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Net Zero Energy Building: An Energy Conservation Solution

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Abstract: ***The world energydemandsandCO$_2$emissionsare and have been growing rapidly since 'n' number of years, it is estimated that they could increase by 65% and 70% respectively in the next 25years [1], with this in mind, the buildings sector is still responsible for around 40% of the energy use at a global scale, which contributes with about 36% of CO$_2$ emissions [1]. For this reason, the NZEBs are crucial and are attained by applying energy conservation and efficiency measures and with the help of incorporating renewable energy systems. [2] Most applicable and widely used renewable energy supply at building scale are those utilizing non – programmable renewable sources (NPRS), large scale NZEBs discussion into existing power grids, originally thought of and designed to deal only with unidirectional power flows, can impact the grids operation and stability. Globally the building sector accounts for more electricity use than any other sector, 42 per cent. With increasing urbanization, the number and size of buildings in urban areas will increase resulting in an increased demand for electricity and other forms of energy commonly used in buildings. [3] In the building sector there is a high degree of regulation for maintaining quality of the structure.***

Keywords: Energy, Buildings, Renewables, Efficient, Environment, Conservable

1. Introduction

Building codes often influence material use, and appliance standards, both mandatory and voluntary, have a significant effect on energy efficiency. It helps reduce energy consumption by minimizing the losses and optimising solar obtains. Its main objective is to preserve the energy and maximise energy efficiency by reducing the overall system's reliance. The design guidelines may vary with region and to achieve targets, solutions and best practices the criteria should be premeditated in accordance to that particular region's rules and regulations [35]. The rate of renewables plays a significant role in maintaining the socio - economic balance; thus, the energy limits should be defined affording the region's directives with minimum proportion of renewables [35]. Turning prevailing structures into a nearly NZEBs is possible which is cost - effective and easier that does not take a toll on the environment. Pre - existing structures comprises of materials and techniques that were suitable in that era, these structures are found out to be hard on the current environmental applications due to the vast energy consumption and emission of green house gases [37]. The basic ideology of a NZEB building is to reduce to relation between energy emitted and energy consumed, to a greater extent. NZEB improves the pre - existing buildings with highly energy efficient sustainable buildings in terms of energy consumption. [3] Though the relation cannot be equals to zero, but it should aim at nearly zero demand with efficient use of renewables. Energy consumption is directly related to thermal consumption and in order to limit the energy consumption thermal performance of the structure should be controlled [37]. This will not only help evaluate the energy consumption but also improvise the overall performance of the building. The main sources of greenhouse gases for this sector are electricity consumed, energy used for heating and cooling, refrigeration, and so on. As the world's energy consumption and population is growing and as we are heavily relying on fossil fuels to satisfy our energy needs and producing great amount of greenhouse gases. [3]

Apart from heating and cooling few other operational energy demands are for the lighting systems and domestic water heating. One of the promising novel systems for transitioning to a low carbon, climate resilient in Decarbonizing of electricity generation. Thinking from a house holders' perspective, it is likely that he would place most importance on the energy demand of the house as this is what their energy bills will be primarily based on. [3] In house holder's scenario energy economics is given utmost importance and environmental indicators are ignored. We also can't ignore the fact that switching from gas fuel heating system to an heating system that would operate on electricity will significantly reduce the life cycle of the equipment. Environment friendly materials do come at an additional cost. [3]

New concept of "double zero" for building envelope, where the "first zero" means zero heat gain/heat loss through building envelopes and the "second zero" means net zero energy consumption to fulfil the "first zero". The "first zero" is realized by TE cooling/heating using power from a PV or battery to control the inward heat flux. The "second zero" is made by model predictive control (MPC) of power flow and battery capacity optimization [4].

Due to rise in upcoming challenges for electricity due to climate change, system security, economic globalization, there is need for new measures like developing energy efficiency measures, developing renewable energy capabilities, dealing with adaptation needs arising due to climate change. [30]Extensive issues in AC grid can be tackled by DC micro - grid. Energy Storage System (ESS) is required to deal with problem of fluctuating torque and wind turbine resulting in voltage and frequency excursions.

