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# A Comprehensive Review on Green Buildings for Quality Living

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**ABSTRACT:** Green buildings have evolved as an important option in contemporary architecture for addressing environmental concerns while also improving tenant quality of life. This study offers a thorough examination of green buildings, concentrating on their design principles, environmental benefits, economic consequences, and impact on occupant health and well-being. Various green building grading systems and certification standards are studied, along with case studies of successful deployments around the world. Furthermore, current trends and technology in green building design and construction are examined, with a focus on their potential to increase sustainability and livability. The purpose of this review is to highlight the importance of green buildings in providing a healthier and more sustainable built environment that is conducive to quality of life.

**KEYWORDS:** include green buildings, sustainability, quality of life, environmental advantages, building certification, and occupant health.

## I. INTRODUCTION

Green building, also known as green construction or sustainable building, is a method of environmental enhancement that improves the human population and the environment by reducing resource consumption and improving quality of life. It reduces greenhouse gas emissions, minimizing the greenhouse effect. Green infrastructure construction technology significantly impacts resource conservation, lowers construction costs, and mitigates climate change impact. Green buildings conserve energy, water, and other natural resources, ensure occupant health, increase labour productivity, and reduce waste pollution. They reduce energy use by 30%, CO<sub>2</sub> emissions by 35%, waste output by 70%, and water usage by 40%. Green construction extends beyond building walls to address site planning, community, and land-use planning challenges. It involves developing ecologically responsible structures and procedures throughout a building's life cycle, from site selection to design, construction, operation, maintenance, renovation, and deconstruction. Green buildings aim to reduce environmental impact, maximize resource efficiency, and improve occupant health and comfort.

The importance of green buildings has grown due to rising environmental concerns and increased understanding of the built environment's impact on global sustainability. They aim to produce healthier, more comfortable, and sustainable living environments using creative design ideas, energy-saving measures, sustainable materials, and indoor environmental quality standards. Green buildings also offer significant economic and social benefits, such as cost savings, improved health outcomes, and community well-being. Despite progress in promoting green building principles, hurdles remain, including governmental and regulatory barriers, technological limits, and market restraints. This review synthesizes previous information and analyzes current trends, issues, and prospects in green building design and construction. It examines case studies and best practices to provide insights into green buildings' transformative potential in supporting great living environments and advancing sustainable development goals.

### Evolution and growth of the green building movement

The green construction movement, which began in the late 20th century, has grown significantly due to increased environmental awareness, technological advancements, and shifting cultural ideals towards sustainability. It initially focused on reducing energy consumption and waste through energy-efficient design and construction methods, with early pioneers promoting passive solar architecture, natural ventilation, and sustainable materials. As environmental concerns grew, the movement gained momentum, leading to the development of green building rating systems like LEED, BREEAM, and Green Star. The adoption of green building principles increased dramatically in the early 21st

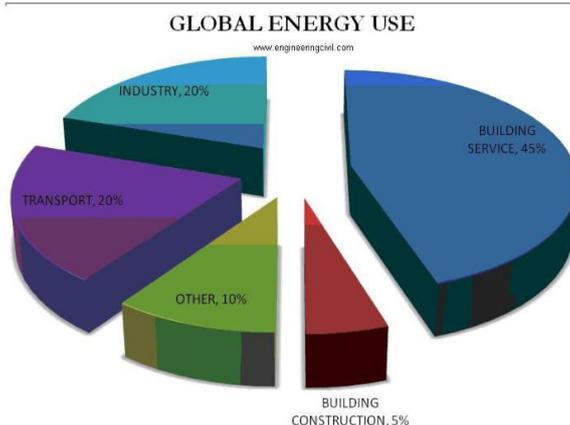


century due to government incentives, market demand, and technological innovation. Governments worldwide have established laws and incentives to encourage sustainable development, including tax breaks, subsidies, and mandatory building regulations. Advances in building technology, such as smart controls and renewable energy systems, have made it easier and less expensive to design and build high-performance green buildings. The green building movement is now a global phenomenon, with green building techniques included in building codes, industry standards, and corporate sustainability initiatives. Projects cover all sectors, from commercial to residential, and have expanded beyond energy efficiency to include broader sustainability goals such as water conservation, waste reduction, biodiversity preservation, and social equity. The green building movement is expected to grow further due to rising climate risks, increased urbanization, and the need to transition to a low-carbon, resilient, and equitable built environment. Green building principles will become increasingly important in shaping the future of the built environment, fostering healthier, more resilient, and sustainable communities for future generations.

