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ZERO ENERGY BUILDING: CALCULATION OF ENERGY CONSUMPTION AND PRODUCTION IN RESIDENTIAL BUILDING

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Abstract: Zero Energy Building (ZEB) which possess high energy efficient design and utilizes renewable energy technology in order to fulfill its energy needs. In this study a case study of house had been taken in the account. This building had face towards east, and doesn't have any obstacles nearby the region which will interrupt the solar energy. Design of the building is also satisfies the passive concept which means it had good number of the openings for the air circulation and day lightning, proper orientation, heat proof terrace surface. House also satisfies the active design because it has the energy efficient lightening. According to the location of the house solar energy is best suited to obtain electricity from the renewable sources. Consumption of the electricity can be calculate from there usage per hour. From the calculation of the consumption required panel can be calculated of particular Watt and battery required for the storage of the electricity. According to the dimension of the open area of terrace optimum size of the panel had been choose. Installation of panel had done according to the sun condition. Hence the amount of cost is involved in installing the solar system is calculated and the recovery of this investment had been studied. After that it become free for using the electricity.

Keywords: Energy Consumption, Photovoltaic cell, solar energy, ZEB (Zero Energy Building)

INTRODUCTION

The over usage of fossil energy is the main contributor towards global climate change. This is due to the excessive consumption of fossil energy will end up releasing large amount of greenhouse gases. The world's fossil energy consumption rate has reached 82 percent. Hence, the improvement of energy efficiency, increasing the usage of renewable energy; preservation of a healthy building indoor environment; and increasing the sustainability of natural resources are among the approaches catching the world's attention. Zero Energy Building (ZEB) is the building that fulfills the needs stated above and capable in reducing the dependence of fossil energy usage. This is because; ZEB manage to produce the amount of energy needs by the buildings through environmentally friendly manner. The development of energy efficient building or ZEB

is important, because the increase of building's electricity consumption contribute to the higher release of greenhouse gasses compared to other sectors. This is because; most of the electricity consumed by buildings is generated using fossil energy.

NEED OF STUDY

The effort to increase the energy efficiency of its residential building, . To reduce the lifetime electricity bill by one time investing the system, which will further recover within 5 or 7 years. Academician from construction management stream in gaining knowledge in regard to ZEB, energy efficient design, and renewable energy technologies.

WORLD SCENARIO

According to the World Bank, the electrical power consumption of different countries are varies. From the below graph, it seems that the power consumption is growing rapidly in United Arab Emirates. In2005, the power consumption of world is about 3000 kWh.

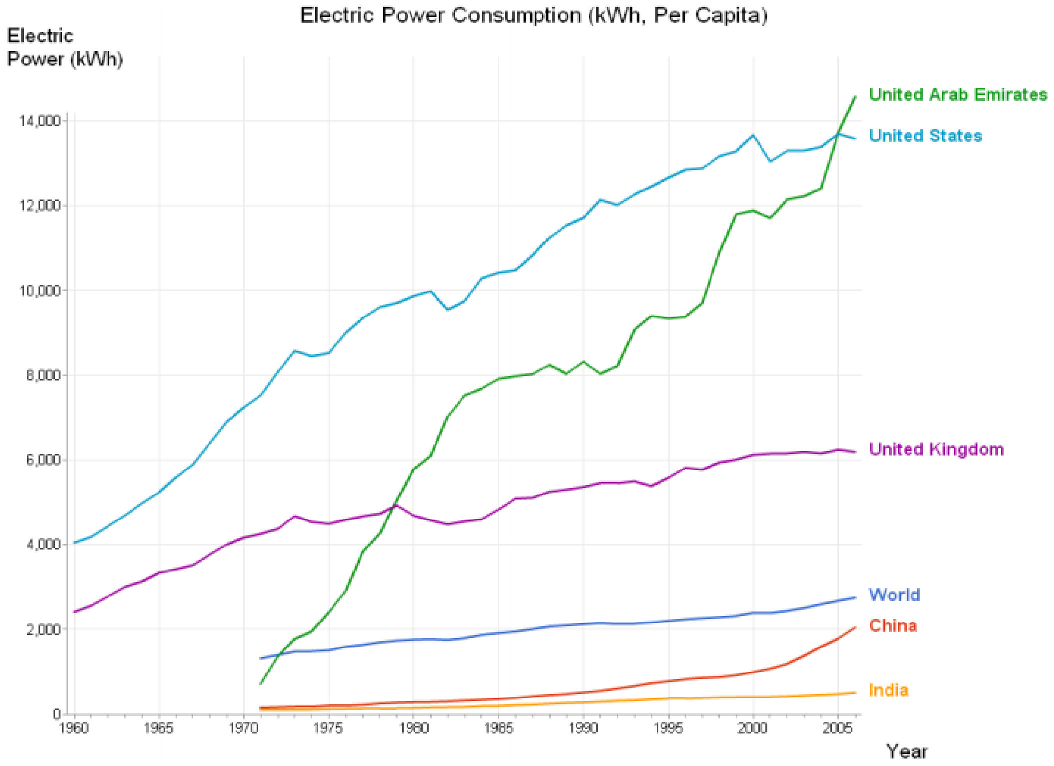

Figure 1: Electric Power Consumption
Source: World Bank

ENERGY EFFICIENT DESIGN

Energy-efficient design can be divided into two part, they are, passive design and active system. Both play an important role in converting the commercial building or domestic building into net zero energy building. In the designing of the zero energy building three important aspects plays an important role.

