Background paper for

Sustainable Buildings and Construction for India: Policies, Practices and Performance

Influence of Indian buildings on Climate change

Preamble

India has rich traditions and history in holistic strategies for buildings and construction. Despite this the sustainable buildings agenda currently receives limited attention in India. While there are some local initiatives promoting sustainable buildings which include research, pilot or advocacy projects, there is no coordinated approach to address the wider sustainable buildings agenda in India.

The proposed Roundtable on Sustainable Buildings and Construction in India will address these issues and bring together key stakeholders in the private and public sectors to share perspectives and ideas on what are the barriers and opportunities for achieving a market transformation towards sustainable buildings in India.

In this regard, UNEP's Sustainable Buildings and Construction Initiative (SBCI) in association with TERI and Marrakech Task Force are working together to establish knowledge on the base-line emissions from buildings in India, highlight priority issues and opportunities for sustainable buildings and identify a network of experts that can contribute to the aims of Sustainable United Nations (SUN) and SBCI. The intent of this roundtable is to get a consensus and useful inputs from the various stakeholders and participants of this roundtable on the above issues.

Existing Building scenario in India: a brief

India, the seventh largest country in the world, is a leading economy and home to over one billion people living in various climatic zones. The country's economy has been growing at a fast pace ever since the process of economic reforms started in 1991. Construction plays a very important role in its economy contributing on an average 6.5%[1] of the GDP. Commercial and residential sectors continue to be a major market for

[1] JLLM, 2007, Accelerating Transformation :Investments in Indian Real estate, Knowledge Centre-White paper series volume 2:2, Jones Lang Lasalle Meghraj

the construction industry. The sectors consume a lot of energy throughout the life cycle of buildings thus becoming a major contributor to greenhouse gas emissions.

Given the spiraling urban growth, the number of buildings, energy consumption and the resultant carbon emissions is on a rise in the country. As per the 17th Electrical Power Survey (EPS) of the Central Electricity Authority, the electricity demand is likely to increase by 39.7% in 2011-12 as compared to 2006-07, by another 43.7% in 2016-17 as compared to 2011-12 and by yet another 37.5% in 2021-22 as compared to 2016-17. With a near consistent 8% rise in annual energy consumption in the residential and commercial sectors, building energy consumption has seen a increase from 14% in the 1970s to nearly 33% in 2004-05. Electricity use in both residential and commercial sectors is primarily for lighting, space conditioning, refrigeration, appliances and water heating.

The rural residential sector continues to rely heavily on traditional non-commercial fuels such as fuel wood and dung. As per 2001 Census of India, only 43.5% of rural households have an electricity connection and more than 85% of electrified rural households use it for lighting purpose only. The urban sector depends heavily on commercial fuels for its energy needs. It is estimated that on an average in a typical commercial building in India, around 60% of the total electricity is consumed for lighting, 32% for space conditioning, and less than 8% for refrigeration. Whereas in a typical residential building, around 28% of the total electricity is consumed for lighting, 45% for space conditioning, 13 % for refrigeration, 4% for televisions and 10% for other appliances[2] in urban sector. The average electricity consumption for space conditioning and lighting in India is around 80 kWh/m^2/annum and 160 kWh/m^2/annum for residential and commercial buildings respectively. Under a Business As Usual (BAU) scenario and based on a 10% annual increase in new built-up area, the projected annual increase in electricity demand in commercial and residential buildings would be 5.4 billion kWh[3].

Energy consumption in Indian buildings is expected to increase substantially due to economic growth, construction growth and human development. The demand for energy to run appliances such as TVs, air conditioning and heating units, refrigerators and mobile phone chargers will increase substantially as living standards rise in India. Also the growth in commercial sector and the shift from rural to urban living will continue to take place. This will result in a substantial increase in resultant emissions from the buildings sector alone and need concerted efforts to bring down the energy consumption by buildings through various measures.

