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"Comparative Study of Net Zero Energy Building"

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ABSTRACT - One of the great option is to outlook on energy production and consumption. People cannot keep up with the exponential growing population by only becoming energy efficient. The best way to create energy is to not use it we can solve the problem by reducing or eliminating our energy demand from the electrical grid. The answer to solving the energy crisis is net zero energy. Building sector consumes more energy than all the forms of the transportation combined. A net zero energy building is a facility that consumes zero energy on a yearly basis. That means building generates no more energy than it can generate itself via on site renewable energy sources. Exponential growth of residential buildings is matter of concern. Housing stock consumes around 40% of energy consumption among other sectors. Indian buildings are silent energy guzzlers. They account for 35% of India's overall power consumption and generate a significant amount of greenhouse gases. Because of ever-increasing population and urbanization, the construction (and energy consumption) of buildings has seen a rampant rise. This study aims to analyze the impact of energy saving methods on a regular residential household building. To minimize the excessive energy and cost consumed in the form of maintenance and operation of building equipment used to provide services and amenities after the completion of building almost to zero, various effective methods have been used to nullify the energy consumption and cost of the building within the construction cost and planning or designing of building

Keywords zero energy building , renewable energy , energy building , embodied energy

I. INTRODUCTION

A Zero energy building, also known as a net zero energy building, is a building with net zero energy consumption, meaning the total amount of energy used by the building on an annual basis is equal to the amount of renewable energy created on the site or in other definitions by renewable energy sources offsite, using technology such as heat pumps, high efficiency windows and insulation, and solar panels. The idea of net zero energy building is getting popular globally. However, popularity about the subject is not the main concern right now. Most of the industries are considering sources only for today's comfortable lifestyle. Industries are refraining to take a part in this new concept, but it is the prime need for sustainable buildings in the future. Building industries are slow pacers compared to other industries and they are heavy consumers of energy. Our population is increasing exponentially and to provide them good services, amenities overall a good sustainable lifestyle in today's world renewable and mostly non-renewable energy is being used and wasted at the same time by the entire requirement from world out there. The next decade is expecting to witness massive volumes of building constructions, which will further also escalate the energy consumption. While there is a strong policy-push towards the adoption of renewable energy technologies such as rooftop solar photovoltaics (RTPV), the potential for making zero energy buildings has not been explored extensively - even though experiments across the world (and India) have shown the possibility. NZEBs have lower energy demand than that of conventional buildings and produce at least as much energy as they consume in a year, through onsite renewable energy technologies. NZEBs are commonly grid-connected to save battery costs. This allows them to draw electricity at night and during cloudy days, and return an equivalent amount of electricity to the local grid on sunny days. Thus, it nullifies the net carbon emissions from buildings.

II. OBJECTIVES OF THE PROJECT

1. To identify the cost and charge of different energy input.
2. To examine the effective energy management.
3. Implementation of procedures for realization of saving costs.
4. To compare net zero energy building with conventional building.

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5. To study and recognize the scope of net zero energy building.

III. LITERATURE REVIEW

- **Concept Project of Zero Energy Building**

Elena Perlova, Mariia Platonova, Alexandr Gorshkov, Xenyiya Rakova

This project study want us to grab attention to the problem causing global climate change effects. Acute problem of carbon dioxide emissions reduction into the atmosphere becomes more important due to the fact of global climatic change. According to the various estimates housing stock consumes over 30-40 % of total energy resources. And to neutralize this drastic consumption of energy towards building industries. They have also discussed about prospects for the construction of a building with low energy consumption in Russian atmosphere. And constructive solutions and insulation as per requirement. They have produced series of studies. It corresponds to identifying and practical application of a body architectural and planning solutions to reduce the heat loss through the building of the building envelope.

- **Net Zero Energy Buildings: Expense or Investment**

R.S.Adhikari, N.Aste, C.Del Pero and M.Manfren

This study wants to conclude whether Net zero energy buildings are way to expensive or is it a good investment in long-term results. The authors of this paper also involved the roles of different renewable assets and compared them with non conventional or non renewable equipment (Traditional method) get the best results. For practical evaluation of results, they also worked on a case study on a building of area about 7000 mtr.sq During the design phase, different evaluations have been made about building envelope in order to minimize thermal energy demand in both winter and summer. A technical-economic analysis of the ZEB case study was carried out in the present work. It must be noted that applied energy performances are lower than estimated ones, but corresponding to an average of efficient buildings. It can be assumed that the results of this study are conservative compared to those actually achievable, but precisely for this reason, more reliable.

