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A Case Study on Netzero Building

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Abstract- In present eon of macro climate change and ecological dilapidation, a huge selection of vindication actions for instance, wits aiming sustainable structures are straight away essential. These comprise the assembly of green structures, deployment of building ranking structures, energy cyphers, and numerous other recommendations. Net Zero Energy Building (NZEBs) developments are aiming to accelerate the concept of self-sufficient not in the electricity generation but with an overall minimal dependence on other resources. Plummeting ecological dilapidation and giving inhabitant coziness are the prime goals of a net zero energy building. Net zero energy buildings are resource efficient, which save more than 40 per cent water and energy, as compared to conventional buildings. These buildings also have reduced operational costs which in itself pays back over a very short period for any incremental in costs. Resource optimization is considered to be the key for cost savings and these buildings truly follow the same concept. The main advantages of net zero building or a green structure to its generator and the their social surrounding are the usage of prime utilized things like water, electricity will be reduced, without any sacrifice of their ease, recycling of waste materials will be increasing the generator's productivity and efficiency also it will inspire other societies to follow the same path of NZEB.

Keywords- Energy efficiency; Energy security; Greenhouse gas; NZEB; Sustainability; Renewable energy.

I. INTRODUCTION

The net zero-energy building (NZEB) concept has shown its account all over the world in short span of time and today it is the one of the key sector to work on with new possibilities and plenty of applications that favor both i.e. the humans and the environment. But still this concept of net zero building is at its dwelling phase and need more things to work upon.Net zero building is pure blended mixture of the ideas of architects and engineers. It is estimated that in our country i.e. India, buildings consumes 40% of country's energy and directly or indirectly is responsible for approximately 40% of greenhouse gas emissions [1].

When there is talk of initiatives regarding energy and buildings then there is demand of a mutual work of government and the people. Government have taken some steps regarding this energy efficiency by Bach at Lamp Yojana which involves replacing the inefficient bulbs with Compact Fluorescent Lamps (CFLs) by grasping the trade of Certified Emission Rights (CERs) under the Clean Development Mechanism (CDM) of the Kyoto Protocol[2]. It was followed by Unnat Jyoti Joyana in May 2015 which involves affordable LED's for all. In this program me28,29,68,670 LED were distributed till 4 Jan 2018 which saves 2,97,66,117 t CO_2 per year[3]. This is a great boost towards the lighting system in building sector but this cannot provide energy security and sustainability as its manufacturing involves the production of greenhouse gasses emission. So in order to assure sustainability and energy security net zero energy building can play a handy role as it have onsite renewable energy source. But still there will be use of non-renewable sources and natural gas in form of utility electricity source in cloudy weather and night time and natural gas for cooking purpose. And people's role is the demand of these buildings from there side, so that market can be created and the trend of net zero building can be started in India

II. NET ZERO BUILDINGS

In order to create definition of zero energy buildings (ZEB) the definitions need to accommodate the collection of buildings which have renewable energy as a share. So in order to take account of the above some definitions are given with some key terms. [4]

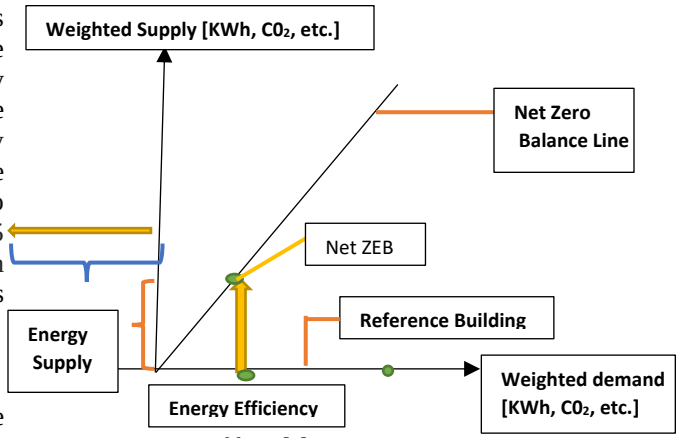

Fig.1.Net Zero Buildings [5]

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- **Zero Energy Building (ZEB):**-An energy-efficient structure where on site generated energy is equal or greater than the consumed energy.
- **Geothermal Energy**: Deep-earth heat used for either electricity generation or thermal energy.
- **On-site Renewable Energy**: The energy which is generated well within the premises of a building and consumed within the green structure and surplus is transported to the grid.
- **Renewable energy**: The energy which are available in huge amount naturally in nature such as wind, hydro, solar , biomass etc., and which are replenished by nature by natural phenomenon.[7]
- **Renewable Energy Certificate (REC)**: A tradable certificate which signifies that one megawatt hour (MWh) electricity is generated by the use of renewable resources.

