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Green Buildings Overview and Analysis of Energy Efficient Building

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Abstract: **The challenges our planet faces, particularly climate change and sustainable economic development, are global in nature and so require global solutions. The building sector, which consumes as much as 40% of world's energy, 12% of its water and contributes 40% of its waste sent to landfill, is the major part of this global problem. Reducing energy use in buildings saves resources and money while reducing pollution and CO2 in the atmosphere. It also leverages even greater savings at power plants. For the average 33-percent-efficient coal-fired power plant, saving a unit of electricity in a building saves three units of fuel at the power plant. So to reduce green house gas emission, government promotes new buildings construction and to retrofit existing buildings while satisfying low energy criteria. This means improving energy efficiency of buildings and energy systems, developing sustainable building concepts and promoting renewable energy sources. "Green" or "sustainable" buildings use key resources like energy, water, materials, and land more efficiently than buildings that are just built to code. With more natural light and better air quality, green buildings typically contribute to improved employee and student health, comfort, and productivity. A green building depletes the natural resources to the minimum during its construction and operation. In this paper an over view of green building is discussed.**

Keywords: **problem of existing building; benefits, cost, rating, efficiency, material.**

I. INTRODUCTION

Green building is the remedy to reduce the environmental degradation. Green or sustainable building use key resources like energy, water, materials and land much more efficiently and creates less waste, compared to conventional building. According to the United Nations, cities consume two thirds of global energy use. 76% of the world's energy-related carbon dioxide (CO2) is also emitted by cities through transport, industry, and building and construction related activities. Studies have shown that buildings and construction activities use 40% energy, 30% mineral resources and 20% water of the world's resources. It also accounts for 40% CO2 emissions, 30% solid wastes and 20% water pollution in the world. As India is emerging as a strong force in the Asian sub-continent and looking to tremendous infrastructure growth, time has come to think for environmental friendly or sustainable building. India has its own organization to rate the green building in India. Agencies like GRIHA, IGBC, and BEE are involved green building development in India.

II. THE PROBLEM OF EXISTING BUILDINGS

Although green buildings represent the next phase of buildings, the reality is that the vast majority of buildings are not green, and these buildings will continue to be used for many years to come. The environmental impacts of buildings are enormous. Conventional buildings use large amounts of energy, land, water, and raw materials for their construction and operation. They are responsible for large greenhouse gas (GHG) emissions as well as emissions of other harmful air pollutants. They also generate large amounts of construction and demolition (C&D) waste and have serious impacts on plants and wildlife.

III. WHAT MAKES BUILDINGS GREEN

In contrast to conventional buildings, green buildings seek to use land and energy efficiently, conserve water and other resources, improve indoor and outdoor air quality, and increase the use of recycled and renewable materials. While green buildings still constitute a tiny subset of existing buildings, their numbers are increasing rapidly.

IV. BENEFITS OF GREEN BUILDING-

1. Green building generate on site energy through renewable energy utilization to cater to its energy needs. For instance, solar thermal systems can help generated hot-water and replace the conventional electrical geyser in buildings. Solar PV panels can help generate electricity which can reduce the buildings dependence on grid power.

2. Green buildings consumes 40% to 80% (depending on the range of measures adopted) lesser water compared to conventional buildings. By utilizing ultra-low-flow fixtures, dual plumbing systems and rain-water harvesting, green building not only reduce their demand for water use but also look at on-site supply options to cater to its internal and external (landscape) water demands.

3. A primary consideration of green buildings is the health and well-being of their occupants. Causes of sick building syndrome typically include inadequate ventilation, chemical contaminants from indoor and outdoor sources, and biological contaminants such as mold. The first step in eliminating the causes of sick building syndrome is carefully choosing the materials that are used in the building. Construction materials and interior finish products should be chosen that emit zero or low levels of volatile organic compounds (VOCs), which are harmful to humans and can vaporize at room temperature in a process called "off-gassing."

4. Green buildings generated lesser waste by employing waste management strategies on site. For example Construction waste consists primarily of lumber and manufactured wood products (35 percent), drywall (15 percent), masonry materials (12 percent), and cardboard (10 percent). Although much of this material is recyclable, most of it is deposited into landfills. Green buildings reduce construction and demolition waste by using inert demolition materials as base material for parking lots and roadways. Demolition generates large amounts of materials that can be reused or recycled—principally wood, concrete and other types of masonry, and drywall. Rather than demolishing an entire building, all or part of a building can be deconstructed.

