Report on Sustainable Building and Construction in Portugal

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Contents

1. Status of national or regional development of performance targets for SB

During the past decade, there has been a significant evolution in the area of urban and building design in Portugal. Visible results were achieved, both in terms of know-how and implementation, however much remains to be done. At national and regional level sustainable development is assumed, even that in terms of sustainable construction and buildings the targets are partial. Focus are mainly at energy, in global terms CO2 and environmental criteria, like water, soil protection, noise, natural conservation and urban or construction and demolition waste.

2. Status of adoption of policies (tax, programs, regulations)

Portugal faces the challenge of achieving economic, environmental and social development, in order to converge with that of other European countries. In terms of Environmental policies, the country has benefited much from the E.U. pressure, for instance on issues of the use of natural resources, the restructuring of land use or constraints on pollution.

In the 1990s, Portugal made much progress in establishing a revised, modern environmental legislative framework (largely but not solely in response to EU environmental directives), in strengthening its environmental institutions (including establishing a single ministry and related regional bodies in charge of both environmental and land use matters), in developing national environmental planning (e.g. its first national environmental plan, in 1995, and strategic plans concerning water and waste services), in adapting physical plans covering the entire country (e.g. national coastal area protection plans, national nature protection plan, municipal land use plans) and in investing in, and programming, water and waste-related infrastructures, particularly in the context of the 1994-99 and 2000-06 EU Community Support Frameworks.

In the last ten years the strategy was based on prevention and targeting a sustained development, pursuing the integration of environmental concerns into the decision making process (e.g. promoting environmental impact assessment of major projects), trying to adopt environmental management and eco-efficient solutions. The discussion on environmental and sustainability issues and the resultant implementation of adequate measures is slowly, but steadily, rising in Portugal, including the critical areas of urban planning and building's design and construction.

There are some examples of urban zones, where Municipalities, begin to indicate that certified sustainable buildings might be eligible for tax reductions. An example is Santarem Municipality where the buildings certified by LiderA – Sustainable Assessment System will pay 25% less taxes.

It is also noted that in many other areas significant developments toward sustainability of construction industry is taking place. One good example is the state of Construction and Demolition Wastes. Portugal produces some 3 million tons of C&DW annually, even though it had been ignored for years and its treatment did not receive sufficient attention.

Academics and Research Centres have been engaged in studying ways and means of minimizing C&DW and recycling them. Portugal participated actively in two major EU projects aiming at development of "European Manual for Construction Waste" and an "Interactive Tool for Building Waste Management". The latter is being used in many EU countries for training of workers, professionals and designers dealing with C&DW.

Other research work on the recycling of mineral waste for replacement of aggregate in concrete has been successfully pursued.

It is encouraging to note that a new law has been passed in 2007 that provides the legal framework for collection and deposition of C&D wastes. Since its introduction a new momentum is noticed in creating treatment centres and recycling processes. It is hoped that in near future the percentage of recycled C&DW will rise from the present 5% to some 70% while the total amount of C&D wastes will be minimised.

New laws are forthcoming on procurement of buildings and public work which will enforce the EU directives as national laws. This new aspect of construction will pay attention to environmental aspects of design and construction at early stages of selecting designers and contractors.

Research work at PhD level is under way on different aspects of SB such as design for flexibility, design for deconstruction, eco-efficiency of certain construction materials and unconventional construction materials.

The combined effect of R&D and new laws passed is expected to affect significantly the progress of SB.

3. Status of adoption of SB by the investor community

3.1. General Aspects

In Portugal, Green Building has been, during the last few years, an area of growing interest for building promoters, who perceive the possibilities and business opportunities existing in it. This fact is mostly due to the relatively large publicity involving the subject.

Although research in the area has existed since the 1970's, its results were kept mostly within Academic and Research institutions until 1998. The realization of the International Exhibition Expo 98, in Lisbon, was basically the starting point for the building market's awareness on the matter, as, at the time, a number of debates were carried out on the implementation of sustainable design regarding its urban and Architectural projects. This process involved construction companies, building promoters and other stakeholders of the building industry.

Since then, successive governments have, at political level, made a positive effort in enforcing sustainable building practices, through sets of recommendations (such as the E4 programme: Energy Efficiency and Endogenous Energy), and revised or new building standards. A key factor was the recent implementation of the new legislation concerning mandatory Energy Certification for new buildings and encouraging the use of solar panels. State Institutions, such as Lisboa E-Nova, were created with the sole purpose of providing support to building professionals and common consumers in the area – by organizing discussion forums between public sector, professionals (including Building Promoters) and academics.

The building industry is, as all industries, ruled by the laws of offer and demand. Until the late 1980's, early 1990's the words "Green building", "Environmental efficiency" or "Sustainable Design" were not only widely known by the building professionals (including Architects), but, and most importantly, they were unknown by the consumers.

Since then, and as a result of several factors, such as:

a) the above referred legislative programmes;

b) growing publicity on Environmental matters (including building-related issues) in the media,

c) the introduction of subjects related to Sustainable Construction on the Curricula of Undergraduate and Graduate courses of Engineering and Architecture; and

d) the number of public, professional and academic events dealing with this issue (among which the regional event PortugalSB07 was a very significant one), have increased consumer awareness and demand – leading to a change in attitude in the building market.

If, some years ago, the issue of Green Buildings was perceived by the Building Industry as being non-profitable (almost “utopia”, in the sphere of radical and “apocalyptic preaching” ecologists), it is now becoming a marketing fashion.

Nowadays, the number of advertisements on “Bioclimatic Condominium”, “Green Urbanizations” or “Environmental Friendly” offices, houses, shopping malls or electrical appliances (even “green HVAC systems”) has become widespread. The same goes for Building Professionals – the number of Green Architects, Green Engineers, and Green Builders has risen exponentially. It is fashionable – and it is basically a good sign.

