



## A Conceptual Review of Green Buildings in India: Importance and Need

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### ABSTRACT

Buildings are built to fulfil a purpose. It must be safe, healthy, comfortable, enable productivity and well-being of the employees, making it a green building. In today's world energy crisis, it is important for architects and builders to focus on efficient buildings. Technologies applied in green buildings will enhance the building environment and functionality for occupants, while reducing operational costs. This paper seeks to provide an overview of Leadership in Energy and Environmental Design (LEED) in India, which is associated with the Indian Green Business Council. The review of the most relevant green building systems demonstrates that there is a significant growth in this field. The objective of the paper is to raise awareness of the importance of a green building for a better future. And further to see the negative impacts of conventional buildings while creating healthy and beneficial places for human beings to live, work and play.

### INTRODUCTION

In 1970's the concept of green building emerged in response to the demand to develop energy efficient and sustainable buildings. Green building consists of materials used to build which are energy efficient, surface water management, pollution health and well-being of occupants. A green building follows a holistic approach with health and wellbeing of the occupants in every aspect. Generally, indoor environments in the green buildings are known to be normal comfort by providing better indoor environmental quality (USGBC 2011). Green building acts as a sustainable or high performance building, increases the efficiency with which buildings and their sites use and harvest energy, water and materials. India is facing multiple problems like energy crisis, global warming, depleting resources; moreover, it is essential to design a more sustainable standard of living for happier us and securing our resources for the next generations. Green structures help in reducing overall impact of the built environment on human health and wellbeing. Green building consists of designs, materials, systems and technologies in order to provide an interactive, adaptive, responsive and dynamic, intelligent environment for achieving the occupants' wellbeing and business development.

The construction of green building reduces on site grading, saves natural resources by consuming alternative building materials and recycling construction wastes for reuse, and sustaining the environment in the green way. The green building's interior spaces consist of natural lighting and

outdoor views, while highly efficient HVAC (heating, ventilating and air conditioning) systems and low-VOC (volatile dynamic compound) materials like paint, flooring and furniture create a superior indoor air quality.

Presently, the term "green" awakens visions of walking barefoot on straw mats and enjoy the refreshing air to loosen and restore mental fatigue. In the current scenario, the term green building lowers overhead costs, greater employee productivity, less absenteeism, stronger employee attraction and retention. Several companies like bank of America, Genzyme, IBM and Toyota are constructing green buildings which further shares their spaces in such offices. Hence, it is observed that green is evolving, becoming essentially important for corporations as well as home builders, retailers, health care institutions, government and others, promoting green into the limelight and into the mainstream over the next 5 to 10 years.

### Origin of Green Buildings

In India, this movement was adopted by the Confederation of Indian Industry (CII) in the early part of this decade. They formed the Indian Green Building Council (IGBC) in 2001, which is actively involved in promoting the green building concept in India.

The Leadership in Energy and Environmental Design (LEED) green building rating system is a national and internationally accepted benchmark for the design, construction and operation of high performance green buildings. It pro-

motes a whole-building approach to sustainability by recognizing performance in key areas like sustainable sites, water efficiency, energy efficiency and renewable energy, conservation of materials and resources, indoor environmental quality and regional priority.

LEED-India was launched in India in 2003, since then it has grown exponentially. This has created a large network of smaller stakeholders, which includes the construction industry, corporate, governmental, nodal agencies, architects, developers, builders, and product manufacturers. Most interestingly, this network also includes green building consultants, which was a profession almost unheard a decade ago.

There is no debating that the human race is growing faster than the planet earth can sustain. This unsustainable growth is clearly causing certain environmental changes that need to be reversed, or at the very least, slowed down. Now, there are many different things we can do to correct our ways in our living, to minimize environmental degradation. However, green buildings seem to be the lowest hanging fruit in this quest to achieve sustainable growth. Buildings are responsible for a large portion of emissions, yet green buildings are convenient to design and build. Additionally, green buildings do not cost much more to build than non-green buildings, and they are not prone to political disagreement, unlike other clean development measures. This makes green building a very attractive option for governments to pursue.

The cost and expenses to build green buildings is reasonable, though developing nations have a tough time fulfilling the basic requirements like food, shelter, basic infrastructure etc. for its citizens. India is a large country with a large population and facing lots of problems. It is practically impossible for even the most efficient government machinery to supply water and electricity for 1.3 billion people or to fulfil the physiological needs of the individuals. Aside from that, they cannot manage the waste generated by the people and these processes at no additional cost. Being a developing nation, India is also facing problems like water-deficiency and the energy crisis seem to be perennial in nature. Moreover, the unsustainable energy and water policies are not helping the cause. Hence, researchers believe that it is only common sense to insulate oneself from the resource crunch and strive towards self-sufficiency and smarter living. This realization has contributed immensely to the growth and promotion of green building. Apart from that, green buildings offer the developers, builders and architects an opportunity to avoid lack of differentiation in their projects. Green building has become the "something new" that has not been done before. Developers are trying hard to leverage their green building credentials for branding purposes

and tapping into the new niche market.

