Design and Planning of Zero Energy Public Building with Movable Solar Panel System by Using Revit Software

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Abstract- ***One of the main contributors towards Pollution and Global Warming are Buildings; 40% of overall globe energy is consumed by buildings and are also responsible for about 36% of total carbon emissions. In Recent events of rise in Global warming due to excess pollution there is immense need to control pollution; this is where the concept of Zero Energy Building comes in Picture. The zero-energy building means the amount of energy used by the building in the annual basis is equal to energy generated on site or of site. These buildings do not increase the greenhouse gases and has less impact on climate. This paper aims to design a [Public] zero energy building by using renewable energy resources. The generation of power from the reduction of fossil fuels is the biggest challenge for the next half century. The idea of converting solar energy into electrical energy using photovoltaic panels holds its place in the front row compared to other renewable sources. But the continuous change in the relative angle of the sun with reference to the earth reduces the watts delivered by solar panel. In this context solar tracking system is the best alternative to increase the efficiency of the photovoltaic panel. Solar trackers move the payload towards the sun throughout the day***

Indexed Terms- ***Zero Energy Building, On-Grid, Off-Grid, Solar Tracking System, Single Axis Solar Tracker.***

I. INTRODUCTION

Currently our planet is facing a major problem of Global warming. Globally, the construction industry is one of the main contributors to global warming by consuming up to 40% of total globe energy and emitting 36% of total carbon emissions. Construction industry is one of the major contributors to depletion of Natural resources and causes various harmful side effects such as air and water pollution, deforestation, solid waste, health hazards, global warming and other negative consequences. It is clear that engineering profession has a significant part to play an affective role towards controlling Global warming. Buildings of future must be efficient, sustainable and must contribute least to global warming. One of the major factors leading to Global warming at an alarming rate is use of natural resources for generation of electricity, currently 63% of total electricity generated is from Natural resources such as Coal, Natural gas and Oil. Major part of electricity in houses, almost 50% is used for Cooling and lighting.

We are selecting public building as a Hospital, because multi-special hospital building provides the medical services to the people and now day's most working building is hospital because of Covid-19.

A zero-energy building may be a building with zero net energy consumption; it means the entire amount of energy employed by the building on an annual basis is adequate to the amount of energy produced on the site or off the site. These buildings don't increase the quantity of greenhouse gases and fewer impact on climate. A building that consumes zero or nearly zero energy on an annual net basis by reducing primary energy consumption within the building through enhanced energy efficiency performance of the building envelop and facilities, networking of neighboring buildings, on-site utilization of renewable energy, and so on.

Now a days the energy deficiency problems faced by the world, more especially the third world countries are urging researches to find an alternative energy source that would complement the conventional fossil fuel. The alternative energy sources include solar, nuclear and wind. Solar energy is the energy generated by harnessing the power of the solar radiation. It is the cleanest source of energy which can pollute the climate the least. The power from the sun intercepted by the earth is approximately $1.8*10^{11}$MW, which is many thousands of times larger than the present consumption rate on the earth from all other in use commercial energy sources. The main problem with the solar energy it's dilute nature. Even in the hottest regions on the earth, the solar radiation flux available rarely exceeds1 KW/M, which is insufficient for technological utilization. This problem can be rectified by a device solar tracker which ensures maximum intensity of sun rays hitting the surface of panel from the sun-rise to sunset.

1.1 Aim and objective of work

The aim of the project is to make public building more sustainable by using renewable source of energy

1.2 Objectives

1. Design public zero energy building.
2. Reduce monthly electricity bills.
3. To reduce the usage of conventional sources of energy as much as possible.
4. To waive unnecessary loads such as lighting during day time.

II. MATERIAL AND METHODOLOGY

2.1.1 Solar Panels

A solar array converts sunlight into an electrical current or heat want to provide electricity for home or building. Solar panels are constructed as a set of many small solar cells that are cover an outsized area to supply enough power. The larger the concentration of sunshine hits the cell the more electricity or heat is produced. Solar panels work by converting light photons into electricity through the solar photo-voltaic (PV) effect. This allows for direct conversion of sunlight into solar energy, or electricity.

2.1.2 Solar Tracker

A solar tracker is a device that orients a payload towards the sun, the use of solar tracker can increase electricity production by round a third, and some claim by as much as 40% in some regions, compared with modules at a fixed angle. In any solar application, the conversion efficiency is improved when the modules are continually adjusted to the optimum angle as the sun traverses the sky. As improved efficiency means improve yield, use of trackers can make quite a difference to the income from a large plant.