5. Green buildings generate lesser pollution both during construction materials, barricading of the site to prevent air and noise pollution during construction and operation, and so on, ensures reduced impact on the surrounding environment.

Green building design is looked in an integrated way:

1. Site planning

2. Building envelope design

3. Building system design HVAC (heating ventilation and air conditioning), lighting, electrical, and water heating

4. Integration of renewable energy sources to generate energy onsite.

5. Water and waste management

6. Selection of ecologically sustainable materials (with high recycled content, rapidly renewable resources with low emission potential, etc.).

7. Indoor environmental quality (maintains indoor thermal and visual comfort and air quality).

V. COST OF BUILDING GREEN BUILDING

The most criticized issue about constructing environment friendly buildings is the cost. Photo-voltaic, new appliances and modern technologies tend to cost more money. In terms of appearance or use, there is no difference between green buildings and conventional ones. The major differences are that green buildings have improved indoor environment and they offer operational savings. The benefits such as the economical advantages are not immediately visible. However, the lifetime payback is much higher compared with that of conventional buildings, which mainly accrue from operational cost savings, reduced carbon emission credits and potentially higher rental or capital values.

The other benefits such as social advantages are due to the positive impact of green buildings in the neighborhood environment. Moreover, due to better working conditions, the productivity of occupiers increase and health problems decreases. 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. In mature markets the cost premium range from 1-6%. Cost premium in India is in the range of 6–18% (Table 2) depending on the level of rating. This can be attributed to lack of technical know-how, immaturity of the market and lack of resources.

IGBC is highlighting the fact that it has recently crossed 2 billion sq. ft. of registered green building footprint in India. "Green buildings also make good business sense with an investment return time of two years and energy savings of almost 30 per cent per year," .it really does not cost extra to develop a green building. It is simple application of conventional wisdom, orientation of the building, concern for our neighborhood and application of mind to minimize use of materials, best described by Reduce, Reuse, Recycle. Even the Platinum Green Buildings of IGBC that used to cost 15 per cent more about eight years ago now cost just around 9-12 per cent more than non-green buildings.

Table 2: Performance of Green Buildings in India

Name of the Project	Location	Built-up Area (sq ft)	Rating Achieved	Increase in Cost (%)	Payback Period (years)
CII-Sorabji Godrej GBC	Hyderabad	20,000	Platinum	18	7
ITC Green Centre	Gurgaon	170,000	Platinum	15	6
Wipro	Gurgaon	175,000	Platinum	8	5
Technopolis	Kolkata	72,000	Gold	6	3
Spectral Services Consultants Office	Noida	15,000	Platinum	8	4
HITAM	Hyderabad	78,000	Silver	2	3
Grundfos Pump	Chennai	40,000	Gold	6	3

VI. GREEN BUILDING RATING SYSTEM

A. GRIHA:

Green Rating for Integrated Habitat Assessment (GRIHA) is India's own rating system jointly developed by TERI and the Ministry of New and Renewable Energy, Government of India. . GRIHA rating system consists of 34 criteria categorised in four different sections. Some of them are – (1) Site selection and site planning, (2) Conservation and efficient utilization of resources, (3) Building operation and maintenance, and (4) Innovation.

Commonwealth Games village, New Delhi, Fortis Hospital, and New Delhi, CESE (Centre for environment sciences) & Engineering Building, IIT Kanpur, Suzlon one Earth, Pune and many other buildings has received GRIHA rating.

B. IGBC:

IGBC Green Existing Building O&M is the first rating programme developed in India, exclusively for existing building stock. It is based on accepted environmental principles and strikes a balance between known established practices and emerging concepts. The system is designed to be comprehensive in scope, yet simple in operation. IGBC Green Existing Buildings O&M rating system addresses green features under the following categories:

- Site & Facility Management
- Water Efficiency
- Energy Efficiency
- Health & Comfort
- Innovation

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The threshold criteria for Certification levels are as under