### Review of Earlier Studies

Sharples et al. (1999) elaborate a new approach to Green Building systems that consist of an intelligent approach to separately governing the building environment. The act of learning building control systems, and contrast this approach with existing building solutions. Architecture, utilizes sensory information to learn and perform tasks related to user comfort, energy conservation, safety and monitoring functions. According to experiences, a large portion of energy consumed by heating, ventilation, air conditioning, cooling (HVAC) systems is due to improper use of electrical appliances. I-Power and wireless system networks (WSNs) are deployed in rooms of a building to collect environmental information. Such information is reported to a control server to determine whether to turn off unnecessary electric appliances. Kian et al. (2001) noted that the importance of understanding the performance of a building in a holistic sense is indisputable. There are six performance criteria in building performance evaluation, namely: (i) Spatial comfort- an individual who has proximity comforts of people surrounding them. It is also referred as notion of personal space, the concept where an individual possesses ownership of their immediate surroundings; (ii) Indoor environment quality- helps in reducing volatile organic compounds and air impurities. Buildings depend on highly efficient designed ventilation system (passively/naturally/mechanically powered) to provide adequate ventilated air from outdoors; (iii) Thermal comfort- the condition of satisfaction with the thermal equilibrium with the surroundings. Satisfaction with thermal environment is essential for its own sake as it influences productivity and health of humans; (iv) Visual comfort- refers to a balance of perceived brightness, fairly uniform and generally comfortable, whether the levels are high or low; (v) Acoustic comfort- good office acoustics is a key promoter to enhance work performance and well-being. The ability to find quiet places and time is fundamental to support work. Having speech privacy is necessary for private interactions and work progress; and (vi) Building integrity- the structural integrity of the building is defined in engineering in terms and good quality of construction practices. An efficient building services control high winds, corrosion, earthquakes and the likes.

Yang et al. (2001) stated that the new advances of green building technologies and ways of supplementing the decision making process by adopting two methods for economical and technical aspects of green building applications. Several scholars have examined the importance of the cost and benefits of implementing green building standards (Von Paumgarten 2003, Edwards 2006, CoStar Group 2008,

Eichholtz et al. 2009). Furthermore, studies have determined that green building standards have positive impacts on reducing energy costs. Added benefits included lower levels of employee absences and a more productive workforce. Buildings constructed following green standards also experienced higher sales and rental prices as well as lower rates of vacancy. Lee & Burnett (2008) explored the efficiency of green buildings in Hong Kong and provided a touchstone for comparing green building schemes across the globe. The work has emphasized on the barriers and challenges in implementing green building practices and standards. Retzlaff (2009) determined that cost was a major issue in implementing the LEED program as a standard for communities. Additionally, she found that a lack of expertise regarding the standards by local officials was a major drawback. Jain et al. (2013) found several obstacles with the implementation of green standards specifically the LEED existing building standard in India including: lack of awareness among the stakeholders, lack of technology in India, standards that were created specifically to the USA and not applicable to India, lack of skilled professionals and high renovation costs associated with existing buildings. Further, the researchers did find that an increase in the prestige of the project and reduced operating costs were the catalysts motivating the greening of existing buildings. However, no research has been carried out to explore the spatial distribution of LEED-India and Green Rating for Integrated Habitat Assessment (GRIHA) projects.

### **The Shift to Green**

Before the year 2000, organizations accepted green buildings as innovative experiments, but unrealistic projects in real estate business. But some major factors contributed to the shift in thinking. Firstly, the creation of reliable building rating and performance measuring system for new developments has enhanced and incorporated changes for green. In the year 2000, U.S. Green Building Council launched LEED building rating program. It evaluates buildings and awards points, measuring six dimensions such as innovation, design, process etc. It further consists of Silver, Gold, Platinum award levels. There are several other rating programs as BREEAM (Building Research Establishments Environmental Assessment Method).

BREEAM was first building environmental assessment and certification rating (Howell 2005), introduced in the UK in 1990 as a comprehensive rating system was essential for the government. This rating system helps in defining buildings on the basis of environmental, social and economic impacts. Effectively, energy efficiency and embodied carbon were the main components of the building environmental assessment methods. The assessment of any building,

measures holistic health of the built environment, inform of physical, social and emotional health. It is essential to minimize pollution effects from building materials, mould the dampness and glares, that have adverse effects on employees. Hence, this is a highly complex approach that would require integrated thinking by the architects, designers and developers. As India is at its infancy stage of green buildings, whereas it is an established concept in Europe, America, China, Hong Kong, Japan and Korea. In present time, the world is being threatened by climate change and to deal with this we need an increasing source of energy and resource-efficient buildings (Yu & Kim 2010). Mostly, companies are permitted to launch their own green building rating programs that follow program guidelines to avoid certification process. The green design criteria consist of abundant daylight, individual climate control, outdoor view-raise morale and employee satisfaction.

