

## UNIT– I

# **Introduction to Green Building– Necessity of Green Buildings, Benefits of Green Buildings. Green Building Materials and Equipment in India, Key Requisites for Constructing a Green Building, Important Sustainable Features for Green Buildings.**

## **1. Introduction to Green Buildings**

### **What is a Green Building?**

Green buildings are essential for sustainable development, addressing environmental concerns and resource efficiency. They offer numerous benefits, including reduced energy consumption, improved indoor air quality, and lower operational costs. In India, green building materials like bamboo and recycled steel are gaining traction, alongside equipment that enhances energy efficiency. Key requisites for constructing a green building include site selection, water management, and energy-efficient design. Important sustainable features encompass renewable energy systems, efficient insulation, and sustainable landscaping practices. Overall, green buildings contribute significantly to ecological balance and promote a healthier living environment & A Green Building is a structure that is designed, constructed, operated, and maintained in an environmentally responsible and resource-efficient manner throughout its lifecycle—from planning to design, construction, operation, maintenance, renovation, and demolition.

Green buildings aim to **reduce the negative impacts** of buildings on the environment and human health by:

1. Efficiently using energy, water, and other resources.
2. Protecting occupant health and improving employee productivity.
3. Reducing waste, pollution, and environmental degradation.

## **2. Necessity of Green Buildings**

### **Why Do We Need Green Buildings?**

In today's rapidly urbanizing world, buildings contribute to:

- ✓ **40% of global energy consumption**
- ✓ **30% of greenhouse gas emissions**
- ✓ **20% of potable water usage**
- ✓ **30% of solid waste generation**

### **Key Reasons for the Necessity:**

- ✓ **Climate Change Mitigation:**  
Green buildings help reduce **carbon footprint** and promote sustainable energy use.

- ✓ **Resource Conservation:**  
Use of **renewable resources**, rainwater harvesting, solar panels, and low-energy systems.
  - ✓ **Energy Efficiency:**  
Traditional buildings consume a lot of energy. Green buildings use **intelligent lighting**, **passive cooling**, and **energy-efficient appliances**.
  - ✓ **Water Efficiency:**  
Adoption of systems like **greywater reuse**, low-flow fixtures, and **rainwater harvesting** reduces water use.
  - ✓ **Waste Reduction:**  
Green construction encourages **reduce-reuse-recycle (3Rs)** principle, and construction materials are often biodegradable or recyclable.
  - ✓ **Health and Well-being:**  
Promotes use of **non-toxic, natural materials**, proper ventilation, and **daylighting** to improve indoor air quality.
  - ✓ **Cost Efficiency Over Time:**  
Though initial costs might be higher, operational costs are significantly **lower** over the building's lifecycle.
- ✓ **Environmental Impact:** Traditional buildings contribute significantly to greenhouse gas emissions, resource depletion, and pollution. Green buildings aim to reduce these impacts through sustainable practices.
  - ✓ **Resource Efficiency:** With the growing population and urbanization, the demand for resources is increasing. Green buildings utilize materials and energy more efficiently, helping to conserve natural resources.
  - ✓ **Health Benefits:** Green buildings promote better indoor air quality and natural lighting, which can lead to improved health outcomes for occupants.
  - ✓ **Regulatory Compliance:** Many governments are implementing stricter regulations regarding energy efficiency and sustainability. Green buildings help meet these regulatory requirements.

### 3. Benefits of Green Buildings

#### Environmental Benefits:

- ✓ Reduction in **carbon emissions**
- ✓ **Less air and water pollution**
- ✓ **Reduced strain** on local resources
- ✓ Encouragement of **biodiversity**

#### Economic Benefits:

- ✓ Lower **operating and maintenance costs**
- ✓ Higher **property values**
- ✓ Reduced utility bills due to energy and water savings
- ✓ Incentives from government (tax rebates, subsidies, fast-track approvals)

#### Social & Health Benefits:

- ✓ Enhanced occupant **comfort and health**
- ✓ Improved indoor **air quality** and **natural lighting**
- ✓ Boost in **productivity** for workers in commercial green buildings
- ✓ Positive **psychological impact** on occupants

**Energy Efficiency:** Green buildings are designed to use less energy through efficient systems and renewable energy sources, leading to lower utility bills.