The sun's position in the sky varies both with the seasons and time of day as the sun moves across the sky. Hence there are also two types of solar tracker:

- Single Axis Solar Tracker
- Dual Axis Solar Tracker

2.1.3 On-Grid vs Off-Grid Solar: On-Grid Solar

Definition: On-Grid Systems are solar PV systems that only generate power when the utility power system is out there. They must connect to the grid to function. They can send excess power generated back to the grid once you are overproducing so you credit it for later use Benefits: These are simplest systems and therefore the most cost effective to install. These systems can pay for themselves by offsetting utility bills in 3-8 yrs.

- Off-Grid/Hybrid Solar:

Definition: These systems allow you to store your solar energy in batteries to be used when the facility grid goes down or if you're not on the grid. Hybrid systems provide power to offset the grid power whenever the sun is shining and can even send excess power to the grid for credit for later use Benefits: Provides power for your critical loads when the facility grid is down.

2.1.4 Insulated Glass Units (IGUs):

An insulated glass unit (IGU) combines multiple glass panes into one window system. Most IGUs are double glazed (two panes of glass) with three panes (triple glazing) or more becoming more common thanks to higher energy costs. The panes of glass IGUs are separated by a spacer and a still layer of air or gas. The glass is then fitted into window frames, which is formed wider to accommodate the 2 panes. Double glazed windows are a perfect energy efficient choice

with the additional advantage of minimizing noise. The sealed air gap between the 2 panes acts as another layer of insulation. This added thermal resistance reduces the quantity of warmth escaping in winter and keeps your home at comfortable temperature. Double glazing has the reverse effect in summer, preventing unwanted heat from coming into the house. This extra insulation lessens your reliance on artificial heaters and air conditioners and may ultimately reduce your energy costs.

2.1.5 Energy Efficient Lighting System

You have many choices in energy-efficient lighting. The most popular light bulbs available are halogen incandescent, compact fluorescent lamps (CFLs), and light-emitting diodes (LEDs). Although they will initially cost quite traditional incandescent bulbs, during their lifetime they prevent money, because they use less energy. You can find these in most hardware and residential improvement stores. Controls like timers and photocells save electricity by turning lights off when not in use.

2.1.6 Air Sealing of Building

Air leakage occurs when outside air enters and conditioned air leaves your house uncontrollably through cracks and openings. It is unwise to believe air leakage for ventilation. During cold or windy weather, an excessive amount of air may enter the house. When it's warmer and fewer windy, not enough air may enter, which may end in poor indoor air quality. Air leakage also contributes to moisture problems which will affect occupants' health and therefore the structure's durability. An added benefit is that sealing cracks and openings reduces drafts and cold spots, improving comfort.

2.1.7 Insulation

Insulation in your home provides resistance to heat flow and lowers your heating and cooling costs. Properly insulating your home not only reduces heating and cooling costs, but also improves comfort.

III. PROPOSED PUBLIC BUILDING

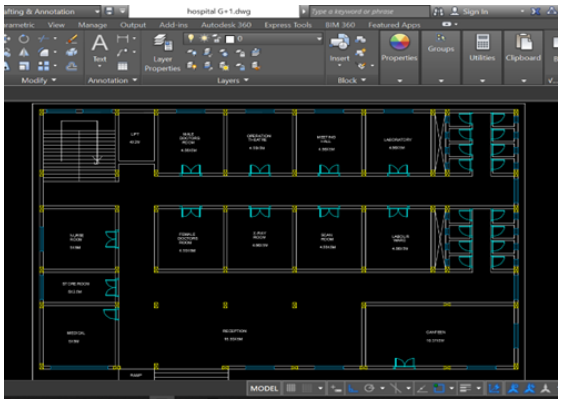

Fig 1- Ground floor plan of building

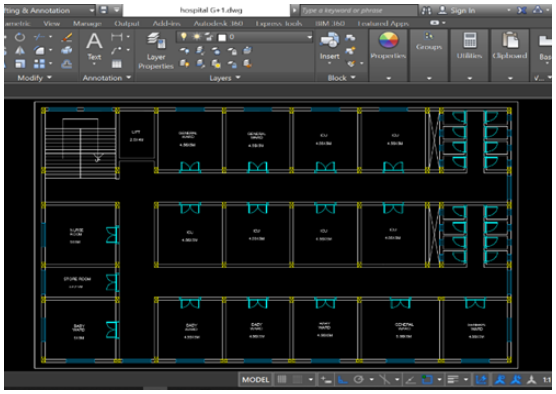

Fig 2- First floor plan of building

Fig -Elevation of building

IV. CALCULATION OF ELECTRIC LOAD

Table 1: Load Calculation for System Size Determination

Rooms	Electricity Consumption
Reception	13.76 Units/day

Male Doctors Room	5.57 Units/day
Female Doctors Room	5.57 Units/day
2 Nurse Rooms	5.57 Units/day
Labour Room	5.57 Units/day
2 Store Rooms	0.28 Units/day
Medical	18.84 Units/day
Canteen	7.2 Units/day
Meeting Hall	1.64 Units/day
Laboratory	8.27 Units/day
X-Ray Room	6.82 Units/day
Scan Room	1.22 Units/day
Lift	0.64 Units/day
Operation Theatre	17.91 Units/day
6 ICU Rooms	7.26 Units/day
4 General Ward	5.32 Units/day
4 Baby Ward	7.25 Units/day
Toilets & Baths	3 Units/day
Ground Floor Passage	2.8 Units/day
First Floor Passage	3.78 Units/day
Outside Lights	Units/day

