Energy Efficiency in Building Design and Construction

1.0 Introduction:

A study conducted by Energy Information Administration, (EIA), U.S. Department of Energy indicates that there is a visible trend across the globe wherein the growth rate in total energy consumption has been greater than the population growth rate.

CII-Sohrabji Godrej Green Business Centre
LEED - Platinum Rated
63% Energy Savings

In the developed countries the energy consumption growth rate is only marginally higher compared to the population growth rate. For example, in USA, energy consumption is projected to grow at 1.3% while the population growth rate is projected to grow at 0.8%.

In contrast, in developing countries like India population growth rate is expected to grow at 1.3% while the energy consumption rate is expected to grow at 4.3%.

This trend would strain the energy sector to a large extent.

The construction industry in the country is growing at a rapid pace and the rate of growth is 10 % as compared to the world average of 5.2%. Hence energy efficiency in the building sector assumes tremendous importance.

Commercial buildings are one of the major consumers of energy and are the third largest consumers of energy, after industry and agriculture. Buildings annually consume more than 20% of electricity used in India.

The potential for energy savings is 40 – 50% in buildings, if energy efficiency measures are incorporated at the design stage. For existing buildings, the potential can be as high as 20-25% which can be achieved by implementing house keeping and retrofitting measures.

The incremental cost incurred for achieving energy efficiency is 5-8% vis-a-vis conventional design cost and can have an attractive payback period of 2-4 years.

1.1 Typical Energy Consumption Pattern in Buildings:

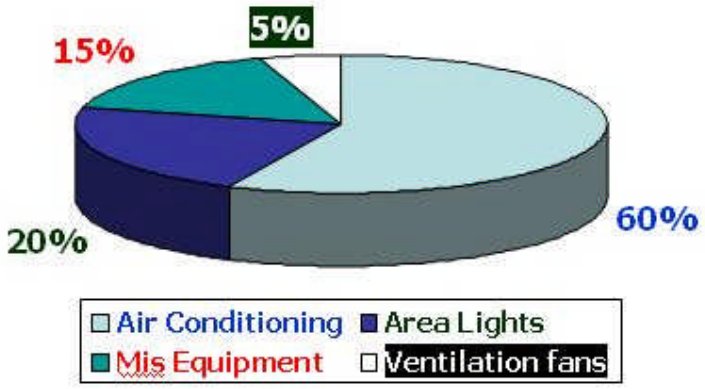

Figure 1: Break-up of energy consumption in a building

Typical break-up of energy consumption in a building is as shown in Fig 1.

In a typical building, air conditioning is the highest consumer of energy followed by lighting and other miscellaneous equipment. Therefore, if the initial design considers energy efficiency measures in these areas, substantial energy savings can be realised.

2.0 Typical Energy Saving Approach In Buildings:

2.1 Orientation:

This is the first step to achieve energy efficiency. The following measures can be adopted:

- Minimize exposure on the south and west
- Use simulation tools and techniques which can help in designing the orientation to minimise heat ingress and enhance energy efficiency.

Wipro Technologies, Gurgaon
LEED – Platinum Rated
40% Energy Savings

2.2 Building Envelope:

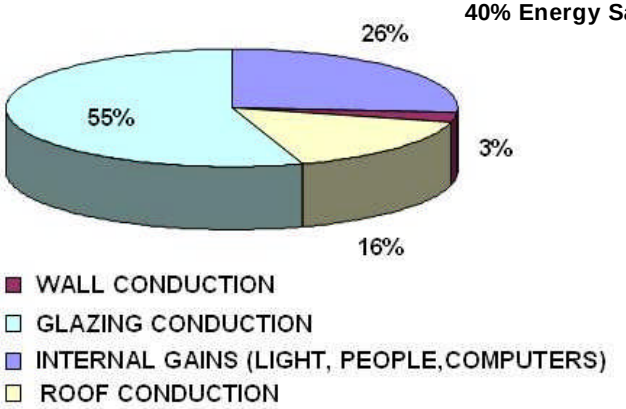

Figure 2: Typical break-up of heat gain in a building

Typical heat gain through the building envelope is shown in Fig.2

The following envelope measures can be considered:

- Select high performance glazing with low U-value, low Shading Coefficient and high VLT (Visual Light Transmittance).
- Insulate the wall. The options for insulation materials can be - Extruded polystyrene, Expanded polystyrene (thermocol), Glass wool etc.,
- Brick wall with air cavity can also significantly reduce the heat ingress.
- Hollow blocks, Fly ash bricks and Autoclaved Aerated Concrete (AAC) Blocks are also good insulators.
- The heat ingress through the roof can be as high as 12-15%. Insulating the roof can substantially reduce the heat ingress.
- Consider shading devices for window openings.

