THE ROLE OF CERAMIC TILES IN THE NEW SYSTEM OF SUSTAINABLE DEVELOPMENT

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ABSTRACT

The international market demands products and services that meet verifiable sustainability criteria due, among other factors, to a greater awareness in society and increased environmental regulation. This situation requires companies to adapt to the new context.

The ceramics industry in Castellón can point with satisfaction to its success in improving regional environmental conditions (sending industrial wastewater as a by-product to spray dryers, reducing diffuse emissions, filtering contaminating emissions, etc.), and aware of changes in demand the sector has launched innovative products in the field of sustainable building. However, it is important to understand the challenges that a system of sustainable development system can entail for companies in the sector, and what role this system plays in what is referred to as sustainable building, and therefore in ceramic tiles as a building material.

The aim of this paper is to determine what the mainstays of sustainable development are, what "green" building means, to define the main features of the most internationally prominent system (LEED®, Leadership in Energy and Environmental Design) and show how ceramic tiles can contribute to this system.

1. INTRODUCTION

The model of construction widely established in our society has in general ignored the environmental, social and economic impact of its activities and has maintained an unsustainable dynamics.

The current system has caused problems for those living in our cities, with an increase in energy demands, air pollution, water consumption, low-density residential areas, etc.

That is, in the medium to long term, unsustainable building may compromise future needs. One of the priorities of the construction sector should therefore be to develop and implement solutions aimed at minimising this problem.

It is important to stress that international and national regulations are currently being introduced to regulate the conservation of the environment and the health of individuals.

As far as Spanish regulations are concerned, Law 38/1999 of November 5th, concerning Building Management (LOE), introduces the basic concepts of the functionality, safety and habitability of buildings.

It is in the Technical Building Code (*Código Técnico de la Edificación* - CTE), approved by Royal Decree 314/2006 of March 17th and complying with the requirements of the LOE, that the term **building sustainability** appears, in addition to the requirement to ensure the safety of individuals, the welfare of society and the protection of the environment.

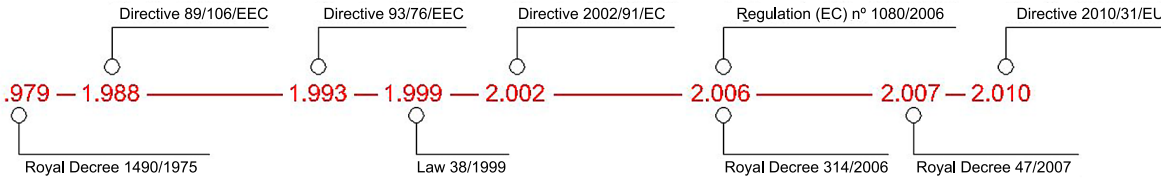
One of the most important aspects of sustainable building is **energy efficiency**. In 2010 in the European Union, the construction sector alone was responsible for 40% of energy consumption and 36% of CO_2 emissions1.

With this in mind, Directive 2002/CE/91, and its transferral to Spanish national law in Royal Decree 47/2007 of January 19th, established the obligation to make the Certificate of Energy Efficiency available to users of buildings.

Since the idea of the CTE is to promote sustainability, a Basic Document (BD) is included with mandatory compliance regarding HE-Energy Saving. The CTE indicates that a building must be designed, constructed, operated and maintained in a way that complies with basic energy saving requirements. This is one of the basic tenets of sustainable construction, i.e. considering the building from its pre-design phase right through until the end of its useful life.

In accordance with Parliament Directive 2010/31/CE, in 2020 the EU will require the application of minimum requirements on energy efficiency, indoor environmental quality and performance in terms of cost-effectiveness for all new buildings, renovations or existing reforms.

Displayed below is a schematic representation showing how the most relevant legislation in the field of energy saving published in the European Union and Spain in recent years has evolved:



Source: Our own compilation based on data from the Boletín Oficial del Estado (http://www.boe.es/), Ministerio de Fomento (www.fomento.es/), Instituto para la Diversificación y Ahorro de la Energía (http://www.idae.es/).