Green Rating for Integrated Habitat Assessment (GRIHA) Council promotes the development of buildings and habitats in India through GRIHA. This council is a unique platform for the interaction on scientific issues related to sustainable habitats in the Indian subcontinent. It was established by TERI (The Energy and Resources Institute, New Delhi) with the support of Ministry of New and Renewable Energy, Government of India. The institute gives training to qualified professionals of the country in the field of technology, to enable skillful learning that helps in designing green buildings.

### **Importance of Green Buildings**

Green building is a systematic system to design, sustain and stimulate changes in practice, technology and behaviour of reducing building related environmental impacts; enhancing healthier and more satisfying places for employees.

In the present scenario, USGBC imagines this vision with a combination of processes, tools including consensus based rating system, with third party constant reviewing. The most important tool designed by LEED is the green building certification program. This certification process evaluates whether the organization meets LEED requirements or not.

Movements helping to transform practice in the design, construction and operation of built environments, to enhance full range of professionals involved in the lifecycle of built environments. LEEDs commit their ability to turn the experience of spending employees' time in the green space that leads to a better physical activity comfort and even happiness.

### **The Future of Green Building in India**

Green buildings and the concept of smarter living offers tre-

mendous opportunity for overhauling an average Indian's lifestyle. As the general public becomes more aware of the benefits of green buildings, developers will get creative and find new ways to brand, market and sell green buildings, hence creating conducive environment for the sector to grow exponentially. One only hopes that this frantic activity remains clean and green the way it was framed to be. Green building features such as daylight, views, and connection to nature and spaces for social interaction, appear to have positive psychological and social benefits. The benefits consist of no stress, improved emotional functioning, increased communication and improved sense of belonging.

### **The Potential Implications of Green Building Design on Health and Wellbeing of Humans**

- **Satisfaction with day-lightning and electric lightning:** Sustainable lightning is designed with energy efficient light sources; the most sustainable source of lightning is daylight, controlled by sensors. A study indicates that seven energy-efficient buildings in the Pacific Northwest have 70% of the occupants, which were satisfied with overall lightning (Heerwagen et al. 1991). It was noted that employees near windows were 25% to 30% more satisfied with lightning than employees having no access to windows. Researchers revealed that satisfaction with electric lightning, improves with reduced glare problems and with increased brightness of vertical surfaces, including walls (Collins et al. 1990, Collins 1993).
- **Thermal comfort:** It is affected by air temperature, humidity, mean radiant temperature and air speed, as well as human variables, such as clothing and activity levels. Most complaints from building occupants relate to their inability to control the temperature of the space, essential to maintain the standard of thermal comfort for occupants of buildings or other enclosures, which is one of the important goals of design engineers. The most effective way to improve thermal comfort and satisfaction is by using individual controls for temperature and ventilation (Wyon 1996). The building management improves comfort and satisfaction in the building (Leaman & Bordass 2001).
- **Perception of air quality:** It refers to the air quality within and around buildings and structures, especially as it relates to the health and comfort of building occupants. Evidence depicts that low air quality is common and associated with low ventilation rate.
- **Psycho-social well-being:** Well-being is a dynamic concept that includes subjective, social, and psychological dimensions as well as health-related behaviours. Researchers noted modest amount of sunlight significantly

enriched psychological functioning and job satisfaction as compared with spaces lacking daylight (Leather et al. 1998). Heerwagen (2000) noted in a building in Holland that if a group of employees were given a break during lunch time in daylight, tree-lined street showed improvement in social functioning and sense of belongingness.

### **Green Infrastructure and Environment Psychology**

The psychology of environment and human health is inter-related because both are dependent on each other. Globally working population is spending maximum time at their work places, so it is important to understand the effects of work places on individuals' performance, mental/physical health, and well-being by providing them a healthier and restorative environment at workplaces. A study found that owners need to understand the impact of workplace affecting their growth and adapting changes accordingly (Joroff et al. 2003).

The dimensions and elements of green infrastructure could contribute ecosystem health in various ways. A green infrastructure maintains and develops the integrity of ecological balance. This further contributes to biodiversity conservation, an integral part of sustainable landscapes (Opdam et al. 2006). In order to replace alternative strategies for emphasizing on the ecological impact of fragmentation; ecological networks are most popular elements of urban planning (Jongmann and Pungetti 2004). There are essential benefits for human well-being determined by diversity of habits and species in and around urban areas (Tilman 1997). There is a close relationship between ecosystem health and ecosystem services, leading to ecological stress, reduction in both quality and quantity of ecosystem service providers (Cairns & Praatt 1995). The environmental strategy on environment and health promoted evidence of a positive relationship between well-being, health and green space (De vries et al. 2003, Takano et al. 2002, Takona et al. 1996). Green spaces helped in reducing negative effects on human well-being by increasing anxiety caused by fear. Wilson (2001) suggested that understanding healing effects of natural environments (restorative environments and favourite places in nature) have proven to be an important study of research as people show emotions and attachments to nature.

