Your City, Your Impact

Green Buildings for Sustainable Living

Priyanka Kochhar

About the author

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Her career spans leadership roles at the Green Business Certification Institute, GRIHA Council, TERI, and as a technical advisor to UN-Habitat and other international organizations. She has contributed to policy, research, and capacity building for sustainable urban development; authored key publications and book chapters on green buildings and climate action; and presented at over 120 national and international conferences. Dr Kochhar serves on several professional bodies, including as President of the TERI Alumni Association, and is a Fellow of the Indian Institute of Architects and of INTACH, the Indian National Trust for Art and Cultural Heritage. She is also a trained Indian classical singer and Bharatnatyam dancer.

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About the series 'Books for the Concerned Citizen'

Leveraging the diverse expertise of its members in the subject domains and in publishing, the TERI Alumni Association proposes to publish a series of books on topics related to energy, resources, and the environment. The idea is to share information and, even more important, critical insights and understanding, with citizens who are keen to know more about some of the critical issues facing society and the world today but are lost in the deluge of information.

Our target audience is educated adults who are concerned about topical issues but lack the understanding to make sense of what they read or watch in the mass media—the series aims to equip them with conceptual tools and essential information not only to enrich their understanding but also to encourage them to act and thereby, albeit indirectly, further the UN Sustainable Development Goals.

The topics to be covered in this series and their respective subject-matter-specialist authors are listed below.

- *Your City, Your Impact*: Priyanka Kochhar
- *Responding to Climate Change in South Asia*: lessons from India Divya Sharma, Raina Singh, and Aditya Raghwa
- *Keeping Cities on the Move*: O P Agarwal
- *The Untold Story of Waste Treatment Plants*: Hina Zia and Priyanka Kochhar
- *Carbon Markets*:: path to net-zero emissions markets Nitu Goel

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GREEN BUILDINGS FOR SUSTAINABLE LIVING

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FOREWORD

Cities are at the epicentre of India's transformation, driving economic growth, fostering innovation, and shaping the aspirations of millions. Yet, as urbanization accelerates, we are confronted with unprecedented challenges: resource scarcity, environmental degradation, and the urgent need to ensure equitable, resilient, and sustainable urban futures. The built environment, particularly the way we design, construct, and operate our buildings, lies at the heart of this challenge—and its solution.

Your City, Your Impact: green buildings for sustainable living arrives at a pivotal moment in India's urban journey. This timely volume demystifies the concept of green buildings, translating technical knowledge into accessible insights for citizens, policymakers, and practitioners alike. It highlights how green buildings are not a luxury, but a necessity—integral to achieving the United Nations Sustainable Development Goal 11 and India's commitments under the Paris Agreement.

Drawing on various case studies, the book demonstrates that sustainable construction is both achievable and rewarding, offering tangible benefits: reduced energy and water consumption, improved public health, and enhanced economic productivity. The book underscores the importance of policy alignment, industry collaboration, and public engagement in mainstreaming green building practices. Notably, the book recognizes the need for a bottom-up approach – empowering local governments, building capacity, and fostering community participation – to localize sustainability and ensure that no one is left behind.

As someone who has spent over two decades working at the intersection of urban policy, governance, and sustainable development, I am heartened by the book's holistic perspective. It resonates with the core values we champion at NIUA: inclusivity, innovation, and evidence-based action. The call to action from all stakeholders – developers, policymakers, professionals, and citizens – is especially pertinent. Only through collective effort we can overcome entrenched barriers, from regulatory hurdles to limited awareness, and unlock the full potential of India's green building movement.

I commend Priyanka Kochhar and the TERI Alumni Association for this important contribution. I am confident that this book will inspire a new generation of urban leaders and engaged citizens to reimagine our cities—not just as engines of growth, but as exemplars of sustainability, equity, and well-being for all.

Dr Debolina Kundu
Director (Additional Charge)
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ABBREVIATIONS

AAC	autoclaved aerated concrete
ASSOCHAM	Associated Chambers of Commerce and Industry
BIM	building information system
BMS	building management system
CFL	compact fluorescent lamp
CII	Confederation of Indian Industry
ECBC	Energy Conservation Building Code
EDGE	Excellence in Design for Greater Efficiencies
FALG	flyash lime gypsum
FAR	floor : area ratio
FSI	floor space index
GEM	Green and Eco-friendly Movement
GRIHA	Green Rating for Integrated Habitat Assessment
HVAC	heating, ventilation, and air conditioning
IFC	International Finance Corporation
IGBC	Indian Green Building Council
ILFI	International Living Future Institute
IWBI	International WELL Building Institute
LBC	Living Building Challenge
LEED	Leadership in Energy and Environmental Design
LPD	lighting power density
MOEFCC	Ministry of Environment, Forest and Climate Change
NDCS	nationally determined commitments
NIUA	National Institute of Urban Affairs
PCMC	Pimpri Chinchwad Municipal Corporation
PHC	Passive House Certification
PHPP	Passive House Planning Package
PMC	Pune Municipal Corporation
SHGC	solar heat gain coefficient
TERI	The Energy and Resources Institute
TR	tonne of refrigeration
UPS	uninterrupted power supply
UPVC	unplasticized polyvinyl chloride
USGBC	United States Green Building Council
VAV	variable air volume
VOC	volatile organic compound

Figure **1** Urban sprawl, an AI-generated image

Introduction: the urban challenge

Relentless urbanization is reshaping our world at an unprecedented pace. Today, over half of the global population lives in cities, a figure projected to surge to nearly 70% by 2050. This massive influx of people into cities is driving economic growth, fostering innovation, and creating vibrant cultural hubs. However, the influx also presents a formidable challenge: How to accommodate this growth sustainably, ensuring a high quality of life for all while minimizing any adverse impact on the environment.

Cities are whirlpools of consumption, gobbling up a disproportionately large share of global energy and water and spewing similarly large amounts of waste. Traditional urban development models, characterized by sprawling infrastructure, reliance on fossil fuels, and inefficient resource management, are exacerbating environmental problems such as climate change, air and water pollution, and resource depletion. The consequences are far-reaching, impacting not only the environment but also the health, well-being, and economic prosperity of urban populations.

In India, the urban challenge is particularly acute. As one of the fastest-urbanizing nations in the world, India is witnessing a rapid transformation of its landscape, with millions of people migrating to cities in search of economic opportunities. This rapid urbanization (Figure 1) is straining the country's infrastructure, resources, and environmental carrying capacity. Overcrowding, inadequate sanitation, air and water pollution, and traffic congestion are common in many Indian cities, highlighting the urgent need for sustainable urban development solutions.

Against this backdrop, green buildings emerge as a beacon of hope. Green buildings, often called sustainable buildings, offer a holistic approach to urban development, integrating environmental considerations into every stage of a building's life cycle, from design and construction to operation and eventual demolition. By prioritizing energy efficiency, water conservation, waste reduction, and the use of eco-friendly materials, green buildings minimize their environmental footprint while enhancing the comfort, health, and productivity of their occupants.

This primer explores the potential of green buildings to transform India's urban landscape, addressing the challenges of urbanization by creating more sustainable, resilient, and liveable cities for all. We delve into the principles and practices of green building, showcase successful case studies from India, examine the incentives and policies that support the adoption of green buildings, and discuss the barriers we need to overcome to unlock the full potential of sustainable construction. Ultimately, the aim is to inspire action by empowering developers, policymakers, and citizens to embrace green buildings as a pathway to more sustainable urban future.