The IPCC Fourth report also reiterates the necessity of taking appropriate efforts to bring down carbon emissions from the buildings sector. In its comparative study of the energy savings potential of the building sector with that of other economic sectors, it is observed that the building sector has the greatest potential among all sectors, in all countries, and at all cost levels. This holds true for India as well given the high growth rate in construction industry. This study is thus a timely first step in this direction to draw an enabling path to minimize carbon emissions from the buildings sector.

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[2] CMIE, 2001, Economic Intelligence Service Report 2001, Centre for monitoring Indian economy, Mumbai, India
[3] TERI estimates

Baseline energy-performance and associated greenhouse gas emissions

Baseline energy performance of a building type is defined as the typical energy consumption of a particular building type in a given geographical area using the prevalent technologies and construction method and building materials(energy performance tend to change drastically with change in climatic zone, nature and function of the building). Very few studies are available on the baseline energy-performance of buildings of various types situated in different climatic zones of India and even those available are limited in scope. In the absence of such a study, an attempt is being made to develop baseline energy-performance and associated greenhouse gas emissions for the major building types in India.

The methodology for arriving at baseline energy-performance and associated greenhouse gas emissions is hereby explained.

- Building typologies covered:

a) Commercial: This constitutes a wide array of building types such as offices, institutions, hotels, IT parks, shopping malls, retail markets, etc. The prime energy consuming and representative building type under this category for India are fully air-conditioned offices and hotels which shall be taken up for this study.
b) Residential: This constitutes single and multiple dwelling type units and ranges from non-air-conditioned to partially and fully air conditioned single and multi-storied buildings. For this study, partially and non air-conditioned residential buildings will be considered.

- Climatic zones :

  India is a land of different climatic conditions varying from very hot and dry to very cold and humid. The characteristics of each climate differ and accordingly the comfort requirements vary from one climatic zone to another. Based on the intended use, comfort requirements and design type, the energy requirement of buildings change. There are five climatic zones based on the hourly temperature, various climatic parameters and solar radiation:

  I. Composite
  II. Hot-dry
  III. Moderate
  IV. Warm-humid
  V. Cold

  However, for the given study representative samples of the two building typologies shall be undertaken from three prominent climatic zones, viz., composite, hot-dry and moderate, for both existing buildings and data on the energy consumption, use of renewable energy (if any), built-up area and resource conservation measures shall be collected from published and unpublished literature, interviews and field visits, if possible. Based on the collected data, baseline energy performance in terms of average EPI[4] will be calculated. Once the average baseline EPI has been arrived at, it will be

[4] EPI stands for Energy performance Index which gives the total electricity consumed per sq. metre by a building annually and measured in kWh/sq.m./annum

multiplied by the average Carbon emission factor as given by CEA to arrive at the baseline greenhouse gas emissions from the selected building types.

Zero net emissions in existing and new buildings:
Zero net emissions are accounted for Zero-energy buildings. Zero energy buildings are defined as buildings that produce as much energy as they consume over a full year. `Zero energy' states that the energy produced on-site through renewable sources (such as wind, sun) is equal to the energy used by the building when annual accounting is done[5].
Based on the above concept of zero-energy buildings an attempt will be made to calculate the quantitative figure as to how far the identified building typologies are from zero net emissions. A simplistic formula representing this is given in Equation 1.

(Electricity consumption per year–Electricity generated from Renewable sources)* Emission factor= Annual Carbon emissions per building = Potential for reduction to reach zero emissions……Eq.1

COST ANALYSIS:
An attempt shall also be made to arrive at indicative costs of implementing various measures to assist in achieving:

- Zero-net emissions in new buildings by 2020 and 2030
- 30-80% reduction in emissions from existing buildings by 2020 and 2030

A list of indicative measures which will act as levers to bring energy-efficiency in buildings and to generate energy from renewable sources and their prevailing costs in the market shall be taken. Based on the identified measures and assumptions such as depreciation in the capital costs of various technologies once they become popular will be considered for arriving at the total indicative costs for each scenario by 2020 and 2030 for existing and new buildings.

Projections for 2020 and 2030
Projections and scenario building for 2020 and 2030 for indicative costs of implementing measures shall be based on Regression analysis. The independent variables which shall be considered for scenario building are as follows:

- Rate of growth of construction in commercial sector
- Rate of growth of construction in residential sector
- Population growth rate
- Migration rate from rural to urban areas

Appropriate statistical tools will be used to normalize data and to remove the anomalies.