Although many of the above-referred professionals, still lack the necessary knowledge on the subject – which is reflected in their designs and products - , the subject is being discussed, publicized, and the public is being more assertive in its demands, thus raising quality standards. Furthermore, the (very) recent generations of Architects and Engineers who already have training in the area (even if basic), will undoubtedly contribute to a major qualitative evolution in the area.

The number of truly “Sustainable” or “Green” new buildings is still quite scarce. However, if one considers the growing market trend for refurbishment - most of which of pre-HVAC buildings -, surely can be said that things are going in the right direction. Furthermore, there are already a few large Promoter Companies (both National and International) that aim to carry out large residential projects complying with SB directives, within the next two years, which will have a huge impact in terms of publicity and public awareness.

In summary, it can be said that things are improving. Building promoters are beginning to realize the potential profitability of the area – and, for architects, it could be the long-awaited source of renewed inspiration – with the added advantage of doing what is morally right!

4. Status of education and training in SB

4.1. General Aspects

Two of the most important barriers for sustainable construction in Portugal are the weakness of R&D in the sector and the low expertise of the Portuguese designers in Sustainable Building (SB).

Construction in Portugal is one of the industrial sectors that have lower investment in research and development. Therefore most of the construction materials, products and practices are common all over the country and most of them are the same that were used fifty or more years ago.

The level of expertise in Sustainable Building of the several stakeholders in the life-cycle of a building, mainly in the construction phase, is very low and therefore their knowledge relies too much on traditional building technologies. Part of this reality is linked to the low industrialisation level of this industry: the huge number of workmanship hours necessary to build a building and the associated price enforce the industry to engage untrained workmanship. Most of the construction contractors think that this is the correct path to assure the economical sustainability of the sector.

On the other hand, there is also some inertia in most of the construction technicians (Engineers and Architects) to adopt new building materials and technologies, primarily because the classic courses of architecture and engineering are too much oriented for traditional way of building: reinforced concrete and hollow brick walls.

In the last few years, the awareness of the Portuguese society about the climate change and environmental impacts of the construction is increasing a lot, mainly because the ever-increasing oil and electricity prices.

Consequently in the last few years sustainable building won industry acceptance in a each time more competitive construction market and now there is an increasing demand for SB in building design, construction, construction processes, operation, real estate development, construction materials industry and sales market. Many design companies, municipalities, universities, the central government and a growing number of private sector construction owners have declared the sustainability a priority on their agendas and as their standard for procurement.

Nowadays there are some few examples of private companies or public organizations either proving or procuring sustainable design or construction products. As a result the demand for detailed knowledge of options and procedures involved in SB increased a lot. At the Universities, although there were not substantial changes in the programs of the classic graduations in architecture and engineering, SB started to integrate the program of some MSc and PhD courses and many seminars, conferences and workshops on this field are being organised. As an example, in September 2007, the University of Minho (UM) and the Instituto Superior Técnico (IST) co-organized in Lisbon (with the partnership of the International Initiative for the Sustainable Built Environment (iiSBE), International Council for Research and Innovation in Building and Construction (CIB), United Nations Environmental Program (UNEP) and Portuguese Government) the first Portuguese international conference on SB topics.

There also some continuous training courses on SB oriented to architects and engineers, most of then in the context of energy efficiency. Examples of education and training initiatives on SB in Portugal are:

- In 2006, the National Agency for Energy Efficiency (ADENE) started to train Qualified Experts in the new Energy Certification System (SCE) for buildings;
- Some years ago, the Department of Civil Engineering and Architecture of the Instituto Superior Técnico (IST) started some courses on sustainable practices and building assessment methods and continues to organise courses to train professionals in the formal building environmental rating system “LiderA”;
- The Department of Civil Engineering of the University of Minho will start in October 2008 a Master Degree Course on Sustainable Construction and Rehabilitation;
- The non-profit organisation «iiSBE Portugal» will start in 2009 a training course on the Portuguese SBTool building sustainability assessment.

The following sections will give some insights about the ongoing education and training initiatives on SB in Portugal.

4.2. Training Courses on Qualified Experts in the new Energy Certification System (SCE) for buildings

The transposition of the European Directive 2002/91/EC (Directive EPBD) to the Portuguese regulation implied the progressive certification of the energy performance of both new and existing buildings (for more information please read the paragraph “Energy Labelling”).

In order to guarantee the quality of the energy efficiency design, according to the legislation the emission of the Energy Certificate is restricted to those engineers and architects that have the title of “Qualified Expert (PQ) on the National System of Energy Certification and Indoor Air Quality in Buildings (SCE).

In order to be a Qualified Expert (PQ) in SCE it is necessary to follow a list of requirements, namely to participate and be approved on a training course recognised by the National Agency for Energy Efficiency (ADENE).

These training courses are made of four independent learning units: three technical units (RCCTE, RSECE-Energy and RSECE-Indoor air quality) plus one unit on SCE Certification (RCCTE or RSECE). The technical units are lectured by public or private institutions that are recognized in the SCE process and ADENE is responsible by the other unit.

The three technical units give to the Qualified Experts (PQ) the necessary insights into the new Portuguese thermal regulations (RCCTE-Decree-law 80/2006 and RSECE-Decree-law 79/2006) in order that they have the necessary expertise in the new energy demand assessment methods, maximum energy demand, minimum quality of the building solutions to adopt in the envelope of the building, etc.

The SCE Certification unit aims to introduce the necessary theoretical and practical knowledge in order that the Qualified Expert (PQ) is able to cope with the new Certification system (Decree-law 78/2006). This way the content of this unit is based on the methodological issues related to the Energy Certification Scheme and Indoor Air Quality and the related assessment procedures.

