

Planning and Analysis of Energy Efficient Building

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Abstract - Energy efficiency is at the foreground of current debates about building technology. The increasing global population, decreasing fossil-based energy resources, rising emissions of harmful gases are the main instigator of energy efficiency in buildings. Although the energy consumption of building varies according to factors like social differences, climate, geographical location, and culture habits, it is estimated that around 40% of the annual energy consumed in the world is used in the buildings today. Based on all these reports, over the last century, increasing effort has been put into the development of energy efficient design. Energy efficient building design that has evolved and changed since the beginning of 20th century with revealing developments and changing approaches. This study has tried to compile the developments and changes made in construction industry.

Key Words: Energy efficiency, climate, sustainability, Green construction.

1. INTRODUCTION

We know that how important it is to use renewable energy in today's world. Because it is abundant and freely available. Nowadays this concept is also used in automobile industries there are electric cars and bikes available in market and research on solar car has started. We can use this renewable energy in construction industry. We can use solar panels to generate electricity, Rainwater harvesting, Water purification using natural elements, Ground water recharge. In this project we are going to design a plan in such a way that the placement of solar panels will be accurate it will not create any problem for the elevation of the building. The building will look attractive. Then we will be doing the structural analysis of this plan and costing and estimation as well and a scaled physical model using results obtained by software. In this project we prepared a working model on energy efficient building which not only provides occupant an ecofriendly environment but it also focuses on re-use of waste materials. Minimal CO₂ emission, less electricity consumption and gives zero discharge. Majority it has solar panels to produce electricity but even biogas plant which emit methane gas and other gases also produce electricity. Most importantly green techniques like double coated window, rainwater harvesting. An energy efficient building is one whose construction and lifetime of operation assure the healthiest possible environment while representing the most efficient and least disruptive use of land, water, energy and resources.

2. METHODOLOGY

2.1 Planning Building.

- Planning for zero building requires special attention from building planner, engineer, architect etc. Major attention is to be given to shape of building, Materials to be used in building, Availability of resources on site.
- Shape of building plays important role in factors of sustainability such as entry and exit of air, Entry of natural light, Collection of water for recycling and most important, general aesthetic of building.
- Materials play a defining role in achieving goal of sustainability, with modern advances in materials, it is very important to have knowledge about kind of materials that should be used in achieving sustainability.
- Apart from shape and materials, Building should be planned in simplistic way with adequate space.
- Plan should not compromise purpose of standard home while achieving sustainability.
- After researching on planning aspects of sustainable home we started planning building
- Planning is start of achieving energy efficiency and sustainability. Methods of achieving energy efficiency and sustainability can be categorized into two ways
 1. through Materials.
 2. through Systems.

These materials and systems should be selected in both economical and effective way to gain maximum benefit.

2.2 MATERIALS

2.2.1 Double Glazed Windows:

- They are windows with two glass and gap in between. The gap in between window is vacuum which allows window to act as good insulating material for house.

- It keeps house cooler from temperature outside in warm days, and warm in cool days.
- Simple phenomenon of double glazed glass to achieve good insulating property if different heating of both glass of window.
- Because it glasses are sandwiched with vacuum in between, It also acts as noise absorber keeping room silent.
- Apart from that it is waterproof, with no way of seepage.

2.2.2 Energy Efficient Appliances:

- Energy efficiency is not only about producing clean energy but also about lowering energy consumption.
- Appliances in home like Refrigerators, which consumes energy throughout day, must be of high energy efficiency rating. Other heavy appliances such as Television, Washing Machines, and Air must be of energy efficiency rating of 4-5 stars. Which reduces net energy consumption of building.

2.2.3 Lighting

- Artificial lighting is necessary but it should be kept as minimal as possible
- Using LED based lighting is best way of achieving it. As it uses minimal power and gives maximum luminous.
- Apart from that LED based lighting have longer life span when compared to CFL and filament bulbs.
- LED lightings are easy to install and maintain.

2.2.4 Reflective Paint

Reflective paints provide cooler temperature inside the building because they shield the roof from absorbing the sun's heat, so there is less transfer of heat from roof to the building, allowing building to be cool for long period of time. Apart from reducing heat it also helps in protecting roof and improving overall life of building as roof is most exposed part of building and any kind of wearing is likely to start from roof.

Apart from that these paints are environmental friendly as they have zero-VOC's (volatile organic compound). Coating of reflective paint on roof can help reducing overall consumption of electricity making it a sustainable material.

2.3 SYSTEMS

2.3.1 Solar Energy:

- Shift of construction method from conventional to modern and efficient one cannot be imagined without generation of energy through solar, especially in country like India.
- People are slowly shifting to rooftop solar farming as major source of energy generation for their homes.
- One of major reason for these shift is awareness campaigns and attractive subsidy offered by Government of India.

Before installation of solar energy system, one must always consult Engineer as initial investment of these system is high.

