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Review Article

ENVIRONMENTAL SUSTAINABILITY GUIDELINES FOR GREEN BUILDINGS IN INDIA: A REVIEW

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ABSTRACT
Real estate sector has significant impact on the environment and resources. It is reported that the buildings use almost 40 % energy, 30 % raw materials, 20 % water & 20 % land of the cities. Additionally, these also account for 40% of carbon emissions, 30% of solid waste generation and 20% of effluents discharged in cities. Commercial and residential sectors continue to be major market for construction industry which consume a lot of energy throughout the life cycle of buildings and, thus, are major contributors to the Green House Gases (GHGs). Buildings which are energy and water efficient having concept of "Reduce", "Reuse" and "Recycle" will be sustainable and effective in improving the country's GDP. The concept of green building is a stepping stone for countries to encourage sustainable Resource use. The Indian Green Building Council (IGBC) and The Energy and Resources Institute (TERI) have developed rating criteria and guidelines for evaluating buildings in India. The present paper discusses the key challenges for the development of green building in India and steps needed to make people, communities and general public aware about the advantages of green buildings for sustainable environmental development and management. Data collected from various secondary sources have been used to evaluate the existing scenario and provide suggestions for developing an ecologically sustainable construction sector and urban ecosystem.

Key Words: Green-Buildings, Green House Gases, Sustainable-Environment, IGBC, India

INTRODUCTION

The real estate industry is a significant contributor to the global warming due to significant emission of Green Houses Gases (GHGs) from the energy used in the buildings. Modern buildings consume energy in five phases (Sengupta, 2008). The first phase corresponds to the manufacturing of buildings materials and components (i.e. embodied energy). The second and third phases correspond to the energy used to transport materials from production plants to the building site and the energy used in the actual construction of the building (i.e. grey energy and induced energy). Energy consumed in fourth phase i.e. at the operational phase corresponds to the running of the building when it is occupied. In the fifth phase, energy is consumed in the demolition process of buildings as well as in the recycling of the parts recovered after demolition. The quantitative cost-benefit analysis proves that green buildings are beneficial in spite of extra investment needed to develop such buildings. The payback period is 2-3 years based on the LEED rating system (Roy & Gupta, 2008). Green buildings can be designed and constructed using various levels of classifications and rating systems to achieve certification. The payback period in such cases can change depending on the investment and rating.

Production of construction materials requires large amount of energy which in turn emit a large volume of GHG's. Alternate technologies/practices will provide tools to reduce emission during construction which need to be encouraged to fight for global warming. If a structure is designed as green building/green construction or sustainable building, built, renovated, operated or reused in an ecological and resource efficient manner, that will qualify to achieve the objective of protecting occupational health, improving employee productivity, using energy, water and other resources more efficiently and reducing the overall impact on the environment.

Sustainable development concept has prompted development sectors to adopt the concept of 'Socially Responsible Investing (SRI) which was dedicated for investment in non-polluting industries initially (Roy & Gupta, 2008). SRI later incorporated other industries also that promote sustainability and now covers real estate sector also. Green funds have been set up in the US, Western Europe and Australia; dedicated to support green buildings (green field, brown field, redevelopment and retrofitting projects). The Green funds in the real estate sector are not yet popular in India, primarily because green building development is still in its nascent stages. However, Confederation of Indian Industry (CII) - The Indian Green Building Council (IGBC) has taken an important initiative to set up Rs.4 billion green funds to support the development of green buildings. It is expected that with green building industry likely maturing in future, the green funds industry shall also emerge, which shall be the next level for the Indian real estate

business incorporating and promoting the green /sustainable buildings norms as new investment opportunities in India. There have been significant progresses in developing green rating system all over the world as several countries developed green rating/appraisal system for construction sector (CSE, 2012).