Courses on the three technical units are organized all over the country by several private and public institutions while the SCE Certification unit is organised in the city of Oporto (North of Portugal), Coimbra (Centre/North of Portugal) and Lisbon (Centre/South of Portugal). Until now there were hundreds of participants in the three technical units courses which promotes the right implementation of new regulation on the market. Although there are only at the moment about 300 Qualified Experts, these training courses have proven to be a good way to insure the energy efficiency in new buildings and large refurbishment operations.

4.3. Post-graduate Course in Sustainable Building

The Master Degree Course on Sustainable Construction and Rehabilitation of the University of Minho is the first master on the SB context organized in a public Portuguese academic institution. Besides that the private University Lusíada of Lisbon has, since 2005, a Master Course on Urban Planning and Sustainable Construction. Additionally there are also some other universities, like the Technical University of Lisbon, which have integrated some modules on SB in their master courses.

The Master Degree Course on Sustainable Construction and Rehabilitation of the University of Minho is aimed for professionals with first degree in Civil Engineering, Architecture and Engineering Sciences. The course is taught in Portuguese or English.

This Master course has 2 options, each corresponding to an emerging technology application area – one option deals with Sustainable Building Design and Management and the other deals with Building Maintenance and Rehabilitation. This course is a 4 semester course with two semester taught modules and a dissertation in the third and fourth semesters.

It offers a set of taught modules in Civil Engineering (Constructions, Construction Materials, Structures and Geotechnics), in which teaching staff from the Civil Engineering Department are actively engaged.

The Master degree in Sustainable Construction and Rehabilitation corresponds to the completion of 120 ECTS. The completion of 60 ECTS entitles a Postgraduate Diploma in Sustainable Construction and Rehabilitation.

A detailed description of the Course and the modules offered is presented in Tables 4.1 and 4.2.

Table 4.1: Learning units of the option *Sustainable Building Design and Management*

	Learning Unit	**ECTS**
1st Semester	Ecology and Sustainability of Constructions	5 ECTS
	Energy and Comfort in Buildings	5 ECTS
	Eco-efficient Construction Materials	5 ECTS
	Seminar	15 ECTS
2nd Semester	Sustainable Efficient Building Design and Construction	5 ECTS
	Sustainable Building Project Management	5 ECTS
	Optional Module – choose one of the following: - Building Use Management - Maintenance of Historical Monuments and Buildings - Technology Innovation in Construction - Sustainable Structures Design	5 ECTS
	Dissertation Plan	15 ECTS
3rd and 4th Semesters	Dissertation	60 ECTS

Table 4.2: Learning units of the option *Building Maintenance and Rehabilitation*

	Learning Unit	**ECTS**
1st Semester	Ecology and Sustainability of Constructions	5 ECTS
	Energy and Comfort in Buildings	5 ECTS
	Eco-efficient Construction Materials	5 ECTS
	Seminaries	15 ECTS
2nd Semester	Non-Structural Pathology and Rehabilitation of Constructions	5 ECTS
	Quality and Durability of Constructions	5 ECTS
	Optional Module – choose one of the following learning units: - Building Use Management - Maintenance of historical Monuments and Buildings - Technology Innovation of Construction - Sustainable Structures Design	5 ECTS
	Dissertation Plan	15 ECTS
3rd and 4th Semesters	Dissertation	60 ECTS

4.3. Training courses on building sustainability and building sustainability assessment methods

LiderA

LiderA (in Portuguese the acronym for environmental leadership to sustainable construction) is a voluntary system to assess the sustainability of the Portuguese buildings/constructions (see section 6.3) that has been in development since 2003 (Pinheiro and Correia, 2005).

Since 2003 a course on sustainable assessment has been running twice a year in Lisbon Technical Institute (DECivil/IST). So far 80 “LiderA Certified Assessors” have been trained and certified by LiderA.

SBTool rating

In 2009 the non-profit organization “iiSBE Portugal” will start a series of training courses on the Portuguese SBTool rating system. These series are designed for professionals who intend to implement the Portuguese SBTool rating system.

These training courses aim, not only to give the necessary insights about the sustainable building technologies, sustainable practices and SBTool rating system, but mainly to train experts in Building Sustainability Assessment (PASC). It is necessary to be an Expert in Building Sustainability Assessment in order to become certified for issuing the Sustainability Certificate (Figure 6.5).

The training courses will be based on the application to case studies, interactive exercises, tools and resources to help those interested in sustainable design, building and operation of buildings. Those who want to be Experts in Building Sustainability Assessment (PASC) will have to be approved in the course.

5. Status of adoption of new SB technologies and techniques

5.1. General Aspects

To define the Status of adoption of new SB technologies and techniques it is important to clarify that the concept of sustainable building is still a fringe movement in Portugal. It started only in the last decade of the twentieth century and along the last few years it has gained acceptance by part of the stakeholders.

In recent years, due to the exponential rise in the energy costs, the increased attentiveness of climate change and the increasing competitiveness of the construction industry and real state sectors and the awareness of the Portuguese society about the “sustainable development” have improved significantly.

Compared to other industries, the Portuguese construction industry is the one where there are more difficulties in integrating the environmental issues with the traditional ones: economical and societal (comfort). Each economical sector has it own characteristics in what concerns to products, processes, producers and consumption patterns. When the sustainable policies are assessed and promoted, it is essential to consider the particularities of the Portuguese construction sector; otherwise it is impossible to develop the necessary instruments to overcome the actual barriers.

There are some important barriers in the Portuguese construction that are delaying the implementation of the sustainable development aims and goals. Most of these barriers are common with the ones of other countries. Table 5.1 presents some of the barriers.

Table 5.1: Barriers to sustainable building in Portugal

Economical barriers

1) Lack of life-cycle cost analysis;
2) Higher (perceived and real) first costs;
3) Budget separation between capital and operation costs;
4) For owners (non-users), “sustainability” and “profits” are perceived to be incompatible;
5) Inadequate funding for public research.

