I J C R M

International Journal of Contemporary Research In Multidisciplinary

Review Article

Application of Green Building in Building Design

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DOI: https://doi.org/10.5281/zenodo.15336848

Abstract

Green building, an approach focused on sustainability, aims to reduce environmental impacts while enhancing the efficiency and well-being of occupants. Integrating eco-friendly design principles, green buildings optimize resource use, minimize waste, and prioritize renewable energy sources. These structures incorporate sustainable materials, advanced energy-efficient technologies, and effective waste management practices, resulting in lower greenhouse gas emissions and reduced operational costs. A key aspect of building green is energy efficiency, achieved through passive solar design, natural ventilation, and the use of energy-efficient appliances. Water conservation techniques, such as rainwater harvesting and low-flow fixtures, are also vital components. Additionally, green roofs and green walls contribute to better air quality, urban biodiversity, and thermal insulation. Indoor environmental quality (IEQ) is enhanced through non-toxic building materials, increased natural lighting, and efficient HVAC systems. Green building certifications, such as LEED (Leadership in Energy and Environmental Design) and BREEAM (Building Research Establishment Environmental Assessment Method), encourage adherence to sustainable standards and promote best practices. Despite the initial higher construction costs, green buildings offer long-term financial benefits, including lower utility bills and increased property value. The growing global awareness of climate change and environmental degradation has driven the demand for sustainable construction. Green buildings not only mitigate ecological impacts but also improve occupant health, comfort, and productivity, contributing to a sustainable and resilient built environment.

Manuscript Information

- **ISSN No:** 2583-7397
- **Received:** 15-03-2025
- **Accepted:** 25-03-2025
- **Published:** 28-04-2025
- **IJCRM:**4(S2); 2025: 57-63

- **Plagiarism Checked:** Yes
- **Peer Review Process:** Yes

How to Cite this Article

Yadav A, Ojha D. Application of Green Building in Building Design. Int J Contemp Res Multidiscip. 2025;4(S2):57-63.

Access this Article Online

www.multiarticlesjournal.com

KEYWORDS: Green building, sustainability, energy efficiency, renewable energy, sustainable materials, water conservation, indoor environmental quality, LEED, BREEAM, environmental impact.

INTRODUCTION

Green building, also known as sustainable building, is a modern approach to construction that emphasizes environmental responsibility, resource efficiency, and the well-being of occupants. This concept has gained prominence in recent decades as societies worldwide grapple with pressing issues like climate change, environmental degradation, and the depletion of natural resources. Unlike conventional construction methods, which often lead to excessive energy consumption, pollution, and waste, green building focuses on minimizing negative ecological impacts while maximizing efficiency and sustainability. At its core, green building integrates eco-friendly materials, renewable energy sources, efficient resource management, and sustainable design principles. These practices aim to reduce carbon footprints, conserve natural resources, and create healthier, more comfortable living and working spaces. By considering the entire lifecycle of a building—from design and construction to operation, maintenance, and eventual demolition, green

buildings seek to optimize resource use and minimize waste generation. A fundamental aspect of green buildings is energy efficiency. Green buildings use passive solar design, natural ventilation, energy-efficient appliances, and advanced insulation techniques to minimize energy consumption. They also often incorporate renewable energy sources, such as solar panels and wind turbines, to generate clean energy on-site. These measures not only reduce greenhouse gas emissions but also lead to significant savings on utility costs over time. Water conservation is another essential component of green building. By using low-flow fixtures, rainwater harvesting systems, and efficient irrigation methods, green buildings significantly reduce water wastage. Additionally, technologies like greywater recycling enable the reuse of water for non-potable purposes, further enhancing sustainability. These practices help address the growing global water crisis and contribute to the responsible use of water resources. Material selection plays a critical role in green building. Sustainable materials, such as recycled steel, reclaimed wood, bamboo, and low-VOC (volatile organic compound) paints, are chosen to minimize environmental harm. These materials are not only durable and energy-efficient but also promote healthier indoor air quality, reducing the risk of respiratory problems and allergies. Green buildings also emphasize waste reduction by implementing construction waste management strategies, such as recycling and reusing materials. Indoor Environmental Quality (IEQ) is a priority in green building design. Proper ventilation, natural lighting, and the use of non-toxic materials create a healthier indoor environment, enhancing occupant comfort and productivity. Studies have shown that improved IEQ can lead to increased focus, reduced stress, and overall better mental and physical health.

