POLICIES AND STRATEGIES ON SUSTAINABLE BUILDINGS IN INDIA

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Summary

The Indian construction sector is growing annually at a rate of 10%, adding approximately 1% of the world's total built up in India alone. Considering the significant energy use by the buildings in India, several policy initiatives have been directed to minimize the detrimental impact of construction on the environment; especially on management of energy end use in residential and commercial buildings; and integration of renewable energy in new and existing buildings. It is required that implementation and enforcement of these policies attain impetus for an effective impact on the environment and society.

This paper provides an overview of the energy saving potential and measures that may be adopted to achieve the same in India. Further, policy tools available to achieve energy efficiency and mitigate carbon emissions from the building and construction sector have been described briefly.

An example of the station building of the Delhi Metro Rail Corporation Ltd. at HUDA City Centre, Gurgaon has been taken up to showcase compliance with various policies and the subsequent energy and cost savings for the project.

Keywords: Sustainable building policies, emission reduction potential, DMRC station buildingIntroduction

With an annual population growth rate of 1.58%[1], India is experiencing a consistent rise in urbanization. According to the Census of India, 41.1% of total Indian population would be in urban areas by 2030. This strong demographic movement indicates increased demand for housing and commercial spaces, thereby providing a further push to the rising growth in the construction sector. The rising trends in construction activity indicate a sustained growth of 10% in the coming years[2]. The year 2004-05[3] experienced a 40.8 million square meter increase in the gross built up area of commercial and residential spaces (which is about 1% of annual average constructed floor area around the world).

With a near consistent 8% rise in annual energy consumption of the residential and commercial sectors, the building energy consumption in India has seen a significant growth from a low 14% in the 1970s to nearly 33%[4] in 2004-2005. As per TERI estimates, there is an annual increased demand of about 5.4 billion units (kWh) of electricity for meeting end-use energy requirement for residential and commercial buildings. This is in addition to energy requirements for manufacturing of building materials/ equipment and

[1] Source: www.censusindia.gov.in
[2] Source: Construction Industry Development Council, India. India Country Report, 2005-06; 801, Address: Hemkunt Chambers, 89, Nehru Place, New Delhi 110019
[3] Source: Construction Industry Development Council, India. India Country Report, 2005-06; 801, Address: Hemkunt Chambers, 89, Nehru Place, New Delhi 110019
[4] Ministry of Statistics and Program Implementation, Government of India, 2006

energy used during construction (comprising the embodied energy of materials and machinery).

The electricity consumption in buildings gives rise, directly and indirectly, to as much as 30%[5] of CO2 emissions (19% from the residential sector and 10% from the commercial sector) and represents more than a third of global consumption. The demand for energy to run appliances such as televisions, air conditioning and refrigerators is also increasing substantially with rise in living standards.

Climate change will further increase site energy demand as people shall seek to maintain comfort levels in more extreme conditions. This puts additional pressure on the emissions balance, which needs to be countered by achieving energy efficiency improvements. Energy efficiency in the residential and commercial building sector could contribute in reduction of green house gas emissions. The following section highlights the energy saving potential and measures that could be adopted to achieve the same.

1 Energy saving potential and measures in new buildings

Energy efficiency measures can help achieve a 30% energy savings in new residential buildings and 40% energy savings in new commercial buildings. Savings in new buildings can be achieved through a combination of passive solar architectural measures and energy efficient systems, equipment, appliances and renewable energy systems such as solar water heating systems or solar photovoltaic systems. Use of control devices for lighting and space conditioning can save further.

As highlighted in Table 1, of the 30–40% achievable savings in residential and commercial buildings, about 10-15% is achievable through proper passive design interventions (e.g. bio-climatic architectural interventions such as proper orientation, appropriate window and shading systems, insulation, high performance glazing etc.) Energy efficient lighting can save 5-15% of energy consumption in residential and commercial buildings respectively. Energy efficient space conditioning that has larger application particularly in commercial buildings can further save 15-20%. Solar water heating systems have potential of nearly 10% energy savings in residential application.

Tab. 1 Some energy-saving options for residential and commercial buildings

Measures in residential and commercial buildings	**Savings Potential (% of total energy consumption)**	
	Residential buildings	**Commercial buildings**
Proper orientation, Fenestration, Shading, Roof & Wall insulation	15%	10%
Energy Efficient lighting (internal)	5%	15%
Solar water heating	10%	-
Energy efficient space conditioning	-	15%
Total	30%	40%

Considering the significant energy use by the buildings in India; and energy saving potential as mentioned above (table 1), several policy initiatives have been directed to minimize the detrimental impact of buildings on the environment. The following section of

[5] Source: www.wbcsd.org

the paper briefly describes government policies and tools especially for management of energy end use in residential and commercial buildings, and integration of renewable energy in new and existing buildings.