RATING PROGRAM /SYSTEM OF GREEN BUILDING

Various voluntary building rating systems have been launched globally which are good instruments in raising awareness and popularizing green designs. These international rating systems are flexible and can be tailored to suit the building industry of any country. IGBC was formed in the year 2001 by CII-Green Business Centre, Hyderabad emphasizing more on energy efficiency measures in AC buildings. The vision of this council is to promote and encourage green building movement in India and facilitate Indian real estate sector to become one of the global leaders in green building. A National Rating System - GRIHA was developed based on the Indian agro-climatic conditions which are suitable for all kinds of buildings in different climatic zones of the country. This was initially developed by TERI (The Energy & Resources Institute) as TERI-GRIHA which has later been modified to GRIHA as National Rating System after incorporating various modifications suggested by a group of architects and experts. GRIHA takes into account the provisions of the National Building Code 2005, the Energy Conservation Building Code 2007 of BEE and other IS codes, local bye-laws and other local standards and laws. GRIHA was adopted as the National Rating System (NRS) by the Ministry of New & Renewable Energy (MNRE) in November 2007. GRIHA guidelines help to quantify energy consumption, waste generation, renewable energy adoption, etc. so as to manage, control and optimize the same to the best possible extent. It has a 100 point rating system with a set of 34 criteria of which some are mandatory. Minimum qualifying score is 50 and rating awarded in 1-5 stars; 1 star for every 10 points over 50. Therefore, this system is able to rate a building of its level of greenness through its both qualitative and quantitative assessment criteria. The rating can be applied to any new and existing commercial, institutional, and residential buildings. Both GRIHA and LEED-INDIA are operating at the national level. The total number of buildings registered with GRIHA is 179 and that with LEED is 1505. The number of buildings actually rated is still much smaller for GRIHA (8) and under IGBC (223). Building rating systems are popular tools to bring momentum in achieving energy efficiency and sustainability in buildings. IGBC has launched different rating programmes to suit variety of building types. We attempt to discuss out these two types of rating system below.

IGBC-Green Rating System

IGBC-Green Rating System is meant for the residential sector in India (Green Homes) based on accepted energy and environmental principles and strikes a balance between established practices and emerging concepts. The most tangible benefits of Green Houses are the reduction in water and energy consumption right from day one of occupancy. These are reports indicating that the energy savings could range from 20 - 30 % and water savings around 30 - 50% (JLLM 2008). Intangible benefits of green homes include enhanced air quality, excellent day lighting, health & wellbeing of the occupants, safety benefits and conservation of scarce national resources. IGBCs Green Factory Building Rating System programme has been launched based on the contemporary materials and technologies. This rating system would facilitate the development of green factories.

IGBC-Green Special economic zone *(SEZ) Rating System*

It is a voluntary and consensus based programme. IGBC in association with the Ministry of Commerce and Industry (MoCI) has prepared the Green SEZ guidelines and the Green SEZ Rating System is an extension of these guidelines which encourages the projects to achieve performance higher than the regulatory or techno-specific requirements of many codes and standards.

IGBC-Green Townships Rating System

The IGBC Green Townships Rating System can be applied to large developments like integrated townships, satellite cities, gated communities, campuses with multiple buildings etc. and does not aim at covering individual buildings and land parcels. The townships can predominantly be commercial, industrial or retail but should necessarily have a residential component. It is designed to address the issues of urban sprawl, automobile dependency, social and environmental impacts with focus on increased ecosystem improvement and long term sustainable benefits.

IGBC-Green Landscape Rating System

Rapid growth in urbanization and consequent immense strain on land and other natural resources is resulting in shrinkage of green spaces. This rating system has been developed with an aim to address these issues and holistically covers modules on water conservation, selection of plant species for landscaping, aesthetics, health and well-being and energy conservation.

