

# *A Comparison of Typical Green Building Evaluation Systems*

## *—Taking China, UK and USA as Examples*

Xingyu Zhang<sup>1,a,\*</sup>

<sup>1</sup>College of Art, Shandong Jianzhu university, Jinan, Shandong Province, 250101, China

a. zxy17861535856@163.com

\*corresponding author

**Abstract:** The international investigation of green buildings is steadily transitioning from simple concepts to practice, and the assessment criteria for enhancing green buildings are conducive to enhancing the understanding of green buildings' healthy development. By following the green building movement, this research examines the fundamental meanings of green building systems in China, the United Kingdom, and the United States. The paper analyzes a variety of potential new issues. For instance, the current green building assessment system has a small number of problems and limitations, and the formation of a system suitable for national conditions and flexible operation is currently a larger problem. Through analysis of the problem, the direction of work to implement the green building system and improve the fundamental concept of China's green building system will be suggested.

**Keywords:** green building, green building assessment system, evaluation methods, suggestions for improvement

## 1. Introduction

With the advancement of science and technology and the improvement of productivity development, humans are confronted with a series of environmental challenges, and the requirements for green and environmental sustainability are increasing, so the traditional way of development is no longer suitable for the current stage of development, which is why the rise of the green revolution, first in the construction industry, and simultaneously to produce a set of green building materials.

In recent years, the green building rating system in a number of nations has progressed toward the formation of a labeling system [1]. The operation mode of the leading green building evaluation system has provided a model for other countries to follow in establishing a green evaluation system. However, the existing green building evaluation system primarily focuses on the value and vitality brought by the building itself. By comparing the operation models of other countries, this paper seeks to identify an operation system that is compatible with the environment and focuses on the value of the building.

This paper adopts a comparative methodology, using the Leadership in Energy & Environmental Design Building Rating System (LEED) and the Building Research Establishment Environmental Assessment Method (BREEAM) as reference objects for comparison and analysis, in order to identify

the flaws in its own evaluation system and make continuous improvements. The study will uncover the flaws in our own evaluation method and contribute to constant improvements.

## **2. Background**

### **2.1. Green Building Concept**

Green building is a concept centered on the reduction of energy consumption and environmental damage caused by buildings; it is also known as eco-building and sustainable building. This form of structure achieves high resource efficiency with minimum environmental effect and offers a comfortable, healthy, and secure living and working environment [2-3]. Modern architectural design promotes the principles of low energy consumption and sustainable development; accordingly, the use of green building performance is being rapidly encouraged and taken into consideration. The design concept of a green building is to combine a figurative architectural object with an abstract environment with the characteristics of resource reuse, adopt a green design concept to ensure that the use of various resources is minimized, scientifically use natural resources, and realize the building's own self-regulation.

### **2.2. The Relationship Between Green Building Systems and Green Buildings**

The green construction system is founded on the ecosystem's virtuous cycle, with "green" economy, society, technology, and environment as its foundation, connotation, support, and symbol. "Green" represents a new building system [4]. At a time when there is a significant demand for green buildings, the first difficulty to tackle is how to evaluate whether a building fits green building standards, and governments have developed a rigorous evaluation system. These include the U.S. Green Building Council's LEED rating system. It is utilized in about 200 countries and is the most comprehensive and important building environmental assessment, green building assessment, and building sustainability assessment standard. The first and most popular green building assessment method is BREEAM, developed in 1990.

There are numerous specialized green building system assessment standards around the world, but the United States and the United Kingdom have the most extensively adopted assessment systems. It is evident from this brief description that the assessment criteria for China's green building system need to be improved and that the problems at this stage are the immaturity of existing green building technology, the imperfection of the green building system, the lack of implementability, and the lack of initial ideas, and that by comparing it with the building systems of other nations, the direction of improvement can be determined and the building standard can be raised.

## **3. Comparison**

There are countless green building assessment systems in existence around the world, and the most famous American and British building assessment systems are used as examples for comparison and analysis with the Chinese assessment system.

