Green building: case study

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Key messages

- Urban expansion in India is enormous and will place great pressures on natural resources, especially water and the atmosphere.
- There are significant opportunities to reduce these pressures and contribute to human development through green building.
- The regulatory framework for green building, with the adoption of Part 5 of the National Building Code, complemented by voluntary codes and green building rating systems, will provide adequate guidance for the expansion of green buildings in the short-term.
- Standards for resource-efficient building materials need to be developed.
- The capacity to design and construct green buildings needs to be strengthened.
- More information about the actual costs and benefits of green buildings needs to be disseminated.

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Table of contents

Figures

Tables

Boxes

Abbreviations

ADaRSH	Association for Development and Research of Sustainable Habitats
BEE	Bureau of Energy Efficiency
BIS	Bureau of Indian Standards
BMTPC	Building Materials and Technology Promotion Council
BRIC	Brazil, Russia, India and China
CO2	Carbon dioxide
CDM	Clean Development Mechanism
CEB	Compressed Earth Blocks
CIDC	Construction Industry Development Council
CSIR	Council of Scientific and Industrial Research
CSR	Corporate Social Responsibility
DSM	Demand-Side Management
ECBC	Energy Conservation Building Code
EE	Energy efficiency
EEO	Energy Efficiency Opportunity
EIA	Environmental Impact Assessment
EPC	Energy Performance Certificate
ESCO	Energy Service Company
FAR	Floor Area Ratio
FCBTK	Fixed Chimney Bull's Trench Kiln
FDI	Foreign Direct Investment
FiT	Feed-in Tariffs
FYP	Five Year Plan
GBC	Green Building Council
GHG	Greenhouse Gas
HUDCO	Housing and Urban Development Corporation
HVAC	Heating, Ventilation, And Air Conditioning
INR	Indian Rupee
JNNURM	Jawaharlal Nehru National Urban Renewal Mission
LEED	Leadership in Energy & Environmental Design
MCBTK	Moving Chimney Bull Trench Kiln
MNRE	Ministry of New and Renewable Energy
MoUD	Ministry of Urban Development
MTEE	Market Transformation for Energy Efficiency
MW	Megawatt
NAPCC	National Action Plan on Climate Change
NBC	National Building Code
NGO	Non-Governmental Organisation
NIUA	National Institute of Urban Affairs
NREGS	National Rural Employment Generation Scheme
NUSP	National Urban Sanitation Policy
PACS	Performance Appraisal Certification Scheme
PPP	Public–Private Partnership
PV	Photovoltaic (solar panels)
RIDF	Rural Infrastructure Development Fund
SEEP	Super Energy Efficient Program
TERI	The Energy and Resources Institute
UIDSSMT	Urban Infrastructure Development Scheme for Small and Medium Towns
VSBK	Vertical Shaft Brick Kiln
WGBC	World Green Building Council

Executive summary

Introduction

The scale of urban expansion in India is and will continue to be enormous, driven by economic and population growth. The construction and use of buildings, driven by rapid urban expansion, is likely to impose tremendous pressures on the natural environment. Today's infrastructure investments will play a critical role in determining future resource intensity and affect India's ability to decouple resource consumption from economic growth. Urbanisation in India is less advanced than in many other countries, which presents an opportunity to avoid being locked into energy- and resource-intensive infrastructure. The promotion of green buildings, which has already begun in India, offers one way to achieve this.

The German Institute for International Development (GIZ) in India commissioned a study from the Overseas Development Institute (ODI) in collaboration with Development Alternatives in order to gain a better understanding of India's construction sector and the incentives for private-sector investment in green buildings. The aim was to make policy recommendations to enhance the incentives for a stronger, private-sector-led 'green' construction sector in India. The study would also draw on lessons from other countries about policies that foster green buildings.

Why green buildings?

A green building is a sustainable building that has minimal impacts on the environment throughout its life. For the purposes of this report 'green building' is understood to mean construction that makes efficient use of energy and resources in every aspect. This includes the production of building materials, and the design, use and eventual demolition of a building in any sector (commercial, residential, industrial, public buildings) and at all stages, from new buildings to 'retrofitting' or adapting existing ones.

The construction sector, which accounts for 10% of global GDP, has direct and indirect impacts on the environment. It produces 23% of global greenhouse gas (GHG) emissions, and buildings are responsible for between 30% and 40% of all material flows. Adopting green building practices would significantly reduce these environmental and resource impacts.

The life-cycle impact is predominantly in the energy consumed to heat, light and cool a building while it is in use. Over its lifetime, the embodied energy of building materials generally has a smaller impact on the climate. According to the US Green Building Council, the cost and amount of energy required to construct an energy-efficient office building is comparable to that of a traditionally designed structure, but there is a significant difference in operating costs.

Green buildings have other benefits besides the obvious environmental ones. The structures are more comfortable, and people working in them become more productive, which adds to the overall economic gains. The asset values and rents of green buildings tend to be higher than for conventional structures.

In most countries the private sector is responsible for much of the construction industry, including building development, management and the supply of appliances and energy. The private sector thus has a vital role in both financing and producing green construction and creating a market. The private sector can also help to promote positive change in green building councils and industry bodies.

Drivers of green buildings market development

The extent to which the green buildings market will grow is determined in large part by the economic incentives facing developers and property purchasers. Construction companies and property developers will respond to the level of demand for green buildings and the price that property purchasers are willing to pay. As we have seen, green buildings cost more upfront, but save money in the longer term. Thus the scale of the savings should by itself create growing demand for green buildings, if the property purchasers themselves reap the benefits of the energy savings, and if they are aware of the potential savings. The extent of the savings, and thus the exact payoff period, will depend very much on the policy context. Factors like fossil fuel subsidies will reduce the savings made by green buildings, and the regulatory framework and any fiscal incentives will determine the costs and benefits of alternative sources of renewable energy.

Even when there are clear savings to be made, the growth in demand for green buildings can be hampered of lack of awareness of the longer term cost savings, short termism on the part of property buyers, limited access to finance for investment in the upfront costs associated with green buildings, and situations where those who pay the energy bills are not those who purchase the property (in the case of rented property).

The social benefits of green buildings will exceed the benefits to private property owners, given that carbon emissions and other pollution are costs which are not currently factored into prices, which is another important reason why the uptake of green buildings will be less than is desirable. In addition, there may also be constraints on the supply side, if for example, there are shortages of the necessary skills and knowledge in the construction sector, building materials, or energy efficient appliances.

Thus policy has a crucial role to overcome these market failures, and create appropriate incentives that will help to establish a viable market for green buildings. This can be achieved by strengthening the demand for green buildings through mechanisms such as tax incentives (including tax rebates, reduction of fossil fuel subsidies etc.), awareness raising, strengthening access to finance for the purchase of green buildings, procurement policies, and enhancing the reputational benefits associated with green buildings through awards etc. Or it can be achieved by driving change on the supply side: through green building regulations, standards and codes; building the knowledge and capacity of market participants in the supply chain such as SMEs; and enhancing access to the necessary materials, through reducing import duties on appropriate raw materials or appliances for example. Efforts to promote demand and tackle supply side constraints should ideally be made in tandem.

Opportunities and potential for green building in India

In 2011–2012, India's construction sector accounted for 8.2% of the country's GDP, employing 41 million people, and is poised to become the world's third-largest construction sector by 2018. In terms of monetary value, the equivalent of $175 billion was spent on construction in India in 2007. This is expected to increase to $ 370 billion in 2013. Over the next ten years, the sector is expected to grow by 16-17%.

The construction sector has a large and growing resource footprint. It accounts for 30% of electricity consumption in India, growing at 8% a year, and for 23.6% of national GHG emissions, owing mainly to thermal power generation. Electricity consumption for lighting, air conditioners, water heaters and other appliances accounts for 10% of total electricity consumption. Between 45% and 65% of the energy consumption in buildings is for heating, ventilation and air conditioning (HVAC). Energy-efficient lighting and electrical appliances used in residential and commercial buildings could save 20,000 megawatts (MW). Solar photovoltaic (PV) and solar thermal systems would also reduce a building's energy-related emissions. There is potential to reduce GHG emissions by 142 megatonnes (Mt) a year by 2020 and by 296 Mt a year by 2030 through the adoption of energy-efficient measures. The energy embodied in building materials should also be taken into account.

Almost all stages of construction require water, and more is consumed while the building is in use. The significant shortfall in current sanitation and wastewater infrastructure and a growing urban population indicate that that there will be a significant rise in the demand for water related to buildings. The per capita investment needed for water, sewerage and urban drainage is estimated at about $ 285. Despite buildings' high water footprint there has been more focus on energy than on water efficiency.

Materials and equipment generally account for nearly two-thirds of total construction costs. The major construction materials are cement, steel, bricks, equipment and machinery, paints and chemicals, fixtures and fittings, timber, tiles and ceramics, aluminium, glass and plastics. Cement production is expected to increase from 228.3 Mt in 2010–2011 to 600 Mt by 2020. Despite a fall in the emission intensity of the cement industry, in 2007 it generated 129.9 Mt CO_2. The increasing use of blended cement, using fly ash or blast-furnace slag, is contributing to lowering emissions. Some 200 billion bricks are produced each year, generating emissions of 41.6 Mt CO_2. These emissions could be reduced through use of more efficient kilns and of compressed earth blocks. It is estimated that 45% of India's steel output, 85% of paint, and 65%–70% of glass are used in the construction industry.

The market for green buildings in India is projected to grow three-fold between 2011 and 2014, reaching $30 billion. The footprint of buildings certified by the Indian Green Building Council (IGBC) is currently over 1130 million m^2. There is considerable potential for the further promotion of green buildings to reduce the environmental impact of construction and urbanisation in India.

Policy framework for green building in India

Although there is no consolidated law with respect to green buildings in India, provisions in existing legislation and several policy initiatives recognise the environmental aspects of the construction sector. The 12th Five Year Plan (FYP) aims to hasten the adoption of codes relating to green building through the Jawaharlal Nehru National Urban Renewal Mission (JNNURM) and by linking financial devolution to local urban authorities to the implementation of green building codes. The National Action Plan on Climate Change (NAPCC) and the National Mission on Sustainable Habitat address energy efficiency in buildings. The government will promote the Energy Conservation Building Code (ECBC) as an integral component of urban planning, applicable to buildings with a load of 500 kilowatts (kW) or more.

A new chapter on sustainability is to be added to the National Building Code (NBC). The Indian Bureau of Standards and the Building Materials and Technology Promotion Council are addressing building materials production and standards. The Bureau of Energy Efficiency (BEE) is using standards and labelling to increase awareness and reduce the energy consumed by appliances.

There are policies for water use in buildings at the state and municipal levels. Rainwater harvesting, for example, is mandatory in a number of states and cities. Hyderabad and Delhi have set standards for wastewater management.

Voluntary green building rating systems have become a popular tool to encourage the construction sector to adopt sustainable practices. In India, the two main rating systems are the Green Rating Integrated Habitat Assessment (GRIHA), developed by TERI and the Ministry of New and Renewable Energy, and Leadership in Energy and Environment Design (LEED), operated by the Indian Green Building Council (IGBC). GRIHA uses a set of 34 criteria to assess buildings with a floor area 2,500–150,000 m^2, and incorporates all the relevant building codes and standards, including the ECBC, and has been adopted by the government Central Public Works Department. To date, 350 buildings (1.02 million square metres) have been GRIHA registered, and 2,029 buildings registered for LEED India certification.

Other rating systems for green buildings in India are the Small Versatile Affordable GRIHA, developed by TERI and Association for Development and Research of Sustainable Habitats (ADaRSH) for small stand-alone buildings; the Eco-Housing rating system developed for Pune; and the Star Rating Programme for Buildings of the Bureau of Energy Efficiency. The IGBC also has rating systems for homes, townships, special economic zones factories and landscapes.

Most of the certified green buildings in India belong to the government or private companies, and to date there has been very limited residential demand. One limitation of the rating systems is that there is no systematic means to find out whether certified buildings are meeting their intended standards. The variety of rating systems, and potential competition between them, may also confuse consumers.

Challenges for green buildings in India

In the area of policy and regulations, existing laws need to be enforced, including the strengthening of regulatory bodies. There are differences at state level in the adoption of policies for green buildings and no standards for green building materials and technologies. A model energy code for residential buildings, and other measures aimed at residential buildings, could complement the ECBC to focus on buildings where the greatest potential can be realised.

There is a lack of technical capacity for the planning, design and construction of green buildings. There is already a skills deficit in the sector, with only 6% of employees having adequate training and a smaller number of engineers going into construction than previously. Similarly, there is a shortage of contractors and a lack of technical training capacity.

One of the main barriers encountered in encouraging green building practices is lack of awareness of the benefits amongst the users of building. The common perception is that green construction is prohibitively expensive. The public are more concerned about the costs than the sustainability aspects, and seem less aware of longer term savings. Green buildings and green appliances are viewed as a luxury market. The affordable housing sector is completely estranged from the concept. However, there is growing awareness of the benefits of green building and demand is growing slowly, especially in commercial spaces. There is a need for large-scale awareness and capacity-building programmes.

Conclusions and recommendations

The study identified three broad areas for further action: policy and regulation, capacity and skills, and awareness and understanding of benefits.

Policy and regulation

The framework of existing and planned regulations for green buildings in India provides a reasonable degree of guidance for expanding the share of green buildings in the construction sector. The new Approach to Sustainability section of the National Building Code (NBC) needs to be incorporated into state byelaws, supported by the preparation of model byelaws. State byelaws could be made more effective by raising awareness of the advantages of green construction among state and municipal legislators and senior officials.

There will be a need to enforce building regulations, requiring action on the part of state and municipal governments. This could include dissemination of information about performance in meeting standards and performance-linked incentives. Well-targeted financial incentives for green buildings, such as lower local government taxes, would encourage development of the market. The removal of fossil fuel subsidies would substantially strengthen the economic incentives for green buildings.

Voluntary codes and green building rating schemes complement statutory regulations by going beyond the minimum and encouraging good practice. The performance of certified buildings should be assessed or audited. Public buildings can also play a significant role in demonstrating sound practices, procurement of resource-efficient products and for training purposes.

Standards for green building materials and products need to be developed and adopted, including the testing and certification of alternative building materials and rating schemes for sustainable building products.

Greater coordination between financial institutions and re-financing bodies would help to increase the investment funds available for green buildings. The availability of data and analytical tools for lenders would enhance confidence in investment in green building. A streamlining of financial mechanisms for

construction Micro-, Small and Medium Enterprises (MSMEs) through the Small Industries Development Bank of India (SIDBI) could facilitate their access to investment capital.

Capacity and skills

There is a lack of appropriately trained professional personnel, and technical and skilled labour. Skilled construction workers need to have the right skills and experience for green construction. Issues concerning sustainability should be an integral part of all relevant professional curricula, and there should be public certification for professional and technical staff in relation to green construction.

There is a need to develop the capacity to supply green building materials and products, including building supply chains and the use of commercial marketing methods.

Awareness and understanding of benefits

Significant knowledge and data gaps include a lack of empirical information, to allow comparison between conventional and green building costs; detailed data on the energy, water and other resource savings from green construction; availability of consultants and providers who offer green building services and products; and evidence to facilitate investment in financing packages for green building. Improving the availability of reliable information and knowledge about the advantages and disadvantages of green building would better inform stakeholders and the general public and help to diminish misperceptions. NGOs and think tanks can play an important role in filling those data gaps, publicising the information, and undertaking awareness raising and policy engagement activities.

Potential areas of focus for GIZ

Green building is relevant to three of the main thematic areas of GIZ in India: sustainable economic development, the environment and energy. To help address the challenges of expanding the market for green buildings in India, it is recommended that GIZ consider:

- Working with the Small Industries Development Bank of India (SIDBI), and other relevant financial institutions, to improve and streamline the supply of capital finance to MSMEs in the construction sector and building materials industry.
- Working with relevant business associations, including the IGBC, to increase the awareness of green building approaches among MSMEs in the construction sector and building materials industry.
- Working with Indian technical training institutions to improve their capacity to provide skills training for the construction sector (e.g. through curriculum development or innovative training methods), with a focus on green building skills and skills for MSMEs.
- Convening actors in the construction sector and other stakeholders to produce a roadmap for the development of green buildings in India.

1 Introduction

The scale of urban expansion in India is and will continue to be enormous, driven by economic and population growth. By 2030, India is expected to have 68 cities with a population of more than one million, 13 cities with more than 4 million people and six megacities with populations of 10 million or more, with Mumbai and Delhi among the world's largest cities in the world (McKinsey Global Institute, 2010). This rapid urban expansion is likely to impose tremendous pressures on the natural environment. The resource footprint during the siting, construction, and operation of buildings as well as during extraction of building materials is huge. Globally, buildings are responsible for about 30%–40% of all material flows, and in India the construction sector alone accounts for 23.6% of the national greenhouse gas (GHG) emissions (Parikh et al., 2009).

According to the Bureau of Energy Efficiency, two-thirds of India's building stock that will be required by 2030 has yet to be built. The infrastructure investments that are made now will play a critical role in determining future resource intensity, and affect India's ability to decouple resource consumption from economic growth in line with national policy. Urbanisation in India is currently lower than it is in many countries, so there remains an opportunity for India to avoid being locked into energy- and resource-intensive urban infrastructure. The promotion of green construction offers one way to achieve this.

GIZ and ODI are working together to 'provide a stronger evidence base on how to promote sustainable and inclusive growth, and to use that knowledge to support policy development, lesson learning and knowledge exchange which successfully incentivises or supports investment and innovation in green technologies and industries in India'. This includes the production of a number of 'case studies of selected policies, approaches and programmes, supporting their implementation and assessing their impact'.

In order to better understand the construction sector in India and, in particular, the incentives for private-sector investment in green buildings, GIZ in India commissioned ODI, in collaboration with Development Alternatives, to undertake a study of the sector, with a view to identifying areas for policy engagement and lessons from India's experience that might be applicable in other developing countries.

Recognising the inter-relationship between the design and construction aspects of green building, and the goal of promoting resource efficiency generally, the purpose of this study is to identify potential opportunities for GIZ and other stakeholders in India to strengthen a private sector-led green construction sector.

The study is structured as follows. Section 2 summarises lessons from green building experience internationally, with a focus on the advantages and disadvantages of different policy instruments. It reviews two main areas: studies and reports at global level, which either review international standard-setting or provide comparative analysis across countries, and country-specific literature, reviewing the progress of green construction within a particular context. Section 3 provides an overview of green construction in India, and Section 4 summarises the policy tools and instruments being deployed in India to promote it. The key drivers and barriers to further expansion of green buildings are outlined in Section 5, followed by conclusions and recommendations in Section 6.

2 International experience on green buildings

2.1 What is green construction?

The market for green buildings is expanding worldwide. According to *World Green Building Trends* (McGraw Hill Construction, 2013), green building accounts for 38% of the business of the 803 firms in the construction sector covered in the survey, across 62 countries. Amongst the firms in the survey, 94% have some green building work, and they expected green building to increase its share of the overall construction market. The largest market is in new commercial buildings (which accounted for the green building business of 63% of firms in the McGraw Hill Construction survey), followed by the adaptation or retrofitting of existing buildings (reported by 50% of surveyed firms) and new institutional construction (e.g. schools; 45% of firms). Fewer than 20% of the surveyed firms are active in green buildings for low-rise residential use (McGraw Hill Construction, 2013).

