# 05 ENERGY EFFICIENCY

Centre for Science and Environment
41, Tughlakabad Institutional Area, New Delhi 110 062, INDIA
Ph: +91-11-29956110 - 5124 - 6394- 6399 Fax: +91-11-29955879
E-mail: sakshi@cseindia.org Website: www.cseindia.org



The construction of new buildings is concomitant with India's growth story. Currently, 28 per cent of the country's population resides in its urban areas. Over 50 per cent of the world population is already urbanised and India is following the global trend – it will reach the 50 per cent target by 2030. Keeping in mind the anticipated population in 2030, the existing building stock would be able to cater to only 30 per cent of the people; the remaining 70 per cent would be built in the course of the coming 20 years.

India's existing built-up area is estimated at 25 billion sq feet. This is expected to go up to 100 billion sq ft by 2030. This would include an additional 20 crore homes coming up in the 20 years.

The energy cost of this massive development to the country would be unaffordable, given the current trend of constructing and operating our buildings – where construction materials being used are made by consuming huge amounts of energy and releasing greenhouse gases (see Table: *Construction material and their energy consumption*).

**Table 1: Construction material and their energy consumption**

| Sl No. | Category | Energy Intensity | Examples |
|---|---|---|---|
| 1 | Low | < 0.5 Giga Joules / ton | Stabilised Earth Blocks, Straw bale, Stone, Sand, Stone chips, Fly-ash |
| 2 | Medium | 0.5 - 5 Giga Joules / ton | Lime, Gypsum, Fired Bricks, Medium Density Fiber boards (MDF), Timber Products, Concrete blocks, Cellulose Insulation |
| 3 | High | > 5 Giga Joules / ton | Glass, Aluminium, Stainless Steel, Plastic, Copper, Zinc, Cement, Plasterboard, Steel, Bitumen, Solvents, Readymix concrete, Cardboard and Paper, Lead. |

*Source: National Building Code, Draft Sustainability Chapter*

The current trend of development which is concentrated in the urban and peri-urban areas is aimed at exploiting the land to the fullest by putting high rise buildings. This high-rise development model restricts the choice of materials that can be used in building construction to the most energy-intensive ones such as cement, steel, concrete and glass. The concentration of population in these mega cities completely chokes the road infrastructure with personal automobiles that come tagged with the suburb model.

## OUR BUILDING PARADIGMS

**The vicious**

- High rise structures built with energy-intensive materials.
- High energy usage in accessing and using the structures (lifts, A/Cs, water pumping)
- Higher time spent on road in commuting from suburbs to places of work and recreation.

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For longer term sustainability, it is important to arrest growth in the cities and develop towns and rural areas to adopt a medium-rise and low-rise building model that is much less energy-intensive.

**The virtuous**

- Low rise structures can be built with local materials.
- Low to zero energy use in accessing and using the structures (natural light, ventilation).
- Lower time spent on road due to lesser number of vehicles and more time for recreation.

There is no policy at any level to shift our development paradigm yet. Where policy exists, it addresses the more immediate, short-term concerns.

For the shorter term survival, it is imperative to moderate energy usage in existing and upcoming buildings by design interventions and retrofit programmes. The Energy Conservation Act, 2001 has created the Bureau of Energy Efficiency (BEE) under the ministry of power, which is mandated to set standards and run programmes for promoting energy efficiency through mandatory compliance.

**Energy efficiency in new buildings**

The BEE has launched the Energy Conservation Building Code (ECBC) in May 2007, which serves as a cross-check for building designs and specifications with the aim of reducing the energy consumption in various building functions by design and choice of material and equipment. Adoption of this code can reduce energy demand by at least 25 per cent in new buildings compared to recent buildings, says BEE.

The code specifies the threshold levels for various energy-related aspects of buildings in five broad categories:

- Walls, windows, roofs and skylights (termed as the building envelope)
- Penetration of day light and design of efficient electrical lighting.
- Mechanical ventilation, air conditioning and space heating (where applicable)
- Service hot water heating (mandates usage of solar water heating)
- Losses in electricity transmission and distribution

The energy consumed in a building for providing comfortable working/living conditions in terms of temperature, humidity, wind speed and adequate lighting levels is governed by local environmental conditions. The environmental conditions in India have been classified into five climate zones for the purpose of building design. ECBC sets specifications appropriate to these climate zones. Recognising the seasonal and diurnal variations in weather, ECBC also encourages the integration of sensors and controls for measuring, monitoring and managing the energy consumption in the buildings.

