Need For a Model to Review the Post- Occupancy Performance of Commercial Buildings in India

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***Abstract* — Emphasis on the reduction of GHG emissions is world over, there has been considerable research on design and materials in the construction sector that support reduction in emissions and rating systems have been developed by various agencies to rate the projects based on various factors such as materials, embodied energy, passive design methodologies and energy consumption, which covers roughly 20% of the overall emission, a major factor being the source of energy. India still relies majorly on non-renewable energy due to its lower cost of production and operation and higher cost of renewable energy, creating an impediment in achieving desired goals. There has been a slight but sizable amount of research in post occupancy performance in the residential sector in India where the consumptions are slight rigid, whereas the commercial buildings have higher energy consumption and there is a good scope to reduce through intervention, it is observed through study that there is a lack of such research. It is indispensable to have a monitoring system for all the buildings on their performance to identify the emissions at the building, city and national levels which would give a realistic measure on emissions and help in creating mitigatory measures in achieving set goals. This paper highlights the need for such a model.**

***Index Terms* — Buildings and Climate Change, Building Stock, Energy Benchmarking, Post Occupancy Building Model.**

I. INTRODUCTION

In the offset of globalisation, there is immense growth in the construction sector especially in the developing nations, India being second largest in population and among the fastest growing economies, there is a huge demand in building stock in both commercial and residential areas, In 2010, buildings accounted for 32% of total global final energy use and 19% of energy-related greenhouse gas (GHG) emissions, with projections for further increase [1] and present day global temperatures have been already raised by 0.85^{O} C with a temporary spike to 1.0^{O} C in 2015 as per UNDP report [2], inferring to the stress on the environment. The building sector in India has seen an unprecedented spike in growth amounting to 38% of total primary energy and 31% of electricity consumption (23% residential and 8% commercial Sector) [3] there is an immense need for an evaluation system that could monitor the total energy consumption and emissions at building level at periodic intervals. This will enable to evaluate the performance of buildings and gives scope to scale up to any geographic level and help policymakers at various levels to make necessary measures in reaching the set goals towards cleaner energy.

II. LITERATURE REVIEW

Literature reviews relating to building resilience, building stock in India and energy conservation pertaining to cutting down on GHG emissions suggests the need for a model at building level, as there is a prevalent gap, all though the green building rating systems are doing the job of rating the buildings based on the materials used, passive design methodologies and other factors in cutting emissions there is no standard system for evaluation of buildings during the operational phase. Several studies have shown that approximately 80–90% of the energy a building uses during its entire life cycle is consumed during the operation phase for heating, cooling, lighting, and other appliances. The remaining 10–20% is consumed during the construction, material manufacturing and demolition phases. The Fourth Assessment Report of the IPCC concluded that there is a global potential to reduce approximately 29% of the projected baseline emissions from residential and commercial buildings by 2020 and 31% from the projected baseline by 2030 at a net negative cost. The potential is the highest and cheapest among all sectors studied. The IPCC report compared the energy savings potential of the building sector with that of other economic sectors and found that the building sector has the greatest potential among all sectors such as transportation, industry, forestry, agriculture, etc., in all countries, and at all cost levels [4]. This gives an ameliorate scenario for the building sector in saving energy and cutting of GHG emissions. The building sector in India is experiencing unprecedented growth. It has 38% (~208mtoe) of India's total primary annual energy consumption and 31% (296 TWh) of the total annual electricity consumption with the residential and commercial sector having 23% and 8% of total electricity consumption respectively. Buildings also represent a dominant share of India's overall cooling demand.