Green construction is a movement towards sustainable, energy-efficient and non-toxic building. A green building is a sustainable building which has minimal impacts on the environment throughout its life cycle. Sustainable or 'green building' design and construction is an opportunity to use resources more efficiently, while creating healthier and more energy-efficient homes. For the purposes of this report, green building is understood to mean construction that makes efficient use of energy and resources in all aspects of the built environment life cycle, from materials, design and building use to demolition, and across all sectors – commercial and residential, and new buildings and retrofitting existing ones.

In some contexts, the term 'green building' has a more restricted meaning. UN-Habitat in East Africa has moved away from the term 'green building', because it is seen as being synonymous with a more rigid focus on certification schemes for the commercial sector. There is a big difference between designing a green building and mainstreaming sustainable features across the entire building stock, while recognising that sustainable buildings cannot be promoted as separate agenda but should be integrated with other national development priorities, such as job creation, economic development, health and education (Svenningsen, 2010).

The construction sector has significant potential to make significant and cost-effective reductions in GHG emissions. With proven and commercially available technologies, energy consumption in new and existing buildings can be cut by an estimated 30% to 80%, with potential net profit during the building's lifespan (UNEP SBCI, 2007). Buildings compliant with India's Energy Conservation Building Code (ECBC) are estimated to be 20% to 30% more efficient than conventional buildings (Parikh, 2011). Besides energy efficiency, using recycled building materials saves between 12% and 40% of the total energy used during materials production, depending on the material (UNEP SBCI, 2007). Building design can maximise natural lighting and ventilation, which reduces energy needs and improves the quality of indoor air. These measures have a noticeable impact on the operating costs and result in savings over the building's lifetime.

Green construction and buildings have many benefits, both tangible and intangible, besides the obvious environmental ones. Since green buildings follow sustainable principles, the structures are more comfortable and raise the living standards of those using them. People become more productive

when they work in green structures, thus adding to economic gains (LEED ND, 2006), because the environment is more comfortable and people-friendly. Rental income from green buildings, especially certified ones, are much higher than non-green structures, as are building asset values.

Green construction takes into account aspects of energy efficiency relating both to the use of the building and to the production of the materials from which it is constructed.

The main components of the green building agenda are:

- Sustainable site development and building resilience (planning and land use; minimising environmental impact; suitability of site, design and construction to take account of climatic and natural disaster factors)
- Water efficiency (in materials, construction, operation and decommissioning)
- Energy efficiency (in materials, construction, operation and decommissioning)
- Indoor environmental quality (air, lighting, temperature)
- Reduced consumption of building materials (durability, adaptability, salvaging/re-using)
- Consequent carbon savings

In terms of policy engagement, most of the above factors can be mutually compatible. For example, designing a building to minimise cooling requirements through its geographical location can minimise both energy and material use. There may, however, be a need to make trade-offs (e.g. designing a house with lower air-conditioning requirements might involve using more roofing material).

Priorities need to be established at different stages of the building's life cycle. The impact is predominantly in the energy required to heat, light and cool the building while it is being used since the embodied energy of the building materials generally has less environmental impact over the life cycle. Renewable energy remains a critical component for sustainable housing in terms of climate change mitigation and adaptation. The use of low-cost, local and low-embodied energy materials remains important for sustainable construction, and can support local economic development while also reducing environmental impacts (UN Habitat, 2011). Retrofitting is more expensive and less effective than purpose-built, which is part of the justification for including energy-efficiency measures in building codes (Lausten, 2008).

Benefits of a green building

Environmental Benefits

- Improved air and water quality
- Reduced waste
- Conservation and restoration of natural resources
- Protected biodiversity and ecosystems

Economic Benefits

- Reduced operating costs
- Creation, expansion and shaping of markets for green products and services
- Occupants become more productive
- Optimised economic performance over the building's lifetime

Social Benefits

- Enhanced comfort and health for occupants
- Aesthetically pleasing

2.2 The main actors influencing the development of green buildings

This section categorises the main actors and outlines their respective roles in the market.

Building materials and construction industry

There is a huge variation in the companies engaged in the building supply chain, from land purchasing and development through to materials, construction, building use and decommissioning. The construction industry is vast, diverse and complex. At the global level, most construction is carried out by the private sector, ranging from informal, micro-enterprises to multinational companies. All are influenced by the incentives in the markets they operate, and respond to government regulation where it affects their activities. There are various lists and directories of green building professionals and suppliers, but there are no comprehensive data on the types and size of companies engaging in green building.[1] Improved information would help to reduce transaction costs, improving efficiency and competition, which would help the industry in general (Kalra and Bonner, 2012) and also provide the foundations for improving sustainability. Recognising the diversity of actors within construction and materials production, and the differing incentives and needs of SMEs and of large firms, is key to promoting a commercial market for green buildings.

Government (national and municipal)

Governments are a dominant force in the move towards green building where their main function is to help overcome market barriers caused by the discrepancy between the private costs faced in producing green buildings and the social costs of climate change and social gains of energy efficiency (Nelson et al., 2010). Governments not only provide the policy and regulatory framework for the construction and building materials sectors but are also a major buyer of their services. Central governments can play an important role in fostering capacity by providing the financial means for governments at the state, departmental or municipal level to enact policies, as well as guiding strategies and tools to reduce the costs of enacting such policies, such as technical assistance and model building codes (OECD/IEA and AFD, 2008).

Governments can also lead by example. In India, the government of Himachal Pradesh introduced guidelines for Solar Passive Architecture and government constructions, such as the HIMURJA building in Shimla, and have set a precedent in following the guidelines. Both national and municipal governments can lead by example, retrofitting existing buildings and ensuring that all new buildings are climate-positive (UNEP, 2009). This can both improve the environmental performance of government buildings, and also, if designed well, have demonstration effects on the demand-side and cost-reduction effects on the supply-side, encouraging wider diffusion in the wider economy (OECD, 2003). Governments play an indirect role in promoting demand and developer activity by raising awareness and demonstrating the validity of the concept. By commissioning green buildings, governments can provide the local market with tangible experience of sustainable building practices (Nelson et al., 2010).

Financial institutions

Financial institutions relevant to green construction range from responsible property investors or impact investors who have strong environmental imperatives (even requirements of environmental returns on investments), to commercial actors seeking market-rate returns on individual mortgages or large loans to property developers. Engaging financial institutions requires both data and also cost incentives to invest in green construction, but investment decisions tend to be firmly rooted in short-term economic gains rather than in long-term savings in energy costs (UN Habitat, 2011).

Non-governmental organisations, membership and consumer groups

Green Building Councils (GBCs) are non-profit, member-based organisations seeking to transform building industries by encouraging the adoption of good building practices. Currently, there are some

1 For example, in the UK, although there are comprehensive data on size of construction firms and their areas of work, they do not disaggregate green construction.

60 GBCs around the world in various stages of development. The World Green Building Council (WGBC) is the umbrella organisation with regional networks for Asia–Pacific, Europe, the Americas and Africa (Malanca, 2010). One of the main activities of most GBCs is the establishment of rating tools for green buildings. The GBC, or another third party, usually awards a certificate, which can be used to market buildings. Most such rating systems also have companion professional accreditation programmes, also usually run by GBCs (Malanca, 2010).

The US Green Building Council has attempted to transform the market by identifying critical research needs and fostering research activity. While continual improvement of the LEED rating systems depends on pending research, the context and benefits of funding, conducting and applying such research are much broader (USGBC Research Committee, 2008).

NGOs, civil society organisations (CSOs), consumer groups and the media can help to raise awareness of the benefits of green building. They can also monitor the performance of government and industry in creating and implementing relevant policy, private-sector adherence to regulations, and the impact on particular sectors of the population. Help can be provided through engagement with the state and private sector, facilitating leadership and bridging efforts to support state and private-sector activities (UNEP, 2009).

Research and educational institutions

Research organisations can help to address data gaps and contribute to monitoring and evaluation (M&E) work. Educational institutions can develop the skills required to build green practices into commercial activities, for example through vocational secondary and tertiary education and training for those working in the built environment. In Brazil, a study by Gomes et al. (2007) found that little had changed in terms of coordinating and deepening research activities since 2004, when challenges were identified (e.g. the need for a reliable life cycle analysis database, regionalisation of sustainability assessment and reporting and defined regional performance benchmarks and indicators). This is partly due to lack of political support and lack of coordination.

International organisations

There is a wide range of cross-country and global green building initiatives, alongside multiple programmes and institutions addressing climate change and sustainable and inclusive development, all of which affect green building. Some initiatives are having a positive impact while others have less clear goals and achievements. The Clean Development Mechanism (CDM) has not to date been effective at encouraging the development of low-cost sustainable housing, but the central role of housing in climate mitigation and adaptation is increasingly recognised within the United Nations Framework Convention on Climate Change (UNFCCC) and future reforms of the CDM look set to encourage greener housing projects (UN Habitat, 2011).

The United Nations and national government partnerships have deployed regional-level approaches. UN Habitat established a five-country partnership in East Africa, sponsored by the Global Environment Facility (GEF), to focus on buildings' energy and resource efficiency through codes, policy, practice, housing finance, and across the building sector through reviewing the status quo (compiling data), then raising awareness and helping to leverage finance, as well as providing demonstration projects. The scheme is soon to be introduced in West Africa.

The IFC and the World Green Building Council (WGBC) are collaborating to expand the construction of green buildings in emerging markets, and have announced a Global Partnership to Accelerate Green-Building Growth. The partnership may demonstrate shared commitment to enhancing the built environment and mitigating climate change, but its wider impact remains to be seen.

2.3 Barriers to green building

While the earlier motivation for green buildings across the world was a moral desire to achieve positive social or environmental impact, green building is now increasingly driven by market factors

and seen as a business opportunity (McGraw Hill Construction, 2013). The main benefits to businesses of investing in green buildings are perceived as their lower operating costs and higher asset value. The social benefits of green buildings, in the view of firms covered in the *World Green Building Trends* survey, are improved health and wellbeing, and the environmental benefits are reduced water use, reduced GHG emissions and conservation of natural resources.

Barriers

The construction sector firms responding to the *World Green Building Trends* survey perceive the higher initial cost of green buildings as the principal barrier to investment (McGraw Hill Construction, 2013). Lack of government support and incentives, a principal-agent market failure (when the investor does not receive the benefits of lower operating costs), and lack of public awareness are also seen as barriers. Many obstacles to green building apply across different country contexts, and are problems that are more widely relevant for the construction industry, for sectors producing materials and other inputs to construction, and also for governments. Some barriers relate to hidden costs or benefits and market failure and others to culture, lack of awareness and financial or political capacity (Erten, 2011). A report by Ellis (2011) found that in Egypt, suppliers and developers (in a sector dominated by SMEs and a high level of informality) there was a lack know-how for the identification, procurement and implementation of appropriate energy-efficiency measures (exacerbated by a fragmented supply chain) and the informal nature of the sector discouraged investment in skills and training of the workforce. Table 1 below categorises barriers with examples and possible policy solutions.

Table 1: Barriers to green building and possible solutions

Barriers		Possible Solutions
Categories	**Examples**	
Economic/ financial barriers	Higher upfront costs for energy-efficient technology and lack of incentives to become more sustainable. Costs and risks, transaction costs. Energy efficiency is often not a major concern for consumers or firms. Absence of data on costs or financing gaps limits progress.	Fiscal and economic instruments, e.g. tax rebates, subsidised loans, regulatory instruments, removal of fossil-fuel subsidies, promoting the use of domestic resources (building materials and techniques). Appliance standards, building codes (to overcome high transaction costs), Energy Performance Contracts (EPCs), public leadership programmes. Temporary fiscal tools to promote market change that allows actors to develop real cost benefits.
Political and structural barriers, rule of law	Gaps between regions and national and municipal government, insufficient enforcement, lack of political leadership/interest.	International cooperation and technology transfer, strengthening regulatory bodies, consumer groups and media monitoring.
Behavioural and cultural barriers	Split internal incentives, corruption, loss of traditional knowledge (and resistance to certain materials/techniques), unsuitability of western techniques. High levels of informal construction activity, informal dwellings and land-rights issues, rapid unplanned urbanisation and intense need for housing. Poverty and social exclusion.	Information and voluntary action, training and awareness-raising. Engagement across ministries and non-state actors; regulatory tools to address severe issues, engagement and education programmes, research, data and monitoring.
Information barriers	Lack of awareness of consumers, industry and politicians of potential benefits and specific initiatives. Lack of post-evaluation data, baseline	Awareness-raising and training. Visibility for green building options in the market to give building owners choice. Certification, labelling or other declaration of energy consumption. Subsidies for evaluations, incentives to

	data and monitoring and evaluation (M&E) systems.	facilitate data-sharing, incentives to finance independent research.
Skills barriers	Employers face difficulties finding qualified personnel.	While in many countries policy-makers and researchers have analysed the skill requirements associated with green building, relatively few have made quantitative studies. Certification and national standards could help the private sector to engage in vocational training, for example.

Source: Adapted from (UNEP, 2009); (OECD/IEA and AFD, 2008); *(ILO, 2011); (Laustsen, 2008)*

Since many of the constraints to green building are combinations of the barriers listed in Table 1, addressing them in isolation is unlikely to shift the market. According to Erten (2011), the lack of institutions that oversee the market and coordinate transactions among different actors, and the lack of government investment and financial support because of the lack of commitment to the green building agenda, are likely to be primary barriers.

2.4 Instruments and tools

The section below identifies five types of policy intervention and briefly outlines what they involve and their relative advantages and disadvantages. Annex 3 provides more detail on policy tools in each of the five categories.

Regulatory measures

Regulatory measures used to prohibit or oblige certain processes and products for the construction sector are seen to be effective in reducing GHG emissions from buildings (appliance standards, building codes, energy-efficiency obligations and DSM programmes) (Svenningsen, 2010). Effective mandatory codes, quotas, certification and labelling force minimum standards and can help to foster behavioural and attitudinal change in favour of sustainable construction.

For genuine market transformation, regulations need to be in place for sufficient time to convince actors that meeting standards is a requirement worth addressing comprehensively (OECD/IEA and AFD, 2008). Regulations can quickly become obsolete as industries and construction patterns shift. Adjusting measures and checking on compliance is costly. Moreover, frequent changes reduce their clarity, resulting in inefficient application. Regulatory measures need to be narrow in scope in order to be effective, yet this narrowness can reduce their overall effectiveness. Balancing clarity and flexibility can be achieved through a combination of targets, while allowing freedom in the means to achieve them (OECD/IEA and AFD, 2008).

Economic instruments

Economic instruments, including forms of PPP, cooperative procurement and white certification/trading schemes, can build collaborative efforts to address issues, but require very careful design and monitoring and can be less cost-effective than regulatory tools (Svenningsen, 2010). For example, lack of information and the complexity of procurement procedures impede cooperative procurement, although when they work well, such schemes can increase economies of scale and contribute to developing the market. White certificate schemes can be complex and costly to set up and regulate to ensure relevance and to avoid creating perverse incentives. The issues are summarised in Table 3.

Table 2: Instruments and tools for policy engagement: regulatory measures

Instrument/ Tool	Description	Benefits	Disadvantages	Examples
Building codes	Incorporating resource- and energy-efficiency into existing building codes can be used to set separate building performance levels (walls, roofing, windows, doors), equipment and lighting, while performance-based codes address specific issues, e.g. setting annual energy-consumption levels.	Codes can set standards for the provision of other programmes (e.g. labelling and subsidies) and making part of such codes mandatory can encourage compliance.	Establishing codes can be lengthy and costly, as can updating them, but codes that remain unchanged for a long time become obsolete. Codes are not flexible to market changes, which can limit private-sector innovation and adaptation.	Most countries have building codes. Their effectiveness varies based on compliance and enforcement structure. **Germany** is seen as one of the few countries where codes cater effectively to both new and existing buildings.
Energy-efficiency obligations and quotas	An energy-efficiency obligation (EEO) is a regulatory mechanism that requires obligated parties to meet quantitative energy-saving targets by delivering or procuring eligible energy savings produced by implementing approved measures.	EEOs can achieve cost-effective energy efficiency, reduce energy bills, and stimulate the development of cleaner energy.	Establishing effective structures and implementation mechanisms can be difficult and costly. Relevant bodies need to have powers to enforce compliance. Publically available information on schemes helps monitor success. Mechanisms need to be sufficiently flexible for companies to meet targets.	The **UK** has two programmes setting mandatory carbon-reduction targets for retail suppliers of electricity and natural gas and for electricity generators: the Carbon Emissions Reduction Target (CERT); and the Community Energy Savings Programme. The programmes have significantly improved energy efficiency but the model leads to higher costs and a lack of coherent delivery.
Mandatory certification	Certification of energy and resource efficiency, usually post-construction and of existing buildings (see below re: voluntary certification schemes)	Provides information about building performance. For new buildings, certification can demonstrate compliance with national building regulations and provide incentives to achieve better standards.	If prospective purchasers and tenants come to regard an energy certificate as important to their decision-making, owners will have greater incentive to make their buildings more energy-efficient. Mandatory building certification is more expensive than labelling of appliances.	**Singapore** has a green-labelling scheme for water efficiency. Domestic water consumption fell from 165 to 160 litres a day from 1999 to 2005. Since 1997, energy certification in **Denmark** has been mandatory for smaller buildings at time of sale, and at regular intervals for large buildings. Data are reported to a central register and used to develop policy for energy efficiency in the entire building stock.

Mandatory audit programmes	Mandatory audit and energy management in commercial, industrial or private buildings is usually subsidised by the government. Financing such audits is a big challenge.	Auditing can help improve building energy efficiency and sustainability in a targeted way.	Audits become less effective if the suggested improvements are not subsidised/ supported. Audits can be costly.	In the **USA**, 0.1 million homes are annually upgraded as a result of auditing with financial support from the federal government.
Mandatory labelling and appliance standards	Labelling programmes are extensively used in most of developed countries and lately in countries like Brazil, China, India and South Africa. Labelling is often combined with appliance standards. They are often not mandatory (see section below)	Limits customer choices to more efficient technology, ensuring adoption.	Can be inflexible (in the USA, they have not been updated regularly and as a result, standards are not high).	A programme was introduced in 1998 in **Japan** for the energy-conservation standards for new home/office appliances. The programme requires close collaboration with industry, as it imposes technical and economic constraints on manufacturers. Non-compliance results in investigation, although no enforcement actions have been made to date.
Utility demand-side management (DSM) programmes	Utility-sponsored programmes that increase energy efficiency/water conservation and include planning, implementation and monitoring activities from advice, auditing, informative electricity bills, education campaigns, etc. The government provides financial incentives, e.g. allowing companies to recover revenues lost to reduced energy consumption.	Successful DSM programmes combine some or all of the following levers: rates, incentives, access to information, utility controls, education and marketing, and customer insight and verification.	Beyond rates-based levers, firms need to be incentivised (or compelled) to engage, which can be costly.	In **Japan**, private firms propose incentives to implement energy-conservation improvement measures. Utilities motivate consumers by offering low-interest loans through tie-ups with private banks when consumers renovate existing houses. Utilities also offer a reimbursement programme for consumers to install energy-efficient appliances. The government provides subsidies to energy service providers to work with local governments.
Procurement regulations	Provisions for energy and water efficiency in the public procurement process.	Likely to be particularly effective in countries with large share of the public sector.	Requires public-sector resources and development of relevant expertise, and designed to provide value for money. Life-cycle costing may not fit with short political cycles.	**Mexico** has an extensive bottom-up scheme supporting municipal governments, federal agencies, and other local organisations to improve energy efficiency through procurement and public-sector energy management. It covers more than 30 cities and provides support to develop procurement policies tailored to cities' specific needs.