1) Total Electricity Consumption per day in terms of Units (Watts/day) =212338 Watts/day.
2) Total Electricity Consumption per day in terms of Units (kWh/day) = 212.338 Units/day
   ~200 Units/day.
3) Total Electricity Consumption for month in terms of Units (kWh/Month) =6200 Units/month.
4) Monthly bill for electricity consumption in INR= 36,084 INR.
5) Total Invertor Load= 28278Watts.
   Total power drawn by appliances = 28278 Watts.
6) To Provide a Small Buffer or margin Inverter choice must be around 30000 Watts.
7) Divide the total daily power required by the number of charge hours for the geographic region (Ratnagiri) = (200 x 1.2)/6 = 40 kW ~ 50 kW
8) Consider 325Watt Panels
9) For Fixed Solar System No. of Panels = Total Watt/Solar Panel Watt = 50000/325 = 154 Panels.
10) 325Watt fixed panel Generate 1320 Watt per day.
11) As the solar panels are movable, they generate 30% extra energy than fixed panels.
12) 325Watt movable panel generate 1716 Watt per day.
13) Therefore, for movable solar panel system total no. of solar panels require=118 Panels.

Rate Analysis:

- Solar Panels = Rs 9,900 per 325 W Panel
- Tracker=Rs 10,000 (Per 4 panels)
- Regulator = Rs 1800
- Inverter = Rs 21,00,000

Total no. of panels=118 panels, Then total price of panels=Rs 11,68,200.

Total no. of trakers=30 trackers, Then total price of trackers=Rs 3,00,000.

Total Cost of Solar System is Rs 35,00,00 or Thirty-Five Lakh Rupees for above planned Hospital Building. In these Solar System Cost consists of cost of Solar Panels, Trackers, Regulator and Inverter, hence, is subject to fluctuate. The Output of Solar System can be expected to vary by 0.25% for every 5 ℃ variation in temperature.

Table 2: System Specifications

PV System Specifications (Public)	
DC System Size	50 kW
Module Type	Thin Film
Array Type	Horizontal Single Axis
Model	PST-1AX6
Max. Capacity Per Tracker	24 Modules (72-cell)
Max. Links Per Actuator (Motor)	6 Rows (1 row=54 modules)
Rotating Angles	+45° ~ -45°
Driving System	Linear Actuator
String Voltage	Up to 1500V DC
Ground Covered Ratio	Adjustable
Array Height	1.45 meters (Adjustable)
System Losses	14%
Inverter Efficiency	96%
DC to AC Size Ratio	1.1
Performance Metrics	
Capacity Factor	19.4%

Table 3: Recovery of Cost of Installed System

System capacity	50 kW
Required roof space	3000 Sq. feet
Average required annual output	77504 Units
Expected annual Output	168763 Units

Average Required Monthly Output	6583 unit
Expected Monthly Output	14064 Units
Lifetime value of electricity generated	Rs.2,45,55,175 (25 Years)
First year value of electricity generated	Rs 9,82,207
Net investment	Rs 35,00,000
Cost/unit without Solar	Rs 5.82
Number of Years to Payback	3.56

CONCLUSION

One of the main contributors towards Pollution and Global Warming are Buildings; 40% of overall globe energy is consumed by buildings and are also responsible for about 36% of total carbon emissions. In Recent events of rise in Global warming due to excess pollution there is immense need to control pollution; this is where the concept of Zero Energy Building comes in Picture. After analyzing and study we conclude that Zero Energy Building is the best & most effective way to reduce pollution and carbon emissions by direct or indirect means. One of the major parts of a Zero Energy Building is Solar System, Solar systems make any building self-sustainable, energy saving, eco-friendly and also help in reducing carbon footprint of the building.

The optimum building orientation to the side of light with the prevailing wind direction during the winter in order to neutralize the negative impact of climate change on the building and thermal balance.

The design building was help us to acquire knowledge about various software, analysis, and design concept. The provided tracking system produces about 30% more energy output compare to the solar panels and about 15% more energy output compare to single axis solar panel.

The invention of solar tracking system helps us to improve performance of PV solar system in simple way

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