The way forward

Policy enablement
Policymakers must enact robust regulations, offer incentives, and introduce support mechanisms to drive widespread adoption of green building practices across India's urban landscape.

Public awareness and engagement
Citizens must be empowered with knowledge and resources to demand and support green buildings, driving a cultural shift towards sustainable living in India's cities.

Green-building ecosystem
Developers, architects, engineers, and construction firms must collaborate to build a thriving green-building ecosystem, leveraging innovative technologies, materials, and construction methods.

Capacity building and training
Comprehensive capacity-building programs must be implemented to equip the construction industry with the necessary skills and expertise to design, construct, and operate green buildings.

Research and innovation
Continued investment in research and development is crucial to drive innovation in green building technologies, materials, and design strategies that are tailored to India's unique climatic and cultural context.

What are green buildings?

Green buildings, often referred to as sustainable buildings, represent responsible design, construction, and operation of the built environment. They are conceived, built, and managed to minimize their environmental impact throughout their life cycle while simultaneously maximizing resource efficiency and enhancing the health and well-being of their occupants. In essence, a green building is a structure that treads lightly on the planet, leaving a positive legacy for future generations.

At the core of green building philosophy lies the principle of sustainability, which emphasizes the interconnectedness of economic prosperity, environmental stewardship, and social equity. A truly sustainable building must not only minimize its environmental footprint but also contribute to the economic vitality of a community and promote social well-being. This means considering factors such as affordability, accessibility, and community engagement in the design and operation of the building.

Core principles of green buildings

- **Use resources efficiently**. Optimize the use of resources such as energy, water, and materials throughout a building's life cycle.
- **Protect the environment**. Minimize pollution, waste, and the emissions of greenhouse gases associated with the building.
- **Ensure health and well-being of occupants**. Create healthy, comfortable, and productive indoor environments for occupants.
- **Think in terms of life cycle**. Consider the environmental and economic impacts of the building over its entire lifespan, from design to eventual demolition.
- **Adopt an integrated and holistic approach**. Approach building design by taking into account not only each building system (electrical, lighting, ventilation, and so on) in isolation but also their interactions and their impact on the environment and occupants.

The core principles are translated into tangible outcomes through the key features of green buildings, which showcase practical strategies such as energy efficiency, water conservation, and the use of sustainable materials. Together, the features convert the visionary concepts with actionable solutions, ensuring that green buildings are both environmentally responsible and economically viable.

Key features of green buildings

- **Energy efficiency**: employing strategies such as insulation, high-performance windows and doors, efficient lighting systems, and smart building controls to minimize energy consumption
- **Renewable energy**: integrating renewable sources of energy such as solar panels, wind turbines, and geothermal systems to generate clean energy on site
- **Water conservation**: using water-efficient fixtures and appliances, rainwater-harvesting systems, and greywater recycling systems to reduce water consumption
- **Sustainable materials**: using recycled, locally sourced, and renewable materials with low embodied energy and minimal environmental impact
- **Waste reduction**: minimizing waste generation during construction and operation through strategies such as modular construction, recycling, and composting
- I**ndoor environmental quality**: ensuring healthy indoor air through proper ventilation, filtration, and the use of non-toxic materials
- **Site design**: minimizing the impact of the building on its surroundings through strategies such as preserving natural habitats, reducing stormwater run-off, and promoting biodiversity

The key features of green buildings provide a road map for designing and constructing sustainable structures that prioritize energy efficiency, water conservation, and the use of environment-friendly materials. To ensure that these efforts are measured consistently and duly recognized, green building certifications serve as standardized frameworks for evaluating a building's environmental performance. These certifications not only validate the implementation of green building strategies but also offer benchmarks and guidance to developers and stakeholders, promoting accountability and excellence in sustainable design.

Certifications for green buildings

To provide a framework for assessing and validating the 'green' performance of buildings, several certification systems have been developed around the world. These certifications set standards for various aspects of the design, construction, and operation of green buildings and provide appropriate benchmarks for developers and building owners to achieve.

Here are some of the most widely recognized green building certifications in India.

GRIHA (Green Rating for Integrated Habitat Assessment). India's national green building rating system, developed by TERI, The Energy and Resources Institute. GRIHA evaluates buildings based on criteria such as site planning, energy efficiency, water conservation, and material selection specifically tailored to Indian context.

LEED (Leadership in Energy and Environmental Design). A globally recognized green building rating system developed by the United States Green Building Council (USGBC). LEED assesses buildings based on a range of aspects, including energy efficiency, water conservation, and indoor environmental quality.

IGBC (Indian Green Building Council). An Indian green building certification developed by the Confederation of Indian Industry. IGBC offers a range of rating systems for different types of buildings, including residential, commercial, and industrial.

EDGE (Excellence in Design for Greater Efficiencies). A green building certification system developed by the International Finance Corporation. EDGE focuses on resource efficiency in emerging markets and emphasizes cost-effective strategies for reducing energy and water consumption.

GEM (Green and Eco-friendly Movement). An Indian green building certification launched by ASSOCHAM, the Associated Chambers of Commerce and Industry of India. The certification encourages environmentally responsible designs that are also financially viable.

WELL building standard. Administered by the International WELL Building Institute, this certification focuses on the health and well-being of the occupants of buildings. The WELL standard evaluates buildings based on such aspects as air, water, opportunities for physical well-being (space to exercise or for growing plants, for example), light, comfort, and mental well-being, ensuring that indoor environments promote health and wellness. WELL is increasingly being adopted in India, especially for high-end commercial and office spaces.

LBC (Living Building Challenge). This rigorous certification, developed by the International Living Future Institute, goes beyond the conventional green building metrics by challenging projects to create regenerative spaces. The challenge evaluates buildings based on seven performance areas, called 'petals', namely place, water, energy, health and happiness, materials, equity, and beauty. LBC is relatively rare in India because of its stringent requirements and focus on regenerative design.

PHC (Passive House Certification). Originating in Germany, this certification emphasizes ultra-low-energy buildings with superior thermal performance, airtightness, and energy-efficient ventilation systems. Passive house design standards significantly lower the energy required for heating and cooling while enhancing occupant comfort. Passive-house projects are gradually being introduced in India, particularly in colder regions.

By adhering to these certification standards, developers can demonstrate their commitment to sustainability and ensure that their buildings contribute positively to environmental and social goals.

In conclusion, green buildings represent a comprehensive approach to sustainable development, integrating environmental, economic, and social considerations into the design, construction, and operation of the built environment. By embracing green building principles, we can create cities that are more resilient, resource-efficient, and liveable for all.

Why green buildings matter: the Indian context

India, a nation of over 1.4 billion people, is undergoing a period of rapid transformation into an urban nation. As one of the fastest growing economies in the world, India is witnessing an exodus from villages to cities in search of livelihoods. This rapid urbanization is driving India's economic growth and modernization but also posing significant challenges to the country's environment, resources, and infrastructure.

Green buildings offer a compelling solution to meet those challenges while ensuring that India's long-term development remains environmentally responsible and socially inclusive. Green buildings are not merely a luxury or a niche market—they are an essential component of a sustainable urban future for India.