**Water Conservation:** Implementing water-efficient fixtures and rainwater harvesting systems reduces water consumption and promotes sustainability.

**Increased Property Value:** Green buildings often have higher market values and attract environmentally conscious buyers.

**Enhanced Comfort:** Improved indoor air quality and natural lighting contribute to a more comfortable living and working environment

**Long-term Savings:** Although the initial investment may be higher, green buildings typically result in lower operational costs over time.

#### 4. Green Building Materials and Equipment in India

##### Green Building Materials:

These are materials that have **low environmental impact** and are **recyclable, renewable, and energy-efficient**.

Type of Material	Examples
<b>Natural Materials</b>	Bamboo, adobe, straw bales, rammed earth
<b>Recycled Materials</b>	Recycled steel, plastic lumber, fly ash bricks
<b>Sustainable Woods</b>	FSC-certified wood, reclaimed wood
<b>Energy-efficient</b>	Autoclaved aerated concrete (AAC), insulated concrete blocks
<b>Low-VOC Products</b>	Paints, adhesives, sealants

##### Common Green Equipment in India:

- ✓ **Solar Panels** (Rooftop PV systems – supported by MNRE)
- ✓ **Rainwater Harvesting Systems**
- ✓ **LED Lighting Systems**
- ✓ **Low-flow Water Fixtures**
- ✓ **Greywater Treatment Units**
- ✓ **Energy-efficient HVAC Systems**
- ✓ **Smart Meters and BMS (Building Management Systems)**

##### □ Example Initiatives:

**GBCI (Green Business Certification Inc.)**

**IGBC (Indian Green Building Council)**

**TERI GRIHA (Green Rating for Integrated Habitat Assessment)**

### □ **GBCI (Green Business Certification Inc.)**

- ✓ GBCI is a global organization that provides third-party certification and credentialing services.
  - ✓ It administers **LEED (Leadership in Energy and Environmental Design)** globally, including in India.
  - ✓ LEED is the most widely used green building rating system worldwide.
  - ✓ GBCI ensures transparency, integrity, and consistency in green building certification.
  - ✓ It offers credentialing programs like **LEED AP** and **LEED Green Associate**.
  - ✓ GBCI started operating in India in 2016 to localize green certification processes.
  - ✓ It partners with developers, government bodies, and architects to promote sustainability.
  - ✓ The Indian arm is called **GBCI India**, headquartered in Gurgaon.
  - ✓ GBCI India also supports EDGE, WELL, TRUE, and SITES rating systems.
  - ✓ LEED-certified buildings are evaluated based on points earned in categories like water, energy, indoor quality, materials, etc.
- 

### □ **IGBC (Indian Green Building Council)**

- ✓ IGBC is part of the **Confederation of Indian Industry (CII)**, established in 2001.
  - ✓ It was formed to promote a sustainable built environment in India.
  - ✓ IGBC has developed India-specific rating systems aligned with national codes.
  - ✓ Rating systems include: **IGBC Green Homes, Green Factory, Green Townships, Green Schools**, etc.
  - ✓ IGBC encourages voluntary compliance with eco-friendly standards
  - ✓ It provides technical support, training programs, and certification services.
  - ✓ IGBC rating levels: Certified, Silver, Gold, and Platinum.
  - ✓ It emphasizes **energy efficiency, water conservation, materials, site selection**, and innovation.
  - ✓ IGBC Platinum is the highest honor, recognizing outstanding performance.
  - ✓ IGBC collaborates with GBCI for third-party certification and audits.
- 

### □ **TERI GRIHA (Green Rating for Integrated Habitat Assessment)**

- ✓ GRIHA is India's **national green building rating system**, developed by **TERI** and **MNRE**.
  - ✓ GRIHA is tailored to Indian climate, materials, and construction practices.
  - ✓ It is mandatory for all government buildings above a certain area threshold.
  - ✓ The system is based on 31 criteria grouped under various heads.
  - ✓ GRIHA promotes **sustainable site planning, water and energy optimization, and waste management**.
  - ✓ Buildings are awarded 1 to 5 stars based on their performance score.
  - ✓ GRIHA supports net-zero, passive design, renewable energy, and life cycle cost analysis
  - ✓ TERI provides training, workshops, software tools, and manuals for GRIHA adoption.
  - ✓ It includes **variants like SVAGRIHA** (for small buildings) and **GRIHA for Cities**.
  - ✓ GRIHA also offers the **GRIHA Council** to manage policy, certification, and education.
-