Assumptions and Constraints

- Sample size: Sample shall not be statistically significant due to time and resource constraints and non-availability of such data at any level.
- Equitable representation from both public and private buildings will not necessarily be sought

[5] UNEP, 2007, Buildings and Climate Change: Status, Challenges and opportunities,

- Climatic zone: Samples from Composite zone, hot-dry and moderate zones only will be considered.
- Multistoried air-conditioned buildings are the dominant commercial building type in India
- Energy consumption in various systems (lighting, air-conditioning, heating, equipments and appliances, power generation, etc.) will not necessarily be taken for all the sample buildings.

State of play of 'Sustainable Buildings' in India

Sustainable is a buzz word, however, defining sustainability in buildings is a complex concept. There have been various popular definitions of sustainable buildings. USGBC (United States Green Building Council), one of the pioneers in propagating green buildings across the globe state, "The term `green building' is synonymous with `high-performance building', `sustainable design and construction' as well as other terms that refer to a holistic approach to design and construction…..Green building design strives to balance environmental responsibility, resource efficiency, occupant comfort and well-being, and community sensitivity" (LEED-NC Version 2.1 Reference Guide). TERI, a not-for profit organisation working in the field of sustainable development defines it as, "A Green building is designed, constructed and operated to minimize the total environmental impacts while enhancing user comfort and productivity" (GRIHA, 2008).

Some of the key attributes of Sustainable buildings are as under[6]:

- Consideration of sustainability aspects in all phases of building design and planning
- Consideration of sustainability aspects during construction and production of building materials
- Use of healthy and environmentally friendly building materials and products
- Use of efficient systems
- Use of constructions and systems which are easy to maintain and service
- Safeguarding of high functionality, flexibility and adaptability
- Safeguarding of health and comfort of users, occupiers and visitors
- High aesthetic and urban design quality; high public acceptance
- Appropriate location with good access to public transportation services and networks

In a nutshell, sustainable buildings use less energy and water, generate less greenhouse gases, use materials more efficiently, and produce less waste than the conventional buildings over their entire life cycle[7].

Policy Environment

[6] UNEP SBCI and UNEP FI, …..Knowledge base report, UNEP Sustainable Buildings and Construction Initiative and UNEP Finance Initiative

[7] Cole, Ray. 2007. Energy use and Urban Buildings In Handbook on Urban Sustainability, Edited by: Nolberto Munier.

The country has a number of policy initiatives to mainstream energy efficiency and green buildings as control and regulatory instruments, including appliance standards, mandatory labeling and certification, energy efficiency obligations, and utility DSM(Demand side management) programs; economic and market-based instruments; fiscal instruments and incentives; support, information and voluntary action. Some of these are briefly explained in the following section:

- *Energy Conservation Building Code 2007*
  The Energy Conservation Act 2001 provides for the establishment of state energy conservation agencies to plan and execute programs. The Act led to the formation of Bureau of Energy Efficiency (BEE) that formulated the Energy Conservation Building Code (ECBC). It targets building energy efficiency and was introduced in the year 2007. This is the nation's first building energy code and aims to have a major impact on energy-efficiency in buildings. It is a voluntary code for all buildings with a connected load of 500 kW and most likely to become a mandatory code. It covers minimum requirements for building envelope performance as well as for 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 climatic zones of India.
- The Ministry of Environment and Forests (MoEF), Environmental Impact Assessment (EIA) and Clearance. This is a mandatory requirement for all buildings with a built up area above 20,000 sq. m and such projects have to be apprised by the MoEF's Environmental Appraisal Committees (EACs) and the State Environmental Appraisal Committees (SEACs).

- The Ministry of New and Renewable Energy has initiated several programs focusing on the utilisation of renewable energy sources in buildings.

