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Green Building Analysis through Energy Modelling

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Abstract: ***Global warming and climate change caused due to the release of greenhouse gases comprising mainly carbon dioxide has been recognised as the most deadly threats of the 21st century. The buildings in modern cities account a share of 40% in total energy consumption. So the energy consumption can be precisely lowered down by improving efficiency factor in commercial buildings which would be an effective measure to lessen greenhouse gas emissions and also reducing the energy cost in a significant way without reducing the thermal comfort and productivity of the building owners. In India, we deal with a diverse climate patterns ranging from cold, moderate and warm types which play an important part in energy consumption practices. So the efficiency programmes should be designed taking the count of relative climate types. This research paper discusses the role of energy efficiency in the commercial buildings in India which is mainly focussed on reducing the energy consumption and environmental degradation due to carbon emissions.***

Keywords: Global warming, Energy Efficiency, Green Buildings, Climate patterns, Energy Modelling.

1. Introduction

Present Scenario

In order to promote energy efficiency in the country, the Government of India enacted the Energy Conservation Act in 2001. Using this act a new body named Bureau of Energy Efficiency was established in March 2002 under the Ministry of Power to deal and enforce energy efficiency policies. By 2030, India is likely to have GDP of 4 trillion USD and a population of 1.5 billion and if we consider about the commercial sector, it is likely to have an overall constructed area rise of approximately 104 billion sq.ft by 2030.

The total electrical energy consumption is over 30% when it comes to building energy consumption in the country with an annual rise of 8%. Energy consumption in buildings is mainly due to building services like HVAC, lighting, water heating, fans and pumping systems which in total accounts for the share of 40%. [1]

A nation's growing infrastructure is reflected by its commercial buildings. The most energy intensive activities inside a building are its heating and cooling followed by lighting and electrical appliances. On the other hand India has temperate climatic conditions which have a demand for more cooling rather than heating purposes. As predicted by International Panel on Climatic Change (IPCC), CO_2 emissions from commercial buildings could increase to 15.6 billion tonnes in 2030.

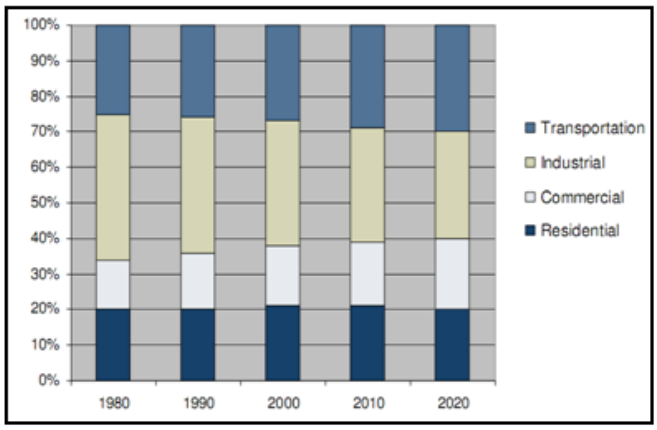

Figure 1: Yearly projections of energy use

An important step has been taken by the Govt. of India by creating an Energy Conservation Building Code (ECBC), which basically deals with the incorporation of efficient technologies, materials, and construction techniques into new and renovated commercial buildings. Buildings that follow the rules and regulations set by the ECBC would hold an efficiency of more than 60 % than the standard buildings in India. [2]

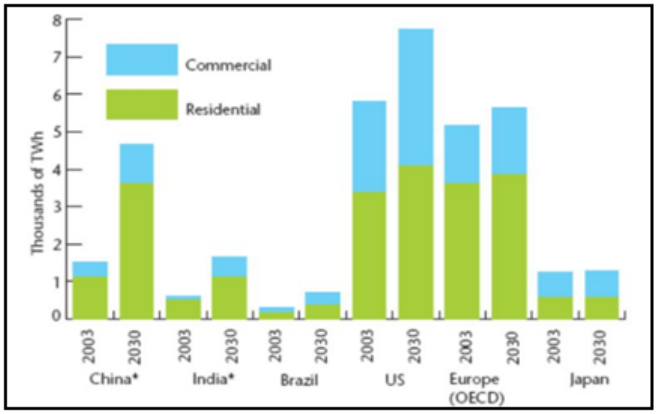

Figure 2: Building energy projection by regions in 2003 and 2030 (Source: IEA, 2008)

1.1. Need of Energy Efficiency

The prediction of Eleventh Five-Year Plan (2007-2012) shows an energy demand of 547 Mtoe in 2011-12 and between 1,350-1,700 Mtoe by the year 2030. The energy consumption of India is expected to increase significantly while the country's per capita energy consumption will remain much lower than that of other industrialized and developed countries leading to more greenhouse gas (GHG) emissions with huge impacts on the global environment; in particular, since the conventional usage of coal in the country's energy sector is expected to continue until 2020. According to an International Energy Outlook in 2009, nearly 7% of the world's coal-related carbon emissions from 2006 to 2030 are from India and carbon dioxide emissions from coal combustion are projected to total 1.3 billion metric tonne in 2030. The predominance of coal in the energy mix, along with the expected increase in energy demand, embarks the significance of promoting energy efficiency. The recent Five-Year Plans (FYP) accentuates the call for competent use of energy resources to achieve sustainable development. By the end of the 11th FYP, an impending was researched to save 23,700 MW of power generation capacity in the country.