## □ Comparison and Integration

- ✓ GBCI promotes **global best practices** via LEED, applicable across countries
  - ✓ IGBC blends **international frameworks** with **Indian environmental needs**.
  - ✓ TERI GRIHA is a **government-backed**, India-specific system focusing on **local adaptability**.
  - ✓ GBCI and IGBC often collaborate, with GBCI acting as the **certifying authority**.
  - ✓ GRIHA is independent and **self-certified under GRIHA Council and TERI oversight**.
  - ✓ IGBC is more **industry-driven**, while GRIHA is more **government-institutionalized**.
  - ✓ GBCI/LEED uses a **point-based** system across various categories globally.
  - ✓ IGBC and GRIHA also use **point and star-based systems** but with regional adaptations.
  - ✓ IGBC tends to be **faster and more popular** among private sector developers in India.
  - ✓ GRIHA is mandatory for **central and state government construction projects**.
- 

## □ Scope and Influence

- ✓ GBCI has **certified 1000+ buildings in India** under LEED and other global standards.
- ✓ IGBC claims over **10 billion sq. ft** of registered green building footprint.
- ✓ GRIHA has over **2000 projects** registered across various climate zones in India.
- ✓ All three promote green buildings but differ in **approach, metrics, and authority**.
- ✓ GBCI targets **global compatibility**, IGBC pushes **corporate voluntary adoption**, and GRIHA aligns with **national policies**.
- ✓ GBCI and IGBC projects usually attract **foreign investment and brand value**.
- ✓ GRIHA focuses more on **social housing, affordability, and public sector mandates**.
- ✓ They collectively advance the goal of **low-carbon, sustainable urbanization in India**.
- ✓ Builders often opt for **dual certifications** (e.g., GRIHA + IGBC or LEED + IGBC) for broader appeal.
- ✓ Together, these three institutions play a **transformational role** in India's green building movement.

**Sustainable Materials:** In India, materials such as bamboo, recycled steel, and fly ash are increasingly used in construction due to their low environmental impact.

**Energy-efficient Equipment:** The use of solar panels, energy-efficient HVAC systems, and LED lighting is becoming common in green buildings, significantly reducing energy consumption.

**Local Sourcing:** Utilizing locally sourced materials reduces transportation emissions and supports local economies.

## **5. Key Requisites for Constructing a Green Building**

To construct a green building, the following requisites must be considered during each phase:

### **□ Planning & Design:**

- ✓ Site selection with **minimum ecological disturbance**

- ✓ Orientation for **maximum daylight and ventilation**
- ✓ Design that minimizes **heat gain** and encourages **passive cooling**

**Materials:**

- ✓ Use of **locally available, renewable, and recycled materials**
- ✓ Non-toxic paints and adhesives
- ✓ Efficient insulation and glazing materials

**Construction Techniques:**

- ✓ **Waste minimization** during construction
- ✓ **Dust and noise pollution** control
- ✓ Use of **prefabricated** components to save energy

⚡ **Energy and Water Systems:**

- ✓ Integration of **solar, wind, or biomass energy**
- ✓ Water conservation via **low-flow fixtures, dual-flush toilets, etc.**
- ✓ **Smart irrigation** using weather-based controllers

**Post-construction & Operation:**

- ✓ **Building Management Systems (BMS)**
- ✓ Monitoring and auditing of energy and water use
- ✓ Maintenance of indoor air quality
- ✓ Awareness and training for occupants

**Site Selection:** Choosing a location that minimizes environmental impact and maximizes natural resources is crucial.

**Water Management:** Implementing systems for rainwater harvesting and greywater recycling is essential for sustainable water use.

**Energy-efficient Design:** Incorporating passive solar design, natural ventilation, and high-performance insulation can significantly reduce energy needs.

**Waste Management:** Developing a plan for construction waste management and recycling is vital to minimize landfill contributions.

