Survey of sustainable approaches in Portugal

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1 NATIONAL PERSPECTIVE OVERVIEW

In Portugal Sustainable Construction has long being recognized as an important goal, although only few objective actions have been implemented over the last years. However, given the emphasis of the European Community on the issue and the mandatory adoption of European Directives in Member countries, in the next years, it is expected that initiatives towards the effective application of the principles of Sustainable Construction will gain a major importance in the construction sector.

Nevertheless, the competitiveness in the construction sector has been forcing stakeholders to take actions in order to prove their awareness of the problem and to show their responsibility in terms of social, economic and environmental aspects. This can be seen by the increasing demand for certifications by the construction and real estate sectors. Also, construction materials manufacturers are aware of the importance of promoting the green credits of their products, and the use of green labels and EDPs is becoming more and more popular.

A few national initiatives are being developed in the country in order to promote the principles of sustainable construction. Some of these actions are described in the next paragraphs:

- Centro HABITAT – *Plataforma para a construção sustentável* (http://www.centrohabitat.net/apresentacao.htm)

Centro Habitat is an innovation platform for sustainable construction, created in 2007. This platform is based on a network of R&D centres, local authorities and companies related with the Habitat cluster, with the main goal being the concentration of resources in order to socially and economically value the knowledge, seeking to state an expertise on sustainable construction. Among other aims are:

- Production of know-how associated to the sustainability of the built environment
- Dissemination of knowledge through specialized formation actions
- Maintenance of a information system oriented towards sustainable construction
- Detection and management of innovation opportunities for the members
- Promotion of innovation projects and integration in the Habitat cluster
- Promotion of a set of recommendations related to construction sustainability in the habitat cluster

- iiSBE Portugal – *Iniciativa Internacional para a Sustentabilidade do Ambiente Construído* (http://www.iisbeportugal.org)

iiSBE Portugal is a non profit organization, created in 2007, that represents at national level the mission of the *International Initiative for a Sustainable a Built Environment* (iiSBE). In or-

der to promote and disseminate the aims of Sustainable Construction, the following actions are foreseen:

- To teach qualified experts in Sustainable Construction Assessment (SCA)
- To adapt SBTool to Portuguese background;
- To certify buildings in terms of sustainability;
- To be a national Forum regarding sustainable construction initiatives that are being developed in several regional and local entities involved in the sustainable construction;
- To promote and be represented in normative and legislative initiatives

2 METHODOLOGIES AND TOOLS

Life Cycle Analysis (LCA) is not part of current practice for most architects and engineers. The advantages and importance of LCA are being recognized but yet its use is still very limited. Life cycle cost analysis are however more common, particularly by agencies that are responsible for the operation and maintenance of facilities for long periods of time (e.g. road authorities).

To give answer to the increasing demand for building certifications, tools for the sustainable assessment of the built environment are being developed. One of these tools is the *SBTool Portugal – Building Sustainability Assessment Tool* (SBtool^{PT}) (http://www.iisbeportugal.org).

The "SBtool^{PT}" building sustainability assessment methodology is a result of a research work from the University of Minho (DEC), with the main purpose to develop and propose a generic methodology to assess the sustainability of existing, new and refurbished buildings in urban areas, taking into account the Portuguese context.

As a first step, a methodology to assess the sustainability of residential buildings has been developed (SBTool^{PT}-H). The reason for this priority is the fact that most of the impacts related to the construction sector are related to the housing sector.

The following requirements were taken into account in the development of the SBTool^{PT}-H:

- A set of parameters wide enough to be meaningful and to comprise the most relevant building impacts, but at the same time limited enough to be feasible (fifty parameters at maximum);
- Whole building assessment, based upon the state-of-art methodologies, and considering ongoing standardization;
- Balancing between all different dimensions of sustainable development (environment, societal and economics);
- Limitation or exclusion of subjective and/or qualitative criteria that are hard to validate (e.g. aesthetics and technical innovation);
- Improved reliability through the use of accepted LCA methods for environmental performance;
- Assessment output and certification label that is easy for building users to interpret and understand, and enabling clients and designers to work with.
- Validation of the work by the development of a prototype tool and application on case study buildings.