Sources: Zia and Kochnar (2010); McGrory et al. and UNEP (2012); OECD/IEA and AFD (2008); Davito et al. (2010); EIA (2005); Laustsen (2010); Gillingham et al. (2006); Joshi (2012)

Table 3: Instruments and tools for policy engagement: economic measures

Instrument/ Tool	Description	Benefits	Disadvantages	Examples
Performance-based contracting (EPC) and Energy Service Companies (ESCOs)	An Energy Performance Certificate (EPC) focuses on developing performance metrics and performance-related payment to and guarantees future savings in energy demand to finance practical, engineered plant improvements. Most ESCOs prefer to use the guaranteed savings model by which the ESCO guarantees a certain level of energy consumption savings and thus shields the client from any performance risk.	EPCs allow organisations to reduce financial risks associated with energy consumption, use ESCO design, implementation and financial resources to improve buildings' energy efficiency and reap guaranteed cost savings. ESCOs can guarantee the results and take on the performance risk, funding the improvements from the savings they provide. ESCOs and EPC projects can be a crucial component of the rapidly expanding or emerging utility DSM programmes and a major trade ally in selected market sectors for administrators of ratepayer-funded energy-efficiency programmes.	ESCOs need to be experienced in measurement and verification processes. Resistance of building owners to undertake any long-term debt obligations both because few industrial customers have the economic security to commit to a long-term EPC contract, and because industries seldom buy turnkey projects like EPCs.	In **Germany** and **Hungary**, public procurement rules are sometimes difficult to understand and to deal with and require competent administrative officials, who are seldom available in many small towns. There are no specifications for EPC in the public tendering process in **Greece** and no proper definition of EPC or third-party financing. The same problem exists in **China**. High transaction costs for the preparation of contracts are an associated problem in **Germany** and **India**. In Germany, legal uncertainties about the ownership of buildings as well as the cost-sharing between tenant and landlord in EPC projects complicate EPC in the residential sector ('split incentives'). In the **UK**, where energy suppliers are obliged to promote customer energy savings, the success is limited as consumers do not believe that energy suppliers are interested in reducing energy use and fear an energy audit will be used to sell other products.
Cooperative procurement	A cooperative purchasing agreement is a formal undertaking between two or more entities that they will jointly enter product purchase orders.	Cooperative procurement can increase economies of scale, reducing unit and shipping costs and making sustainable measures more affordable.	Two barriers are lack of information and the complexity of procurement procedures.	Examples found were in the USA and not specific to green building.

White certificates/EE certificate schemes	White certificates certify that a certain reduction of energy consumption has been attained – both an accounting tool and a tradable commodity.	Allows obliged market actors who face problems in fulfilling energy-saving targets (e.g. due to increasing costs in their customer base) to certify savings or import white certificates generated elsewhere. For voluntary markets for white certificates, links to emission markets could be an early stimulus. Can also be a tool for corporate social responsibility (CSR).	Initial property rights over a white certificate and basing on first-year savings only can provide disproportionate outcomes for different actors. Regulating schemes can be expensive and setting them up can be complex.	The Regional Greenhouse Gas Incentive (RGGI) in the **USA**, which now extends to ten states, is the leading regional effort in the USA to cap GHG emissions from the power sector. One of its key achievements is the creation of a formal consumer allocation of carbon credits (allowances).

Sources: eu.bac (2011); Bertoldi and Rezessy (2009); Lees (2006); ICF (2007); Ürge-Vorsatz et al. (2007)

Fiscal and incentive-based measures

Fiscal instruments and incentive mechanisms including grants, loans, subsidies and taxation, can lower the costs of energy- and resource-efficiency measures and can be effective, but also more costly, than instruments that push up the price (Svenningsen, 2010). Aligning fiscal incentives to other tools can also be effective – fiscal incentives for energy-efficient buildings on the basis of national baselines and aggressive standards attach an increased property market value to such buildings and develop knowledge and capacity from corresponding tax revenues (Svenningsen, 2010).

Grants may not be sustainable over the long term but can be an appropriate means to fill short-term gaps and address temporary market issues. They can also provide a demonstration effect and build supply capacity in a way that can stimulate a longer term market response. Effectively targeted taxes and subsidies can create strong incentives towards better practice, driving demand and supply. For example, short-term subsidies for LED light bulbs created rapid market demand in Ghana.[2]

2 'There was an energy efficiency drive after 2007 energy crisis resulting in a systemic switch from high energy to low energy light bulbs across the country. The first batches of light bulbs were distributed free with regulation put in place to ban the import of high-energy bulbs. Thus regulation and a one off subsidy have achieved nationwide change.' (Cameron, 2011)

Table 4: Instruments and tools for policy engagement: fiscal and incentive-based measures

Sources: OECD/IEA and AFD (2008); Clinton et al. (1986); EIA (2005b, 2005c); OECD (2003)

Instrument/ Tool	Description	Benefits	Disadvantages	Examples
Grants and subsidies	National or local government financial incentives – can be provided to a wide range of actors for diverse products and services promoting green building.	Grants and subsidies can fill an immediate financial gap, allowing a temporary shift in the market. By targeting specific measures or appliances, they also send clear messages to customers. Training and information programmes operating alongside grants programmes can help sustain change after the programme finishes.	Low sustainability – often once a grant programme is finished, there is no sustained change in the market. Longer implementation of grant programmes can make these costly.	In **Japan**, the introduction of energy-efficient equipment to residential buildings is subsidised up to a third of the cost of installing energy-efficient appliances and efficient renewable-energy systems. Providing direct funding through the State Energy Programme is important in the **USA**, without which states would be limited in implementing energy-efficient measures, although variations in annual funding amounts add uncertainty.
Preferential loans	A government-sponsored (below market rate) loan to stimulate investment in underdeveloped market areas. Preferential loans are a form of public–private partnership (PPP).	Preferential loans administered by private actors appear more flexible and able to adapt rapidly to changes in the market. The combined forces of the public and private sectors appear to deliver cost-effective policy instruments.	Loans can distort markets in ways that do not necessarily justify the cost, e.g. through being unsustainable once the concessionary loan period is over.	Preferential loans have been used by a large number of applicants in both **Japan** and **Germany** for improvement work that increase building EE. PPPs can potentially encourage a sustainable shift in the market for housing loans that favours energy-efficient refurbishments. In **France** and **Japan**, an increasing number of loan products include energy efficiency in their provision conditions.
Taxation and tax exemption, rebates and credits	Income-tax credits or property-tax rebates (e.g. for solar-water heating, rainwater harvesting and solar lighting in some Indian municipalities).	Tax incentives can target a financial-liquidity barrier, and offer incentives that create demand for energy-efficient goods.	Taxation schemes often lack clarity and are poorly explained to the public. Updates to account for new energy-efficient measures and equipment are slow.	Tax incentives can target a financial-liquidity barrier, e.g. reductions in VAT rates for energy-efficient installations in **France**.

Sources: OECD/IEA and AFD (2008); Clinton et al. (1986); EIA (2005b, 2005c); OECD (2003)

Voluntary approaches and partnerships

Voluntary approaches can be developed and provided by governments, the private sector and combinations of different actors. Unmonitored voluntary approaches are typically cheaper than developing and ensuring compliance with regulation and can provide greater flexibility for actors to develop their own solutions, focusing on things that are most relevant (and achievable) in their sector. Voluntary approaches can promote partnership, which can be a resource-efficient approach to achieving good practice and change.

In Brazil, however, non-mandated labelling caused 'greenwashing', as meaningless labels multiplied and it was not until mandatory minimum standards were established that schemes became more effective (Gomes et al., no date). As with the US Energy Star Program, it seems that a voluntary approach can be useful when initiating a scheme but that to ensure wider compliance at least some components of the programme need to be mandated or incentivised through fiscal measures. These issues are summarised in Table 5.

Table 5: Instruments and tools for policy engagement: voluntary approaches and partnerships

Instrument/ Tool	Description	Benefits	Disadvantages	Examples
Voluntary labels	Non-mandated labelling schemes, including firm-level and industry-generated schemes.	Cheaper to enforce, greater flexibility.	In Brazil 'a huge wave of greenwashing has accompanied the certification euphoria, and meaningless labels are cascading and being multiplied in short periods of time'.	Voluntary labelling schemes for appliances have been applied in **Brazil** since 1984, and have been seen to help stimulate national manufacturing of energy -efficient equipment. The **US** Energy Star Program was introduced as a voluntary labelling programme to facilitate identification and promotion of energy-efficient products. It now covers major appliances and new homes, commercial and industrial buildings.
Voluntary assessment systems and ratings tools	Optional performance targets ('credits', organised by environmental categories such as energy, water, materials and indoor environmental quality) for a wide range of building initiatives. Credits use metrics and compliance with international standards to gauge performance and minimise subjectivity. Buildings are not meant to achieve every credit. The aim is to achieve enough to receive a rating.	Rating tools are at most effective when evaluating objective criteria with specific measureable outcomes. Environmental data lend themselves to these kinds of metrics, whereas social metrics can be harder to measure.	Where government codes determine the minimum levels of building performance, rating tools set the highest thresholds. By rewarding market innovators, they stimulate competition and create market differentiation. Compliance with guidelines can be used to confirm credibility with investors. Very few existing rating schemes are designed to reward low-cost building technologies or low-cost housing needs.	A building's operational performance is not reassessed by the **UK's** BREEAM labelling scheme once the building is operational so certification does not convey information about the empirical performance of the building. With BREEAM an assessor is assigned to and paid by the project, which raises concerns about corruption and conflict of interest. LEED is a US-originated voluntary, consensus-based national rating system with a separate tool for continuing operations, re-certificating every 3-5 years. The **South African** Green Star rating system is unique in having tools for each sector (based on who has control – owner or tenant) and environmental weightings (to allow for variance between sectors and regions).

Sources: Gomes et al. (n.d.) ; Malanca (2010) ; UN-Habitat (2010); Chegut et al. (2012); Energy Star (2007); EPA (2007); OECD/IEA and AFD(2008)

Information and capacity-building

Many of the tools above focus on fostering demand. Supply is also important and there is a need for policies which promote sustainable construction throughout the built-environment professions and beyond, for example in materials construction and energy supply. Government and private entities, such as academic institutions or employers, can provide skills and training programmes, and policy measures can encourage their uptake – bursaries and grants, support to professional bodies to raise awareness, PPPs to finance vocational, on-the-job skills upgrading.

Both the government and the private sector can also play active roles in public leadership and awareness programmes, improving the reputation of green building and ensuring public knowledge of schemes that could promote engagement in the sustainable construction agenda and green building suppliers. Unless the relevant actors understand policies and measures they are unlikely to be effectively used and implemented (OECD/IEA and AFD, 2008). The issues are summarised in Table 6.

Table 6: Instruments and tools for policy engagement: information and capacity building

Instrument/ Tool	Description	Benefits	Disadvantages	Examples
Public leadership and awareness programmes	Government and company-led initiatives to promote consumer awareness.	Public (consumer) engagement in green building is an important part of creating markets, and awareness-raising also helps to disseminate information about existing support and incentives. Effective public-awareness programmes, combined with consistent policy approaches, can help to change consumer and supplier behaviour.	Public-awareness programmes can be expensive and may be ineffective if policy is not consistent. Leadership requires clear progress, either in procurement for government, or across green building firms and energy providers, for example, if sound practice is to trigger wider change.	The move of business tenants towards 'green' real estate in the **UK** is due to enhanced reputation benefits, CSR mandates and employee productivity. Shifting preferences suggest that tenants are using buildings they occupy to convey their corporate vision to shareholders and employees. Earlier domestic energy-audit and information programmes had limited impact on homeowners in the **USA**; low participation rates, limited potential for cost-effective conservation and ineffective marketing were some of the causes. Information measures, e.g. on-site workshops, auditor training and targeted information campaigns were deemed more useful.
Skills and training	Curriculums and courses to provide relevant training at secondary and tertiary levels.	Trained professionals can use their expertise to maximise support for green building by both understanding sound practice and through strong knowledge of available tools and incentives.	If skills-development and training are not demand-driven, jobs may not be available to people with specific skills that are less widely recognised within the materials and construction industries.	In **Brazil**, a prominent bottleneck is seen to be education and training. The lack of professionals who not only know what to do, but are confident enough to use their knowledge to solve problems, is likely to hamper uptake in the near future.

Sources: Nelson and Rakau (2010); Gomes da Silva et al. (2007); Clinton et al. (1986); Chegut et al. (2012); Turban and Greening (1997); Margolis and Walsh (2003)

2.5 Policy lessons from international experience

Policy packages, coordination and consistency

No policy can exist or function effectively in isolation. Policy tools work best as packages, and ideally need to operate across the categories of regulation, voluntary approaches and awareness-raising ('carrots, sticks and tambourines') (Svenningsen, 2010).

For example, Germany has been successful in raising the profile of sustainability and encouraging market changes using a combination of instruments, including below base rate mortgages, grants, tax exemptions, budgetary allowances and concessional loans (Zia and Kochhar, 2010). Similarly, a review of Australian policy measures on green building demonstrated the long-term advantage of simultaneously addressing the initial cost barrier, information failure, and training failure of the financier (T'Serclaes, 2007).

Policy packages must be coherent in order to be effective. Coordination of different policy instruments is necessary to ensure their effectiveness, the economic efficiency of policy packages and public acceptance (OECD, 2003).

In Japan, energy efficiency in residential buildings is promoted through cross-ministry collaboration through the Energy Conservation Law. The strength of this arrangement is that it seeks to promote a mix of policies, from mandatory to voluntary measures, while emphasising the potential of PPPs. It has the potential to encourage sustainable policies which have a horizontal impact across the economy (OECD/IEA and AFD, 2008).

The green agenda in the UK has suffered in the last few years owing to government indecision (e.g. over proposed higher standards for energy efficiency in new homes3), or premature policy alterations (alterations to the solar feed-in tariff prior to the completion of consultation4) leading to lack of trust in the stability of the green markets, and the apparent ineffectiveness of flagship policies (low uptake of home energy-efficiency financing under the Green Deal5).

Policy development and political will

The way in which policy tools are developed and implemented can be key in terms of relevance, uptake and impact. In the USA, federal and state actors often collaborate with industry professional bodies and NGOs in developing and implementing policies. This has both advantages and disadvantages. States can develop and implement measures adapted to local conditions, which can result in policies that are clearer as well as more flexible and sustainable. However, the absence of a comprehensive, mandatory national-level approach to energy efficiency has allowed some states to fall behind in terms of taking appropriate measures to encourage energy-efficiency improvements in existing residential buildings – especially regarding building codes, as several states either have no mandatory residential building codes or the codes they have are rather lax (OECD/IEA and AFD, 2008).

In Singapore, a green building master plan, developed by the Building and Construction Authority, aims to bring 80% of the buildings up to the Green Buildings Mark standard by 2030. Strong private leadership and national support (which includes subsidies for buildings and high standards for public buildings) have been important drivers for green buildings and energy efficiency (Laustsen, 2010).

The degree of state engagement in the green building agenda has an impact on both policy development, but also policy uptake and compliance (UN Habitat, 2011; Erten, 2011; Nelson et al., 2010). Strong political will is required for construction to become greener and problems can arise where politicians see the sustainability agenda as competing with other policy priorities (national economic development, job creation, state benefits) rather than potentially complementing them.

3 http://www.guardian.co.uk/environment/2013/feb/18/zero-carbon-home-housing-industry

4 http://www.solarcentury.com/uk/supreme-court-rejects-governments-solar-appeal/

5 http://www.bbc.co.uk/news/business-23081896

In terms of compliance, clarity of requirements and capacity for monitoring are important, and are not the exclusive domain of the state to develop and provide – it can be useful to collaborate with key non-state actors in industry as well as CSOs and the media.

Engaging with the private sector

The state is usually central to creating the incentives and compulsion to push for green building, but it is the private sector that is responsible for much of the construction industry in most countries, and for building development, management and the provision of appliances and energy. As such, the private sector has a vital role in both financing and providing green construction. The creativity and resources of private actors is needed to bring about wide scale impacts and durable market transformation (de T'Serclaes, 2007).

The private sector can also foster change through green building councils and industry bodies. In Brazil, sustainability is not mainstream business and technology is often seen as specialist and is usually imported. LEED ratings standards (see Annex 3) have helped products already on the market to improve their sustainability credentials but there is still a need for improved supplier selection. One way to achieve this is through key construction industry bodies following the lead of the Brazilian Association of Architectural Practices, responsible for over 65% of development design in São Paolo, which has created a sustainability structure and is contributing to public policy development on land use restrictions, design approval by performance assessment and criteria and regulation of certificate and labelling schemes, and progressive tax reduction (Gomes et al., no date).

It can also be important to offer relevant support to the private sector – telling the construction industry what to do is likely to be less successful than providing guidance and technical assistance, knowledge and evidence.[6]

It is important to address the fact that much of the construction sector in developing countries operates in the informal sector to ensure that skills training, job quality and health and safety issues are properly taken into account. Professionalising the construction sector through both skills and training, and regulation on health and safety, could also contribute to ensuring that workers identify with and engage in the green building agenda.

Creating a market for energy and resource efficiency

Lasting changes in construction occur through the demand-driven development of a market for resource- and energy-efficient tools, skills, technologies and materials. Yet such markets today remain very rare (T'Serclaes, 2007), and where they do exist they are weak and perceived as too risky (OECD/IEA and AFD, 2008). Enlivened demand and actors' competence in energy efficiency would strengthen markets (Urvoas, 2006). Although investors need more certainty to invest, enhanced demand will also push them to design appropriate tools (T'Serclaes, 2007).

Private actors are pivotal and because those required to develop the market will not enter it because of its current weakness, there is a key role for public policy to trigger and strengthen the market and the role played by public and private actors in transforming it. Some literature suggests that soft instruments (e.g. private-sector voluntary agreements, labelling, training and information provision) are important to strengthening the green building market. Others provide examples of policy approaches using both soft and hard tools. For example, the European Union (EU) is aiming to promote market transformation through policies combining regulations for member states and voluntary agreements with manufacturers and regulations to improve the energy efficiency of equipment and appliances (OECD/IEA and AFD, 2008). In Japan the most sustained policies, which focus on building and appliance standards, have proven effective and have continuously expanded their applicability. They appear to be sustainable, having instigated a shift in building practices and appliance manufacturers (Ashina and Nakata, 2007).

