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# A Conceptual Review of Green Buildings in Energy Saving

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***Abstract:*** *Being one of the biggest consumers of energy and also one of the largest producers of greenhouse gases, buildings are considered as a field, where tremendous opportunities exists for energy saving through some changes at designing stage. Energy consumption in buildings account for 40% of total energy consumption in the world and it accounts for 18% of global emission today, which is equivalent to 9 billion tons of* $Co_2$ *emission annually according to National Building Code (NBC). This highlights an immediate requirement to implement sustainability in every new construction, which helps to create a sustainable environment and a healthy ecosystem. Green buildings (GB) follow the principle of optimum usage of water, energy and non-renewable sources and also generate less waste and provide healthier environment for residents. The objective of the paper is to familiarize the importance of a green building for a better future and further to incorporate the changes in an existing building to become a Green Building.*

***Keywords:*** *Greenhouse gases, National Building Code (NBC), Green Buildings (GB).*

## I. Introduction

Tremendous growth in industrial sector and advancements in technology energy use has been increasing all over the world, causing an irreversible damage to the global environment; this will have an undesirable impact on the quality of life of the future generations. As per Indian Green Building Council (IGBC) Report, at present, conventional buildings contribute as much as one-third of total global greenhouse gas (GHG) emissions. The building sector contributes up to 30% of global annual greenhouse gas emissions and consumes up to 40% of all energy [1]. One of the main culprits is carbon dioxide emissions, which is implicated to contribute up to 47% of all global emissions in world, in which India's position is 144$^{th}$ (1.4 metric ton) in carbon emission rating [2].

Due to increasing of new infrastructural developments in transitional economies of developing countries, and the insufficient and improper use of existing buildings universally, it is an imperative of the industry to develop sustainable building technologies. If no necessary steps are taken soon, greenhouse gas emissions from buildings will become more than double in the next two decades [3]. The flow chart for root cause of environmental pollution due to conventional buildings is shown in below Fig. 1.1. It shows that energy consumption is the main reason for greenhouse gas emission from buildings.

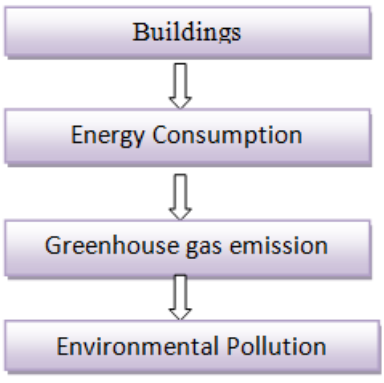


**Fig. 1.1** Root cause of pollution

Green building is a key architectural concept of the 21$^{st}$ century and it is the technique of constructing or transforming structures to become environmentally conscientious, sustainable and resource-efficient throughout their life cycle.

The GB are capable to have efficient water use, energy-efficient and eco-friendly environment, use of renewable energy and recycled/recyclable materials, effectual use of landscapes, effective control and building

management systems and enhanced indoor quality for good health and comfort of the residents as compared to conventional buildings. The concept of green buildings not only favors human health, but also safeguards earth from harmful and poisonous effects, fulfilling the accountability of the concept of sustainable development.

## II. What Makes A Building Green?

A green or sustainable building is one which uses less water, optimizes energy efficiency, conserve the natural resources, generate less waste and provide healthier space for occupants. It often emphasizes taking advantage of renewable sources. National Building Code (NBC) provides the guidelines on energy consumption for green buildings in India.

According to NBC green buildings save water (36-40%), save energy (30-40%) and save material (25-40%) compared to conventional buildings [4].

The specific features of sustainable buildings are as follows

- Site selection with full respect to ecology of the area, existing environment and use of local materials
- Minimum consumption of energy by the building
- Minimum use of fresh water from external sources
- Maximum use of non-toxic, recycled and renewable material
- Highest indoor air quality without affecting the energy consumption
- Integrated Building Management System for control, monitoring, measurement and verification
- Innovation in design and construction technique
- Secured power infrastructure

## III. Aspects Of Green Buildings

The following are important aspects of green building

### A. Sustainable Site

It refers to a site that would have the least environmental threat during construction stage. It has access to basic amenities like water and sand thereby, reducing pollution caused because of transportation. It optimizes the use of on-site storm water management and provision for ground water recharge. Measures are adopted to preserve top soil for absorbing less water through effective methods [5].

### B. Water Efficiency

The main goal here is to increase the effective use of water within the building, thereby reducing the amount of water needed for specific operations. Some methods which can be adopted for this include, efficient landscaping techniques and use of innovative wastewater management technology. Technologies for reuse of water such as Rainwater Harvesting, Wastewater treatment plant and waterless urinals are installed for conservation of water [6].

### C. Energy Efficiency

It involves the installation of various methods of on-site renewable energy production to reduce the overall energy consumption of the building and other means of using green power (solar, wind). The optimization of building orientation, shape, design and interior color's and finishes is done which maximizes the use of natural day lighting [7]. This reduces the dependence on artificial lighting energy. Window frames, sashes and curtain wall system are so designed to optimize energy performance.

