

A Review on various Green Building Rating Systems in India

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Abstract— The growth and development of our society has a large impact on our natural environment. The research, design stage, construction and operation of the buildings in which we live and work are responsible for the consumption of many of our natural resources. The rating systems set benchmarks for green initiatives for constructing and using buildings to make them sustainable and energy efficient buildings thus to reduce their negative impacts on environment. The most recommended green building evaluation criteria in India are Leadership in Energy and Environmental Design (LEED), Indian Green Building Council (IGBC) and Green Rating for Integrated Habitat Assessment (GRIHA). This paper focus on the study of LEED, IGBC and GRIHA rating system and compare those rating systems with regards to their evaluation methods; scopes, performance criteria and energy rating measures. Through this study, an attempt is made to make clear understanding of LEED, IGBC and GRIHA rating system evaluation criteria that need to be considered during comparison. From this comparative study one can make a general checklist study which cover each and every aspect required for evaluation and certification for any building project.

KEYWORDS— LEED; IGBC; GRIHA; STYLING; RATING SYSTEMS; SUSTAINABLE BUILDING

1. INTRODUCTION

Green building in other phrase is a practice of green construction or sustainable building. It deals with, both structural and application of processes that are eco-friendly and resource-efficient throughout a building's life-cycle: from planning to design and execution such as construction, operation, and maintenance, renovation, and demolition [1]. This process is accomplished with the help of skilled labors corresponding to the consultants, the contractors, the engineers, the architects and the clients [2]. The main aspects of Green Building practices contribute to the designing of classical building related to economy, durability, utility, and comfort [3]. The benefits of green building include reduction of water and energy consumption, reduction of ecological footprint, and the improvement of the quality of workspace. The basic function of the conventional building is to impart shelter. Apart from this, the green building provides Visual comfort and Thermal comfort. These 'comfort zones' can be provided artificially or naturally. Moreover, these zones respond to the Local and Global conditions. It is important to say that the increase in energy demand and excess greenhouse gas emissions to the environment leads to the framework of energy efficient buildings in the modern construction industry [4]. The two scenarios which are closely interlinked are environmental and global energy. On the other hand, the consumption and supply of energy lead to the wider environmental issues including air contamination, deforestation, ozone decimation, and the radioactive waste [5]. As the building sector is responsible

for more than 40% of the total primary energy consumption of World's energy consumption, and about 30% of the total emissions of CO₂. It plays a key role in solving these environmental issues [6]. Due to the rapid increase of energy consumption, enfeeblement of energy resources and environmental concerns around the world, the implementation of green building has a significant attention in the society. It is said that, between 2010 and 2040, the expected increase in the global energy usage is 56% [7]. The implementation of green building rating system is essential in the current world energy scenario. It reduces the energy consumption without compromising the comfort zonal levels with minimum operational costs. The lifecycle costing of the investment is better. In recent decades, the trend in the green building industry has suddenly increased worldwide. The thought of green rating systems of green buildings arises in India. With the global trend, the rating tools set the benchmarks for the green building measures.

For the construction thus to make them sustainable and to reduce the negative impacts on the environment. The points are awarded to the building based on the magnitude of adopted rating measures, thus the total score is achieved to the building after the appropriate weighting. This assist to deliver the various green rating measures in the building construction. A green building is one which optimizes water usage, optimizes energy efficiency, preserves natural resources, produces less waste and thus provides healthier zones for occupants when compared to the conventional building. Green Building is a design conceptualization that minimizes the environmental impinging of buildings