IGBC- Leadership in Energy and Environmental Design (LEED) India Rating System

LEED is a nationally and internationally accepted benchmark for the design, construction and operation of high performance green buildings developed by the U.S. green building council. LEED India is the indigenized version of

the LEED rating system and is administered by the IGBC. LEED rated green buildings are given silver, gold and platinum tags according to the points. This rating system is applicable for those buildings where the design and operation is fully in the scope and control of owner or the developer, such as corporate office, Institutional building etc. LEED is a point based system where building projects earns LEED points to satisfy specific green building criteria in respect of Water Efficiency (WE), Energy and Atmosphere (EA), Materials and Resources (MR) and Indoor Environmental Quality (IEQ). An additional category, Innovation in Design (ID) has been added which addresses sustainable building expertise as well as design measures not covered under the environmental categories. The number of points a project earns will determine the level of LEED certification the project is given. LEED certification is available in four progressive levels of 100 base points as Certified (40–49 points), Silver (50–59 points), Gold (60–79 points), Platinum (80 points and above).

Green Rating for Integrated Habitat Assessment (GRIHA)

GRIHA has been developed to help 'design and evaluate' new buildings that are still at the inception stages. A building is assessed based on its predicted performance over its entire life cycle i.e., planning through operation. The life cycle stages identified for evaluation are the preconstruction, building design and construction, building operation and maintenance. The issues that get addressed in these stages are as follows:

- Pre-construction stage (intra- and inter-site issues)
- Building planning and construction stages (issues of resource conservation and reduction in resource demand, resource utilization efficiency, resource recovery and reuse, and provisions for occupant health and well being of workers). The prime resources that are considered in this section are land, water, energy, air, and green cover.
- Building operation and maintenance stage (issues of operation and maintenance of building systems and processes, monitoring and recording of consumption, occupant health and well being, and also issues that affect the global and local environment).

Scoring points for GRIHA

The GRIHA is a guiding and performance-oriented system where points are earned for meeting the design and performance intent of the criteria. A project intending to meet the criterion would qualify for the points on the basis of compliances submitted in the prescribed format. The points related to particular criteria are awarded provisionally and are finally awarded through monitoring, validation, and documents/photographs to support the award of point. GRIHA has a 100 point system consisting of some core mandatory points and optional points. There are innovation points also available over and above the 100 point system. Different levels of certification (one star to five stars) are awarded based on the number of points earned. The minimum points required for certification is 50. Buildings scoring 50 to 60 points, 61 to 70 points, 71 to 80 points, and 81 to 90 points shall get, respectively, one star, 'two stars', 'three stars' and 'four stars'. A building will get the five stars if it scores 91 to 100 points.

GREEN BUILDING MOVEMENT IN INDIA

The first green building in India i.e. CII-Sohrabji Godrej Green Business Centre was inaugurated on 14 July 2004 in Hyderabad. India has the second highest foot print of green building in the world. The construction industry in India is one of the largest economic activities and is growing at an average rate 9.5% as compared to the global average of 5%. The country has 1.2 billion sq. feet of being built or ready, and pre-certified by LEED green building. Information about a few building rated as green building has been discussed in details in a report published by Centre for Science and Environment, New Delhi (CSE, 2012).

As per IGBC, the Indian green building industry will be of $ 100 billion size by 2015 with total built up space reaching to 25 billion sq. feet by 2012, 100 billion sq. feet by 2030. According to IGBC annual report 2011-12, a total of 1,795 green building projects were initiated covering homes, commercial building, factory building, SEZ and township. It is estimated that 1.58 billion tons CO_2 reduction, 1,848,000 MW energy saving, 5,940,000 KL water saving, 59,400 tons construction waste diverted from land fill, 3.5 MW renewable energy (installed capacity) have been received as benefits by 295 certified green buildings.(IGBC, report)

BUILDING SECTOR AND ENERGY CONSUMPTION

The world energy outlook 2009 states that two thirds of the world's energy is already consumed in cities by just half the world's population (Anon 2008). de la Rue du Can et al, (2009) suggested that the residential sector is significant user of 37% of the total primary energy in India. The building sector consumes 30% of total electrical energy consumption in India and this is growing at the rate of 8% per annum (Shankar, 2011). The BEE, responsible for energy regulation for buildings, has come up with typical values for different climatic zone of the country as well as for different building users. The value shows that offices, retail establishment and hotels are high end users of