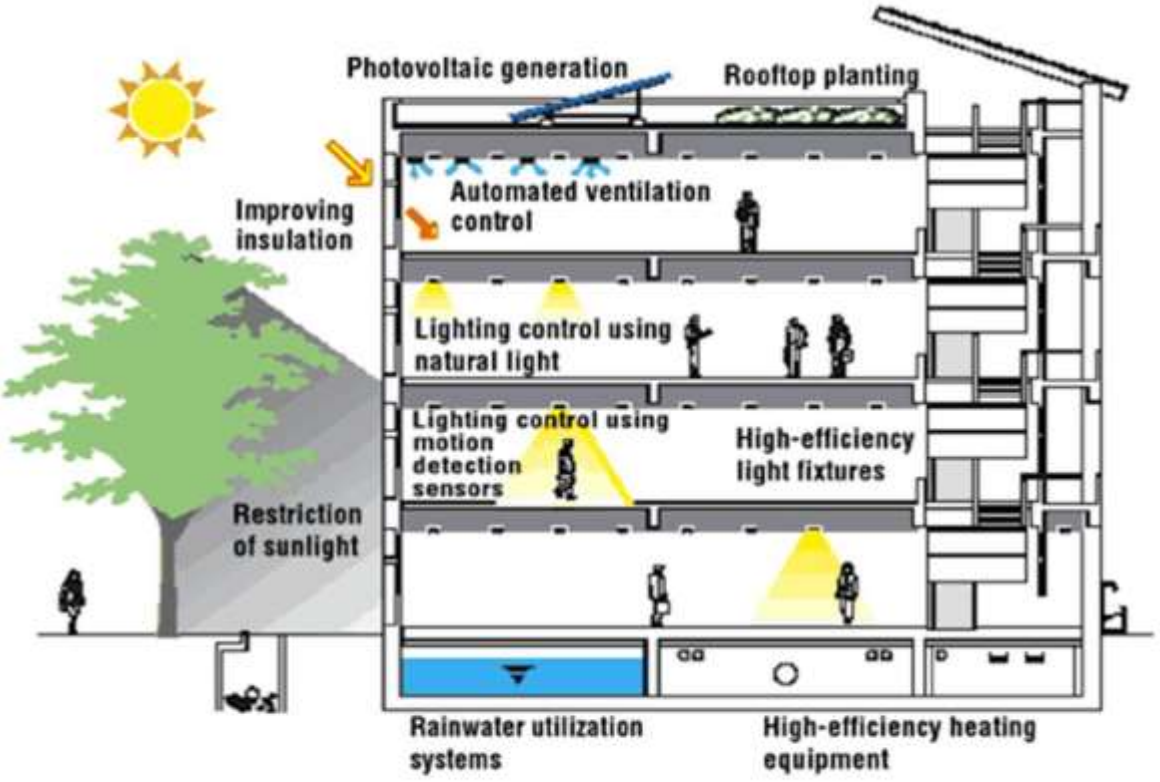
Certification Level	Points	Recognition
Certified	50 - 59	Best Practices
Silver	60 - 69	Outstanding Performance
Gold	70 - 79	National Excellence
Platinum	80 - 100	Global Leadership

C. Bureau of Energy Efficiency (BEE):

BEE developed its own rating system for the buildings based on a 1 to 5 star scale. More stars mean more energy efficiency. The unit of Kilo watt hours per square meter per year is considered for rating the building and especially targets air conditioned and non-air conditioned office buildings. The Reserve Bank of India's buildings in Delhi and Bhubaneswar, the CII Sohrabji Godrej Green Business Centre and many other buildings has received BEE 5 star ratings.

VII. ENERGY EFFICIENCY

Green buildings are around 25–30% more energy efficient, with gold-rated buildings as much as 37% efficient. On an average, green buildings obtain 2% of their energy from renewable or green sources. 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 reduces pollution and the emission of GHGs.



Conceptual Drawing of Green Building

Water Efficiency: Green buildings use 20–30% less water compared with similar conventional buildings. This reduces the operational water expenses and the pressure on civic amenities. Moreover, 70–100% of used water is treated and reused for landscaping and air conditioning. This reduces the load on an area's sewage system.