Technical barriers

1) Lack of specialised workmanship;
2) Long life-cycle and huge number of different stakeholders;
3) Heterogeneity of the products;
4) Lack of specific training courses in sustainable building in architecture and engineering degree courses;
5) Low industrialisation of the sector;
6) Insufficient research and development (R&D).

Other barriers

1) Lack of awareness of the stakeholders (conventional thinking prevails);
2) Aversion to perceived risk;
3) Lack of an accepted tool to support and to certify the sustainable design, construction and operation of buildings;
4) Lack of policies to promote the sustainable building.

The main barriers identified in the Portuguese market are on one hand the lack of awareness of stakeholders (conventional thinking prevails) and on the other hand the fact that most of the degree courses in architecture and civil engineering are oriented toward conventional building solutions.

However, progress toward new approaches and solutions in SB technologies and techniques are being adopted. The Solar XXI office building (were passive and active solar techniques were implemented, Figure 6.1) and the SHE pilot residential buildings are two good examples of the status of adoption of new SB technologies and techniques in Portugal. Nevertheless the main question is that such examples are limited in number and in solutions that have employed.

Figure 5.1: Aspect of the façade of the Solar XXI office building at INETI

Due to the impact of the SHE Project in the Portuguese construction industry, mainly in the residential sector, this Project and the pilot building will be presented in detail in the following sections.

5.2. SHE: Sustainable Housing in Europe

SHE: Sustainable Housing in Europe is a demonstration project funded by the European Commission under the 5th Framework Programme "Research and

Development", programme on "Energy, Environment and Sustainable Development", Key Action 4 "City of tomorrow and cultural heritage".

The project aims to demonstrate the real feasibility of sustainable housing, through pilot projects in four different countries (Denmark, France, Italy and Portugal). The reasons for the SHE project lie in the challenge to move the present examples of sustainable housing from the “extraordinary” to the “ordinary”, as well as to improve the link between buildings and neighborhoods. The concern and daily involvement of the social housing organizations in the field of residential buildings has led to the theory that a holistic study and assessment of the building life-cycle will certainly ease balancing investment costs with economic, environmental as well as social benefits, thus demonstrating the real feasibility of such principles to ensure better living conditions.

The main aims of the project were (SHE, 2008):

- to assess and demonstrate the real feasibility of sustainable housing using pilot projects;
- to integrate sustainability and closer participation of tenants in the main stages of the construction decision-making process, at a reasonable cost and with high potential to be replicated;
- to develop best practice solutions to set up quality assessment and guidelines based on the direct experience acquired;
- to create a transferable and demonstrative effect of the innovative methods, operations and achievements by defining tools and procedures in a general methodology to manage sustainability throughout the whole building process and equipping all stakeholders with the understanding of long-term costs and direct and indirect benefits of sustainable construction;
- to evaluate the degree of satisfaction of sustainable houses by future tenants.

The project aims the introduction of sustainable thinking in the several phases of the building life stages. At the **design stage** the project introduced a framework with detailed actions and prescriptions regarding architectural, engineering and resource (energy, waste and water) aspects, starting from site analysis and diagnoses. Besides that it set up a comprehensive design approach, both on a neighborhood and building scale, aiming to reduce building environmental impact; to reduce water and energy consumption and promote the rational use of natural resources; to promote an ecological mobility approach; to promote passive strategies for climate control; the correct use of daylight and to increase indoor and outdoor acoustic comfort, to promote the use of safe and ecological materials and technologies, which can be re-used and re-cycled, according to LCA procedures.

In order to archive a sustainable building, according with the results of this project, the activities of the design teams could be divided in three stages: **site analysis and diagnosis**, **definition of specific sustainable design targets**, **sustainable design and simulations**.

During the first stage, **site analysis and diagnosis**, design teams have to perform a site analysis and diagnosis of the area. This diagnosis is to be shared with the municipality (politicians as well as technical services) and if possible with the occupants and users, improving governance and participation of occupants and users. The following studies have to be performed: environmental diagnosis, sustainable development diagnosis; architectural diagnosis.

On the second stage, **definition of specific sustainable design targets**, design teams have to define the design targets of any pilot project. This targets are based on a “table of minimum sustainable standards” and on a set of “recommendations for definition of specific sustainable design targets” developed for the project.

The third stage, **sustainable design and simulations**, is based in the two previous stages. In this stage the design teams have to choose and verify throughout simulations the building technologies and materials to be used in order to verify the "specific sustainable design targets". This phase includes the following aims:

- to integrate detailed measures into the overall planning land use strategy, regarding energy and environmental aspects; (measures taken to reduce construction and operating solid and liquid wastes;
- to maximise the quality of the indoor environment;
- to optimise the "sun-air impact";
- to reduce energy consumption of primary energy and freshwater;
- to reduce the use of cars by occupants, to preserve bio-diversity and other natural values;
- to perform energy simulations in order to carry out well designed sensitivity studies and to calculate the specific and global energy efficiency and environmental performance of selected measures;
- to perform acoustic simulations according, both concerning the acoustic climate at neighbourhood and building scale;
- to perform an appropriate daylight design through calculation methods and simulation tools;
- to appreciate the opportunities of many architectural, technical and equipment alternatives in light of the criteria of tenants' and inhabitants' requests and especially those aimed at social integration.

During the **operation stage** the main objective is to carry out accurate monitoring of buildings in order to measure and document the quantitative performance and the impact of energy and environmental conscious design. These activities are focused on checking the overall energy and water consumption and waste management, along with the real performances of the strategies implemented in each project. The information collected during the monitoring activities will be used in order to understand the effects and efficiency of the various actions that were undertaken during the design phase. The results are compared to simulation results and the pre-defined sustainability standards.

