

## Green Buildings Concept towards Sustainable Urban Development and Panacea for Global Warming

**Bhavesh Jha<sup>1</sup>, Shalwee<sup>2</sup>, Sanyogita Verma<sup>3</sup> and Pramod R. Chaudhari<sup>4</sup>**

<sup>1,2,4</sup> Grass Roots Research & Creation India (P) Ltd., 374-375, Sec 63, Noida 201301, Uttar Pradesh, India

<sup>3</sup> Anand Niketan College, Anandwan, Warora, Maharashtra, India

---

**Abstract:** As per the United Nation's report, the urban population in India is going to reach more than 600 million by 2031, increase of around 40% of the population. Currently, almost 10 percent of Indian GDP is based on construction activities and is important for Indian economy. However, this resulted in environmental degradation. Natural resources degradation (Air, soil, and water etc.) and increasing toxic waste due to urbanization has become a challenge for an economy to sustain. The sustainable urban management has become one of the important issues these days. Recently developed Green Building Concept is the potential solution and key to sustainable urban development. It is the practice of increasing efficiency with which buildings use resources – energy, water and materials – while reducing building impacts on human health and the environment. These practices are healthy and more resources efficient in the process of siting, construction, renovation, operation, maintenance and demolition. This consists of life cycle assessment (LCA) based planning for green building. Therefore, all the suitable technologies and innovative ideas available in different areas depending on local resources are suitable to make the green building environment- friendly. Green building technology is thus undergoing constant changes and getting more improved with the time. Government should also ensure proper guidelines for sustainable construction activity to implement this concept and to reduce environmental degradation.

**Keywords:** Green Building, Impacts, Sustainable Development, Urbanization

---

### INTRODUCTION

World Population is rapidly increasing since mid-20<sup>th</sup> Century. This has resulted in increasing demands for natural and man-made resources. Intelligent human being has made tremendous progress in technology in different fields to satisfy the ever-growing demands. Most of the developments have been carried out without controlling the ill effects of the development. As a result, the pollution of air, water and soil has affected the quality of environment and available resources depriving the share of our next generations of their due share of natural resources. There is now increasing awareness about this and principles of sustainable development have been developed and being applied throughout the world. However, we are far from achieving the sustainable development. Population increase is resulting in rapid urbanization especially in developing countries which is one of the factors responsible for global warming. The effective remedy for this is to develop and implement eco-construction technique, which is now popularly known as *Green Building Concept*. This article summarizes the various aspects of urbanization and global warming and the overview of green building concept along with guidelines and ratings developed worldwide to achieve Green Buildings which will be useful in development of sustainable urbanization.

### DISCUSSION

#### Impacts of Un-Planned Construction Activity

Traditional buildings or houses in India were energy efficient because architecture depended on the places. They were having thick walls acting as insulators. Buildings in the hot and dry regions had corridors directing the wind to cool naturally. In wet regions, structures using natural light and breeze were used (Business Standard, 26 March 2010). The famous examples are Hawa Mahal or Palace of Winds or Palace of the Breeze in Jaipur, India, with articulated windows that provide cool breeze in a desert area [1] and Golkonda where ventilation is designed to let in fresh cool breeze, in spite of summer [2]. However, recent concrete constructions lack environmental friendly design.

The building and construction sector and its sprawling growth have a significant impact on the environment and resources. As per the Millennium Ecosystem Assessment Study 2005, it has been observed that there has been more than 62% decline in the availability of natural resources in the last 4 decades. The real estate industry has been one of the significant energy consumer and green house gas (GHG) emitters. This sector despite having more than 50% share of resources, also account for more than 36% of all the waste generation worldwide. The

## Green Buildings Concept towards Sustainable Urban Development and Panacea for Global Warming

particulate matters and the other hazardous substances used and emitted during construction activities are sufficient to contribute in environment degradation. The waste has non-recyclable materials such as wastes containing mercury, fluorescent bulbs, batteries, hazardous waste, and lead based paints etc., which pose serious environmental and health concerns.