The SBTool^{PT}-H is based in the international approach SBTool (http://www.iisbe.org), and in harmonization with CEN/TC350 draft standards "Sustainability of Construction Works – Assessment of Environmental Performance of Buildings". This methodology allows future rating and labeling of buildings, in analogy with the Energy Performance of Buildings Directive (EPBD).

In terms of outputs, the methodology adopted a similar approach to the one used in existing labeling schemes such as the EU energy labeling scheme for white goods and the European DisplayTM Campaign posters. The performance of a building is measured against each category, sustainable dimension and global score (sustainable score), and will be ranked on a scale from A to G. Where, A is the best score, G the worst score, and F the score of the conventional solution. Figure 1 represents the certificate of the SBTool^{PT}-H methodology for a hypothetical case study.

Figure 1. *SBTool^{PT}-H building sustainability certificate*

For SBTool^{PT}-H to be used as a rating system, validation by an independent third party is mandatory. When a formal certification is intended, the design team, or the project owner, has to submit to iiSBE Portugal the preliminary self-assessment results and design documentation. Then the project will be assessed and certified by an independent qualified expert in Building Sustainability Assessment (BSA). The building sustainability certificate is, at the end, issued both by iiSBE Portugal and iiSBE International. The certification process of a building is represented in Figure 2.

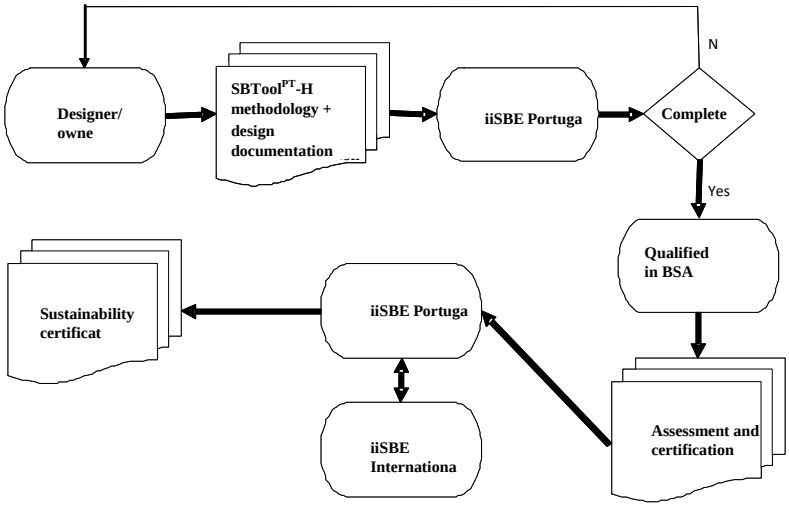

Figure 2. *Certification process of a building according to SBTool^{PT}-H*

This methodology is, currently, at the final stage of development and, until now, it has not being applied to a real case study. Therefore the consequences of its application in the Portuguese construction market are still unknown. Nevertheless the methodology is intended to foster the awareness of Portuguese stakeholders in the construction sector. Simultaneously, it will allow adequate policy implementation on sustainable construction, since it supports measures to-

wards the sustainable design and construction, through the definition of a list of objectives that are easily understandable by all intervenient in the construction sector and that are compatible with the Portuguese construction technology background.

Other examples of tools developed in Portugal are given below:

- LiderA Approach - Leadership by Environment (www.lidera.info), which is a voluntary rating system, based on LEEDs, but adapted according to national demands.
- EcoBlock (http://gasa.dcea.fct.unl.pt/ecoblock), which is a voluntary eco-label system for products or companies, based on a simplified life cycle analysis.