5.3. Brief description of the Portuguese pilot project

The Portuguese pilot project was the second phase of the Ponte da Pedra housing state that was built in the municipality of Matosinhos, Northern Portugal. It is a multifamily social housing project, which promoter is NORBICETA - União de Cooperativas de Habitação, U.C.R.L. This project has two building blocks, a footprint of 3105m^2, a total gross area of 14.852m^2 and 101 dwellings. 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 project SHE and by the National Housing Institute (INH) and had the support of the 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 having a very good contribution for the implementation of sustainable buildings in Portugal because it is a very well disseminated project that shows that it is possible to build in practice a building with lower environmental impacts, higher comfort and lower life-cycle costs, when compared to a conventional building. On the other hand it is the only sustainable building built so far that is recognized by an internationally accepted building sustainability guidelines.

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 phases of design gathered the active participation of the several intervenient in the building life-cycle, i.e., the municipality, promoter, owner, contractor, designers, engineers, technicians, neighbour inhabitants and potential users. This way it was possible to fulfil the social cohesion commitments in an integrated strategy for the Sustainable Development.

b) Site selection, project planning and development - The project was built in a pre-developed area that was formerly occupied by decaying industrial buildings. Therefore this project had a positive contribution in the regeneration of that area and at the level of the urban land planning (figures 5.1 and 5.2). Since it does not uses new land for construction it also contributes to the maintenance of the biodiversity. The proximity of public transportation will encourage the use of it, which will reduce the potential impacts related to the mobility of the inhabitants.

Figure 5.2: Aspect of the site, before the intervention

Figure 5.3: Aspect of the site, after the intervention

c) Materials selection - Part of the materials proceeding from the demolishment of the existing industrial buildings were recycled and used as aggregated in concrete. The project gave priority to local or national manufactured materials with high durability and low maintenance. As external cladding, design team chose one of the solutions with lower 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 5.4 and 5.5);
- green spaces irrigation controlled by an humidity sensor;
- implementation of double flush (3+6 liters) toilets (figure 5.6);
- 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 5.7).

Figure 5.4: Low flow showers

Figure 5.5: Thermostatic valves for the water temperature control

Figure 5.6: Double flush toilets

Figure 5.7: Underground water tank

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

- use, during construction phase, of different containers 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 5.8);
- implementation of indoor waste containers on each dwelling to enable the separation of the household waste (figure 5.9).

Figure 5.8: External household waste containers

Figure 5.9: 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 consumptions, use of renewable energy sources, implementation of energy efficient equipments, use of low embodied energy materials and equipments, implementation of an information system about the best practices to reduce the energy consumption to be used by the users (development of a Building User Manual with relevant information about the building operation and maintenance). Several building solutions were implemented to reduce the heating and cooling needs and the necessary energy for hot water heating and to allow the energy certification of the building:

- correct 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°C for the external envelopes and total correction of the thermal bridges;
- reinforcement of the thermal insulation according to the new thermal regulation demands. Although this building was designed before the new thermal regulation it was designed in order to respect the new (actual) demands;
- implementation of solar collectors in the roof (figure 5.10);
- 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 in natural ventilation devices (figure 5.11);
- design of an A class building, according to the new building energy labelling scheme.

Figure 5.10: Solar collectors in the roof

Figure 5.11: Self natural ventilated window frames

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

6. Status of adoption of SB whole-building performance rating systems

6.1. General Aspects

Nowadays, for some consumers, the low environmental impact is a surplus value when two products that fulfil the same performance are compared. Notably, answering to this new demand of the market, some organizations, either proving or procuring sustainable design or sustainable construction services, have emerged. The central government, some municipalities and a growing number of private sector constructions owners have declared sustainable design or “green” materials and methods as their standard for procurement. The priority is being given to the buildings’ cluster; due to the importance of it in the economy, in the environmental burdens and in the quality of life of its users or inhabitants.

Nevertheless, some owners, project teams and construction companies, are improperly using the “sustainable construction” label, since their priority is only to maximize sales and profits. Therefore the design of many of that so-called new “sustainable buildings” are not really based on an accepted list of sustainable aims and goals and one part of them do not have any advantage when compared with the conventional buildings and the other is even worst.

Even there are several building performance rating systems, most of than are partial, with whole building approach is important to refer the obligatory energy labelling (6.2) and the voluntary assessment systems like LiderA (6.3) or MARS-H (6.4) that will present in the next tree sections.

6.2. Energy Labelling

Construction sector is one of the most important economic sectors in Portugal, since it represents 8% of the Gross National Product (GNP) and employs about 10% of the active population.

In Portugal, buildings cluster is very active, with a strong bet in new buildings and therefore more than 20% of the existing buildings were built in the last decade. Between 1991 and 2000 the average construction rate was 8.4 new buildings per each 1000 inhabitants. In 1999 and 2000 this rate reached the maximum value of 10.0 (INE, 2001).

Most of the Portuguese total energy consumption (over 65%) is based in oil and 100% of this energy source is imported. Portugal signed the Kyoto Protocol and was committed to maintain the global emissions of greenhouse gases (GHGs) bellow a target that is 27% higher than the 1990's value (figure 1). However in 2002 the national GHGs emissions were already higher than the Kyoto's target for the 2008-2012 verification periods. It means that if the actual level of emissions is maintained, Portugal will have to pay about 300 million of Euros per year to compensate the over target emissions.