Green building certifications, such as LEED (Leadership in Energy and Environmental Design), BREEAM (Building Research Establishment Environmental Assessment Method), and WELL Building Standard, provide guidelines and frameworks for evaluating and recognizing sustainable construction practices. These certifications encourage builders and developers to adhere to stringent environmental standards, ensuring that projects are genuinely sustainable. While green building may involve higher initial construction costs, the long-term benefits outweigh these expenses. Reduced operational costs, increased property value, improved occupant health, and environmental conservation make green building a viable and forward-thinking approach to construction.

2. Benefits of Green Building

i) **Environmental Impact:** They Help Reduces Carbon Footprints, conserve resources, and decrease pollution.
ii) **Economic Savings:** Green Buildings Can Lead to Long-Term Savings in Energy and Water Costs.
iii) **Health and comfort:** They provide better interior air quality, natural lighting and improved comfort for occupants, which can increase productivity and well -being.
iv) **Resilience:** Green Buildings Often Incorporate Elements That Make Them More Resilient To Natural Disasters and Climate Change.

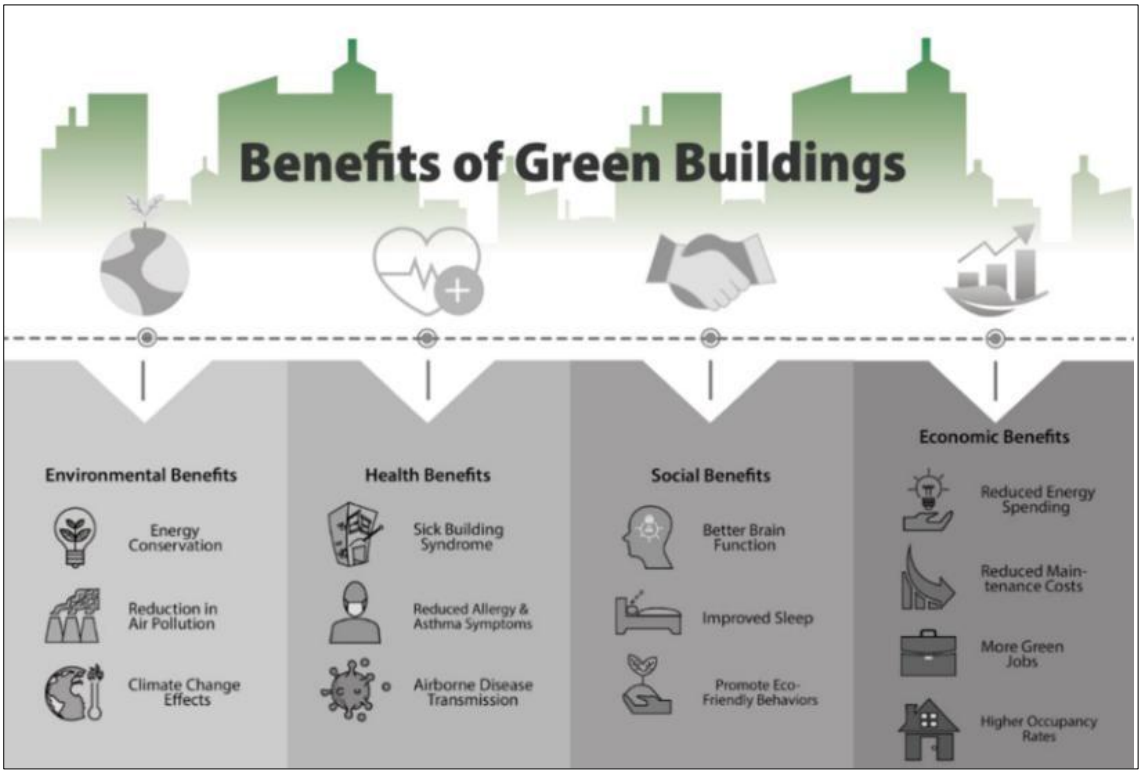

Fig 1: Benefits of Green Building

3. Green Building Design Features

Green Buildings Incorporate to Variety of Design Features That Focus on Sustainability, Energy Efficient, and Environmental Impact Reduction. These characteristics address the entire life cycle of the building, from its construction to its operation and eventual demolition. These are the main design features of green buildings:

