CONTRIBUTION OF NET ZERO ENERGY BUILDING IN ENERGY SECURITY

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ABSTRACT

There is considerable impact of buildings on energy consumption and environment brunt, which consequently persuades the growth of country. Buildings are major source of climate change and energy security. In India buildings consume more than 40% of country's total energy generated and responsible for nearly 40% of green house gas emissions. A lot of initiatives have been taken by Government to increase the efficiency of buildings, such as use of Energy Efficient Lamps and use of star labeled appliances. Such developments save substantial amount of energy and reduce the environmental brunt. However, they do not assure energy security and sustainability. In the pursuit of energy security and sustainability, Net Zero Energy Buildings (NZEB) can play a very important part. NZEB's are so energy efficient that they can depend largely on renewable energy produced onsite. They merely utilize non renewable energy, at times when renewable energy does not meet the demand. This paper presents the net zero energy building concepts and their implementation.

KEYWORDS: - Net Zero Energy, Energy Security, Energy Efficiency, Green House Gas.

I. Introduction

A Net Zero Energy Building (NZEB) is the linkage among energy efficient technology and renewable energy consumption. A Net Zero Energy Building also called as Zero Energy Building (ZEB) is a building with net zero energy consumption. That means the total amount of energy used by the building over the period of a year is equal to the amount of renewable energy produced on the locality. The major object of Net Zero Energy Building is that these buildings contribute little amount of Greenhouse Gas (GHG) to the atmosphere during operation than similar non net zero energy buildings [1]. The growth of zero-energy buildings is encouraged by the need to have little impact on the environment. Around the globe, engineers, architects and policy makers have been exploring means to deliver exceptionally proficient buildings whose reduced energy demand is satisfied through clean, renewable energy. The conception of the Net Zero Energy Building focuses on the energy dynamics and performance of the building and as policy makers and leaders align towards the net zero concepts, the focus on accomplishing profound energy efficiency has centered on integrated technologies and means to connect buildings to the natural environment. Though, interaction with an accessible energy infrastructure is vital to balance the energy supply and demand, together in terms of quantity and type of energy, in a few cases, seasonal storage inside the building is deliberately omitted from the contemplation of Net Zero Energy Building. However as an alternate of seasonal storage, buildings can sell excess amount of energy to the nearby building with the assistance of smart grid system. Typical code-complaint buildings consume 40% of the total fossil fuel energy and are important supplier of greenhouse gases to conflict such high energy usage, more and more buildings are starting to realize the carbon neutrality principle, which is observed as the means to decrease carbon emissions and reduce reliance on fossil fuels. Even though Zero Energy Buildings remain

limited, they are gaining significance and recognition [2]. The majority Net Zero Energy Buildings utilize the electrical grid for energy storage, although a few are independent of the grid and a few comprise energy storage onsite. The buildings are called "Energy-Plus Buildings" and sometimes they are called "Low Energy Houses". These buildings generate energy onsite by means of renewable energy technology such as solar and wind, while reducing the overall utilization of energy with extremely competent lighting and heating, ventilation and air-conditioning (HVAC) technology. The zero energy objectives is flattering more practical as the costs of alternative energy technologies reduce and the costs of conventional fossil fuels increase. The growth of recent Net Zero Energy Buildings became feasible mainly through the development made in new energy and construction technologies and techniques. These comprise highly insulating spray-foam insulation, high- efficiency solar panels, high efficiency heat pumps and highly insulating, low emissivity, triple and quadruple-glazed windows. These advances have considerably enhanced by academic research, which gathers accurate energy performance data on conventional and investigational buildings and gives performance parameters for sophisticated computer models to forecast the effectiveness of engineering designs [3].

1.1 Advantages of Net Zero Energy Buildings:-

Following are the few major advantages of NZEB.

1) Reduced energy costs. Net Zero Energy Buildings are designed to be highly energy-efficient, which can significantly reduce energy costs for building owners and occupants.
2) Environmental sustainability.
3) Improved indoor air quality.
4) Increased occupant comfort.
5) Resilience.