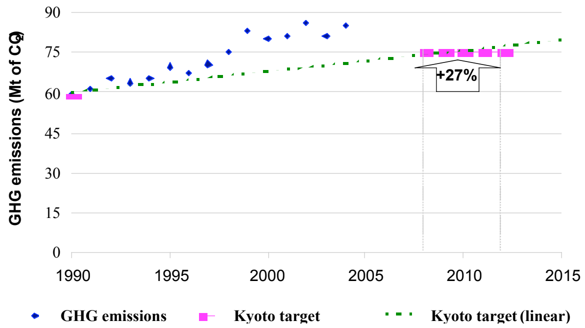

Figure 6.1: GHG emissions in Portugal and Kyoto Protocol target (source: DGGE, 2005)

Buildings have an important input on the total energy demand and therefore in the GHGs emissions, since both residential and services sectors have a 30% share in this value and a 62% contribution in the total electricity needs (figure 2). Although Portugal has a mild climate, compared to most European countries, the energy consumption in buildings is growing fast and getting close to the European average (40% of the total energy consumption). The energy consumption in buildings is growing at an average rate of 7% per year and between 1999 and 2005 the weight of buildings in the total energy consumption grew about 8% (DGGE, 2005).

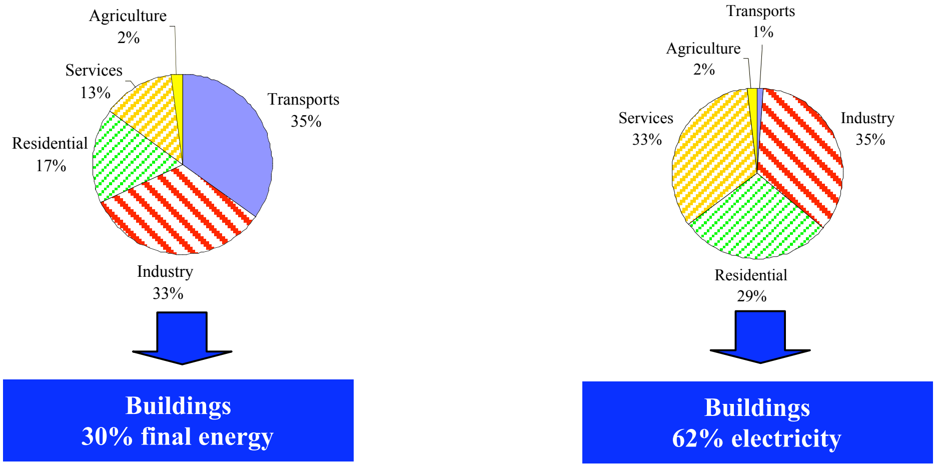

Figure 6.2: Final and electricity energy demand in buildings (source: DGGE, 2005)

Having in mind the environmental, economic and social problems related to the energy consumption and the importance of buildings in the total energy demand, most of the discussions about the sustainability of the buildings sector are related to energy. For this reason in many cases the concepts “energy efficient building” and “sustainable building” are mistakenly considered equivalent: most of the research carried out in Portugal on the field of the sustainable buildings aims to improve the energy efficiency of buildings, and the other sustainable indicators and parameters are in general mistreated.

In order to overcome the increasing demand of energy in buildings, Portugal transposed to the internal legislation the European Directive 2002/91/EC, of the European Parliament and Council of 2002, on Energy Performance of buildings.

The main objectives of the new thermal performance regulation are the following:

- To set a calculation method to assess the integrated energy performance of buildings;
- To apply minimum requirements for energy performance of new buildings;
- To apply minimum requirements for the energy performance of the large existing buildings;
- To apply a methodology for the energy certification of buildings;
- To determine a procedure for the regular inspection of boilers and air-conditioning installations in buildings.

The new thermal performance regulation introduced in Portugal the first whole-building performance rating system (thermal performance labelling). This regulation is in force since April 4th 2006 and is composed by three main laws that replaced the former RCCTE (Decree-law 40/90) and RSECE (Decree-law 118/98):

- The SCE (law no 78/2006) which is the energy certification system of buildings in Portugal;
- The RSECE (law no 79/2006) which is the regulation that concerns the energy systems and air-conditioning in large buildings;
- The RCCTE (law no 80/2006) which is the regulation that concerns the characteristics of the thermal behaviour of buildings.

The SCE (energy certification system) is related to the transposition to the Portuguese legislation of the Directive 2002/91/CE and the main objectives 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 (energy systems and air-conditioning regulation) 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 are over 1000m^2) or buildings with a centralized HVAC systems with an installed power over 25kW.

Residential and service buildings with a net floor area lower than 1000m^2 and with a centralized air-conditioned system with an installed power bellow 25kW are covered by the RCCTE. This regulation 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 requirements 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 $1000m^2$ (figure 4).

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.

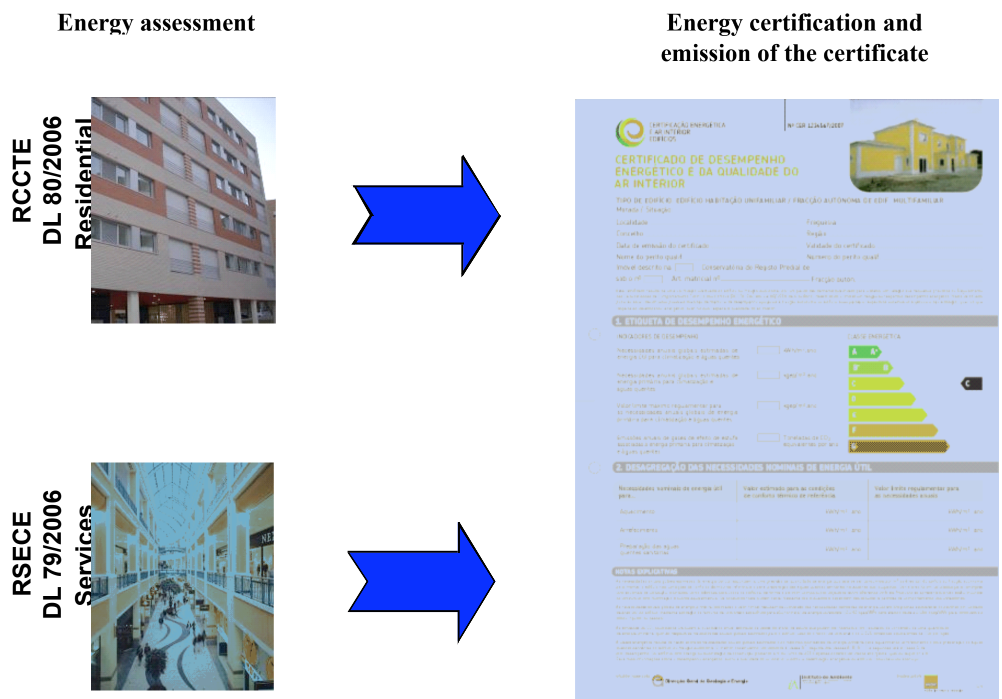

Figure 6.3: Energy certification system in Portugal (Decree-Law 78/2006)

