Energy Efficient Building: A Step towards Environmental Control

Amey R. Khedikar*
Assistant Professor, Civil Engineering Department,
TULSIRAMJI GAIKWAD-PATIL College of Engineering & Technology,
Nagpur, Maharashtra, India
amey.khedikar@gmail.com

Sanjay K. Bhadke**
Assistant Professor, Civil Engineering Department,
TULSIRAMJI GAIKWAD-PATIL College of Engineering & Technology,
Nagpur, Maharashtra, India
bhadkesanjay4@gmail.com

Abstract— India is amongst the top countries in the world contributing to the emission of CO_2. The maximum emission of CO_2 is due to burning of coal for production of electricity. Today, nation's household and commercial buildings consume more energy than transportation or industry sector accounting for nearly 30% of total Indian energy use. This continuous rise in power generation forces us to rethink on the building structure which includes efficient use of energy, making the structure more economic and environment friendly. An energy efficient building must fulfill the following four criteria: 1) Bioclimatic architecture: proper orientation, shape of building, passive solar systems. 2) Less energy use: the building must be operated in such a manner as to have a low energy use compared to other similar buildings. 3) High performance building envelop: through high performance ventilation, glazing and windows, air-sealed construction, avoidance of thermal bridge. 4) Proper mechanical insulation and heat recovery. An efficient building must, at a minimum be above average in all four aspects. An energy efficient building lowers household energy bills; increases comfort and reduce local air pollutants. This paper deals with various aspect of energy efficient building with their applications.

Keywords- *Bioclimatic architecture; air-sealed; efficient; orientation.*

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I. Introduction

India is at a crossroad in its development path. Building design was not a subject of study in India for its electrical and thermal performance. Building configuration, its aesthetic , first cost uniqueness and ultimate salability are some of the factors which have driven the building design with the design , the building operating energy cost has increase tremendously as the energy efficiency factor where either not considered or ignored at the design stage.

India's building occupies area is projected to skyrocket from 8 billion sq. m in 2005 to 41 billion in 2030. While an individual household may not appear to use much energy, one only has to multiply that by the population to appreciate the skill of domestic energy consumption. Building already account for more than 30% of the country's electricity consumption and nearly 70% of the building in India that will exist by 2030 have yet to be build. In India the domestic sector is responsible for 45% primarily fuel use and domestic use of all fuel is increasing; 23.8% of annum for electricity, 35% of LPG and 3.7% for fire wood .Under a business scenario India's current power production is and will be unable to meet the expected demand .Energy efficient building will be cheapest, faster way to close the energy demand and supply gap. If developers across India implement standard energy efficiency measure in new construction and major retrofits, the country, could avoid the need for 2,988 megawatt (MV) of generation capacity and save $42 billion annually.

II. What is energy efficient building?

Energy efficient building can be defined as the buildings that are designed to reduce the energy consumption for heating and cooling, independently of the energy and of the equipments that will be chosen to heat or cool the building. Also, an energy efficient building must take maximum advantage of natural resources such as sunlight through its proper shape and orientation. It should also use renewable energy and reduce CO2 emission at a large scale. It should reduce waste of energy, water, materials used in building.

An energy efficient building must fulfill the following four criteria:

1) Bioclimatic architecture: proper orientation, shape of building, passive solar systems.

2) Less energy use: the building must be operated in such a manner as to have a low energy use compared to other similar buildings.

3) High performance building envelop: through high performance ventilation, glazing and windows, air-sealed construction, avoidance of thermal bridge.

4) Proper mechanical insulation and heat recovery: An efficient building must, at a minimum be above average in all four aspects. Only when the building has been designed to minimize the energy loss, it makes sense to start looking at the energy source and at the heating and cooling equipments.

III. What Is Zero Energy Building?

A number of buildings use renewable sources of energy (solar, wind, geothermal) at the building site to fulfill its energy demand. These buildings are energy efficient with respect to fossil flues and co2 emissions, and seem to be probably an overall waste of resources (especially money) but, during their usage they save so much energy that the money spent on its creation will return at least 10 times. The study carried out in shows that even 20% of investment into energy efficient building will elaborate 10 times more saving.

The concept of ZEB appears to mean "a building that relied entirely upon energy capture on side to provide all the desire amenities ". But the united states department of energy offered the following definition ,"cost effective buildings that have zero net annul need for non-renewable energy." this definition allows the buildings to be connected to the electrical grid. Later, in the face of various political and practical needs DOE revised the definition to," any building that demonstrates significant integration and optimization of both energy efficient and site power generation."