India's urbanization: a quick overview

- India's urban population is projected to reach 675 million by 2035, making it one of the largest urban populations in the world.
- This rapid urbanization is placing immense strain on India's infrastructure, resources, and environment. For example, 21 major Indian cities – including Delhi, Bengaluru, Hyderabad, and Chennai – are projected to run out of groundwater by 2030, potentially affecting 100 million people and leaving 40% of India's population without access to drinking water. Additionally, overpopulation in urban areas has led to frequent power outages and inadequate waste management systems.
- Many Indian cities are grappling with issues such as overcrowding, poor sanitation, air and water pollution, and

traffic congestion. For instance, the average peak-hour speed of BEST buses in Mumbai has dropped from 16 km in 2008 to just 9 km in recent years, highlighting severe congestion.

- The construction sector in India is booming, with the industry set to reach a value of $1.4 trillion by 2025, making India the world's third-largest construction market after China and the United States.

Environmental challenges in India

- **Energy demand**. In India, buildings account for nearly 40% of the country's total energy consumption, and this share is expected to rise sharply in the coming decades. This high energy demand is primarily met by fossil fuels, contributing to emissions of greenhouse gases and accelerating climate change.
- **Water scarcity**. Water scarcity is a pressing issue in many parts of India, exacerbated by excessive withdrawals of groundwater, climate change, and population growth. Many cities are facing severe water shortages, impacting both residents and businesses.
- **Waste management**. The construction industry in India is a significant contributor to solid waste, much of which ends up in overburdened landfills. Improper waste management practices lead to environmental pollution and health hazards.
- **Climate change**. India is highly vulnerable to climate-related risks, including heatwaves, floods, and rising sea levels. Climate change is already impacting India's agriculture, water resources, and coastal communities.
- **Air pollution**. Many Indian cities are among the most polluted in the world, with high levels of pollutants such as particulate matter smaller than 2.5 micrometres ($PM_{2.5}$), posing serious health risks to urban populations.

The environmental challenges facing India highlight the urgent need for innovative solutions that mitigate adverse impacts on the environment while supporting urban growth. Green buildings present one such solution because they lower energy and water demand, manage waste more efficiently, and improve air quality. Beyond their environmental contributions, green buildings offer significant economic and social benefits, making them a key strategy for achieving a sustainable and inclusive urban future.

Economic and social benefits of green buildings

- **Reduced operating costs**. Green buildings can significantly reduce energy and water consumption, leading to lower utility bills for building owners and occupants.
- **Job creation**. The green-buildings sector is creating new opportunities for innovation, job creation, and skill development in the construction industry.
- **Healthier indoor environments**. Green buildings prioritize indoor environmental quality, ensuring healthier and more productive spaces for occupants.
- **Improved productivity**. Occupants of green buildings are more productive than those working or living in conventional buildings and also experience fewer sick days.
- **Enhanced brand image**. Green buildings can enhance the brand image and reputation of a company or an organization, demonstrating its commitment to sustainability.
- **Social equity**. Green buildings can promote social equity by providing affordable and accessible housing options for low-income populations.

The economic and social benefits of green buildings underscore their potential as a transformative solution to India's environmental and urban challenges. Recognizing this, India's federal government has introduced appropriate policies and launched a number of initiatives that support the green-buildings movement, aligning it with India's climate commitments under the Paris Agreement and the country's Nationally Determined Contributions (NDCs). These policies not only encourage the adoption of green practices but also create a framework for integrating sustainability into mainstream urban development efforts.

Policy alignment

Green buildings align perfectly with India's commitments to the Paris Agreement and the country's NDCs. India has pledged to reduce the carbon intensity of its economy and increase its renewable energy capacity, and green buildings can play a crucial role in achieving these goals.

India's central government has implemented several policies and programmes to promote green buildings, and some of these initiatives are listed below.

- **National Mission on Sustainable Habitat**, a national mission under the National Action Plan on Climate Change, focuses on promoting sustainable urban development and green buildings.
- **Smart Cities Mission** is a flagship programme aimed at developing one hundred smart cities across India, focusing on sustainable infrastructure and green buildings
- **Energy Conservation Building Code** is a set of mandatory energy efficiency standards for new commercial buildings in India.
- **Incentives for green buildings** include tax breaks, density bonuses, and expedited permissions for green-building projects offered by several state governments. A density bonus allows a builder to exceed, by the specified percentage (typically 5%–15%), the stipulated FAR (floor : area ratio) or FSI (floor space index): these two measures typically cap the number of storeys or total floor space that can be built on a given area of land.

India's modern policies for green buildings are rooted in its rich heritage of sustainable practices. Traditional Indian architecture, with its focus on resource efficiency, climate responsiveness, and community-centric design, offers valuable lessons in designing contemporary green buildings. By blending modern technologies with time-tested traditional methods, India can create buildings that are both innovative and deeply connected to its cultural and environmental context.

Inspiration from tradition

India has a rich tradition of sustainable architecture, dating back to ancient times. Traditional Indian buildings were designed to use energy and water more efficiently, to take into account the region's climate, and to prefer local materials and construction techniques. Such features include

- **stepwells**, which were ancient water-harvesting structures that also provided cool and shaded spaces for communities
- **courtyards**, especially central courtyards, which provided natural light and ventilation
- **mud houses** built with mud bricks, which provided excellent insulation and thermal mass
- **thatched roofs** made of natural materials such as straw and reeds, which provided insulation and protection from the elements.

In conclusion, green buildings are not just an environmental imperative for India but also a pathway to inclusive growth, resource efficiency, climate resilience, and social well-being. By embracing green building principles on a large scale, India can lead the global transition to sustainable urban development while enhancing the quality of life for its citizens.

How green buildings differ from conventional buildings

Green buildings represent a fundamental departure from typical conventional construction practices, prioritizing environmental sustainability, resource efficiency, and occupant well-being throughout the life cycle of the building. Whereas conventional construction often focuses primarily on cost and speed, potentially neglecting long-term environmental and operational impacts, green buildings take a holistic approach, integrating sustainability considerations into every stage of the process, from design and material selection to construction, operation, and eventual demolition. Understanding these differences is crucial to appreciating the transformative potential of green buildings.

Table 1 compares green buildings and conventional buildings across seven key areas.

Key differences between green buildings and conventional buildings

DESIGN PHILOSOPHY

Green building design begins with a comprehensive understanding of the site's climate, topography, and the surrounding environment. Architects and engineers use passive-design strategies to optimize natural light and ventilation, reducing the building's reliance on artificial systems. They also consider the building's orientation, shading, and landscaping to minimize solar heat gain and maximize energy efficiency. The design process also incorporates principles of biophilic design, connecting occupants to nature and creating a more restorative and inspiring indoor environment.

Conventional buildings often prioritize speed and cost over environmental considerations. Designs may be standardized and replicable, without taking into account the specific characteristics of the site. The focus is often on maximizing floor space and minimizing construction time, potentially leading to inefficient designs that consume more energy and resources.