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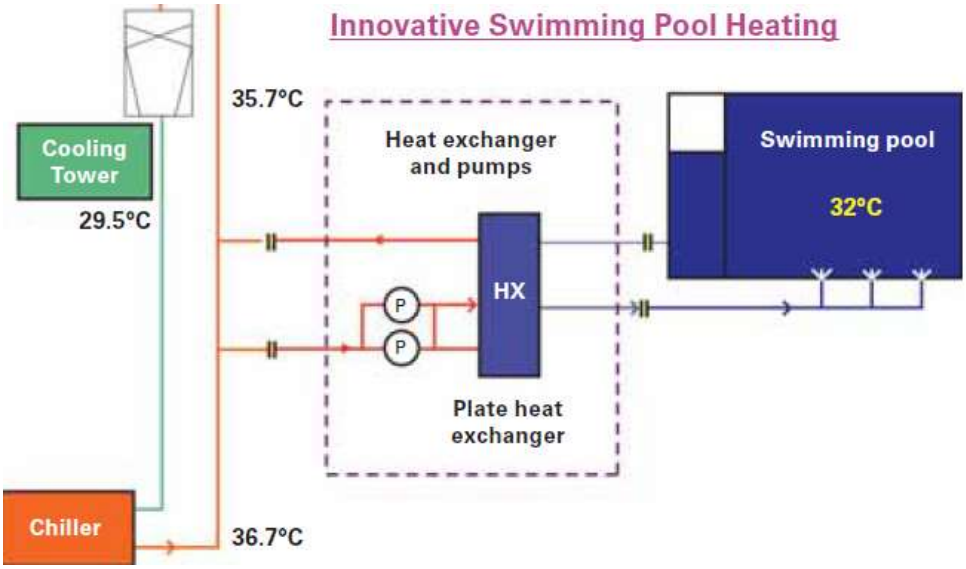

Waste Reduction: Green buildings emphasize waste reduction. Construction wastes and demolition debris are the main wastes produced during the construction process, and these wastes degrade the quality of the environment. Green buildings ensure waste reduction by:

1. The reuse and minimization of construction wastes and debris and diverting them to recycling units;

2.The use of existing building structure and reclaimed building materials in the core and shell of a project;

3. The increased use of recycled content in construction materials;

4. Designing the structure to produce less scrap and execute it according to the plan. Green buildings reduce construction waste by approximately 50% compared with that of similar conventional buildings,

Land Use and Consumption:

Normally poor poor sitting of buildings that leads to large amounts of land (and other resources) being consumed. For example, buildings that are not built in existing residential or commercial areas require the construction of new roads, sewer lines, utility poles, and other infrastructure to reach them, which can lead to, among other things, habitat destruction. Most significantly, buildings that are built on the fringes of existing urban or suburban areas often contribute to the problem of sprawl.

The site can be graded to accommodate runoff and prevent damage to the surrounding ecosystem. Geotextiles and silt fences can be used during construction to prevent erosion. Light, shade, wind, and water should be considered when designing the building's envelope, windows, and utilities to take full advantage of the conditions of the site. Landscape elements should include native plants as alternatives to conventional grass lawns, which often depend on irrigation and pesticides. Native plants are adapted to the natural hydrology, climate, and geography of the region and have evolved in relation to other local plants.

VIII. REDUCED ENERGY USE

Green buildings often include measures to reduce energy use. To increase the efficiency of the building envelope, (the barrier between conditioned and unconditioned space), 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 (day lighting) 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. Power generation is generally the most expensive feature to add to a building.

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IX. GREEN MATERIAL

A green material is one that simultaneously does the most with the least, fits most harmoniously within ecosystem processes, helps eliminate the use of other materials and energy, and contributes to the attainment of a service-based economy. non-toxic, reusable, renewable, and/or recyclable (e.g. Tress, Linoleum, sheep wool, panels made from paper flakes, compressed earth block, adobe, baked earth, rammed earth, clay, vermiculite, flax linen, sisal, sea grass, cork, expanded clay grains, coconut, wood fiber plates, calcium sand stone, concrete (high and ultra high performance, roman self-healing concrete) , etc.).

Building material Roof: Insulate composite slab roof with 75mm extruded polystyrene.

1. Reduces heat transmission by 50%

2. Truss insulation of PEB ceiling with 75mm rock wool

3. Roof finish with high reflexive material; SRI > 78. Reduces heat transmission .

Building material wall and window:

1. Use AAC or cellular concrete blocks (0.12-0.15 btu) to reduce U-factor.

2. Better material can reduce heat gain from walls by 35%.

3. Use of low- E glass with double glazed windows.

4. E.g.: 6mm glass + 12mm air gap + 6mm ecologic (ST150, light blue gray, U factor of 0.33 btu) has 21% reflectance 39% transmittance.