IV. Design of Energy Efficient Building

India has a great potential for the use of renewable energy technologies, but before considering how the energy is supplied, first step should be to reduce the loads in the building. Energy use in "existing buildings" since we replace old buildings with new ones only at a very slow rate, it is important to consider how we use energy in the buildings already there.

The first step in an energy efficient approach is to find out where in the building the most energy is used. The proposed solutions for saving energy may apply throughout the building. From the roofs, walls, and insulation that enclose it to the appliances and lights inside.

4.1 Bioclimatic architecture

Buildings location and surroundings play a key role in regulating its temperature and illumination. For example, trees, landscaping, and hill can provide shade and block wind. In cooler climates, designing northern hemisphere buildings with south facing windows and southern hemisphere buildings with north facing windows increases the amount of sun entering the building, minimizing energy use, by maximizing passive solar heating.

The openings must be properly oriented. Proper placement of windows and skylights as well as the use of architectural features that reflect light into building can reduce the need for artificial lighting. Use of reflective colors and surfaces and other appropriate techniques to the external envelope and its openings protect the building for solar heat in winter as well as in summer.

4.2 Thermal insulation

New insulation materials such as nano porous silica phase change materials, are thinner and are able to store energy and reduce emission, the moment they are installed. Well installed insulation ensures energy efficiency in every part of the building envelope including ground decks, roofs, lofts, walls and facades.

In cold regions, insulation keeps building warm limiting the needs for energy for heating where as in hot/warm regions the same insulation system keeps the heat out and reduce the need for air conditioning.

It is particularly cost-effective on roofs as at latitudes closer to the equator most of the solar radiation entering the building comes from the roof.

An exterior wall is well insulated when its thermal resistance(R value) is high, meaning the heat losses through it are small (reduce V value). Insulation is a key component of the wall to achieve a high R value (or a low V value) for the complete wall. The thermal resistance R of the installed insulation products has to be a high as possible.

4.3 Air tightness

The building must be air tight so as to control flow of air through gaps and cracks. The tightness of the building must be increased as much as possible in order to create efficient, controllable, comfortable, healthy and durable buildings.

Careful attention must be paid to seal gaps and ensure the continuity of air barrier at the time of construction face of the building. It is simple to design and build an air tight construction than to carry out the remedial measures in draughty home.

Most existing building, even those build recently are far from being air tight. Due to air leakages, cold air outside enter through gaps(infiltration) into the home resulting in cold draughts. In some cases infiltration can cool the surfaces of elements in the structure, leading to condensation. Warm air leaking out through gaps in the dwelling's envelop (exfiltration) is a major cause of heat loss and consequently wasted energy.

Ventilation is the indented and controlled ingress and egress of air through buildings, delivering fresh air, and exhausting stale air through purpose built ventilators in combination with the designed heating systems and humidity control, and the fabric of the building itself. A controlled ventilation strategy will satisfy the fresh air requirements of an air tight building.

4.4 Appliances

4.4.1 Solar Water Heater: 24 solar water-heating panels provide up to 2000 liters of hot (65 degree Celsius) water every day.

Figure 1: Solar Water Heater

4.4.2 Integrated Photovoltaic System: The energy capture by the photovoltaic panels is fed into a battery bank, which is the main source of power at night. A number of panels each measuring 1.1 by 1.2m are joined and formed an integral part of the roof of the building. The panels can generate up to 10.7 KW peak of energy, which is feed into a 900 ampere-hour/240 volt battery bank.

4.4.3 Biomass Gasifier: firewood, dried leaves and twigs, the stubble left in the field after a crop is harvested, and such other forms of biomass fuel the 50 kilowatt gasifier , which is the source of power for building during the day. The gasifier run generator, the diesel required of which of which have been cut down to 30% after appropriate modifications; the rest of fuel comes from the gasifier in the form of 'producer gas' .1 unit of each electricity produced needs 1 kilogram of biomass and 90 milliliter of diesel.

4.4.4 Day lightning Specially Designed Skylights: Energy efficient lights and a sophisticated system of monitoring and controlling the consumptions of electricity illuminate the complex. The conference room enjoys glare-free daylight through strategically placed skylights. A master control system switches off the lights automatically whenever it senses the daylight alone is enough to maintain the desire level of illumination. In living room strategically placed lights points and specially designed swivels makes it possible to use the light at the study table as well as for bedside reading.