through the advanced land use and construction strategy. Green building incorporates the usage of tidy, inexhaustible energy and efficient usage of natural resources and the usage of recycled or recyclable substances, thus to provide the healthy interiors. The advanced buildings fulfill the needs of artificial human comforts, just in return, have the excess energy and natural resources. On the reverse, Green buildings totalize different eco-friendly concepts and thereby increases the human working efficiency, thereby providing the luxuries with minimum costs. The analysis of the last two decades shows that, there is a significant evolution in the methodologies of rating system that reevaluate the building sector. The rating tool measures with the main focus in the design stage was developed in the beginning of 1990's. But, the actual construction was not so prior. At the beginning of 21ST Century, the rating tool measures shows rapidly increase in the real construction and a minimum focus in the building design. From 2006, the main focus on the green building has raised on the basis of sustainable performance. These performance trend has widened the entailment of sustainable buildings. Based on the parameter of orientation in direction to the construction level and sustainable development changes accordingly with the increasing weight of rating measures for the proper building performance and design. Thus, this leads to an efficacious on the future redundancy of the building sector. LEED, IGBC and GRIHA are the most recognized rating systems in the Indian green building industry. In this approach, the LEED India and GRIHA systems are likely in aims, process. Thus, framing to rate the building performance and to create the corresponding grade levels for the accreditation. Nevertheless, the sustainability rating system differs considerably, from the rating system of one to another long run of measurement of performance of the building, scope and environmental measure within the substructure sector.

2. INDIAN GREEN BUILDING RATING SYSTEMS

2.1 GRIHA

GRIHA - Green Rating for Integrated Habitat Assessment, is India's National Rating System. It was developed by TERI and approved by the MNRE. It follows five 'R' philosophy viz, Refuse, Reduce, Reuse, Recycle and Reinvent. GRIHA attempts to quantify aspects, like Energy / power consumption, Water consumption, Waste generation and Renewable energy integration in order to manage and reduce them [8]. GRIHA is one of the rating systems that help people to evaluate the performance of the building as per specifications that are accepted nationally. It

evaluates the performance of building for its entire life span.

The basic features of GRIHA

The system was developed to 'design and evaluate' new buildings. A building is evaluated based on its performance that was predicted for its entire life span – inception through operation. The stages of the life cycle that are identified for assessment are:

- Pre-construction stage
- Building planning and construction stages
- Building operation and maintenance stage

A) The benefits

This system will benefit the community by decreasing adverse effect on the environment by decreasing GHG (greenhouse gas) emissions, decreasing energy/ power consumption and dependence on natural resources [9].

Some of the benefits of a green building to owner, user, and the society are:

- Reduction in energy consumption without compromising the comfort levels
- Decreased destruction of natural areas, habitats, and biodiversity, and reduced soil erosion etc.
- Reduced air pollution and water pollution (direct health benefits)
- Reduced water consumption
- Reduced waste generation because of recycling and reuse

List of criteria and points for GRIHA are given below:

Table 1: Threshold Criteria for Certification Levels

Sl. No	Criteria	Points
1*	Site selection	1
2*	Preserve and protect landscape during construction/compensatory depository forestation	5
	Soil conservation (post construction)	4
4**	Design to include existing site features	2
5*	Reduce hard paving on-site	2
6	Enhance outdoor lighting system efficiency and use renewable energy system for meeting outdoor lighting requirement	3
7	Plan utilities efficiently and optimize on-site circulation efficiency	3
8**	Provide at least minimum level of sanitation/safety facilities for construction workers	2
9**	Reduce air pollution during construction	2

10	Reduce landscape water requirement	3
11	Reduce building water use	2
12	Efficient water use during construction	1
13**	Optimize building design to reduce conventional energy demand	6
14	Optimize energy performance of building within specified comfort	12
15	Utilization of fly ash in building structure	6
16	Reduce volume, weight and time of construction by adopting efficient technology (such as pre-cast systems, ready-mix concrete)	4
17	Use low-energy material in interiors	4
18*	Renewable energy utilization	5
19	Renewable energy based hot water system	3
20	Waste water treatment	2
21	Water recycle and reuse(including rainwater)	5
22	Reduction in waste during construction	2
23	Efficient waste segregation	2
24	Storage and disposal of waste	2
25	Resource recovery from waste	2
26	Use of low VOC paints/adhesives/sealants	4
27**	Minimize ozone depleting substances	3
28**	Ensure water quality	2
29	Acceptable outdoor and indoor noise levels	2
30	Tobacco and smoke control	1
31	Universal Accessibility	1
32**	Energy audit and validation	2
33**	Operations and maintenance protocol for electrical and mechanical equipment	2
	Total score	100
34	Innovation (beyond 100)	4
	Total points	104

Table 2: Points achieved for GRIHA Rating

Certification levels	Points
1 STAR	25-30
2 STARS	31-35
3 STARS	36-40
4 STARS	41-45
5 STARS	46-50