5. Reduces heat gain by 15 -20%.

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Sun Pipes used at ViswaSyamalam, Chennai

UNDER FLOOR HEATING: It can used either for a new build or a retrofit and can be made to suit almost any floor type. The method circulates warm water through a closed loop where the water is reused.

•It provides quite comfort with uniform distribution of warmth.

•Heating via radiant energy avoiding dryness associated with conventional heating systems.

•One can choose an energy source to heat the water like – gas, solar, heat pump, geothermal.

• Maximize performance with optimal control through room thermostats with integrated timers.

The choice of a green material depends on following parameters:

1. Physical suitability: Its physical properties like compressive strength, tensile strength, water resistance etc.

2. Dependability: Its dependability on other materials for its aesthetic or functional efficiency.

3. Cost: Affordability subject to the budgetary constraints.

4. Aesthetics: Its aesthetic blend with the entire schema of things

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X. PASSIVE DESIGN

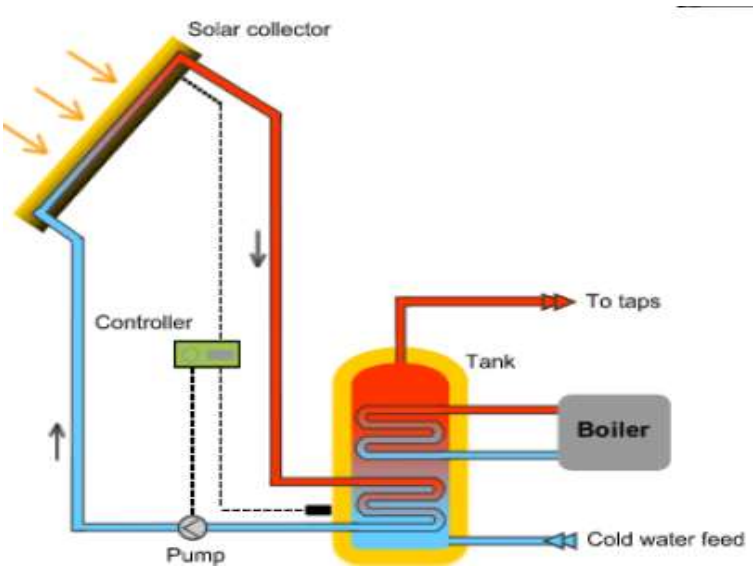
Optimizing passive design is the first step towards reducing the energy demand of a building or project. Initial site planning establishes the orientation, massing and location of the components and uses of a project, all of which impact and set the parameters for passive design strategies. Some of the primary issues to consider are:

SOLAR HEAT GAIN:

Solar heat gains (via direct solar radiation) increase the cooling load of a project and hence energy use.

In naturally ventilated spaces, solar heat gains heat up spaces such that they typically become thermally

Uncomfortable to occupants. The first step in minimizing solar heat gains is to optimize the orientation and massing of a project specific to its location. Certain orientations (east and west for example) provide more exposure to the sun and therefore greater heat gains. This varies according to the location of a project so the sun path needs to be looked at for different locations and at different times of the year.



Solar water heating system

NATURAL VENTILATION:

Maximizing the amount of space to be naturally ventilated is another strategy towards reducing energy demand on a project since natural ventilation requires little energy use as compared to air-conditioning. Establishing and understanding prevailing wind directions and how they work on your specific site will affect massing and orientation decisions.

DAYLIGHT:

While minimizing solar heat gains is important, it is also important to take advantage of and harness natural daylight for spaces. This reduces the need for artificial lighting which requires significant amounts of energy. Bringing in daylight via window openings at appropriate heights, skylights and/or atrium spaces are all effective strategies that will affect massing and orientation decisions.

XI. CONCLUSION

Green building reduces energy consumptions in numerous ways. Decrease embodies energy of the building through efficient design, use of recycled and local materials and recycling construction waste. Green building design reduces energy consumption over its lifetime. Strategically placing windows and skylight can eliminate the need for electrical lighting during the day. High quality insulation reduces temperature regulation costs in both summer and winter. Green building consumes less water as compared to conventional building. As green materials are easy available in India so cost of green building is not so high compared to existing building in India. For reducing greenhouse gas emission we need to go towards to green building so that people can live healthier life by using fresh air.

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