Uncertainties characterising the valuation of future energy savings and the appropriate discount rate to be used, make it risky for private investors to mainstream energy-efficient loans. Public policy has

6 Interview with Vincent Kitio (UN Habitat), June 2013.

played an important role in reducing the risk to investors, e.g. the diffusion of housing loans has been induced by PPPs, and supported by quantification methods for energy savings most often developed by regulations. Even voluntary labelling schemes that can affect loan provision, such as home energy labels in Japan and France, have been government-led initiatives (OECD/IEA and AFD, 2008).

Financing green construction

Two broad issues affect the financing of green construction – first, understanding the finance gaps, such as by auditing developer costs to know what is the financial shortfall to build green (i.e. what are the additional costs and shortfall to meeting them, if any), and then be able to address it (Kalra and Bonner, 2012). Second, to identify and attract finance to fill these gaps.

Although there are savings for the state, industry and consumers from building green, the initial costs can be prohibitive, especially when combined with uncertain and/or long-term returns. Methods to quantify benefits, the small size of the investments, difficulties in standardising investment, and the continuing debate on the nature of the discount rate, still discourage investments in energy efficiency (T'Serclaes, 2007).

One solution is to establish appropriate public–private finance mechanisms including revolving funds whereby projected savings from more energy-efficient buildings support investments to make new and existing stock energy-efficient. Upfront capital from developed countries provided on favourable conditions could be linked to technology-transfer agreements, and carbon finance could be used to support energy-efficient buildings (Svenningsen, 2010). Neither markets nor public intervention will overcome the financial barrier alone. Most financial measures to address specific obstacles – such as the initial cost barrier – exist in the absence of a common framework for green building investments, while investors' subsequent scepticism hampers the adoption of existing tools (T'Serclaes, 2007).

Investment in green buildings is held back by exaggerated assumed cost premiums and a range of barriers that range from financial constraints to the fragmented structure of the industry (Erten, 2011). The need for a long payback period leading to low rates of return on investment in the face of preference for investments offering quick returns (especially for retrofitting projects) is a constraint on private investment (Erten, 2011). Cost–benefit analysis is not easy in the context of green building, evaluation methods are not clear and it is difficult to evaluate energy-efficiency projects due to the absence of standardised measurements and verification of energy efficiency (Erten, 2011).

Monitoring and data

Even in developed markets the lack of data restricts investment and growth in the green building sector (UNEP, 2010). There is 'a chicken-and-egg situation' in terms of increasing finance for green construction whereby investors are keen but need data to support investments, but the lack of investments restricts the data available (UNEP, 2010).

Establishing a framework to regularly monitor the environmental performance of the building sector not only enables governments to set out quantified policy targets in the sector-based strategy, but also provides policy-makers with information to help them reform policy instruments (OECD, 2003). Data are vital to identifying policy priorities and developing appropriate tools. Many policy instruments are unlikely to remain effective without fine-tuning based on monitoring results. Monitoring frameworks needs good time-series data rather than ad-hoc measurements of environmental performance (OECD, 2003).

Supporting collaboration, innovation and technology

A key constraint to progress is often the lack of collaboration among actors (Kalra and Bonner, 2012), in the private sector (e.g. industries finding ways to share good practices to promote the sector) and also across government departments. Policy development is part of this collaboration, but the private

sector in particular could be encouraged to collaborate further (including in developed countries like the UK[7]).

Effective use of technology is also vital. At the high-tech end, engineering software to simulate effectiveness of green construction approaches can both accelerate and reduce the costs of green construction. Equally, promoting alternative technology can be important to achieving context-relevant solutions, as in the case of locally developed soil-stabilised block technology in Kenya, which is more appropriate – cost-wise and for the way the Kenyan construction industry is structured – as opposed to imported technology from South Africa.[8]

Targeting areas of green construction

Obtaining data on different components of the construction industry may be a challenge, but addressing specific issues in different parts of the industry, using appropriate tools and approaches, is likely to lead to better results. The main areas of construction – commercial and residential – can usefully be broken down, and comprehensive analyses of, for example, the potential to improve the sustainability of the affordable housing sector, or of high-end commercial buildings, can promote effective, tailored engagement to stimulate change. It is also important to consider targeted approaches to technology and materials use, or to engagement with particular groups of actors.

Awareness and public profile for green construction

Raising the public profile of green construction, including across related industries, is in large part an education and knowledge-sharing process, tackling biases, both in terms of knowledge and also against particular technologies or building design approaches.

Moreover, while there can be an additional costs associated with building green, the cost premium is typically lower than is perceived (World Green Building Council, 2013). Studies show a pattern of green buildings being able to attract tenants more easily and to command higher rents and sale prices.[9] In markets where green has become more mainstream, there are indications of emerging 'brown discounts', where buildings that are not green may rent or sell for less (World Green Building Council, 2013). It is critical to disseminate research findings, and to engage key actors as part of building the evidence base for green construction.

7 Jeremy Watson, Director of Global Research at Arup, speaking at Oxford Brookes on 11July 2013 on 'Opportunities for research and innovation in the built environment: a view from public and private sectors'.

8 Ripin Kalra, interview 12 July 2013.

9 A study matching publicly available information on the addresses of Energy-Star and LEED-rated office buildings to a commercial data source detailing the characteristics of US office buildings and their rental value and analysing the micro data on 694 certified green buildings and on 7,489 other office buildings located within a quarter mile of the certified buildings. It found systematic evidence that rents for green offices are about 2% higher than for comparable nearby buildings, and that effective rents, i.e. adjusted for the occupancy levels in office buildings, are about 6% higher in green buildings. At prevailing capitalisation rates, conversion of the average non-green building to an equivalent green building would add more than US$5 million in market value. These findings are robust due to the statistical models employed (Eichholtz et al., 2008).

3 Construction in India

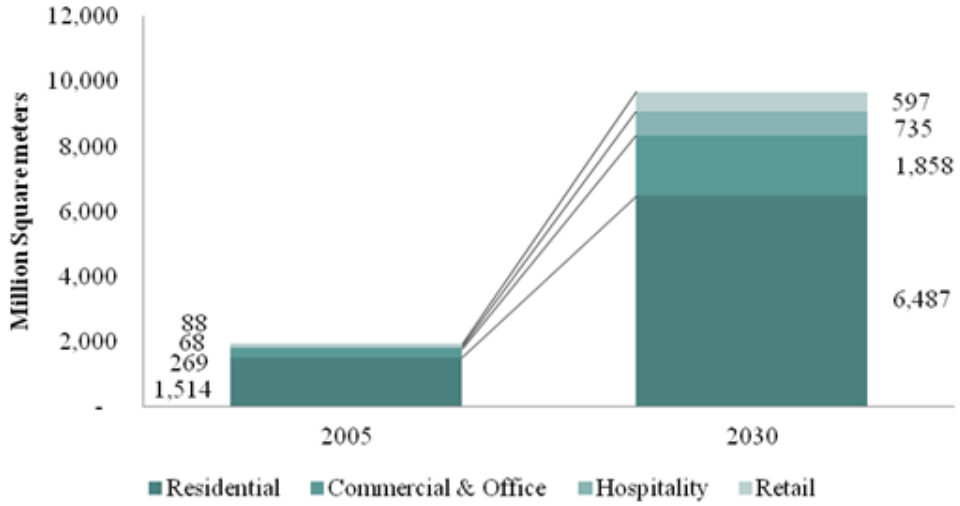
3.1 Urbanisation

India is currently witnessing a construction boom owing to rapid urbanisation and the increased housing and infrastructure needs of a growing population. The urban population has grown by 3.35% a year since 2001, and 31% of the total population now live in India's towns and cities, 370 million people. The urban population is expected to increase to about 600 million by 2030 (Census of India, 2011). Currently, much of this urbanisation is occurring in small cities and towns, and the number of towns increased from 2,774 in 2001 to 7,935 in 2011(Census of India, 2011). By 2030, the populations of Gujarat, Karnataka, Maharashtra, Punjab and Tamil Nadu will be predominantly urban (Sankhe et al., 2010).

According to a report by Pricewaterhouse Cooper (PwC), *Global Construction 2020*, India is poised to become the world's third-largest construction market by 2018. The sector accounted for 8.2% of national GDP in 2011–2012 (Ministry of Finance, 2013), and its growth is expected to remain strong over the 12th Five-Year Plan (FYP) period (2012–2017), as a result of the government's commitment to improving the country's infrastructure. The Planning Commission of India has proposed an investment in infrastructure valued at around $ 1 trillion in the 12th FYP, double that in the previous FYP (2007–2012). It is projected that this will push the construction industry to grow at a 16%–17% compound annual growth rate (CAGR) over the next decade (Planning Commission, 2013).

Major growth will be seen in residential and commercial construction. Figure 1 shows the predicted increase of 4,972 million m^2 in residential area between 2005 and 2030. A similar trend is predicted for commercial buildings. Demand for commercial property has increased to meet the needs of businesses for offices, warehouses, factories and other industrial buildings. Construction activity in the residential market is driven by the growth in the number of nuclear families and the rising urbanisation rate, as well as government support and state investment in affordable housing schemes. The growth rates in hospitality and retail sector are also high although their total areas are relatively small (Parikh, 2011).

Figure 1: Future trends in the building sector in India



Source: CWF, 2010

According to IHS Global Insight, $175 billion was spent on construction in India in 2007. Of this, $140 billion (80%) was on non-residential (industrial and commercial) buildings, and $35 billion (20%) was on residential construction. Construction spending is expected to rise to $370 billion by the end of 2013, with residential totalling $63 billion (17%) and non-residential registering $307 billion (83%) (India Construction, 2 009).

Although the value of investment in commercial buildings is higher than for residential construction, the total commercial building stock has a much smaller physical footprint, representing roughly 660 million m^2 and accounting for 8% of the energy use whereas the residential floor space is estimated to be around 8 billion m^2 (India Bureau of Energy Efficiency, 2009). Nevertheless, there is a housing shortage of over 60 million units across the country, including 26 million in urban settlements. With 75% of India's urban population in low-income groups, the need for low-cost housing is expected to increase from 25 million units in 2007 to 38 million in 2030 (Sankhe et al., 2010).

Addressing the current housing shortage and meeting future demand, together with the likely need for reconstruction due to property damage caused by climate change, will drive growth in the construction sector. To boost the development of urban infrastructure across the country, the government has initiated a number of measures, such as the Jawaharlal Nehru National Urban Renewal Mission (JNNURM), the Bharat Nirman Initiative, the Urban Infrastructure Development Scheme for Small and Medium Towns (UIDSSMT), and the Rural Infrastructure Development Fund (RIDF). The JNNURM stipulates a smaller target of 1, 00,000–200,000 residential units a year, but this will cover only 1% of the housing shortage (Ministry of Housing and Urban Poverty Alleviation, 2011). In addition to these government initiatives, which are increasingly focused on encouraging banks to fund PPP projects, private developers are also venturing into the affordable housing segment of the market. Leading players in the real-estate business, for example, have recently unveiled plans to build houses costing about INR 20 lakh (around $32,500) per unit.[10]

Actors

In 2011, there were 31,000 enterprises in India's construction sector, 95% with fewer than 200 employees. Only 350 enterprises employed more than 500 people (Planning Commission, 2013). Rural home-owners, with the help of a mason, often build their own residence. In urban areas home-owners may do the same thing, but draw on the services of an architect or contractor.

Providers of building material and services can offer their products and services directly to the homeowners, often via the contractors or project managers in urban areas. Alternative material and technology providers are slowing entering the market with energy and resource-efficient options, but the supply chain for the MSMEs servicing the sector is not well developed. Current barriers are the pioneering costs of technology and the opportunity cost of moving away from the conventional technology.

Project managers are primarily found in urban areas, where they play a liaison role between design and construction. Sensitisation and capacity-building at this level are important to ensure that the green design elements prescribed by the architect are observed. Architects and engineers can shape the green building movement as they are the face of the value chain to clients, whether developers or homeowners. The onus of creating awareness of the need and benefits of green buildings lies in part with this group to convince their clients to adopt green practices.

Two other actors not directly involved in construction, but who play a significant role in the sector, are the government and the financial institutes. The municipal regulatory authorities have an oversight role in ensuring that the buildings conform to existing codes and guidelines. At a central level, the government develops these codes and guidelines such that they incorporate green features. Financial institutes like banks are playing a growing part in the value chain by enabling easy access to finance through home loans. The central and state government through the medium of banks disburse subsidies for social housing schemes.

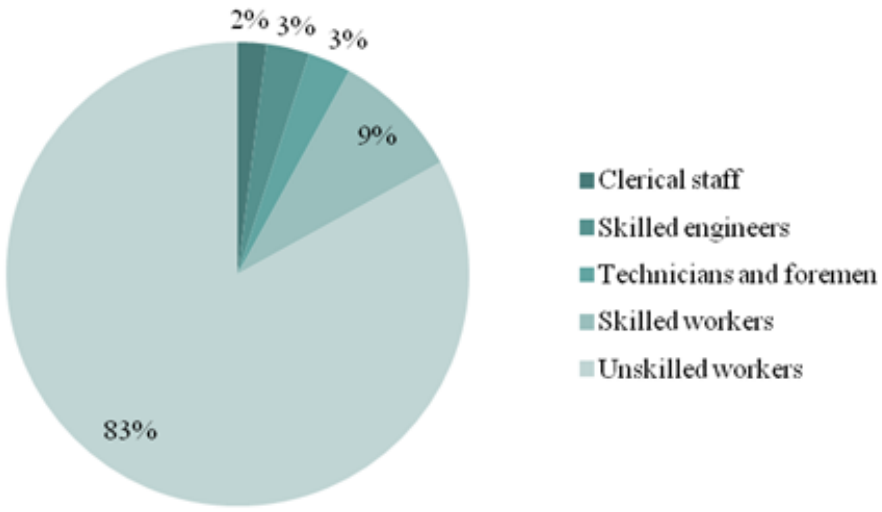
10 http://www.nbmcw.com/reports/construction-infra-industry/1835-construction-sector-current-scenario-and-emerging-trends.html

In addition to the actors involved in the conventional building value chain, green buildings call for another group of stakeholder, i.e. the green building rating bodies and their evaluators. Bodies like IGBC, GRIHA, and BEE have developed codes and rating systems. They are responsible for registering and certifying structures. In addition there are freelance consultants and evaluators who help clients to prepare and certify the structure respectively.

Employment

The construction sector employed 41 million people in 2011, almost four times as many as in 2005, and construction is India's second-largest employer after agriculture (Planning Commission, 2013). The construction industry has a varied workforce employed throughout the value chain, ranging from labourers to contractors and architects. As depicted in Figure 2, the bulk of the workforce comprises unskilled workers, who are predominantly migrant workers (Planning Commission, 2013). Only 6% of employees in the sector have received proper training, and the shortage of skilled workers is exacerbated by a lack of capacity in public and private training institutions.

Figure 2: Breakdown of employment in the building, construction and real-estate sector in India in 2011



Source: Planning Commission (2013)

3.2 Building materials

The construction sector has strong linkages with other industries, such as cement, steel, chemicals, paints, tiles, and fixtures manufacture. It is estimated that 40%–45% of India's steel, 85% of paint production, 65%–70% of glass, and significant portions of the output from automotive, mining and excavation equipment industries are used in the construction industry.

Investments in construction have a positive multiplier effect on supplier industries, thereby contributing to economic development. The construction materials and equipment sector accounts for approximately 8.6% of India's GDP and overall for nearly two-thirds of the total construction costs. The share of construction materials in project costs ranges from 40% to 60% and the corresponding cost for construction equipment ranges from 5% to 25% (National Skill Development Corporation, 2009).

Cement

Currently India is the world's second-largest producer of cement after China, with about 6% of total cement production (Parliament of India, Rajya Sabha, 2011). The CAGR in production has been

particularly high (9.2%) during the 11th FYP period (2007–2012) reflecting robust demand from the construction sector and high exports. Cement production increased by 56% to 228.3 megatonnes (Mt) between 2000–2001 and 2010–2011. Estimates suggest production of 600 Mt by 2020 (Parikh, 2011). Cement consumption increased from 81% in 2003–2004 to 96% in 2007–2008. Of this, about 50% is used for housing and 25% for industrial and commercial construction. The remaining 25% is used for other infrastructure development (NSDC, 2009).

Cement is an energy-intensive industry with high emission intensity. Industry consumes about 303 million tonnes (Mt) of limestone and 30 Mt of coal. CO_2 emissions were 129.9 Mt in 2007. However, the cement industry has decreased its emission intensity from 1.04 Mt CO_2/Mt cement in 1995 to about 0.79 Mt CO_2/Mt cement in 2007. Current practices routinely replace up to 30% or more of the Portland cement with blended materials, the most common being fly ash. The share of blended cement now accounts for 75% of all production (Parikh, 2011). Blended cement uses industrial by-products like fly ash, slag, and silica fume[11] as raw material. During 2008–2009, the industry consumed 35 Mt of fly ash and 7.5 Mt of slag (Parliament of India Rajya Sabha, 2011). These supplementary materials are among the most feasible means of reducing the embodied energy and associated GHG emissions as fly ash and blast-furnace slag reduce dust emission by 9,800 tonnes a year and CO_2 emissions by 33.6 Mt a year. It also contributes to the conservation of lime by 67 Mt a year (Parliament of India Rajya Sabha, 2011).

Initially fly ash was free for cement companies, but following new policies issued by the Ministry of Environment and Forests it became a saleable commodity. This pushed up the cost of producing environment-friendly blended cement (Parliament of India Rajya Sabha, 2011). Nonetheless, the prospect of carbon taxes and cap-and-trade markets has led industries worldwide to adopt green or sustainable cement initiatives. Their approaches range from supporting basic research to advocating for reform of international building codes. If successful, these could eventually halve the cement industry's CO_2 footprint. India has also adopted cap-and-trade schemes and has adopted policies to introduce resource-efficient technologies in the sector.

Steel

The Indian steel industry ranks fifth in the world with crude steel production of 55.1 Mt in 2008, up from 19.3 Mt in 1994. Steel production has grown at a CAGR of 7.8% over the same period (National Skill Development Corporation, 2009). The construction sector and, in particular, project construction (relating to development of infrastructure) is a crucial driver of demand for the steel industry, accounting for around 45% of India's total demand. An investment worth $143 billion is likely to go into the steel sector by 2020.[12] It is estimated that the growth in India's steel consumption will primarily be fuelled by demand for construction projects worth $732-814 billion (2012–2017) (National Skill Development Corporation, 2009).

The Indian steel sector consumes about 33% of total energy consumption in the country's industries (Samajdar, 2012). The sector's energy consumption of 6.6 gigacalories (Gcal) per tonne, is 50% higher than the global best practice[13] (Centre for Science and Environment, 2012).With the higher cost of energy and the introduction of regulatory and voluntary initiatives, the Indian steel industry has been gradually modernised and renovated to adopt energy-efficient and environment-friendly technologies. Existing plants need to evolve short- and long-term plans to phase out the old and obsolete facilities with state-of-the-art clean and green technologies. The goal is both to achieve higher productivity and also to harness all waste energy with minimal environmental damage.

