Renewable and Sustainable Energy Reviews 82 (2018) 950–960

Contents lists available at ScienceDirect

Renewable and Sustainable Energy Reviews

journal homepage: www.elsevier.com/locate/rser

Critical review and methodological approach to evaluate the differences among international green building rating tools

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ARTICLE INFO

Keywords:
Sustainability
Green buildings
Rating tools
Methodological approach

ABSTRACT

Building performances play a fundamental role in the worldwide energy scenario. In the last years, many countries have developed certification procedures in order to rate the environmental sustainability of buildings, aiming at reducing energy consumptions and environmental impacts during the construction, management and operational phases of a building.

This study firstly provides an overview of the different certification procedures employed in several countries all over the world, considering also which Green Building Rating System (GBRS) is only applied in its own country and which one is developed in other countries by means of proper adaptations. Five widespread and well known green building rating systems (CASBEE, Green Star, BREEAM, LEED and ITACA) are then analyzed in detail and differences and similarities among them are highlighted. To this aim, six new macro-areas (site, water, energy, comfort and safety, materials and outdoor quality) are defined and a normalization procedure is implemented, in order to provide significant information about the sustainability aspects taken into account in the different rating tools and aiming at comparing them. This comparison allows to identify the main features of the five tools and to highlight qualitative and quantitative differences. The analysis shows that the certification tools are not homogeneous from both points of view.

The aim of this work is to understand which issues have more influence on the final performance rate of each system and to give to final users a deeper knowledge of the aspects included in these tools.

1. Introduction

The world global energy consumption has been continuously growing in the last years and it seems that this growth will continue at least in the near future [1]. It is well known that in developed countries the building sector is responsible of about 40% of the total energy use [2]. As a result, increasing buildings energy efficiency is a primary goal [3–5] and many solutions have been studied and suggested in order to improve this aspect [6–8]. Indeed, energy-labelling procedures were developed by various countries in order to assess buildings energy performance [9–12]. Besides the fact that increasing energy efficiency is one of the most important issues for governments, there is the need to assess building performance from a broader perspective, taking into account also the environmental, social, and economic impacts of constructions. The concept of sustainable development, which dates back to the '70 s [13], has become increasingly important in recent years, embracing several different fields and being applied to widely different territorial scales. As a matter of fact, a measure of sustainability is fundamental to evaluate competing alternatives when a selection of materials, energy resources, production processes design choices, locations for building placement has to be performed [14]. In this framework, the concept of green building has come to light and many definitions can be found in literature. For instance, Kibert defined a green building as: "… healthy facilities, designed and built in a resource-efficient manner, using ecologically based principles" (p. 9) [15]. According to Robichaud and Anantamula, there are four pillars of green buildings: the minimization of environmental impact, the enhancement of health conditions of building users, the economical returns to investors and local community, the life cycle impacts on the planning, development and operational phases [16].

In this context, in order to estimate buildings sustainability level, the so-called green rating systems were developed in the last years. While energy efficiency labelling is generally mandatory, sustainability labelling is still mostly made on a voluntary basis.

They consist in methodological approaches able to evaluate the environmental sustainability of buildings by analyzing their energy

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http://dx.doi.org/10.1016/j.rser.2017.09.105
Received 29 April 2017; Received in revised form 20 July 2017; Accepted 26 September 2017

