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STUDY OF

# ZERO ENERGY BUILDING

WITH VARIOUS ASPECTS OF ENERGY CONSERVATION & SUSTAINABLE MATERIALS

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## ABSTRACT

According to statistics, 40% of world's energy is consumed by buildings also the 21% of greenhouse gas emissions come from Buildings. So, the main aim of the project is to study and analyse the all-different aspects of concept zero energy buildings. Also, with the purpose of around 40% of energy can be realized through Intelligent Building Automation and by achieving nearly zero energy. The present study attempted to evaluate the effects of renewable energies and Zero Carbon Building & Zero Energy Building on improving life quality and environment. This study is descriptive and library design. The results show that by increasing growth of cities population and consumption of fossil energies and environmental pollutions and reduction of green space, health and life of all live creatures are threatened and to eliminate such environmental pollutions, we should move from fossil fuels to renewable energies.

## INTRODUCTION

Buildings that produce a surplus of energy over the year may be called 'Energy+ Buildings' & buildings that consume slightly more energy than they produce are called 'Near-Zero Energy Buildings' or 'Ultra-low Energy Houses'. Zero-Net Site Energy use: In this type of ZNEs, the amount of energy provided by on-sit renewable energy sources is equal to the amount of energy used by the building. In the United States, 'Zero Net Energy Building' generally refers to this type of building. Zero-Net Source Energy use: These ZNEs generates the same amount of energy as is used, including the energy used to transport the energy to the building. This type accounts for losses during electricity transmission. These ZNEs must generate more electricity than Zero-Net Site Energy Buildings. A Zero-Energy building, also known as a

Zero-Net Energy (ZNE) building, Net-Zero Energy building (NZEB), or Net-Zero Building, is a building with **'0'** Net Energy consumption, which means the total amount of energy used by the building on an annual basis is roughly equal to the amount of renewable energy created on the site. These buildings do not increase the amount of Greenhouse Gases in the atmosphere. The wording **'Net'** emphasizes the energy exchange between the building and the energy infrastructure. By the Building-Grid Interaction, the Net ZEBs become an active part of the renewable energy infrastructure. Zero-Net Energy (ZNE) has unprecedented potential to transform the way buildings use energy. This Ultra-efficiency goal is one that owners can define, design teams can reach for and occupant's desire. An increasing number of buildings are meeting this standard, raising confidence that a ZNE goal is realistic given current building technologies and design approaches. The considerable progress of science and technology in the current world has led into the comfort and welfare of human life but the world is faced with serious environmental and energy crises as these crises are not only threats for life quality of human communities but the continuance of the present trend of human life is faced with serious risk. Great part of annual energy consumption of countries is dedicated to construction sector and saving and finding a method and solution reducing energy consumption.

## PROBLEM STATEMENT

Net-Zero energy is an ambitious goal for any building; one that can't be achieved without scrupulous attention to every aspect of a building's design, construction, and operation. Like the related goal of creating a carbon-neutral building, any Net-Zero building has to first achieve significant load reductions and system efficiencies, and then meet the remaining loads with onsite energy generation.

A couple of programs now certify projects that have achieved their specific definition of net-zero energy:

I. In addition to its Living Building Challenge program**,** which requires better than Net-Zero performance, the International Living Future Institute (IFLI) has a Zero Energy certification**.** ILFI also has a Zero-Carbon certification**,** which addresses embodied carbon as well**.**
II. U.S. Green Building Council (USGBC) has a LEED-Zero certification, which requires LEED certification + Net-Zero performance.

## ACTUALITY OF RESEARCH

Its India's first net zero energy building that has been constructed with adoption of solar passive design