energy. Bassi (2010) revealed that the key challenge of energy management in buildings is how to minimize energy use at a higher comfort level. According to BEE, most commercial buildings in India have an energy performance index (EPI) of 200 kwh/sq m/year or higher whereas it considers 180 kwh/sq m/year as the typical national average. Buildings in North America and Europe have an EPI of less than 150 kwh/sq m/year due to overall efficiency gains. Energy consumption in buildings varies according to the building material used, as well as direct use of energy during building construction and operations phases. It is possible to select materials and architectural designs that can help improve thermal efficiency of buildings and reduce energy use. The direct use of energy in building operations of residential and commercial buildings varies significantly. The lighting, heating, ventilation, and air conditioning dominate consumption patterns in commercial buildings with just lighting and air conditioning accounting for 80 % of the consumption. Residential buildings witness more diverse uses like lighting, ACs, fans, coolers, refrigeration, televisions etc. In residential buildings, fans and lighting use energy up to 34 % and 28 % respectively (Shankar, 2011). By adopting energy efficient building design and appropriate building material, innovative and energy-saving operational features and energy-efficient electrical appliances, in-situ renewable energy, etc. the buildings can save energy. Regulations need to play a critical role here in ensuring the adoption of these features. Energy audits of buildings done by BEE show that existing buildings in India have a 30 to 50 % energy saving potential. For example, energy use at an EPI of 605 kwh/sq m/year in a typical new hospital can be brought down to 312 kwH/sq m/year. Similarly, in a typical office building, EPI can be reduced from 186 to 86 kwh/sq m/year (Anon, 2009). Estimates from energy consultant Environment Design Solutions (EDS) show significant potential of greenhouse gas (GHG) savings (24 % from lighting and 12 % from ACs) from energy conservation measures. Sankhe et al., (2010) reported that the national power demand can be reduced by as much as 25 % by 2030 by improving energy efficiency of buildings and operations. With improved and optimized insulation and more efficient electrical appliances etc, energy consumption can be reduced by 55 % which can lead to 150-million tonne reduction in CO2 emission by 2030.

BUILDING SECTOR AND WATER CONSUMPTION

Water deficit is becoming a serious constraint in Indian cities. With irregular and inadequate municipal water supply, dependence on groundwater is increasing. National Institute of Urban Affairs (NIUA, 2005) concludes that 56 % of metropolitan, class-I and class-II cities are dependent on groundwater either fully or partially. Cities are now drawing water from sources hundreds of kilometers away, giving rise to conflicts among the users of that water. It is within this scenario that the building sector is taking shape in Indian cities. Water is used intensively both during construction and operational phases of buildings. Water is required during construction, foundation lying, brick-soaking, masonry, curing, concreting, whitewashing, setting of roofs and flooring. A study in India looked at a group of high income multistoried apartments in Kolkata with a total built-up area of over 3 million square feet. The buildings had primarily used steel and concrete as their building material. Bardhan (2011) found embedded water (water used in the production of building materials) to be 25.6 KL/sq m, while the water consumed in actual construction was 2 KL/sq m – the total (about 28 KL/sq m) was almost 8 KL higher than in countries like Australia.

According to India Business inside Database (IBID) web site, the 85, 62,021 kl of water was consumed for the construction of an entire building in Kolkata, which is equivalent to the amount of water needed by nearly 34 families with five members each for a whole year at 138 litre per capita daily. However, there is some scope of savings in this sector. For example, research on concrete mixes in Indian conditions has estimated a savings of 75 lakh tonnes of cement and 37 lakh KL of water by using water reducers.

A large part of water used in buildings can be attributed to the operational phase of buildings, where it is directly related to lifestyle of the occupants. The average water consumption in India has been calculated as 135 liter per capita per day (as prescribed by the Central Public Health and Environmental Engineering Organization or CPHEEO). But other agencies have arrived at estimates which are quite different. Attempts have been made to compile and analyze patterns of water use in buildings which indicate that toilets and bathrooms are the biggest water guzzlers in a house, with flushes, taps and showers making more than 60-70 % of the total water used (Shaban, 2008). Rate of water consumption may also depend on the scale of construction, building type and ratio of concrete and steel used.