One of the impacts of construction sector is creation of Urban Heat Islands (UHI) leading to hotter cities [3]. Heat islands are formed [4] due to following factors:

- Low spacing between buildings, and building dimensions,
- Relatively dense building materials that are slow to warm and cool and store a lot of energy,
- Replacement of natural surfaces by impervious or water proof surfaces, leading to a drier urban area, where less water is available for evaporation, which offsets heating of the air,
- Lower surface reflectivity to solar radiation — dark surfaces such as asphalt roads absorb more sunlight and become much warmer than light-colored surfaces,
- Waste heat generated by energy usage is a secondary contributor,

UHI is most noticeable during the summer and winter. Monthly rainfall is greater downwind of cities, partially due to the UHI. Increases in heat within urban centers increases the length of growing seasons, and decreases the occurrence of weak tornadoes. The UHI decreases air quality by increasing the production of pollutants such as ozone and decreases water quality as warmer waters flow into area streams and put stress on their ecosystems. Heat islands results in human discomfort, health risks, increase in energy use, air pollution, release of green house gases, and higher costs due to greater water and energy use.

With the increasing urbanization all over the world, especially in tropical countries, it has potential to contribute to global warming directly or indirectly. Around 61% of population is expected to live in urban area by 2030. This will increase the impact of urban heat islands on human health as well as on global warming directly and indirectly. The observations on the climate change over large cities over the past century show similarities with projected future climate changes. Therefore cities may serve as a model for assessing the impacts of, and adaptation strategies to, climate change on both local and global scales.

### **History of Green Building Concept**

Green buildings / green homes have only been building up by individuals and companies for the past thirty years. Green movement has been constantly growing during this period. During the energy crisis of the 1970's, green building moved from research and development to reality. In order to reduce the use of fossil fuels in homes, solar panels were used to make more environmental friendly homes, although in small numbers due to high initial costs. After development of more efficient and less expensive solar panels to make building more efficient, it was then used in large numbers. Along with this, builders and consumers started to search for other techniques to make even greener homes. This has led to eco-construction. A large number of issues and steps that help to make green home are now used. Today, we are still at the beginning of the Eco-construction movement.

### **Green Building Concept: An Overview**

Green building or green homes or sustainable building refers to both a structure and the using of the processes that are environmental responsible and resource-efficient throughout a building's life cycle from siting through construction, operation, maintenance, renovation, and demolition. It is the practice of increasing efficiency with which buildings use resources – energy, water and materials – while reducing building impacts on human health and the environment. Green building concept is gaining importance in various countries, including India.

Sustainable development is simply meeting the needs of present generation without compromising the needs of future generations [5]. Sustainable real estate development activities are necessary for achieving development with ecological concern. Sustainable Green building concept has a special concern for natural resources management, human safety, energy efficiency, use of recycled materials etc. The practices followed are healthy and more resources efficient in the process of siting, construction, renovation, operation, maintenance and demolition. Green measures can help in improving the ecological environment and helps in reducing energy uses by at least 30-35%, carbon emission by 35% and wastages by 70% and use of water by more than 40%.

The methods to construct a green home are easy and simple. All the ideas or techniques that can save energy can be implemented in creating a green space for the family. These may change from place to place, depending upon local environment and infrastructure availability. Some of the common methods are siting and structure, design efficiency, light colored roofs and pavements, planting trees around the buildings to shade urban surfaces to reduce urban heat, green roofs using terrace garden (the city of Chicago has more than 80 municipal green roof in the country), creation of green spaces such as parks, rainwater harvesting, efficient use of energy, use of solar energy, use of renewable resources, recycling of solid and liquid waste, use of world class energy efficient practices, water and other resources, pollution and environmental degradation, indoor environmental quality enhancement, operations and maintenance optimization and waste and toxics reduction [6, 7, 8], solar tiles,

paper insulation, triple-glazed windows. Shading of vehicles in parking lots can reduce evaporative emission from gasoline, which contribute to increased levels of urban ozone.

### **Green Building Policy and Codes**

ISO21931:2006, Sustainability in Building Construction - Framework for Methods of Assessment for Environmental Performance of Construction Works – Part 1: It identifies and describes issues to be taken into account when using methods for the assessment of environmental performance for new or existing properties in the design, construction, operation, refurbishment and deconstruction stages. It is not only an assessment system in itself but it is intended be used in conjunction with, and following the principles set out in, the ISO 14000 series of standards.