Permanent Magnet Synchronous Generator (PMSG) is used for wind power generation. Variable load of each house cluster comprises of critical and interruptible load and can be laid off according to deficit of power as per state of charge of battery pack. [30]

Features of Smart DC Grid Net Zero Building:
- Efficient lightning
- Double insulation
- Photovoltaic panels
- Energy management
- Low flow water fixtures
- Efficient electric heating and cooling [5]
- Heat recovering ventilation
- Exceptional air sealing
- High performance windows and doors [30]

The two major parts of ZEB, passive building envelope and active/ optimum utilization of renewable energy sources, serving as two separate sub - systems [4]. The main task of building envelope in ZEB
1) Lower as much as possible heat gain/loss, this is a priority as it can significantly reduce the energy consumption.
2) The renewable energy systems are used to generate usable electrical power for other equipment like air conditioner or heat pump.

One of the major challenges to conquer in NZEB building is improving building energy performance (i.e., increasing energy generation and reducing the usage of energy as far as possible) and to provide with thermal and visual comfort simultaneously. [6]

The design parameters considered for the same were width, angle, thickness, blind distance to the glass, shading location and shading control devices.

For minimizing the thermal discomfort of the habitants, it was essential to first minimize the number of thermal discomfort hours. This can be tackled using Indoor Air Temperature control. This strategy was based on level of CO_2 and indoor air control. [6] This effect was also combined with the amount of direct or indirect solar radiation entering the building. Also, for the same various shading controls (facade) were used as to minimize the direct contact with radiations. But at the same time providing these facades were at the cost of luminescence units. Like to explain providing these shading devices were obstructing the natural Daylight entering the building. Therefore, it was necessary to also think to improve the lighting system and find a sweet spot in these contradicting factors.

It was experienced that lower air flow rate was satisfying the primary goal of minimizing the energy use while contradicting to this a higher air flow rate was better for providing visual and thermal comfort. In the optimized cases high amount of electricity could generated and exported during summers but in winters high proportion of energy was being imported.

Another important thing to point out NZEBs were that it will always be economically viable that the building would self - consume the energy it generates instead of transferring it to the grids. [2] This would be due to multiple reasons the major one being tariffs charged as it would only be for the imported electricity and not for the exported thus the cost would be nearly halved. So now if we see the import of energy in the winters would come at greater cost thus to balance that there should be a significant amount of surplus energy that should be generated in summers as to bring the net zero cost.

2. Case - Study

Indira Paryavaran Bhavan in New Delhi is the first Net Zero Energy Building (NZEB) constructed in India (Fig.1). It is the office block of the Ministry of Environment and Forest (MoEF), situated at JorBagh Road in South Delhi. It is solar passive design and energy - efficient building materials. Earthquake resistant structure with a complete plinth area of 31, 488 sq. m, quite 50 per cent area outside the building may be a soft area with plantation and grass [31].

The building features the robotic parking system within the basement which will accommodate 330 cars and thin - client networking system has been provided rather than conventional desktop computers to attenuate energy consumption. Design of structure allows for 75% of natural daylight to be utilized to reduce energy consumption. Along with installed capacity of 930 kW peak power, the building has the most important rooftop system among multi - storied buildings in India. [31] Total energy savings of about 40 per cent through the adoption of energy efficient chilled beam system of air - conditioning is plausible. Air - conditioning is completed by convection currents instead of airflow through air handling units, and chilled water is circulated right up to the diffuser points unlike the traditional systems.

Adoption of UPVC windows with hermetically sealed double glass, Calcium Silicate ceiling tiles with high recyclable content and grass paver blocks on pavements and roads, renewable bamboo jute for door - frame, fly ash bricks. 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 tide demand in landscaping, use of geothermal cooling for HVAC system, rainwater harvesting and use of curing compounds during construction. [31]

Main features of this structure are preservation of maximum possible number of trees standing over the site, solar passive architecture with proper orientation and shading of fenestrations, appropriate building envelope design with envelope insulation to reduce heat intake, use of permanent, durable and local materials such as sand stone on exterior face, low heat transmission glass and reflective roofing, priority for pedestrians within the front, with vehicular access on the edges of the building, reduction of conventional lighting load by ensuring 75% day - light use, natural ventilation thanks to stack effect. The building is designed in such a way that there is free ventilation across the entire building and architectural design of the building is primarily based on following concepts [31]:

Utilization of high efficiency solar panels to realize net zero criteria energy efficient T - 5 and LED fixtures, innovative chilled beam system for cooling, pre - cooling of fresh air from exhaust using heat recovery wheel in order to reduce load on chiller plant, water cooled chillers, double skin air handling units with variable frequency drives, Geo thermal heat exchange technology used for heat rejection from air - conditioning system, innovative energy saving regenerative lifts which are installed for the primary time in government institutional building. Some of the known factors that have been found to impede the achievements of NZEB are Building size, building use, and building height. [31]

Figure 1: Indira Paryavaran Bhavan
Source: [31]

ZERO - PLUS

ZERO - PLUS is a comprehensive, cost - effective approach for the design, construction, and monitoring of NZE settlements [7]. The ZERO – PLUS project's primary aim is to reduce the cost of achieving NZE requirements by implementing the NZE concept at a settlement scale.