- Passive design.
- Active design.
- Renewable energy technology.

Passive Design

Passive design has two major aspects, the use of the building's location and site to reduce the building's energy profile and the design of the building itself such as its orientation, aspect ratio, massing, fenestration, ventilation paths, and other measures. Some other measure such as building orientation, thermal mass, day lightning, passive ventilation.

Active Design

Active system involves the mechanical and electrical approaches in order to improve energy efficiency of the building. Heat, Ventilation, and Air Conditioning (HVAC) are the mechanical system, light and electrical motor are the electrical system:

- Active mechanical system
- Electrical power system

Renewable Energy Technology

Renewable energy can be generated on-site by three different techniques, photovoltaic, wind energy, and biomass. According to location, any natural resources could be select to produce electricity and made the net zero energy building. Mostly in every location solar energy is the most suitable renewable energy. Other two energy such as biomass and wind energy is still lack behind in the technology.

ENERGY CONSUMPTION BY RESIDENTIAL BUILDING

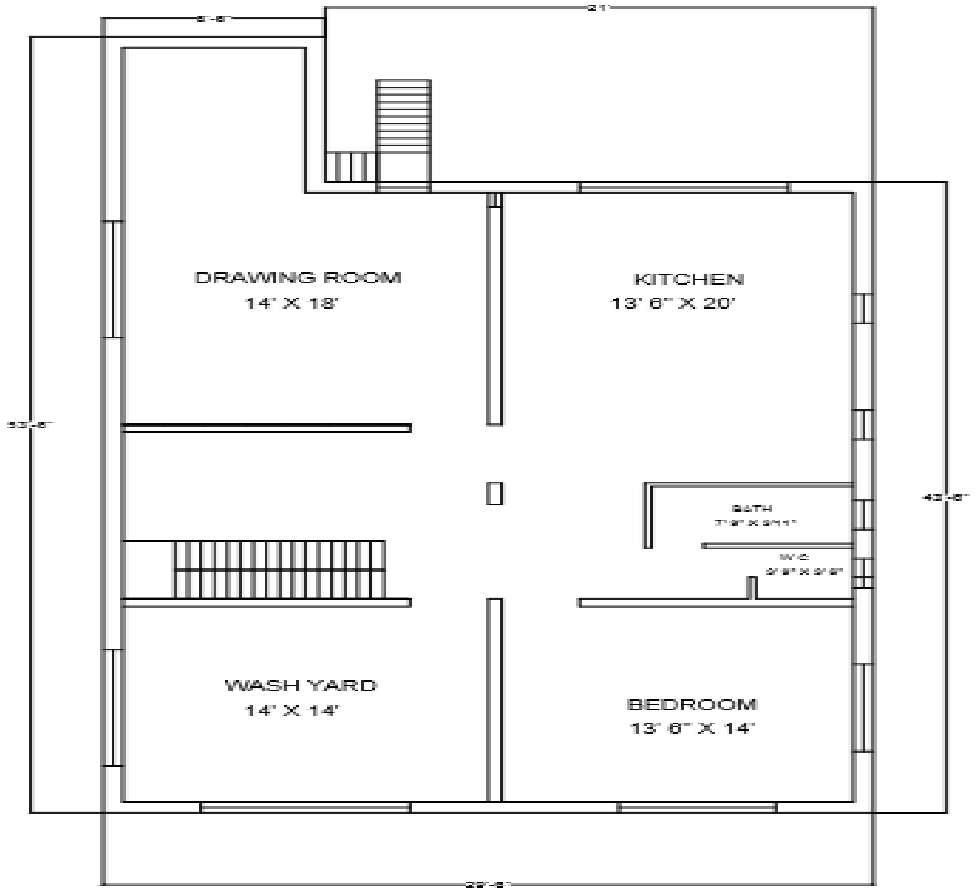

Figure 2: Ground Floor Plan

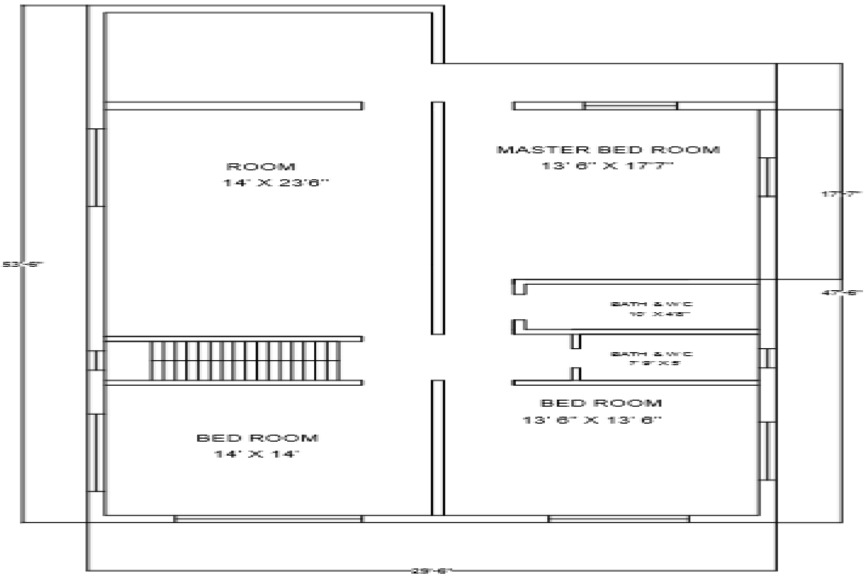

Figure 3: First Floor Plan

Energy Consumption

Table 1: Energy Consumption of Residential Building

Room No	**kWh**
Room No1	0.7500
Room No 2	0.3559
Room No 3	0.7091
Room No 4	0.1348
Room No 5	0.1776
Drawing Room	0.6286
Kitchen	4.3212
Extra Appliances	2.23
Total Usage	9.30715

Calculation Example:

- 1kW = 1000 Watts

$$\text{Daily kilowatt hour consumption} = (Wattage\ of\ appliances * Hours\ per\ day)/1000$$

- A Ceiling fan = 100 Watts Hours used Per day = 12 hours
- 100 * 12 = 1200
- 1200 / 1000 = 1.2 kWh
- To calculate the annual consumption1.2kWh * 365 days = 438 kWh

CALCULATION

Electrical power is measured in Watts and energy consumption is measured in kilowatt hours (kWh).

A kilowatt hour is simply: The amount of electricity used (1000 Watts = 1 kilowatts), in kilowatts multiplied by The number of hours the energy is used .Usually the calculation states the time period such as one day, one month or one year.

- For example: if a 100 W light bulb is on for 10 hours a day then: 100/1000 (kilowatt) x 10 (hours) = 1 kWh per day.

- In one month, that same 100 W light bulb, turned on for 10 hours a day will consume: 100/1000 (kilowatt) x 10 (hours) x 30 days = 30 kWh hours per month.