2. SUSTAINABLE DEVELOPMENT

In the report "Our Common Future" (later known as the "Brundtland Report") by the World Commission on Environment and Development in 1987, the term **sustainable development** was first defined as *that which meets present needs without risking that future generations will be unable to meet their needs2*. In the last three decades the concept has evolved, and by means of global meetings and initiatives at different levels (the World Conference in Rio de Janeiro in 1992, or the UN World Summit on Sustainable Development in Johannesburg, 2002) it has become an institutional concept, becoming a part of political discourse and action plans.

Contrary to widespread belief, sustainable development is not merely an environmental factor. While the multiple theoretical perspectives that characterise it mean that the concept of sustainable development may appear ambiguous, the accepted consensus is that it is a combination of three basic elements operating at once: the economy, society and the environment._

With sustainable development *a company finds a sound balance between its **economic success**, **environmental impact** and long-term relationship with its **social environment**3*.

In the building industry specifically, **sustainable building** has three verbs associated with it: reducing, conserving and maintaining. It is based primarily on the principles that Charles J. Kibert listed in 1994: the conservation of resources, the re-use of resources, the use of recyclable and renewable resources in construction, lifelong management of the raw materials used (with the corresponding prevention of waste and emissions), reduced use of energy, increased quality (both in terms of materials, and of buildings and the urban environment) and environmental protection4.

The benefits of applying criteria of sustainability to building are reflected in what is known as the "Triple Bottom Line":

- **Economic Benefits**
  - It reduces operating costs.
  - It increases the value as an asset.
  - It optimises costs in accordance with the concept of Life Cycle Cost.
- **Social Benefits**
  - It increases user satisfaction.
  - It increases productivity and reduces absenteeism.
  - It leads to an overall improvement in the quality of life.
- **Environmental Benefits**
  - It reduces the impact on the environment.
  - It helps to protect natural resources.
  - It optimises efficiency.

3. BUILDING CERTIFICATION SYSTEMS

In order to inform customers and other stakeholders, certifications distinguish organisations that actively contribute to sustainable development.

In the case of building, the voluntary systems for assessing and certifying buildings provide a standard against which to compare the levels of sustainable design and efficiency of these buildings in order to decide whether they warrant environmental certification.

The green certifications are not limited simply to assessing and certifying energy efficiency, but also include criteria relating to sustainability (the economy, society and the environment). A forerunner to the system can be found in **energy efficiency certifications** for buildings, such as the pioneering *Passivhaus* design standards, began as early as the 1970s with the construction in Darmstadt (Germany) of the first house based on this concept.

Voluntary **assessment and certification systems** for buildings are carried out by the **Green Building Councils**, private non profit-making associations of businesses and organisations in the industry. The Green Building Councils combine to form the private non profit-making international association known as the World Green Building Council (WGBC), the most influential organisation in the green building market5. The WGBC's mission is *to facilitate the global transformation of the construction industry towards sustainability using market-driven mechanisms*. Each Green Building Council either develops a classification system or adopts one of those already in place.

Below are some of the most relevant classification systems associated with the WGBC:

Classification system	Main scope	Number of projects certified
BREEAM (Building Research Establishment Environmental Assessment Method for buildings)	The United Kingdom, the Netherlands	200,000 (2011)
LEED (Leadership in Energy and Environmental Design)	The United States, Canada, India	8,479 (2011)
Green Star	Australia, New Zealand, South Africa	366 (2011)
IGBC (Indian Green Building Council)	India	195 (2011)
(Deutsche Gesellschaft für Nachhaltiges Bauen)	Germany	168 (2011)
CASBEE (Comprehensive Assessment System for Building Environmental Efficiency)	Japan	80 (2010)

Source: Own compilation based on http://www.breeam.org, http://www.usgbc.com, http://www.gbca.org.au, http://www.igbc.in, http://www.dgnb.de, http://www.usgbc.com

It should be noted that 2009 saw the establishment of the Spanish Council: the *Asociación Green Building Council España*6, an autonomous, non-profit organisation affiliated to the WGBC. GBC España has now been recognised as an Established Council (full member) of this organisation. GBC España has developed its own assessment system, *GBC España - VERDE*.

