

Energy Saving Analysis of High Performance Commercial Buildings in India

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Abstract

This study introduces an idea that a significant amount of energy saving can be achieved by converting a Conventional Building to Green Building. To demonstrate the energy saving, two building models have been developed using energy plus software. Delhi has been chosen as its site location, its altitude is 216 m, latitude 28⁰35' N and longitude 77⁰12' E. The first model demonstrates the energy consumption in Conventional Building. The second model shows the energy consumption in the same building by modifying the orientation and using energy saving parameters such as building envelopes, Insulation, lighting controls etc. The comparison shows that the proposed Green Building uses less energy in comparison to Conventional Building. By incorporating low energy passive strategies, 49.5% higher net saving of energy and cost as compared to Conventional Building is found. Photovoltaic panels are also implemented to share a prescribed amount of electrical load. The result shows that carbon emission can also be reduced to a great extent. The study shows that the Green Building is much reliable, economical and beneficial for human health and environment.

Keywords: Energy efficiency, Energy Simulation, High performance Commercial buildings (HPCB's), Energy plus, Carbon emission, Green building, Renewable sources of energy and Simulation.

1. Introduction

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% of the GDP. Commercial and residential sectors continue to be a major market for 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^[1].

The selection of commercial buildings as the target segment is supported by a number of factors: (i) increasing commercial and business activities are accelerating the space needed for commercial buildings and the trend is expected as the economy grows; (ii) electricity consumption in buildings is responsible for a share of about 7% of the total electricity consumption in the country which is modest at present, however the consumption is increasing rapidly as building sector is growing at about 8% per year; (iii) many existing and also new commercial buildings are not energy efficient, but significant improvements could be made at moderate costs; and (iv) increases in electricity tariffs are enabling building owners/users more aware of the energy bill and likely to drive towards energy efficiency measures in commercial buildings.

1.1 Commercial Building Sector in India

The construction sector in India is witnessing a fast growth due to several factors. Some of the key growth drivers are increased demand for housing, strong demographic impetus, expansion of organized retail, increased demand for commercial office spaces by multinationals and IT (information technology) hubs, and coming up of SEZs (special economic zones). The gross built-up area added to commercial and residential spaces was about 40.8 million square meters in 2004/05, which is about 1% of annual average constructed floor area around the world, and the trend shows a sustained growth of 10% over the coming years^[1, 2].

Total office space demand is expected to be 196 million sq. ft. in the period under consideration of which approximately 42% is expected to be generated in the Tier 1 and 2 cities. According to the C&W report, though the office market is expected to witness a fall in demand in the year 2009 with an expected absorption of 27 million sq ft. The period from 2010 onwards will see the markets experience a healthier demand with a CAGR of 19% from the period 2009 to 2013. The highest demand during the period under study is expected in Bangalore with a cumulative 34 million sq ft followed by Chennai at 27 million sq ft. This increase in demand is largely due to improving economic conditions, positive market sentiments and growing corporate confidence.

ECO-III project has estimated that in the year 2010, commercial buildings had build up area of 0.65 billion square meters, and this is expected to grow to 1.9 billion square meters. This means that about 66% of commercial building stock that will be there in 2030 is yet to come in the country shown in Figure 1.1.

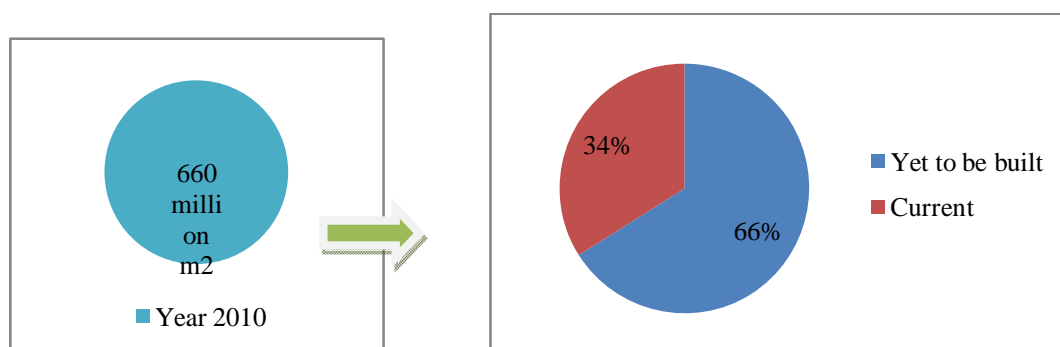


Figure 1.1: Projected growth across commercial building sector in India ^[3, 4 & 5]

There exists significant possibility for energy efficiency in commercial buildings in India. For new commercial buildings, BEE has developed the Energy Conservation Building Code (ECBC). The purpose of ECBC is to provide inputs to the energy-efficient design and construction of buildings. The total commercial building floor area in India is estimated to be about 292 million m² in the year 2005. Most commercial buildings in India have an EPI of 200-400 kilowatt-hour (kWh) per m² per year, while similar buildings in North America and Europe have EPI lower than 150 kWh per m² per year. BEE has data on energy savings through the implementation of energy efficiency measures in new and existing buildings. BEE has facilitated implementation of such initiatives in several government buildings ^[6].