III. COMMERCIAL BUILDING STOCK

The globalisation of the Indian economy has boosted the country's real estate demand, foreign investment coupled with the rise in GDP and per-capita income has given an upsurge in real estate demand both in the residential and commercial building sector. Commercial Building space has doubled from the last decade and it is projected to grow by three times by 2030, with an average growth assumption of 5-6% of annual growth rate.[5] From the data given it is understood to have a proportionate increase in energy consumption in the coming years, besides it is pivotal in India's commitment towards reduction of CO2 emissions and future energy demand. In India, total final energy demand is projected to grow from around 9 EJ in 2014 to more than 14 EJ TWh in 2050 under business-as-usual scenarios. However, to contribute to achieving a 2°C scenario, final energy demand should decrease to about 12EJ in 2050. by 2050 (IEA, 2017a, 2016) [6]. Currently, India's growing economy and rise in demand for commercial building stock gives a unique scenario in reduction of CO2 emissions and adapting a policy towards green energy.

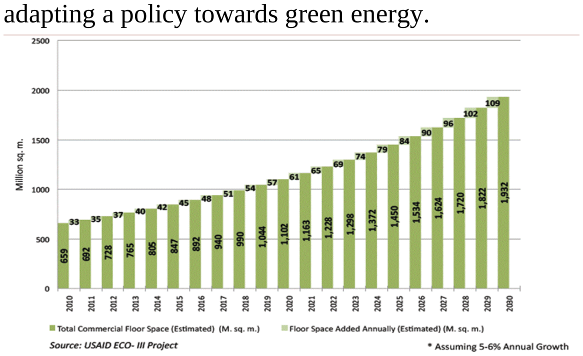

Fig 1. Commercial Building Stock Growth

IV. ENERGY STATISTICS

Consumption of energy in commercial buildings has increased by one and half times in this decade from 819 KWH in 2010 to 1209 KWH in 2020, this is in line with the growth rate of the commercial building stock, given the projected building stock of 1932 Mil. Sq. Mts. by 2030 the projected consumptions are estimated to be at 2120 KWH [projection data calculated using MS Excel].

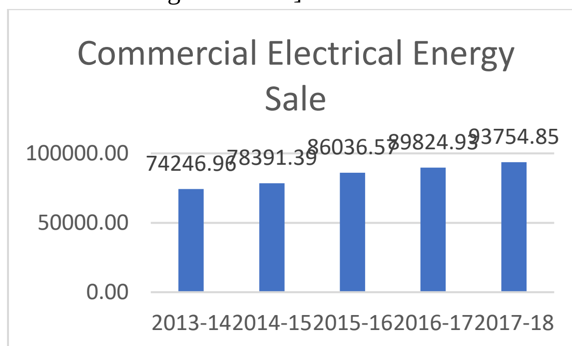

Fig 2. All India Energy Consumption by Commercial Buildings
(Source Ministry of Power, Government of India)

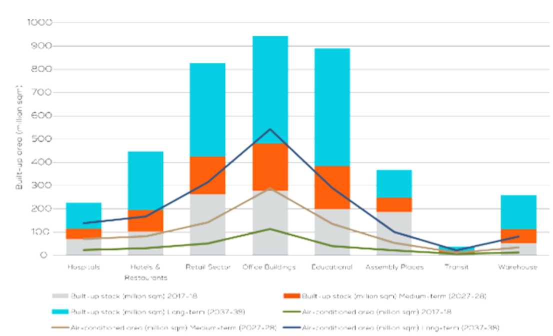

Fig 3 Commercial Sector-Built-up and air-conditioned stock (million sqm)
Source: Alliance for an Energy Efficient Economy
Most of the rating systems consider the initial stages of the building like materials, design considerations, passive design systems and on-site energy production, which is only 20% of the energy consumed by the buildings the rest is during the operational stage. The commercial sector floor area in 2017-18 is estimated to be 1160 million m2 and is expected to grow 1.6x in the next decade to 1880 million m2, and 2.7 times the size of 2017-18 to 3090 million m2 by 2037-38. The per cent air-conditioned area is expected to increase

from approximately 26% in 2017-18 to 43% in 2027-28 and around 54% by 2037-38[7].