1.2. Setting of Energy Efficiency in India

There is an urgent need of energy efficiency in the commercial sector of India to promote sustainable development. Several key efforts promoting energy efficiency in the past are concussed underneath:

- Setting up or supporting institutions for the promotion of energy efficiency services. These comprise trade relations such as Confederation of Indian Industry (CII), the Indian Green Building Council (IGBC), research institutes, such as The Energy and Resources Institute (TERI) and Financial Institutions (FI), such as the Indian Renewable Energy Development Agency (IREDA), Industrial Development Bank of India Limited (IDBI Bank) and ICICI Bank, as well as the National Productivity Council (NPC).
- The Bureau of Energy Efficiency (BEE) was recognized in March 2002 below the Ministry of Power (MoP) to put into practice the EC Act 2001. It is a legislative body for promoting energy efficiency policy and strategies focussing on self-regulation and market principles and for coordination of energy efficiency at the central level and state level through "**state designated agencies**" (SDAs) for 30 states.
- . In June 2008, National Action Plan on Climate Change (NAPCC) was issued in India outlining present and future policies for climate change lessening and adaptation. The plan focussed on eight core national missions including a National Mission for Enhanced Energy Efficiency (NMEEE).

2. Role of Climatic Zones

The ECBC has regulated some building envelope requirements that are based on the climatic zone in which the building is located. ECBC defines five major climatic zones (hot-dry; warm humid; composite; temperate; cold). Each climatic zone has its distinctive thermal comfort requirements in buildings and their physical manifestation in architectural form based on the characteristics of the climate.[3]

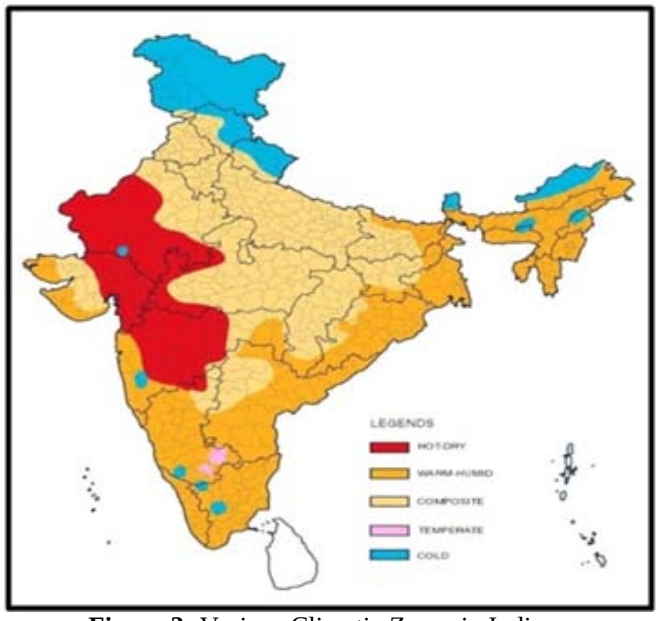

Figure 3: Various Climatic Zones in India

3. Developments to Achieve Energy Efficiency

a. Insulation

Insulation helps retain cool in summer and heat in winter, and acts as sound proof. This can create a major impact on indoor thermal comfort of the building. Implementation of energy-efficiency in building systems is almost entirely dependent on effective thermal insulation of the building envelope. Insulation provides less dependency on HVAC systems as it focuses on the building materials and with their proper installations new levels of thermal comfort can be reached making the building more energy efficient. Insulation can be done at various places starting from the base foundation, the walls and the roof leading to lesser carbon emissions which ultimately increases the building efficiency.

b. HVAC

More than one fourth of building energy consumption comes from the HVAC systems. Space heating of the building is the most important factor when it comes in providing thermal comfort to its occupants. Efficient HVAC systems can save up to 30% of the total energy use. With more implementations of efficient HVAC systems the annual cost can also be lowered up to 20%.