1.1.1 High Performance Buildings in India

High performance buildings would be defined as buildings that have integrated low energy/solar passive architectural design strategies and energy efficiency measures, as recommended by the ECBC 2007/ ASHRAE 90.1-2007. The ECMs (Energy Conservation Measures) and design strategies may vary from one climate to another. This also includes the energy saving potential and EPI ^[2].

1.1.2 Greenhouse Gas (GHG) Emissions

Increased energy consumption will lead to more greenhouse gas (GHG) emissions with serious impacts on the global environment; in particular, since the predominant usage of coal in the country's energy sector is expected to continue until 2020. Coal provided about 52% (199 M toe) of the energy demand in 2006-07. The capita energy consumption and emissions have remained relatively low at 1.2 tons of carbon dioxide per person in 2005 due to the large population. India is currently the world's seventh largest consumer of energy and the sixth largest source of greenhouse gas (GHG) emissions and second in terms of annual GHG emissions growth. According to an International Energy Outlook in 2009, India accounts for 7% of the world's coal-related carbon dioxide emissions from 2006 to 2030 and carbon dioxide emissions from coal combustion are projected to total 1.3 billion metric tons in 2030, accounting for more than 7% of the world total ^[6].

2. Methodology

The method to be employed in carrying out this study is as follows:

- Literature review made from past work.
- Identification of performance effecting parameters of the building.
- Data determination with the help of Climate Design Data 2009 ASHRAE Handbook, a consulting firm Green Evolutionary Energy Design (GEED) and a commercial building like Pacific Mall, Ghaziabad near New Delhi is taken for Study.
- Performed whole building energy simulation for showing improvement in the proposed building performance rating compared to the baseline building performance rating as per ASHRAE/IESNA standard 90.1-2007 described base line standards.
- Analysis and evaluation of the simulation results.

3. Performance Affecting Parameters of the Building

- Orientation and Site design- Windows and Glazing
- Landscaping
- Day lighting
- Lighting Systems
- Building Envelop
- Heating Ventilating & Air Conditioning (HVAC)
- Solar Heat Gain Coefficient (SHGC)
- Embodied Energy
- Indoor Air Quality

4. Building Energy Modeling

The performance evaluation analysis is done for a 5301.69 m² commercial building in New Delhi, India. Net conditioned building area is 3706.44 m². There are three floors with a basement in the building. The building is to be used for multipurpose. This building is having parking, mechanical and miscellaneous areas in basement, atrium, shops, office areas and corridor on ground and first floor and shops, food court, and lobby, corridor on the second floor. To improve day lighting, the window to wall ratio increased from 22.51% to 28.29% in proposed case. The cooling system is DX type units used at each conditioned space. Ventilation would be provided in toilets.

High efficiency solar panels are located on the building ground or roof mounted. Thus, generating electrical power by converting solar radiation into direct current electricity and also making hot water available throughout the year. Energy modeling of building is an important tool for understanding the requirement of efficient design and development during the building design process. The energy modeling can be explained as a comprehensive process, which includes all the possible parameters like weather, occupancies schedule, and building envelop and Systems. The performance Evaluation of the Building is generally done in terms of Energy Consumption by it. Hence energy modeling is important tool. So LEED by United States Green Building Council (USGBC) is committed for Low energy building development by its Green

rating system. The software available for energy modeling is sensitive enough to report a change in annual energy consumption even if we, e.g. slightly alter the window size on any side of a large building. The above fact gives rise to huge number of possibilities of improvement and optimization during the design process of an energy efficient Building. It also gives off certain financial indication about the feasibility of certain options over the other available options. This constitutes strong reasons to go for energy modeling in a building so that it can be made as Energy Efficient.

5. Conclusions

In this study, two energy models for Conventional Building and other for the low energy building have been developed using Energy Simulation Tool Energy Plus - 7.1.

On the basis of simulation results carried out in this study, the following conclusions are made:

- i) The annual energy consumption has been brought from 1156564.35 kWh to 587761.23 kWh by adopting low energy strategies.
- ii) It has been found that roof mounted solar PV panel produces 145941.6 kWh energy per year. This shows that about 25% of energy required is supplied by the mounted PV panel.
- iii) In terms of money, the cost saving of ₹ 2644715.87 has been achieved annually.
- iv) Low energy/ passive design strategies consideration gives about 422861.52 kWh energy and 62% cost saving w.r.t. Conventional building.
- v) The CO₂ emission is reduced to 663283.09 kg in the proposed building.

This saving is a great saving as our aim must be to save energy for the benefit of self and nation. Therefore, this high performance building can be said as energy efficient and environmental friendly in the real sense.

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