MATERIAL SELECTION

Green buildings prioritize the use of sustainable materials that have a minimal environmental impact. These include recycled materials (such as recycled concrete and steel), locally sourced materials (to reduce transport-related emissions), renewable materials (such as bamboo and wood from sustainably managed forests), and materials with low embodied energy (the total

Table **1** Green and conventional buildings compared

Green buildings	Conventional buildings
Design philosophy Holistic, integrating energy efficiency, water conservation, and waste management from the outset	**Design philosophy** Siloed interventions by project team lead to inefficient design (lack of integrated approach)
Material selection Prioritize recycled, locally sourced, or rapidly renewable materials with low embodied energy	**Material selection** Often prioritize cost and availability, which may result in use of materials that are energy-intensive to produce or transport and harmful to the environment
Energy efficiency Designed to optimize energy consumption through features such as insulation, high-performance glass,and solar panels	**Energy efficiency** May lack such features, leading to higher energy demands and carbon emissions
Water conservation Integrate advanced water management systems, including low-flow fixtures and rainwater harvesting	**Water conservation** Typically less emphasis on water efficiency, contributing to wastage and strain on local water resources
Waste management Minimize waste during construction and operation of building	**Waste management** Often generate significant amounts of waste that end up in landfills
Indoor environmental quality Prioritize occupant health and well-being by incorporating non-toxic materials and improving ventilation	**Indoor environmental quality** May lack these considerations, sometimes leading to poorer indoor air quality and less comfortable living or working environments
Life-cycle costs Higher upfront investments but lower operational costs with quick payback	**Life-cycle costs** Less expensive initially, but may incur higher costs in the long run owing to high electricity and running expenses

energy required to produce and transport a given quantity of material). Designers of green buildings also avoid the use of hazardous materials such as asbestos, lead, and volatile organic compounds (VOCs), which can be harmful to the occupants.

Conventional buildings often rely on readily available materials without necessarily considering their environmental impact. These may include materials that are energy-intensive to produce (such as aluminium and cement), materials that have to be transported over long distances (increasing carbon emissions), and materials that contain hazardous substances.

ENERGY EFFICIENCY

Green buildings are designed to minimize energy consumption through a variety of strategies. These include insulation to reduce heat loss and gain, energy-efficient windows and doors to minimize air leakage, efficient lighting systems (such as those that use LED lighting) to reduce electricity consumption, and smart building controls to optimize energy use. Green buildings also often incorporate renewable energy systems such as solar panels to generate clean energy on site, reducing their reliance on fossil fuels.

Conventional buildings often lack these energy-efficient features, leading to higher energy demands and carbon emissions. Air-conditioned buildings may not use insulation, windows may use single glass and leak, lighting systems may be inefficient, and building controls may be basic or non-existent.

WATER CONSERVATION

Green buildings integrate water management systems to reduce water consumption. These include low-flow fixtures (such as faucets and showerheads used in toilets and bathrooms) to reduce water use, rainwater-harvesting systems to collect and store rainwater for non-potable uses (such as irrigation and toilet flushing), and greywater recycling systems to treat and reuse wastewater from showers and sinks. Green buildings also often incorporate drought-tolerant landscaping to minimize the need for irrigation.

Conventional buildings typically place less emphasis on water efficiency, contributing to wastage and strain on local water resources. Fixtures may be inefficient, rainwater may be allowed to run off, and landscaping may require extensive irrigation.

WASTE MANAGEMENT

Green buildings aim to minimize waste generation during both construction and operation. During construction, they deploy strategies such as use of modular construction (using pre-fabricated building components to reduce waste), careful management of materials (reducing on-site material waste), and recycling of construction debris. During operation, the strategies include providing recycling and composting systems to occupants, designing buildings for durability and longevity, and promoting responsible consumption habits.

Conventional buildings often generate significant amounts of waste that ends up in landfills. Construction sites may be poorly managed, leading to material waste, and buildings may be designed with a short lifespan, contributing to demolition waste in the future.

QUALITY OF INDOOR ENVIRONMENT

Green buildings prioritize the health and well-being of occupants by creating healthy, comfortable, and productive indoor environments. The measures include using non-toxic materials (such as low-VOC paints and adhesives) to reduce indoor air pollution, improving ventilation to provide fresh air and remove pollutants, ensuring ample natural light to improve mood and productivity, and controlling noise levels to reduce distractions.

Conventional buildings may lack these considerations, sometimes leading to poorer indoor air quality and less comfortable living or working environments. Materials may contain hazardous substances, ventilation may be inadequate, natural light may be limited, and noise levels may be high.

LIFE-CYCLE COSTS

Green buildings may require higher upfront investments because they use advanced materials and technologies; however, the operational costs of green buildings are significantly lower over time. Lower energy and water bills, coupled with lower maintenance costs, make green buildings financially attractive in the long run. Studies have shown that green buildings can have a positive return on investment over their life cycle, making them a smart choice for building owners and occupants.

Conventional buildings may be cheaper initially, but can lead to higher costs in the long run due to inefficiencies and environmental penalties. Higher energy and water bills, increased maintenance costs, and potential environmental liabilities can erode the economic benefits of conventional buildings over time.

Ultimately, the differences between green buildings and conventional buildings underline the importance of adopting sustainable practices. Green buildings not only mitigate environmental challenges but also enhance social equity and economic resilience, offering a blueprint for a sustainable future.

Case studies: green buildings in action (India)

Green buildings are not only environmentally sustainable but also serve as exemplars of energy efficiency, resource conservation, and occupant well-being. This section presents three institutional green buildings in India that showcase best practices in sustainable design and construction. All the three, in New Delhi and designed for the composite climate zone, have achieved GRIHA ratings for their environmental performance, paving the way for future projects.

Building 1: Office building for a central ministry in Jor Bagh, New Delhi

Specifications

- Built-up area: 31,400 square metres
- Completion date: 2014
- GRIHA rating: 5 star (provisional)
- Project cost: ₹200 crore (2 billion rupees)

Detailed description

Building 1 (Figure 2), an office complex, exemplifies the integration of cutting-edge green building practices within the public sector. The eight-storey structure is a testimony to how thoughtful architectural design can be harmonized with advanced energy systems to reduce environmental impact while enhancing functionality and occupant comfort.

Figure **2** A 3D model of Building 1
(Credits: Priyanka Kochhar and Kanika Trivedi)

Architectural design and orientation

The building's architectural design is rooted in passive strategies aimed at optimizing natural light, ventilation, and energy efficiency. With its optimal north–south orientation, the building minimizes heat gain while maximizing daylight penetration. Narrow floor plates, interconnected by atriums, allow deeper penetration of natural light, reducing reliance on artificial lighting. These design elements also facilitate natural ventilation through a stack effect, enhancing indoor air quality and thermal comfort.

The structure comprises two primary blocks connected by corridors on the fourth floor, with a large central courtyard that serves as a focal point. The courtyard not only provides aesthetic value but also contributes to the building's self-shading capabilities, further reducing energy demand for cooling. The design includes a spacious entrance atrium with a high ceiling, offering a clear vertical space up to four storeys, creating an inviting and open environment. The roof features large span trusses and a space frame supporting solar panels, underlining the building's commitment to renewable energy.