In India, the related policy and codes are: National Building Code (NBC), The Bureau of Indian Standards (BIS), Energy Conservation Building Code (ECBC), The Bureau of Energy Efficiency (BEE), and Environmental Impact Assessment (MoEF&CC).

### **Planning a Green Building**

The successful planning of a green building requires evaluation of the Life Cycle Assessment (LCA) by assessing a full range of environmental, economic and social impacts associated with all cradle-to-grave stages of a process. This will help to identify the important issues in a particular set of environment and local conditions, and accordingly planning can be done to achieve sustainable green building. LCA is widely recognized as the best way to evaluate the environmental impacts of building. ISO 14040 provides a recognized LCA methodology. However, rating of green building considers factors beyond LCA also.

### **Green Building Rating Systems in India**

The International Finance Corporation (IFC), a member of the World Bank Group, and the Confederation of Real Estate Developers' Associations of India (CREDAI), apex body of private real estate developers, have partnered to promote green buildings in the country through IFC's EDGE certification. MoU was signed in the presence of Minister for Environment and Forests Prakash Javadekar on November 25, 2014 [9].

The green building evolution has led to the emergence of many rating systems. India, with an increasing footprint of green building, has primarily three rating systems namely GRIHA-TERI (Green Rating for Integrated Habitat Assessment from the Energy & Resources Institute) [10], LEEDS-IGBC (Leadership in Energy and Environmental Design from Indian Green Building Council) [11] and EPI-BEE (Energy Performance Index from Bureau of Energy Efficiency, Government of India) [15]. The GRIHA TERI rating has been one of the independent rating systems of green buildings developed by The Energy & Resources Institute (2015)[12] and Ministry of New and Renewable Energy, Government of India [13]. Based on the weightage of various green indicators, the buildings are certified.

#### **1. LEED-IGBC certification**

Leadership in Energy and Environmental Design (LEED) developed by United States Green Building Council (USGBC) [14] provides a complete framework for assessing building performance and meeting sustainability goals. Indian Green Building Council (IGBC), a nonprofit research institution has license from the United States Green Building Council to provide such certifications for green structures. LEED-IGBC certification system has levels/ratings and the thresholds which are shown in Table I.

LEED considers best of the scientific measures and strategies for the sustainable site development, water savings, energy savings, energy efficiency, material selection and indoor environmental quality. In India, there are around 150 registered green buildings, out of which only 23 are LEED certified. IGBC in line with the rating standards and measures defined by USGBC, following categories of structures are categorized for green ratings.

- i. LEED India for New Construction
- ii. LEED India for Core and Shell
- iii. IGBC Green Homes
- iv. IGBC Green Factory Building
- v. IGBC Green SEZ
- vi. IGBC Green Townships

#### **2. GRIHA-TERI Certification**

Green Rating for Integrated Habitat Assessment (GRIHA), an independent green building performance rating system developed by The Energy & Resources Institute (TERI) and Ministry of New and Renewable Energy, Government of India [13]. The Energy & Resources Institute (formerly TATA Energy Research Institute) is one of finest nonprofit global think tank in the area of energy, environment and sustainable development. GRIHA basically is green building design evaluation system where the buildings are rated in a three tier process i.e. initiation documents submission, site visit by the professionals and experts from GRIHA Secretariat and Evaluation based on various parameters based on different sections. There are mainly 34 criteria to assess and

## Green Buildings Concept towards Sustainable Urban Development and Panacea for Global Warming

evaluate the green performance as per the laid guidelines of GRIHA under different sections. Broadly some of them are:

- i. Site selection and site planning
- ii. Conservation and efficient utilization of resources
- iii. Building operation and maintenance
- iv. Innovation.

The weightage points score based on various parameters are rated accordingly. Point based scores or performance that are given star ratings, are exhibited in Table II.

### **3. EPI- BEE Certification**

Energy Performance Index (EPI) is the building performance rating system developed by Bureau of Energy Efficiency, Government of India (BEE) [15]. The rating systems defined by BEE are based on a 1 to 5 star scale where more stars mean more energy efficiency of the concern. In this performance index, the unit of Kilo watt hours per square meter per year (kwh/sq m/year) is considered for the buildings rating. The label provided under the scheme is applicable for a 5 year period. Various categories such as office buildings, shopping malls, hotels, hospitals and IT parks are identified and given star marks as per the five climatic zones in the country under this scheme.