At present GBC España only certifies residential and office type buildings. They are currently developing assessment methods that will enable GBC España to expand the certification to include other types of building.

3.1. LEED

At the moment, of all the building certification systems, the one which has the greatest international presence is the LEED certification system. Developed by the U.S. Green Building Council (USGBC), the pilot project was launched in 1998[7]. LEED promotes sustainable building in which priority is given to a balance between existing technologies and emerging concepts. It provides a tool for recognising projects that implement strategies aimed at minimising the associated environmental impacts. The LEED system certifies buildings rather than companies' environmental aspects, products or materials, which would be certified, for example, using eco-labelling or management systems.

Sustainable construction has changed the way buildings are designed, constructed and managed, and embraces the **Integrated Design Process**, a proc-

ess that continues from the pre-design phase right through until the end of the building's life. LEED promotes the Integrated Design Process. This means that all those involved in a project (engineer, owner, builder, architect, maintenance staff, etc.) come together in the pre-design phase to determine the requirements and objectives, with these being reviewed periodically during the project to assess compliance.

While this LEED philosophy of designing, building and maintaining based on an Integrated Design Process is not new in the building industry, it is not widely implemented. As an example, thanks to the Integrated Design Process, rather than installing an inappropriate lighting system in a building involving higher consumption and maintenance, a system will be chosen, designed and calculated taking into account the objectives to be achieved.

In LEED, the important terms are **Life Cycle Assessment** (LCA) and **Life Cycle Cost** (LCC). LCA takes into account the building and the materials and facilities of which it consists throughout all the phases of its life, thus minimising the negative impacts the building may have on the environment during construction, occupancy and maintenance.

In the case of LCC, not only the costs of the building during the design phase and construction are considered, but also those associated with maintenance, energy consumption, water, etc. during the life of the building and the residual value of the building. Based on this LCC, it can be confirmed for example that it is more cost efficient to install one type of cooling system compared to another more conventional system even though the initial investment may be higher.

The perception we have of sustainable construction is that it is much more expensive than the traditional approach. Yet in reality a green building involves an additional cost that varies from 1 to 7% depending on the level of certification aimed for8.

As for savings, in LEED buildings built in the U.S., energy consumption has fallen by 25 to 50%, CO_2 emissions by 30 to 40%, water by 40% and waste by 70%.

LEED can be applied to all building types, since there are several LEED Sustainable Building Rating Systems, depending on the type of action to be performed and the subsequent use of the building:

- **LEED-NC** (New Construction), LEED for New Construction and Major Renovations.
- **LEED-EB: O&M** (Existing Buildings: Operations & Maintenance), LEED for Existing Buildings: Operations and Maintenance.
- **LEED-CI** (Commercial Interiors), LEED for Commercial Interiors.
- **LEED-CS** (Core & Shell), LEED for Cores and Shells.

- **LEED-ND** (Neighbourhood Development), LEED for Neighbourhood Development.
- **LEED SCH** (Schools), LEED for Schools.
- **LEED-HC** (Healthcare), LEED for Healthcare Centres.
- **LEED-Retail**, LEED for Retail Outlets.
- **LEED-Homes**, LEED for Homes, the sole system that can only be applied in the United States and not externally.

LEED provides an assessment of the sustainability of the building, evaluating their impact in accordance with the main categories: Sustainable Sites (SS), Water Efficiency (WE), Energy and Atmosphere (EA), Materials and Resources (MR), Indoor Environmental Quality (IEQ) innovation in a design or process (ID), Regional Priorities (RP), etc. To this end, these categories are structured around a set of mandatory prerequisites and optional credits which must be satisfied in order to obtain the points required to access one of the four levels of certification: Certified (40-49 points), Silver (50-59 points), Gold (60-79 points) and Platinum (80+ points). The Green Building Certification Institute (GBCI) is responsible for administering LEED certification for all projects.