3 NATIONAL CODES AND LEGISLATION

Portugal has been adopting a series of measures to implement European directives related to Sustainable Construction into the national law. Most national codes and legislation, relevant to the sustainability of the construction sector, are derived from this process.

i) Energy regulation

In 2006, the Portuguese Government has adopted three Decrees that, together, constitute the transposition of the EPBD [1] into national law:

- Decree 78/2006 – It creates and defines the operational rules for the System for Energy and Indoor Air Quality Certification of Buildings (SCE);
- Decree 79/2006 – RSECE [2] – It establishes the new revision of the Regulations for HVAC systems, including requirements for regular inspection of boilers and air-conditioners;
- Decree 80/2006 – RCCTE [3] - It establishes the new revision of the Thermal Regulations for Buildings.

These new/reformulated regulations specify requirements for new buildings and major renovations, which became mandatory since 3 July 2006.

The main objectives of the SCE are:

- To assure that the buildings fulfil the requirements included in RCCTE and RSECE, related to energy efficiency, use of renewable energy systems, and the indoor environment conditions;
- To certify the energy performance and the indoor air quality in buildings;
- To identify the appropriate measures or necessary improvements to archive higher energy performance.

The RSECE defines hygienic and thermal comfort conditions. It enforces rules for the efficiency of HVAC systems, for its maintenance, and for the indoor air quality. The main objectives of RSECE are:

- To assure the thermal comfort and indoor air quality conditions in buildings;
- To limit the energy consumption in buildings (by determining the maximum limits);
- To assure the quality of HVAC equipment in buildings (design, installation and maintenance);
- To ensure the renovation of the energy certificate (the certificate has a validity of 10 years or 6 years in case of services buildings with a total net floor area over 1000 m^2).

The RSECE is applied in two different phases of the building life-cycle: design and operation. During the design phase, this law is used for the appropriate sizing of the HVAC equipment and to estimate the energy consumption. In the operation phase it is used to verify the estimated energy consumption. This regulation mainly concerns large buildings (net floor over 1000m^2) or buildings with centralized HVAC systems, with an installed power over 25kW.

Residential and service buildings with a net floor area lower than 1000m^2 and/or with a centralized air-conditioned system, with an installed power bellow 25kW, are covered by RCCTE. RCCTE is applied both to new buildings and large refurbishing works (cost of the works 25% higher than a new building with the same characteristics). Compared to the former one, this new regulation of the thermal behaviour of buildings, almost duplicated the thermal performance re-

quirements in both new and renovated buildings and imposed the use of solar collectors for hot water heating, whenever it is suitable their application.

The main objectives of the RCCTE are:

- To set the limits in the primary energy consumption per net square area of the buildings;
- To set the requirements for thermal comfort, during the heating and the cooling seasons as well as the minimum ventilation requirements in order to assure acceptable indoor air quality levels;
- To set the maximum U-value for all construction elements of the envelope;
- To impose the use of minimum shadow devices in all windows;
- To set the maximum energy consumption for sanitary hot water production, including the mandatory use of solar collectors for all buildings;
- To set the minimum quality and efficiency requirements to all cooling and heating systems (for non residential uses).

The energy certificate is aimed to inform the building's users, owners or potential buyers about the energy performance of the whole building or part of it (figure 3). Energy certification is compulsory to obtain the operation permit of new buildings, in case of major refurbishing operations, when a residential or service building is sold or rented (the maximum validity of the certificate is 10 years) and it should be renewed each 6 years in case of service buildings with a net floor are over 1000m^2.

The main content of the energy certificate (CE) is the Energy Performance Label. This label is divided in 9 energy classes. The energy class results from the ratio between the global annual calculated demand and the maximum allowed global annual primary energy demand for heating, cooling and hot water heating.

A+ is the best performance class and is followed by the A, B, B-, C, D, E, F and G (worst) classes. Besides that the energy certificate gathers other information such as: description of the building; energy improvement measures and new energy class if they are considered; and description of the characteristics of the building's envelopes and acclimatization systems.