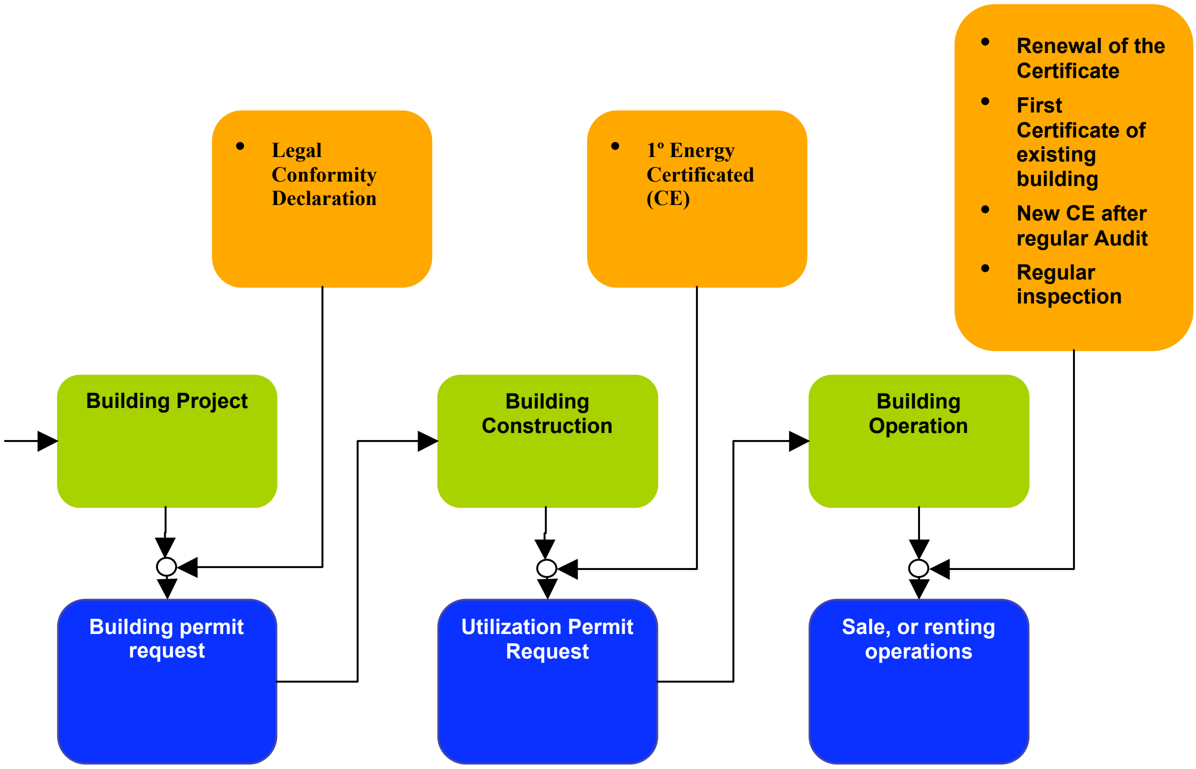

Figure 6.4: Energy certification and building life-cycle stage

Energy certification will be progressively implemented in all buildings. According to DGGE the sequence will be:

- New residential and services buildings and major refurbishment operations (2007) ;
- Big existing services buildings (2008);
- Small existing services buildings (2009);
- Existing residential buildings (2009).

Until now there are around 3000 energy certified buildings and fractions in Portugal.

6.3. LIDERA – Sustainable Assessment System

The practice shows that to assure efficiency evolution is important to define the areas to invest in sustainability and create leadership to whole life urban programs and projects. This can be done by pointing out (an asses) the environmental performance to be achieved and adopt an environmental management system.

One of the new tools for pursuing this objective is the LiderA system, an acronym for the Portuguese designation of "Liderar pelo Ambiente", which means: be a leader for Environment, in order to support urban sustainable (www.lidera.info).

The LiderA system (Pinheiro and Correia, 2005) has three levels: strategic, tactical and operational. The strategic level is based on the definition of Environmental Policy that gives orientation to operational framework and further proactive development.

The tactical is based in an assessment process and is based in a core criteria, nesting in categories involving local and integration; resources consumption and efficiency, environmental areas minimization, interior environment comfort; durability and adaptability; environmental management and innovation: The next level includes 18 areas, eg: soil, landscape, energy, water.

The scales include five levels, in which zero is the actual practice: pass, good environmental performance, very good, weak sustainability and strong sustainability. The last two imply a reduction of factor 4 and 10 and complementary criteria. This assessment process gives the signals to tactical and operational levels.

The applications imply the implementation measures (plan, project) and in a management system that supports a continuous improvement in all urban life cycle. Depending of the environmental performance and the phase, the urban zone and buildings can be recognized by LiderA performance (plan, project, construction and deconstruction phase) and certified at the operational phase.

The system is a continuous tool to promote environmental performance and innovation and is a new level of support to urban sustainability.