### **Green Building Rating System in Other Countries**

Green Building design and solution helps in minimizing the interference on environment, use of environment friendly material, utilization of renewable energy etc. Various performance practices and indicators of green buildings have been taken worldwide in the past. Some of the Green Building Rating Systems followed worldwide can be listed as:

- i. BREEAM: Building Research Establishment Environment Assessment Method is developed and widely used in United Kingdom (UK).
- ii. LEED: Leadership in Energy & Environment Design has been developed by United States Green Building Council (USGBC) and is used in US.
- iii. Green Star: Green Star is the green building rating system developed by Green Building Council of Australia (GBCA) and widely used in Australia. The New Zealand Green Building Council has also developed their own version of green star rating and is used there.
- iv. NABERS: National Australian Built Environment Rating System managed by New South Wales Department of Environment and Climate Change is the only such rating system for measuring ongoing operation performance.
- v. CASBEE: Comprehensive Assessment System for Building Environmental Efficiency developed by Japan Sustainable Building Consortium (JSBC) widely used in Japan.
- vi. Green Mark: Developed by Singapore and mandatorily used for all the development works.

### **Green Performance Indicators**

The overall sustainable mechanism of construction industry depends upon various factors. The consideration of natural/ecological concerns primarily measures the green performance rating of a building. Green performance of a building is based on broadly five key parameters i.e. Sustainable Site, Water Efficiency, Energy and Atmosphere (Fig. 1) [16], Material and Resources and Indoor Environment Quality. Various other sub indicators under these above mentioned five indicators are used to assess and evaluate the performance of a building being carbon neutral.

### **Cost and Payoff**

The most sensitive issue of green building is the high price of construction. The requirements of green building such as photo-voltaics, new appliances, and modern technologies are quite expensive. Most green buildings cost a premium of <2%, but yield 10 times as much over the entire life of the building. It is projected that different sectors could save \$130 Billion on energy bills. Similarly, higher consumer productivity can be added to savings and cost deductions. Studies have shown that over a 20 year life period, some green buildings have yielded \$53 to \$71 per square foot back on investment. LEED and energy star certified buildings achieve significantly higher rents, sale prices and occupancy rates as well as lower capitalization rates potentially reflecting lower investment risk [17].

### **Implementation and Barriers in India**

There has been a tremendous growth almost four fold in the number of certified green buildings in India as per Indian Green Business Council (IGBC). The EBTC (European Business Technology Centre) report on *Green Buildings in India* says that with more than 914 million square ft of green building footprints, India stands on the 2<sup>nd</sup> spot only behind the United States (US) in total green building footprint.

## Green Buildings Concept towards Sustainable Urban Development and Panacea for Global Warming

There is still lack of awareness for green buildings and its benefits. Governments and green bodies need to be more conscious towards enhancing the capacity of the corporate and increase the communication in this regard. Some of the barriers as discussed in one of the reports of EBTC for green buildings are:

- i. Lack of awareness about the green buildings and the provision of incentives by the governments in terms of additional floor space index etc.
- ii. Lack of performance evaluation tools to assess and measure the gains of green building
- iii. The myth of high cost which is around 2-3% now higher than the conventional buildings (but the savings in the long term is significant).
- iv. Local materials and equipments are still not available despite the growth of green building sector.

### **Green Buildings in India**

The performances of few of the green building projects in India are shown in Table III. Apart from these buildings, there are many green buildings in India namely Green buildings of Suzlon Energy Limited at Pune, Biodiversity Conservation India Ltd. (BCIL) at Bangalore, ITC Green Centre at, Gurgaon, The Druk White Lotus School at Ladakh etc. Eco-construction of green building is being done in India [18, 19].