- **Net Zero Energy Buildings**

Prof. Karsten Voss University Wuppertal, Department Architecture, Building Physics and Technical Services.

This study explains in brief knowledge (Basics) about Net Zero Energy Buildings. They have explained the concept behind NZEB, how does it works, by showing and comparing statistical graphs about consumption of energy by the building by traditional methods and by the renewable energy methods. They tried to focus on long-term results of c0nventional methods or initial investment of various green energy related material equipment in the building such as use of PV panels (solar roof) , floor heaters.

IV. METHODOLOGY

4.1 Using cost efficient solar panel system and its cost saving calculations to gain a long-term results.

One of the biggest reasons to go a solar is that you eliminate or significantly reduce your light energy bill.

Going solar can eliminate your electric bill or reduce dramatically that electricity costs are no longer significant factor in your budget. Your savings with solar depend on a few factors, like how much energy your system produces and how much you consume, but the biggest factor is the rates you would pay to your utility. Because your savings are equal to the costs you avoid by going solar, you will save even more electricity rates are high in your area. Moreover, since electricity prices will continue to rise, your savings will continue to grow every year over the 25+ year lifespan of your solar panel system. Reducing one of your largest monthly expenses makes perfect sense, but the benefits of solar are not just economic. Because electricity prices can be unpredictable, they make managing your budget difficult. By installing a solar panel system, you also fix your electricity costs and make them more predictable. This is especially beneficial for anyone with a fixed income, as well as for business who predictable by going solar, you also improve your expense forecasting and management capabilities.

4.1.1 Following table represents energy power consumption by typical home appliances for a 1 BHK apartment

Sr no.	Name of Equipment	Rating of equipment (watt)	No. of installed equipment
1	Tube light	35	4
2	LED bulb	15	4
3	Fan	70	3
4	Fridge	200	1

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5	Laptop	50	1
6	LED TV	70	1
7	Geyser	1000	1
8	Washing machine	500	1
9	Oven	1500	1

Total energy (watt)	**No. of operating hours**	**Total energy consumption (kW)**
140	5	0.140
60	4	0.060
210	10	0.210
200	12	0.200
50	4	0.050
70	3	0.070
1000	1	1
500	1	0.5
1500	1	1.5

4.1.2 Conversion of total energy consumption from Kw into kWh.
Conversion formula of energy consumption from **kW to kWh** as follows :
Energy produced in kW X No of hours = **Energy produced in unit or kWh**
Energy in kWh X No of days equip. used = **Energy produced in unit or KWh**

Similarly, by calculation we obtained –

Sr no	**Total energy consumption**	**No of days equipment usage**	**Total energy consumption (kWh)**
1	Tube light	28	15.68
2	LED bulb	28	3.36
3	Fan	20	42
4	Fridge	28	67
5	Laptop	20	4
6	LED TV	28	5.88
7	Geyser	20	28
8	Washing machine	20	10
9	Oven	20	30

4.1.3 Before Solar Energy System

We concluded that 1 apartment consume up to 200 kWh of electric energy. That means 30 apartments need around 6000 kWh of electrical energy per every month. Currently the rate of electricity per 1 kWh in India is **6.5 Rs to 7.30 Rs.**
If we calculate the energy consumption of building for the next 25 years,
6000 kWh x 8 Rs = 48000 Rs monthly cost
48000 Rs x 12 months = 576000 Rs Annually cost
576000 Rs x 25 years = 1,44,00,000 Rs

4.1.4 After Solar Energy System

We will need a 40 kW solar panel system, which is able to generate upto 5000 kWh per month.
That means we only need to pay for remaining 1000 kWh that is coming from power grid.
Now, if we calculate the cost of this 1000 units of electricity in kWh,
1000 x 8 Rs = 8000 Rs per month
8000 x 25 years = 24,00,000 Rs

4.1.5 Cost and Maintenance of solar system

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- The timely and regular cleaning of **solar cells** and **PV panels**.
- Regular **maintenance** of all thermal-based components.
- Servicing of HT side equipment on an annual basis.
- Diagnosis and tests pertaining to low **solar power** production.