### **3.1. Existing Green Building Assessment Systems in China, the UK and the US**

#### **3.1.1. China - Green Building Evaluation Criteria**

a. Use criteria. China's green building evaluation standards were completed in the context of China's vigorous development of a low-carbon economy, in accordance with China's economic development trends; China has proposed the development of energy-saving and land-saving residential and public buildings from the perspective of the practical situation, the harmonious development of man and

nature, the conservation of energy, the efficient use of resources, and the protection of the environment. Additionally, trial implementation of green building evaluation standards has begun in a number of places.

b. Applications. The data shows that in 2008 just 10 projects across the country obtained the green building evaluation mark for green buildings, covering a total of only 1,412,200 square meters. As of the end of 2018, approximately 14,000 building projects across the country have been awarded the green building evaluation mark, representing an annualized growth rate of 1.02% [5]. Table 1 shows that the number of Star Mark-certified green buildings in China expanded fast in 2012 and continued its upward trend into 2013.

Table 1: Number of green building star projects in China, 2008-2012.

Time (in years)	Number of 1-star projects	Number of 2-star projects	Number of 3-star projects
2008	4	2	4
2009	4	6	10
2010	14	44	24
2011	76	87	78
2012	141	154	94

### 3.1.2. UK—BREEAM

a. Use criteria. BREEAM is a tried and tested evaluation system for both new and existing buildings, with multiple versions of assessment criteria for different building types. It was developed by the BRE in 1988. BREEAM is applicable worldwide. It is the first and by far the most successful assessment system in the world, and its open and transparent nature has led 25-30% of UK buildings to be assessed using it, as well as other regions and countries to model their local green building assessment systems on it, or even directly after it [2].

b. Applications. To top it all off, it's the gold standard for environmental building evaluation and has been around longer than any other method. It defines the gold standard for sustainable design and evaluation criteria in construction. To date, BREEAM has certified approximately 110,00 structures, and another 500,000 are registered for assessment [6]. The assessment of over 2.2 million structures in 78 countries has resulted in the issuance of over 560,000 certifications.

### 3.1.3. USA—LEED

a. Use criteria. The LEED rating system considers the building's effect on the environment across six categories: sustainable sites, water efficiency, energy and air, materials and resources, indoor air quality, innovation and design process. Indicators in each of these categories are used to assign a score to each building, and the total score is then used to assign one of five quality levels (Platinum, Gold, Silver, Bronze, or Certified) to the structures under review. According to the assessment results, a building's "greenness" is classified as "platinum," "gold," "silver," "bronze," or "certified" [7]. As of right now, it's the gold standard for evaluating effectiveness.

b. Applications. As of June 2010, there were 27,581 LEED registered projects in the market; as of October 2010, 278 projects had been registered in China, covering an area of 15 million square metres, and 70 projects had been certified [6].

### 3.2. Comparing Building Assessment Systems in China, the UK and the US

Table 2: Comparison of three national green building assessment systems.

	Green Building Evaluation Criteria	LEED	BREEAM
Origins	China	United States	United Kingdom
Institutions generated	Green Building Council	Green Building Council	Building Research Institute
International evaluation	—	The most commercially successful green building rating system	The earliest green building assessment system
Applicable buildings	Residential, office, shop and hotel buildings	Six types of new and existing buildings, houses, communities, etc.	Eight types of new and existing office buildings, educational buildings, etc.
	Green Building Evaluation Criteria	LEED	BREEAM
Evaluation methods	One star, Two stars, Three stars	Through, silver, gold and platinum	Pass, good, very good, excellent, outstanding, performance of one to five stars
Evaluation content	1.Land saving and outdoor environment 2.Energy efficiency and energy use. 3.Water Conservation and Water Use. 4.Material saving and material resource utilization. 5.Indoor environmental quality. 6.Operations Management.	1.Sustainable site planning 2.Improving water efficiency 3.Energy and Atmospheric Environment 4.Materials and Resources 5.Indoor environmental quality 6.Innovative design	1.Management 2.Health and comfort 3.Energy 4.Transportation 5.Water saving 6.Materials 7.Land use 8.Ecology 9.Pollution
Usage cycle	None	None	Yes