### **Benefits of Green Buildings**

It is important to note that green buildings do have a long term significant advantage as far as the tangible (Operational savings, energy and water efficiency, waste reduction etc.) and intangible (Less toxic interiors, better facilities etc.) benefits are concerned. The energy (around 40-50% savings) and water (20-30%) savings, reduction in waste, improvement in indoor environment quality, greater comforts helps in achieve lesser health cost for employees or residents, lower operation and maintenance costs. The life cycle analysis for assessing the cost benefit associated for green buildings shows various social, economic and environmental benefits (i.e. reducing impact of the built environment on human and ecological environment). Natural resources conservation provides pollution free environment, better air quality, and better productivity. Social benefits enhance occupant comfort and health heightens aesthetic qualities, minimize strain on local infrastructure and improve overall quality of life. Environmental benefits enhance and protect biodiversity and ecosystems improve air and water quality, reduce waste streams, conserve and restore natural resources. Economic benefits reduce operating costs, expand and shape markets for green product and services improve occupant productivity, and optimize life-cycle economic performance [20, 21]. Therefore, the merits of green building are efficient technologies, easier maintenance, return on investment, improved indoor air quality, energy and material efficiency, water efficiency, economical construction for poor, improvement of recreation. Demerits of green building are high initial cost, non-availability of materials, need more time to construct and need skilled workers.

The governments in this regard have also made various provisions and benefits for the builders and customers viz. Concession in Floor area ratio for following green building norms, fast track environmental clearance for the projects, rebate in property taxes and others incentives as well etc.

## **CONCLUSION**

Green building concept is one of the solutions to reduce/minimize the impact of rapid urbanization and construction sector. This concept has been developed recently and there is great scope for its development by adding various technologies and methods which also differ depending upon the local resources and infrastructural facility. Green buildings will be helpful to make the construction industry environmental friendly reducing environmental degradation and conserving resources for the future generation and thus achieving sustainable development.

## **ACKNOWLEDGEMENTS**

The authors wish to thank the Managing Director, Grass Roots Research and Creation India (P) Ltd., Noida, Uttar Pradesh, India for his encouragement during the preparation of this article.

## **REFERENCES**

- [1]. Vijayasanan T.A., Ecological Building. University of Michigan. Browsed 27 April 2012.
- [2]. NIC (2012) Monuments – Golconda Fort. National Informatics Centre, Indian Government. Retrieved 27 April 2012.
- [3]. Voogt James A., Urban heat islands: Hotter cities. 2014, [www.actionbioscience.org/environment/voogt.html](http://www.actionbioscience.org/environment/voogt.html)
- [4]. Li Y. and Zhao X., (2012). An empirical study of the impact of human activity on long-term temperature change in China: A perspective from energy consumption. *Journal of Geophysical Research*, 2012, 117. doi:10.1029/2012JD018132