ZERO - PLUS approach has three phases – 1. Design, 2. Construction, 3. Occupancy

1) Design

The Design phase comprises of planning of the settlement and the designing of the buildings. With the help of simulation tools, energy generation and consumption projections are produced first at the building level, and then at the settlement level to define the energy performance, considering a certain set of candidate technologies [7]. Although construction and lab experiments of NZEB are costly, computer simulations are convenient and quick. Energy and TRNSYS are used, in which, TRNSYS is applied for both energy efficiency and renewable energy analyses. TRNSYS is used in building systems for simulations of passive as well as active solar design.

The microclimate of the settlement is assessed to determine the future needs of each building, and together with the combined building - level assessments, this informs the design of indoor and outdoor living spaces. The final activity of the design phase revolves around the development, commissioning i.e., selection of monitoring devices and details of tendering process and Measurement and verification (M&V) plans of the design.

2) Construction

Here building of the structures and installation of devices takes place by carefully following the guidelines laid out in design phase, quality assurances of installation, functional checks and calibration of the systems as per requirements and norms. Post installation pre - occupancy measurement and monitoring of system testing is done.

3) Occupancy

Continuous monitoring is done to obtain data on thermal/visual comfort, indoor and outdoor air quality checks with the help sensors, post occupancy check and evaluation is carried out. Problem identification procedures are carried out, data processing and analysis is done.

The benefits of the ZERO – PLUS settlement – scale application

Provision of a clear road map for achieving compliance with European regulations for energy efficiency in buildings
Optimization of energy performance through optimized technology design and the optimized integration of renewable energy and energy management measures in the settlement

Economies of scale leading to opportunities for lower initial investment costs and lower maintenance costs

Increased efficiency and reliability of the system through the application of communal energy generation and management technologies

Access to the expertise required for the design, construction, and maintenance of advanced technologies, as well as of innovative building and settlement design solutions

Improved microclimate conditions through urban design solutions leading to a reduction in energy demand andCO_2emissions
Energy savings and enhanced quality of life for the end - users [7].

Barriers encountered in the implementation of the ZERO - PLUS approach

Policy and regulatory barriers

1) Long – term urban planning: If put simply it means that ZERO - PLUS approach needs to align with the already existing long term urban plans, which are prepared by the local and/or national authorities.
2) Building permits: Another important policy barrier are permits. These have to be obtained in advance from the authorities for smooth and undisturbed working, as it gives a clear indication of the support from the authorities.
3) Regulation of communal energy systems and connection of hybrid renewable energy systems to the grid: This barrier arose in a case study done in Italy, which is simply that national regulations may not allow energy sharing schemes at neighborhood levels.

Project management challenges

1) Team alignment: Access to experts for realizing the concept of NZE settlements is very vital and for them to work as a coherent unit with good understanding and communication to tackle various problems involved in design, construction and occupancy phase.

2) Integration of different technologies and technology holders i.e., providers of the technology.
3) Agreement among different owners.
4) Cooperation of occupants.

Stakeholder analysis:

a) ExternalstakeholderswerethePlanningauthoritiesandutilit ycompaniesthatdictatedspecificrequirements for the approval of the submitted designs. These requirements are a result of the legislation, planning policies, and energy policies that are in place in each country and directly affect the implementation potential of design strategies and technologies [7].
b) Internal stakeholders are the members of the project team that are involved since the beginning i.e., throughout all project phases. It consists of academics, technology providers, project owners, design team and construction team.

Since these use fossil fuels whilst affecting emissions and resulting in higher emission rates, therefore load matching and grid interaction is highly important. Matching on – site generation with on – site demand is known as "load matching", whilst grid interaction concerns the matching of grid export, grid quality and stability requirements [1]. Load match and grid interaction indicators aim at:

a) Quantifying the variability of energy demand.
b) Supply at the building side, but do not include the associated variable environmental impacts.

The multidisciplinary design approach has been applied to a NZEB case study and a parametric analysis is carried out to find out the trade – off between the optimal grid interaction and the minimum environmental impacts.

The parametric analysis is performed considering the following parameterizations variables:

- PV (Photovoltaic system) system nominal power;
- Electric storage system nominal capacity;
- Fuel cell system nominal power.