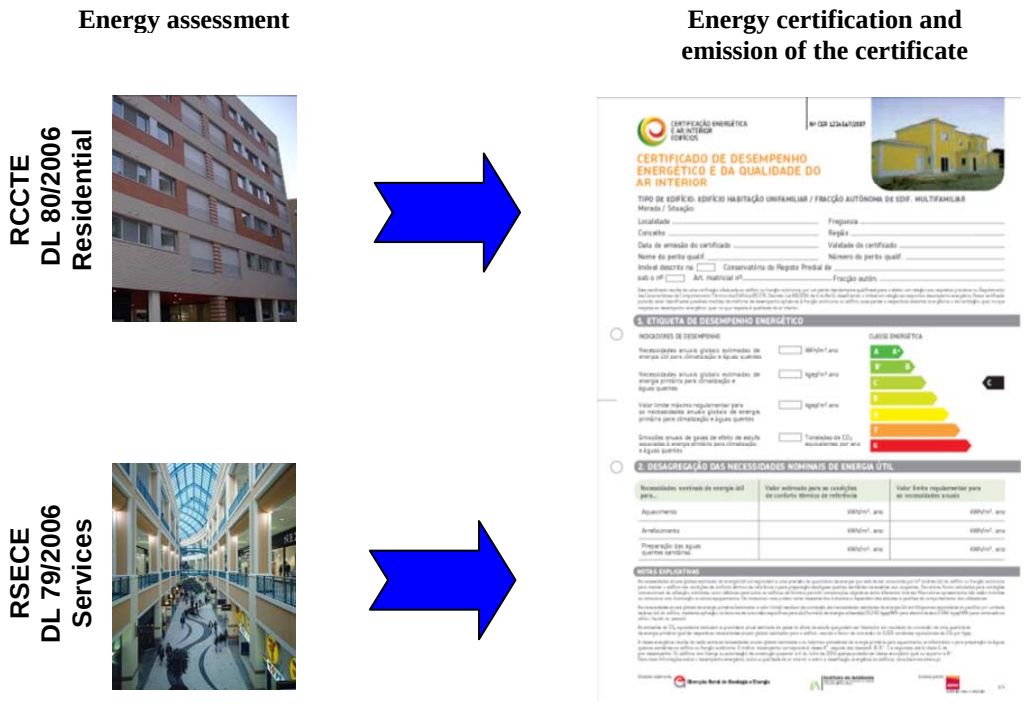

Figure 3. *Energy certification system in Portugal (Decree-Law 78/2006)*

Certification is mandatory for all new buildings requesting a use permit after mid 2007. For public buildings, a certification is needed from 1 January 2008 or 2009, depending on size.

Other buildings when rent or sold must have an energy performance certificate from 1 January 2009.

Inspections of boilers and air-conditioners are covered by RSECE and they shall become mandatory from the 1st January 2009. The procedures for inspection of boilers and air conditioning systems are still under discussion.

ii) Materials regulation

Currently many Portuguese construction products have the CE marking in conformity with European directives.

The CE marking signifies that the products are suitable for construction works and satisfy the following essential requirements (one, some or all of these requirements may apply):

- Mechanical resistance and stability
- Safety in case of fire
- Hygiene, health and the environment
- Safety in use
- Protection against noise
- Energy economy and heat retention

Such requirements must, subject to normal maintenance, be satisfied for an economically reasonable working life.

Besides the certification provided by the mark, products assigned with the EC mark must be allowed free movement and free use for their intended purpose throughout the European Community.

iii) Construction waste regulation

The transposition of the European Directive 2006/12/EC [4] to the Portuguese law, gave rise to the revision of previous legislation and to the creation of a new legislative framework, decree no. 178/2006 [5], for the general management of waste. The management of waste from construction and demolition has been done according to the general requirements in this law. However, the complex management of this kind of waste, very often, create problems in the application of current legislation. Therefore, in March 2008, decree no. 46/2008 [6] was published that introduces a legislative framework for the specific management of construction and demolition waste. Among others, a new mandatory requirement in this law specifies a previous selection of the construction and demolition waste before its deposition in landfills, thus promoting the recycling of waste and the minimization of waste in landfills.

iv) Green public procurement

Following the guidance from the European Commission, the Portuguese government wants to adopt, during the period 2008-2010, environmental and sustainable criteria into public procurement. The national strategy of green public procurement was approved in May 2007 by a resolution of the council of ministers [7]. This strategy identifies the construction of public works as a priority area for which public entities should start their political of green purchases.