Froeschle (1999) conducted a study on water poverty in urban India. A study by Tata Institute of Social Sciences (TISS) indicated that bathing consumes the highest amount of water in the household level. It was found on the basis of survey of seven cities that bathing accounts for about 28 % of the total water used followed by consumption in toilets (20 %), washing clothes (19 %) and washing utensils (16 %). On an average, less than 10 % of the total water in a household is used for drinking and cooking. This shows that promotion of water efficiency standards for water

appliances and right pricing signals can help reduce water usage. Recycle and reuse of water may be more viable and sustainable option. Green building concept includes these factors in its assessment.

ECO-FRIENDLY BUILDING MATERIALS

Green building materials are composed of renewable rather than non renewable resources. Green materials are environmentally responsible because impacts are considered over the life of project. There are many construction materials and cost involved in green buildings which are given in Table 1.

Table 1: Construction materials and cost involved in green building

Construction materials for green building	Steel – with recycled metal	Cement – with fly ash content	Aerated blocks
	Double-glazed glass	Special chillers	Ultra-low plumbing fixtures
	Low side HVAC		
Cost involved	Consultant costs	Energy efficiency costs	Water efficiency technology cost
	Storm water control system cost	Rooftop landscaping costs	
	Energy modeling consultant cost	LEED consultant cost	Building systems consultant cost

Table 2: Environmental Material Criteria for Use and Green Building Assessment and Evaluation (Froeschle, 1999)

Environmental Criteria	**Product**
Low toxicity	Materials the manufacturer demonstrates to have reduced toxicity or is nontoxic and avoids carcinogenic compound and ingredients.
Minimal emissions	Products that have minimal chemical emissions, emit low or no volatile organic compounds (VOCs), and avoid the use of chlorofluorocarbons (CFCs).
Low- VOC assembly	Materials installed with minimal VOC-producing compounds or no- VOC mechanical attachment methods and minimal hazardous.
Recycled content	Products with identifiable recycled content in the material including post-industrial content with a preference for post-consumer content.
Resource efficient	Products manufactured with resource-efficient processes including reducing energy consumption, minimizing waste, and reducing green house gases.
Recyclable	Materials those are recyclable at the end of their useful life.
Reusable	Building components that can be reused or salvaged.
Sustainable	Renewable natural materials harvested from sustainably managed sources and preferably that have an independent certification.
Durable	Materials that are longer lasting or are comparable to conventional product with long life expectancies.
Moisture	Products and systems that resist moisture or inhibit the growth of biological contaminants in buildings.
Energy efficient	Materials, components, and system that help reduce energy consumption in buildings and facilities.
Water conservation	Products and systems that help reduce water consumption in building and conserve water in land scaped areas.
Improves IAQ	Systems or equipment that promotes healthy IAQ by indentifying indoor air pollutants or enhancing the air quality.
Healthfully maintained	Materials, components or systems that require only simple, nontoxic or low-VOC methods of cleaning.
Local product	Building materials, components, and system found locally or regionally saving energy and resources in transportation to the project site.
Affordable	Building product life-cycle coast comparable to conventional materials or as a whole, are within a project defined percentage of the overall budget.

Froeschle (1999) indicated the environmental assessment process for building products involves three basic steps such as research, evaluation & selection. Product selection begins after the establishment of project specific environmental goals. Based on the environmental material criteria established for a green building project, selection of appropriate building products and systems can be accomplished. The environmental material criteria may vary depending on whether it is a new project or a renovation of an existing building. He has recommended environmental material criteria for use in green building product or system assessment and evaluation which is reproduced in Table 2.