Building integrated photo – voltaic thermo electric wall (BIPVTE) system, through simulation it was shown, the energy efficiency can be 4.8 times higher than standard massive wall. Drawbacks:

1) In the absence of sun light at night, heat gain/loss is still there;
2) During daytime, the cooling energy in summer and heating energy in winter provided by BIPVTE is excessive [4].

Therefore, if energy storage system could be introduced and coupled with BIPVTE system to realize optimal control of heat flow and electrical power flow, the task of "double zero" may be achieved through this system.
Although the concept of BIPVTE system can be much more energetic efficient than BIPV, it was found that the thermal bridge problem in BIPVTE hindered its wide applications.

Electrolyser

The integration of the natural resources in the electrical systems and the microgrids and buildings has been developed rapidly in the recent years. The main sources from which renewable energy could be extracted till date are: Wind, Hydro, Hydrogen, Solar and Geothermal It is very essential for NZEB buildings to have both electrical and thermal storage systems. Different combinations of wind and solar battery and hydro pumped systems should be used. The photo voltaic system and the hydrogen production process go hand in hand to produce energy. From the electrolyzing water hydrogen is often produced and energy for electrolyser is acquired from renewable sources. [2] The energy profiles are uncertain and complicated. Problems arise when various energy resources are operated or used simultaneously. This type of system is called as solar - hydro - hydrogen fuel cell systems. [2] This beautiful integration of different renewable energy resources operates together, and optimum operating patterns are determine as depending on the seasonal variation. In summers solar energy satisfies the demand for lack of hydro energy and vice versa in winters. when the energy is produced is more than the load (Day) the excess energy is converted to the hydrogen with the help of water electrolyser this excess stored energy is utilized when the energy produced is not sufficient to meet with the load demands (Night). In the process Water electrolyser charges, he hydrogen and the fuel cells are used to consume hydrogen (discharged). The economic consideration for this type of energy is storing systems is on the higher side and vary according to the implementation and optimization of storage systems. Emission of co2 is also seasonal and it would naturally depend on the demand for energy being directly proportional. As demand for energy will reduce in winters emission of co2 is also minimized and vice versa in summers. For the economic analysis the net energy cost for the building is zero as it does receive any energy from the grid. The major cost required is at the initial stages to install this system.

Micro Grid

Micro - grid is a small - scale power system, usually located downstream of distribution substations. It consists of variety of DGs (distributed generators), ESSs (energy storage system) and loads that can be controlled in a coordinated, consistent way and can either operate in parallel with the utility grid or work on the islanded mode [8].

Due to its ability of reliable integration of DGs and overall control for system components, micro – grids are an effective alternative for the current power distribution system of buildings to achieve the all - important nearly/net zero energy target by maximizing the local consumption of RESs (Renewable Energy Sources).

A hybrid micro - grid (merging of AC and DC micro - grids into one system), the AC/DC DGs and loads are directly connected to the corresponding AC/DC sub - grid, leading to an overall improvement inefficiency by minimizing the power conversion losses.

Although the hybrid micro - grids mentioned in above articles can achieve desired power flow control, there still exist following operation limitations:

To realize power sharing, the DGs in droop control need to regulate its output according to the load conditions. They cannot always deliver current MPPT (Maximum power point tracking) power, thereby decreasing the efficiency of RES [8].

These strategies belong to the decentralized control method, which uses the power lines as the sole channel of communication. Still it is difficult for them to realize systematic coordination due to lack of global information.

An ILC (interlinking converter) that exhibits an integrated and compact structure, multiple interfaces and functions are favorable to be installed in building micro - grid, which prefers small size, integration of grid components in a "plug - and - play" manner, flexible control and networking. However, the single - stage converter, viz., the VSC, which is utilized as the ILC in, cannot satisfy the above requirements [8].

The power flow control is mainly implemented in islanded scenario of micro - grid. However, the objectives of power flow control in grid - connected scenario, for e. g., improving the local consumption of RESs, is not considered.

There are two aspects, i. e., control approach and micro - grid architecture, that should be concentrated on to address the above issues.

A solution that contains the advantages of both centralized and decentralized control is the hierarchical control approach, which consists of multiple control levels.

Primary control ordinarily features the fastest response in the three control levels. It apprehends the independent local control for several components in micro – grid by respective LCs.

The control objectives contain:
1) AC/DC voltage, frequency and power control of SIU (Small Interlinking Unit);
2) MPPT and power control of DGs;
3) Charging and discharging control for EVs;
4) Load management, i.e., load shedding and recovering.