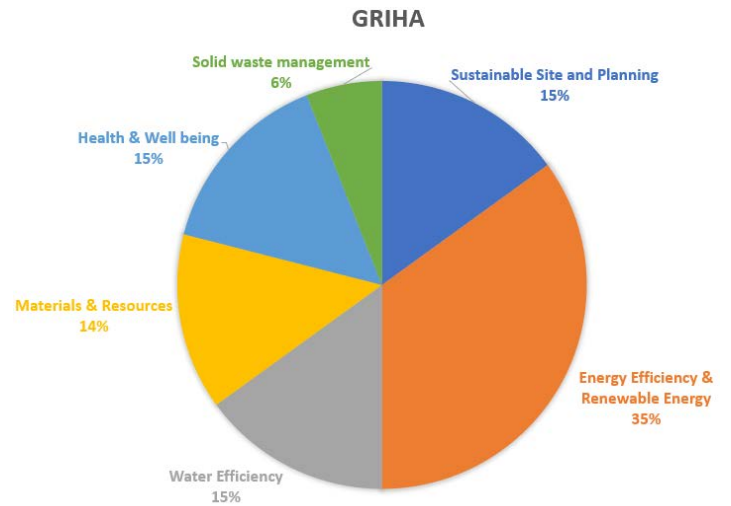


Figure 1: GRIHA Evaluation Criteria

2.2 IGBC

IGBC Green New Buildings rating system is a voluntary and consensus-based programme. The rating system has been developed based on materials and technologies that are presently available. The objective of IGBC Green New Buildings rating system is to facilitate a holistic approach to create environment-friendly buildings, through architectural design, water efficiency, effective handling of waste, energy efficiency, sustainable buildings, and focus on occupant comfort & well-being. The rating system evaluates certain mandatory requirements & credit points using a prescriptive approach and others on a performance-based approach. The rating system is evolved so as to be comprehensive and at the same time user-friendly. The program is fundamentally designed to address national priorities and quality of life for occupants [10].

Some of the unique aspects addressed in this rating system are:

- Recognition for architectural excellence through integrated design approach.
- Recognition for passive architectural features.
- Structural design optimization with regard to steel and cement. This is a developmental credit. Projects are encouraged to attempt this credit, so as to help IGBC in developing baselines for future use.
- Water use reduction for construction. This is also a developmental credit.
- Handholding from IGBC Counsellors will now be available for the projects.

Table 3: Threshold Criteria for Certification

IGBC Green New Buildings Rating System Checklist		Points Available	
		Owner-occupied building	Tenant - occupied building
Modules		100	100
Sustainable Architecture and Design		5	5
SA Credit 1	Integrated Design Approach	1	1
SA Credit 2	Site Preservation	2	2
SA Credit 3	Passive Architecture	2	2
Site Selection and Planning		14	14
SSP Mandatory Requirement 1	Local building regulations	Required	Required
SSP Mandatory Requirement 2	Soil Erosion Control	Required	Required
SSP Credit 1	Basic Amenities	1	1
SSP Credit 2	Proximity to public transport	1	1
SSP Credit 3	Low-emitting vehicles	1	1
SSP Credit 4	Natural topography or vegetation	2	2
SSP Credit 5	Preservation or Transplantation of trees	1	1
SSP Credit 6	Heat island reduction, non - roof	2	2
SSP Credit 7	Heat island reduction, roof	2	2
SSP Credit 8	Outdoor light pollution reduction	1	1
SSP Credit 9	Universal Design	1	1
SSP Credit 10	Basic facilities for construction workforce	1	1
SSP Credit 11	Green building guidelines	1	1

IGBC Green New Buildings Rating System Checklist		Points Available	
		Owner-occupied building	Tenant - occupied building
Modules		100	100
Water Conservation		18	19
WC Mandatory Requirement 1	Rainwater harvesting, Roof, and Non-roof	Required	Required
WC Mandatory Requirement 2	Water efficient plumbing fixtures	Required	Required
WC Credit 1	Landscape Design	2	2
WC Credit 2	Management of irrigation systems	1	1
WC Credit 3	Rainwater harvesting, Roof and Non - roof	4	4
WC Credit 4	Water efficient plumbing fixtures	5	5
WC Credit 5	Wastewater treatment and Reuse	5	5
WC Credit 6	Water metering	1	2
Energy Efficiency		28	28
EE Mandatory Requirement 1	Ozone depleting substances	Required	Required
EE Mandatory Requirement 2	Minimum energy efficiency	Required	Required
EE Mandatory	Commissioning plan for building equipment and systems	Required	Required