2.3.2 Rainwater Harvesting

- Rainwater harvesting is the simple process or technology used to conserve Rainwater by collecting, storing, conveying and purifying of Rainwater that runs off from rooftops, parks, roads, open grounds, etc. for later use.
- Rainwater, which is pure and of good quality, can be used for irrigation, washing, cleaning, bathing, cooking and also for other livestock requirements.
- Rainwater harvesting has been made mandatory in all new buildings with an area of 300 sq m or more irrespective of the roof area. It has been made mandatory to provide RWH in all Group Housing and Commercial Complexes.

2.3.3 Kitchen Waste Composting

- Composting is simply the process of breaking down the organic matter (food waste) in the presence of air and water, using microorganisms and small insects present in nature. The end product is called compost which is rich in readily usable plant nutrients forming a part of healthy soil.

2.4 ANALYSIS

- Analysis was done on STAAD.pro v8i.
- These software uses finite element method for analyzing model.
- Result of these analysis were compiled together using STAAD RC-Designer.

2.5 COMPUTER 3-D MODEL

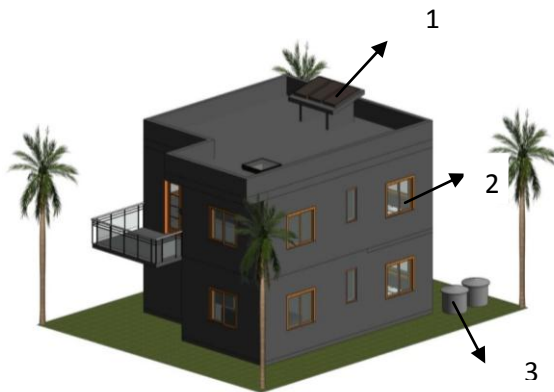


Fig -1: 3-D Model with details.

- 1- Solar panels placed on southern wall at 45° tilt
- 2- Double glazed window placed for light in living room.
- 3- Water collected from rooftop Collected in this filter tank Consisting layer of gravel, Charcoal and sand

Filtered water later passed to main storage tank. Excess rain water left for groundwater recharge.

3. RESULTS

- Solar panel wattage = Daily power requirement / (Average sunlight hours x efficiency of the system)

In our daily power requirement = 5 KWh

Average Sunlight Hours = 5 hrs.

Efficiency of the system = say 80% = 0.8
(Here the conversion losses of inverters, solar charge controllers, battery and wiring are taken)

The solar panel wattage requirement = $5 / (5 \times 0.8) = 1.25$ Kilo watts per day

In India average monthly consumption is 400 units. (1 unit = 1 Kwh) 1 unit costs 6Rs. so our monthly electricity bill is 2400/-

$$\frac{140000}{2400 \times 12} = 4.86$$

Therefore, we can recover solar panel installation cost in 5 years.

- Rain water harvesting
 - Water requirement is 135lpcd (liters per capita per day). So in a family of 4 member's water

requirement per year is $4 \times 135 \times 30 \times 12 = 194,400$ liters per year.

- Suppose the system has to be designed for meeting drinking water requirement of a four-member family living in a building with a rooftop area of 65 sq. m. The average annual rainfall in the region is 1200 mm (average annual rainfall in Kolhapur is 1239 mm).
- Annual Harvesting Capacity = $65 \times 1.2 \times 0.85 = 66.3$ Cu.m. (66,300 lit)
- We will require 128,100 liters of Municipal Water Supply per year compared to 194,400 liters per year.

4. PRO's AND CON's

Pros	Cons
Green buildings are energy-efficient	High initial cost
Higher fraction of eco-friendly materials	Green construction is not a magic pill
Water efficient devices	Energy supply may depend on weather conditions
Reduction in waste	Unclear Long-term effects
Reduction in greenhouse gas emission	Maintenance may be difficult
Protection of our natural resources	Indoor temperature may greatly vary over time
Concept takes the whole life cycle of a building into account	Green construction is not suitable for all locations
Use of recycled metals and other construction materials	Availability issues of green construction materials

Table -1: Pro's and con's.

5. CONCLUSIONS

- For energy efficient building using solar energy is the best energy source in regards to saving energy and cost efficiency.
- Photovoltaic solar panels are the best solution for generation of electricity.
- The installation of the solar panels initially would be costly, but in the long run the owner of the building would save money on their energy bill.

- More importantly, in the scarcity of natural resources we would be providing self-sufficient, energy saving, non-polluting, zero energy building.
- The solar panels that would be installed would be on the back side of the building, which would be facing south.
- This would allow for the most direct sunlight to be absorbed by the panels.
- Providing 4 number of 200 watts solar panel with battery of 48 volts whose installation cost is 140,000/- In India average monthly consumption is 400 units. 1 unit costs 6Rs. So our monthly electricity bill is 2400/- which can be recovered within 5 years
- In a family of 4 members water requirement per year is 1, 94,400 liters. Annual water harvesting potential is approx. 66 cu.m.

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