Material selection and thermal performance

Sustainable material selection was the cornerstone of Building 1's design. The outer walls were constructed using AAC blocks (autoclaved aerated concrete) combined with rockwool insulation, offering superior thermal performance. FaLG (flyash lime gypsum) bricks were used for internal walls, in keeping with eco-friendly construction practices. The double-wall units with rockwool insulation achieve a U-value of 0.37 W/m^2K, well below the requirement of 0.44 W/m^2K stipulated in the ECBC (Energy Conservation Building Code) of 2007. The U-value (U for unit) is a measure of how good the windows or even walls are in insulating the spaces they enclose (preventing outside heat from entering and inside heat from escaping, which are desirable features, respectively, in summers and winters). The lower the U-value, the better the insulation. U-values are expressed in watts per square metre per Kelvin: watts to show how quickly power is transferred or consumed, and Kelvin to represent absolute temperature (a change of 1 K is equivalent to a change in temperature by 1 °C). In a double wall, a layer of rockwool is sandwiched between two walls because rockwool is an excellent insulating material.

The roof assembly incorporates a three-layer insulation system, including polyurethane foam insulation and heat-reflective tiles. Additionally, a terrace garden on the seventh floor reduces urban heat-island effects, slows run-off, and provides a recreational space for occupants. All windows are double-glazed and with UPVC frames (unplasticized polyvinyl chloride), featuring advanced solar control and thermally insulated glass. These windows achieve a U-value of 1.5 W/m^2K and a solar heat gain coefficient (SHGC) of 0.25, significantly improving energy efficiency. Double-glazed windows trap air between the two layers of glass, the air acting as an insulator, and UPVC is superior to wood or metal as a material for window frames because UPVC is a poor conductor of heat. The solar heat gain coefficient measures how much of the sun's heat passes through a window. The coefficient is a number between 0 and 1; the lower the number, the lesser the heat that gets in. For example, a coefficient of 0.25 means only 25% of the sun's heat passes through, which helps to keep buildings cooler in hot weather.

Energy systems and integration of renewable energy

The energy systems in Building 1 are designed to optimize efficiency while integrating renewable energy sources. A rooftop solar power plant with a capacity of 930 kW supplies clean energy to the building, contributing to its net-zero aspirations. The lighting system employs energy-efficient LED fixtures and T5 lamps (compact and more efficient fluorescent tubes), supplemented by daylight and occupancy sensors to minimize power consumption. T5 refers to the diameter of the tube: 5/8th of an inch (approximately 16 mm). These lamps are more compact and give more light per watt than the older fluorescent types such as T8 and T12 do. Therefore, T5 lamps are commonly used in modern lighting systems for offices, commercial spaces, factories, etc.

The heating, ventilation, and air-conditioning (HVAC) system represents a significant innovation. The building employs a chilled beam air-conditioning system, the first of its kind in an Indian government building. This system reduces operational costs, minimizes noise, and requires less ceiling space compared to that required by traditional forced-air systems. Complementing this system is a vertical closed-loop geothermal heat exchange system, which leverages the temperature differential below the ground to reduce the cooling load by 160 TR (tonne of refrigeration, 1 TR being the heat required to melt one short ton (907 kg) of ice at 0 °C in 24 hours). These systems collectively enhance energy efficiency and occupant comfort.

Water and waste management

Although the focus of the case study is on energy and envelope design, it is worth noting that Building 1 incorporates pervious paving and advanced water management systems to reduce run-off and promote groundwater recharge. Flyash-based construction materials further demonstrate a commitment to sustainable waste management practices.

Integrated building management system

A state-of-the-art BMS (building management system) monitors and controls the building's mechanical and electrical systems, including HVAC, lighting, lifts, and indoor air. This centralized system ensures optimal performance, reduces energy wastage, and enhances maintenance efficiency. The building management system also integrates data from daylight and motion sensors to adjust lighting levels dynamically, providing a comfortable and energy-efficient indoor environment.

Innovative features and firsts

Building 1 includes several innovative features that have set benchmarks for green construction in India. The robotic car parking system in the basement accommodates 330 vehicles, optimizing space and reducing emissions associated with traditional parking systems. Energy-saving regenerative lifts and underfloor radiant heating in communal areas further highlight the building's advanced technological integration.

The use of chilled beam air-conditioning and geothermal heat exchange systems marks a significant milestone in Indian green building practices. These technologies not only improve energy efficiency but also demonstrate the feasibility of implementing cutting-edge solutions in large-scale public-sector projects.

Impact and legacy

Building 1's design and operational strategies have paved the way for future GRIHA-rated buildings in India. By showcasing the successful implementation of passive and active design principles, it serves as an educational tool for architects, engineers, and policymakers. The project underscores the importance of aligning public-sector construction with national sustainability goals, setting a precedent for resource-efficient and environmentally conscious development.

Summary of green features

- **Energy efficiency**. Rooftop solar power plant, LED lighting, chilled beam air-conditioning, and geothermal heat exchange
- **Material sustainability**. AAC blocks, FaLG bricks, UPVC windows, and flyash-based materials
- **Thermal comfort**. Optimized building orientation, insulated walls and roofs, and natural ventilation
- **Innovations**. Robotic parking, regenerative lifts, and advanced BMS

Building 1 exemplifies how government projects can lead by example, integrating sustainability into every aspect of design and operation. Its success highlights the potential for green buildings to address urban challenges while fostering a healthier and more sustainable built environment.

Building 2: Office building for an autonomous public research institute, Hauz Khas, New Delhi

Specifications

- Built-up area: 45,761 square metres
- Completion date: 2015
- GRIHA rating: 4 star (provisional)
- Project cost: ₹115 crore (1.15 billion rupees)

Detailed description

Building 2 (Figure 3), located within the expansive campus of the institute, serves as an educational and research hub and exemplifies the integration of sustainable design in academic settings to house lecture halls, laboratories, and conference facilities. The building's compact and functional design demonstrates the effective use of resources and space.

Figure **2** A 3D model of Building 2
(Credits: Priyanka Kochhar and Kanika Trivedi)

Architectural design and layout

The building has been designed as a compact structure to minimize its environmental footprint. Its external envelope employs cavity walls with thermal insulation to enhance energy performance. With a total built-up area of 45,761 m^2, the building accommodates a floating population of 2200 students and faculty members. To ensure thermal comfort and minimize cooling requirements, 40% of the building's superstructure is air-conditioned.

Block A, the central foyer, features a circular design with a very high ceiling, reaching to a height of nearly 11 metres. Blocks B and C house lecture halls and laboratories, designed with long spans to accommodate large groups while minimizing the use of structural materials. Block D includes an auditorium with a seating capacity of 500, equipped with advanced acoustics and audiovisual systems.

Material selection and thermal performance

The outer walls are of flyash bricks and finished with sandstone cladding for durability and aesthetic appeal. The cavity wall design achieves a U-value of 0.766 W/m^2K. Windows are of 24 mm thick glass sheets, double-glazed, hermetically sealed, and with sun louvers, achieving an SHGC of 0.28 and a U-value of 1.9 W/m^2K. Roof assembly with fibreglass wool insulation and brick coba (a sloping, waterproof layer on flat roofs using broken bricks, or brickbats, embedded in mortar) minimizes heat gain, contributing to a U-value of 0.596 W/m^2K.

Energy systems and lighting

The lighting system employs compact fluorescence lamps and T5 lamps with electronic ballasts, ensuring energy-efficient illumination. The achieved lighting power density (LPD) values are even lower than those stipulated in the ECBC recommendations, with specific densities tailored to lecture halls, equipment rooms, and miscellaneous spaces. Daylight penetration is optimized for 51.6% of the occupied areas, reducing reliance on artificial lighting.