1.2 Disadvantages of Net Zero Energy Buildings:-

Following are the few major disadvantages of NZEB.

1) Initial costs can be higher.

2) A handful designers or builders have the essential skills to construct NZEB.

3) Challenge to recover higher initial costs on resale of building.
4) Solar energy capture through the house envelope merely works in localities unobstructed from the sun.
5) Building guidelines like height restrictions or fire code may avert implementation of wind or solar power or external additions to an existing thermal envelope.

This paper is presented in six sections first section gives the introduction. Second Section presents about optimizing Net Zero Energy Building for environment brunt. Third Section gives the design and construction of Net Zero Energy Building. In fourth section Energy productions in Net Zero Energy (NZEB) Building has been discussed. In section fifth Materials and methods used in net zero energy buildings is presented and finally sixth section gives the conclusion of the paper.

II. Optimizing Net Zero Energy Building (NZEB) for environmental brunt.

The introduction of Net Zero Energy Buildings makes buildings more energy efficient and decreases the rate of carbon emissions once the building is in operation. Though, there is a lot of pollution connected with a buildings embodied carbon, which is the carbon emitted in the manufacture and transportation of buildings materials and the construction of the building itself. It is accountable for 11% of global green house emission and 28% of global building sector emissions. The significance of embodied carbon will grow up as it will instigate to account for the greater part of buildings carbon

emissions. In a few recent Energy efficient buildings, embodied carbon has raised to 47% of the buildings life time emissions. Focusing on embodied carbon is element of optimizing construction for climate brunt and zero carbon emissions needs a little diverse considerations from optimizing merely for energy efficiency [4].

A 2019 study found that between 2020 and 2030, reducing upfront carbon emissions and switching to clean or renewable energy is more significant than increasing building efficiency, since building a highly energy efficient structure can actually produce more green house gas than a basic code complaint one if carbon intensive material is used. One means to condensed embodied carbon is by employing low-carbon materials for construction like straw, wood, linoleum or cedar [5].

III. Design and construction of Net Zero Energy Building (NZEB).

To realize efficient energy use, zero energy design differs considerably from conventional construction method. Zero energy building designers normally mingle time tested passive solar or artificial Conditioning, theories that work with the on-site resources. Sunlight and solar heat, prevailing breezes, and the cool of the earth below a building, can offer day lighting and steady indoor temperatures with least mechanical means. NZEB's are usually optimized to utilize passive solar heat gain and shading, shared with thermal mass to stabilize diurnal temperature variations throughout the day, and in most climates is super insulated [6]. All the technologies required to create zero energy buildings are available off-the-shelf today. NZEB are built with considerable energy saving aspects. The heating and cooling loads are lowered by using high efficiency equipment (such as heat pumps instead of furnaces as heat pumps are four times as efficient as furnaces), added insulation (especially in the attic and basement of building), high efficiency windows (such as low emissivity, triple-glazed windows), draft-proofing, high efficiency appliances (particularly modern high efficiency refrigerators), High efficiency LED lighting, Passive solar gain in winter and Passive solar shading in summer, natural ventilation and other techniques. These aspects vary depending on climate zones in which the construction takes place. Water heating loads can be reduced by using water conservation fixtures, heat recovery units on waste water, and by employing with skylights or solar tubes can offer 100% of daytime illumination within the building. Night time illumination is typically done with LED lighting. And miscellaneous electric loads can be reduced by selecting efficient appliances and minimizing phantom loads or standby power. Other method to reach net zero are Earth Sheltered building principles, super insulation walls using straw-bale construction, pre-fabricated building panels and roof elements plus exterior landscaping for seasonal shading. Once the energy utilization of the building has been minimized it can be feasible to generate all that energy on site using roof-mounted solar panels. NZEB's are often designed to make dual use of energy including that from white goods. For example, using refrigerator exhaust to heat domestic water, ventilation air and shower drain heat exchangers, office machines and computer servers and body heat to heat the building. These buildings make use of heat energy that conventional buildings may exhaust outside. They may use heat recovery ventilation, hot water heat recycling, combined heat and power and absorption chiller units [8].