Up to September 2011, over 8470 projects have been certified (14 of which have been in Spain) and in excess of 23,700 projects registered (63 of which have been in Spain). Although most of the projects are located in the United States, its scope includes more than 41 countries. Buildings as iconic as the Empire State Building in New York have achieved LEED certification9. In Spain, mainly office buildings and commercial areas have been certified; however, the projects being assessed include housing, logistics centres, schools, sports centres, etc., which demonstrates the flexibility of the system.

The building rating systems are constantly evolving to adapt to the market and to resolve the deficiencies noted by the various specialists. In 2012 the USGBC will launch the new version of LEED, and along with representatives from seventeen countries is developing the **International LEED** programme, to ensure that the classification system will include local criteria to aid in implementing certification outside of the U.S. This process is expected to be completed by late 2011. Its innovations include absolute values based on the measurement of performance which will replace, wherever possible, the referenced standards.

According to a collaboration agreement signed between the USGBC and GBC España, the USGBC recognises GBC España as the Spanish representative in the development of the International LEED programme, as well as a channel for offering all the information about the LEED tool in Spain.

3.2. LEED buildings with ceramics as a construction material

What does all this mean for the Castellón ceramic industry?

The commitment to sustainable construction is of particular importance for the ceramic tile industry as a producer of construction materials that contribute to the achievement of third-party environment certifications.

By their very nature, ceramic tiles can contribute to the acquisition of LEED credits in the following categories:

- **Materials and Resources**: re-use of the building (MR credit 1.2), management of construction and demolition waste (MR credits 2.1 and 2.2), recycled material content (MR credits 4.1 and 4.2), regional materials (MR credits 5.1 and 5.2).

Since ceramics are materials that have the same longevity and lifetime as the building, they can contribute to obtaining 1 point with credit MR 1.2 by helping to meet the demands of this credit in terms of maintaining the non-structural interior elements in the reuse of a building.

It is also important to stress that ceramics, being inert materials, can be used as a filling material after the useful life of the building, so that if a building is recycled or if 50 or 75% of non-hazardous construction and demolition waste is recovered, 1 or 2 LEED points will be obtained respectively.

In the category of recycled material, it should be noted that the LEED requirements require the builder to *use materials with recycled content such that the sum of post-consumer recycled content plus one half of the pre-consumer content constitutes at least 10% (which would provide 1 point) or 20% (2 points), depending on the cost, of the total value of project materials*. The value of the recycled content of the manufactured product is determined by weight. The recycled fraction of the product is then multiplied by the cost of the product in order to determine the recycled content value10.

The formula for calculating the recycled content of a material is: (mass of recycled material/mass of product) x 100. This formula is the assessment methodology proposed in Standard UNE-EN ISO 14021, Ecolabel Type II11. It should be noted that the 10% or 20% is not required for each material of the project, but rather that these percentages are applied to the total value of the project materials.

In relation to the concept of regional materials, ceramic products can help in obtaining 1 or 2 points if 10 or 20% respectively of the total cost of the value of the project materials are extracted, manufactured or recovered within a radius of 800 km from the location of the project, thereby reducing the environmental impact caused by transporting them.

- **Sustainable sites:** the heat island effect (Credit SS 7.1)

For the LEED programme it is important to reduce the heat island effect that occurs in urban areas due to accumulation of heat, i.e. to reduce the temperature difference between developed and undeveloped areas. Among the different strategies that LEED presents for this section is the use of paving materials with a Solar Reflectance Index (SRI) greater than 29, which would provide 1 point.

For example, light-coloured ceramic products can replace traditional exterior paving materials on pavements, patios or parking areas, since they have a high SRI that minimises heat absorption or the heat island effect.

- **Environmental quality of indoor air:** materials with low VOC emissions (EQ Credit 4.3).