Secondary control operates in a relatively slower time scale. In this control level, the PFC (Power Flow Controller) of SIU collects and processes the data from corresponding LC (Local Controller) on a time - to - time basis. In return, the power dispatching command is generated online and delivered back to the LC of SIU according to the power flow control strategy [8].

Tertiary control level, globally coordinated control is to be implemented by MGCC (Microgrid Central Controller) to realize a long - term optimal operation of the microgrid.

Lighting

NZEB focusses to maximise the illumination by saving the energy that is used by artificial energy sources. Inhibiting the natural day light reduces the consumption of LEDs and other materials. It is often found difficult to design the roofs that allows daylight and natural air to penetrate. Illuminating Engineering Society (IES) lists down in its handbook the ideal lighting levels for various components that are for cafeteria 200 - 300 lux, classroom 300 - 500 lux, conference room 300 - 500 lux, corridors 50 - 100 lux, gymnasiums 200 - 300/300 - 500 lux, etc. These minimum light levels are provided by IES that are set as targets in accordance with the energy standards of that region.

Air Coolers

To keep air cooler without consumption of electricity by making use of a change in design is what modern technology should be able to do. This is done by making use of eco - air cooler, a component which is shaped like the top of a bottle. The broader part of the component is placed on the outer side of the building eventually turning the narrower part or the bottle neck on the inner side. When warm air is moved inside the eco - air cooler, it compresses the air inside while moving it inwards, by the time the air reaches the other end, the air is been cooled down. From the reports of this approach, it is been observed there is a reduction in the temperature of 5 C.

Instead of using refringent thermoelectric cooling has appeared as new solution for green cooling strategy. The concept of thermoelectric cooling or heating is based on Peltier effect, in which conversion of electrical energy into temperature gradient. [5] The modes can be easily switched on reversing the current directions. These thermoelectric generators operate with an efficiency of 4.6%. [5] Considering this efficiency, the heating and cooling capacities of one thermoelectric generator are usually low and therefor number of thermoelectric generators are operated together in assembly to form thermoelectric cooling module. In a thermoelectric cooler the outside air is primarily cooled and DE humified as it is passed through the cooler side of the thermoelectric module. Now if the supplied air is cold too then it will be reheated by passing through the hot side of the module before entering the indoor space. Another solution is Radiant cooling, in this the temperature is controlled by adjusting the surface of radiant panels. [5], [9] The area of solar panel is defined to be equal to the ceiling surface area of the room. At first the performance increased with increasing electrical current but after reaching the maximum the performance is seen to decrease with further increase in electrical load. The radiant panel systems provide better thermal comfort than convectional HVAC systems as the create a small vertical variation in the air temperature and are capable of reducing the fraught in the environment and thus minimizing the thermal discomfort of the body.

Water Turbines

There is a constant flow of water in a building. This flow of water creates a velocity that is sufficient for producing energy by making use of small sized turbines. The daily flow of water will rotate the turbines which will be installed right before the outlet of the taps and at a suitable distance in all the water systems. The energy produced from it may be used to meet the energy requirement of the building. This will reduce the need for external energy supply for the electrical uses of the building. With advancement in this, the buildings can be made an autonomous in terms of energy. Which can be further helpful in creating a net zero energy building.

Solar Paint

A paint when applied to any surface, it captures energy from the sun and transforms it into electricity. The paint is similar to a normal paint but the difference is that it has billions of pieces of light sensitive material suspended in it. It contains a synthetic substance, Molybdenum - sulphide., which absorbs the moisture from the air. This absorbed moisture is broken down into hydrogen and oxygen particles by Titanium oxide, a substance already extant in conventional paint. The hydrogen can then be used to produce clean energy. What makes this technology particularly special is that it outputs hydrogen, a clean source of fuel and energy storage. This hydrogen - collecting solar paint is an environmentally friendly and cost - effective way to collect hydrogen for producing energy.

Solar Heater

The Greatest part of cooling load is because of the solar radiations. [10] So, the basic ideology is to prevent or reduced the amount of direct solar radiations entering the building. Orientation of windows play a major role in achieving this also coefficient of shading of windows should be minimized. Heating load are reduced as the sun will act as a natural heater due to the greenhouse effect. Also, the angle at which solar radiation will enter the building and the angle which they will form with the external Wall would be significant to reduce the discomfort as well as energy utilization. Many other factors apart from solar radiations such the color of the building and the material that is used also affect the cooling comfort. As the darker colors will absorb more solar radiation while lighter colors would reflect these solar radiations. [10] While different experiments and research could be done to manufacture materials, which would heat absorption. By taking care of all these factors cooling loads can be reduced without spending much energy and implementing design solutions.