- [5]. Drexhage John and Murphy Deborah, Sustainable development: From Brundtland to Rio 2012. Background Paper, International Institute of Sustainable Development (IISD), United Nations Headquarters. New York, September 2010.
- [6]. U.S. Environmental Protection Agency, Green Building Basic Information. Retrieved December 10, 2009, from <http://www.epa.gov/greenbuilding/pubs/about.htm>.
- [7]. U.S. Environmental Protection Agency, (October 28, 2010). Green Building Home. Browsed November 28, 2009, available from <http://www.epa.gov/greenbuilding/pubs/components.htm>
- [8]. WBDG (Whole Building Design Guide), WBDG User's Guide. A Programme of the National Institute of Building Sciences. 1090 Vermont Avenue, NW, Suite 700 | Washington, DC 20005-4950 | (202) 289-7800 | Fax (202) 289-1092© 2015, from <http://www.wbdg.org/designsustainable.php>
- [9]. Business Standard, MoU was signed in the presence of Minister for Environment and Forests. November 25, 2014.
- [10]. [www.grihaindia.org](http://www.grihaindia.org), (browsed 2015)
- [11]. Anonymous, IGBC Green New Building Rating System, Version 3.0, Abridged reference guide, July 2014 Available at [www.igbc.in](http://www.igbc.in) (accessed on Sep 07, 2015)
- [12]. Centre for Science & Environment, Green-building rating: overrated, [http://www.cseindia.org/userfiles/green\\_building\\_rating.pdf](http://www.cseindia.org/userfiles/green_building_rating.pdf) (browsed on Oct 12, 2015)
- [13]. Ministry of New & Renewable Energy, BEE Rating for Buildings. Ministry of New & Renewable Energy, Indian Government, 20 January 2012.
- [14]. [www.usgbc.org](http://www.usgbc.org), (browsed 2015)
- [15]. Bureau of Energy efficiency (BEE), Energy Conservation Building Code (ECBC), May 2007.
- [16]. Jones Lang Lasalle Meghraj, Cost Efficiency of Green Buildings of India. Available at [http://www.joneslanglasalle.com/ResearchLevel1/research\\_greenomics\\_cost\\_efficiency\\_of\\_green\\_buildings\\_in\\_india.pdf](http://www.joneslanglasalle.com/ResearchLevel1/research_greenomics_cost_efficiency_of_green_buildings_in_india.pdf) (browsed on Sept 11, 2015).
- [17]. Nivithavaralakshmi C. Alagaryuvashree (III-CIVIL), Green building: The Future with Intention. ppt, 17/08/2013, Author Stream (online), 2013.
- [18]. The Hindu, Construction of solar-powered green houses for the poor to begin soon. The Hindu (Madurai, India). 14 November 2011.
- [19]. Times of India, 11 buildings in Tamilnadu get energy-efficient rating from central agency. Times of India (Chennai, India). 23 July 2010.
- [20]. Indian Institute of Management, Facilitating green building adoption - An optimization based decision support tool, Working Paper No: 485, March 2015, Available at <http://www.iimb.ernet.in/research/sites/default/files/WP%20No.%20485.pdf> (browsed on Nov 18, 2015)
- [21]. Economic Policy Forum, GIZ, Promoting sustainable and inclusive growth in emerging economies: Green buildings, Available at <https://www.economic-policy-forum.org/wp-content/uploads/2014/05/Green-Buildings-final.pdf>.

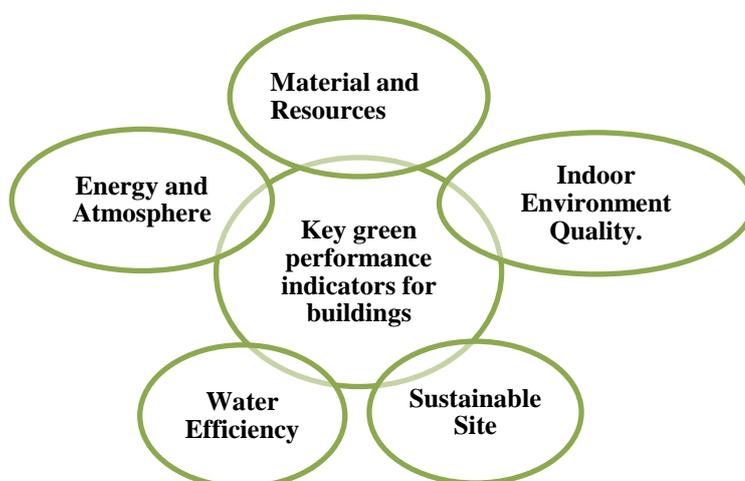


Fig. 1: Key Green Performance Indicators

**Table I: Ratings and Thresholds of LEED-IGBC Certification System**

Certification Level	Recognition	Thresholds for Buildings
Certified	Good Practices	50 – 59
Silver	Best Practices	60 – 69
Gold	Outstanding Performance	70 – 79
Platinum	National Excellence	80 – 89
Super Platinum	Global Leadership	90 – 100

Source: IGBC

**Table II: Star Ratings Based on Point Based Scores**

Points Scored/ Thresholds	Rating
50-60	One Star
61-70	Two Star
71-80	Three Star
81-90	Four Star
91-100	Five Star

Source: TERI- GRIHA

**Table III: Performance of Green Buildings in India**

Name of the Project	Location	Rating Achieved	Increase in Cost (%)	Payback Period (years)
CII-Sorabji Godrej GBC	Hyderabad	Platinum	18	7
ITC Green Centre	Gurgaon	Platinum	15	6
Wipro	Gurgaon	Platinum	8	5
Technopolis	Kolkata	Gold	6	3
Spectral Services Consultants Office	Noida	Platinum	8	4
HITAM	Hyderabad	Silver	2	3
Grundfos Pump	Chennai	Gold	6	3

Source: CII