### Green building features

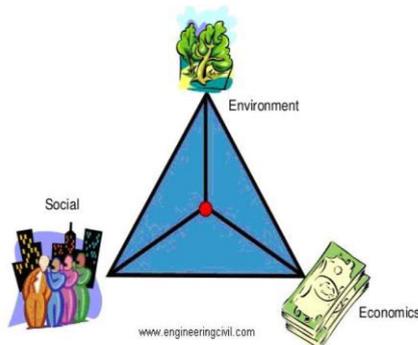
Ecofriendly by disrupting the ecology. Energy efficiency is achieved by natural lighting ventilation and solar passive designs. Water is used efficiently through recycling and water harvesting, and renewable energy is generated through photovoltaic and solar systems. Nontoxic materials are used in the indoor environment, as well as recycled materials for waste utilisation and disposal.

### WHY IT IS NECESSARY TO MAKE THE BUILDINGS GREEN?



CONSTRUCTION INDUSTRY CONTRIBUTES TO NEARLY 50% OF ENERGY CONSUMPTION

### BENEFITS OF GREEN BUILDING



Building has a significant impact on the environment, human health, and the economy. The proper implementation of green building technologies can improve both the economic and environmental performance of buildings.

**1. Environmental benefits:** Protect biodiversity and ecosystems, enhance air and water quality, decrease waste, and conserve natural resources.



2. **Economic benefits:** Reduce operating costs, develop, extend, and define the market for green products and window services, and increase occupant productivity.
3. **Social benefits:** Improve tenant comfort and health, and increase aesthetic quantities. Reduce the impact of trains on local infrastructure while improving the general quality of life.
4. **Natural resources:** According to surveys made in 2006, 107.3 million acres of total land area have been developed, representing a 24% growth in land covered by green buildings over the previous three years. Buildings consumed 39.4% of energy and 67.9% of total electricity. Reducing operational costs creates, expands, and shapes markets for green products and services while increasing occupant productivity.

### III. INTEGRATING RENEWABLE ENERGY SOURCES AND INCREASING ENERGY EFFICIENCY

Energy efficiency and the use of renewable energy sources are critical components of green building design, working together to reduce energy consumption, dependency on fossil fuels, and greenhouse gas emissions. Energy efficiency techniques include a variety of strategies for improving building performance and lowering energy demand across several systems and components. This includes using high-performance building envelopes with superior insulation, air sealing, and efficient glazing to reduce heat loss and gain, as well as advanced HVAC systems with energy recovery ventilation, variable-speed drives, and smart controls to improve indoor climate control while lowering energy consumption. Furthermore, lighting and daylighting solutions, such as efficient fixtures, occupancy sensors, and daylight harvesting, are used to optimize natural light while minimizing artificial lighting usage, resulting in lower energy consumption. Renewable energy sources, such as solar photovoltaics, wind turbines, and geothermal heat pumps, are also incorporated into building design to produce clean, renewable energy on-site. Renewable energy systems are designed to meet the building's energy needs while reducing reliance on grid-supplied electricity and lowering carbon emissions. Furthermore, technological developments and cost reductions have made renewable energy systems more accessible and affordable, encouraging their use in green building projects. Green buildings have the potential to significantly reduce energy consumption by combining energy efficiency measures with renewable energy integration, increase resilience to energy price fluctuations, and contribute to the transition to a low-carbon, sustainable energy future.

#### A. Water conservation and management

Sustainable building design focuses on water conservation and management to reduce water usage, minimize wastewater creation, and preserve freshwater resources. Green construction projects use water-saving fixtures, appliances, and landscaping features to improve efficiency. Low-flow faucets, toilets, and showerheads reduce indoor water use while water-saving irrigation systems, drought-resistant plants, and permeable surfaces reduce outdoor water demand. Rainwater harvesting systems and greywater recycling technologies catch and reuse rainwater and wastewater for non-potable purposes, reducing reliance on centralized water supply and wastewater treatment infrastructure. Stormwater management strategies like green roofs, bioswales, and permeable pavements reduce runoff and erosion, promoting groundwater recharge and protecting water quality and aquatic habitats. Green buildings can significantly reduce water consumption, preserve natural water systems, and strengthen resilience to water scarcity and climate change impacts by combining water-efficient fixtures, decentralized water systems, and stormwater management practices.

