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Feasibility of Zero Energy Building at Noida, Uttar Pradesh

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Abstract:

Due to advanced technology & modernization, energy requirement is massively increased to fulfill the needs& thereby, Carbon dioxide (CO_2) emission into the environment increased day by day. CO_2 emissions act like a blanket in the air, increasing heat in environment and thereby warming up the earth& changing the climate drastically. CO_2 emission layer prevents the Earth from cooling & inviting other issues. We all know that global warming would adversely affects the condition of environment, food and water supplies, health issue and sea levels etc. According to various estimates, buildings consume 30to 40%[i] of all energy resources and by energy consumption reduction method, it is possible to reduce CO_2 emissions intoatmosphere. With help of renewable energy technologies, energy needs through efficiency gains are greatly reduced**.** In this paper I have tried to explore the concept of zero energy in a residential building located at Noida sector 168. It is well understood that maximum people across the globe usually spend maximum time inside homes,hence it becomes important to save energy by suitable means. We have to more develop efficient energy conversion devices with low environmental impacts and using maximum energy, which is produced thro' renewable energy sources as it has no or low impacts on environment and good for earth & depletion of O_3 layer can be minimized.

Key Words:Energy Management System, thermal energy; Active &Passive Solar; Zero Energy Building;

1. Introduction

Present usage rate of Earth's resources is highly unsustainable and has started showing alarming signs of global warming and climate change. This current situation can be attributed to reliance on non-renewable resources for energy generation, non-uniformity of available resources, unsustainable lifestyles and lack of awareness towards life cycle approach. Sustainable development focusing on

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harmonizing life-styles with renewable sources as well as improving efficiencies in systems is required for current growth trends in India [1-3].

According to Goldman Sachs BRIC Report[ii], India will be the second largest economy by 2050. The construction industry in India is currently the second largest industry after agriculture contributing approximately 8-9% to GDP [1,2]. India has recorded the highest construction spending growth driven by growing number of infrastructure projects and a booming real estate sector. Sustainability in construction through energy efficient fixtures and systems, use of rapidly renewable building materials and efficient resource management through BIM can reduce the carbon footprint and promote an environment friendly growth. By implementing three principle measures like Building envelop measures, energy efficient measures & Renewable energy Measures, we can achieve good net zero energy building[2,3]. Not only this will be beneficial for environment but also it will be economical and good for nations. I have selected Lotus Zing Building at Sector 168, Noida for suggesting & supporting the builders to incorporate the measures to achieve Zero Energy Building.

1.1 High Performance Buildings: A whole-building design approach that integrates the building performances (energy consumption, acoustics, etc) with occupant comfort (thermal comfort, Indoor Air Quality, lighting, etc.) considering life-cycle impacts of the entire HVAC & R systems can enable high performance green buildings [1,4]. These green buildings can further incorporate Energy Management Systems (EMS) and Building Automation Systems (BAS) to increase energy efficiency performance capabilities, giving facility managers the information to make better decisions during building operations[4,5].

A high performance building considers all the components and subsystems together, along with their potential interactions and impacts on occupants [2-4,6]. This whole building approach crosses disciplines and requires that planning, siting, aesthetic design, equipment and material selection, financing, construction, commissioning, and long- term operation and maintenance be integrated[. Developing a high-performance building requires an integrated design team that fosters close collaboration between owners, architects, engineers, financiers, managers and operators, building trade representatives, contractors, and other key players.

In future, such buildings will be dramatically reshaped by research result &product development in various fields— HVAC equipment, energy-efficient building shells; daylighting; lighting; passive and active solar, windows; PV power systems; advanced sensors and controls; fuel cells and combined heating, cooling, and power. These technologies, together with a whole- building design approach, called as systems engineering or integrated design, takes advantage of interactions between components &building systems, will serve their needs and meet goals of environmental protection, economic growth, and sustainable development.

1.2 Net Zero Energy Buildings: Next generation high performance buildings are the Zero Energy buildings or ZEB's. A Net Zero Energy Building (ZEB) is designed in such a way that energy efficiency and on-site production convert the building from an energy consumer to an energy producer **[6,7]**. Waste containers are used in developing the habitat. A concept of NZEB has been illustrated in the given Figure 1

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Figure:1 A concept of NZEB

2. Methodology:

Achieving the ZEB goal depends on four characteristics:

1. Number of stories - Single-story buildings are the most likely to achieve net zero energy consumption.
2. Plug and process loads - Buildings with lower plug and process loads (for appliances, office equipment, computers, and other electrical and gas equipment) are also better able to achieve net zero status.
3. Principal building activity (PBA) - Non-refrigerated warehouses, retail, vacant, religious worship and education are the best chance of achieving zero energy consumption whereas less chance of achieving zero energy consumption are hospitals, food service establishments, and laboratories. We can get below average chance of achieving net zero levels, largely because of plug and process loads and height in office buildings.
4. Location – Buildings which are located in hot area with ample sun-light are more likely to achieve the net zero levels.

Need to emphasizes the principle of bringing together the best materials, efficient systems, efficient lightings, Lighting Sensors, efficient appliances and use of passive & daylighting strategies **[7-9]** while constructing a building to suit the climatic conditions at the site [9-11]. These features enable 50 percent reduction in electricity requirements as compared to a conventional building space for this region.The electricity for all building end-uses of the Project is produced by Solar Photo Voltaic Cells at the site[12].