There is growing concern about the impact that Volatile Organic Compounds (VOCs) may have on people's health. For this reason, LEED seeks to reduce the amount of indoor air in a building that is irritating or dangerous to the health and welfare of users due to the vaporisation of carbon compounds by using materials that release no VOC emissions or low amounts of these. Therefore, the use of ceramic tiles as a general lining on the inside of a building will be awarded the highest score in this section, 1 point.

- **Innovation in design**: (Credit ID 1)

Exceeding the credit requirements and/or proposing a project strategy not covered by LEED that provides measurable environmental benefits is rewarded with a maximum of 5 points.

In this sense, the ceramics industry has made significant progress in reducing the environmental impact of its production process and launching on the market products that are innovative in terms of sustainable building materials, such as ceramics with a photoluminescent coating that accumulates incident light and returns it by shining in the dark; or incorporating a catalyst glaze which, in the presence of sunlight and humidity, causes pollutant emissions (NOx and HNO3) in urban areas to react, transforming them into substances that are harmless to human health (nitrates); or tiles that are resistant to dirt; self-cleaning tiles; among others.

The effort being made in R&D to develop solutions that contribute to the sustainable development system is not profitable if it is not visible. The companies in the sector have understood that they need to communicate their achievements and the environmental benefits of using their products, with initiatives ranging from specific websites, eco-labels, third party verification, self-declarations or other external communication activities. In line with this, in 2010 the Spanish Ceramic Tile Manufacturers' Association (ASCER)12 presented the Lifecycle Analysis of the sector, a study providing real and objective information on the impact on the environment generated throughout the lifecycle of ceramic tiles, and providing the public with credible information and comparison with other materials.

Below are three LEED-certified buildings in which ceramics are used as recycled and sustainable materials. As can be seen, the term sustainable is not incompatible with building design, and ceramics have the possibility of becoming a significant presence in sustainable architecture.

1

2

3

1. Florida High Performance Green House, 2 World Headquarters for IFAW, 3 Third Creek Elementary, Statesville, NC. Source: LEED Case Studies US Green Building Council, Italian Trade Commission (http://www.usgbc.org/DisplayPage.aspx?CMSPageID=2359)

4. CONCLUSIONS

This article has focused on the contribution of ceramic tiles to building certification systems, and especially the LEED system, in terms of the interest in the topic detected among stakeholders in the ceramic sector.

Since ceramic products are long-lasting and inert, with a significant recycled material content and capacity to minimise heat absorption in addition to their innovation potential, as discussed in previous sections, the ceramics sector is well-positioned with regard to the new building values to compete in the market.

However, working only with issues of resources, waste, pollution, etc. it runs the risk of reducing its actions to a single aspect of sustainable development: the environmental dimension.

If the contribution to sustainable development is to be genuine, it needs to address the complex interactions between **environmental**, **economic** and **social** variables from a comprehensive perspective.

Society as a whole, and in particular companies as key players, must engage in a process of change that demands the participation of everyone, and addresses problems that are very real and not in the least utopian as some sceptics maintain: i.e. air pollution, climate change, the destruction of resources, social segregation and exclusion and poverty, among others.

Now more than ever, as stressed in the conclusions of the latest National Congress of the Environment, CONAMA10, *we need to act and give a sharp turnaround towards a more sustainable world*. While it is true that for decades there have been

calls for a change towards greater sustainability, the economic crisis has shown us that there is an urgent need to reshape current patterns of production and consumption13.

This change of mentality is not a trend; it is a development system that is here to stay, and which is referred to as a *new ideology based on working together for sustainability*. As pointed out by the Observatory of Sustainability in Spain in its 2010 report: *the solution to the crisis is to establish processes that allow an absolute decoupling between economic growth and environmental degradation and the use of resources (producing better with less), while incorporating criteria of "sufficiency" aimed at a rational consumption14*. In short, combined with necessary policies for external communication, sustainability is a sound and strategic concept which has all the signs of becoming a driving force for change in order to boost the economy and to position Spain among the world leaders in this field.

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