#### B. Materials selection and resource efficiency

Green building design focuses on reducing environmental impact, conserving natural resources, and promoting sustainable manufacturing and construction processes. It uses materials with minimal embodied energy, recyclable content, and environmentally preferred properties, such as rapidly renewable materials, certified wood products, and non-toxic finishes. Green buildings reduce their carbon footprint and limit environmental damage associated with extraction, processing, and disposal. Resource efficiency methods are used throughout the building's lifecycle to maximize material utilization, limit waste output, and extend the lifespan of building components. Technologies like building information modelling (BIM), lean construction approaches, and just-in-time delivery optimize material utilization and reduce construction waste. Green construction projects prioritize durability, longevity, and maintenance requirements when selecting materials and building components. High-performance materials and building systems reduce maintenance and repair costs, enhancing total building performance. Green buildings can significantly reduce their ecological footprint, promote sustainable development, and improve the quality of life for occupants and communities by prioritizing low-impact materials, minimizing waste generation, and optimizing resource use throughout the building lifecycle.



### **C. Indoor environmental quality optimization**

Indoor environmental quality (IEQ) optimization is a key focus in green building design, aiming to create healthy, comfortable, and productive indoor environments for inhabitants. Green buildings focus on improving air quality, thermal comfort, lighting, and acoustics to reduce indoor air pollutants, such as volatile organic compounds (VOCs), particle matter, and biological contaminants. They implement high-efficiency HVAC systems with improved filtration and fresh air intake and exhaust ventilation to efficiently dilute and eliminate interior contaminants. To improve thermal comfort, green buildings improve building envelope design, insulation, and shading measures to reduce temperature changes and ensure equitable distribution of heat and cold throughout the interior space. They also enhance natural daylighting, daylight-responsive controls, and high-performance glazing to limit glare and solar heat gain. Acoustic comfort is addressed by limiting noise transmission between rooms, specifying sound-absorbing materials, and creating spaces with proper reverberation periods to improve speech intelligibility and reduce stress. Green buildings prioritize occupant health and well-being by reducing exposure to toxins and allergens, promoting biophilic design principles, and promoting physical activity and wellness among tenants.

In conclusion, green buildings can improve indoor environmental quality, occupant satisfaction, and well-being while promoting sustainable development goals by incorporating advanced ventilation, thermal comfort, lighting, and acoustics strategies.

### **D. Innovative design strategies and technologies**

Green building design is a growing trend that focuses on sustainability, energy efficiency, and occupant comfort. Biophilic design principles aim to connect residents with nature by incorporating natural components like plants, water features, and materials into the built environment. This approach has been proven to lower stress, improve cognitive function, and increase overall well-being. Passive construction solutions, such as orientation optimization, shading devices, natural ventilation, and high-performance building envelopes, reduce energy consumption, improve thermal comfort, and reduce environmental impact while preserving occupant comfort. Smart building technologies are transforming green building design by enabling real-time monitoring, control, and optimization of building systems and processes. These technologies use sensors, actuators, and data analytics to optimize energy consumption, improve indoor air quality, and enhance occupant comfort. Building automation and management systems offer remote monitoring and control, allowing facility managers to identify inefficiencies and optimize performance. Renewable energy technology, such as solar photovoltaics, wind turbines, and geothermal heat pumps, is accelerating the shift to net-zero energy buildings. Integrating renewable energy systems into green building design allows buildings to generate clean, renewable energy on-site, reducing dependency on grid-supplied electricity and lowering greenhouse gas emissions.

## **IV. ENVIRONMENTAL BENEFITS OF GREEN BUILDINGS**

Green buildings offer numerous environmental benefits, including lower energy use and carbon emissions, and reduced reliance on fossil fuels for heating, cooling, and electricity. They incorporate energy-efficient design, advanced technologies, and renewable energy sources, reducing greenhouse gas emissions and mitigating the environmental impacts of energy production and consumption. Green buildings also encourage water conservation and management by incorporating water-saving fixtures, rainwater harvesting systems, and greywater recycling technology. They contribute to the conservation of natural resources and ecosystems by reducing waste output, supporting recycling and reuse, and selecting materials with minimal environmental impact. Green buildings also improve indoor environmental quality by reducing air pollutants, increasing thermal comfort, enhancing natural daylighting, and boosting occupant health and well-being. They create healthy, comfortable, and productive indoor environments while lowering reliance on energy-intensive mechanical systems. They also help preserve biodiversity and ecosystems by implementing sustainable site planning and landscaping strategies, such as protecting existing plants and supporting habitat restoration and biodiversity protection. Green buildings offer numerous environmental benefits, including lower energy consumption, carbon emissions, water usage, trash generation, and ecological effects. They can mitigate climate change, conserve natural resources, and protect ecosystems while creating healthy, comfortable living environments for current and future generations.