c. Lighting

Lighting holds a major part of total energy consumption in office and other commercial buildings. Nearly one third of the total cost of energy consumption comes due to the use of lighting appliances. An efficient lighting system saves up to 20% of the total energy consumption throughout the

year. Use of LED and CFL systems can provide with huge savings in both cost and energy consumption departments. Intelligent lighting systems with ambient light sensors are the latest innovations in this field.

d. Passive and Active Solar Heating

Passive and Active solar heating is a very simple yet effective way to achieve energy efficiency in buildings. An active solar system uses a mechanical device to gather, accumulate, and allocate solar energy and passive systems do not use such devices to harness the solar power. These systems can be used for various purposes right from the generation of electricity to space heating lowering the dependency on conventional power source and also minimising the total energy consumption and its related costs.

e. Building Materials

Use of conventional building materials like concrete, sand and mud bricks not only increase the building heat and also are responsible for building carbon emissions. Energy efficient buildings use materials that add up to 10% of the total energy savings. Use of fly ash bricks instead of normal bricks and hollow concrete block walls helps to reduce the radiant heat of the building decreasing the relative cost for space heating. Some other materials like china mosaic tiles which can used in roofs to reflect the sun rays keeping the building cool and vermiculite mixture which has lesser thermal conductivity, density and weight provides excellent insulation and fire resistive properties provide good energy efficiency and cost effectiveness.[4]

4. Literature Survey

Green Building (GB) is another name of 'energy efficient buildings' comprising sustainable design and construction to cater the needs of energy efficiency and lower levels of building carbon emissions. The design of Green Buildings focuses on delivering ecological balance, resource efficiency, and occupant comfort, sense of well being, community sensitivity and most importantly sustainable development. The design strategy of these buildings comprises of all members in an integrated development process, from the construction team (material manufacturers, contractors and waste haulers), design team (architects, engineers and consultants), maintenance staff and building occupants. The Green buildings gives remarkable high performance results that maximizes the owner's returns on investment by continued savings of energy by 30-50%, water sources savings by 20-30% and great reduction in preliminary venture.

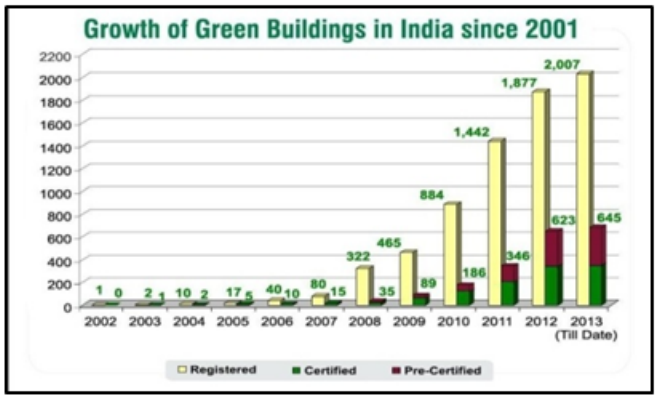

Figure 4: Green Building Scenario in India

In the past 3-4 years, The Green building movement has gained incredible thrust ever since the CII- Sohrabji Godrej GBC embarked on achieving the prominent LEED rating for its own centre at Hyderabad. The building was provided with Platinum rating which initiated a substantial eagerness in the country. Nowadays diverse pools of green building projects are coming up in the country with residential complexes, hospitals, educational institutions, exhibition centres, laboratories, airports, government buildings, IT parks and corporate offices. A recent statistical survey by TERI shows the growth of Green Buildings not only in the metros but also in fast growing cities like Bangalore, Jaipur and Gurgaon. The amount of efficiency provided by these high performance buildings is boosting the culture of Energy Efficiency in Commercial Sector of the country.

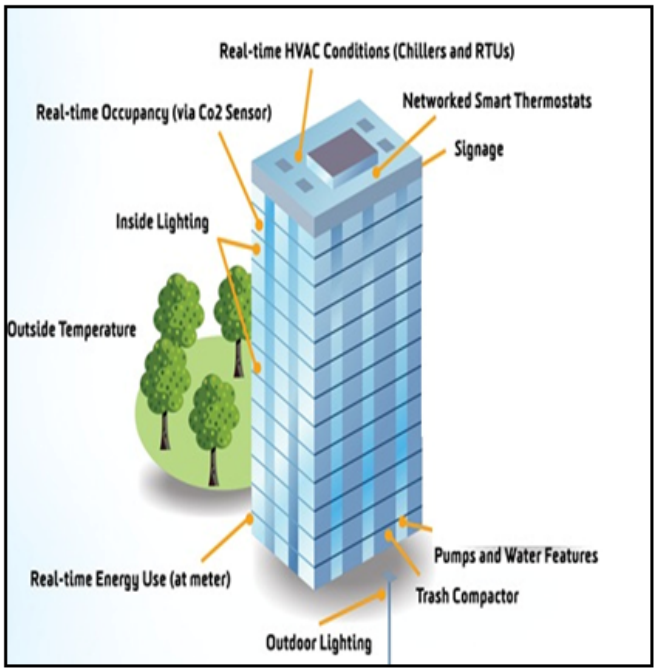

Figure 5: Green Building Simplified

5. Methodology

Energy modelling of buildings can help in getting desired energy savings and can help lower the energy consumption of a building fulfilling the main aim of promoting and creating green buildings. In this research paper an energy