1. Energy efficiency

i) **High performance insulation:** walls, ceilings and windows are designed to reduce heat transfer, maintain a constant interior temperature and reduce the demand for heating and cooling energy.
ii) **HVAC Energy Efficiency Systems:** Heating, ventilation and air conditioning systems (HVAC) are optimized for minimum energy use while maintaining comfort.

2. Water conservation

i) **Low flow accessories:** Taps that save water, showers and bathrooms reduce water consumption without sacrificing performance.
ii) **Rainwater collection systems:** The capture and storage of rainwater for non -drinkable uses (such as irrigation or toilet) reduces dependence on municipal water systems.

3. Sustainable construction materials

i) **Materials of local origin:** The use of local materials reduces transport energy and supports local economies.
ii) **Recycled and recovered materials:** the embedding of recycled content in construction materials, such as recovered wood, recycled steel and recycled glass, helps reduce waste and the need for new raw materials.

4. Interior Environmental Quality (IEQ)

i) **Natural lighting:** Maximize natural light through windows, skylights and open spaces placed strategically reduces the need for artificial lighting and improve the well-being of the occupants.
ii) **Ventilation systems:** High-quality ventilation systems improve air circulation and interior air quality, reducing the risk of indoor air pollution.

5. Sustainability and landscaping of the site

i) **Landscape of native plants:** a landscape with native plants reduces water consumption and helps preserve local biodiversity.
ii) **Green ceilings:** A green roof covered with plants helps to isolate the building, reduce the effect of the island of heat and administer the junction of rainwater.

4. Green Building Construction Process

The construction process for a green building follows the same basic steps as conventional construction projects, but with an approach to sustainability, resources efficiency and environmental impact minimization. The process is more integrated and requires careful planning and coordination in all phases. Below is a general description of the process of construction of ecological buildings:

4.1. Phase prior to construction

i) **Location of the sustainable site:** The first step in the process of building ecological buildings is to choose a site that minimizes the environmental impact. This includes avoiding ecologically sensitive areas (wetlands, flood plains, etc.) and considering the proximity to public transport to reduce dependence on private vehicles.
ii) **Site analysis:** The site is analysed for factors such as topography, local climate and sun orientation. These factors will influence the design of the building for energy efficiency, water management and environmental impact.

4.2. Design phase

i) **Energy and sustainability objectives:** Ecological buildings design equipment collaborate to establish clear sustainability objectives, ensuring that design incorporates energy efficiency systems, water conservation, sustainable materials and waste reduction.
ii) **Green certifications:** During the design phase, the project team determines what certification standards (for example, Leed, Breams, Well), the building will point, which will guide the selection of materials, technologies and construction methods.
iii) **Environmental impact evaluation (EIA):** Depending on the location and scope of the project, an environmental impact assessment may be required to ensure that construction does not negatively affect the environment.

4.3. Construction phase

i) **Materials acquisition:** Sustainable escape construction equipment, of local origin and ecological materials. These may include recycled content, low voc paints and durable and efficient products such as insulation and windows.
ii) **Waste reduction:** During construction, efforts are made to reduce waste by recycling materials, reusing existing structures and carefully managing the flow of waste to minimize the contributions of the landfill.

4.4. Site preparation

i) **Landscaping:** Earth is prepared for the construction of the building, ensuring that the natural landscape is conserved as much as possible. This may involve preserving existing vegetation or implementation of strategies such as erosion control.
ii) **Storm-water Management:** Measures such as permeable pavement, bioswales and rainyard gardens in site design are incorporated to control rainwater runoff and reduce the risk of floods.