## **V. ENERGY SAVINGS AND CARBON FOOTPRINT REDUCTION**

Green buildings are a significant contributor to climate change mitigation and environmental sustainability. They reduce reliance on fossil fuels for heating, cooling, and electricity by implementing energy-efficient design strategies, advanced technologies, and renewable energy systems. Green buildings use high-performance insulation and modern



glass systems to reduce heat loss and gain. Efficient HVAC systems with energy recovery ventilation and smart controls improve indoor climate management. Renewable energy sources like solar photovoltaics, wind turbines, and geothermal heat pumps generate clean, renewable energy on-site, reducing grid-supplied electricity reliance and mitigating greenhouse gas emissions. Green buildings can significantly reduce energy consumption and carbon footprints, contributing to global efforts to combat climate change, promote sustainable development, and create healthier, more resilient built environments for current and future generations.

#### A. Water conservation and reduced water pollution

Green buildings, using new design techniques and technologies, help to advance water conservation efforts and reduce pollution. Green buildings use water-efficient devices like low-flow faucets, toilets, and showerheads to drastically reduce potable water use indoors. Furthermore, rainwater harvesting systems and greywater recycling technologies collect and treat rainwater and wastewater for non-potable uses such as landscape irrigation, toilet flushing, and cooling tower makeup, reducing demand for freshwater resources and relieving pressure on municipal water supplies. Green buildings also use stormwater management strategies like green roofs, permeable pavements, and bioswales to reduce runoff, and erosion, and encourage groundwater recharge, all of which help to protect water quality and aquatic habitats. Furthermore, through sustainable site planning and landscaping methods, green buildings reduce impermeable surfaces, conserve natural habitats, and encourage biodiversity conservation, all of which help to protect water quality and ecosystem health. Overall, green buildings have the potential to dramatically improve water conservation efforts and minimize water pollution, resulting in healthier, more sustainable communities and ecosystems for current and future generations.

#### B. Mitigation of urban heat island effect

Green buildings play an important part in moderating the urban heat island effect, which is the phenomenon in which cities experience greater temperatures than surrounding rural areas as a result of human activity and urbanization. Green buildings contribute to urban cooling by implementing sustainable design techniques and technologies. One significant strategy is to employ cool roof materials and green roofs, which reflect sunlight and absorb less heat than standard dark-coloured roofs, lowering surface temperatures and decreasing heat buildup. Furthermore, green buildings incorporate flora, trees, and green areas into their design, which provide shade, evaporative cooling, and natural cooling effects, thereby lowering ambient temperatures and creating microclimates of cooler, more comfortable surroundings. Furthermore, green buildings use passive design strategies such as orientation optimization, shading devices, and natural ventilation to reduce solar heat gain and the need for mechanical cooling, lowering energy consumption and reducing heat emissions from air conditioners. Furthermore, green construction projects focus on sustainable site planning and landscaping strategies including permeable pavements, shade trees, and green infrastructure, which assist reduce heat absorption and encourage natural cooling while also improving biodiversity and ecosystem resilience. Overall, green buildings have the potential to reduce the urban heat island effect by generating cooler, more resilient, and sustainable urban settings that improve residents' quality of life while also contributing to climate change adaptation efforts.

### VI. BENEFITS OF GREEN BUILDING

#### A. Environmental Benefits

- 1. Resource Efficiency:** Green buildings are designed to make the best use of resources like electricity, water, and materials, decreasing waste and conserving natural resources.
- 2. Reduced Energy Consumption:** Including energy-efficient elements like high-performance insulation, efficient HVAC systems, and renewable energy sources results in significant energy savings and greenhouse gas emissions.
- 3. Water Conservation:** Green buildings use water-efficient fixtures, rainwater harvesting systems, and greywater recycling to reduce water consumption and relieve pressure on local water supplies.
- 4. Improved Air Quality:** Green construction techniques prioritize the use of low-emission materials, adequate ventilation systems, and indoor plants, resulting in cleaner indoor air and a healthier living environment.
- 5. Mitigation of Urban Heat Island Effect:** Green roofs, permeable pavements, and reflective surfaces reduce heat absorption and mitigate the urban heat island effect, improving urban microclimates and lowering energy demand for cooling.