Use of Bureau of Energy Efficiency (BEE) rated electrical equipment's is encouraged. CFC-free refrigerants in Air conditioners (AC) and refrigerators are installed. Renewable sources of energy such as solar, wind, geothermal etc. are used to reduce the electricity loads at peak hours.

### D. Material Selection

Maximizes the use of recycled content materials, re-usable, renewable, sustainably managed and bio-based materials [8]. Ways are identified to use high recycled content materials which range from blended concrete using fly ash, slag, recycled concrete aggregate or other admixtures to structural steel, ceiling and floor tiles, carpeting, carpet padding etc. Bio-based materials and finishes such as various types made from agricultural waste and byproducts including straw, wheat, barley, soy, sunflower shells, peanut shells etc. are used. Reuse of household waste in the form of biogas is also a feature of this aspect.

### E. Indoor Environment Quality

In order to enhance the health of the occupants, buildings should be constructed with materials having low emissions. Building is designed to maximize the use of natural light for all occupants. Bio degradable and

environment friendly cleaning agents are used, that do not release harmful agents and residue [9]. There should be a provision for cross ventilation and enhanced ventilation system.

By considering all above aspects a green building will be designed and constructed. The conceptual drawing green building is shown in Fig. 3.1.

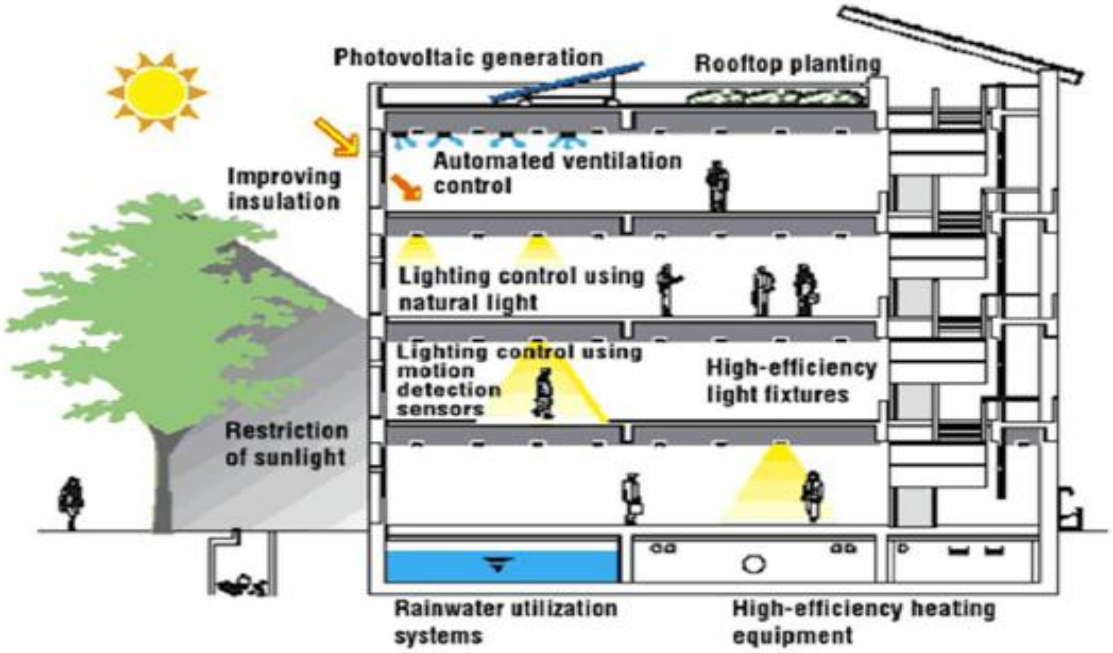


**Fig. 3.1** Conceptual Drawing of Green Building

## IV. Benefits Of Sustainable Building

On a broader scale, design and construction of green buildings will benefit the community at large with the improvement in environment by reducing GHG (greenhouse gas) emissions, improving energy saving, and reducing the stress on natural resources. Green concepts and techniques in the residential sector can help address national issues like handling of consumer waste, water efficiency, extinction of fossil fuel in nature by increase energy efficiency, conserve the natural resources. Some of the benefits of a green design to a building owner, user, and the society as a whole are as follows:

- Reduced energy consumption without sacrificing the comfort levels
- Reduced destruction of natural areas, habitats, and biodiversity, and reduced soil loss from erosion, etc.
- Reduced air and water pollution (with direct health benefits)
- Reduced water consumption
- Limited waste generation due to recycling and reuse
- Reduced pollution loads
- Increased user productivity
- Enhanced image and marketability

## V. Green Building Rating System

Buildings are long-lasting and have the longer life span; their impacts translate into the lives of several generations to come; into a future of unknown resources, pollution and unstable climatic conditions. The green building movement has led to the materialization of an assortment of green rating systems [10].

Rating system is a guiding and performance-oriented system where points are allotted for meeting the design and performance intent of the criteria. Each criterion has a number of points assigned to it. It means that a project intending to meet the criterion would qualify for the allotted points.