III. METHODOLOGY

The methodology includes establishment of boundary conditions, conducting energy measurements and achieving energy balances for implementing the net zero energy building concept. The parameters address the following:

A. Boundaries

Firstly the site boundary is defined. The site boundary signify the workable boundary that is part of the building(s). One building's site boundary is also its property boundary. The site boundary includes utility interfaces **shows** the site boundary of energy and how it forms from building energy, on-site renewable energy production, delivered energy and exported energy. The site boundary for a ZEB could be round the building footstep or round the building site if the on-site renewable energy is within or not within the building footstep respectively and permits the building sites on a campus to be aggregated so that the collective on-site renewable energy could balance the collective building energy from the buildings on the campus. The site boundary for a Zero Energy Community or Zero Energy Portfolio would allow a cluster of project sites at different locations to be gathered so that the combined on-site renewable energy could equipoise the pooled building energy from the gathered project sites. Zero Energy Communities can share the benefit of renewable energy Projects in the community that pool investments from multiple building owners and provide power benefits in return.

B. Energy Account and Dimensions

ZEB energy account would be including energy used for heating, cooling, ventilation, domestic hot water (DHW), indoor and outdoor lighting, plug loads, process energy and transportation within the building. Vehicle charging energy for transportation inside the building would be included in the energy accounting. On-site renewable energy can be transmitted through grid and other than grid, such as charging of electric vehicles used outside the building. Energy consumption of the building includes grid electricity, district heating and cooling, renewable and non-renewable fuels. A ZEB balances its energy use so that the exported energy to the grid or other energy network (i.e., campus or facility) is equivalent to or larger than the delivered energy to the building on an annual basis. A ZEB utilize on-site renewable energy in equipoising the delivered energy. Renewable fuels used are not included in this prospect, they are considered to be off-site renewable. For example, biofuel generated inside the building are onsite renewables while the one which is imported from outside is not considered to be on-site renewable. On-site renewable energy systems generates utilizable building energy, thus dipping the necessity for the imported energy to the building. This is taken into consideration for the energy balance. Zero Energy buildings can combine the on-site renewable energy among diverse sites below a combined site boundary to balance the conveyed energy [8].

C. Source Energy Calculations

Maximum building managers knows the amount of energy consumed by a building as measured by utility meters. Site energy consumption can be beneficial for considerate the performance of the building and the building systems, but it does not state the whole story of effects from resource intake and emissions concomitant with the energy use. Site energy is not a good comparison metric for buildings that have different blends of energy categories, buildings with on-site energy generation, such as photovoltaic, or buildings with cogeneration units. To relate the efficiencies of buildings the equivalency of raw fuel consumption is taken into consideration with their con version factors which are based on national average ratios. Source energy is calculated from delivered energy and exported energy for each energy type using source energy conversion factors. Resource energy conversion factors are implanted to convert energy delivered and exported on-site into the total equivalent source energy. The conversion factors implanted are from ASHRAE Standard 105. [9] Table 1 summarizes the national average conversion factors for various energy types.

Example: -Calculation for ZEB with Multiple Delivered Energy Types A building has the following actual annual delivered energy types: 200 kBtu electricity, 60 kBtu natural gas and 100 kBtu chilled water. The on-site renewable exported energy is 260 kBtu electricity from photovoltaic.

Sol:-Using the formula above, the annual source energy balance would be: E Source = [(200kBtu × 3.15) + (60kBtu × 1.09) + (100kBtu × 1.04)] - (260kBtu×3.15) = -19,6kBtu.

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Since E≤ 0, the building fulfills Zero Energy Building criteria

D. Renewable Energy Certificates (REC)

Renewable Energy Certificates (RECs) are merchandize tools that can be utilized for renewable energy targets. Energy handlers can meet voluntary renewable energy goals and back the disposition of green power through the purchase of REC's. RECs are a reliable and easy means to keep track of who can claim the environmental traits of renewable electricity generation on the grid. The claimed the used REC cannot be utilized again and considered to be retired.

E. *Terminology "zero energy building" and "renewable energy certificate zero energy building*"

The Zero Energy Building (ZEB) tag should be provided to the buildings that export energy rather than consume energy. The tag of Renewable Energy Certificate Zero Energy Building (REC-ZEB) would be given to the building whose statistics show that energy exported is equal to or more than the energy consumed as

Energy Form	**Source of Energy Conversion factor (r)**
Imported Electricity	3.15
Exported Renewable Energy	3.15
Natural Gas	1.09
Fuel oil (1,2,4,5,6) Diesel kerosene	1.19
Propane and liquid Propane	1.15
Steam	1.45
Hot water	1.35
Chilled Water	1.04
Coal or other	1.05

well as that must processes the REC.