#### B. Economic Benefits

- 1. Lower Operating expenditures:** Despite possibly higher initial expenditures, green buildings often have lower operating expenses due to reduced energy and water use, resulting in long-term benefits for both owners and tenants.
- 2. Enhanced Property Value:** Green building certifications, such as LEED or BREEAM, are connected with increased



property value and marketability, attracting environmentally aware investors and tenants.

**3. Government Incentives:** Many governments provide financial incentives, tax credits, and grants to green construction projects, promoting investment in sustainable development while balancing early costs.

**4. Job development:** The green building industry promotes job development in sectors such as design, construction, sustainable material manufacture, and green building operation and maintenance, contributing to economic growth and employment prospects.

#### C. Social Benefits

**1. Quality:** Green buildings offer higher interior air quality, natural lighting, thermal comfort, and access to green spaces, leading to enhanced physical health, productivity, and well-being.

**2. Equity and Accessibility:** Sustainable design principles encourage inclusion and accessibility, ensuring that green buildings are suitable for people of all ages, abilities, and socioeconomic backgrounds.

**3. Community involvement:** Green construction projects frequently incorporate community stakeholders in the planning and design process, which promotes community involvement, social cohesiveness, and a sense of ownership among inhabitants.

**4. Educational Opportunities:** Green buildings can be used as educational platforms to raise environmental awareness, sustainable living habits, and the value of conservation among residents and tourists.

## VI. CONCLUSION

Green buildings are an important step toward developing sustainable, healthy, and resilient built environments that promote environmental responsibility, occupant well-being, and long-term economic growth. Green buildings provide numerous benefits by using energy-efficient design strategies, sustainable materials, and biophilic design components, including lower energy consumption and carbon emissions, as well as enhanced interior air quality, thermal comfort, and access to nature. Green buildings provide indoor settings that promote well-being, improve quality of life, and encourage a deeper connection with nature by putting occupant health, productivity, and happiness first. Furthermore, green buildings contribute to environmental sustainability through the conservation of natural resources. Minimizing waste output and lowering environmental impact can mitigate climate change, preserve biodiversity, and develop healthier, more resilient societies. As the need for sustainable, high-performance buildings grows, green buildings emerge as a critical answer to tackling major global concerns while advancing a vision of a more sustainable and fair future for all. Green buildings have the potential to revolutionize the way we design, construct, and live the built environment, leaving a good legacy for future generations, if they continue to innovate, collaborate, and prioritize sustainability.

## REFERENCES

1. Bose, P. (2017). "Green Buildings: Concepts and Strategies for Sustainable Development". *Journal of Indian Institute of Architects*, 82(3), 32-39.
2. Chatterjee, S., & Bhattacharya, T. (2015). "Green Building Concept in India: A Review". *International Journal of Engineering and Technical Research*, 3(10), 360-366.
3. Devadas, V., Chauhan, S.S., & Murugan, S. (2016). "Green Building Concept: A Review". *International Journal of Civil Engineering and Technology*, 7(3), 220-229.
4. Ghosh, T., Chakraborti, S., & Majumder, M. (2014). "A Review on Green Building Research in India". *International Journal of Research in Engineering and Technology*, 3(6), 672-680.
5. Singh, A., & Saini, M.S. (2018). "A Comprehensive Study on Green Building Concepts and Implementation in India". *International Journal of Engineering and Management Research*, 8(1), 97-106.
6. Verma, A., Bansal, A., & Garg, P. (2019). "Green Building Concept: A Review". *International Journal of Civil Engineering and Technology*, 10(2), 131-138.
7. Cole, R.J. (1998). "Building Environmental Assessment Methods: Redefining Intentions and Roles". *Building Research & Information*, 26(1), 5-19.
8. Edwards, B. (2006). "Greening the Building and the Bottom Line". *Environmental Quality Management*, 16(1), 1-13.
9. Heschong, L., Wright, R., Okura, S., & Whitney, J. (2002). "Daylighting Impacts on Retail Sales Performance". *Journal of the Illuminating Engineering Society*, 31(2), 101-114.
10. Kibert, C. (2008). *Sustainable Construction: Green Building Design and Delivery*. John Wiley & Sons.
11. Lützkendorf, T., & Lorenz, D. (2005). "Sustainable properties of a sustainable building: A conceptual framework". *Sustainable Development*, 13(4), 227-239.
12. Thumann, A. (2012). *Handbook of Energy Audits* (9th ed.). Fairmont Press.
13. Yudelson, J. (2009). *The Green Building Revolution*. Island Press.



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