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*Review Paper*

# Green Buildings

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## ABSTRACT

The term "green building" is used to describe buildings that are designed, constructed, and operated, to have a minimum impact on the environment, both indoor and outdoor. Most discussions of green buildings refer to the importance of providing an acceptable, if not exceptional, indoor environment for the building occupants. However, these discussions of indoor environment quality have not included many specific recommendations or criteria for building design, construction, or operation. In addition, rating systems that have been developed to assess the greeness of a building are based largely on design features and are not particularly specific with respect to indoor air quality. This paper reviews the features of indoor air quality that are considered in green building discussions, demonstration projects, and rating systems. These green building features are discussed in terms of their completeness and specificity, and are compared to other guidance on building design, construction, and operation for good indoor air quality. A case study of indoor air quality performance in a green building is presented. This study includes a description of the indoor air quality features of the building and the results of a short-term indoor air quality evaluation of the building involving ventilation and contaminant concentration measurements.

***Key words:*** green building, indoor environment, construction, building design.

## INTRODUCTION

Green building (also known as green construction or sustainable building) refers to both a structure and the application of processes that are environmentally responsible and resource-efficient throughout a building's life-cycle: from planning to design, construction, operation, maintenance, renovation, and demolition. It is a practice of increasing efficiency with which buildings use resources-energy, water and materials while reducing building impacts on human health and the environment. Green buildings refer to both a structure and the application of processes that are environmentally responsible and resource-efficient throughout building's life-cycle: from planning to design, construction, operation, maintenance, renovation, and demolition. Green building means making healthy and sustainable choices, especially in the way your building uses energy, water, materials, and its site. In recent years, more and more professionals have been focusing on energy efficiency in a variety of industries. Studies show that the development and long-term growth of larger communities has had a major impact on the surrounding natural environment. As such, experts are beginning to focus on the design, construction and large-scale manufacturing of green buildings that could provide individuals with a more responsible way to consume natural resources. Not only does the widespread functionality of green buildings improve the local environment,

but those working and living inside the buildings can enjoy healthier atmospheres, free of unnecessary pollution and waste.

## MATERIALS

Building materials typically considered to be 'green' include rapidly renewable plant materials like bamboo and straw, lumber from forests certified to be sustainably managed, ecology blocks, dimension stone, recycled stone and other products that are non-toxic, reusable, renewable and/or recyclable (e.g. Trass, Linoleum, sheep wool, panels made from paper flakes, compressed earth block, adobe, baked earth, rammed earth, clay, vermiculite, flax linen). The EPA (Environmental Protection Agency) also suggests using recycled industrial goods, such as coal combustion products, and heavily reduces carbon emissions as well. Polyurethane blocks are being used instead of CMTs by companies like American Insulock. Polyurethane blocks provide more speed, less cost, and they are environmentally friendly. Building materials should be extracted and manufactured locally to the building site to minimize the energy embedded in their transportation.

## REDUCED ENERGY USE

Green buildings often include measures to reduce energy use. To increase the efficiency of the building envelope, they may use high-efficiency windows and insulation in walls, ceilings, and floors. Another strategy, passive solar building design, is often implemented in low-energy homes. Designers orient windows and walls and place awnings, porches, and trees to shade windows and roofs during the summer while maximizing solar gain in the winter. In addition, effective window placement can provide more natural light and lessen the need for electric lighting during the day. Solar water heating further reduces energy loads.

Finally, onsite generation of renewable energy through solar power, wind power, hydro power, or biomass can significantly reduce the environmental impact of the building.

## REDUCED WASTE

Green architecture also seeks to reduce waste of energy, water and materials used during construction. For example, in California nearly 60% of the state's waste comes from commercial buildings. During the construction phase, one goal should be to reduce the amount of material going to landfills. Well-designed buildings also help reduce the amount of waste generated by the occupants as well, by providing on-site solutions such as compost bins to reduce matter going to landfills.

To reduce the impact on wells or water treatment plants, several options exist. "Greywater", wastewater from sources such as dishwashing or washing machines, can be used for subsurface irrigation, or if treated, for non-potable purposes, e.g., to flush toilets and wash cars. Rainwater collectors are used for similar purposes.

Centralized wastewater treatment systems can be costly and use a lot of energy. An alternative to this process is converting waste and wastewater into fertilizer, which avoids these costs and shows other benefits. By collecting human waste at the source and running it to a semi-centralized biogas plant with other biological waste, liquid fertilizer can be produced.