The green rating systems that are currently being followed in India are:

- LEED India – Leadership in Energy and Environmental Design administered by the Indian Green Building Council (IGBC)
- GRIHA - Green Rating for Integrated Habitat Assessment developed by TERI (The Energy and Research Institute)
- SVAGRIHA - Small Versatile Affordable Green Rating for Integrated Habitat Assessment developed by TERI (The Energy and Research Institute)

Among the above GRIHA is most widely used 100 point rating system, dedicated with some core points, which are mandatory to be met while the rest are optional points, which can be earned by complying with the commitment of the criterion for which the point is allocated.

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 one star, 'two stars', 'three stars' and 'four stars' respectively. A building scoring 91 to 100 points will get the maximum rating of 'five starts'. The rating criterion of GRIHA is shown in Table 1.

**Table 1** Rating Criteria

| Points scored | Rating |
|---|---|
| 51-60 | ★ |
| 61-70 | ★★ |
| 71-80 | ★★★ |
| 81-90 | ★★★★ |
| 91-100 | ★★★★★ |

## VI. Retrofitting Of Existing Buildings

It's not impossible to transform an existing building to a green one, but to the some extent it may be difficult. There are some easy items that can be retrofitted into an existing building at relatively low cost and in time, often pay for the retrofit. Existing buildings require considerable investment to replace something that already exists and in working order. However, not all of the necessary alterations need to be done at same time.

Start with what equipment needs to be fixed or repaired such as leaking pipes. If the building is being remodeled, keep the green concept in mind and use recycled material and paints that are environment friendly. Whether the building is old or new, installing low-flow fixtures is one of the easiest ways to save money and conserves water.

If leaking pipes or fixtures cannot be repaired, replace them with ultra-low-flow fixtures. Some of the easiest green retrofits to an existing building are methods for decreasing power usage and water consumption. For example, anytime a light bulb burns out, replace it with an ultra-low-energy use bulb like LED bulb. When landscaping, use native plants and garden designs that require less (or no) irrigation.

## VII. The Issue Of Cost

Considerable research and analysis is being carried out with regard to the cost impacts of a green building. The cost could be slightly higher than a conventional building, but it has to be seen with a different paradigm.

The question is how do we compare the costs? There needs to be a baseline cost for all comparisons. The incremental cost is always relative and depends on the extent of eco-friendly features already considered during design [11]. The incremental cost would appear small if the baseline design is already at a certain level of good eco-design; it would appear huge if the base design has not considered green principles.

### F. Use of Net Present Value (NPV) Method

One of the most widely used method to calculate the current value of green buildings and components is present value (PV) or net present value (NPV) method. PV is the present value of a future stream of financial benefits. NPV reflects a stream of current and future benefits and costs, and results in a value in today's Rupees that represents the present value of an investment's future financial benefits minus any initial investment [12]. If the net present value is positive then the investment should be made (unless an even better investment exists), otherwise it should not.

This provides a calculation of the value in today's Rupees for the stream of 20 years of financial benefits discounted by the 5% real interest rate. It is possible to calculate the net present value of the entire investment, both initial green cost premium and the stream of future discounted financial benefits by subtracting the former from the latter.

## VIII. Prospects Of Green Buildings And Their Development

The construction of Green Building mainly focuses on reduction of electricity and water consumption. Lighting loads are biggest consumption points of electricity in buildings. Usage of Sky lights maximizes the day lighting thereby reduces usage of artificial lighting. Photo Voltaic cells are to be installed on the roof top of building to generate the electric energy. Rainwater harvesting and waste water treatment plants are also to be installed within the building to conserve the water. There are lot of options available to build green homes, a few of those are energy saving air conditioners (HVACs), high performance glass windows, water saving solutions, composting toilets, and efficient building management systems.

Green powering resource output and the connected electrical load of the private house spots including public areas of the small sized Green building, to the extent possible should get balanced. For huge constructions at least the public walk-a-way area lighting and lift and pumping loads should be met by the said resource.

Usage of solar window technology could not only generate electricity through nano PV cells and miniscule wires, but also illuminates the indoor area spreading the sun light without losing transparency during day time. However generated electricity can be utilized for illuminating the same area during night hours. Molten salt storage tanks can be erected on the roof for storing solar thermal energy for several hours and its fluid can be circulated for heating water instead of conventional immersion water heaters and gejers. Solar water heaters can also be used for serving the above purpose in small scales.

## IX. Conclusion

The green building experiences in India are challenging due to cost. Even through cost of sustainable buildings are higher, it will be paid back in significant time, in the form of savings. This will ultimately serve to improve not only the energy performance of buildings but will also assist the country to conserve energy and natural resources by increased recovery and recycling of materials. The easy availability of most of the green materials and equipment in the country has made it easier for the designers to adopt local materials to a very large extent. Green Building movement is to stay for the benefit of individuals, society and the country at large. Energy savings are only the most obvious and most easily quantified of the cost benefits of green buildings.

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