and energy-efficient building materials. Functional since a year, a tour of the Indira Paryavaran Bhavan, a building under the Central Government, was organized by The Energy and Resources Institute (TERI) and the Association for Development and Research of Sustainable Habitats on Tuesday. It was aimed at reinforcing the need for more such buildings across the country. Speaking about the energy efficiency of the building, TERI (Sustainable Habitat Division) director Mili Majumdar said: "The Indira Paryavaran Bhavan is one of the first buildings in India to have deployed energy efficiency and renewable energy technologies at a large scale. It is one of the exemplary projects to be rated under Green Rating for Integrated Habitat Assessment [GRIHA] and has set standards that can be emulated by upcoming buildings in the region." The building boasts an earthquake-resistant structure with a total plinth area of 31,488 sq. m. It covers only 30 per cent of the total area, while more than 50 per cent area outside the building is a soft area with plantation and grass. The building has a robotic parking system in the basement that can accommodate 330 cars. Thin-client networking system has been provided instead of conventional desktop computers to minimize energy consumption. "Buildings have an enormous impact on environment, human health and economy. The energy used to heat and power our buildings leads to consumption of large amounts of energy, mainly from burning of fossil fuels, oil, natural gases and coal, which generate significant amounts of carbon dioxide, the most widespread greenhouse gas. The successful adoption of green building strategies can maximise both the economic and environmental performances of buildings," added Ms. Majumdar. The building has received GRIHA 5-star (provisional) rating for the following features like, the design allows for 75 per cent of natural daylight to be utilized to reduce energy consumption, The entire building has an access friendly design for differently-abled persons. With an installed capacity of 930 kW peak power, the building has the largest rooftop solar system among multi-storied buildings in India. The building is fully compliant with requirements of the Energy Conservation Building Code of India (ECBC). Total energy savings of about 40 per cent have been achieved through the adoption of energy efficient chilled beam system of air-conditioning. As per this, air-conditioning is done by convection currents rather than airflow through air handling units, and chilled water is circulated right up to the diffuser points unlike the conventional systems. Green materials like fly ash bricks, regional building materials, materials with high recyclable content, high reflectance terrace tiles and rock wool insulation of outer walls have been used. Use of renewable bamboo jute composite material for doorframes and shutters.UPVC windows with hermetically sealed double glass. Calcium Silicate ceiling tiles with high recyclable content and grass paver blocks on pavements and roads. Reduction in water consumption has been achieved by use of low-discharge water fixtures, recycling of waste water through sewage treatment plant, use of plants with low

water demand in landscaping, use of geothermal cooling for HVAC system, rainwater harvesting and use of curing compounds during construction.

## PROSPECT FOR THE CONSTRUCTION OF BUILDING WITH LOW ENERGY CONSUMPTION

A Non-Autonomous Zero Energy Building typically uses traditional energy sources such as electricity and natural gas from the utilities when on-site generation does not meet the building loads. Reversely, whenever the on-site generation is greater than the building loads, the electricity in excess is exported to the grid. By using the grid to account for the energy balance, the excess production is hence used to offset the later energy use. A ZEB is typically a Grid-connected building with very high-energy performance so that the primary energy that is fed into the grid or other energy networks equals the primary energy delivered to the building from the infrastructure energy networks during more critical loading time. An annual net balance of the primary energy use typically leads to the situation that on-site energy generation is exchanged with the grid, which is used as an energy sink.

Several parameters have been proposed for assessing the load matching; for example, regarding the benefits of solar systems applied to buildings, the so called 'Solar Fraction' is typically used. Given the importance of energy exchanges with the grid, an important characteristic to promote ZEB is hence the grid interaction and flexibility toward a ZEB target, understood as the ability to respond dynamically to new signals (smart grids), for example, price signals. Consequently, ZEB would need to adjust their loads; for example, by adopting local generation (e.g., CHP) and storage in order to serve both the grid needs and the building needs, and to react to favorable (market) conditions for energy exports and imports. Zero energy buildings may or may not be considered green in all areas; such as using recycled building materials, such as reducing waste etc.

However, zero energy buildings do tend to have a much lower ecological impact over the life of the building compared with other green buildings that require imported energy and/or fossil fuel to be habitable and meet the needs of occupants.

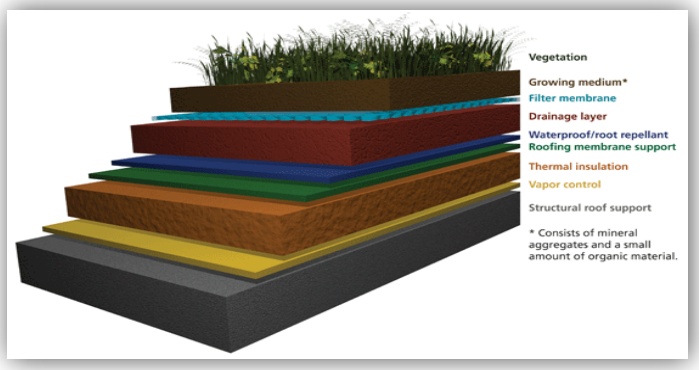
## THE OBJECT OF RESEARCH

The objective of Net-Zero Energy Buildings (NZEB) is not only to minimize the energy consumption of the building with passive design methods but also to design a building that balances energy requirements with active techniques and renewable technologies.