Bricks

India is the world's second-largest producer of bricks after China with an annual production of approximately 200 billion. Most brick production in India employs traditional techniques, such as

11 Fly ash is produced during combustion of coal collected by electrostatic precipitators generally in thermal power plants. Silica fume is an amorphous polymorph of silicon dioxide collected as a by-product of the silicon and ferrosilicon alloy production. Slag is a partially vitreous by-product of the process of smelting ore, which separates the desired metal from the unwanted fraction. Slag is usually a mixture of metal oxides and silicon dioxide.

12 Press Release, Ministry of Steel, Government of India.

13 http://www.cseindia.org/content/india%E2%80%99s-best-iron-and-steel-company-gets-average-score-sector-rated-poor

clamps and fixed-chimney kilns, which are highly energy-intensive and resource-inefficient with a coal consumption of around 20–30 tons for every100, 000 bricks.[14] It is estimated that the sector produces 41.6 Mt of CO_2 emissions. The industry also exerts pressure on natural resources like fertile topsoil, competing with agricultural yield and food security.

> 'Perhaps, the paint industry has not been successful in convincing the consumers that these are good products worth the expense. We have to work towards this'.
>
> (Dr Mosongo Moukwa Vice President – Technology, Asian Paints)

It is vital to promote cleaner brick-production technologies like the Vertical Shaft Brick Kiln (VSBK), the Hybrid Hoffman Kiln (HHK), fly-ash brick technology and compressed earth blocks (CEB). VSBK technology has resulted in coal savings ranging between 30% to 40 % a year, and there have been reduced emissions of sulphur dioxide ($SO_{2)}$ and nitric oxide and nitrogen dioxide ($NO_{x)}$. The HHK improves kiln efficiency, while reducing CO_2 and other emissions, since it employs a direct fuel-injection technology to create thermal bonding. Replacing burnt bricks there are also materials such as CEB and fly-ash bricks. On average, a CEB uses between three and five times less energy to produce than a fired brick and produces no emissions. If one constructs 10,000 Indira Awas Yojana (IAY)[15] units with micro-concrete tile roof with CSEB wall, CO_2 emissions will be reduced by 52,000 tons compared to that of the emission by stone roofing and 230mm solid brick wall. Fly-ash bricks comprise fly ash, sand and cement. The environmental advantages are that since they are not fired, their production requires much less energy than burnt bricks and in turn re-uses waste materials. Fly-ash bricks account for about one-sixth of India's annual brick production, putting over 20 million tons of fly ash to productive use each year.[16]

Timber

Traditionally, timber is a very important component in construction, but it has now almost completely been replaced by Reinforced Cement Concrete (RCC) construction in urban areas. Among substitutes are aluminium for windows and door frames, marble, cement and tiles for floors, and steel, plastic and glass for furniture. RCC for railway sleepers has almost replaced tropical timber and of course, bricks and mud for construction. The Central Public Works Department (CPWD) banned the use of wood in building in April 1993. Increasing costs, the decline in the supply of wood and the easy availability of alternatives have contributed to the phasing out of timber in construction. The overall annual production of industrial round wood from forests is estimated at around 50 million m^3, while demand is projected to increase to 60 million m^3 in 2020 (Muthoo, 2004).

Low embodied energy and local availability make timber an ideal component for green construction, but unsustainable harvesting and use has led to deforestation. Forest-product certification was developed during the 1990s as a means to identify products that come from sustainably managed forests, and the area of certified forests has steadily increased since then (Bansal, 2004). A sustainable supply of wood requires fewer resources than does the production of non-renewable wood substitutes, such as steel and plastics, but steel substitutes cost only 50% of the cost of timber and plastic substitutes only 40% (Muthoo, 2004).

There is a need for greater awareness and possible policy shifts in favour of green economics and even more stringent conservation of natural forests and controlled harvesting. New technology has permitted the development of stronger, eco-friendly and more versatile reconstituted wood products, which are replacing raw timber across almost the whole range of uses. Several other renewable fibre materials, including bamboo, can be used for manufacturing alternatives to wood, providing an environmentally responsible solution to bridge the gap between demand and supply of wood (Bansal and Zoolagud, 2002). Composites help to prevent further deforestation and reduce pollution hazards by using waste

14 http://www.ecobrick.in/Home_read_more.aspx

15 Indira Awas Yojana is India's flagship social housing scheme.

16 http://www.worldbank.org/en/news/feature/2012/12/01/fly-ash-bricks-reduce-emissions

products. There is already a market for corrosion-proof doors, windows, partitions etc... Composite products can be made of industrial waste like red mud, and other fibres like coir and bagasse.

Paints

The Indian paint industry has grown up to twice as fast as GDP growth since 2010. SMEs account for 30% of the $2.6 billion Indian paint industry, with the bigger brands such as Asian Paints, Berger Paints, Kansai Nerolac, ICI and Shalimar Paints, accounting for the rest.[17] Many of the household or decorative products of the large paint companies no longer contain lead, mercury, arsenic and chromium. However, conventional paint contains a multitude of harmful chemicals (volatile organic compounds, or VOCs) that evaporate, contributing to ground-level ozone and damaging the health of people and the planet. Hence the recent focus on water-based paints, from which only water evaporates. There was over 20% growth in in water-based paints from SMEs in 2012.[18] There is also an increased focus on using paint to reduce a building's energy costs, insulating buildings from solar heat and thereby reducing the need for air-conditioning.[19]

3.3 The resource footprint of construction

Energy

In the past few years India has become the world's third-largest energy consumer, using 462 Mt of oil equivalent (mtoe) total final consumption (Shnapp and Laustsen, 2013). The building sector accounts for 30% of electrical energy consumption with a growth rate of 8% a year (Girija, 2011). The residential sector accounts for 21% (Parikh, 2011). Energy consumption is on the rise in buildings owing to the use of electrical appliances. Electricity consumption due to lighting and appliances like refrigerators, air conditioners, and water heaters accounts for about 10% in the country as a whole (Planning Commission, 2013). This demand is expected to rise to 155 billion units by 2016–2017 owing to economic growth and human development.

Electricity consumption in commercial buildings has gone up by 13% annually since 2003. In commercial buildings lighting and air-conditioning dominate consumption patterns, accounting for 80% of all consumption (Shankar, 2011).

India's energy efficiency is the fifth-lowest in the world so there is room for substantial energy savings.[20] The main focus is on the operating energy of a building, but the embodied energy of construction materials should be taken into account in view of the associated environmental implications of resource depletion and GHG emissions. There is a need to combine cutting-edge energy-efficient technologies with the adaptation of practices used in vernacular architecture, which use more locally available materials and resources, especially for countries like India where per capita energy consumption is rising rapidly due to high economic growth. This will reduce dependence on importing fossil fuels. This poses a challenge to the overall energy supply, and at the same time has an impact on the environment. The adoption of energy-efficient design and technology is crucial.

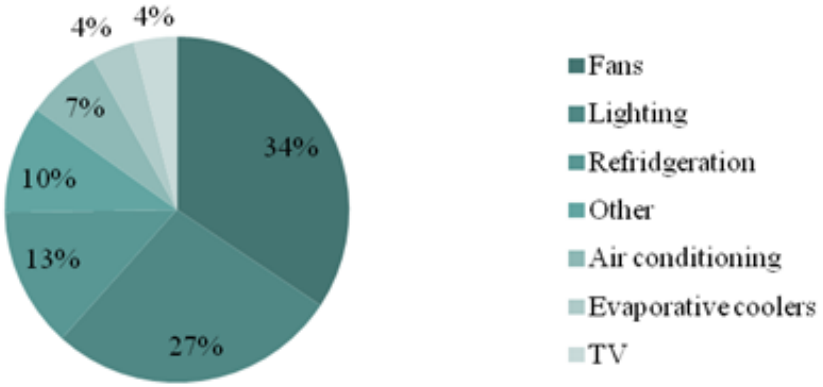
17(http://articles.economictimes.indiatimes.com/2010-06-07/news/27598643_1_paint-industry-paint-segment-lewis-berger)

18 http://www.goldensegroupinc.com/mosongo/Sector-Watch-CW-July-2010.pdf

19http://mobilepaper.timesofindia.com/mobile.aspx?article=yes&pageid=4&sectid=edid=&edlabel=ETKM&mydateHid=07-06-2010&pubname=Economic+Times+-

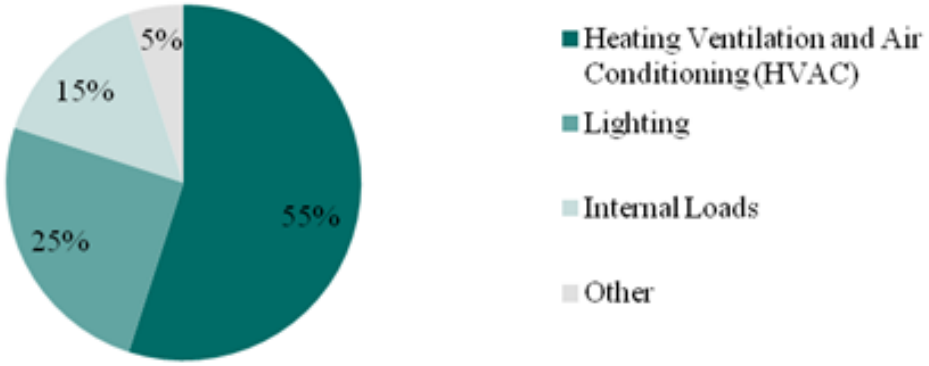
20 http://etvision2035.in/socialandenvironmental/energy-efficient-india-working-out-differently/

Figure 3: Energy consumption distribution in residential buildings



Source: Parikh (2011)

Figure 4: Energy consumption distribution in commercial buildings



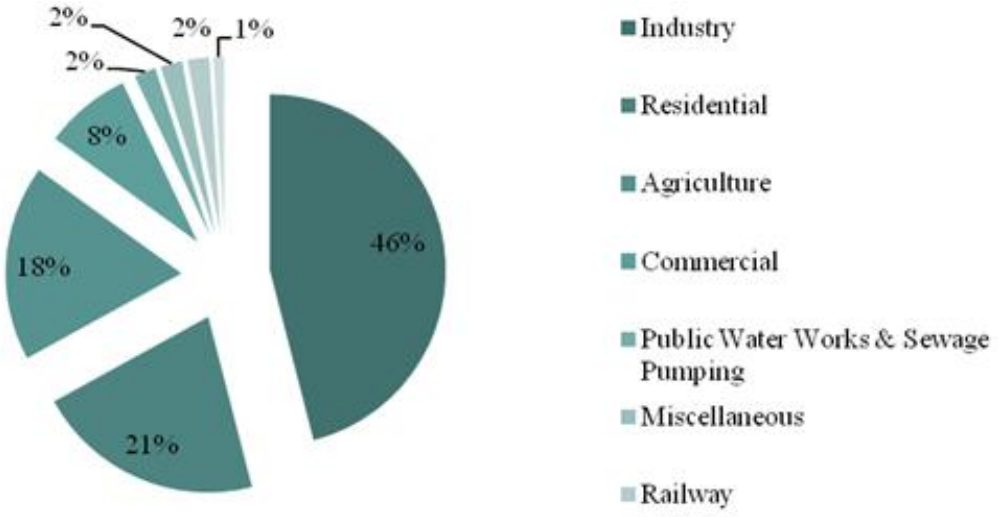
Source: Parikh (2011)

Together, residential and commercial buildings account for around 35% of total electricity consumption in India, in which the residential sector accounts for 21% (Rawal et al., 2012). As a result of population and economic growth, total Indian residential energy use is expected to increase by around 65% to75% in 2050 compared to 2005. Coal remains the dominant fuel, accounting for 43% of primary energy mix. High GHG emissions due to a predominantly thermal-based grid mix are an increasing concern for all.

Currently, about 75% of Indians have access to electricity (IEA, 2012) although consumption per capita is low. India has long suffered from inadequate electricity-generation capacity, resulting in regular power outages. Nationwide electricity shortages of 10.6% are predicted for 2012–2013 (CEA, 2012–13) and increased demand, coupled with meeting existing deficits, will exacerbate the environmental impact.

The growth in India's use of energy in building will determine its future energy demand, as the building floor area is expected to increase fourfold while the final thermal energy demand could potentially increase by around 700% (Urge-Vorsatz et al., 2012). This primarily covers buildings' operating energy. Embodied energy is a function of materials used. The sectors that account for most of the electricity/energy use are lighting, heating, ventilation, and air conditioning (HVAC) and appliances.

Figure 5: Energy consumption of different sectors



Source: Parikh (2011)

Water

Construction is a water-intensive industry and shortage of water has affected the sector. Almost all stages in construction require water – for foundations, brick-soaking, masonry, curing, concreting, whitewashing, painting and mosaic flooring. A large part of water consumption is used during the operational phase, but the amount depends on the income and lifestyle of the occupants.

The water deficit is becoming a serious constraint in Indian cities. With irregular and inadequate municipal water supply there is growing dependence on groundwater. In a 2005 study, the National Institute of Urban Affairs (NIUA), based in New Delhi, concludes that 56% of metropolitan, class-I and class-II cities are partly or fully dependent on groundwater (Anon, 2005). Cities are drawing water from hundreds of kilometres away, giving rise to conflicts with the existing users.

Despite the high water-consumption footprint of buildings, the focus remains on improving energy efficiency at the expense paying sufficient attention to water.

A massive urban transformation is accompanying India's rapid economic growth, posing unprecedented challenges to India's growing cities and towns particularly in the provision of infrastructure such as water, sanitation and sewerage to meet the needs of an urban population of 600 million people by 2031. This growth needs massive capital and operation and maintenance (O&M) investment in urban infrastructure, as highlighted by various Finance Commissions and expert bodies. The High Powered Expert Committee report on Indian Urban Infrastructure and Services estimates (at 2009–2010 prices), the per capita investment needed for capital infrastructure in the water, sewerage and storm-water sector at $285 and another $136.7 million annually for O&M. This suggests that the total investment needed for the 2012–2031 period is $122.8 billion for capital and $133 billion for O&M.

On the urban front, while access to household toilets in urban India is relatively high, sanitation is a different story. Out of 300 Class-1 cities, about 70 have partial sewerage systems and sewage-treatment facilities. Of the total wastewater generated in the metropolitan cities, barely 30% is treated before disposal (WHO-UNICEF, 2002). Non-revenue water accounts for 50% of water production and 4,861 out of India's 5,161 cities and towns lack even a partial sewerage network. Almost half of households in cities like Bangalore and Hyderabad have no sewerage connection. Only 21% of the wastewater generated is treated, compared with 57% in South Africa. Less than 20% of the road network is covered by storm water. Thus water efficiency and wastewater treatment are poorly addressed by the municipal systems.

The Indian waste water re-use and recycling equipment market was valued over $140 million in 2011. The market is expected to see a double-digit growth rate year on year for the foreseeable future. Key factors include water scarcity, increasing awareness, government regulations, the advantages of green technology and improved product quality market-wide. The key participants in the market include VA TECH WABAG Ltd., Ion Exchange India Ltd., Veolia Water India Pvt-Ltd., Triveni Engineering and Industries Ltd., Ramky Infrastructure Ltd., Driplex Water Engineering Ltd., Degremont India Ltd. and UEM India Ltd.[21]

Building materials

The construction materials and equipment sector accounts for an annual production growth rate of 9.8% (Planning Commission, 2013). The major materials used in the construction of buildings are cement, steel, bricks, construction equipment, paints and chemicals, fixtures and fittings, timber, tiles and ceramics, aluminium, glass and plastics.

A major share, almost 80% of the GHG burden of the sector, is borne by the building materials alone. Cement, steel, lime and bricks are the largest bulk consumption items in the Indian construction industry and also the most energy-guzzling. Production of cement increased by 56% to 228.3 Mt between 2000 and 2011. The Indian steel industry also witnessed an increase in production of over 300% between 1994–1995 and 2008–2009. The brick sector in India, although unorganised, has tremendous size and spread. As stated earlier, India is the world's second-largest brick producer, with an annual demand for over 200 million bricks.

The introduction of eco-friendly technologies and products within these sectors would reduce GHG emissions. For example, the shift towards production of blended cement has contributed to reducing its emissions intensity (Parikh, 2011). The aadoption of energy efficient-brick production measures like the VSBK and fly-ash bricks can contribute to savings of 100 Mt of CO_2 emissions per year by 2020. This is extremely important in light of the nation's attempts to reduce carbon emissions in order to mitigate climate change.

21 http://globenewswire.com/news-release/2013/03/12/530034/10024876/en/Indian-Wastewater-Reuse-and-Recycling-Market-Due-for-Double-Digit-Growth.html

4 Green buildings in India

When the Indian Green Building Council (IGBC) was established in 2001, one green building with a floor area of 1,858 m^2 marked the beginning of green building in the country. Today, more than 2,100 IGBC-certified green buildings occupy almost 140 million m^2 (IGBC). The IGBC has 1,413 members and around 20,000 professionals in the construction sector have been trained in its rating system. In 2011, the total floor area of green buildings in India was higher than in Brazil, Canada, China and South Korea (Watson, 2011), although green buildings account for a small proportion of the total building stock and a small share of the Indian construction market.

According to industry analysts, the market for green building in India is expected to grow three-fold from $10 billion in 2011 to $30 billion in 2014 (Iyer, 2011). The key elements of this expanding market are outlined in this section, which ends with a discussion of the main drivers of and barriers to green building in India.

4.1 The policy framework

India has repeatedly reiterated a commitment to low-carbon, sustainable and inclusive growth. For example, in 2009, India declared the intention to reduce the emission intensity of its GDP by 20%–25% from 2005 levels by 2020 (Parikh, 2011). Low-carbon growth is not seen as being in conflict with the country's economic development, and it is now accepted that both should go hand in hand for a better and sustainable future. Of the 12 focus areas for the 12th FYP (2012–2017), areas 10 and 11 (Lighting, Labelling and Super-Efficient Equipment Programme) and 11 (Faster Adoption of Green Building Codes) are particularly relevant to green construction.

To mainstream green-building and energy-efficiency practices, the Government of India has several policy initiatives in the form of regulations and voluntary schemes. In the building sector, the 12th FYP aims to revamp the JNNURM to hasten the adoption of green building codes. The 12th FYP also proposes linking financial devolution to urban local authorities to the application of green building codes within their jurisdiction. The 2008 National Action Plan on Climate Change (NAPCC) also highlights energy efficiency in the building sector. The National Mission on Sustainable Habitat aims to make the built environment more sustainable through improvements in energy efficiency, and the government will promote the Energy Conservation Building Code (ECBC) as an integral component of urban planning. The National Solar Mission will promote the use of solar energy for power generation and other applications.