IV. Energy production in Net Zero Energy (NZEB) Building.

Net Zero Energy Buildings produce available energy to meet their electricity and heating or cooling needs. The most general method to produce energy is to utilize roof-mounted solar photovoltaic (PV) panels that convert the sun's light in to electricity. Energy can also be produced with solar thermal collectors (which makes use of sun's heat to heat water for the building). Heat pumps too produce heat and cool from the air or ground near the building. In principle, heat pumps move heat rather than produce it. But, the overall outcome in terms of reduced energy utilization and reduced carbon foot

print is alike. In the case of individual houses, various micro generation technologies may be employed to supply heat and electricity to the building, using solar cells or wind turbines for electricity, and biofuels or solar thermal collectors linked to a seasonal thermal energy storage (STES) for space heating[9,10]. An STES can also be employed for summer cooling by storing the cold of winter underground. To manage with variations in demand, zero energy buildings are often connected to the electricity grid, export electricity to the grid when there is excess and drawing electricity when not sufficient electricity is being produced. Energy harvesting is more efficient in regards to cost and resource use when done on a local but combined scale, for example a group of houses, cohousing or village rather than an individual house basis. The advantage of this method is it virtually eliminates electrical transmission and distribution losses.

V. Materials and methods used in net zero energy buildings.

5.1 Concept of Net Zero Energy Buildings

A Net Zero Energy Building is a building with zero net energy consumption, meaning that all the energy utilized by the building is totally based on renewable energy sources created on the site like solar, wind, geothermal etc. These buildings accordingly do not enhance the amount of green house gases in the atmosphere. Majority of the NZEB's get half or more of their energy from the grid and return the same amount of energy during surplus energy. Buildings that generates surplus of energy over the year are called as "Energy-Plus Buildings."The zero energy thought allows for a wide variety of approaches owing to various options for generating and conserving energy. Fig.1 shows the concept of Net Zero Energy Building [1, 12].

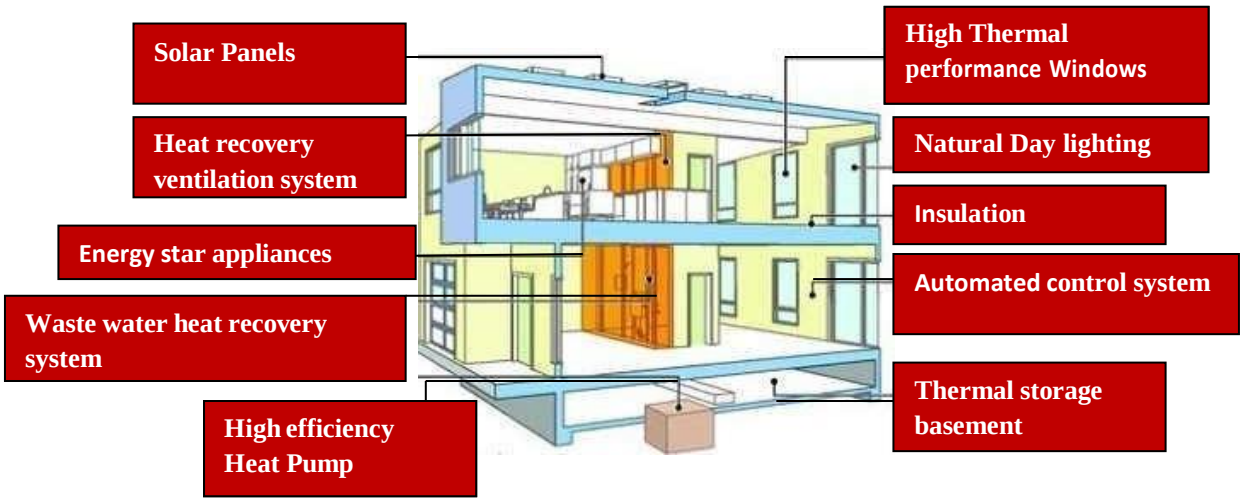

Fig.1 Concept of Net Zero Energy Building.