The increasing number of NZEBs demonstration and research projects highlights the growing attention given to NZEBs. Goals for the implementation of NZEBs are discussed and proposed at the international level.

## IMPORTANT COMPONENTS SOLUTIONS FOR ZEBs

- **Green roof (₹724 - ₹1809/Sq. foot) :**




Over the house you have a green roof with local plants, it's used as part of insulation as well as cooling system, and water is stored on roof in small tanks which is used to water the plants. A green roof system is an addition made to the roof of an existing building for growing flora. Depending on the type of green roof you install, the plants may be modular or have drainage layers. However, all green roofs include a few important features, such as waterproofing and root repellent, to keep the structure safe and undamaged.

- **Hollow Blocks with Concrete (₹65/piece):**

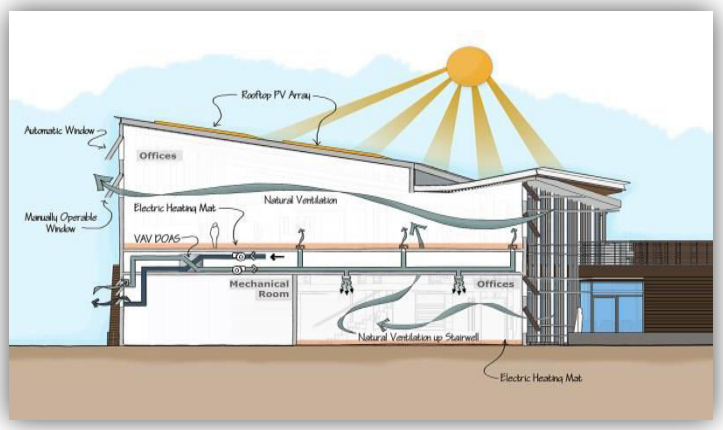
All the walls in house are built with hollow blocks and filled with concrete. Block is a mix of concrete and wood which acts and anti-bacterial and has great insulation properties. Insulation is provided inside the blocks to prevent energy loss. Hollow blocks are used to make walls that handle moisture and insulates at the same time, the blocks are filled with concrete (which is having 50 % fly ash replacement for the Portland cement) and smaller rebar.

On the roof they put a fabric, gives airspace between fabric materials and the roof, blow foam under the fabric which expands on itself and takes shape of a cave like roof. Foam has got insulation properties. Alternatively, for winter season, roofing system which is metal panel's dark colour, it absorbs heat like any other dark colour.

- **Solar Integrated Roof Panels (₹62,000 - ₹87,000/kW):**

Source of hot water is through solar integrated roof panels, but sometimes when sun shines high, water becomes too hot, and so a system is installed inside all sanitary fixtures which mix the cold water with the hot water thus making the temperature safe for use. Similarly, when sun shines too low, scarcity of hot water comes, so it has a backup of hot water which mixes with cold to make it safe for use. Water heater is installed which is gas operated which comes on & off automatically, so lot of precaution is needed to operate the system. Push buttons are installed at kitchen, toilets, whenever you want hot water, push the button, a circulating system bring the hot water from the stored place to the toilets and kitchens which reduces to the predetermined temperature at the receiving end like washbasin, shower, bathtub, and all over the home where is required.

- **Natural Ventilation in Zero Energy Buildings (₹0):**




Zero energy home provides enhanced natural ventilation, windows installed is the key, casement windows on wall top and at bottom provides natural and healthy ventilation of air. In the front and back of the house all the windows open and closes in reverse direction providing natural ventilation, skylight is given on the roof for natural air and light. Natural ventilation regulates the indoor climate and changes the air in the building through openings in the façade and/or roof. The result lowered CO2 levels for a fresh indoor climate and a cool indoor temperature during the summer months. Natural ventilation achieves through temperature and pressure at inside and outside.