This will add up to a cost of maintenance per **1 kW** is **1000-1400 Rs** (Avg - 1100) And it need to be done on specific regular time interval let say every **8-9 months.** So, the total cost of the operation and maintenance of solar system for 25 years will be,

1100 x 40 = 44000 Rs for every 10-12 months
44000 x 25 = 14,52,000 Rs (Approx = 15,00,000 Rs)

The cost of on grid 40 kW solar panel system is 17,00,000 including the subsidiary from govt.

The total cost of the system will be **17,00,000 + 15,00,000 = 32,00,000 Rs**

4.1.6 Cost saving :

Before solar system the cost is 1,44,00,000 Rs
After solar system the cost is 24,00,000 Rs
The cost of solar system is 32,00,000 Rs

From all the observation and calculations, **we saved 5000 kWh energy per month** . That means the **total energy saved is worth of 88,00,000 Rs**

4.2 Water Management System

Net zero water building has been achieved when the amount of alternative water consumption and water returned to the original water source is equivalent to the building's water consumption

Objectives of Net Zero Water Building

- Minimize total water consumption.
- Maximize alternative water sources
- Minimize wastewater discharge from the building & return water to the original water source.

TERM	DEFINITION
Alternative Water	A sustainable water source not derived from fresh, surface or groundwater source. Alternative water includes: • Harvested rainwater, storm water, sump-pump water. • Graywater • Rejected water from water purification systems. • Reclaimed wastewater A net zero water building uses alternative water sources to offset the use of freshwater.
Freshwater	Water sourced from surface or groundwater such as lakes & rivers.
Original water source	Surface water & groundwater sources that are within the same local watershed and aquifer of the building.
Water Returned	The amount of water collected from the building systems such as green infrastructure & on site treated wastewater, which is returned to the original water source.

Total Annual Water Use = Total Annual Alternative Water Use + Total Annual Water Returned

Total Water Use = It is the amount of water consumed within the boundaries Of a building from all sources such as potable, non potable Including fresh water & alternative water.

Alternative Water Use = It is the amount of water consumed from alternate Sources such as harvested rainwater, graywater, reclaimed wastewater etc.

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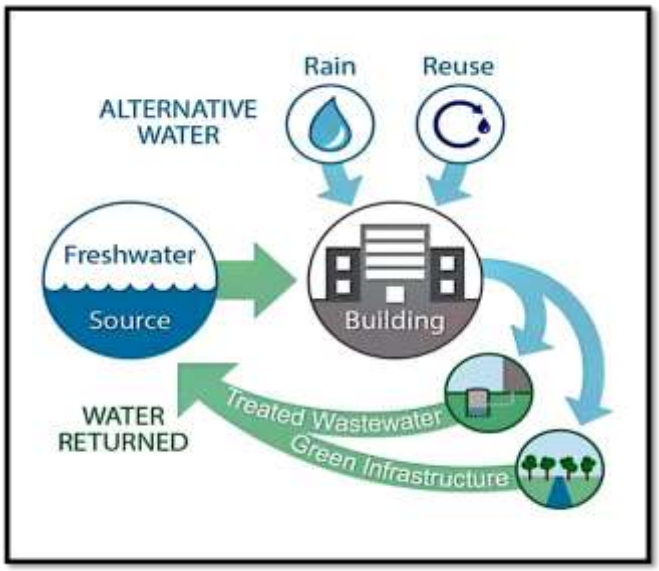
Water Returned = Amount of water collected from the on site treated waste water and returned back to the original water source.