V. STEPS TO MAKE TRADITIONAL BUILDINGS ENERGY EFFICIENT

5.1 Insulate Your Home

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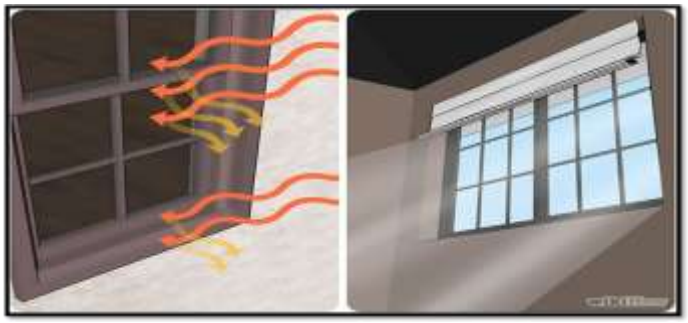
Adding new or additional insulation to your ceilings, attic and walls along with using caulking or weather stripping to make sure doors and windows are properly sealed will prevent cold drafts and air leaks to keep warm air inside during the freezing winter

Revamp Your Windows. Your windows are a major source of heat loss in a home.

5.2 Replace Aluminum Frames. Aluminum window frames let heat transfer very easily. Vinyl frames are much more resistant to heat transfer.



•Get Multiple Panes. Double or triple paned argon gas-filled windows are great for keeping the heat in and the cold out. (The argon between the glass acts as an incredibly effective insulator.)

•Tint Your Windows. While you may not think that tinted windows on the front of your house looks very attractive, you can always do it to the back windows. It's surprising how much unwanted heat and cold you can keep out by having tinted windows.

5.3 Replacing Old Appliances.

Older appliances are less energy-efficient than newer models. Replace these old "clunkers" in your home with Energy Star certified appliances. This will go a long way towards saving energy and lowering your electric bills. When it's time to replace your kitchen appliances, the washer, dryer, water heater or furnace, research the various models and features so you'll know which ones are the most energy efficient. When shopping, look for models that are labeled as "Energy Star Certified" to ensure you're getting an energy- and money-saving appliance.

•A high efficiency on-demand water heater only fires when you call for hot water. It heats up quickly-and then quits burning fuel. (An added bonus is the fact that they are amazingly easy to maintenance.)

•Get low-flow fixtures and appliances. Low-flow toilets, shower heads, and washing machines can save a lot of water

5.4 Use Your Appliances Efficiently.

Study the operator's manual for each appliance so you're familiar with the proper operating methods. Then, be mindful of how you're using your appliances. Minimize their energy expenditure by maximizing their use. Do full loads of clothes and dishes each time. Since your refrigerator is the one appliance in your home that's always on, maximize its efficiency by turning the temperature to the "energy-efficient" setting (if indicated on your temperature control) or to 37 degrees (3 degrees for your freezer). Also when you go on vacation don't just turn off your appliances, unplug them. Even though they're off, there is still energy that getting wasted.

Switch from Incandescent to Fluorescent. Although compact fluorescent bulbs cost more initially, the end result is considerable savings. This is because fluorescent light bulbs last eight to twelve times longer than incandescent bulbs. Even using a mix of fluorescent and incandescent lighting throughout your home can have an impact in overall energy usage.

Add Solar Panels. Adding solar panels to your house can help you cut down on energy costs by helping you produce a little bit of your own electricity.

5.5 Plant a Tree.

Outside your home, plant deciduous shade trees in your yard on the side of your house that gets the most intense sun during the summer months (usually the side with the western exposure). The tree and its leaves will then provide shade during the hottest time of day and naturally help to keep your home cool. In winter, when the tree will be bare, it will allow

warm sunshine into your home during the most optimal time of day.

VI. BEST EXAMPLES OF ENERGY EFFICIENT BUILDING IN WORLD AND INDIA

Madison, Wilsons's Holy Wisdom Monastery has made numerous, "greenest building" list.

•Highest rating awarded by U.S. green building council the LEED-NC version 2.2. Rating system with 63 out 69 potential points.

•Offers parking for fuel efficient vehicles.

•Accessible green roof.

•No permanent irrigation systems.

•Photovoltaic cells are responsible for the generation of 13% of all energy needs.

•**Manitoba hydro place in Winnipeg, Manitoba, Canada** is listed fourth most environmental friendly design in Canada in 2009.

•More than 40% of total light is provided by one natural source, being the sun.

•A geothermal system provides all the heating and cooling needs for the buildings.

•**Indian Tower:** The Indian tower in Mumbai has a very intriguing design that looks as through a number of boxes were stacked one on top of the other, but symbolizes an increase in environmental awerness throughout the country.