model of a building is discussed showing the various energy end uses in a building and the parameters which are needed to be simulated for lowering the total energy consumption of the building. All the above parameters have been taken in consideration while creating the energy model and the total savings have been generated after a simulation in eQuest 3.64 Quick Simulation Tool which has been designed by the DOE (Department of Energy), USA. It runs on a back simulation program which helps to figure out the total energy consumption and helps to find the energy savings by comparing baseline model which is designed on the guidelines of ASHRAE/ECBC with a proposed model which designed as per the needs of the building owner.

5.1 eQuest 3.64

In this quick simulation tool there are two modes namely building development wizard mode and detailed mode. The wizard mode deals with building designing feature and the detailed mode deals with the scheduling of various parameters and then linking them with the various equipments which consume energy in the building.

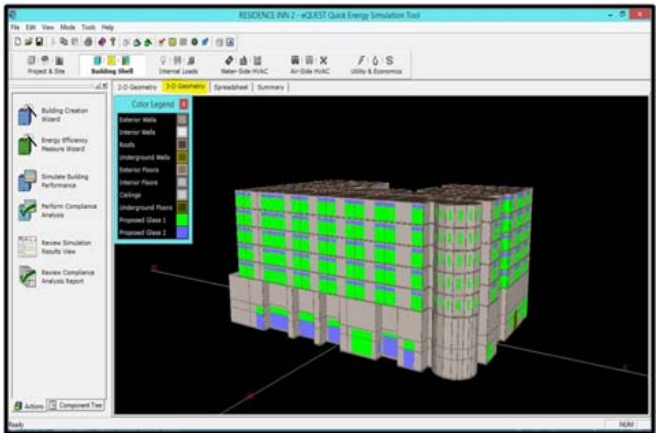

Figure 6: Building Designed in Wizard Mode

Figure 7: HVAC equipment scheduling in Detailed

As the simulation tool is very vast software, only HVAC scheduling is shown in this paper. After all equipment scheduling is done with the inputs given by the building owner keeping in mind the ASHRAE/ECBC guidelines, the simulation is done with the help of this tool.

6. Results / Discussion

After simulation, results are generated by comparing the proposed case and the baseline case that have been taken in account of the building for which energy modelling has been done. Three parameters are accounted in the result structure that are basically electrical energy usage, fuel/gas energy usage and cost which are analysed by comparing the baseline model and the proposed model of the building.

	Electric Energy	Fuel Energy	Cost
Proposed consumption	701,990	2,750,100,000	79,224
Baseline consumption	847,425	2,208,825,000	96,081
Saving number	17%	-25%	17.54%

Figure 8: Total Energy Saving

The fuel energy in the proposed case is more as per the building requirements so savings could not be achieved in that parameter as per the data given by the building owner. Yet a total amount of 17% of electrical energy can be saved by the energy model leading into a cost reduction of 17.54%.

7. Conclusion

Energy modelling of a building can save huge amount of energy and also lower the total cost of the building energy consumption as per the results above. All the Green Building Rating system have a mandatory requirement of the energy model of the building as it is the most efficient way to analyse the total energy consumption and savings of the building. In the above results we see a 17% energy saving in the electrical part which is huge in terms of the ASHRAE/ECBC guidelines as these guidelines are designed for efficiency and getting 17% more efficient system than the guideline is itself a great result. So we can conclude that energy modelling can help to analyse and save useful energy and this is the reason for which it is a prerequisite requirement for the Green Buildings.

8. Future Scope

As we all know that conventional sources of fuel are depleting day by day. Sustainable development is very important for a better future and with the help of Green Buildings and Energy Modelling we can save valuable energy which are lost due to the various day to day practices of humans. This research paper is just a glimpse of what we can save and in the near future promotion of more and more green buildings will be done as various Governmental bodies have been formed specially to look after these areas.

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Jaypratik Goswami, completed B.Tech in Electrical Engineering from Suresh Gyan Vihar University, Jaipur (India). He is currently pursuing M. Tech in Energy Engineering from Suresh Gyan Vihar University, Jaipur (India). During this tenure I have been an intern at Design2Occupancy Services LLP firm as an Energy Analyst for two months which deals with Green Building Consulting, Energy Modelling, MEP and CFD Designing as well as Third Party Commissioning.