PURPOSE	Amount of Water in Lit/Day for 1 Flat
Bath	125
Laundry	50
Toilets	100
Dish Washers	30
Cook	10
Drink	15
Total Usage of 1 Day	330 Litres.
Total Water Consumed For Building	330*30 = 9900 Litres/ Day

Total Water Usage for 1 Month = 9900*30=2,97,000
Total Water usage for 1 year = 297000*12= 35,64,000 Litres

4.2.1 Sewage Treatment Plant
Sewage Treatment Plant can be

- Open Unit
- Partially Sealed Unit
- Fully Sealed Unit

For our residential building, We recommend completely sealed package unit

4.2.2 Grey Water Treatment Plant.

- Grey water can be defined as any domestic wastewater produced, excluding sewage.
- The main difference between grey water and sewage (or black water) is the organic loading. Sewage has a much larger organic loading compared to grey water.

4.2.3 Rain Water 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 roof of the building for later use.
- The rainwater harvesting system is one of the best methods practised and followed to support the conservation of water.

Today, scarcity of good quality water has become a significant cause of concern. However, Rainwater, which is pure and of good quality, can be used for irrigation, washing, cleaning, bathing, cooking and also for other livestock requirements.

4.2.4 Total Quantity of Water collected in rain water harvesting

Total Water collected (m3) = Roof top area X average monsoon rainfall (m) X 0.8
= 560*0.4*0.8
=179.2 m3
=**1,79,200 Litre**

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4.2.5 Water Returned from Grey water treatment Plant

Sources	Usage
Bath	125
Laundry	50
Dish washers	30

Total Grey Water discharge to GWT = 205 litres
10% wastage = 20.5 Litres
Treated Water from GWT= 205-20.5
= 185 lit
Water Returned from GWT to original Source = 185 Litres/day
Total Building (for 30 flats) = 5550 Litres/day

4.2.6 Water treated in STP

Source	Usage
Toilet	100

Black water discharge (Toilets) To STP = 100 Litres/day
10 % wastage(Sludge) = 10 litres
Treated Water from STP = 100-10
= 90 litres/day

4.2.7 Water Discharge from STP to ground water = 90 Litres/day
Total Building (for 30 Flats)= 90*30
= 2700 litres/day

Alternative Water Source	Water Returned To Original Water Source		
	Daily	Monthly	Annually
Harvested Rainwater	-	-	1,79,200
Grey Water	5550	166500	19,98,000
From STP	2700	81000	9,72,000
			31,49,200 litres

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Water Returned From Alternative Water Source = 31,49,200 Litres
Annual Water Usage = 35,64,000 Litres

4.3 Environmental Dimension

Objectives

- Reduce energy consumption
- Reduce noise pollution
- Reduce the temperature of surrounding
- Decreasing air pollution
- Reducing green house gases

4.3.1 Designing methods and the creation of green buildings in cities

- **Vertical green surfaces or green wall :**

Green wall is a new technology that is now finding itself slowly in contemporary cities of the world. Green wall is an independent or part of a building structure, covered with vegetation. Types of Green walls from the perspective of implementation, including green facades (Green Facades) and indoor and outdoor living walls (Living Walls) and the green walls and green walls are classified into two types of the air purification: active and passive.

- **Green facades :**

Green facades, a green wall in which plants can be planted in the ground or in pots brought in height. In traditional green facades or direct climbing, plants are connected directly and without retaining to the wall and go up. Two shells green facades are indirectly attached to the wall by means of a support structures. Scaffold structure of this type can be made of different sorts, such as wood, metal or mesh network

- **Interior and exterior living wall**

Living walls are a combination of panels with vegetation and those are mounted vertically by a structural lightweight system, narrowly to the building facades and are self supporting. Living wall can be used in interior and exterior of building. Box systems, are modules that are placed as place of plant growth in metal support frame and has the ability to separate from the wall or replaced to change the mod. In the system of industrial felt roots are placed between the fiber and food and water go through woven layers of plants. The system is suitable for dry weather.

4.3.2 A Case Study of green buildings and their impact on energy efficiency-

California Academy of Sciences

The Academy is designed in 2008 by the famous Piano Italian architect Renzo and constructed from recycled materials. The index features is respecting the environment and the site and the application of solar cells. Its basic design has reduced energy consumption by 30 to 35 percent. Green roofs are one of the most fundamental parts of the construction that have placed 9 native plant species in California. Plants on the roof are equipped with a thermal insulation layer. Roof has played the role of insulation and makes building warm in winter and cool in summer and prevents more than 405 million pounds of greenhouse gas emissions in a year.