2 Policy scenario with reference to energy efficiency in new buildings

2.1 Energy Conservation Building Code (ECBC) 2007

The ECBC sets minimum energy performance standards for commercial buildings. Under the Energy Conservation Act, 2001, Central Government has powers to prescribe ECBC for commercial buildings (at present for buildings with a connected load of 500kW or contract demand of 600kVA) or building complex for efficient use of energy and its conservation. The state governments have the flexibility to modify ECBC to suit local or regional needs. The ECBC is presently applicable on voluntary basis and is expected to be made mandatory in future.

The code covers minimum requirements for building envelope, mechanical systems and equipment, including heating, ventilation and air conditioning (HVAC) system, interior and exterior lighting system, service hot water, electrical power and motors in order to achieve energy efficiency in different climate zones of India. The objective of the ECBC is to reduce the baseline energy consumption by supporting adoption and implementation of efficiency measures in buildings.

2.2 Standards & Labeling Scheme

The Bureau of Energy Efficiency (BEE) has several programs which target high energy end use equipments and appliances to lay down minimum energy performance standards. Labeled products (refrigerators, air conditioners, motors and other appliances) have been in the market since 2006. Each appliance is ranked on a scale of five stars, with more stars indicating higher efficiency and more power savings – thus the program motto of "More Stars, More Savings!"[6] The labels provide information about the energy consumption of an appliance, and thus enable consumers to make informed decisions.

To widen the scope for energy savings, BEE has included several widely used equipments & appliances such as Distribution Transformers, Motors, Colour TVs, Ceiling Fans, Geysers, LPG Stove and Agricultural Pumps under 'Standards and Labeling' programme in 2008-09.

2.3 Initiatives of the Ministry of New and Renewable Energy (MNRE)

MNRE has initiated several programmes focusing on the utilisation of renewable energy sources in buildings. The MNRE has a solar buildings programme that provides financial support for the design and construction of energy efficient and solar passive buildings[7]. Emphasis during the tenth five-year plan (2002-2007) was to provide central financial assistance for the development of efficient building guidelines to be implemented by community housing development organizations or corporations and to encourage the adoption of building integrated photovoltaics (BIPV).

6 Bureau of Energy Efficiency, Appliance Efficiency Standards <http://www.bee-india.nic.in/Implementation/Standards%20&%20Labellings.html>
7 Ministry of New and Renewable Energy <http://mnes.nic.in/>

In addition to states such as Haryana, West Bengal, Karnataka, Rajasthan, Uttaranchal, and Andhra Pradesh, cities such as Bangalore, Thane, Nagpur and Rajkot, solar water heating is mandatory/ incentivised for certain types of buildings.

The MNRE has also launched and incentivised GRIHA (Green Rating for Integrated Habitat Assessment) as a national rating system.

2.4 Building Rating systems

2.4.1 Environmental Clearance for large construction projects (Ministry of Environment and Forests)

The Ministry of Environment and Forests (MoEF) has established mandatory norms and standards for environmental clearance of large construction projects. All new construction projects are appraised on the basis of the norms and standards by both the Expert Appraisal Committees (EACs) at MoEF and State Expert Appraisal Committees (SEACs) at the State/ UT level. The EACs/ SEACs grade the projects as Platinum (90-100 points), Gold (80-89 points), Silver (60-79 points) and Bronze (40-59 points). Buildings receiving lower than 40 points would not receive environmental clearance.

The State Pollution Control Board is responsible for verifying that the Environmental Management Plan is complied with during construction and post-construction and that all proposals that resulted in the given rating are also followed through appropriately.

For buildings and construction projects larger than built up area of 20,000 sq m, compliance with the Energy Conservation Building Code is mandatory, thereby contributing to energy savings[8] .

2.4.2 Green Rating for Integrated Habitat Assessment (GRIHA)

Endorsed by the MNRE, GRIHA is a five star rating system for green buildings which emphasises on passive solar techniques for optimizing indoor visual and thermal comfort. In order to address energy efficiency, GRIHA encourages optimisation of building design to reduce conventional energy demand and further optimise energy performance of the building within specified comfort limits. A building is assessed on its predicted performance over its entire life cycle from inception through operation.

GRIHA was developed as an indigenous building rating system, particularly to address and assess non-air conditioned or partially air conditioned buildings. GRIHA has been developed to rate commercial, institutional and residential buildings in India emphasizing national environmental concerns, regional climatic conditions, and indigenous solutions. It integrates all relevant Indian codes and standards for buildings (as mentioned above) and acts as a tool to facilitate implementation of the same.