4.5. Installation of energy efficiency systems: HVAC systems, lighting and insulation of energy efficiency are installed to help regulate temperature and reduce energy consumption.

i) **Solar panel and renewable energy integration:** solar panels or wind turbines can be integrated into the building design to take advantage of renewable energy and reduce dependence on non -renewable sources.
ii) **Water efficiency systems:** plumbing and irrigation systems are designed to minimize water use. Low flow accessories, water recycling systems and rainwater collection technologies are installed.

4.6. Interior air quality and health measures

i) **Non -toxic materials:** Materials with low emissions of volatile organic compounds (VOC) are used to guarantee good interior air quality and occupants' health.
ii) **Ventilation:** adequate ventilation systems are installed to provide fresh air and eliminate interior pollutants, improving air quality for the occupants of the buildings.
iii) **Intelligent systems:** a building management system (BMS) can be installed to control and monitor energy use, ensuring that the building uses energy efficiently.
iv) **On the building:** isolation, windows and doors are carefully installed to ensure that the building envelope is sealed, minimizing the loss of energy and improving comfort.

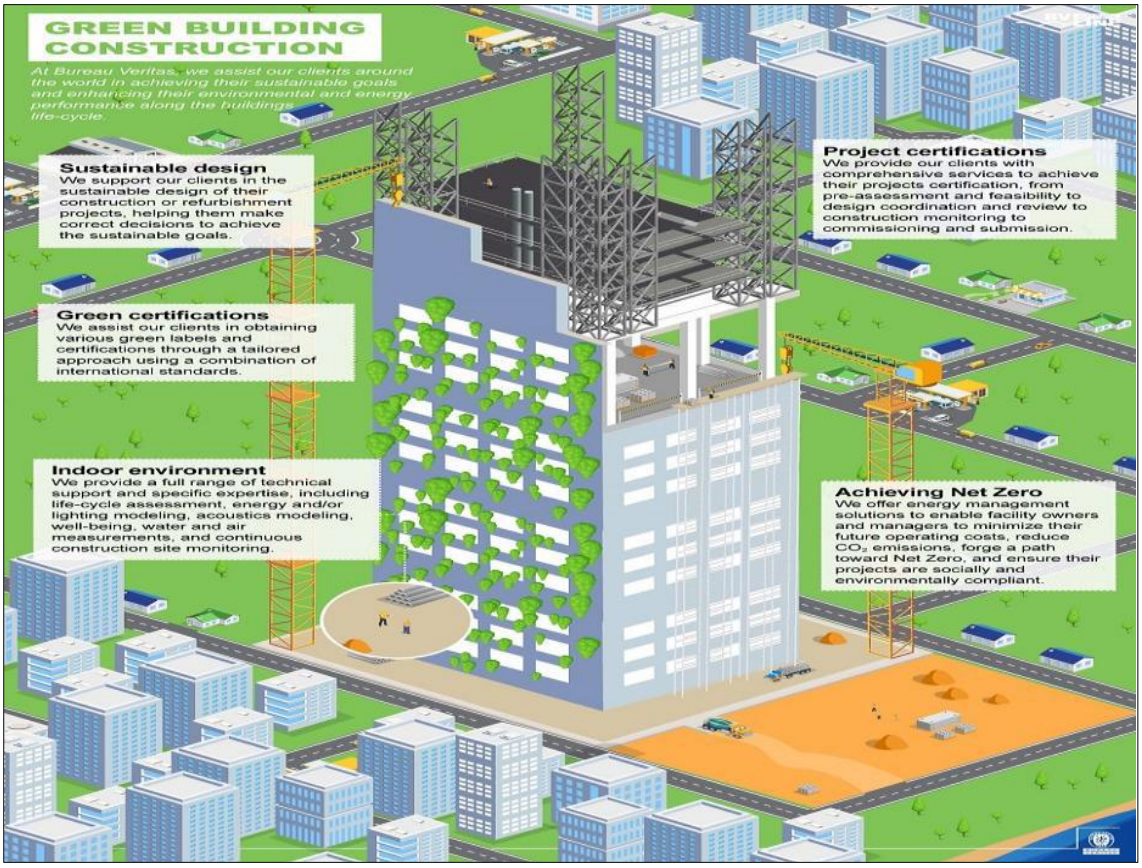

Fig 2: Advanced energy efficiency technologies

4.7. Net and net positive energy buildings: future buildings will aim to produce more energy than they consume, often through renewable energy sources such as solar panels, wind and geothermal systems. The objective is to achieve net zero (where energy consumption is equal to energy production) or net positive buildings, where energy generation exceeds demand.