The strategy defines general and specific criteria to support the implementation of green purchases and foresee the introduction of a new section regarding green purchases in the new code of public contracting.

General environmental criteria includes energy efficiency, reduction of greenhouse gases, prevention of pollutants' emissions, prevention in the production of waste, recycled content of products, minimization of environmental impacts and preservation of nature and biodiversity. However, no procedures are indicated for the quantification of those criteria.

As a global aim it is expected that by 2010, 50% of all public procurement will include environmental criteria in their tender proceedings.

4 ECO-LABELS AND EPDS

Following the European context of Integrated Product Policy, eco-labelling is being encouraged as a market tool in order to promote the trade of products with low environmental impacts and to stimulate consumer demand for greener products

International certification systems such as EMAS and ISO14001 are being achieved by companies and entities as part of their internal policies towards sustainable development. An example of a national certification system (voluntary) for the real estate sector was developed by the SGS Group Portugal (http://www.pt.sgs.com/pt/). Two systems were created: *DomusQual* and *DomusNatura*. While the first provides a certification in terms of the quality and conformity with technical requirements of the construction work, the second system provides a certification in terms of the sustainability of the construction (involving environmental aspects, energy efficiency, etc)

The most common eco-label in Portugal is the European Eco-label, which is regulated by "Regulamento (CE) no. 1980/2000".

The Portuguese Agency of Environment (http://www.apambiente.pt/) presents an eco-label, "Remade in Portugal", which aims to promote recycling of products. It is a voluntary label and can be applied to any product (except food and medical products) with a recycled content higher that 50%.

Currently, the development of EPDs is very limited, although, taking into consideration current policies, it is foreseen that the demand for EPDs will increase in the near future. One of few examples of Portuguese EPDs is a simplified EPD for concrete products developed in the framework of the European project "Stepwise EPD" by *CONCRETETOPE – Fábrica de betões, S.A.* in coorperation with INETI/CENDES [8].

The *Centro Tecnológico da Cerâmica e do Vidro* (CTCV) has also published some environmental data for benchmarking about the national production of ceramic bricks and tiles [9].

5 CASE STUDIES

5.1 *R&D Case studies*

5.1.1 *Sustainable Housing in Europe (SHE) – Portuguese Pilot Project*

The Portuguese Pilot Project was the second stage of the "Ponte da Pedra housing state" that was built in the municipality of Matosinhos, Northern Portugal. It is a multifamily social housing project, promoted by NORBICETA - *União de Cooperativas de Habitação, U.C.R.L.* This project comprehends two building blocks and 101 dwellings, with a footprint of 3105m^2 and a total gross area of 14.852 m^2. The construction phase of this project finished in the second half of 2006 and the total budget of the project was 9.216.160 €. It was co-sponsored by the European project SHE (http://www.she.coop/) and by the National Housing Institute (INH), and supported by FENACHE (national federation of social housing cooperatives), FEUP (Faculty of Engineering of the University of Porto) and UM (University of Minho). The design team was coordinated by the architect Carlos Coelho.

This project is providing a very good contribution towards the implementation of sustainable buildings in Portugal, as it is a very well disseminated project, and it is showing that it's possible to build a building with low environmental impacts, high comfort and low life-cycle costs, when compared to a conventional building. On the other hand, it is, currently, the only sustainable building that is recognized by internationally accepted building sustainability guidelines (SHE).

This project is the first sustainable social housing project in Portugal and its main characteristics, in the following sustainable categories, are:

a) Participation of different intervenient - The several stages of design gathered the active participation of various intervenient in the building life-cycle, i.e., the municipality, the promoter, the owner, the contractor, designers, engineers, technicians, neighbourhood and potential users. This way it was possible to fulfill the social cohesion commitments in an integrated strategy for a Sustainable Development.

b) Site selection, project planning and development - The building was built in a pre-developed area that was formerly occupied by degraded industrial buildings. Therefore, this project had a positive contribution towards the rehabilitation of the urban area (figures 4 and 5). Since it did not use new land for construction, it has also contributed to the maintenance of the biodiversity. The proximity of public transportation will encourage the use of it, reducing the potential impacts related to the mobility of the inhabitants.