- It is 74 stories and each block will incorporate a different use, such as office, residential, and retail.
- The design of the building incorporates solar shading, day lighting, natural ventilation, rain water harvesting, and a green interior.
- It is one of the greenest buildings in India and has achieved United States green building Council's LEED gold rating.
- Crystal Island: Crystal Island in Moscow, Russia will more 1500 ft tall with more than 25 million sq. ft of floor space.
- It is a self contained city with eco- friendly management in energy conservation techniques.
- The island will be able to generate low carbon energy via solar arrays as well as wind turbines located around the building, along with large atriums that will be utilized in the regulation of internal air temperature throughout extreme temperatures that are present during the summer and winter in Russia.

VII. APPLICATIONS

Energy efficient buildings requires a higher investment of 29,500 rupees per square meter, as compared with 19,000 rupees per square meter for non-energy efficient buildings, but offer substantial saving in energy consumptions. For a 1,000 square meter hotel building with a life expectancy of 30 years, an energy efficient buildings will consume energy to tune of 300 KW/meter sq. as compared with the non-energy efficient buildings that will need 500 KWh/meter sq. of energy .The net present value is calculated to be positive at 8.1 million rupees with an electricity tariff rate of 6 rupees/KWh and a discount rate of 10%.

Develop, implement and evaluate proven, cost effective energy efficiency measures in existing buildings.

Assemble confidence buildings demonstration of emerging technologies and energy management practice not commonly used by buildings professionals.

Demonstrate the potential for achieving energy saving while maintaining or improving indoor environmental conditions such as reduced indoor air pollution, better lighting quality, and thermal comfort.

Transfer design and application methods and tools to private sector, practitioners such as architectures and engineering firms.

Support energy savings performance contracting at the national level.

8. Advantages

The advantages of building energy efficient housings are as follows:-

1. Operating costs are lowered thanks to reduction in energy usage;

2. Environmental benefits results from a reduction in energy usage;

3. Occupant comfort is increased through improved air quality.

4.Although energy efficient house can cost up to 10% more than conventional housing, but the total home energy usage can be reduced by up to 60% when the home is build with energy efficient measures, and the increased cost of construction pay for itself within 5 to 8 years,

5. It is affordability strategy in most housing styles or types, and can be incorporated into multi unit buildings as well as single detached homes.

6. Increasing Energy Available For Export: Energy exports are an important pillar of economic activity. By using energy more wisely, energy exporters will have additional power to sell into global markets and the resulting revenue can be invested in our schools, hospitals and infrastructure.

7. Reduce Local Air Pollutants: Energy efficiency can reduce the amount of local air pollutant that can come from sources like oil or wood. These are separate from green house gas emissions and includes fine particulate matter in the air as well as other chemicals, such as sulphur dioxide, that are harmful to human health.

VIII. LIMITATIONS

One of the most significant barriers to energy-efficient building design is that buildings are complex systems. While the typical design process is linear and sequential, minimizing energy use requires optimizing the system as a whole by systematically addressing building form, orientation, envelope, glazing area and a host of interaction and control issues involving the building's mechanical and electrical systems.

Compounding the flaws in the typical design process is fragmentation in the building industry as a whole. Assuring the long-term energy performance and sustainability of buildings is all the more difficult when decisions at each stage of design, construction and operation involve multiple stakeholders. This division of responsibilities often contributes to suboptimal results

How to Make Your Home Energy Efficient

Energy efficient isn't just for those of us who want to save the environment, but energy efficient building can really help you to save money. Whether it's something as big as installing solar panels or something as small as turning off the lights, when you cut back on how much energy you use-you save

money. There are many steps you can take to make your home more energy efficient. Some energy-efficient changes are one-time investments...others are things you can do every day! Realize, though, that you don't have to follow every step to be energy efficient. Even if you only implement two or three of these changes you will be saving energy, money, and Mother Nature too.

IX. CONCLUSION

The India economy and environment are linked to the buildings we construct and the energy they use. As the population and economy grow, so does our use of energy, which comes predominantly from fossil source. In this paper we have tried to explain why it is the need of the hour to switch over to an energy efficient building from an ordinary building, what is exactly an energy efficient building its advantages and limitations.

Though an energy efficient building is a bit little costlier compared to any other ordinary buildings but studies show that even 20% of investment into energy efficient building will elaborate 10 times more saving. Urbanization trends over the past decades have increased the energy needs of developing countries 70% more than International Energy Agency predicted back in 2002. At the same time investing in building energy efficiency can yield some high compelling financial returns.

The building must be properly oriented, it must be equipped with efficient equipments and materials appropriate for the location and condition. It must provide amenities and services appropriate to the buildings intended use and it must be operated in such a manner as to have a low energy use compared to other, similar buildings. In the future the energy embodied in construction and the demolition may also need to be considered in judging efficient buildings**.**

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