4.4 Eco friendly construction materials

A **building's carbon footprint** is defined as the amount of **CO2** it produces during its operations and activities. Considering a **building's carbon footprint** is something that affects both new construction as well as existing **buildings**.

To minimize the effect of carbon footprint and to avoid the wastage of any materials these eco friendly and environment friendly materials are used they are as follows :

- Blended cements
- Compacted fly ash blocks
- low energy intensity floor and roofing systems

Blended Cements

- These are cements containing a high volume of one or more complementary cementing materials (CCM), such as coal fly ash, granulated slag, silica fume and reactive rice-husk ash.
- A large volume of CO_2 is directly emitted during the cement manufacturing process (0.9 tonnes/tonne of clinker). Reduction in the quantity of clinker by substituting with CCM results in lesser CO_2 emissions.
- There is a considerable amount of ongoing R&D in the direction of using CCM in Portland cements and up to 40% substitution by CCM is possible.
- CO_2 emissions from cement/concrete industry to reduce drastically by 2030. CO_2 emissions will be at 940×10^6 tonnes by 2030, which is same as that for the year 1990 though there will be a considerable increase in the total volume of concrete consumed.

Compacted fly ash blocks

- A mixture of lime, fly ash and stone crusher dust can be compacted into a high-density block. Lime reacts with fly ash minerals forming water insoluble bonds imparting strength to the block.
- These reactions are slow at ambient temperatures (~30°C) and can be accelerated by either low-temperature steam curing or by using additives like phospho-gypsum (an industrial waste product).
- Block strength depends upon the composition of the mix, density and percentage of stabilizer/additives. Some advantages of the technology are: (a) decentralized production in tiny scale industries, (b) utilization

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of industrial waste products and (c) energy efficient and environment friendly.

Low energy intensity floor and roofing systems

- Floor and roofing systems are an assembly of two or more building materials or products. For example the most commonly used reinforced concrete (RC) slab is made up of reinforcing steel, concrete and other non-structural elements like floor finish, renderings and paints.
- Energy intensity of RC slab arises from the energy intensity of its various component materials.
- Composite masonry jack-arch roof or floor system, RC filler slab, unreinforced masonry vaults, etc. represent some of the low energy intensity options for floor and roof slabs

V. OBSERVATIONS AND RESULTS

Solar energy :

- It is not so much a matter of achieving net zero-energy buildings on the short term, but of formulating a goal and reducing the distance from this goal on a broad basis by measures applied to buildings and supply grids.
- Apart considering from the annual balance, it is important to achieve optimal matching in time between feeding in electricity and drawing it from the grid. Passive houses with their high energy efficiency reduce the demands on the seasonal compensation effect of electricity grids.

Water Management system :

- So here now, as we studied earlier that In net zero energy building the total annual alternative water use nearly offsets the Total annual water use
- Water saving should be managed efficiently to control the waste water throughout the building from GWT & STP.

Environmental dimensions :

- By creating green buildings, we can take a big step towards urban sustainability and optimizing energy consumption. Design and construction of these buildings is possible with four overall method green views, indoor and outdoor living walls, green walls and green roofs area.
- In the planning of most cities in the developed world to create green spaces in the building have been implemented as a recipe in the building and in Iran by using various methods trying to increase green space on the existing building and build them on buildings under construction.

Construction materials :

- Certain issues concerning embodied energy in buildings, carbon emissions and sustainability of currently used methods of construction were discussed in detail.
- The analysis shows that embodied energy of buildings using the low-energy materials and techniques results in 50% savings in total embodied energy. There is a large potential and scope for utilizing the industrial and mine solid wastes for the manufacture of building materials for promoting sustainable construction practices.

VI. CONCLUSION

The net zero-energy concept offers an ambitious scenario in which energy efficiency and the use of renewable energy sources are combined.
The Net zero water concepts present a new vision and it is now becoming a practical & technologically feasible for a wide variety of water reuse applications.
While making a home net zero energy might have a slightly upfront cost the long term cost is going to be lower as you will be producing your own power

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