The code is not mandated yet and the state governments are expected to take lead in adapting the code to their state and implementing it through the urban local bodies (city and town governments) The provisions of the code are also meant for larger buildings with a connected electric load of 100 kW (roughly 200 sq.m. of air-conditioned area). No state was able to implement the code in the 11th Five Year plan period (2007 - 2012). It is expected that implementation would be complete by the end of the current plan period (2012-2017) starting with eight states in the current fiscal year.

Based on a survey of commercial buildings, it was found that office buildings consume 200 kWhr/sq m/ annum or more. The consumption of electricity in older buildings which

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were designed without A/Cs but have later been fitted with them, and newer buildings which are boxes of glass, is much higher than the average. The implementation of the code for new buildings can influence the architecture (by reducing the excessive glass on the surface of the buildings) and mechanical and electrical systems (by including control systems and measurement aand verification protocols) which will reduce the specific energy consumption (also called the EPI, Energy Performance Index, expressed in kWhr (units) per sq m per year) below 150.

Green buildings, which have measurable performance goals in energy conservation, water conservation, material utilisation etc, are required to meet and exceed the performance levels prescribed by the code. Buildings exist today that consume half the energy permitted by the code (Bayer Eco Commercial Building in Noida consumes around 75 kWhr/sq m/year). The upcoming building of the ministry of environment and forests in Delhi is targeting to reduce further to less than 50 units per sq m per year.

While it is desirable that the high-end buildings compete voluntarily to set higher benchmarks of performance, their contribution to energy savings in the sea of mediocre buildings coming up, is insignificant. Implementation of mandatory energy codes is the need of the hour to shape our new buildings for resource conservation and enhanced comfort. The implementation, however, involves overcoming certain key barriers like institutional capacity development of our urban local bodies, technical enhancement of professionals along the building sector value chain, validation of code through demonstration buildings, adequate financial frameworks for boosting investment in energy efficiency and heightened awareness about energy efficiency in buildings.

## EXISTING BUILDINGS

The UP government has recently urged commercial establishments to close down by 7.00 PM every day till the summer heat comes down. This year's peak electricity demand in UP was over 1,000 MW above the last year's peak demand. With a current 70 per cent dependance on imported fuels for our energy needs and the conflicts over land acquisition for setting up new thermal, nuclear, hydro and wind power projects, it is almost certain that our power generation capacity addition will not keep pace with the increase in demand. Without moderating our rise in demand through energy efficient new buildings and retrofitted older buildings, there will be chaos.

**Table 2: BEE's star labeling system**

| EPI (Kwh/sqm/year) | Star Label |
|---|---|
| **A. Office building in composite climate** | |
| 190-165 | 1 Star |
| 165-140 | 2 Star |
| 140-115 | 3 Star |
| 115-90 | 4 Star |
| Below 90 | 5 Star |
| **B. Shopping mall in composite climate** | |
| 350-300 | 1 star |
| 300-250 | 2 star |
| 250-200 | 3 star |
| 200-150 | 4 star |
| below 150 | 5 star |

The BEE also has a star labeling scheme for existing buildings. Due to the diversity of energy usage intensity in commercial buildings, schemes are tailored to specific types of buildings.

- Energy label for office buildings (since February 2009): 108 buildings have been labelled so far
- Energy label for BPO buildings (call centres / 24X7 buildings) (since December 2009): 11 have received labels so far
- Energy label for malls (since January 2011): No mall has been labeled so far

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Malls consume many times more energy per sq m area compared to any other type of non-industrial buildings. Malls also contribute to spikes in peak load during evening hours.

The energy consumption bandwidths are set specific to the climate zones that the buildings operate in. Getting an Energy Star Label is just about adding up your annual electricity consumption by the area of the office building and then locating your result on the energy consumption bandwidth specified in the labeling scheme. A registered user of the label can upgrade his label by improving performance in the next five years. 135 office buildings, both public and private have received the label so far. Given the simplicity of the labeling process, many more buildings should have been labelled in these three years. Either there is no incentive to label one's building energy efficiency or the bandwidths are so stringent that hardly any building can make it. Both are cause of concern. CSE has tried to investigate by requesting the actual performance of green rated buildings from respective agencies. The rating agencies are silent on actual performance of the buildings rated by them.

Most of the buildings rated by BEE so far are government buildings, that too from a few departments like Reserve Bank of India, Indian Railways and a few other pan-India government establishments. The private buildings seem to be content with the 'intent' based green labels that do not require actual performance for awarding the label.