The heating, ventilation, and air-conditioning system is designed for central cooling with a total capacity of 550 TR, supported by variable air volume (VAV) water-loop chillers. These devices use water as a secondary refrigerant and can vary the temperature and flow rate of the air they supply, which allows the system to maintain a comfortable indoor temperature while optimizing energy consumption.

Integrated building management system

An advanced BMS monitors and controls the building's mechanical and electrical systems, ensuring optimal performance and reducing energy wastage. The system integrates data from sensors and adjusts HVAC, lighting, and electrical systems dynamically to enhance efficiency.

Sustainable features

The building incorporates smart classrooms with advanced audiovisual equipment, acoustically treated lecture halls, and dedicated emergency power systems, including diesel generators and UPS (uninterrupted power supply) systems. These features contribute to a functional, resilient, and sustainable academic environment.

Impact and educational value

Building 2 showcases how sustainable practices can be seamlessly integrated into institutional settings, serving as a model for future educational infrastructure. The building's design and operational strategies highlight the importance of energy efficiency and material sustainability in creating resource-efficient learning spaces.

Summary of green features

ENERGY EFFICIENCY

- ◐ Centrally air-conditioned classrooms and laboratories with a VAV (variable air volume) water-cooled chiller system

(3 × 275 TR, two for regular use and one as a standby) designed for a comfortable indoor temperature of 24 ± 1 °C

- ◐ Lighting system comprising T5 lamps with electronic ballasts and CFLs (compact fluorescent lamps), achieving LPD levels (lighting power density) better than ECBC 2007 benchmarks
- ◐ Daylight access to 51.6% of occupied areas, reducing artificial lighting needs
- ◐ Integrated BMS for efficient control of HVAC, electrical, and safety systems

MATERIAL SUSTAINABILITY

- ◐ Cavity walls with thick stone cladding and comprising 230 mm long and 115 mm thick flyash bricks finished with plaster, resulting in a U-value of 0.766 W/m^2K
- ◐ Aluminium doors and windows, fire-resistant structural glazing, and aluminium composite panels
- ◐ Roof assembly including slabs of reinforced cement concrete, a 50 mm thick insulating layer of fibreglass wool, and waterproofing with a 150 mm thick layer of brick coba, achieving a U-value of 0.596 W/m^2K

THERMAL COMFORT

- ◐ Double-glazed, hermetically sealed windows (24 mm thick) with sun louvers on the north-west and south-west, providing a U-value of 1.9 W/m^2K and SHGC of 0.28, limiting heat gain and glare
- ◐ Acoustically treated lecture halls
- ◐ Compact building form orientated to minimize heat gain and optimize energy use

Building 2 demonstrates how large educational facilities can integrate energy-efficient systems, sustainable materials, and occupant-comfort strategies while meeting stringent green building standards in India at the same time.

Building 3: Headquarters of a public-sector bank, New Delhi

Specifications

- Built-up area: 76,188 square metres
- Completion date: 2017
- GRIHA rating: 5 star (provisional)
- Project cost: ₹405 crore (4.05 billion rupees)

Detailed description

Building 3 (Figure 4) exemplifies the integration of green principles in corporate infrastructure. Spanning 76,188 square metres across six floors and three basements, the building accommodates 1650 employees. Designed to achieve a balance between aesthetics and functionality, this structure serves as a benchmark for energy-efficient and sustainable corporate architecture.

Figure **4** A 3D model of Building 3
(Credits: Priyanka Kochhar and Kanika Trivedi)

Architectural design and layout

The building's design is centred around a central axis that seamlessly integrates with its surrounding environment. A large atrium serves as the focal point, enhancing natural ventilation and lighting. The design strategically harnesses the Venturi effect – the drop in fluid pressure when a moving fluid flows faster from a larger section of a pipe to a smaller section – to draw air from the south-west into the atrium, facilitating natural cooling and reducing reliance on mechanical systems.

The roof design further underscores the building's innovative approach. Comprising four panels – two lower side panels reflecting the geometry of the building and two raised panels covering the atrium – the roof is optimized to reduce solar heat gain and support renewable energy installations.

Material selection and thermal performance

The building's envelope features double-wall units with extruded polystyrene insulation to enhance thermal efficiency. The outer walls are of 200 mm thick aac blocks whereas the inner walls are of 100 mm thick AAC blocks. This combination achieves a U-value of 0.39 W/m^{2}K, surpassing the standards stipulated in ECBC 2007.

Windows use UPVC frames and are double-glazed, thus providing superior thermal insulation. The windows achieve a U-value of 1.48 W/m^{2}K and an SHGC of 0.23, significantly reducing heat gain while allowing in ample daylight. The roof assembly, consisting of a 250 mm thick reinforced cement concrete slab with 75 mm thick XPS (extruded polystyrene) insulation, further enhances the building's thermal performance.

Energy systems and renewable integration

Building 3 is designed to maximize energy efficiency while incorporating renewable energy sources. A 200 kWp rooftop solar power plant supports the building's energy requirements, contributing to its sustainability goals. The heating, ventilation, and air-conditioning system includes high-efficiency water-cooled chillers with a combined capacity of 660 TR, ensuring optimal indoor climate control.

The lighting system employs LED fixtures equipped with daylight and occupancy sensors, achieving an LPD of 0.60 W/ft^2 (approximately 6.5 W/m^2) for office floors. These measures are compliant with ECBC recommendations and reduce energy consumption significantly.

Integrated building management system

A sophisticated BMS is deployed to monitor and control the building's mechanical and electrical systems. This system integrates data from various sensors to dynamically adjust HVAC, lighting, and electrical systems, ensuring energy optimization and occupant comfort. The system also supports emergency power systems, enhancing the building's resilience.

Innovative features and firsts

Building 3 introduced several innovative features, including a large circular glazed cylinder that houses the building gallery, VIP lounges, and conference rooms. This six-storey structure enhances the building's aesthetic appeal while promoting natural light and ventilation.

Emergency power systems include gas- and diesel-based generator sets with capacities of 1000 kVA and 500 kVA respectively, ensuring uninterrupted operations during power outages. The integration of advanced insulation techniques, efficient HVAC systems, and renewable energy sources positions Building 3 as a model of sustainable corporate infrastructure.

Impact and legacy

The headquarters stands as a testimony to how sustainability can be integrated seamlessly into corporate infrastructure without compromising functionality or aesthetics. By achieving a GRIHA 5-star rating, Building 3 highlights the potential of green buildings to drive corporate responsibility while addressing environmental challenges. It serves as an inspiration for financial institutions and corporations aiming to adopt sustainable practices in their operations.

Summary of green features

- **Energy efficiency.** Rooftop solar power plant, LED lighting, and high-efficiency chillers
- **Material sustainability**. AAC blocks, UPVC windows, and extruded polystyrene insulation
- **Thermal comfort**. Venturi-effect-driven cooling, insulated roof panels, and advanced windows
- **Innovations**. Integrated BMS, renewable energy systems, and unique architectural elements

Building 3 exemplifies how sustainability and innovation can converge to create a resilient and energy-efficient workspace. Its success underscores the importance of adopting green building practices in shaping a sustainable future.