5.2 Vision of Net Zero Energy Building.

The vision of Net Zero Energy Building is convincing. The principle of net zero energy consumption is viewed as a means to reduce carbon emissions and to reduce the dependency on conventional fuels. The development of modern zero energy buildings became possible not only through the development made in new energy and construction technologies, but it has been considerably improved by academic research, which collects precise energy performance data on conventional and experimental buildings and present performance parameters for advanced computer models to predict the

effectiveness of engineering designs. Building design professional societies have also recognized the vision of Net Zero Energy Buildings [12, 14].

5.3 Methodology

The most cost effective method in reducing the buildings energy consumption generally starts from design process. Zero energy building designers normally mingle time tested passive solar or artificial/fake Conditioning, theories that work with the on-site resources. Sunlight and solar heat, prevailing breezes, and the cool of the earth below a building, can offer day lighting and steady indoor temperatures with least mechanical means. NZEB's are usually optimized to utilize passive solar heat gain and shading, shared with thermal mass to stabilize diurnal temperature variations throughout the day, and in most climates is super insulated. All the technologies required to create zero energy buildings are available off-the-shelf today. NZEB are built with considerable energy saving aspects. There are various NZEB supply options available today [12,13]. These options are categorized as below,

a) On-site Demand management
b) On-site supply options
c) Off-site supply option

Fig.2 gives few examples of NZEB supply options

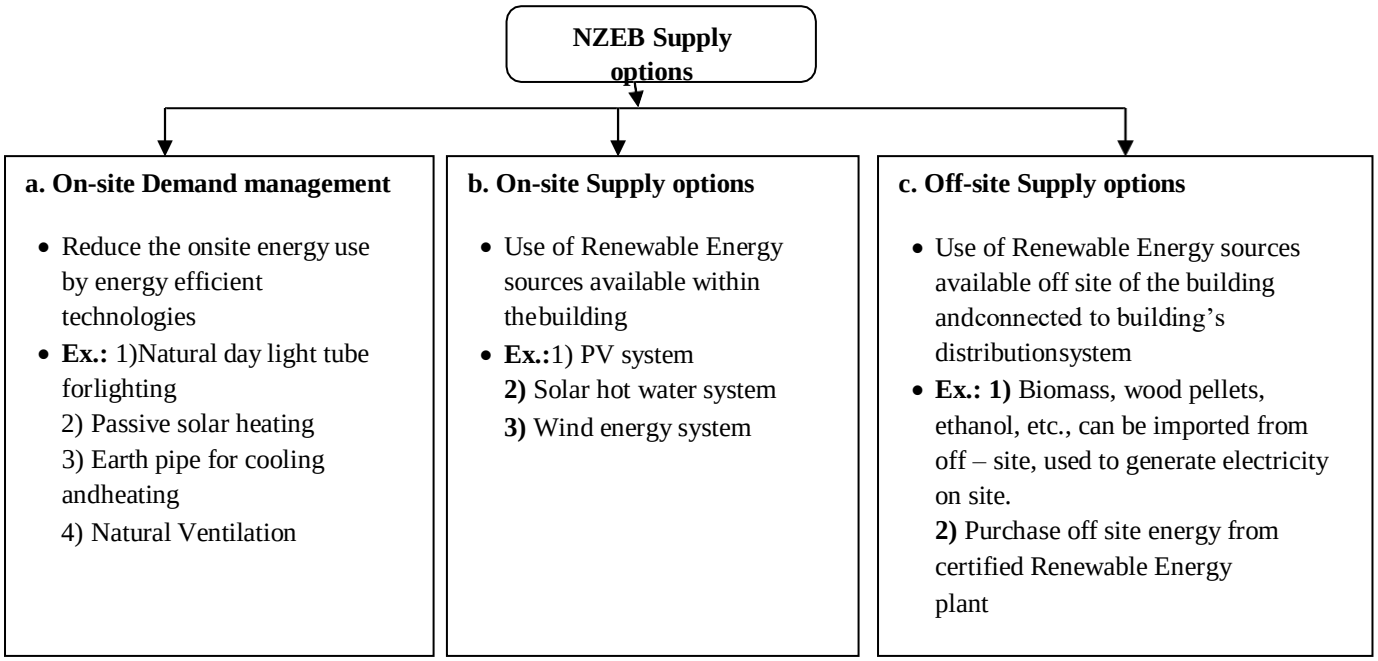

Fig.2 . Few examples of NZEB supply options.

5.4 Details of supply options:

a). On-site Demand management:- This option specifies that a building must decrease site energy from demand side management and energy efficient technologies. This option is measured as a prerequisite for NZEB. A well-optimized NZEB design should comprise energy efficiency strategies to the point that the accessible renewable energy strategies become more cost effective. Any renewable energy source such as passive solar space heating, solar thermal air heaters, ground –source

heat pumps and natural ventilation that cannot be commoditized, exported and sold are considered to be demand-side technologies and efficiency measures. Combined heat and power system that makes use of fossil fuels to produce heat and electricity are regarded to be demand-side technologies. Fig.3 shows a Natural Daylight tube and fig.4 shows installation of earth tube.