4.8. Improved insulation and glazing: Innovations in insulation materials (such as aerogels, phase change materials and vacuum insulation panels) and advanced glazing (smart windows, dynamic glass that fits according to light) will further improve energy efficiency and thermal comfort in buildings.

4.9. Innovation of construction materials

1. **Carbon kidnapping materials:** future buildings could use concrete or carbon capture biocement, which absorb CO2 as they cure, helping to reduce the construction carbon footprint. In addition, the use of plants -based materials or biodegradables (for example, mycelium or hempcrete) could reduce the environmental impact.
2. **Recycled and circular materials:** a greater approach will be placed in the use of recycled and recycled materials that close the material loop, reducing the need for new raw materials and decrease the generation of waste. Technologies that allow the circular economy (where the

materials are reused, re -remanufactures and recycled continuously) will play a key role.

4.10. Water conservation and management

1. **Recycling of gray and sewage waters:** future green buildings can expand the use of gray waters (wastewater of sinks, showers and washing machines) and black water recycling systems (wastewater of the toilets), treating and reusing water inside the building to significantly reduce the general consumption of water.
2. **Toilets without water or low water:** new technologies for warehouses without water and high efficiency water systems will reduce the demand for drinking water in buildings, especially in areas where water shortage is a growing concern.

5. Urban and Community Green Design

1. **Integration of smart cities:** green buildings will become a key part of smart cities that integrate energy efficiency technologies, green spaces, transport, waste management and climate resilience strategies at the level of the entire city. Smart urban planning will improve the efficiency of the building while promoting the well -being of the community.
2. **Vertical farms and green infrastructure:** more buildings can include vertical agriculture in roofs or within construction systems, integrating food production with urban life. In addition, green infrastructure, such as urban forests, green walls and gardens on the roof, will improve biodiversity and improve the local climate.

6. Resilience and Climate Adaptation

1. **Resistant construction materials:** As climate change brings more extreme weather events, buildings will increasingly incorporate more materials and resistant designs that can resist floods, hurricanes, forest fires and extreme heat.
2. **Adaptable design:** green buildings will focus on adaptability to changing climatic conditions. This could include passive cooling or heating systems, high structures in flooding areas and flexible building designs that can be adjusted for new future needs.