### **Dynamics of Occupants in the Buildings**

Buildings are complex system due to the social and organization activities within them. Building occupants are assigned building space consisting of an environment with comfort and food, adequate lightning and ventilation, to interact with other building occupants. Sustainability should be nurtured through good choice architecture, organizing the context in which people make decisions and shape the range

of behavioural options they can use (Thaler & Sunstein 2009). It is essential to adapt a healthy work setting for mental peace and health of employees. Adaptive comfort, a process which provides better and more choices for people to adjust their behaviour and environments as they desire. It consists of mobility supports (laptops, less connectivity, mobile phones etc.) that help people to move to green spaces as comfort needs change. It consists of several workstation choices such as ceiling lights and ventilation. Researchers working at Centre for Built Environment at University of California, Berkeley, worked on designing, testing technologies to enhance and support flexible comfort needs (Zang et al. 2009). The condition enables ambient temperature conditions to regulate according to the demands of weather conditions. This equipment saved energy upto 40% to reduce ambient heating or cooling loads. The design and location of stairways strongly influence employees to take stairways instead of elevator for better energy and health purpose (Nicol 2006).

### Benefits

The green buildings and restorative places are beneficial for individuals' psycho-social growth.

- The open green pockets of parks, gardens and pot planted for courts and building atria, helps in restoring energy in city staff and visitors. In addition, research depicts that employees spending half an hour time with nature during lunch time leads to lower blood pressure. This laid emphasis on psychological benefits of natural surroundings, which helps in reducing fatigue, played important role in restorative environments (Kaplan & Kaplan 1987).
- Green spaces and planted corridors are essential elements of the green office environment and organization as 90% of our own time is spent indoor. Therefore, plants play the role of restorative inside buildings. The primary purpose of adopting green buildings in India is to reduce energy use and reduction of electricity bills and it helps in enhancing the occupant comfort and productivity (Iwayemi et al. 2011).
- Hosein et al. (2011) noted the emerging trend of technologies in relation with the sustainable development of urban areas, smart homes are essential for future generations as climate change is affecting both, economy and lifestyle. These facts further equips adaptable built environment to protect both, environment and social issues.
- Green buildings are safer, popular for reducing energy consumption and increases productivity and growth. Gronbaek et al. (2014) examined the different perspective range from controlling energy usage over interactive room supports, work in offices. The research activities will be encouraged for the development of sustainability in different disciplines.
- Nikolau et al. (2014) briefs that it is important to protect the ecosystem through protection of resources. Building energy management system (BEMS) contributes significantly in reducing the energy consumption of buildings and improved indoor comfort. Furthermore, suggested that social and cultural aspects of sustainability include comfort, wellbeing and safety of the building occupants. Booy et al. (2014) confirmed that builders use autonomous actuation heating, ventilation and air conditioning (HVAC) with intelligent buildings.

### CONCLUSION

This conceptual review of green buildings pointed out that the present stage of system is extremely opaque, as a result public understanding of green buildings remain poor. Even though government of India as well as the State governments are giving incentives for rated buildings, no official system has been designed for reporting of information on actual performance of buildings as pre-condition to obtain those incentives. Further, this paper is indicating that any changes in science and technology suppose to be in favour of positive development and growth of people, generations, and societies to create sustainable living. The key points of the present paper are given below.

- Government and private construction industries must emphasize on sustainable design strategy which further helps to set up industry standards in future and for organizations it will help to decide the best suited intelligent green design for their organizational needs.
- It is essential to implement a healthy comfortable and productive indoor environment for people. The human creativity and labour force must be used effectively and efficiently.
- Establish regulatory framework to mandate performance monitoring, reporting and disclosure of resource use buildings.
- Create a facility towards safe, healthy and comfortable living and enable productivity and wellbeing of its occupants. Thus exhibiting key attributes of environmental sustainability to benefit present and future generation.
- Builders must adopt building design which values, preserves, restores and regenerate valuable habitat, green space and associated ecosystems that play a vital role in sustaining life.

- The green rating agencies develop checks to measure transparency and verify their claims.
- To achieve the goal of greener spaces and buildings in India, researchers need to emphasize on in-depth research on health effects of living in nature and restorative workplaces.
- A consolidation of ecologists, biomedical, public health scientists, urban planners and social scientist to develop and implement policies for restoring and sustaining environment.

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