EE Credit 1	Eco-friendly refrigerants	1	1
EE Credit 2	Enhanced energy efficiency	15	15
EE Credit 3	On-site renewable energy	6	6
EE Credit 4	Off-site renewable energy	2	2
EE Credit 5	Commissioning, Post-installation of Equipment and Systems	2	2
EE Credit 6	Energy metering and management	2	2
Building Materials and Resources		16	16
BMR Mandatory Requirement 1	Segregation of waste, Post-occupancy	Required	Required
BMR Credit 1	Sustainable building materials	8	8
BMR Credit 2	Organic waste management, Post-occupancy	2	2
BMR Credit 3	Handling of waste materials, During construction	1	1
BMR Credit 4	Use of certified green building materials, equipment	5	5
Indoor Environmental Quality		12	11
IEQ Mandatory Requirement 1	Minimum fresh air ventilation	Required	Required
IEQ Mandatory Requirement 2	Tobacco smoke control	Required	Required
IEQ Credit 1	CO2 Monitoring	1	1

IEQ Credit 2	Day lighting	2	2
IEQ Credit 3	Outdoor views	1	1
IEQ Credit 4	Minimize indoor and outdoor pollutants	1	1
IEQ Credit 5	Low emitting materials	3	3
IEQ Credit 6	Occupant well-being facilities	1	-
IEQ Credit 7	Indoor air quality testing, after construction & before occupancy	2	2
IEQ Credit 8	Indoor air quality management, During construction	1	1
Innovation and Development		7	7
ID Credit 1	Innovation in Design Process	4	4
ID Credit 2	Optimization in structural design	1	1
ID Credit 3	Wastewater Reuse, During Construction	1	1
ID Credit 4	IGBC Accredited Professional	1	1

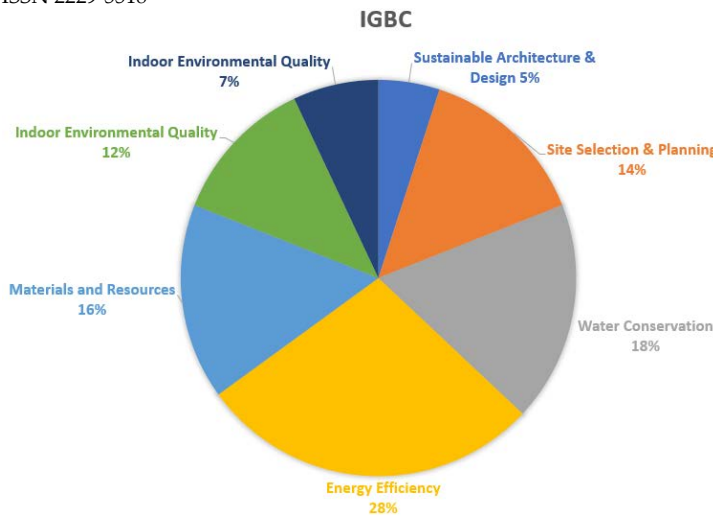


Figure 2: IGBC Evaluation Criteria

Table 4: Buildings can qualify for four levels of certification:

Certification Levels	Points
Certified	50-59
Silver	60-69
Gold	70-79
Platinum	80-89
Super Platinum	90-100

2.3 LEED

Leadership in Energy and Environmental vogue (LEED) is also a classification system devised by the US inexperienced Building Council (USGBC) to classify the environmental conduct of a building and applaud market transfiguration towards property vogue. The system is credit-established, permitting comes to earn points for environ friendly behavior taken throughout construction and purpose of a building. LEED was launched in an endeavor to develop a "consensus-established, market-driven scoring system to accelerate the event and implementation of inexperienced building practices." The program isn't bolt structured; no each project should meet identical necessities to qualify [11].