2.5 National Action Plan on Climate Change (NAPCC): Mission on Sustainable Habitats

As a response to combat the impacts of climate change, the Prime Minister's Council on Climate Change has released India's National Action Plan on Climate Change (NAPCC) on June 30, 2008. The NAPCC, along with its eight missions[9], serves as the first country-

8 MoEF and MoP, GoI (2007) India: Addressing Energy Security and Climate Change http://envfor.nic.in/divisions/ccd/Addressing_CC_09-10-07.pdf

9 The eight missions of the NAPCC are:

wide framework on climate change with the approval and support of the Government of India. These eight NAPCC missions map out long term and integrated strategies to achieve key national goals from the climate change perspective. The NAPCC identifies measures that promote development objective of the country while producing co-benefits that address climate change effectively.
The National Mission on Sustainable Habitat comprises three components, namely,

- Promoting energy efficiency in the residential and commercial sector
- Management of municipal solid wastes, and
- Promotion of urban public transport

In an attempt to promote energy efficiency in the residential and commercial sectors, the mission emphasises on the extension of the Energy Conservation Building Code (ECBC), use of energy efficient appliances and creation of mechanisms that would help finance demand side management.

2.6 Electricity from renewables

The Electricity Act, 2003, requires State Electricity Regulatory Commissions to specify a percentage of electricity that the electricity distribution installed renewable capacity over 11,000 MW. Of this, a little over 7,000 MW is based on wind power. India now has the fourth largest installed wind capacity in the world. The National Hydro Energy Policy companies must procure from renewable sources. Several Commissions have already operationalised this mandate, and also notified preferential prices for electricity from renewables. This has contributed to acceleration in renewable-electricity capacity addition, and over the past three years (2005-2007), about 2000 MW of renewable-electricity capacity has been added in India every year, bringing the total has resulted in the accelerated addition of hydropower in India, which is now over 35, 000 MW.

In the eleventh five-year plan (2007-2012), the outlay for non-conventional energy has been enhanced from the tenth five-year plan. Fifteen hundred remote villages would be targeted by the government for electricity/ lighting facility through Solar Photovoltaic/ other renewable energy systems and devices.

Various State authorities such as the Rajasthan Electricity Regulatory Commission and the Gujarat Electricity Regulatory Commission have implemented mandatory renewable energy purchases as well[10].

3 Policy scenario with reference to energy efficiency in existing buildings

3.1 Energy Auditing

In March 2007, the conduct of energy audits was made mandatory in large energy consuming units in nine industrial sectors. These units, notified as “designated consumers”

National Solar Mission, National Mission for Enhanced Energy Efficiency, National Mission on Sustainable Habitat, National Water Mission, National Mission for Sustaining the Himalayan Ecosystem, National Mission for a Green India, National Mission for Sustainable Agriculture, and National Mission for Strategic Knowledge for Climate Change
10 Rajasthan Electricity Regulatory Commission, Renewable Energy Obligations www.rerc.gov.in/reg/RE_Obligation_Regulations.pdf
14 Gujarat Electricity Regulatory Commission Regulations “Power Procurement from Renewable Sources” http://www.gercin.org/main/REGULATION_FULL.HTM

are also required to employ "certified energy managers", and report energy consumption and energy conservation data annually.

Bureau of Energy Efficiency (BEE) and the Central Public Works Department (CPWD) have also partnered to train a team of energy audit consultants to perform audits of several important government buildings and to contract the implementation of the recommendations. They expect annual savings of more than 30 GWh per year with payback of less than two years.

3.2 Scheme for star rating of office buildings

In order to accelerate the energy efficiency activities in commercial buildings, BEE has developed the scheme for star rating of buildings. The programme is based on actual performance of the building, in terms of specific energy usage in terms of kWh/sq m/year. The programme rates office buildings on a 1-5 Star scale with 5 Star labeled buildings being the most efficient. Five categories of buildings, namely office buildings, hotels, hospitals, retail malls, and IT Parks in five climate zones in the country have been identified so far.

4 Emission saving potential from buildings in urban India

The above-mentioned policies and strategies to achieve energy efficiency direct the buildings and construction sector towards reducing electricity consumption and hence associated carbon emissions. In a study conducted by TERI (2009), compliance with the existing policy initiatives shall enable a 47.5% reduction in electricity based emissions from new and existing buildings by 2020 (Figure 1).