These three case studies illustrate the transformative potential of green buildings in reducing energy and resource consumption while enhancing occupant comfort. By integrating passive-design strategies, advanced materials, and efficient energy systems, these buildings set benchmarks for sustainable construction in India. They also highlight the importance of government-led initiatives, such as GRIHA, in promoting green practices and aligning construction projects with national sustainability goals.

Incentives for green buildings

Governments and local authorities play a critical role in promoting green buildings by providing incentives and support to developers, builders, and homeowners. These incentives can help offset the initial costs of constructing green buildings and make sustainable building practices more accessible and attractive. This section explores the range of incentives available for green building projects in India, drawing upon information from the GRIHA Council and the Indian Green Building Council.

Green building incentives can be broadly categorized as follows.

Tax benefits

- **Rebates in property tax**. Many state governments offer subsidies on property tax for green-certified buildings. For instance, the Punjab government offers a 10% rebate on property tax for residential buildings that have been certified as green. In Hyderabad, buildings with LEED or GRIHA certification are eligible for rebates up to 15% on property tax. The rebates are administered through local municipalities or corporations or similar local self-governing bodies.

Bonus in floor area ratio

- **Additional floor area ratio** is granted to developers of green-certified projects. For example, Noida and Greater Noida development authorities offer up to 5% additional FAR for GRIHA-, IGBC-, or LEED-certified buildings. Haryana offers additional FAR ranging from 3% for 1-star to 15% for 5-star GRIHA-certified projects.

Expedited permissions

- **Priority approvals**. Green-certified projects are often granted the required environmental and construction-related approvals on priority. The central Ministry of Environment, Forest and Climate Change grants fast-track environmental clearance for GRIHA and IGBC pre-certified projects.

Recognition and awards

- **Certification-based recognition**. Municipal bodies and state governments often host events to reward green-certified projects, enhancing their market appeal and reputation.

Examples of green building incentives in India

- **Pimpri Chinchwad Municipal Corporation**
  - Premium discounts. Developers receive discounts ranging from 10% for lower-rated projects to 50% for 5-star GRIHA projects.
  - Property tax rebates. Residents of GRIHA-certified buildings can avail themselves of rebates in the annual property tax.

  These measures have significantly reduced the demand for potable water and energy consumption in the city's green-rated projects.

- **Pune Municipal Corporation**. Financial rebates and additional far for green-certified projects are offered by the PMC.
- **Haryana Building Code**
  - Additional floor : area ratio. GRIHA-certified projects are granted 3% (for 1-star) to 15% (for 5-star) higher FAR.
  - Faster environmental clearance. Although green-certified buildings may receive expedited clearances, they are not entirely exempt from standard environmental regulations.
- **Maharashtra**
  - Mandatory compliance. The Government of Maharashtra has made compliance with GRIHA mandatory for new government buildings.
- **Chandigarh and Rajasthan**
  - Chandigarh enforces compliance with green building standards for large projects.
  - Rajasthan offers additional FAR and financial incentives to encourage sustainable development in cities such as Jaipur.

Accessing green building incentives

Developers must register their projects with recognized certification agencies such as GRIHA, IGBC, or LEED. The process involves pre-certification, periodic audits during construction, and final certification upon project completion. Developers must submit the final certification to municipal bodies or other authorities to claim the incentives such as additional FAR or tax rebates.

Overcoming barriers to green buildings

Although green buildings offer many environmental, economic, and social benefits, several barriers hinder their widespread adoption. Addressing these barriers is crucial to unlocking the full potential of sustainable construction and creating a greener built environment.

This section explores the common challenges to green building adoption and offers practical solutions to overcome them.

Common challenges

1 **Higher initial costs**. One of the most significant barriers to green buildings is the perception that they are more expensive to construct than conventional buildings. Some green building technologies and materials may indeed have higher upfront costs; however, they are cheaper in the long run because the substantial savings in life-cycle cost often outweigh the initial costs.

Solution. Emphasize lower life-cycle costs; showcase successful case studies with higher returns on investment; and offer financial incentives to offset initial costs.

2 **Lack of awareness and knowledge**. Many developers, builders, and homeowners are unfamiliar with green building principles, technologies, and certification systems. This lack of awareness can lead to scepticism and reluctance to adopt green building practices.

Solution. Conduct extensive education and awareness campaigns; train green-building professionals; and disseminate information through online resources and industry events.

3 Limited availability of green materials and technologies. In some areas, the availability of green building materials and technologies may be limited, making it difficult and expensive to source sustainable products.

Solution. Promote local manufacturing of green building materials; create online marketplaces for green products; and offer incentives for companies that produce and distribute green building materials.

4 Regulatory hurdles. Complex and time-consuming procedures and formalities to obtain the required approvals and clearances can discourage developers from pursuing green building projects. Outdated building codes and zoning regulations may also hinder the adoption of sustainable building practices.

Solution. Streamline the relevant procedures and formalities; update building codes and zoning regulations to encourage green building practices; and offer technical assistance to developers in navigating the regulatory landscape.

5 Misdirected incentives. In rental properties, the benefits of green building investments (such as lower utility bills) may be enjoyed by the tenant, whereas the costs are borne by the landlord. This can discourage landlords from investing in energy efficiency and other green building upgrades.

Solution. Implement policies that align the incentives for landlords and for tenants: for example, make it mandatory for landlords to disclose energy-performance data to prospective tenants or offer rebates for energy-efficient upgrades in rental properties.

6 Lack of consumer demand. If consumers do not demand green buildings, developers may be hesitant to invest in sustainable construction practices.

Solution. Educate consumers about the benefits of green buildings; promote green building certifications; and create marketing campaigns that highlight the value of sustainable living.

7 Perception of complexity. Some developers and builders may perceive green building as overly complex and time-consuming, requiring specialized expertise and adding to project management challenges.

Solution. Simplify green building standards and guidelines; provide easy-to-use tools and resources; and offer technical assistance to developers and builders.

The common challenges faced in constructing green buildings highlight the critical barriers that must be addressed to make sustainable construction a mainstream practice. Strategies to overcome these barriers provide a road map for enabling widespread acceptance and implementation.

Together, these insights emphasize the need for a multifaceted approach – spanning policy, education, collaboration, and technology – to drive the transformation of built environment towards sustainability. By aligning these strategies with the challenges, stakeholders can create a supportive ecosystem that accelerates the adoption of green building practices.

Strategies to overcome barriers to green buildings

- **State leadership**. Governments at all levels play a crucial role in promoting green buildings through policies, incentives, and regulations.
- **Industry collaboration**. Collaboration between developers, builders, architects, engineers, material suppliers, and other stakeholders is essential for driving innovation and sharing best practices.

- **Education and training**. Investing in education and training for green-building professionals is critical to building a skilled workforce.
- **Public awareness campaigns**. Raising public awareness about the benefits of green buildings is essential for creating consumer demand.
- **Financial innovation**. Developing innovative financing models, such as green bonds and revolving loan funds, can help overcome financial barriers.
- **Technology**. Use of technology such as BIM (building information modelling) can enable better building management and reduce waste.

By addressing these challenges and implementing effective strategies, we can encourage the adoption of green buildings and accelerate the transition to a sustainable built environment.