The LEED products presently available are

LEED - for brand spanking new Construction and Major Renovations

LEED - for Homes

LEED - for Core and Shell

LEED – for Existing Buildings: Service and Conservation

LEED – for business Interior

LEED - for faculties

LEED - for Retail

LEED - for tending

LEED - for Neighborhood Development

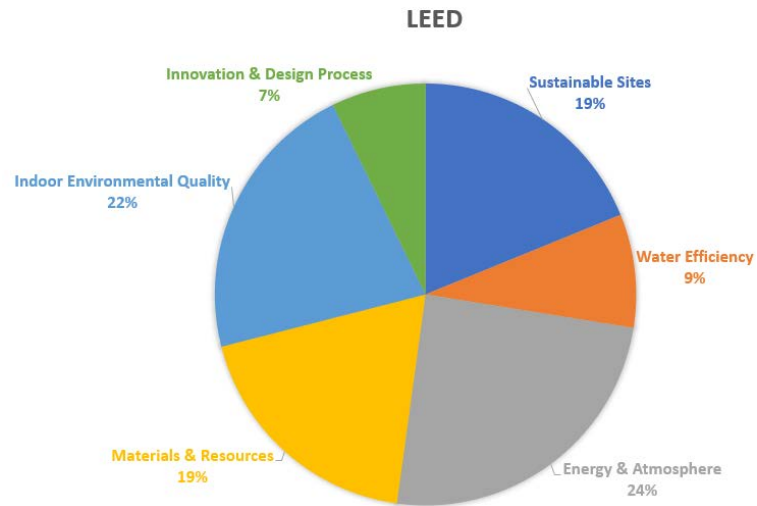


Fig. 3 LEED Evaluation Criteria

Table 5: Buildings can qualify for four levels of certification:

Certification	Points
Certified	40-49
Silver	50-59
Gold	60-79
Platinum	80 points and above

The performance and effectiveness of LEED in two credit category areas – energy and indoor environment quality. In one study of 953 NYC office buildings, 21 LEED certified buildings collectively showed no energy savings compared with non-LEED buildings, although LEED Gold buildings "outperformed other NYC office buildings by 20%"[12]. IEQ-related studies provide two contrasting results - the first used occupant survey results in 65 LEED buildings and 79 non-LEED buildings and it concluded that occupants of LEED certified buildings have equal satisfaction with the building overall and with the workspace than occupants of non-LEED rated buildings [13].

Table 6: Threshold Criteria for Certification

LEED India NC Project checklist		Points Available
Sustainable Sites (max 13 points)		
<i>Prerequisite 1</i>	<i>Erosion & Sedimentation Control</i>	<i>Required</i>
Credit 1	Site Selection	1
Credit 2	Development Density & Community Connectivity	1
Credit 3	Brownfield Redevelopment	1
Credit 4.1	Alternative Transportation, Public Transportation Access	1
Credit 4.2	Alternative Transportation, Low Emission & Alternative Fuel Refuelling Stations	1
Credit 4.3	Alternative Transportation, Parking Capacity	1
Credit 5.1	Reduce Site Disturbance, Protect or Restore Habitat	1
Credit 5.2	Reduce Site Disturbance, Development Footprint	1
Credit 6.1	Stormwater Design, Quantity Control	1
Credit 6.2	Stormwater Design, Quality Control	1
Credit 7.1	Heat Islands Effect, nonroof	1
Credit 7.2	Heat Islands Effect, roof	1
Credit 8	Light Pollution Reduction	1
		13

Water Efficiency (max 6 points)		
Credit 1.1	Water Efficient Landscaping, Reduce by 50%	1
Credit 1.2	Water Efficient Landscaping, No potable use or No irrigation	1
Credit 2	Water Efficiency in Air conditioning System, Reduce by 50%	1
Credit 3	Innovative Wastewater Technologies	1
Credit 4.1	Water Use Reduction, 20% Reduction	1
Credit 4.2	Water Use Reduction, 30% Reduction	1
		6
Energy & Atmosphere (max 17 points)		
<i>Prerequisite 1</i>	<i>Fundamental Building Systems Commissioning</i>	<i>Required</i>
<i>Prerequisite 2</i>	<i>Minimum Energy Performance</i>	<i>Required</i>
<i>Prerequisite 3</i>	<i>Fundamental Refrigerant Management</i>	<i>Required</i>
Credit 1	Optimise Energy Performance	10
Credit 2	Onsite Renewable Energy, 2.5%, 5%, 7.5%	3
Credit 3	Additional Commissioning	1
Credit 4	Ozone Depletion	1
Credit 5	Measurement & Verification	1
Credit 6	Green Power, 50%	1
		17