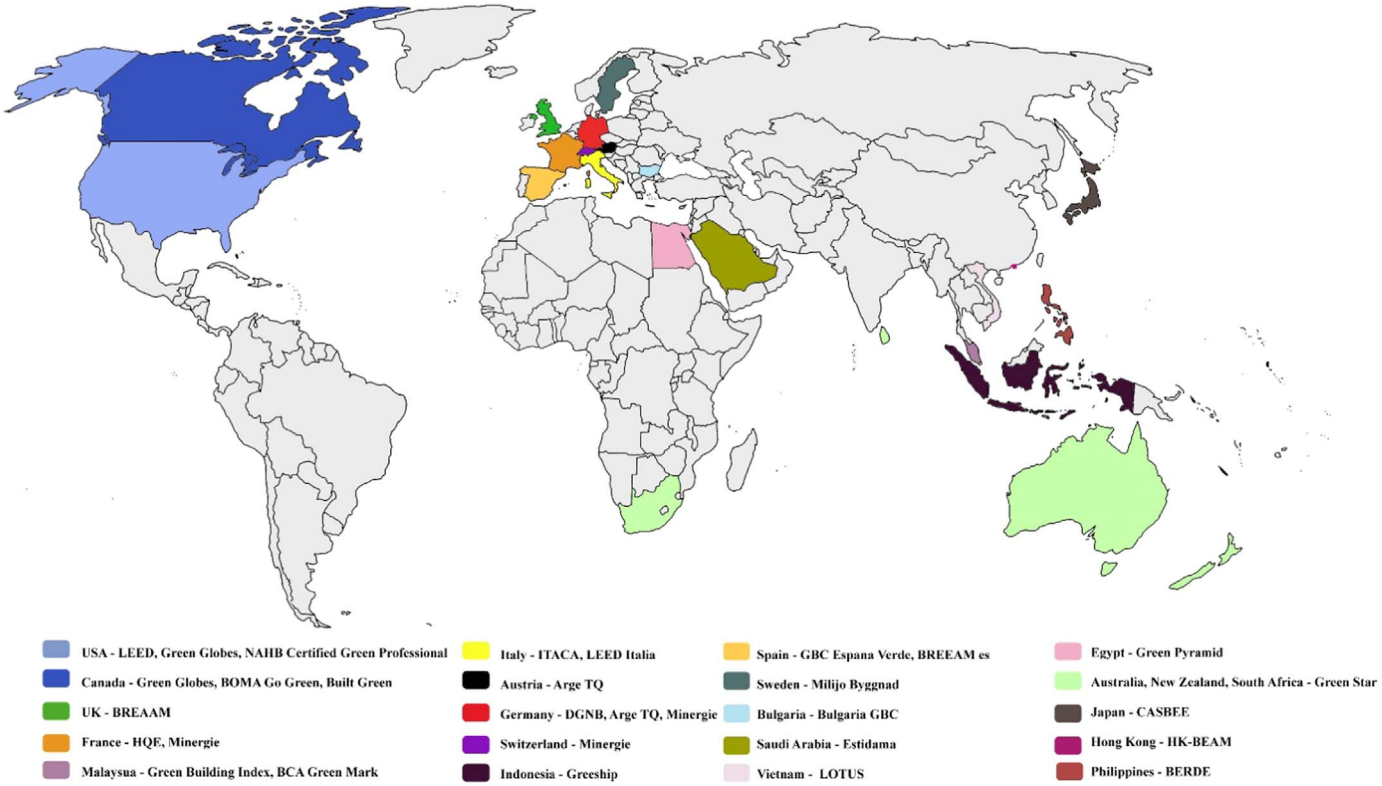

Fig. 1. A global map of Green Building labelling systems.

consumptions, the characteristics of the site, the indoor well-being and the effects on human health. In these tools, energy efficiency is actually one of the main ingredients [17] but energy efficiency and sustainability may be also conflicting [18,19].

Starting from the different characteristics, objectives and standards requirements of each country worldwide, several green rating systems were accordingly developed.

Two kinds of approaches have been followed for implementing the rating systems [20]. The first one is based on a multi-criteria credit system: a certain amount of credits within a prescribed range is assigned to each issue/topic in a set of specific categories that are considered to have an impact on the overall building sustainability. The second approach is based on synthetic environmental indicators quantified by means of a Life Cycle Assessment (LCA) procedure. The latter procedure is a scientific method to assess the environmental impact of buildings, but it is more complex and onerous than the criteria-based system. The most widespread Green Building Rating systems are therefore based on the multi-criteria approach.

Both international and national rating tools have been developed worldwide (Fig. 1). The most famous and widespread international tool is LEED (USA) [21], which has been also declined into many national versions; Green Star (Australia) [22] is also quite famous and it has been customized with national versions in New Zealand and South Africa; other examples are BREEAM [23], Arge TQ [24], Minergie [25], Green Globes [26]. Example of national tools also provided with an English version are CASBEE in Japan [27], DGNB in Germany [28], Green Pyramid in Egypt [29]; finally national tools only available in the language of the original country are for example ITACA Protocol in Italy [30] and Haute Qualité Environmentale, HQE, in France [31]. Alternative systems to the most famous protocols often coexist in various countries (as in USA, Canada, Germany).

Building sustainability can be assessed by means of several labelling tools, which are characterized by different calculation methods, credits, weights and issues taken into account in each of these protocols. These differences can highly impact on the final scores, which result to be very different from each other [32,33]. It is also worthy to notice that the green building rating tools are defined according to local climatic and geographic conditions [2] and these differences are the consequence of the adaptation of sustainability concept at a local level. In fact, as stated in [34] and [35], the weights of well-known green building assessment tools cannot be globally applied since they may not be suitable for each specific country. But, in the globalized world, the buildings sustainability level should be hopefully comparable among different countries in spite of their distinctive features. The energy efficiency concept is applied at a local level with different strategies according to climatic, cultural and geographical conditions, but the pillars and targets on which this topic is based should be worldwide shared. Similarly, the sustainability concept is declined in each country as needed, but it is also necessary to define the boundaries of the evaluation of this “local” sustainability [36]. At present, common topics have not been yet defined at a global level and huge differences do exist among the green protocols, so that a building which is assessed as “green” in one country can achieve a low sustainability score in another country.

As highlighted in [37–39], most of these labelling tools lack important indicators which can be used to assess the sustainable performance of building envelopes such as material efficiency, economic efficiency and indicators based on life time parameters (life cycle cost, embodied energy etc.). Thus, there is the need to identify the most appropriate sustainability indicators which can incorporate the most relevant sustainable issues and make them adaptable for different local situations in terms of specific credits and weights. This would allow to define the pillars of the “global” sustainability concept, which should be worldwide recognized, and, at the same time, to adjust them to each country, in order to assess sustainability performance at a “local” level. In [38] a questionnaire survey was carried out with public and professional experts for identifying common sustainable energy performance indicators for residential building envelope. These results corroborate findings from the reviewed literature indicating that sustainable performance has to be appraised by integrating a huge