- **Green Plaster**

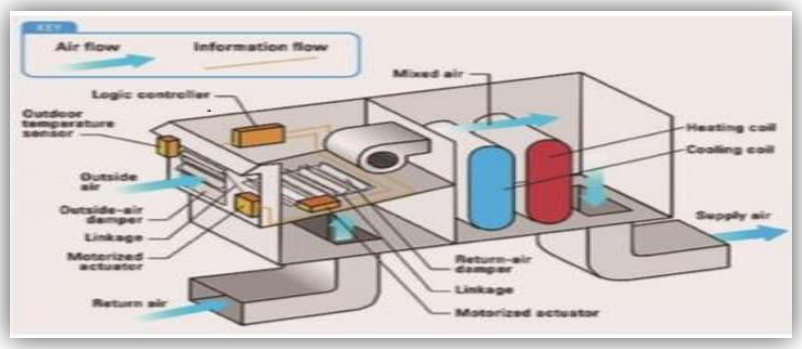
To maintain the comfortable humidity inside the house the walls are plastered with a special plaster which is a green material, and it has the capacity to absorb the moisture from air giving a maintained humidity inside the house. The cooling system is also used as dehumidifying machine, in case we want to reduce the relative humidity of house, the variable speed fan starts sending lesser air thru blowers further into the house which results to low humidity.

- **Solar Panels on the Rooftop (₹7000/kw)**

The solar panels on the rooftop converts the sunrays to electrical energy so the electric dept. is amazed to see that the electric meter starts running backward, in fact you can ask tell your utility companies to pay you is something extraordinary. There is inverter installed inside which converts the direct current produced by solar panels to alternative current which is used in USA. Reduced consumption of electricity from lighting system, all are fluorescent lights or low voltage lights which are generally advanced lighting package and very decorative lights it can give you a very aesthetic and antique look.

Solar panels produce no electricity at night. But they tend to produce extra power during the day when the sun is out. In order to balance things out, and keep the electricity running after dark, solar customers use either solar battery banks to store energy or net metering.

- **HVAC System in Zero Energy Buildings (₹40,000 - ₹3,00,000/piece)**




HVAC system air is cooled by a chiller system that either chills or heat water. The water is then sent thru copper tubes not under a high pressure to the coils which gets cooled with chilled water and is connected to the blowers at various location, thus the house gets chilled. Sometimes 1.5 tons and 2 tons compressors are placed outside, both are factory charged with refrigerant. Attach to each compressor is chiller system. So, at a time when there is a single family the 1.5 tons or 2 tons compressor is working automatically.

## CONSTRUCTIVE SOLUTIONS, MATERIALS

While constructing, it is important to use the best quality sustainable materials that are long lasting, durable and materials that are Eco friendly.

In construction, resource consumption as a material is high.

Here the minimization can take place by using sustainable materials.

Your dream home or other commercial building construction it should be strong enough to fight against every odd.

- Green Laminated Timber:

Zero energy house uses glue laminated timber (which has low carbon footprint) as the main structural element in place of concrete and steel, so reduces the overall weight of the structure and also less damage in case of any natural disasters.

Glued laminated timber, also abbreviated glulam, is a type of structural engineered wood product constituted by layers of dimensional lumber bonded together with durable, moisture-resistant structural adhesives. In North America, the material providing the laminations is termed *laminating stock* or *lamstock*.

- Blocks with Concrete:

All the walls in house are built with hollow blocks and filled with concrete. Block is a mix of concrete and wood which acts and anti-bacterial and has great insulation properties. Insulation is provided inside the blocks to prevent energy loss. Hollow blocks are used to make walls that handles moisture and insulates at the same time, the blocks are filled with concrete (which is having 50 % fly ash replacement for the Portland cement) and smaller rebar's

- **Bamboo:**

Bamboo technically is a perennial grass, not a wood, and it continues spreading and growing without having to be replanted after harvest. It is prevalent around the world and can be found on every continent except Europe and Antarctica.

Bamboo has a high strength-to-weight ratio and exceptional durability; even greater compressive strength than brick or concrete. So it can take a beating without being replaced very often, which is not necessarily the case with other fast-growing, sustainable items such as hemp. That makes bamboo a viable choice for flooring and cabinetry.

Because it is lightweight, bamboo is less energy intensive to transport than many other materials of comparable durability.

A drawback is that it requires treatment to resist insects and rot; untreated bamboo has a starch that insects like, and it can swell and crack when it absorbs water.

