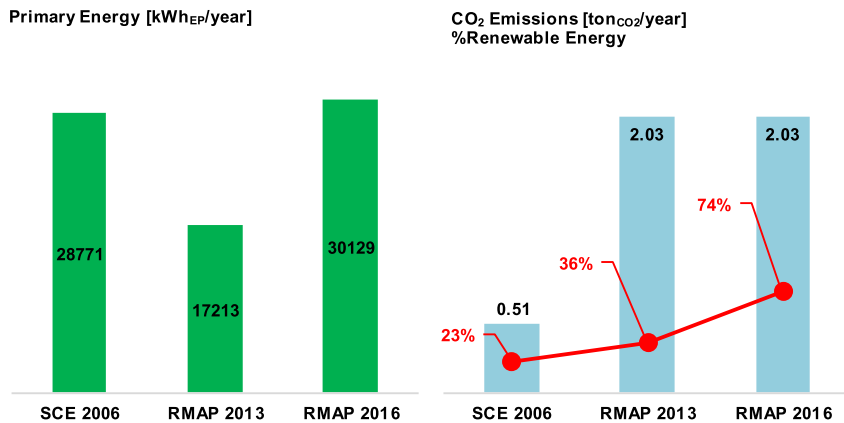


Fig. 5. Evolution of primary energy use (left) and CO<sub>2</sub> emissions / %Renewable Energy (right).

Finally, renewable energy in the building. Note that nothing has changed, and the solar thermal system has remained in the building with the same annual energy capture. From 2006 to 2013, the change is due only to the reduction of useful energy needs which made the contribution of the thermal solar system to the total consumption of the building increase. But, between 2013 and 2016, the energy consumption by type of use has remained stable so, this difference is only due to the inclusion of the share of renewable energy coming from the HVAC system. This contribution does not interfere with the energy class of the building but increases its contribution to the fulfillment of the objectives of the Europe 2020 strategy as outlined above.

#### 4. Conclusion

Buildings Energy Certification System was implemented through the publication of the DL 78/2006 and, it is mandatory, as of January 1, 2009, in all, new or existing, residential and service buildings.

After 10 years and around 1.250.000 certificates issued [6], it is time to evaluate all the changes to which SCE was subject and what their impact on buildings performance. Common sense will say that a building certified in 2009 should now have a lower energy class, but with all the initial constructive characteristics and the same technical equipment, its energy consumption should remain unchanged. However, as demonstrated by the application of the three calculation methodologies that SCE had adopted over the years, the main energy efficiency indicators have changed without coherence.

Results showed that a certificate issued in 2009 had a final energy consumption 37% higher than the same building certified in 2013 which, in turn, are 52% lower than those resulting from the methodology to be applied since 2016. A similar situation occurred for primary energy, but CO<sub>2</sub> emissions quadrupled, clearly offsetting the reduction of primary energy. Finally, with the accounting for the share of renewable energy from heat pump equipment, the renewable energy contribution has gone, from Roadmap 2013 to 2016, from 36% to 74%.

These results will cause confusion about the real energy performance of buildings. Ten years have passed, and the first Energy Certificates issued are about to lapse. Its renewal will show inconsistencies in the changes that have been implemented and discredit SCE.

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