GREEN BUILDINGS IN INDIA: THE PROSPECTS

Green buildings provide improved indoor environment and offer operational savings and there is no difference in appearance between green and conventional buildings (Fisk, 2000). Platinum-rated buildings have a higher payback period of five to seven years, while gold-rated and silver-rated buildings have a payback period of three to four years (CSE, 2012). Green buildings are operationally very efficient than conventional buildings. Green buildings are 25–30% more energy efficient, with gold-rated buildings as much efficient as 37%. On an average, green buildings obtain 2% of their energy from renewable or green sources (JLLM, 2008). This energy efficiency proves beneficial during peak periods, when energy costs rise due to higher demand. This reduces the demand for fossil fuel-generated electricity and also reduces pollution and the emission of GHGs. Roy & Gupta (2008) and JLLM (2008) enumerated various operational savings and other benefits of green buildings such as use of 20–30% less water in green buildings, reuse of treated water for landscaping and air conditioning reducing the load on existing sewage system. These conservation measures and water reuse by green buildings promote savings on operational costs and sustainability including waste reduction and reuse and minimization of construction wastes and debris and recycling and generation of less scrap and waste during construction and operation.

As per report of JLLM (2008), green buildings ensure better air quality, natural light and indoor environment as intangible benefits. Indoor Environmental Quality can be improved by using less toxic interiors, low emitting adhesives, paints, carpets and composite wood; illuminating most of the areas with natural light; thermal comfort due to local control over air conditioning and better ventilation. Green buildings help in improving productivity by 5% (Roy & Gupta 2008). Therefore, green technology in construction sector may achieve improvement in health quality index in India and other developing nations.

PROMOTING GREEN BUILDINGS

Government of India has developed regulatory framework and guidelines and financial incentives, including environmental appraisal for construction sector projects. The rating systems are now getting linked with promotional policies for green buildings in India. Official incentive programmes to promote rating of buildings as a means to give a push to the green building movement, has been emphasized. Building /Construction projects of ≥20000 sq. mtrs and Area Development projects and Townships with <1,50,000 sq. meters of built-up area are included in Environmental appraisal process in the country and are monitored for status of compliance of safeguards stipulated under Environment Impact Assessment Notification, 2006. The term 'built-up area' is clarified as "built up or covered area on all floors put together including its basement and other service areas, which are proposed in the building or construction projects". However, the industrial shed, school, college, hostel for educational institution are now not covered, but such buildings are advised to ensure sustainable environmental management, solid and liquid waste management, rain water harvesting and may use recycled materials such as fly ash bricks. Local development authorities may stipulate these safeguards while approving the building plan of exempted categories of projects.

The Ministry of Environment, Forest and Climate Change (MoEFCC) in 2011 has decided that the proposal for obtaining environmental clearance in respect of Building and Construction projects which have obtained Green Building rating (pre-classification of provisional certification) under the rating programmes of GRIHA, IGBC including LEED India etc. by integrating high level of environmental norms into their building plans, shall get priority for their consideration, out of turn, by the State or Union territory level Expert Appraisal Committee (SEAC) or Expert Appraisal Committee (EAC) as the case may be. Following safeguards are generally stipulated during environmental clearance for sustainable and Green Building in India:

- Adequate drinking water and sanitary facilities for construction workers.
- Use of top soil in horticulture/ landscape development within the project site.
- Proper muck disposal during construction phase.
- Proper disposal of hazardous waste
- Residential standards for ambient noise level both during day and night.

- Use of fly ash in building material.
- Use of ready mixed concrete in building construction.
- Use of low flow fixtures for showers, toilet flushing and drinking.
- Use of glass may be reduced by up to 40% to reduce the electricity consumption and load on air conditioning.
- Roof should meet the prescriptive requirement as per Energy Conservation Building Code by using appropriate thermal insulation material to fulfill the requirement.
- Opaque wall should meet the prescriptive requirement as per Energy Conservation Building Code which is proposed to be mandatory for all air conditioned spaces while it is aspiration for non air conditioned spaces by use of appropriate thermal insulation material to fulfill the requirement.
- Approval of the competent authority for structural safety of the building due to earthquake , adequacy of fire fighting equipments, etc. as per National Building Code including protection measures from lightening etc.
- For disinfection of waste water, use ultra violet radiation, not chlorination.
- The green belt design along the periphery of the plot shall achieve attenuation factor conforming to the day and night noise standards prescribed for residential land use. The open spaces inside the plot should be suitably landscaped and covered with vegetation of indigenous variety.
- Application of solar energy should be incorporated for illumination of common areas, lighting for gardens and street lighting in addition to provision for solar water heating. A hybrid system or fully solar system for a portion of the apartments should be provided.
- Implement energy conservation measures confirming to energy conservation norms of Bureau of Energy Efficiency incorporating details about building materials & technology, R & U Factors etc.