- **Green Plaster:**

To maintain the comfortable humidity inside the house the walls are plastered with a **special plaster which is a green material,** and it has the capacity to absorb the moisture from air giving a maintained humidity inside the house. The cooling system is also used as dehumidifying machine, in case we want to reduce the relative humidity of house, the variable speed fan starts sending lesser air thru blowers further into the house which results to low humidity.

It is a premium quality plaster product imported from Green Gypsum Plasters.

It provides tremendous resistance against earthquakes due to its light weight.

Green gypsum plaster contains **no dangerous chlorides**.

It retains its composition for 1000s of years as testified by the Cheops Pyramids.

These materials have low conductive & good thermal properties, ensuring energy & power saving. The thermal conductivity is **0.2W/m0k**.

- **Terrazzo:**

Terrazzo is a composite material, poured in place or precast, which is used for floor and wall treatments. It consists of chips of marble, quartz, granite, glass, or other suitable material, poured with a cementitious binder (for chemical binding), polymeric (for physical binding), or a combination of both. Metal strips often divide sections, or changes in colour or material in a pattern. Additional chips may be sprinkled atop the mix before it sets. After it is cured it is ground and polished smooth or otherwise finished to produce a uniformly textured surface. "Terrazzo" is also often used to describe any pattern similar to the original terrazzo floors.

Terrazzo installation includes both bonded and unbonded methods. Bonded systems include: bonded underbed, monolithic, chemically bonded, and the most recent, thin set method (epoxy resin). Bonded

terrazzo is applied over a sand-cement mortar underbed which sits on top of a concrete slab. The sand-cement layer allows for variations in the finished concrete slab that it sits on. Monolithic terrazzo is applied directly over an extremely flat and high-quality concrete sub-floor. Thin-set terrazzo does not require a concrete sub-floor. Instead, a flexible membrane can be installed so that cracks do not appear on the surface.

- **Hempcrete:**

Hempcrete or hemplime is bio-composite material, a mixture of hemp hurds (shives) and lime, sand, or pozzolans, which is used as a material for construction and insulation. It is marketed under names like Hempcrete, Canobiote, Canosmose, Iso-chanvre and Iso-Hemp. Hempcrete is easier to work with than traditional lime mixes and acts as an insulator and moisture regulator. It lacks the brittleness of concrete and consequently does not need expansion joints. The result is a lightweight insulating material ideal for most climates as it combines insulation and thermal mass.

The fact that the mixture contains a plant-based compound introduces the caution against water and rising damp levels. Hempcrete walls need to be built with a joint between the wall and the ground in order to avoid capillary rising as well as water runoff at the wall base. Moreover, hempcrete block can only be installed above the ground level. External walls need to avoid rotting of shives by implementing protection by the rain gale with sand and lime plaster. The exterior of a hempcrete based assembly needs these protections, but the interior side of an assembly can stay exposed.

- **Recycled Plastics:**

Recycling plastics is helping to save energy and landfill space. Recycled plastics are used in new building and construction applications every day. Recycled plastics can be blended with virgin plastic (plastic that has not been processed before) to reduce cost without sacrificing performance. Such recycled plastics are used to make polymeric timbers for use in everything from picnic tables to fences, thus helping to save trees. Plastic from two-liter bottles is even being spun into fiber for the production of carpet—another recycled product solution for our homes.

## CONCLUSION

- Zero Energy Buildings reduce total net monthly cost of living.
- Offer a new criterion for building with high performance.
- Can represent greater quality for internal averment which improve quality of life.
- Initial investment can be higher.
- Zero energy building may not reduce the required power plant capacity.
- Reduce comfort due to more uniform interior tempter.
- Can offer a solution for global challenge of humanity and better future planet.
- Moreover, intense sentimental profit association with resource and energy conservation.
- The building with net zero energy has economic and social.
- They provide simultaneously the least life cycle and great market value.
- Increase comfort in life, better reliability.
- Lower emission of carbon, sustainable construction.
- Isolation for building owners from further energy prices increases.
- Minimize extra cost.
- Reduce required energy.
- Without an optimized thermal envelope, the embodied energy, heating and cooling energy and resource usage is higher than need.
- A net zero emissions building produces at least as much emissions free renewable
- energy as it uses from emissions producing energy sources.
- Moreover, intense environmental profit association with resource and energy
- conservation.

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