b). On-site supply option:-This option covers all the energy sources available within the building itself. Renewable energy that is produced and utilized within the building is directly connected to the buildings distribution system. Renewable energy technology comprises photo voltaic (PV) and solar thermal system which is mounted on building roof or façade. Building mounted with small wind turbines also include in this option. Building mounted RE technologies is desirable, since the collection area can be assured to be accessible over the life of the building.

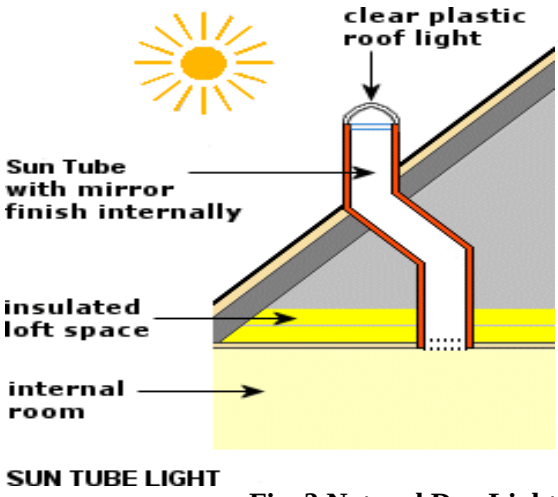

Fig. 3 Natural Day Light Tube

Fig.4 Installation of earth tube

c). Off-site supply option: - This option proposes renewable sources like wood pellets; ethanol and bio diesel can be imported to the site and generate electricity for building. An example of this would be woodchips imported to heat a building. Other off-site renewable sources covered under this option

include waste vegetable oil, biodiesel and ethanol. Methane from human and animal waste treatment processes, recovery of waste energy streams from industrial process, or landfill gas collection are all possible off-site renewable energy generation options. This option is suitable for high energy use buildings such as hospitals, laboratories and huge shopping malls that do not have sufficient renewable energy generation capacity available within the building itself [14].

VI. Conclusion

As there is significant raise in global population, energy use has increased drastically. Today, buildings consume approximately 40% of total energy consumed in the world. If we persist on this course of energy consumption in conjunction with population growth projections, fossil fuels may be depleted in few years. Therefore it is needed to find some energy efficient methods. There is an urgent need for net zero energy buildings, going green with renewable energy sources like, biomass, solar, wind and geothermal. NZEB's are needed to address the challenges of climate change, rising energy costs and environment protection. NZEB's are designed to generate as much energy as they consume, resulting in zero net energy consumption. NZEB's not only contribute to cost savings but also reduce the carbon emissions, making them an important step towards sustainable and efficient energy use in the building sector.

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