The 2007 National Urban Housing and Habitat Policy endeavours to devise sustainable strategies for development of cities and towns in an environment-friendly manner with concern about dealing with solid waste disposal and drainage. Policies regarding air and water pollution, solid waste disposal, use of solar energy, rainwater harvesting, energy recovery from wastes and electricity supply should be integrated into the planning process. The Policy also focuses on reducing embodied energy by promoting the use of low-energy construction materials and techniques through fiscal concessions and taxing materials that consume energy. The National Housing and Habitat Policy (1998) also promotes the sustainable development of housing and settlements to provide a healthy environment by making greater use of renewable energy sources; increased energy efficiency, especially for lighting, ventilation, heating and cooling purposes; the use of renewable and innovative materials like fly ash and red mud; efficient technologies requiring less energy and materials; a pollution-free atmosphere and solid waste disposal.

India's National Building Code (NBC), first adopted in 1970, provides guidelines to regulate construction activities, including structural, safety, and design measures. The latest revision of the NBC included aspects of planning, energy conservation and sustainable development. A new chapter entitled '*Approach to Sustainability*' is being added, which will provide guidance for ensuring sustainability in the planning, design, construction, operation and maintenance of buildings.

Environmental Impact Assessment (EIA) is a decision-making tool to evaluate the likely impacts of a proposed project or development activity. The provisions of the EIA were extended to cover large construction projects including new townships and industrial estates. All building and construction projects/area development projects and towns with threshold limits need environmental clearance. The applicant must submit a proposal in a prescribed format. Clearance is given after the impacts of the project on the air, noise, land and water environment, ecology, and the socio-economic life of local residents have been assessed. Sustainable site planning, solid waste management and energy conservation are also addressed.

The Bureau of Indian Standards (BIS) has laid down a number of standards detailing classification, general quality, dimensions and physical requirements for building materials. For example, IS 1077 establishes specifications for burnt-clay bricks, IS 3951 and IS 3952 for hollow clay bricks, and IS 12894:1990 for fly-ash lime bricks. The Performance Appraisal Certification Scheme (PACS) of the Building Materials and Technology Promotion Council (BMTPC), renewed for a further two years in 2013, provides third-party certification of the performance and suitability of new building materials, components, products, elements, construction system and assemblies that are not yet covered by the BIS. BMTPC has been promoting development, manufacture and use of alternate materials and technologies with an emphasis on environmental protection through use of waste products, energy conservation, development of substitute materials for scarce materials e.g. wood, and disaster resistant construction technologies. In order to give greater impetus to the actual use of such materials and technologies to derive the envisaged social benefits, a scheme called Performance Appraisal Certification Scheme (PACS) has been instituted by Ministry of Urban Development and Poverty Alleviation. The preliminary application includes criteria like environmental concerns, energy concerns and conservation. Technologies are assessed on these criteria before getting certified.

In order to promote technical research and development (R&D) in the construction sector, several national laboratories and field centres have been established under the Council of Scientific and Industrial Research (CSIR), including the Central Building Research Institute in Roorkee. Agencies like the Housing and Urban Development Corporation (HUDCO) and the Building Materials and Technology Promotion Council (BMTPC) promote appropriate technology for building, and the development, production and standardisation of building methods. Building centres were set up across the country to disseminate the research benefits.

4.2 Certification and rating schemes

Green building rating systems have become a popular means to encourage the construction sector to adopt sustainable practices by stimulating market and consumer interest. They measure the environmental performance of a building throughout its lifetime. The total score is determined according to the number of measures adopted. Developers are using these voluntary rating systems to advertise green buildings. National and local governments can also build upon voluntary rating systems to encourage green building practices through fiscal and other incentives.

Rating systems are designed to evaluate the performance of buildings over their lifetime, i.e. from the pre-construction phase to operation. The basic parameters usually considered fall into three main categories: sustainable site selection, planning and construction and the buildings' operation and maintenance (O&M). A rating system usually consists of a set of criteria related to the various parameters of design, construction and building operation. Each criterion has pre-assigned points, and the final rating of the project is decided on the basis of the total number of points awarded.

The two main rating systems in India are the Green Rating Integrated Habitat Assessment (GRIHA) and Leadership in Energy and Environment Design (LEED). The LEED India programme was the country's first such initiative and is operated by the IGBC. Both GRIHA and LEED follow a point-based evaluation system. The IGBC also has other rating systems for homes, towns, special economic zones, factories and the landscape.

The IGBC Green Factories rating system, launched in 2009, is the first of its kind addressing sustainability in industrial buildings. It evaluates certain credit points using a prescriptive approach and others on a performance-based approach. This rating system would facilitate the development of factories that are energy-efficient, water-efficient, healthy, more productive and environment-friendly. To date, nine companies have been rated and a further 60 are working towards it.

Green Rating for Integrated Habitat Assessment (GRIHA)

Green Rating for Integrated Habitat Assessment (GRIHA) is a national rating system jointly developed by The Energy and Resources Institute (TERI) and the Ministry of New and Renewable Energy (MNRE). GRIHA is a five-star rating system for commercial, institutional and residential green buildings ranging from 2,500 m^2 to 150,000 m^2. GRIHA has developed a set of 34 criteria, categorised under various headings.

Incentives for GRIHA-certified Projects

- Fast-track environmental clearance for GRIHA pre-certified projects
- Additional Floor Area Ratio[22] concessions (FARs) for projects complying with GRIHA rating
- Rebate on property tax
- Incentives to consumers on home loans and also to architects and developers to design buildings
- Reimbursement of fees for GRIHA rating
- Annual awards to green buildings rated five-star

One of the unique features of the GRIHA rating system is that it consolidates all the relevant codes and specifications, such as the NBC, the ECBC, the BEE energy-labelling programme for appliances, environmental clearance norms for large construction projects, and others. It therefore helps in enforcing these regulations even if they are not mandatory, making it more suitable in the Indian context. It also distinguishes between non-air-conditioned and partially air-conditioned buildings in the country's five different climatic zones, and emphasises energy-efficient techniques such as passive solar heating. GRIHA also looks at the embodied energy in the materials used, in addition to operating energy-efficiency, design and siting parameters.

The GRIHA system has slowly gained popularity due to awareness-raising programmes and the promotion of GRIHA in government buildings. During the 11th FYP period (2007–2012), 117 projects with a total built area of 4.98 million m^2, including 81 projects from government departments with a 3.22 million m^2 total built area, were registered for GRIHA certification.[23] In all there are 350 GRIHA-registered buildings, amounting to a footprint of approximately 11 million m^2.[24]

The Central Public Works Department of India has adopted GRIHA as its official Green Building Standard (Kumar, 2010b). Under this programme, all new central government and public-sector buildings will be constructed to meet the GRIHA three-star rating (Kumar, 2010).

22 Ratio of a building's total floor area to the land on which it is built

23http://www.npti.in/Download/Annual%20Report/mnrepdf/4%20Renewable%20Energy%20for%20Urban,%20Industrial%20&%20Commercial%20Applications.pdf

24 www.grihaindia.org

Small versatile Affordable GRIHA (SVAGRIHA)

A TERI–ADaRSH initiative, SVAGRIHA, is an off-shoot of the GRIHA system designed for small stand-alone buildings like houses, commercial offices, motels and dispensaries, with a cumulative built area of 2,500 m^2 or less. It is currently in its pilot phase. An example of a SVAGRIHA-rated building is in Nasik, the first rated building in Maharashtra, built by the residential developer Green Spaces.

Leadership in Energy and Environmental Performance (LEED) India

This market-driven rating system is designed for new and existing commercial, institutional and residential buildings. Specific LEED India programmes include LEED India for New Construction and LEED India for Core and Shell. LEED India certification is centred on building design as opposed to building operation and therefore does not determine whether green design actually results in better energy performance.

To date, 2,029 buildings have been registered under LEED India with certification granted to 362.[25] The Confederation of Indian Industry's Godrej Green Building Council, Hyderabad, was the first LEED-certified building in India.

Table 7: Examples of LEED-certified buildings in India

Building	Built-in Area (m^2)	Energy Consumption (kWh)		Rating Achieved	EPI (kWh/m^2)
		Conventional	LEED Designed (Reduction, %)		
CII- Godrej, GBC, Hyderabad	1,858	350,000	130,000 (63%)	Platinum	70
ITC Green Centre, Gurgaon	15,794	3,500,000	2,000,000 (45%)	Platinum	127
Wipro, Gurgaon	16,258	4,800,000	3,100,000 (40%)	Platinum	191

Source: UNDP/ GEF (2011)

Eco-Housing

The Eco-Housing rating system was initially developed for the city of Pune in 2004. It is now being modified to address the variable requirements of India's five distinct climatic zones. This five-star rating system is specifically designed for residential buildings. Similar to GRIHA, it also focuses on efficient building materials.

Currently, Eco-Housing assessment is being used by a number of developers in Pune, such as Nyati Developers, Deepa Housing Society, Gera Development Pvt Ltd. and K. Raheja Corporation.[26] Four residential buildings in Pune are in the process of complying with the Eco-Housing certification.[27]

Star Rating Programme for Buildings

The BEE Star Rating Programme for Buildings aims to create a demand for energy-efficient green buildings by giving them public recognition. This is the only rating scheme that grades buildings only for their energy efficiency if they have a connected load of 500 kW. The scheme has five categories of building – offices, hotels, hospitals, retail malls and IT Parks – in the country's five climatic zones. This scheme is currently invoked for air-conditioned and non-air-conditioned buildings in two categories – office buildings and business-process outsourcing buildings in three climatic zones: warm

25 The first step in the process is to get registered. Once registered, the buildings undergo assessment and certification. A registered building is not necessarily certified as green, it's in the process. Thus by inference, it should have green features.

26 http://www.scitechpark.org.in/index.php/servcies/eco-housing

27 www.iiec.org

and humid, composite and hot and dry. The Energy Performance Index (EPI) in kWh/m^2/year will be considered in rating the building.

So far, only 123 commercial buildings have been labelled since its launch in 2009.[28] However, this scheme is currently in its pilot stage and will subsequently be extended to other climatic zones and building types (Shnapp et al., 2013).

Standards and Labelling Programme for Appliances

Similar to the Star Rating Programme for Buildings, the Star Rating Programme for Appliances was developed to label energy-efficient appliances. Currently, labelling for four appliances is mandatory: frost-free refrigerators, tubular fluorescent lamps, room air-conditioners and distribution transformers. It is a voluntary scheme for other appliances, such as direct cool refrigerators, general purpose industrial motors, pumps, ceiling fans, domestic gas stoves, stationary storage-type water heaters, colour televisions and washing machines.

To apply for the label, manufacturers submit an application along with non-refundable registration fees and a labelling fee. After scrutinising the application, BEE will decide whether to grant the label, which the manufacturers affix on their equipment. The Programme has resulted in electricity savings of 4,350.92 million units, equivalent to avoided capacity-generation of 2,179.31 MW in 2009–2010 (Bureau of Energy Efficiency, 2010).

Market uptake

Despite the availability of several labelling programmes, uptake remains slow. This is illustrated by the fact that there are only 362 LEED-certified buildings in India since its inception in 2001. Most of the labelled buildings belong to a branch of government or large corporations, indicating a lack of demand for labelled buildings in the residential sector. Due to the government's active endorsement of GRIHA, a large proportion of certified buildings are government-owned. LEED-certified buildings range from large corporate to office spaces, factories and hotels. This lack of demand from residential buildings is illustrated by the poor response of developers to the Government of Maharashtra's project to fast-track planning approval for certified property development projects by 18 months. Developers have applied for certification for only 15 out of 300 projects since the announcement of this scheme in 2011.

Another critical issue is the actual performance of certified buildings. As these rating systems are backed by government schemes and incentives, close monitoring of post-construction performance is required. LEED does have a self-reporting data-collection system, but the reliability of the data is uncertain. Accountable, reliable and transparent information about the performance of the buildings is necessary.

Finally, the multiplicity of rating programmes can be confusing for consumers. There is a need for greater awareness among consumers so that they can make intelligent choices with regard to the rating systems and certified buildings. Competition among labels increases the need for supporters to spend significant resources before the real-estate market can match the value that labels offer.

4.3 Energy efficiency initiatives

The 12th FYP emphasises enhancing buildings' energy efficiency by improving appliances and equipment and through energy-efficient designs. It is estimated that by 2030 the national demand for power could be reduced by as much as 25% by improving the energy efficiency of buildings and operations (Sankhe et al., 2010). Currently, the focus is on energy efficiency because the benefit is clear and immediate: lower utility bills and a reduced carbon footprint. The Government of India enacted the Energy Conservation Act, 2001. The Act provides for the legal framework, institutional arrangement and a regulatory mechanism at the Central and State level to embark upon energy efficiency drive in the country. Five major provisions of EC Act relate to designated consumers, standards and labelling of Appliances, Energy Conservation Building Codes (ECBC), Creation of Institutional Set up (BEE) and the establishment of the Energy Conservation Fund. The Building Code

28 Working Group on Environmental Sustainability of Indian Cities for the Formulation of 12th FYP.

directly applies to us, in context of the study. The Energy Conservation Building Code (ECBC) was launched by the Government of India on 27th May, 2007. The ECBC sets minimum energy standards for new commercial buildings having a connected load of 100kW or contract demand of 120kVA in terms of Energy Conservation (Amendment) Act, 2010. It is voluntary in nature and seems to have been honoured more in the breach than the observance.[29]. The uptake is still slow and it caters to a very small part of entire construction in the country today. There is some movement towards creating awareness on these codes now through the BEE.

Energy efficiency is a low-hanging fruit for climate change mitigation. Each unit of electricity saved means fewer GHGs released into the atmosphere. Under the 11th FYP, programmes promoting energy efficiency aimed to save 5% of energy consumption, and avoid a 10,000 MW addition in generation capacity. India spent $4.17 billion in clean energy programmes in 2012.[30]

According to experts in the power sector, energy-efficient electrical appliances used in household and commercial establishments could save about 20,000 MW of power a year, resulting in savings of $19.53 billion in capital investment on new power plants, besides transmission and distribution infrastructure.[31] Residential electricity use is highly subsidised compared to the commercial sector, which makes the goal to reduce energy consumption in residential buildings less attractive. India's frequent blackouts, due to inefficiencies in the power sector, give rise to a requirement for expensive back-up diesel generators, which currently have a market of around $585.8 million. The need for expensive generators in order to ensure reliability in supply should serve to highlight the importance of establishing energy-efficient buildings and encourage stakeholders to call for energy-efficiency programmes.

In 2007, BEE came up with the Energy Conservation Building Code (ECBC) to provide minimum requirements for energy-efficient design and construction of buildings. It applies to buildings with a connected load of 500 kW or greater or a contract demand of 600 kVA or greater and with a conditioned area of 1,000 m^2 or more. It has provisions for building envelopes, mechanical systems and equipment, including HVAC, interior and exterior lighting and electrical powers and motors.

ECBC-compliant buildings are estimated to be 20% to 30% more efficient than conventional buildings. With the implementation of ECBC and other codes along with energy-efficient measures, it is estimated that there is potential to abate 142 Mt of CO_2 emissions per year by 2020 and 296 Mt per year by 2030 (Parikh, 2011). Estimates from the energy consultancy Environment Design Solutions (EDS) also show significant potential for GHG savings from energy-conservation measures (24% from lighting and 12% from air conditioners). The ECBC is currently in the voluntary phase of implementation, and only a few states like Orissa and Rajasthan have notified it in their jurisdiction. It is important to note that the ECBC looks only at the operating energy of a building and not at the embodied energy of the building materials. The rate of compliance with ECBC is anticipated to reach 10% until 2013, 35% in 2015 and 65% by 2017 (Rawal et al., 2012).

Case study: Fortis Hospital, New Delhi

Fortis Hospital, situated at Shalimar Bagh in New Delhi, complies with the 2007 Energy Building Conservation Code. Several energy-efficiency and resource-conservation measures have been incorporated in various aspects of the design, construction and operation of the green building.

The Environmental Performance Index (EPI) [32]was reduced by 2% from 605 kWh (the baseline) to 593 kWh per m^2 per annum by incorporating the ECBC optimisation recommendations. These interventions include use of 200mm autoclaved aerated concrete blocks (AAC), plastered on both

29 http://home.howstuffworks.com/home-improvement/construction/green

30 Ashok Lavasa, Additional Secretary, Ministry of Power.

31 http://articles.economictimes.indiatimes.com/2012-05-01/news/31528334_1_energy-efficient-electrical-appliances-energy-efficient-devices-energy-conservation

32 The EPI is a method of quantifying and numerically benchmarking the environmental performance of a state's policies. It was developed from the Pilot Environmental Performance Index, first published in 2002, and designed to supplement the environmental targets set forth in the United Nations Millennium Development Goals.

sides in the external wall, 150mm reinforced concrete cement (RCC), 65mm vermiculite, 100mm brick coba and 25 mm tiles and double-glazed low-emissivity glass with a light transmission of 46%. A further 21% reduction in the EPI was achieved by optimising the artificial lighting. The use of HVAC and controls on the HVAC system like variable frequency drive on chilled-water pumps and air-handling units further improved the EPI to 312 kWh per m^2 per annum, a total of 48% reduction in the EPI of the building.

Source: UNEP-SBCI (2010).

Lighting Systems

Lighting is one of the important aspects in residential or commercial decor. About one-quarter of the total electricity consumption cost is spent on lighting. By specifying a high-quality energy-efficient lighting system that uses both natural and electric sources as well as lighting controls, a comfortable yet visually interesting environment can be created for the building's occupants.

Havells, Phillips and other new manufacturers of lighting equipment, seeing the rising number of green buildings and demand for energy-efficient options, have introduced light-emitting-diodes (LED), which consume 50% less energy than traditional lights and are four times more energy-efficient than incandescent lamps. There is no use of glass or filament in LED and they have a much longer lifespan (average of 50,000 to 80,000 hours), and thus help reduce waste. The Indian LED lighting market was valued at $73.3 million in 2010, and is expected to reach $470 million by 2015. Street lighting is expected to account for approximately 60% of the LED market in 2015.

HVAC

According to the World Business Council for Sustainable Development (WBCSD) between 45% and 65% of energy consumption in buildings worldwide is for heating, ventilation and air conditioning (HVAC) systems that keep the inside environment comfortable and healthy. The slightest inefficiencies in cooling and heating systems create a huge energy drain and have a significant financial and environmental impact.

The Indian HVAC market is growing fast, mainly owing to the huge rise in construction activity. Between 2004 and 2009 it grew at a CAGR of 20% and in 2009, the market was worth almost $2.3 billion. India's cooling demand is much greater than its heating demand (Shnapp and Laustsen, 2013), and buildings for commercial services account for the largest share of the market (78%). Government development schemes and incentives have contributed to the expansion of the market for air-conditioning, and investment in HVAC between 2012 and 2017 is envisaged to have a CAGR of 14%. Infrastructure investment rose by 575% between the 10th and 12th FYPs, which has heavily contributed to the growth of the HVAC industry.[33] The HVAC system provider, Trane say they develop solutions that incorporate emerging technologies to optimise energy and operational efficiency and increase sustainability.