## **6. Important Sustainable Features for Green Buildings**

### **Key Sustainable Features Include:**

#### **Energy Efficiency:**

- ✓ Use of **LEDs, solar panels, and high-performance glass**
- ✓ **Passive solar design and thermal insulation**

#### **Water Conservation:**

- ✓ **Rainwater harvesting**
- ✓ **Greywater recycling systems**
- ✓ **Efficient irrigation systems**

#### **Indoor Environmental Quality (IEQ):**

- ✓ **Non-toxic materials**
- ✓ **Natural ventilation and daylighting**
- ✓ **Indoor air quality monitoring**

#### **Waste Management:**

- ✓ **Segregation and on-site composting**
- ✓ **Construction and Demolition (C&D) waste management**
- ✓ **Use of recycled aggregates**

#### **Sustainable Site Planning:**

- ✓ **Avoiding construction on eco-sensitive zones**
- ✓ **Tree preservation**
- ✓ **Permeable paving** to reduce stormwater runoff

#### **Smart Building Technology:**

- ✓ **IoT-based sensors** for monitoring usage
- ✓ **Automated lighting** and HVAC control
- ✓ **Real-time energy dashboards**

#### **Occupant Well-being:**

- ✓ **Access to natural views, acoustic comfort**
- ✓ **Use of ergonomic designs**
- ✓ **Green roofs and living walls**

### **1. Energy Efficiency**

- ✓ Energy efficiency is a core feature of green buildings.
- ✓ It reduces energy consumption and operating costs.
- ✓ Use of **LEDs** is encouraged due to their low power usage.
- ✓ **LEDs** last longer and reduce lighting-related emissions
- ✓ **Solar panels** are installed to harness renewable solar energy.
- ✓ Solar PV systems can supply electricity and reduce grid dependence.
- ✓ Buildings often use **high-performance glass** for insulation
- ✓ Such glass reduces heat gain, lowering air conditioning needs.
- ✓ **Passive solar design** uses building orientation and materials.
- ✓ It maximizes natural heating in winter and shading in summer.
- ✓ **Thermal insulation** improves heat retention and loss.
- ✓ Roof and wall insulation reduce HVAC energy usage.
- ✓ Cool roofs reflect more sunlight, keeping buildings cooler.

- ✓ **Energy-efficient appliances** lower electricity demand.
  - ✓ Use of **smart meters** to track energy use is encouraged.
  - ✓ **Motion sensors** in corridors reduce lighting waste.
  - ✓ Efficient **building envelopes** limit energy leaks.
  - ✓ **Low-E windows** reflect heat without blocking light.
  - ✓ HVAC systems are optimized for minimum energy use.
  - ✓ All these features combine to reduce the building's **carbon footprint**.
- 

## □ 2. Water Conservation

- ✓ Water conservation reduces the stress on municipal supply.
  - ✓ **Rainwater harvesting systems** capture and store rainwater.
  - ✓ Stored rainwater can be used for irrigation and flushing.
  - ✓ **Recharge pits** help replenish groundwater levels.
  - ✓ **Greywater recycling** reuses water from baths and sinks.
  - ✓ Treated greywater is used for landscaping and flushing.
  - ✓ **Dual flush toilets** use different volumes for solid and liquid waste.
  - ✓ **Low-flow taps and showers** minimize water wastage.
  - ✓ **Drip irrigation** targets water directly to plant roots.
  - ✓ This system is ideal for green areas in buildings.
  - ✓ **Sprinkler systems** with timers ensure controlled watering.
  - ✓ **Waterless urinals** reduce water use in public buildings.
  - ✓ **Condensate recovery systems** reuse HVAC moisture.
  - ✓ Efficient **water meters** help track consumption per unit.
  - ✓ Landscaping with **native plants** reduces watering needs.
  - ✓ **Permeable surfaces** reduce runoff and promote infiltration.
  - ✓ **Stormwater management** prevents erosion and flooding.
  - ✓ **Green plumbing design** uses short piping paths.
  - ✓ Proper grading directs water away from foundations.
  - ✓ Water conservation practices ensure **long-term sustainability**.
- 

## □ 3. Indoor Environmental Quality (IEQ)

- ✓ IEQ improves the health and comfort of occupants.
- ✓ **Non-toxic materials** like low-VOC paints ensure clean air.
- ✓ VOCs (Volatile Organic Compounds) harm respiratory health.
- ✓ Use of **eco-friendly adhesives and finishes** is encouraged.
- ✓ **Natural ventilation** brings in fresh outdoor air.
- ✓ Cross ventilation is achieved through strategic openings.
- ✓ **Windows and vents** are placed for maximum airflow.
- ✓ **Daylighting** reduces dependency on artificial lighting.
- ✓ Large windows, skylights, and glass walls are used.
- ✓ Natural light improves mental health and productivity.
- ✓ **Air purifying plants** enhance oxygen and remove toxins.