Materials & Resources (max 13 points)		
<i>Prerequisite 1</i>	<i>Storage and Collection of Recyclables</i>	<i>Required</i>
Credit 1.1	Building Reuse, Maintain 75% of Existing Walls, Floors, and Roof	1
Credit 1.2	Building Reuse, Maintain 100% of Existing Walls, Floors, and Roof	1
Credit 1.3	Building Reuse, Maintain 100% shell + 50% Non-shell	1
Credit 2.1	Construction Waste Management, Divert 50% from Disposal	1
Credit 2.2	Construction Waste Management, Divert 75% from Disposal	1
Credit 3.1	Resource Reuse, 5%	1
Credit 3.2	Resource Reuse, 10%	1
Credit 4.1	Recycled Content, 5%	1
Credit 4.2	Recycled Content, 10%	1
Credit 5.1	Regional Materials, 20%	1
Credit 5.2	Regional Materials, 50%	1
Credit 6	Rapidly Renewable Materials, 5% of Building Materials	1
Credit 7	Certified Wood, 50% of Wood-based Materials	1
		13
Indoor Environmental Quality (max 15 points)		
<i>Prerequisite 1</i>	<i>Minimum IAQ Performance</i>	<i>Required</i>
<i>Prerequisite 2</i>	<i>Environmental Tobacco Smoke Control</i>	<i>Required</i>
Credit 1	Outdoor Air Delivery Monitoring	1
Credit 2	Increased Ventilation, 30% above ASHRAE 62.1 requirements	1
Credit 3.1	Construction IAQ Management Plan, During Construction	1
Credit 3.2	Construction IAQ Management Plan, Before Occupancy	1
Credit 4.1	Low Emitting Materials, Adhesives & Sealants	1
Credit 4.2	Low Emitting Materials, Paints	1

Credit 4.3	Low Emitting Materials, Carpet	1
Credit 4.4	Low Emitting Materials, Composite Wood & Agri fiber Products	1
Credit 5	Indoor Chemical & Pollutant Source Control	1
Credit 6.1	Controllability of Systems, Lighting	1
Credit 6.2	Controllability of Systems, Thermal Comfort	1
Credit 7.1	Thermal Comfort, Design	1
Credit 7.2	Thermal Comfort, Verification	1
Credit 8.1	Daylight and Views, Daylight 75% of spaces	1
Credit 8.2	Daylight and Views, View 90% of Spaces	1
		15
Innovation & Design Process (max 5 points)		
Credit 1.1	Innovation in Design	1
Credit 1.2	Innovation in Design	1
Credit 1.3	Innovation in Design	1
Credit 1.4	Innovation in Design	1
Credit 2	LEED™ Accredited Professional	1
		5
	Total Maximum Points	69

3. CONCLUSION

The several factors that got to be thought about whereas constructing an inexperienced building. it's terribly necessary to grasp however effective a selected project is in term of its setting friendliness. This transient resemblance would check the building on varied points thus on provides a truthful plan of wherever it stands in being an inexperienced building. Each rating systems measure adequate to be employed in sure a part of the country however they're not distinctive in nature. Since these three systems supported totally different parameters, there's a break of each rating systems rate an equivalent building otherwise. Conjointly they're quite advanced in nature and don't essentially provides a clear plan of the comes effectiveness. Every system has sure robust points and sure weak points and that they don't seem to be specific on certain assessment criteria. As from on top of resemblance study of LEED and GRIHA classification system some

appropriate points for inexperienced building which is easy and effective is recommended for little contractors to attain inexperienced agenda merely and economically. Now is an integration of assorted points appreciate it carries the benefits of each system where because it overthrown the individual shortcomings.

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