The Ministry of Environment, Forest and Climate Change has constructed an office Building at Jor Bagh, New Delhi known as "INDIRA PARYAVARAN BHAWAN". This is said to be net zero energy green building constructed taking in to account all environmental conservation aspects i.e. to reduce adverse impacts and utilize natural principles for adequate natural light, reduce ambient temperature, maximize energy saving system and minimize operation cost by adopting green building concepts, conservation and optimization of water requirement by recycling the waste water etc. Solar Panels, energy efficient electrical fixtures, energy efficient lifts and air-conditioned systems have been installed. Adoption of water conservation measures like drip irrigation system for green areas, and rain water harvesting system in the complex add savings to the fresh water requirement (http://envfor.nic.in).

Ministry of New and Renewable Energy (MNRE) granted various incentives for GRIHA rating projects under its 'Energy-efficient solar/green buildings' scheme to GRIHA-NRS projects under the 11th five year plan period:

- Building Owners- Reimbursement of 90% of the registration-cum-rating fee for projects upto 5000 sq. m. built-up area with minimum 3 star rating & for projects > 5000 sq.m. built-up area with minimum 4 star rating
- Architects / Design consultants- Rs.2.5 lakhs for projects upto 5000 sq. m. built-up area with minimum 3 star rating & Rs. 5 lakhs for projects > 5000 sq.m. builtup area with minimum 4 star rating
- Municipal Corporations / Urban Local Bodies - Rs. 50 lakhs to Municipal Corporations & Rs. 25 lakhs to other Urban Local Bodies that announce rebate in property tax for Green Buildings & make it mandatory to get the new buildings under Govt. & Public Sector rated under GRIHA.
- Annual Awards - Awards of Rs. 50 lakhs to Municipal Corporation & Rs. 25 lakhs to other Urban Local Body who performs best.
- Annual Awards to 5 star rated buildings under GRIHA.
- Promotional Activities- Up to Rs. 2.00 lakh for each activity to specialized Institutions for organizing workshops/ seminars/ training / publications/ awareness campaigns etc.
- Scheme presently confined to commercial and institutional buildings including housing complexes with minimum built area of around 2500 sq. m. Release of incentives will be made by MNRE on reimbursement basis through GRIHA Secretariat after validation of Star Rating Post -Construction by the National Advisory Committee of GRIHA.

BUREAU OF ENERGY EFFICIENCY (BEE) CERTIFICATION

The BEE has developed Energy Conservation Building Code (ECBC) setting energy efficiency standards for design and construction. The energy performance index of the code is set from 90 kW·h/sqm/year to 200 kW·h/sqm/year where any buildings under the index can be termed as "ECBC Compliant Building". BEE also launched a 5 star

rating scheme on 25 February 2009 for office buildings operated only in the day time in 3 climatic zones, composite, hot & dry, warm & humid. IGBC rated green buildings are also able to meet or exceed the ECBC compliance.

CONCLUSION

In the past few years, several green buildings have been constructed in India, but still the concept of green buildings has not reached to the stage exhibiting greater impact in the society. Present review work is an attempt to make people, communities and general public aware about the advantages of green buildings for sustainable environmental development and management. Traditional knowledge in combination with new technological innovations will further improve the water and energy efficiency including waste reduction and reuse which are the principal components in sustainable use of natural resources. Achieving successful energy efficiency and maintaining high performance throughout the life cycle of the project will make green buildings to offer greater human satisfaction in terms of socio-economic and environmental compliance.

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