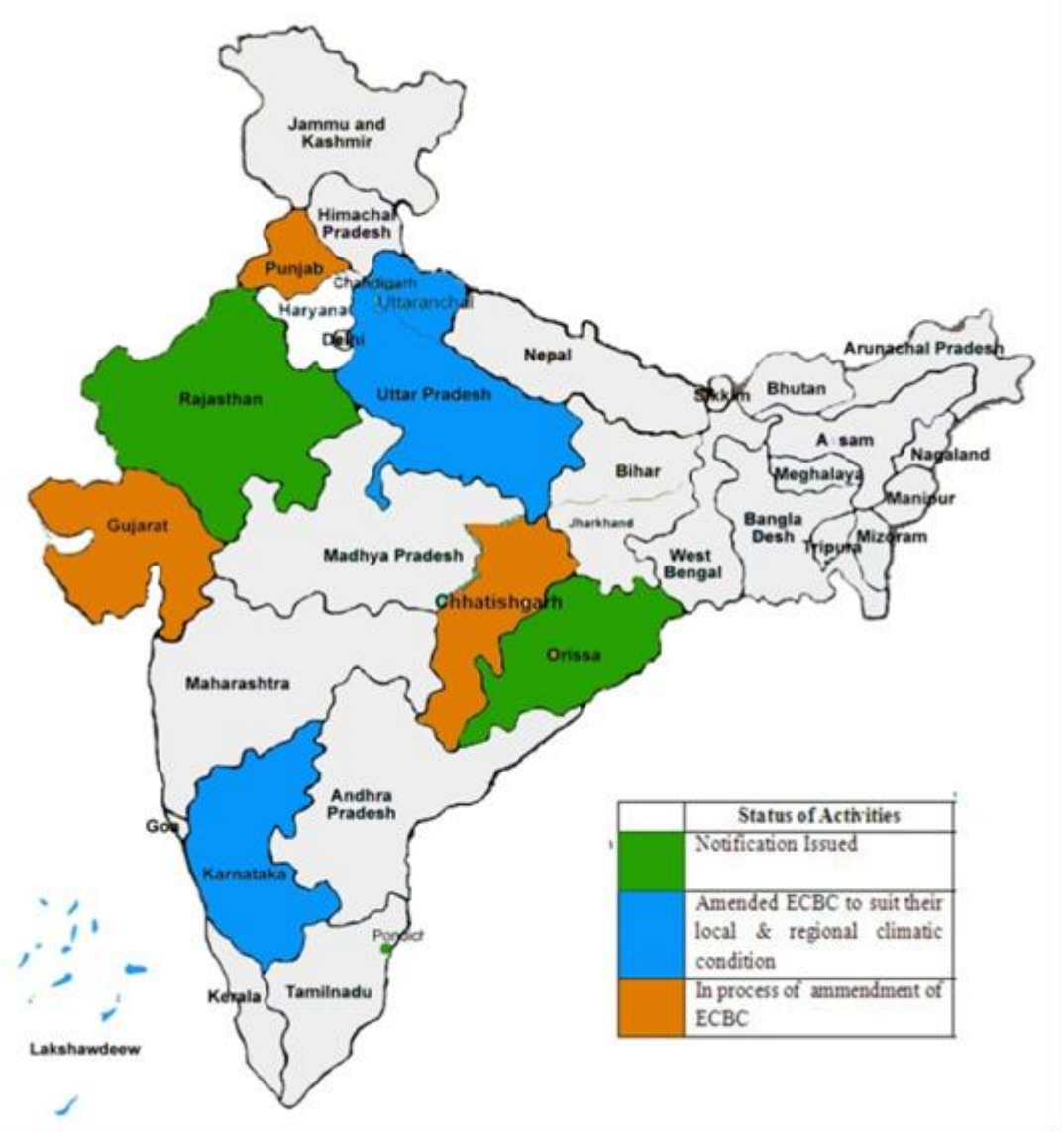
The BEE Standards and Labelling programme has helped in increasing consumer awareness of energy-efficient appliances. Savings due to the standards and labelling programme avoided an installed capacity of over 7,500 MW during the 11th Plan period. BEE is expected to tighten the norms for refrigerators and air conditioners from 2014. As a result of such interventions, it is expected to achieve a further 30% reduction in the average energy consumption of refrigerators and air conditioners by 2016–2017, as compared to those sold in 2011–2012 (Planning Commission, 2013).

The Super Energy Efficient Programme (SEEP), part of the Market Transformation for Energy Efficiency (MTEE) initiative, seeks to increase the domestic manufacturing of energy-efficient appliances by reducing their cost through market incentives. This programme would offer incentives to

33 http://www.iifir.org/clientBookline/service/reference.asp?INSTANCE=EXPLOITATION&OUTPUT=PORTAL&DOCID=IFD_REFDOC_0006851&DOCBASE=IFD_REFDOC_EN&SETLANGUAGE=EN

the manufacturers to produce appliances that are 30%–50% more energy-efficient than the most efficient ones currently on the market. Currently, BEE is in the process of improving the efficiency of ceiling fans. **The Bachat Lamp Yojana (BLY)** is an innovative business model to promote Compact Fluorescent Lamps (CFL). BLY is designed as a PPP between the Government of India, private-sector CFL suppliers and state-level Electricity Distribution Companies (DISCOMs). CFLs would be sold to households at the same price as incandescent light bulbs. The balance would be recovered as carbon credits.

Figure 6: Status of implementation of ECBC in different states



Source: www.beeindia.in

Renewable Energy Initiatives

With over 300 clear sunny days annually in India, there is a huge potential to tap, store and retrieve solar power – much more than the current power requirements. However, the exploitation of solar power to meet the country's energy requirements is insignificant when compared to other energy resources. The government has launched the Jawaharlal Nehru National Solar Mission (JNNSM) as a

major initiative to promote ecologically sustainable growth while addressing India's energy security challenges[34].

The use of solar-powered systems and devices through the application of Solar Photo-Voltaic (PV) and Solar Thermal methods have remained underused due mainly to high unit costs. There is a need for an enabling framework to expand the market for solar energy by bringing down the costs. The Ministry of New and Renewable Energy (MNRE) has introduced a Scheme for Solar Off-grid (PV and thermal) by which solar energy systems will be available with financial incentives.

The BEE has claimed it is likely to meet the FYP target (to save 5% of energy consumption) since the avoided generation capacity recorded by December 2010 was 7,415 MW, equivalent to the generation capacity of two proposed ultra-mega power plants in India (about 4,000 MW each). But experts say a closer look at the figure shows the actual saving is in fact much less (Kandhari, 2007).

The incentives to use renewable energy depend in large part on how conventional energy is priced. Renewables are often more expensive in the short term than fossil fuels, and in India suffer further from a very uneven playing field as a result of the subsidies given to fossil fuels. Environmental fiscal reform could thus make an enormous impact on the incentives to develop renewable energy technologies. Other fiscal incentives could also help, such as tax breaks for the use or import of green technologies.

The 'Development of Solar Cities', set up by the Ministry for New and Renewable Energy in 2008 to support local government to adopt renewable energy technology and energy efficient measures, aims at a minimum 10% reduction in the projected demand for conventional energy in a five-year span, through a combination of enhancing supply from renewable energy sources and energy-efficiency measures. The basic aim is to motivate local government to adopt these by providing up to $81,300 per city/town for the preparation of a Master Plan, setting up of a Solar City Cell, implementation and capacity-building and other promotional activities. Sanctions have been given to 31 cities, and draft Master Plans have been prepared for eleven. The setting up of a Solar City Cell in these cities is in progress.

A scheme promoting solar-based heating systems through financial incentives in the form of Central Financial Assistance to non-profit institutions/ organisations and commercial/industrial organisations is in place. Support is also provided to create awareness about the benefits of the system.

Under the Solar Building Programme, the Ministry of New and Renewable Energy (MNRE) provides incentive of Rs. 50,000 for the preparation of the Detailed Project Report (DPR) for a solar passive building. The additional cost for solar passive buildings is met by the MNRE, limited to 10% of the cost of the building or Rs. 10 lakh per building. These incentives are available only in Govt./ semi Govt. sector. The programme was launched in 1998-99.The Solar Buildings Programme will provide financial support for preparation of detailed project reports and construction of solar buildings, apart from organising workshops and seminars for engineers, planners, builders, architects, consultants, housing financing organisations and potential users. Support will also be extended for compilation and publishing of documents related to solar buildings.

On the recommendations of BMTPC, some low energy **building materials**, such as cement-bonded particle boards, sand-lime bricks and fly-ash bricks, have been exempted from excise duty. Duty concessions have also been provided for various machines, plant and equipment required for the production of fly-ash and phosphogypsum-based materials, and other materials that save forest wood and cement use.[35] Heavily polluting brick kilns have been banned, encouraging enterprises to move towards energy-efficiency options such as the vertical shaft brick kiln (VSBK) and Fixed Chimney Bull's Trench Kiln (FCBTK). By 2002, 75% of the heavily polluting kilns had been converted to

34 The objective of JNNSM is to establish India as a global leader in solar energy by creating conducive policy conditions for its diffusion across the country. The immediate aim is to focus on establishing an enabling environment for solar technology penetration both at a centralized and decentralized level. The first phase (up to 2013) will focus on capturing of the low hanging options in solar thermal; promoting off-grid systems and modest capacity addition in grid-based systems. After taking into account the experience of the initial years, capacity will be aggressively ramped up in phase two to create conditions for up scaled and competitive solar energy penetration in the country.

35 http://mhupa.gov.in/ministry/associates/autonomousbodies/bmtpc.htm

FCBTKs by 2002 (Lalchandani and Maithel, 2013), but they have not yet been completely eliminated from all states. The government has also encouraged greater energy efficiency in building materials by requiring the use of fly-ash bricks around power plants and introducing technology-based emission standards.

4.4 Water use and management

A lot of policy focus is given to improving energy efficiency in buildings. Policies related to water mostly emphasise access to safe drinking water and sanitation (National Urban Sanitation Policy 2008), water and food security, and its use in agriculture and conservation in both rural and urban areas. More emphasis is therefore required on water usage and conservation in buildings and the residential sector.

Municipalities are taking steps to promote rainwater harvesting in different areas. The Central Ground Water Authority issued a notification in 2001, making it mandatory for every household in areas with groundwater level below 8m to have a rooftop rainwater-harvesting system. The Ministry of Urban Development and Poverty Alleviation (Delhi division) modified the building byelaws making rainwater harvesting mandatory in all new building plots of 100m^2 and above. Goa, Gujarat, Haryana, Hyderabad, Indore, Kanpur, Kerala, Karnataka, Mumbai, Surat and Tamil Nadu are some of the states/cities where rainwater harvesting has been mandatory in India.

There has also been some emphasis on wastewater treatment in residential areas. According to the Environmental Building Guidelines for Greater Hyderabad, only 25% of the treated wastewater can be disposed outside the site limits where a wastewater-treatment system is installed. All large developments (>50 acre site area) must adhere to 'zero discharge' of treated wastewater outside site limits. All buildings in Delhi having a minimum discharge of 10,000 litres and above per day should incorporate a wastewater-recycling system. Decentralised systems for sewage treatment should also be promoted, but it is necessary to first define standards for different uses of water.

The MoUD has initiated a number of programmes and activities to address the above issues, including Service Level Benchmarks to improve efficiency in the functioning of Urban water supply systems, including governance, finance, institutional capacity etc. The National Urban Sanitation Policy (NUSP 2008) covers all aspects of urban sanitation. The City Sanitation Rating exercise has been initiated under the NUSP to create mass awareness and mainstreaming of sanitation-related activities, and National Urban Water Awards are issued to honour best efforts in improving water-supply services (Ministry of Urban Development, 2012).

Success stories in Delhi

Rainwater harvesting has been implemented in Delhi and adopted by various buildings including Rashtrapati Bhavan, Shram Shakti Bhavan, Lodhi Gardens, Jamia Hamdard University, Varunalaya building, Delhi Jal Board and many more. The Rain Water Harvesting system adopted by Mira Model School led to rise of about 1.5 m in groundwater levels in between 2002 to 2005.

The Government of NCT in Delhi is promoting rainwater harvesting by paying up to half of the cost of the rainwater-harvesting structures or $1,630 to the Registered Resident Welfare Associations/Cooperative Group Housing Societies, private/recognised and government. schools, industrial buildings, hospitals, charitable institutions, NGO Buildings etc. Delhi Jal Board has approved 189 grants and as of 31 March 2008 assistance has been released in 117 cases totalling $ 91,619. These 117 schemes will yield about 325,000 m^3 of rainwater annually, allowing for recharging of groundwater.

Source: www.delhigov.in

4.5 Finance

The easy availability of housing finance has had a major impact on the construction market. The residential real-estate market in India has seen substantial growth over the past decade. Housing finance cumulatively grew at a rate of 30% during 2002 and 2007 (National Housing Bank, 2007). The sector has shown signs of recovery following the recession, with an 18% year on year rise in housing finance disbursements in 2009–2010 (CRISIL, 2010).

Green housing finance has still not caught on, however. There are some instances of financial institutions taking the initiative to offer customised products to green homeowners. A programme was initiated jointly by NHB and KfW in 2008 to promote energy-efficient residential housing by extending financial and technical assistance through housing loans to individual borrowers via retail-lending institutions for purchase and/or construction of energy-efficient residential houses and flats. By the end of 2012, this programme had supported the construction of 73 buildings in 11 housing developments, providing more than 20,000 apartments (Calov, 2012).

The State Bank of India has launched a nationwide product to promote green homes. Customers buying IGBC-certified Green Homes can take advantage of a 0.25% cut in interest rates and the waiving of loan processing fees.[36] Similarly, the Bank of Maharashtra and ING Vysya Bank created eco-housing mortgages for Eco-Housing-certified projects that allowed either higher repayment tenure or a three-month moratorium on repayment. In order to promote purchase of efficient equipment and appliances, the banks offered a 1% interest rate subsidy on the products.

The government also offers financial incentives to builders and developers for green buildings. The Pune Municipal Corporation (PMC) offers a 10%–50% concession on total premium paid by builders, depending on the project rating achieved by a certified Eco-housing project (PMC, 2010). Municipalities provide 90% reimbursement of the registration fee, rebate in property tax and concessions in electricity, water charges and Municipal Corporation tax to GRIHA-certified buildings (TERI, 2009).

In addition to green buildings, finance is also available for green appliances and products. The Ministry for New and Renewable Energy (MNRE) has announced 30% subsidies on solar appliances. The subsidies are provided on the cost price of items such as solar lanterns, home lights, streets lights, solar water-pumping systems and solar water-heating systems. LED Home Lighting Systems are provided to MNERGA[37] beneficiaries and Below the Poverty Line (BPL) families.

An area where finance is almost completely lacking is in the MSME sector that supplies building material and services. These are unorganised MSMEs, which often lack the necessary capital to improve their existing technologies or move to energy-efficient technologies. Currently there is no fund catering to this need.

36 State Bank of India (2010). SBI Green Home Loans http://www.sbi.co.in/user.htm

37 Job guarantee scheme for rural Indians.

Incentives for GRIHA-NRS projects (CES, 2012):

- Building Owners: Reimbursement of 90% of the registration-cum-rating fee for projects up to 5,000 m^2 built area with minimum 3star rating, and for projects > 5,000 m^2 built area with minimum 4-star rating.
- Architects/Design Consultants: INR. 2.5 lakhs for projects up to 5,000 m^2 built area with minimum 3-star rating, and INR 5 lakhs for projects > 5,000 m^2 built-up area with minimum 4-star rating.
- Municipal Corporations/Urban Local Bodies: INR 50 lakhs to Municipal Corporations and INR. 25 lakhs to other Urban Local Bodies that announce a rebate in property tax for green buildings and make it mandatory to get the new buildings in the government and public sector GRIHA-rated.
- Awards: awards of INR 50 lakhs to Municipal Corporation and INR. 25 lakhs to another best-performing Urban Local Body.
- Annual Awards: to GRIHA 5-star-rated buildings.
- Activities: up to INR 2.00 lakh for each activity to specialised institutions for organising workshops, seminars, training, publications awareness campaigns, etc.

4.6 Drivers and barriers

The extent to which the green buildings market will grow is determined in large part by the economic incentives facing developers and property purchasers. Construction companies and property developers will respond to the level of demand for green buildings and the price that property purchasers are willing to pay. As we have seen, green buildings cost more upfront, but save money in the longer term. Thus the scale of the savings should by itself create growing demand for green buildings, if the property purchasers themselves reap the benefits of the energy savings, and if they are aware of the potential savings. The extent of the savings, and thus the exact payoff period, will depend very much on the policy context. Factors like fossil fuel subsidies will reduce the savings made by green buildings, and the regulatory framework and any fiscal incentives will determine the costs and benefits of alternative sources of renewable energy.

Even when there are clear savings to be made, the growth in demand for green buildings can be hampered of lack of awareness of the longer term cost savings, short termism on the part of property buyers, limited access to finance for investment in the upfront costs associated with green buildings, and situations where those who pay the energy bills are not those who purchase the property (in the case of rented property).

The social benefits of green buildings will exceed the benefits to private property owners, given that carbon emissions and other pollution are costs which are not currently factored into prices, which is another important reason why the uptake of green buildings will be less than is desirable. In addition, there may also be constraints on the supply side, if for example, there are shortages of the necessary skills and knowledge in the construction sector, building materials, or energy efficient appliances.

Thus policy has a crucial role to overcome these market failures, and create appropriate incentives that will help to establish a viable market for green buildings. This can be achieved by strengthening the demand for green buildings through mechanisms such as tax incentives (including tax rebates, reduction of fossil fuel subsidies etc.), awareness raising, strengthening access to finance for the purchase of green buildings, procurement policies, and enhancing the reputational benefits associated with green buildings through awards etc. Or it can be achieved by driving change on the supply side: through green building regulations, standards and codes; building the knowledge and capacity of market participants in the supply chain such as SMEs; and enhancing access to the necessary materials, through reducing import duties on appropriate raw materials or appliances for example.

4.6.1 Drivers in the Indian context

Direction of policy in India

The FYP and the National Action Plan on Climate Change have highlighted green buildings as a focus area. The National Housing policies promote alternative technologies and a holistic approach to sustainability. A number of incentive mechanisms have been set up, as set out above. Thus it is clear that there is a national policy intent that could promote the growth of green construction in India. Following the national policies, some states have established byelaws based on the principles of sustainability and green construction. Byelaws on rainwater harvesting are the most widespread, and most new construction is incorporating this in their plans. Himachal Pradesh has taken a lead in making passive solar features mandatory for government buildings. Thus a start has been made in encouraging new construction to take into account green impacts.

Figure 7: Green Building Drivers

Trends in market demand

The market is beginning to respond to this policy direction set by government, to growing international interest in green buildings, and to the gradually increasing market demand (albeit mainly for government institutional buildings and commercial complexes). An increasing number of private developers are looking at investing in green construction and marketing their buildings as such. Corporates are also playing a major role in the promotion of green buildings as is evident from various examples, like the LEED-rated CII Sohrabji Godrej Green Business Centre in Hyderabad, Cognizant campus in Kolkata, Chennai and Coimbatore, and Infosys Technologies. They are promoting green buildings as a part of their CSR activities which in turn boosts their reputation. This trend is still largely restricted to commercial and office spaces rather than residential developments.