China's green building evaluation standard employs a star rating standard, known as the 'three-star rating system,' which was implemented by the Ministry of Construction in 2005 (see Table.2). The other two countries also use rating systems in their evaluation methodologies. A building can receive one star for minimal compliance with green building requirements, two stars for superior performance, and three stars for outstanding achievement in this voluntary system. Energy and water efficiency, indoor air quality, waste management, and materials selection are just a few of the many topics that are addressed by the standards. The United States Leadership in Energy and Environmental Design (LEED) certification is the most advanced and practical worldwide scoring system for green building certification, awarding points on a scale from zero to one hundred and ten for each category. Sustainable site planning, water resource protection and conservation, energy use efficiency, use of renewable energy sources, material and resource issues, and indoor environmental quality are the five criteria against which a building is graded. Certificates and medals are given out for each of the four levels that are certified based on the scores: Certified (40-49 points), Silver (50-59 points), Gold (60-79 points), and Platinum (80 points or more). The British BREEAM system was the first of its kind and evaluates a building's eco-friendliness based on ten different indicators: energy, management, health and comfort, transportation, water, materials, waste, land use, pollution, and ecology. The final score is then multiplied by the corresponding environmental weight for each indicator to determine the building's certification level. I.e., pass, good. The evaluation may be conducted within a high-quality framework because BRREAM has its own rigorous evaluation standards and operational guidelines [8].

In terms of applicable types, LEED is comparable to BRREAM in that it covers nearly all building types, has a broader scope of evaluation, and takes into account the relationship between building type, building mass, and climate when establishing evaluation criteria, whereas China's green building evaluation is still in its infancy, covering primarily basic buildings.

The US LEED focuses more on the development and promotion of the building for business, and more on the enhancement and return of the building value, with better commercial use and market positioning, whereas the UK BREEAM focuses more on the comprehensiveness of the building evaluation and the advanced construction technology, as well as the mutual harmony between the building and the natural environment. China's green building evaluation system is still in the process of development and is presently primarily based on the LEED model mixed with the current scenario.

### 3.3. Analysis of Advantages and Disadvantages

This chapter provides a concise comparison of the three green building evaluation systems by outlining their respective benefits and drawbacks.

Table 3: Strengths and weaknesses of three national green building evaluation systems.

Green Building Assessment Criteria	Advantages	Limitations
BREEAM	1. The evaluation framework is flexible and transparent, and the assessment conditions can be increased according to the actual situation	1. The system was developed on the basis of the UK situation and does not take into account the regional issues of other countries, resulting in its adaptability being limited

Table 3: (continued).

BREEAM	2. The most significant advantage is that the whole life cycle of the building is examined and the useful life of the building is valued. 3. The assessment process is simple and open, easy to understand and accepted	2. The assessment process is complex and requires a number of BRE licensed professional valuers to operate, which is costly in terms of time
LEED	1. The entire system is designed to be simple and easy to understand, making it easier to implement assessments 2. It has become a model for most countries to establish green building and sustainability assessment standards 3. The adoption of a third-party certification mechanism increases the authority of the system	1. The environmental impact of a building throughout its life cycle is not fully examined 2. The assessment does not set negative values for environmental performance scores, and the evaluated person may choose a design strategy based on cost or the ease of meeting the requirements
Green Building Evaluation Criteria	1. Upgraded evaluation methods, constantly adjusted and improved according to national conditions. 2. The structure system is tighter and the operability is more rational 3. The evaluation criteria are clearer and more explicit, and the criteria become more flexible	1. The evaluation system does not have universal applicability 2. Has multiple indicators and is relatively complex to manage 3. The evaluation process has a large workload and high time cost 4. There is a certain error in the accuracy of the evaluation system

In summary, the formation of an international green ecological building system is in a phase of rapid development, continual improvement, and renewal, and valuable experience has been gathered, but there are also several issues that need to be resolved and fixed.

#### 4. Countermeasures

In compared to the United Kingdom and the United States, China's green building system still lacks a significant amount of practical experience and technology, and many professional research areas are not extensively integrated. The following recommendations are given in this regard.

For the evaluation of green buildings is a very complex project, China's research in this area is limited and the connection between theory and practice is not strong enough; therefore, the theoretical research must be expanded, the green building evaluation system must be integrated with other components, and a complete theoretical foundation must be established.

Government agencies increase support for green building and sustainable development, create a relative encouragement system, bolster the establishment of rules and regulations, and continually enhance the regulatory framework.

In China, the same standards are applied to all buildings of the same type, without distinguishing between the nature of use and the age of use, which leads to differences with the actual situation.

According to China's natural conditions, the assessment system should be further subdivided and different types of construction evaluation systems should be established.

## 5. Conclusion

The establishment of a scientific and fair green building assessment system is crucial to the industry's future growth, making green building the dominant trend. In comparison, the foreign excellent building assessment system for China provides a lot of information with reference value, but there are also many problems; thus, China's green building system, while learning from foreign systems and combining them with China's specific development needs, is still in its infancy.

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