- Sustainable Habitat Mission under the National Action Plan on Climate Change
  National Action Plan on Climate change was launched by the honourable Prime Minister, Mr. Manmohan Singh on June 30, 2008. It encompasses a broad and extensive range of measures, and focuses on eight missions, which will be pursued as key components of the strategy for sustainable development. These include missions on solar energy, enhanced energy efficiency, sustainable habitat, conserving water, sustaining the Himalayan ecosystem, creating a "Green India," sustainable agriculture and, finally, establishing a strategic knowledge platform for climate change. For the habitat mission, the strategies proposed aim at promoting efficiency in residential and commercial sector through various measures such as, change in building bye laws, capacity building, research and development in new technologies, education and awareness, etc., management of municipal solid wastes, and promotion of urban public transport.

- *Energy labelling of appliances*

BEE has several programs to set labels and energy efficient standards for refrigerators, air conditioners, motors and other appliances. Labelled products have been in the market since 2006. In a move to manage energy demands, BEE has made star rating for energy efficiency mandatory for a host of electrical appliances from September 20, 2008. The implementation of this mandate is yet to be seen.

City level regulations

A city has a final set of building guidelines in the form of building bye laws which are finally implemented at town and city level by the respective Development Authorities and Municipal Corporations/Municipalities. These byelaws however, currently have not been able to integrate the ECBC provisions and other sustainability parameters.

Rating systems

Building rating systems are a popular tool to bring momentum in achieving energy efficiency and sustainability in buildings. The country has currently two rating systems namely, LEED and GRIHA.

a) Leadership in Energy and Environmental Design (LEED) :

The Leadership in Energy and Environmental Design (LEED) Green Building Rating System™, developed and managed by the USGBC, is the most widely used rating system in North America. Buildings are given ratings of platinum, gold, silver, or "certified", based on green building attributes. LEED is evolving rapidly; in the United States, at least nine types of specific programs exist, including those for new commercial construction and major renovation projects, existing building operation and maintenance, commercial interiors, homes, schools, neighborhoods and retail. USGBC is also developing LEED® for Healthcare, and LEED for Labs.

The Indian Green Building Council (IGBC) founded by the collaboration between the Confederation of Indian Industry (CII) and the private manufacturer Godrej, has taken steps to promote the green building concept in India. Currently, IGBC is facilitating the LEED rating of the U.S. Green Building Council in India. LEED-India was launched in 2001 and rates buildings on environmental performance and energy efficiency during the design, construction and operation stages.

Green Rating for Integrated Habitat Assessment (GRIHA): The Ministry of New and Renewable Energy have adopted a national rating system- GRIHA which was developed by The Energy and Resources Institute (TERI). It is an indigenously developed rating system completely tuned to the climatic variations, architectural practices, existing practices of construction and attempting to revive the passive architecture. The GRIHA rating system takes into account the provisions of the National Building Code 2005, the Energy Conservation Building Code 2007 announced by BEE and other IS codes. This was developed specifically aimed at 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.

GRIHA stresses passive solar techniques for optimizing visual and thermal comfort indoors20 and encourages the use of refrigeration-based and energy-demanding air conditioning systems only in cases of extreme thermal discomfort.

There has been an upcoming trend especially in the commercial sector to look at sustainability aspects and of lately a number of such projects have gone in for either of the above prevalent building assessment system (rating system). As an indication, there are some 375 registered green building projects in India with LEED amounting to 260 million sq. ft. and 28 registered green building projects for GRIHA amounting to 1.3 million sq. ft.

With this background, an attempt will be taken to identify the definition of sustainable buildings for India based on the current scenario in the country. Efforts will also be made to address issues such as extent of life-cycle consideration while building sustainable buildings in the country, policy initiatives which have encouraged taking such initiatives, if any, implementation barriers, market scenario, etc.

Sample buildings
Sample buildings from both residential and commercial sectors which are popular as green buildings and have been built employing principles of Sustainability and representative from all climatic zones will be selected for understanding and analyzing following aspects such as:

- Key principles and indicators for defining sustainable building performance in Indian context
- Extent of life-cycle considerations
- Driving force and the context for taking up such projects
- Areas for further research, policy development requirements, etc.

The roundtable invites discussion and valuable inputs on all of the above.