However, advertisements for some housing complexes now highlight that a building is green in their sales pitch and the growing popularity of the green-building rating systems also proffers evidence of growing interest. Admittedly, this is largely an upper-middle class trend since most green buildings are pitched as luxury apartments and structures. Coupled with appropriate marketing, this can provide a demonstration effect to make green buildings desirable.

The demand for green materials and equipment is also rising. The industry has introduced green materials such as blended cement, green paints, energy-efficient bricks, and energy-efficient lighting

devices and appliances. Production and manufacturing processes are also increasingly moving towards more efficient alternatives. This reflects both cost advantages, and the growing demand from government and wider society that sustainability considerations are factored in.

4.6.2 Barriers in the Indian context

Policy and regulations

While the national policy intent is clear, its application at the state and city level is not consistent. While some states have opted to incorporate certain features, this is not uniform across the country. Also the laws still follow a piecemeal approach. An overall sustainability approach that can be seen at the national level has not translated into a comprehensive set of laws and codes. The implementation of existing laws is also a major lacuna. There is a need to build and strengthen the capacities of regulatory bodies, especially at the local level, to ensure the effective implementation of these laws.

There is a lack of standardisation of alternative green materials and technologies that could help to reduce the costs of green construction. This prevents mainstreaming these materials as all buildings have to meet national building codes and local byelaws. Also, current policies do not simultaneously promote housing that is both affordable and green. The issues are encapsulated in Figure 8.

Figure 8: Green Building Barriers

Capacity and skills

The lack of technical capacities is one of the largest barriers facing the construction sector generally, and is seen at the levels of planning, design and construction. Policy-makers and planners do not look at planning spaces and buildings in a holistic and sustainable fashion, especially in relation to the municipal services and utilities. Sites often discourage designers who try to incorporate green features, precisely due to the lack of green planning. Moreover, there are not enough technical experts and masons qualified to construct green buildings.

In India, about 12 million people join the workforce each year, of whom only 4 million are skilled workers (FICCI & Ernest and Young, 2012). This illustrates the skill deficit in various sectors,

including building and construction, despite the fact that India has the world's second-highest working-age population (15–59 years) and the government is emphasising skills development. Only 6% of employees have the benefit of proper training and skills. The sector also faces an acute shortage of workers especially in mechanised trades and there has been a decline in the share of engineers in the construction sector. Moreover, it is hard to find workers who are knowledgeable about green building practices and sustainable design. India also faces a shortage of contractors. These shortcomings hamper the growth of green buildings in the country. Schemes such as NREGS have further eroded the number of new entrants in the construction sector since the unskilled or semi-skilled workforce no longer wishes to migrate if they can obtain employment locally.

Apart from the issue of shortage of workers, the training capacity of the country is also inadequate. Only about 500,000 people each year obtain training, which is very low compared to the requirement of 3.5 million trained and certified workers. Although the government has launched skill-upgrading schemes, they remain inadequate. Only a few relevant trades are offered by the Industrial Training Institutes. The technical training of masons and engineers is not organised on a regular basis and it is hard to obtain industry-sponsored apprenticeships. The training and skill-certification programmes of the Construction Industry Development Council (CIDC) have been introduced only in a few states like Bihar, Haryana, Madhya Pradesh and Rajasthan and the programme has yet to be expanded. The government and the industry need to collaborate to promote the training and skill-upgrading of the workforce, and to explore the financial options to do so. Apart from such initiatives, there is a need for innovative schemes in the construction sector to promote green building practices. Tools for training university students and professionals must also be further developed and disseminated since India is in need of green building experts.

Initiatives for skill development in the construction sector

There have been a few initiatives to develop workers' skills in the construction sector. CIDC provides short-term skill-development programmes and training courses. It aims to train 20 million people by 2022. The 64 HUDCO building centres offer similar courses.

NREGA, Swarnjayanti Gram Swarozgar Yojana, Swarna Jayanti Shahari Rozgar Yojana are some of the government-sponsored skill-development programmes for both urban and rural areas. The Construction Industry Vocational Training Council has been set up at the national level to provide training to vocational and supervisory cadres in the construction industry.

Awareness and understanding of benefits

There is limited knowledge amongst the general population in India of issues around green construction and the availability of green products. When there is awareness, there is limited understanding of the potential cost savings over the longer term. The lack of empirical evidence on the costs and savings associated with green buildings makes it more difficult for people to assess the economic case for their uptake.

Another significant problem is that there is no strict definition of a green building. This means that buildings could be marketed as green in spite of the fact that they do not actually abide by the standards expected, and will thus not deliver the expected benefits. This is likely to undermine the quality and the share of the green construction market.

5 Conclusions

5.1 Action to progress green buildings in India

In this final section, lessons from the literature review, information from interviews and findings from a stakeholder workshop held on 31 July 2013, are used to draw key conclusions and recommend possible steps forward.

The global literature review identified the following areas as key to the development of green building:

- Policy packages that are targeted, consistent and coordinated
- Private-sector involvement in green construction
- Developed markets for energy and resource efficient technology, skills and materials
- Finance for green construction, including materials supply
- Monitoring, data collection, and information sharing
- Raising awareness and public profile.

The review of green building in India in Section 4 suggests there are three broad areas for further action to develop this market: policy and regulation, capacity and skills, and awareness and understanding of the benefits. The recommendations for action identified in the stakeholder workshop, which was attended by representatives from 15 organisations (including donors, NGOs and governments – see Annex 2 for a full list), included suggestions on codes and regulation; capacity, skills and jobs; finance and economics; and market development (presented in Annex 3). Together, these discussions indicate more specific suggestions for action to develop the market for green buildings in India, discussed below and summarised in Table 8.

5.1.1 Policy and regulation

India's existing and planned regulations for green buildings provide a reasonable degree of guidance to facilitate a greater share of green buildings in the construction market. The challenge lies in their adoption and effective application. The addition of 'Part 5: Approach to Sustainability' in the National Building Code (NBC) will provide guidance to planners and developers, but to achieve the full potential for efficiency gains and emission reductions, it is recommended that its standards be incorporated into state byelaws across India, adapted as necessary to suit the state or municipal context, including the local climate.

The approach of developing and disseminating model byelaws has contributed successfully to the mainstreaming of good practice in earthquake-risk reduction, and could do the same for resource efficiency. One option, therefore, is that the model byelaws provided by the Ministry of Urban Development be adapted to include the new Approach to Sustainability. The effectiveness of model byelaws for sustainability could be further enhanced by raising awareness of the advantages of green construction among state and municipal legislators and senior officials.

The enforcement of mandatory regulations will be necessary to ensure that the potential resource savings from green construction are realised. This will require action on the part of state and municipal governments, although the task could be contracted out to and undertaken by private-sector organisations, hence creating an additional market for expertise in green building. Dissemination and transparency of information about performance in meeting standards would also contribute to improving compliance. Performance-linked incentives (e.g. tax concessions for buildings that meet

sustainability standards) could also be used to enhance compliance and encourage green construction when the private returns do not provide enough incentive. Removal of fossil fuel subsidies – by raising the cost of energy - would strengthen economic incentives for energy efficient green buildings considerably.

The voluntary codes and green building rating schemes (e.g. GRIHA and LEED) complement statutory regulations by going beyond the minimum and encouraging good practice. The IGBC has initiated voluntary assessments of performance but it will be important in future that the performance of certified buildings over time, for example on energy consumption, is systematically assessed or audited to ensure that promised resource efficiencies are achieved and to maintain the reputation of the rating scheme.

Standards for green building materials and products need to be developed and adopted. This will entail the testing and certification of alternative building materials and the introduction of rating schemes for sustainable building products. The incorporation of Part 5 of the NBC in state byelaws will encourage the development of national supply chains for these goods, often helping to reduce unit costs and reduce high-cost imports, while the certification of materials would help to strengthen the market by giving assurance to buyers. Public buildings can also play a significant role in demonstrating sound practices, procurement of resource-efficient products and for training purposes.

Financial incentives for green buildings, such as lower local government taxes or, as in Noida, floor area ratio (FAR) concessions, would encourage development of the green building market. Such incentives would need to be well-targeted and their effectiveness verifiable to avoid earmarked funds being used for other purposes.

The expansion of green construction would be facilitated by better access for green building developers to financial mechanisms, and it could be encouraged by financial incentives. Financial mechanisms are also needed to enable building owners to finance the higher initial investment cost from savings achieved during a green building's occupation. Improved coordination between financial institutions and re-financing bodies could help to increase the investment funds available for green buildings, as has occurred through the KfW partnership with the National Housing Bank. The availability of data and analytical tools for lenders would help increase confidence in investment in green building.

MSMEs in the construction and building materials sectors face a diverse and complex range of potential financial mechanisms, which makes it difficult for them to obtain investment capital. A streamlining of financial mechanisms for construction MSMEs through the Small Industries Development Bank of India (SIDBI) could facilitate improved access to investment capital.

5.1.2 Capacity and skills

There is a need to strengthen the capacity of the construction sector to design and build green buildings. There is a lack of appropriately trained professional personnel, and of technical and skilled labour. To address this, sustainability should be integrated into all relevant professional curricula, and professionals and technical staff should be certified for green construction. Lists of certified personnel should be made available to enable developers to call on their services, as has been done for energy auditors.

Skilled labour in the construction sector also needs to have skills and experience appropriate for green construction. The shortage of skilled labour could be addressed by revising the eligibility for Industrial Training Institutes (ITIs), and including green building in the training they offer.

The capacity of producers to supply green building materials and products needs to be developed. This will entail building supply chains for these goods, while developing the overall market for green buildings, so that demand and supply grows in tandem. Development of the supply chain will be facilitated by the inclusion of Part 5 of the NBC in state byelaws and by the adoption of standards for green building materials.

Table 8: Possible policy action to promote green buildings in India

Action	Rationale	How to deliver
Incorporate sustainability in state byelaws on building.	Limited uptake through voluntary codes only. Mandatory standards are necessary to mainstream green building.	Develop and promote use of model byelaws on green building. Raise awareness and knowledge among state and municipal legislators and officials. Ensure compliance.
Performance-linked incentives for compliance with codes.	Non-compliance with existing regulations and codes. Ensure certified buildings are and remain green throughout their life cycle. Develop supply chain for green building materials.	Raise awareness with government, green building rating schemes and certified building owners. Incentives to be linked to performance rather than to design/intent.
Introduce standards for green building materials.	Need to develop market for green materials and alternative technologies. Ensure consistency in resource-efficiency assessments.	Testing and certification of green building materials and products. Demonstration and promotion by non-government actors.
Integrate sustainability into all professional curricula.	Lack of skilled professionals for green building design and construction. Mainstream green practices among built environment professionals.	Raise awareness of government, universities/colleges and professional bodies. Develop appropriate curricula.
Develop skills and certify technical personnel and service providers.	Lack of skilled personnel. Need to improve ease of access to appropriate skilled personnel.	Technical training institutions introduce appropriate training and certification.
Revise eligibility criteria of Industrial Training Institutes.	Current requirements exclude many semi-skilled workers who could be trained to build green Need to increase the number of workers who can obtain green building qualifications.	Lobbying government, awareness of benefits to raise demand from educational institutions.
Streamline financial mechanisms for MSMEs	Current diversity and complexity of available financial mechanisms for MSMEs prevents access to capital. Increase MSME capacity for green construction activity.	Raise awareness of financial institutions.
Local government tax concessions for green buildings.	Create market drivers to encourage green building.	State and municipal government introduce targeted concessions.
Coordination between banks and re-financing bodies.	Need to increase capital available for green building. Improve flows of capital among actors. Increase confidence in green building market.	Banks, re-financing bodies, donors, government.

5.1.3 Awareness and understanding of benefits

As the number of green buildings in India and membership of IGBC have grown, information about green building in India has become more readily available. The study found, however, that there remain a number of significant knowledge and data gaps that could constrain expansion of this market.

One major gap is a lack of empirical information to allow a proper comparison between the actual costs of conventional and green buildings (investment and operating costs), even at an aggregated level. Estimates do exist, and key informants suggest the investment cost difference is narrowing, but Indian data on the actual initial capital costs for buildings (and on the costs of using them) are not in the public domain. It would be useful to have data – including for a range of different types of building used in India's different climatic zones – on the relative costs of green buildings.

A second significant gap is detailed data on the energy, water and other resource savings from green construction. The available estimates are mostly for energy consumption (see section 4.4 above), but the data offer limited information of actual savings achieved. The estimates also omit the energy embedded in building materials. Equivalent data for potential water-resource savings is even sparser. More comprehensive information, disaggregated by building type and climatic zone, and considering the embodied energy and water of materials as well as resource use during the construction and use of buildings, would help actors to identify areas of focus and priority, as well as guide incentive mechanisms. Better data would also facilitate investment in green buildings by developers and property owners, who require knowledge about the potential energy savings.

There are also information gaps relating to skills, expertise and financial services, that could constrain the efficiency of the market for green buildings. There is no readily available information about consultants, contractors and providers of green building services and products. The certification of professional and technical personnel for green buildings and making this knowledge public in the relevant city or state would help to address this gap.

Addressing these knowledge and information gaps would support the expansion of green buildings. Improving the availability of reliable information and knowledge about the advantages and disadvantages of green building would better inform the public and specific stakeholders and serve to remove the existing misperceptions that constrain the market. There is scope for NGOs and research institutes such as CSE and TERI to undertake research to fill this gap in the evidence base, and to publicise the information obtained and undertake awareness raising and policy engagement activities.

5.2 Potential areas of focus for GIZ

The focus of this study was to determine the state of the green building sector in India and the potential for supporting its development. More specifically, it sought to identify ways that GIZ could contribute to advancing green building in India through private-sector development initiatives. Green building is potentially relevant to three of the main thematic areas of GIZ in India: sustainable economic development, the environment, and energy.

In the area of sustainable economic development, there are potentially three areas where GIZ's Private Sector Development programme could engage with the green-building agenda: financial institutions and finance for green building, SME development and employment creation.

The vast majority of businesses in India's construction sector and building materials industry are MSMEs. They find it hard to obtain capital for investment in new resource-efficient technologies, including being able to choose the most appropriate financial mechanism for their needs. Working capital can also be difficult to secure. **It is recommended, therefore, that GIZ consider working with the SIDBI and other relevant financial institutions and the enterprises in the construction sector to improve and streamline the supply of capital finance to MSMEs in the construction sector and building materials industry.** This could include strengthening the capacity of MSMEs to obtain and manage finance.

MSMEs also lack knowledge and skills for resource-efficient building techniques and production of building materials. GIZ should consider working with relevant business associations, including the IGBC, to increase the awareness of approaches to green building among MSMEs in the construction sector and building materials industry. This could include strengthening the capability of such enterprises to select between green options for both design and materials.

There is a shortage of skilled and trained workers throughout the construction sector in India and training institutions are unable to meet the shortfall. This presents an opportunity to strengthen the green building capability of the sector by supporting training capacity as a means to enhance the relevant skills and knowledge. **It is recommended that GIZ consider working with Indian technical training institutions to improve their capacity to provide skills training for the construction sector (e.g. through curriculum development or new training methods), with a focus on green building skills and skills for MSMEs.** This could be done in collaboration with larger construction enterprises.

At the stakeholder workshop it was suggested that various, often disconnected, actors in the green building sector should collaborate to produce a roadmap to plan actions and interventions which would help develop the market for green buildings in India, and that the pursuit of this roadmap should be monitored over time. Such a roadmap should set out a range of immediate ('easy win'), medium-term (two to five years) and longer-term objectives (up to 15 years, i.e. beyond conventional national plan periods). This could have the added benefit of bringing together, for a shared purpose, key players from the government, the private sector (industry, large corporates and SME representatives, financial institutions, accreditors and networks such as IGBC), research and educational institutions, and donors (including development finance institutions and non-profit organisations). **It is therefore suggested that GIZ consider taking an active role in convening stakeholders in order to develop such a roadmap.**

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Appendix

Annex 1 – Workshop Participants

Name	Organisation
Avikal Somvanshi	Centre for Science and Environment
Sakshi Dasgupta	Centre for Science and Environment
Sheetal Rakheja	Design & Development
George Varughese	Development Alternatives
Dr K Vijaya Lakshmi	Development Alternatives
Zeenat Niazi	Development Alternatives
Kriti Nagrath	Development Alternatives
D. Varsha	Development Alternatives
S. K. Gupta	Dychief (TDESOC), Building Material and Technology Promotion Council
Tanmay Tathagat	Environmental Design Solutions
Deepak Singhal	Ernst & Young
Dr Shailesh Agarwal	Executive Director, Building Material and Technology Promotion Council
Pragya Kothari	GIZ
Stefanie Bauer	GIZ
Justin Jebakumar	Habitat for Humanity
Usha Rao	KfW
Anupam Sisodia	Lead India
Kanha Ram	National Institute of Urban Affairs
Dr. Debolina Kundu	National Institute of Urban Affairs
Andrew Scott	Overseas Development Institute
Emily Darko	Overseas Development Institute
Dr Arun Kumar	TARA Machines & Tech. Services
Hina Zia	The Energy and Resources Institute
Dr. P K Nandi	UN-Habitat

Annex 2 – Expert Interviews

Ashok B. Lall, Architect

Vinod Gupta, Architect

Sanjay Prakash, Architect

Sameer Maithel, GRIHA Evaluator

Vishal Goyal, NHB

Kanwarjeet Nagi, KfW

Shailendra Agarwal, BMTPC

Ramesh Kumar, Swarna Pragati Housing Finance

Nalini Andrade, FEM

Bodhisatya Datta, UNDP-GEF-BEE

Hina Zia, TERI

Arun Gupta, Earth Infrastructure Pvt Ltd

Waseem Alam, Green Solution

Niharika Jain, Fortune Questa

Sophia Joseph, Habitat for Humanity

Marco Bonetti, UNEP-SUSHI

Ripin Kalra - Architect, University of Westminster

Vincent Kitio - Energy Efficiency and Renewable Energy, UN Habitat

Annex 3 - Priority actions suggested at the workshop

Group Discussion Area	Suggested Action
Codes and Regulations	Sustainability mainstreamed in byelaws
	Performance-linked incentives for compliance with codes
	Codes and standards, testing and certification of building materials
Capacity, skills and job creation	Sustainability integrated into professional curricula, and raising awareness.
	Skill development and certification – making available lists of certified service providers and professions
	ITIs – review eligibility criteria
Finance and Economics	Streamlining financial mechanisms for MSMEs (SIDBI)
	Earmarked funds for energy efficiency
	Lower local government taxes (tax concessions)
	Coordination between banks and refinancing bodies
Market Development	Project financing incentives for developers
	Enforcement of regulations
	Build the supply chains for materials, contractors, labour (skills)
	Focus on luxury homes to make green attractive
	Build awareness by commercial means for demand creation; certification helps.

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