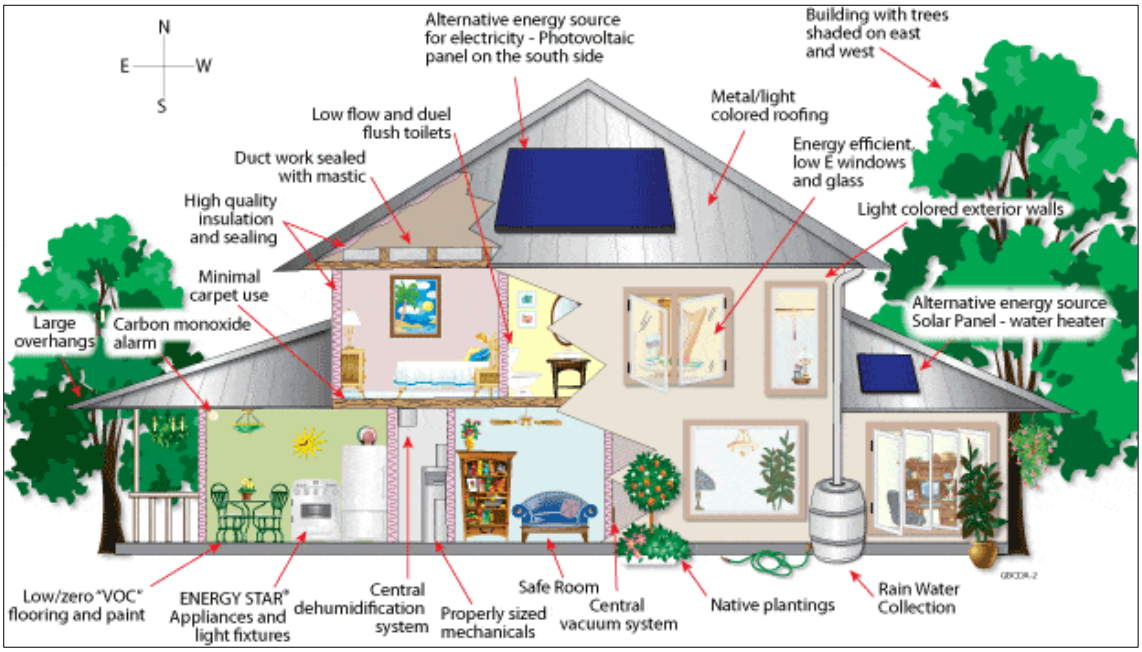

Fig 3: Green Building components

7. Advantages of green buildings:

i) Energy efficiency

Green buildings use energy efficiency systems, such as solar panels, efficient insulation and HVAC smart systems, reducing energy consumption and reducing public service invoices.

ii) Reduced environmental impact:

These buildings generally use sustainable materials, reduce water consumption and incorporate renewable energy sources, contributing to a lower carbon footprint.

iii) Healthier interior environment

Green buildings use non -toxic materials, improve air quality and allow a better natural light, improving the health and well -being of the occupants.

iv) Cost savings:

While the initial investment may be higher, green buildings can lead to significant long -term savings in energy costs, water invoices and maintenance due to their design and efficient systems.

v) **Increased property value:**
Green buildings are often seen as more desirable due to their sustainability and, therefore, they can have a higher resale value and appeal to buyers aware of the environment.

vi) **Government incentives:**
Many countries offer tax exemptions, subsidies and incentives to promote the development of green buildings, which can compensate for some of the initial costs.

vii) **Better resource management:**
Green buildings incorporate resource efficiency technologies, such as rainwater collection and waste management systems, which can further reduce environmental impact.

8. Disadvantages of green buildings

i) **High initial cost:**
The initial cost of building a green building is often higher than that of traditional buildings due to the price of sustainable materials, specialized systems and design characteristics.

ii) **Complex design and construction:**
Green buildings require specialized knowledge and skills, and construction can be more complex due to the integration of energy efficiency systems, renewable technologies and ecological materials.

iii) **Limited availability of materials:**
Sustainable construction materials are not always available, and sometimes they can be more expensive or difficult to obtain.

iv) **Continuous maintenance:**
Some green construction technologies, such as solar panels or green roofs, require regular maintenance and monitoring to guarantee optimal performance.

v) **Longer recovery period:**
Although energy savings are substantial over time, the period of recovery of the initial investment can take many years, which may be a concern for some owners or investors.

vi) **Potential for overline:**
The design and systems of a green building can become too complex, which could make repairs and updates more difficult and expensive.

vii) **Regional limitations:**
The effectiveness of certain ecological construction technologies may vary according to the location, especially in regions with extreme climatic conditions or limited access to renewable energy resources.

viii) In summary, although green buildings offer significant benefits in terms of environmental sustainability, cost and health savings of the occupants, they come with challenges as higher initial costs and the need for specialized construction and maintenance.

9. CONCLUSION

In conclusion, green buildings represent a significant step towards sustainability and environmental responsibility in construction and architecture sectors. These buildings are designed to minimize their impact on the environment using energy efficiency technologies, sustainable materials and efficient water management systems. In addition, green buildings prioritize the health and well -being of the occupants through a better quality of the interior air and natural lighting.

By reducing energy consumption, water use and waste production, green buildings help reduce carbon emissions and promote resources conservation. They also offer long -term cost savings, which makes them not only beneficial to the environment but also economically viable. As governments, organizations and people continue to prioritize the environmental impact, it is likely that the adoption of ecological construction practices will increase, contributing to the creation of more sustainable and resilient communities.

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