- ✓ **Air filtration systems** are integrated in HVAC systems.
  - ✓ Buildings use **indoor air quality (IAQ) monitors**.
  - ✓ Carbon dioxide and humidity levels are tracked.
  - ✓ **Sound insulation** enhances acoustic comfort.
  - ✓ **Thermal comfort** is maintained with proper HVAC design.
  - ✓ Materials with **thermal mass** stabilize temperature.
  - ✓ **Occupant control systems** for lights and airflow are included.
  - ✓ **Ergonomic lighting** reduces eye strain and fatigue.
  - ✓ IEQ ensures that green buildings support **human well-being**.
- 

#### 4. Waste Management

- ✓ Waste minimization is a key goal of green building design.
  - ✓ **Segregation at source** is essential—wet, dry, and hazardous.
  - ✓ Buildings have **separate bins** on each floor.
  - ✓ **On-site composting units** handle organic waste.
  - ✓ Kitchen and garden waste are converted into manure.
  - ✓ **Construction and Demolition (C&D) waste** is sorted.
  - ✓ Bricks, tiles, and debris are reused or recycled.
  - ✓ **Recycled concrete aggregates** are used in substructures.
  - ✓ **Steel scrap** is melted and reused in new components.
  - ✓ **Packaging materials** are minimized and reused.
  - ✓ Tenants are encouraged to follow the **3Rs – Reduce, Reuse, Recycle**.
  - ✓ **Electronic waste bins** handle batteries and gadgets.
  - ✓ **Plastic ban policies** are enforced in many buildings.
  - ✓ **Compost generated** is used in gardens and landscapes.
  - ✓ **Waste audits** are conducted periodically.
  - ✓ **Green housekeeping** avoids harmful chemicals.
  - ✓ **Pest control** methods are eco-friendly and non-toxic.
  - ✓ Vendors are selected based on **green credentials**.
  - ✓ Residents participate in **waste awareness drives**.
  - ✓ Sustainable waste management reduces **landfill load and pollution**.
- 

#### 5. Sustainable Site Planning

- ✓ Site selection is critical to long-term environmental impact.
- ✓ Avoiding **eco-sensitive zones** protects biodiversity.
- ✓ Buildings are placed away from **floodplains and wetlands**.
- ✓ **Tree preservation** during construction is ensured.
- ✓ **Green buffers** are maintained around site boundaries.
- ✓ **Permeable paving** allows rainwater to seep into soil.
- ✓ This reduces **surface runoff and flooding**.
- ✓ **Native vegetation** is retained and integrated in landscaping.
- ✓ **Open spaces** promote biodiversity and well-being.

- ✓ Sustainable site planning enhances **environmental resilience**.
- 

## □ 6. Smart Building Technology

- ✓ Smart tech improves efficiency and reduces human error.
  - ✓ **IoT-based sensors** track lighting, temperature, and humidity.
  - ✓ **Automated lighting** adjusts based on occupancy and daylight.
  - ✓ **HVAC systems** are controlled via **Building Management Systems (BMS)**.
  - ✓ **Energy dashboards** provide real-time consumption data.
- 

## □ 7. Occupant Well-being

- ✓ Green buildings focus on mental and physical health.
- ✓ **Natural views** from windows reduce stress.
- ✓ **Acoustic comfort** ensures minimal noise disturbance.
- ✓ **Ergonomic design** supports physical comfort and productivity.
- ✓ **Green roofs and living walls** promote air quality and aesthetics.

**Renewable Energy Systems:** Integrating solar, wind, or geothermal energy systems can provide clean energy and reduce reliance on fossil fuels.

**Efficient Insulation:** High-quality insulation materials help maintain indoor temperatures, reducing heating and cooling demands.

**Sustainable Landscaping:** Using native plants and xeriscaping techniques can reduce water usage and promote biodiversity.

**Smart Technologies:** Implementing smart building technologies can optimize energy use and enhance occupant comfort.