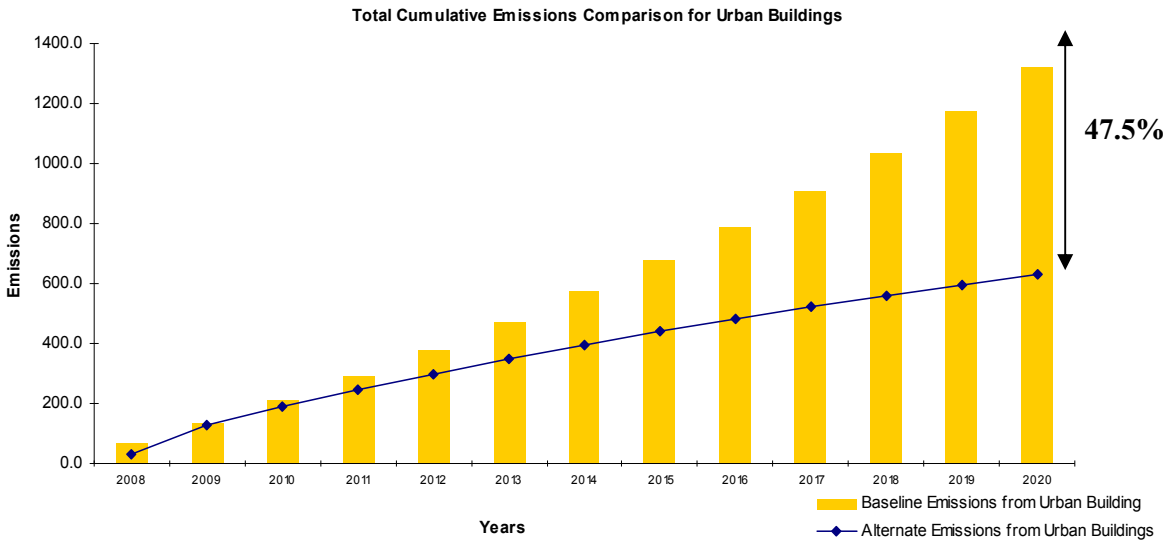

Fig. 1 Baseline Emissions and Saving Potential from buildings in urban India: 2008-2020 (Baseline Scenario versus Alternate Scenario)

As an example, the following case study of the Delhi Metro Rail Station, which is a GRIHA compliant building, exhibits the savings (energy and cost) that may be achieved when a project complies with the various policies of the government.

5 Case study: Station building of the Delhi Metro Rail Corporation Ltd. at HUDA City Centre, Gurgaon

The Delhi Metro Rail Corporation (DMRC) station at the HUDA City Centre (Figure 2), Gurgaon shall be the first GRIHA compliant metro station in India. Subsequently, the project shall comply with the applicable national standards and benchmarks such as:

- Energy Conservation Building Code (ECBC) 2007
- National Building Code 2005 and other IS Codes
- Local bye-laws
- The mandatory norms and standards for environmental clearance for large construction projects, issued by Ministry of Environment and Forests
- Programmes focusing on the utilization of renewable energy sources in buildings (such as the Solar Buildings Programme by the Ministry of New and Renewable Energy); and
- State Pollution Control Board guidelines

Fig. 2 Upcoming DMRC station at the HUDA City Centre

Various design interventions incorporated to reduce the load requirement and energy consumption for the operation of the building include:

- Mitigation of heat island impact by using vegetated pergolas along with the roof and other paved areas topped with finishes having solar reflectance of 0.5 or higher;
- Incorporating ECBC compliant roof, wall and fenestration specifications;
- Integration of daylight;
- Efficient indoor and outdoor lighting; and
- Pre-cooling of fresh air by energy recover ventilators (ERVs).

Overall, integration of mitigation strategies to minimize heat island effect, compliance with ECBC, daylight integration in perimeter zone, efficient indoor and outdoor lighting, and pre cooling of fresh air by ERVs shall result in reducing the air conditioning load from 1500 TR to 875 TR, i.e. achieving a reduction of 42%. The approximate avoided cost of load reduction is estimated to be USD 800000/-.

Further, parameters incorporated to reduce energy consumption by the building include:

- AHU fan with variable fan Drive (VFD)
- Secondary chilled water pumps with VFD
- Energy efficient screw chillers with IKw/TR = 0.642
- Efficient cooling tower

Compliance with the above parameters shall result in reducing the Energy Performance Index (EPI) from 214 kWhr/m^2/annum to 128 kWhr/m^2/annum, i.e. achieving a 40% reduction in EPI. As a result, approximately, 3,625,126 kWhr units of electricity shall be saved, amounting to an annual saving of USD 463000/-.

The building also integrates a solar farm above surface parking canopies shall generate 28 KW of electricity.

6 Conclusion

Energy efficiency in the residential and commercial building sector can contribute to up to 40% energy savings in new buildings. A combination of measures as mentioned in the paper could be used to achieve the same. In order to mainstream green buildings in India, and contribute to energy efficiency, several policy tools and programs exist in the country. The National Action Plan on Climate Change (NAPCC) launched in 2008 provides an integrating platform to existing policy. The Green Rating for Integrated Habitat Assessment (GRIHA), the national rating system for green building provides an implementation platform to all relevant existing policy initiatives, including those to promote energy efficiency. The case study of the DMRC station building at HUDA City Centre, Gurgaon highlights how a GRIHA compliant building integrates the ECBC and the NAPCC; and directs the buildings and construction sector of India to follow a low carbon strategy.