V. KEY CHALLENGES

The complex challenges involve creating a normalised assessment tool involving different climatic zones within India due to heterogeneity in the consumption of energy. Age of the building, occupancy factors, connected load, comfort cooling/heating being the major factors. Currently, there is very faded data available on buildings and many buildings do not comply with the energy conservation norms (mostly old buildings), buildings owned by multinationals are maintaining the energy data. Still, the buildings are far net negative but the organisations are using the carbon credits in other Nations to offset the energy balance, in buildings occupied by tenants the developer has less interest in measuring and maintaining the energy consumption, even though such practices are being incentivised by the Government, as this may involve in key changes in infrastructure that involves an investment with slow returns.

VI. NEED FOR MODEL

Given the scenario India has an opportunity rather than a challenge in making policies towards cleaner energy, adhering to India's commitment towards reduction of emissions and becoming Net-Zero by 2050. Curbing growth in the energy demand of India's building sector offers more than 8% of global building energy-related greenhouse gas (GHG) mitigation potential (https://www.gbpn.org/ - GBPN, 2012). However, to create a roadmap for formulating such policies it is important to have clear datasets on end-user load profiles at the building level that would put energy usage to the optimal level. At present, there are no such studies that can be used to simulate projected energy use and emissions for future building stock. To address this issue, it is desired to create a model at the building level and that can be scaled up to city level or (climatic) zonal level or national level. This would help in creating a prediction model for emissions and acts as a tool for assessment and monitoring of present and future energy, emissions and gives factors to control and curb the GHG Emissions. It is also important to understand that the model gives a complete demand side (end-user) data projections helping individual company owners, developers to act at the unit level in curbing the emissions.

VI. ADDRESSING THE ISSUE

There were past efforts in India in collecting end-user data for commercial buildings, projects such as Situation Analysis of Commercial Buildings in India (2008) conducted by Spatial decisions with support from BEE, Performance Based Rating and Energy Performance Benchmarking For Commercial Buildings in India (2010) conducted by ICMQ (data collection) and ECO3 (analysis), Market Assessment of Public Sector Energy Efficiency Potential in India (2009-2010) conducted by LBNL, Graduated Energy Benchmarking for Hotels and Hospitals (2015) Conducted by ECO3 (Data Collection), & CBERD India (analysis), Report on Energy Benchmarks for Commercial Buildings (2016) BEE with support from UNDP-GEF appointed Darashaw, High Performance Commercial Buildings in India: Adopting Low-Cost Alternatives for Energy Savings (2010)conducted by Undertaken by the Asia-Pacific Partnership on Clean Development and Climate, the project was supported and funded by the US Department of State and the BEE. It was implemented by TERI, India, and White Box Technologies, USA [8]. The net outcome of all the studies reflect towards common challenges such as lack of building occupant/developer not segregating energy usage, some have no data available except monthly energy (electricity) consumption. In some cases, data of backup energy used (a common practice) in the form of diesel generators data is not available. From the above studies, it is implicative that to create a model for assessing the end-user load profile a shared model across the geographic level in assessing the energy performance index (EPI) of buildings and maintains data sets that deliver key variables in creating energy benchmarking of buildings during the operational phase. It is vital to obtain detailed data on ownership and activity (building occupancy type/ activity type/ green mark labelling), building data (gross floor area, carpark area, number of rooms, major retrofitting), building services information (lifts/ ACMV/ lighting/ hot water systems/ building electricity and other fuels consumption [8] including the age of the building and age of the equipment their rating and performance.

VII. CONCLUSIONS

Post-occupancy building performance has a greater potential in energy efficiency and its contribution in the reduction of GHG emissions A shared model for all the commercial buildings is need of the hour to assess the energy performance of the commercial buildings and participation of all the building occupants and developers is key in creating a data set that can be used in energy benchmarking of the buildings. The model should be able to monitor, assess and project the key savings potential and areas of savings at the building level. This enables local governing bodies to monitor the energy consumption and emissions, and at the national level, this model creates a data-set for future energy demand, emission levels and vectors on scale and size of investment towards green energy and reduction on carbon-intense energy.

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