**Electrical appliances**

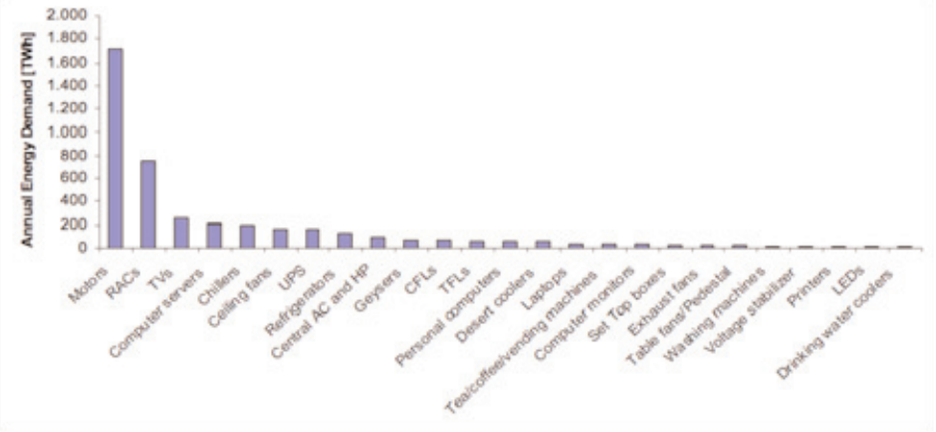
The BEE's scheme on labeling appliances has been including the key categories into the scheme based on their extent of usage and scope for improvement. Seen in the graph are figures from a study conducted by Environmental Design Solutions with other partners regarding energy saving potential in electrical appliances. *RAC is Room AC

The appliances that topped the list in energy use and potential for saving already require to be labeled while other high potential appliances are currently in the voluntary rating scheme.

Mandatory label for:

- Frost free refrigerators
- Room air conditioners
- Tubular fluoroscent lamps
- Distribution transformers

**Figure 1: Top 25 products with the highest annual energy use**




**Total annual energy demand for top 25 appliances is 4.2 GWh; motors and RACs are top 2 appliances, annual energy demand is 2.5 GWh**

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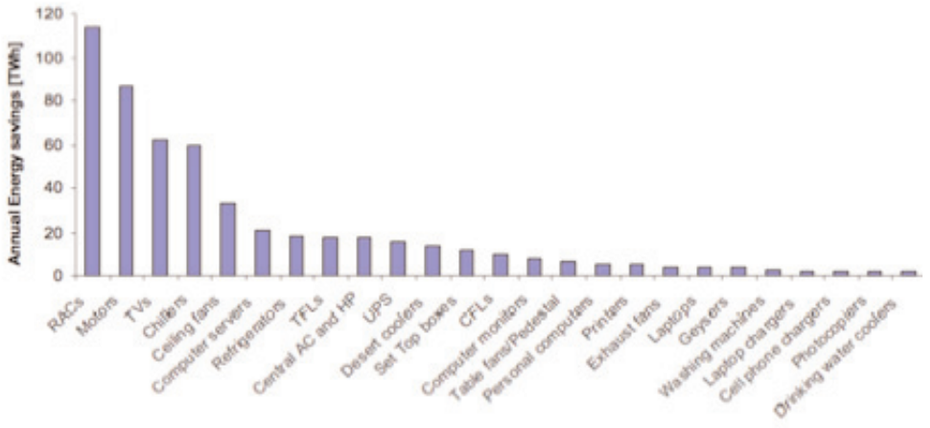
**Figure 2: Top 25 products with the highest annual energy savings potential**




**(12.7% of total energy consumption for top 25 products)**
**Motors and RACs are top 2 appliances, annual energy saving potential of 199 GWh**

Voluntary label for:

- General purpose industrial motors
- Submersible pumpsets
- Open well pumps
- Monoset pumps
- Direct cool refrigerators
- Gas stoves
- Stationary storage water heaters
- Ceiling fans
- Washing machines
- Colour televisions

The labels will become more stringent in two-year cycles and products under the voluntary scheme would be shifted to the mandatory scheme.

Building design plays the most important role in reducing energy usage. When energy labelled appliances are used in a building with 'climate responsive' architectural design, savings can be maximised. However, contemporary buildings mostly ignore simple architectural principles such as proper orientation, shading, ventilation and follow the cliches of 'contemporary' architecture by erecting huge glass facades in unusual shapes for novelty but with no functionality.

Thus, energy usage in buildings can be reduced by:

- Shifting to a low and medium rise urban model that reduces the need to transport goods and people vertically against gravity.
- Encouraging mixed use developments with preference for non-motorised transport and access to work by walk.
- Integrating solar passive, climate responsive architectural features into all the buildings appropriate to the local climate
- Choosing the nearest possible sources for building materials to reduce their embodied energy from transportation.
- Eliminating the inefficient energy consuming appliances by mandating energy star labeling schemes
- Incentivising energy performance with lower electricity tariff and penalising the energy-guzzlers with higher tariffs and disconnection in case of non compliance with code.