Figure 4. *Aspect of the site, before the intervention*

Figure 5. *Aspect of the site, after the intervention*

c) Materials selection – Use of recycled aggregates in concrete, resulting from the demolition of existing industrial buildings. The project gave priority to local or national manufactured materials, with high durability and low maintenance. For the external cladding, the design team adopted a solution with low maintenance (solid ceramic block).

d) Water efficiency – Some technologies and equipments were adopted in order to promote the reduction of freshwater use, both in the interior and exterior of the building:

- use of low flow showers and thermostatic valves for the water temperature control (figures 6 and 7);
- green spaces irrigation controlled by an humidity sensor;
- implementation of double flush (3+6 liters) toilets (figure 8);
- construction of an underground water-tank for rainwater storage and reuse (the water is used for the irrigation of green space and in the toilets (figure 9)).

Figure 6. *Low flow showers*

Figure 7. *Thermostatic valves for the water temperature control*

Figure 8. *Double flush toilets*

Figure 9. *Underground water tank*

e) Construction and operation waste management – Several measures were introduced in order to promote the reduction and separation of waste during construction and operation phases:

- during the construction phase, different containers were used to separate the construction waste, according to the waste category;

- implementation of external waste containers to enable the separation and recycling of waste produced during the operation phase (figure 10);
- implementation of indoor waste containers, on each dwelling, to enable the separation of the household waste (figure 11).

Figure 10. *External household waste containers*

Figure 11. *Internal household waste containers*

f) Energy efficiency - In order to maximize the energy efficiency, the project considered several measures at different levels: maximization of the passive solar potential (building orientation), minimization of the energy consumption, use of renewable energy sources, implementation of energy efficient equipments, use of low embodied energy materials and equipments, and implementation of an information system about the best practices to reduce the energy consumption by the users (development of a Building User Manual with relevant information about the building operation and maintenance). Several building solutions were implemented in order to reduce the heating and cooling needs, the energy need for hot water, and to enable the energy certification of the building:

- appropriate orientation of the building, in order to benefit from the passive solar potential and to limit the heating needs of the dwellings;
- maximum U-value of 0,35 $W/m^2{}^oC$ for the external envelope, and total correction of the thermal bridges;
- use of thermal insulation according to the new thermal regulation demands;
- implementation of solar collectors in the roof (figure 12);
- use of high efficiency compact fluorescent bulbs and electronic devices, in common spaces, controlled by solar cells in the exterior;
- implementation of natural cross ventilation in the interior spaces, in order to improve the air quality and to minimize the use of mechanical ventilation. All windows frames are equipped with natural ventilation devices (figure 13);
- design of an A class building, according to the new building energy labelling scheme.

Figure 12. *Solar collectors in the roof*

Figure 13. *Self natural ventilated window frames*

g) Life-cycle cost - Compared to a building with the same area and shape but using conventional building technologies in Portugal, the construction cost was 9% higher, while the dwellings price was only 5% higher. The lower operation cost will allow recovering the additional initial investment within a period of only 5 to 6 years.

5.1.2 *Edifício Solar XXI – demonstrative project in the field of renewable energies and energy efficiency in buildings Sustainable Housing in Europe – Portuguese Pilot Project*

This project was developed by *Instituto Nacional de Engenharia, Tecnologia e Inovação* (INETI) (http://www.ineti.pt/projectos/projectos_frameset.aspx?id=325), in order to prove that it is possible to build energy efficiency buildings without significant over costs. This project aimed to highlight the advantages of solar energy (thermal and photovoltaic) in buildings. The thermal optimization strategy included the integration of photovoltaic panels in the southern façade of the building, the use of solar thermal collectors for the heating and the integration of a cooling system by air ventilation through the ground floor of the building.

Figure 14. *Edifício Solar XXI (INETI)*

6 REFERENCES

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