Call to action: building a sustainable future

The pressing challenges of urbanization, climate change, and resource scarcity demand a transformative approach to the built environment. Green buildings offer a powerful solution, providing opportunities to minimize environmental impact, reduce energy and resource consumption, and enhance occupant well-being. However, achieving a sustainable future requires collective effort and commitment from developers, policymakers, industry professionals, and citizens. This call to action outlines the actions each stakeholder can take to contribute to the adoption of green building practices, thereby helping to create a sustainable and resilient built environment for generations to come.

A call to action for developers and builders

Developers and builders are at the forefront of transforming the construction landscape. By integrating green building principles and innovations into their projects, they can lead the way in sustainable urban development.

1 Embrace green building principles
Incorporate green building principles at every stage of the project life cycle, from design and material selection to construction and operation. Passive-design strategies, resource-efficient materials, and energy-efficient systems are essential components of a green building.

2 Pursue green-building certification
Obtain certifications such as LEED, GRIHA, IGBC, or EDGE to validate the environmental performance of projects. Certifications not only demonstrate a commitment to sustainability but also enhance marketability and appeal to environmentally conscious consumers.

3 Innovate and experiment
Explore cutting-edge green building technologies and strategies, such as renewable energy integration, smart building systems, and sustainable construction materials. Share successes and lessons learnt with industry peers to foster innovation.

4 Communicate the value of green buildings
Educate clients and stakeholders about the economic, social, and environmental benefits of green buildings. Highlight cost savings through reduced energy and water bills, improved indoor air quality, and enhanced property value.

5 Focus on life-cycle costing
Shift the focus from initial costs to life-cycle costs. Demonstrate how investments in green building technologies and materials yield significant long-term savings and contribute to financial viability.

A call to action for policymakers

Policymakers play a pivotal role in promoting green buildings by accelerating the transition to sustainable construction practices through policy frameworks, incentives, and leadership in the public sector.

1 Strengthen green building policies
Develop and enforce policies that encourage green building

practices, such as energy efficiency standards and green building incentives, and streamline procedures and formalities to obtain the required permissions, approvals, and clearances. Align regulations with international standards to ensure consistency and credibility.

2 Invest in research and development

Support the development of innovative green building technologies and materials. Fund research initiatives and partnerships between academia, industry, and government to promote sustainable construction practices.

3 Raise public awareness

Launch campaigns to educate citizens about the benefits of green buildings and to increase the demand for sustainable construction. Use public platforms to showcase successful projects and share information on available incentives.

4 Lead by example

Set a precedent by constructing new government buildings to green standards and retrofitting existing public buildings for improved sustainability. Public-sector leadership can demonstrate the feasibility and benefits of green building practices.

5 Provide tax benefits and financial incentives

Introduce tax benefits for using green building materials and energy-efficient systems. Provide subsidies or offer low-interest loans to support developers in adopting sustainable practices.

A call to action for industry professionals

Architects, engineers, and construction professionals are instrumental in advancing the adoption of green building. Their expertise and advocacy can shape the future of sustainable construction.

1 Develop expertise in green building practices

Invest in education and training to become skilled in green building design and knowledgeable about materials and technologies. Certifications and continuing professional development enhance professional credibility and expertise.

2 Promote green building solutions
Advocate for sustainable design strategies and technologies in projects. Provide evidence-based recommendations to clients and stakeholders to demonstrate the value of green solutions.

3 Collaborate with stakeholders
Work closely with developers, policymakers, and citizens to promote green buildings. Collaboration ensures alignment of goals and maximizes the impact of sustainability initiatives.

4 Share knowledge and mentor others
Contribute to the development of industry best practices by sharing knowledge and mentoring aspiring professionals. Collaboration and knowledge-sharing drive innovation and build capacity within the industry.

5 Leverage technology
Use tools such as building information modelling and integrated building management systems to use resources optimally and to improve project outcomes. Technology can simplify green building implementation and monitoring.

A call to action for citizens

Citizens are essential drivers of demand for green buildings. By making informed choices and insisting on sustainable practices, individuals can influence market trends and encourage developers to prioritize green construction.

1 Demand green buildings
Choose to live, work, and shop in green buildings whenever possible. Support developers and builders who demonstrate a commitment to sustainability, signalling consumer demand for environmentally responsible construction.

2 Reduce your environmental footprint
Adopt sustainable lifestyle practices such as conserving energy and water, reducing waste, and using public transport. Small changes in daily habits can collectively make a significant impact.

3 Advocate for green building policies
Engage with local and national policymakers to express support

for green building policies and incentives. Community advocacy can drive policy changes that promote sustainability.

4 Educate yourself and others

Learn about the benefits and features of green buildings and share this knowledge with friends, family, and colleagues. Awareness and education are critical to fostering a culture of sustainability.

5 Ask for green homes

When purchasing or renting homes, actively seek sustainable design and construction features. Consumer preferences for green homes can drive market trends and influence developers.

Conclusion: a collective vision for sustainability

The path to a sustainable future lies in collective action. Green buildings are not merely a solution to environmental challenges—they are an opportunity to reimagine urban living and create healthier, more resilient communities. By embracing sustainable construction practices, we can reduce resource consumption, lower greenhouse gas emissions, and improve the quality of life for all.

Developers, policymakers, industry professionals, and citizens must unite to transform India's built environment into a model of sustainability. Together, we can build cities that are not only functional but also liveable, equitable, and environmentally responsible. The future of our planet depends on the actions we take today—let us commit to creating a greener, equitable, and more sustainable world for future generations.

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About TERI Alumni Association

The TERI Alumni Association is a society registered under the Societies Act, and donations to the association qualify for tax rebate as the association is recognized as a charitable institution under Sections 12A and 80G of the Income Tax Act. The association has about 400 members, comprising 300 alumni and about 100 current employees of TERI. The current president (Priyanka Kochhar, founder and director of The Habitat Emprise) and the current secretary (Pranab J Patar, Chief Executive, Indo-US Environmental and Social Impact Organisation) are duly elected office bearers of the Executive Committee whereas other office bearers are nominated by TERI.

Your City, Your Impact: green buildings for sustainable living is an essential guide for anyone who cares about the future of our cities and the planet. As urbanization accelerates and environmental challenges mount, this accessible primer unpacks the urgent need for sustainable buildings in India's rapidly growing urban landscape.

Drawing on real-world case studies, clear explanations, and expert insights, the book demystifies what makes a building 'green' – from energy efficiency and water conservation to healthier indoor environments and the use of sustainable materials – and explains how green buildings can reduce costs, improve well-being, and contribute to economic and social equity, all the while supporting India's climate and development goals.

Whether you are a policymaker, a developer, an architect, an industry professional, a student, or a concerned citizen, this book equips you with the knowledge to understand, advocate for, and participate in the green building movement and offers practical guidance on overcoming barriers, leveraging incentives, and making informed choices—empowering you to be part of the solution.

Why read this book?

- ◐ Understand the principles and benefits of green buildings, tailored to Indian context.
- ◐ Learn from pioneering projects that are setting new benchmarks in sustainability.
- ◐ Discover how individuals and communities can drive demand for healthier, more resilient, and resource-efficient cities.
- ◐ Get inspired to take action – at home, at work, and in your community – to help build a sustainable urban future for all.

Your City, Your Impact is your invitation to reimagine urban living and join the collective journey toward greener, more liveable, and more equitable cities.

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