Example

Requirement of Solar array

It depends on your lifestyle and energy consumption. If you require 3.85 kWh per day, then you'll require the following number of solar panels:

$$\frac{\text{3.85 KWH (PER DAY)}}{\text{7 HOURS OF SUNLIGHT (PER DAY)}} = \textbf{0.55 KW FROM THE SOLAR ARRAY}$$

- If you have a **120 W** panel,
- So, $\frac{0.55\ (kW)}{0.120\ kW} = 4.6\ panel \approx 5\ panels$
- For our calculation,we have **9.3071**kwh per day
- According to selected residential location, about **5 to 6 hours** sunlight will give solar energy and rest of time it doesn't provide that much energy to produce electricity.
- Peak hour is **5 hour**

$$\frac{\text{9.3071 KWH (PER DAY)}}{\text{5 HOURS OF SUNLIGHT (PER DAY)}} = \textbf{1.861 kW FROM THE SOLAR ARRAY}$$

- Let's consider **250W** panel for this project.
- Hence, we need **:**

$$\frac{1.861\ kW}{0.250\ kW} = 7.445\ panel \approx 8\ panel$$

- **Hence 8 panels is required.**

SOLAR PANEL INSTALLATION DIRECTION

Solar panels will work anywhere there is sun; however, some locations are better than others here are some of the more important factors you need to take into account:

- Location. Southern locations receive more direct sunlight than northern locations.
- Season. In the northern hemisphere, daylight hours are longer in summer and, once the batteries are fully charged, the excess electricity will be wasted. In winter, the days are shorter and there may not be enough sunlight to recharge the batteries for the night-time requirements.
- Climate. Solar arrays are most efficient in bright, direct sunlight and can be reduced by 50% if the sky is overcast. If snow collects on the panel, the array will stop produce electricity until the snow melts or it is manually cleared.
- Obstacles. Anything that blocks sunlight from falling on the panels will reduce the efficiency of the arrays. This includes shadows, leaves, dust and other debris. The panels can quickly become inefficient when obstructed from full, direct sunlight.

CONCLUSION

Economy

- High performance and low / zero energy buildings require an integrated building design and delivery process
- Now cost of the 1 panel = 18,200 Rs
- Than cost of the 8 panel = 1,45,600 Rs
- Cost of the battery = 12699 Rs
- Total cost of hybrid system = 1,45,600+12699 = 1,58,299 Rs

Recovery

- Electricity bill of each month is <2500 Rs hence per year approx. 30,000 Rs is obtained
- Hence this value is recovered after 5.5 years. After 5 years it will be free.

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