The LiderA sustainable assessment has its core in environmental components, like soil and integration, resources (energy, water and materials) and environmental loads, complemented with social aspects like comfort, accessibility, and technical components like durability, environmental management and innovation.

The system have a top-down approach with 6 categories, divided in areas (21) and subsequently in criteria (50) in order to allow in those, the nesting of different levels of detail and analysis. The global set of criteria can be applied to different uses with different thresholds to define levels of sustainable performance. Levels range from G to A++, in which A level means 50 % of improvement towards practice (usual E level) and A+ and A++ an improvement Factor 4 and Factor 10.

To be certified, LiderA system must verify that it complies with legislation and have a performance that achieve at least a C level. The first five certificated buildings appeared in 2007 and are (name, data of use, use type, built area):

- Hotel Jardim Atlantico (Calheta), 1993, tourist complex, 7 497,20 m^2, 97 apartments;
- Torre Verde (Lisbon), 1998, one residential building, 7 200 m^2, 41 apartments;
- Casa Oásis, (Faro), 2002, one tourist house, 240 m^2;
- Ponte da Pedra, phase 2 (Matosinhos), 2006, two residential buildings, 14 852 m^2, 101 apartments;
- Parque Oriente (Lisbon), design phase approved, 13 buildings, 41 441 m^2, including a residential area (27 912 m^2) with 185 apartments and different types of commercial use in other areas.

LiderA is a voluntary Portuguese system to assess the sustainable buildings that begins to be in the market in an experimental phase, but certified in 2007 the first five buildings, involving 72 230 m^2 in residential (70 %), tourist (11%) and commercial uses (19%), from a house to several buildings, in design and operation phases. In 2008 there are 7 buildings certified and 22 in verification process.

These certifications show that it is possible to have a multi-application to different types of buildings and to several life phases, resulting from the top down structure with different levels of detail and thresholds linking design, construction, use and final end life.

Since the final performance depend on several factors, including design and users, the two approach can be complementary and can create a win-win relation if they use the environmental assessment system as a base to implement a full strategy to ensure environmental and sustainable performance with broader view, environmental performance focus, and adjust from environmental management system.

6.4. MARS – Building Sustainability Assessment Tool

The MARS building sustainability assessment methodology resulted from a research work performed in the University of Minho (DEC), which main aim was to develop and propose a generic methodology to assess the sustainability of existing, new and renovated buildings in the urban areas and especially in the Portuguese context.

As a first step, a methodology to assess the sustainability of residential buildings has been developed. 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 acronym of the methodology is MARS-H (from the Portuguese name "Metodologia de Avaliação Relativa da Sustentabilidade de Edifícios de Habitação").

The following priorities were stated in the development of the MARS-H:

- List of parameters wide enough to be meaningful and to comprise the most relevant building impacts and at the same time limited enough to be practical (fifty parameters at maximum);
- Whole building assessment, based upon the state-of-the-art of 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 but is also one which clients and designers can work with.
- Validation of the work by the development of a prototype tool and test it on case study buildings.

As a result of the research work, the MARS-H is based in the SBTool approach and is harmonized with the 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 the existing labeling schemes such as the EU energy labeling scheme for white goods and the European DisplayTM Campaign posters. However, due to the possible compensation between categories, the global performance of a building is not communicated using only the overall score. This way, 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. A is the best score, G the worst and F the score of the conventional solution. Figure 6.5 represents the certificate of the MARS-H methodology for a hypothetical case study.

Figure 6.5: MARS-H's building sustainability certificate

MARS-H cannot be used as a rating system unless it is validated by an independent third party. When a formal certification is intended, the design team or the project owner has to submit to iiSBE Portugal both 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 the iiSBE Portugal an iiSBE international. The certification process of a building is represented in Figure 6.6.

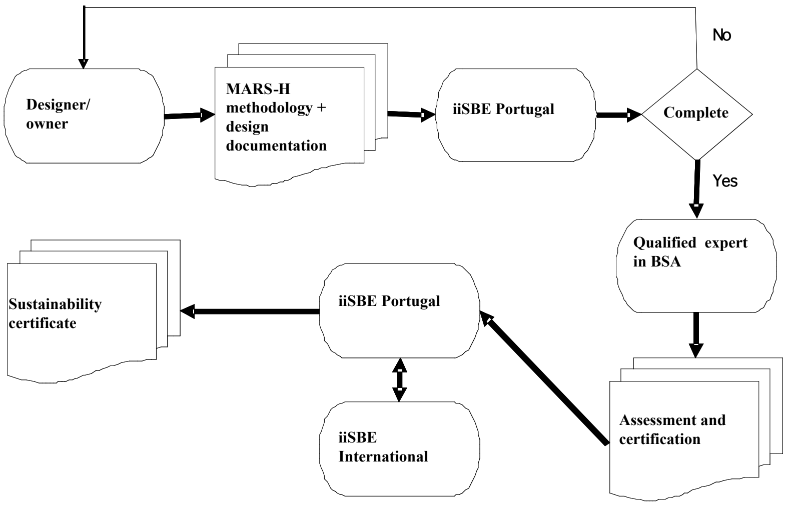

Figure 6.6: Certification process of a building according to MARS-H

This methodology is at the final stage of development and until now it was not 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 the Portuguese construction market stakeholders and to allow adequate policy implementation on sustainable construction, since it supports steps toward the sustainable design and construction, through the definition of a list of objectives that are easily understandable by all intervenient in construction market and compatible with the Portuguese construction technology background.

7. Conclusions

During the past decade, there has been a significant evolution towards sustainable building and construction in Portugal. Visible results can be noted and further development with more tangible results are underway. A growing attentiveness and discussion on how to foster SB and how to analyse the proposed solutions is taking place. Sustainable assessment systems and certifications process, courses, R&D and new laws provide a solid framework for the stakeholders to foster and enhance sustainability of constructions.

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