2.3 Equipment & systems:

ITC Green Centre, Gurgaon
LEED-Platinum Rated
45% Energy Savings

- Select chillers with high Coefficient of Performance (CoP).
- Install Variable Frequency Drives (VFD) for supply & return air fans and pumps.
- Select high efficiency cooling towers.
- Use high efficiency motors, transformers and pumps.
- Install Heat recovery wheels and economizers
- Consider night purging with ambient air to flush out the heat trapped within the building during the day
- Adopt Controls & Building Management Systems for effective control
- Engage a Commissioning Authority to ensure that savings are realised once the building becomes operational

2.4 Lighting:

- Design in such a way that the building gets maximum day lighting.
- Overall lighting power density can be designed as less as 1.0 W/sq.ft.
- Use daylight-cum-dimmer controls
- Install occupancy sensors
- Select energy efficient luminaires like CFL, T-5, LED, etc.,

3.0 LEED India Rating System & Energy Efficiency:

NEG-Micon India (Pvt) Ltd, Chennai
LEED - Gold Rated

The LEED (Leadership in Energy and Environmental Design) green building rating system developed by the US Green Building Council is now recognised as an international rating system and followed by more than 24 countries. The LEED rating system has been indigenized by the Indian Green Building Council to suit the national context and priorities. Energy efficiency in design has been achieved by a number of buildings in India by adopting the LEED India green building rating system.

A LEED rated building consumes 30-50% lower energy as compared to a conventional building. These buildings are designed to surpass the ASHRAE 90.1.2004 standards or ECBC (Energy Conservation Building Code).

Energy performance of three 'LEED Platinum' rated buildings have been monitored for about 3 years and energy savings achieved are shown in Table -1

Table – 1: Monitoring of energy savings in LEED rated buildings

Building	Built-up Area (Sq.ft)	Consumption of Conventional Building (kWh)	Consumption of LEED Designed Building (kWh)	% Reduction	Annual Energy Savings (Rs in Lakhs)
Wipro Technologies, Gurgaon	1,75,000	48,00,000	31,00,000	40%	102
ITC Green Centre, Gurgaon	1,70,000	35,00,000	20,00,000	45%	90
CII Godrej GBC, Hyderabad	20,000	3,50,000	1,30,000	63%	9

The IGBC (Indian Green Building Council) has launched two rating programmes LEED India NC (New Construction) and LEED India CS (Core & Shell). As on date, 195 projects with a built-up area of more than 110 million sq.ft. are registered for rating. Thus far, 19 buildings have achieved the LEED rating in India.

4.0 Challenges & Opportunities:

Achieving energy efficiency in building poses a number of challenges and at the same time presents a host of opportunities. A few of them are discussed below:

4.1 Awareness & Training:

Incorporating energy efficiency measures at design stage requires knowledge of the green building concepts. There is now a need for skilled and knowledgeable professionals who have deep understanding of architecture and energy systems. IGBC is addressing this through number of training and awareness programmes all over the country. Thus far, 3500 professionals have been trained on these concepts.

Grundfos Pumps India Ltd, Chennai
LEED - Gold Rated

Energy simulation programmes are excellent tools to design energy efficient buildings. The tools typically used are Visual DOE, Energy Plus and Lumen Micro. As of now, the number of trained professionals on these tools and techniques is scarce. IGBC is facilitating training of professionals on these tools.

4.2 Availability of Materials, Equipment and Technologies:

The availability and affordability of materials/equipment which contribute to energy efficiency is another major challenge. Tremendous potential exists for materials & equipment like heat resistive paints, fly ash blocks, insulation materials, high efficiency chillers, variable frequency drives, high efficiency cooling towers, building management systems, lighting controls, BIPV (Building Integrated Photo Voltaics), etc., New technologies like wind towers, geothermal systems etc., are gaining importance. The business opportunity for these products and technologies in India expected to cross 25 billion USD / annum by 2010. To facilitate the penetration of these products, IGBC has platforms like Green Building Congress, Permanent Technology Centre in CII-Godrej GBC, Manufacturers meet, etc., to showcase energy efficient products.

4.3 Sustained Savings:

A building can have the best of materials, equipment and systems in place at the design stage; however, the building can sustain the savings only if it is monitored on a continuous basis.

IGP Office Complex, Gulbarga
LEED – Gold Rated

LEED rated buildings use IPMVP (International Performance Measurement and Verification Protocol) to monitor and sustain the savings. Proper measurement & verification of savings will help the building owner to fine-tune the base line and achieve high level of savings.

Applying rating programmes like LEED EB (LEED for Existing Buildings) can help buildings to sustain energy efficient practices over the life of the building.

4.4 National Codes and Standards:

Government of India has launched the 'Energy Conservation Building Code (ECBC)' code. This code is voluntary and applicable to buildings or building complexes that have a connected load of 500 KW or a contract demand of 600 KVA, whichever is greater. This code addresses the minimum performance standards for energy efficiency in a building covering building envelope, mechanical systems & equipment, service hot water heating, interior & exterior lighting and electrical power & motors. This is an excellent initiative which will enable design of high performance buildings.

5.0 Conclusion:

With the tremendous growth the country is witnessing, energy efficiency in buildings assumes paramount importance. The energy saving potential can be as high as 40-50%, if addressed right at the design stage. The application of codes like ASHARE / ECBC as a benchmark can help in designing high performance buildings. There exist tremendous opportunities to introduce new materials, equipment and technologies which can help enhance energy efficiency of buildings.