IV. CASE STUDY ON INDIRA PARYAVARAN BHAWAN

Name: Indra Paryavaran Bhawan

Location: New Delhi

Coordinates: 28^0 N 77^0 E

Occupancy: Office

Climate: Composite

Ratings: GRIHA 5Star and LEED Platinum

Indira Paryavaran Bhawan is a first Indian net zero building. This project initiates the NZEB concept in India Practically. The project was specially designed to cut out the energy demand by conventional building and by use of day lighting system and by recycling of used water, facades and structures are so designed to drop the ambient temperature and also mixing it with conventional systems of heating and cooling. In this site the electricity is generated within the premises by use of solar rooftop PV technology.

A. Complaisant Measures

1) Orientation: Building structure is north-east, with different blocks joined through corridors and a large central courtyard. The structure orientation minimizes the heat admittance. Windows to wall ratio is also has been decided according to the minimum heat admittance to building.
2) Landscaping: More than 50% of the area is covered with green plantation.
3) Day lighting: About 75% of building area is day lighted, thus decreasing the dependency of building on active lighting devices.
4) Ventilation: The space between the two blocks gives natural movement of air due to stack effect. The windows gives the cross ventilation process.

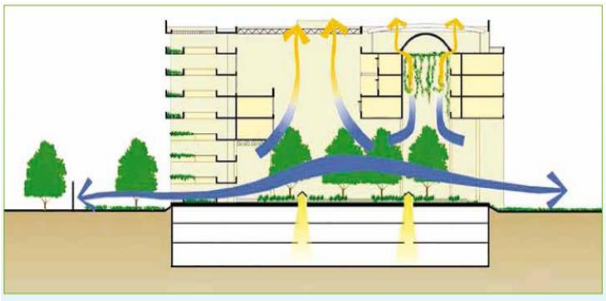

Fig.3. The courtyard serves multiple purposes. It creates a landscaped connection with the rest of the vegetation on the site, aids cross ventilation within the building and acts as a human interaction area. The hot air escapes easily, while the cool air is preserved [10].

B. Building envelope and fenestration

Window structure with U-value= 0.049W/m^2, VLT =0.59, SHGC = 0.32

1. Low heat transmittance index glass used
2. Cool roofs: The tiles used at roof are highly reflective in nature and heat resistant also these and these tiles provide strength also.

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C. *Conventional Strategies*

1. Highly efficient lighting system used (LPD= 5W/m$^{2)}$ in combination with day lighting strategies decrease the energy demand.
2. Electricity is produced by building integrated photovoltaic panels.
3. Lux sensors are used to make the conventional lighting system more efficient.
4. HVAC system: Air conditioning load = 160TR and it is met through chilled beam system and when compared to conventional system it is 50% more efficient.
5. Input chilled water temperature = 16^{0}C
6. Output water temperature = 20^{0}C
7. The HVAC equipment monitoring is maintained through the integrated building system.
8. Room temperature = 26-27^{0}C
9. Geothermal heat exchange system:
   a) Boring is dine about 80 m deep and in numbers equal to 80 with minimum 3m distance.
   b) Every bore is having U-loop HDPE pipe and is connected to the condenser water pipe in the central air conditioning system.
   c) Rejection capacity of single U-loop has 0.9TR.
   d) The collection of each loop produces 160TR of heat rejection.

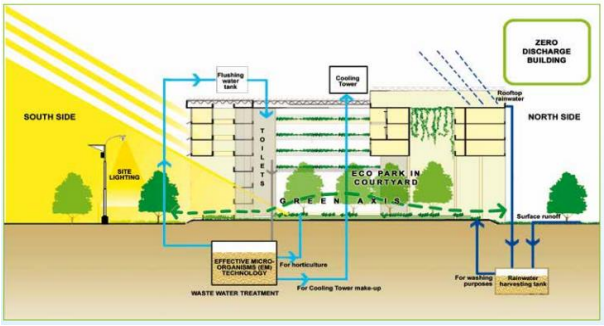

Fig.2.Efficient water-use and reuse cycle in Indira Paryavaran Bhawan makes it a zero-discharge building [10].

Table 2 .Renewable Energy Sources

SNO.	PARAMETER	QUANTITY
1	Solar PV System	930 KW
2	Total Area	6000m^2
3	Total area of panels	4650 m^2
4	Number of panels	2844
5	Annual Generation	14.3 Lakh units

The success of this endeavor is expected to pave the way for many other decentralized urban initiatives aimed at self-sufficiency in energy and other resources within the built environment [10]

V. CONCLUSION

Taking into account the present increasing population energy demand and one of the basic need i.e. building (shelter), the concept of net zero energy building can play a significant role. In fact the demand for green certification has significantly increased in the states and municipalities where incentives are being provided to the developers for green constructions .The smart city programmers are yet another growth driver for this sector, as at least 80% of the up-coming buildings are required to be energy efficient and green as per the essential features of the Smart City Program me (SCP). The initiatives would generate increasing interest in the developer community to construct all future upcoming projects as green. Simultaneously, the manufacturing sector is also poised to tap the increased demand of green and environmentally friendly material, products and technologies, necessary to construct green buildings.

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