## THE COSTS AND FINANCIAL BENEFITS OF GREEN BUILDINGS

Green Buildings provide financial benefits that conventional buildings do not. These benefits include energy and water savings, reduced waste, improved indoor environmental quality, greater employee comfort/productivity, reduced employ health costs and lower operations and maintenance costs. Integrating “sustainable” or “green” building practices into the construction of state buildings is a solid financial investment. In the most comprehensive analysis of the financial costs and benefits of green building

conducted to date, a minimal upfront investment of about two percent of construction costs typically yields life cycle savings of over ten times the initial investment. For example, an initial upfront investment of up to Rs.100,000 to incorporate green building features into a Rs.5 million project would result in a savings of at least Rs.1 million over the life of the building, assumed conservatively to be 20 years.

The financial benefits of green buildings include lower energy, waste disposal, and water costs, lower environmental and emissions costs, lower operations and maintenance costs, and savings from increased productivity and health. These benefits range from being fairly predictable to relatively uncertain. Energy and water savings can be predicted with reasonable precision, measured, and monitored over time. In contrast, productivity and health gains are much less precisely understood and far harder to predict with accuracy.

## THE ISSUE OF COST

While there seems to be consensus on the environmental and social benefits of green building, there is a consistent concern, both within and outside the green building community, over the lack of accurate and thorough financial and economic information. Recognizing that the cost issue was becoming more and more of a prohibitive factor in the mainstreaming of green building not only within India but across the World, several members of the Task Force funded an Economic Analysis Project to determine more definitively the costs and benefits of sustainable building. Sustainable buildings generally incur a "green premium" above the costs of standard construction. They also provide an array of financial and environmental benefits that conventional buildings do not. These benefits, such as energy savings, should be looked at through a life cycle cost methodology, not just evaluated in terms of upfront costs. From a life cycle savings standpoint, savings resulting from investment in sustainable design and construction dramatically exceed any additional upfront costs.

## PERCEPTIONS AND REALITIES

Having covered on the benefits it is also important to know that people have different perceptions on green buildings; some are correct and some are otherwise. It is important to look at these:

**Perception 1: Green buildings are costlier**
Reality: Considerable research and analysis has been carried out with regard to the cost impacts of a green building. The cost could be slightly higher than a conventional building. But then, this needs 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 to be alike.

The incremental cost is always relative and depends on the extent of eco-friendly features already considered during design. 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.

**Perception 2: Green buildings have to be air-conditioned**
Reality: Green building concepts and the LEED rating can be applied for non-air conditioning buildings. It has been applied on three such buildings in India viz., IGP office, Gulbarga, the Royal Engineering College, Hyderabad and LIC office, Shimoga.

While performing the energy analysis using software tools, such buildings will input the same cooling system both in the baseline and the proposed design. This ensures that the building is recognized for any of the other energy efficiency measures incorporated, for example- the envelop, lighting, roof insulation etc. This kind of an approach also ensures that an apple-to-apple comparison is made while evaluating two

green buildings, whether conditioned or not.

**Perception 3: Green buildings take more time Reality:**

There is a general perception that going the green way may affect the project schedules. This was perhaps the case for the CII-Godrej GBC building when it was the first time that a green building rating tool was being applied in the country.

The design in this case took about one-and-half years while the construction was completed in about 9 months!

Thanks to the Green building movement; now there is so much of capacity building that has happened in the country. Now, there is absolutely no difference in the time involved in constructing a green building vis-à-vis a normal building. The time schedule for the rating can be synchronized with that of the building. This has been amply demonstrated in buildings like the Wipro in Gurgaon and Grundfos in Chennai.

**USE OF PRESENT VALUE (PV) AND NET PRESENT VALUE (NPV)**

This will seek to calculate the current value of green buildings and components on a present value (PV) or net present value (NPV) basis. 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. If positive, 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.

**INFLATION**

If we assumes an inflation rate of 2% per year, in line with most conventional inflation projections. In reality, this is quite an oversimplification and a more detailed analysis might attempt to make more accurate but complicated predictions of future costs. In particular, energy costs are relatively volatile, although electricity prices are less volatile than primary fuels, especially gas.

## CONCLUSION

Green and sustainable buildings are naturally different from conventional buildings. They require special materials and building practices as well as management commitment to sustainability (Anantatmula & Robichaud, 2011). Due to the barriers reported, the unique characteristics of sustainable building project required adjustments to conventional project management practices to minimise risks and improve the chances of delivering the project within acceptable costs and schedule. Realistic financial and time constraints, superior planning, design and construction processes are needed to deliver a green and sustainable building project (Korkmaz et al., 2010). Sustainable and Green buildings will only results from building professionals working together to achieve this common objective. It is important to explore the strategies for containing cost during the planning phase of a project to reduce developers first cost in delivering the green and sustainable building project (Korkmaz et al., 2010). Sustainable and green building requires a client who is sympathetic to this ideal, user who understands and values the concepts and designers and contractors who as a team evolve the design with a sustainable outlook.

If the technologies discussed here can be adopted for new buildings and building retrofits, the energy, water and waste footprint of the built environment can be significantly reduced, while at the same time ensuring occupant comfort and safety with the appropriate choice of technologies.

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