Natural Ventilation

As said earlier humidity plays a major role for causing discomfort in tropical and sub - tropical areas. [10] Providing adequate amount of natural ventilation will help to solve this problem if not at least reducing the intensity of it. To make sure pleasant living conditions in hot climates high velocity air intake is required. Different variable factors such wind speed and wind direction does play a major role in the provision of natural ventilation. These factors are primarily responsible and will regulate the efficiency of natural ventilation that would be provided. Wind driven forces are responsible for 76% more indoor airflow that buoyancy driven forces [10]. It should also be considered to reduce the amount of air blockages and obstacles as to get the maximum from the ventilation systems. Ventilation systems also get affected by types of winds like for e. g.: predication of turbulent Air can be difficult at times this can lead to lack or increased ventilation whereas a steady ventilation could be achieved in the presence of steady winds. In coastal areas breezes can also be used for effective ventilation.

Natural Construction Material

Different types of materials having low thermal mass are available. This are traditionally light weight and can be conveniently used in adverse climatic conditions. These materials help in low relative humidity and high temperatures at night as otherwise it would create negative effect at night.

Aerated Autoclaved Concrete is a well - known material and is best suited for humid and hot conditions. [10] Some of the key factors of this concrete are it is lightweight, workable, environment friendly, long lasting, etc.

For better insulation effect double or triple paned windows can be used. Due to the provided insulation heat transferred due to solar radiations is reduced.

Green Roofs

During hot and sunny days green roofs are most effective and, they do work as heaters at night. During the day this green roof will provide with a pleasant cooling effect. [10]

Another significant novel system is sun tracking intelligent solar systems. It would track the relative motion between the sun and the building and thus providing with an angle which would always try to maximize the absorption of solar energy.

Some of the factors on which NZEB strategies depends:

1) Site sustainability
2) Water and energy efficiency
3) Resource management
4) Indoor air quality

Energy Conservation Measures

In conclusion with the advancement in renewable technology, Net Zero Energy Buildings are the future. Many governments have framed Zero Energy building laws, whereas, few governments are also providing subsidies to individuals and organizations for creating Zero Energy Buildings. The goal of zero energy buildings wouldn't be fulfilled till the time all the people don't understand their responsibility and contribute towards reducing energy consumption. Solar and wind energy are going to be the main contributor of renewable energy for ZEB's due to their widespread availability. Biogas also can be used for our energy needs but its only constraint is that it needs huge quantity of waste and it's also not feasible everywhere. Geothermal energy is an upcoming sort of energy having great potential to get electricity but tons of research still has got to be done to tap into its full potential.

3. Conclusion

As we are progressing the amount of carbon footprint is increasing day by day. [10] Many strategies in different sectors have been incorporated to reduce the carbon footprint as well as to use the scarcely available resources effectively. In the construction sector Net Zero Energy Buildings (NZEB) are a new trend towards effectively reducing carbon emission. Two key services for which abundance of energy is used are cooling and heating loads. There are several factors as well. By preparing new strategies, design variations and using modern technologies these loads can be drastically reduced and hence overall consumption of energy can be reduced. Conventional air conditioners are widely used in tropical and sub - tropical climate zones. Due to inefficiency of these commercial cooling systems a large amount of energy is utilized by them. [5] These systems also dissipate high amount of heat and cause pollution. Therefore, the need for profitable, environmentally friendly and efficient new technologies. The conditions should be healthy and comfortable for the habitats.

One of the prime problems to establish new strategies is Humidity. [10] Due to this factor it very difficult to design buildings which are fulfilling NZEB as well as comfort requirements of the habitats. By the process of transpiration (heat loss) we humans cool our body temperatures. In humid climatic conditions due to the water present in the air the process of transpiration is limited to a certain extent. As humid air already has greater proportion of water, so it won't absorb more amount water due to this the human body gets uncomfortably warm. As we are moving towards electrical economy it is necessary to generate more amount of electricity as the demand will increase also the environmental impact due generation of electricity should be continuously monitored and mitigated then only, we will be able to achieve the target of sustainable buildings.

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5. Conflict of Interests

On behalf of all authors, the corresponding author states that there is no conflict of interest.

6. Data Availability

All data, models, and code generated or used during the study appear in the submitted article.

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