2.1 Measures to be followed

- Need to be independent on electricity rather utilize the maximum renewable energy (from sun, wind)
- Need to emphasis to take essential steps for attaining maximum sustainability by utilizing natural resources.
- The designer has to reduce energy demands as low as 1.5 w per sq ft against 8 to 10 w per sq ft and loads, optimize passive strategies and incorporate efficient mechanical strategies.

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- Project is to be constructed by using plenty of waste materials including the building shell, four recycled cargo container.
- Building has to be planned and deigned using well recognized energy and daylight simulation tools and with whole-building approach which brings all the building components and subsystems together, along with their potential interactions and impacts on occupants.
- Building has also incorporated traditional Indian Architectural features such as courtyard, used for natural ventilation and daylighting and is shades with louvers designed optimally for summer and winter climate.
- More than 50% savings in electric energy compare to conventional building of the climate region. Up to 40% savings in Electric energy through passive energy conservation features. The passive measures are high-performance heat insulation, improved protection against sunlight, optimized window wall ration, effective daylight uses and natural ventilation strategies.
- All Energy Uses of the building are with electricity generated by 100% solar and thus emission-free energy supply through the use of a 3 kW photovoltaic system with a total surface area of approx. 25 m^2.
- Maintains Occupant Thermal and Visual comfort[iii]. Main living areas are air-conditioned for both cooling heating requirement. The project is completely day-lit with 75% of the living area achieving more than 2% of Daylight factor.
- Sensors are installed throughout the house and interconnecting wiring was run to monitoring energy consumption for all End-Uses and the same were displayed on the interaction panel at site.
- 24 hour autonomous operation of the building, independently of the electrical grid through the use of a battery back-up.
- Zero run-off Water.
- Graph showing the path towards a Net Zero Energy Building (Net ZEB), with the nearly and plus variantsshown in given Figure 2.

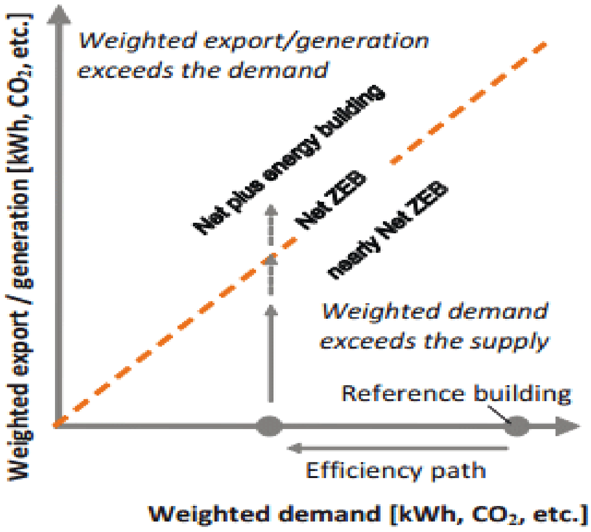

Figure 2: Weighted demand Vs Weighted export

3. Result And Discussion

3.1 Impact on Green House Gas Emissions:

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In a net zero energy building, the amount of energy generated by on-site renewable energy sources in a year is equal to or more than the amount of energy consumed by the building in that year. The energy simulation predicts the annual consumption of Project at 4252 KWh and an on-site generation of 4270 kWh.

When compared to a convention building, this translates to an emission reduction of about 3.8 tons ofgreenhouse gases. In terms of sustainability equivalencies, this is same as preventing emissions generated by 3 passenger cars in a year. This is also the same amount of greenhouse gases that would be sequestered by about 200square meter area of forest thus preserving this much area of forest from deforestation. Comparative analysis given in tabular form (Table 1).

Table 1: Comparative Analysis of Conventional Building consumption to Net Zero Building based upon Energy Simulation.

	Conventional Building	**Net Zero Building**
Annual Energy Consumed (kWh/yr)	8562	4252
Carbon Emitted (Tones/yr)	7.6	0(All Electricity produced by Solar PVs)
Cooling Load (sq.ft./ton)	270	550
Electric Load (W/sq.ft.)	4.5	1.65
Equivalent Cars Kilometers on Road/yr.	3	0
Pollution (Sqmt. of Forest Deforested)	200	0

3.2 Net Zero Building:

Got the privileged to work with an architects and sustainability consultants for this project, the new building will retain most of the energy conservation features, additionally some new features will be incorporated in the new building.The energy generation will mainly be through the Solar Tracking PVs , in addition the wind energy through Micro Wind Turbines will also contribute in energy generation (Figure 3). Biogas produced at the site through waste organic materials will also contribute to the energy demand of the net zero building. Piezoelectric appliances/floors for generate the electricity for through human motions.

Figure 3: Figure showing (a) Solar Tracking PVs, (b) Micro Wind Turbines and (c) Green Wall

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The net zero building will be designed with many passive strategies to minimizes the heat gains, HVAC requirement, artificial lightings and thus building energy requirements. Some of the passive strategies used in the project will be:

- High performance Wall, Roof and Window Assembly
- Optimized Orientation and Window Wall Ratio
- Optimized shading devices/louvers with automatic controls to protect penetration of direct sun radiation and glare
- Self-Shading Building form
- Smart windows - Photochromic Windows, Thermochromic
- Windows, Liquid Crystal Windows, Electrochromic Windows
- Green Walliv and Roof, Cool Roofs/Walls, Vacuum Walls,
- Water Wall, Water filled windows
- Structure frame with light weight and recyclable fiber or recyclable bamboo material
- The Indian TraditionalCourtyard, Varandas, Zarokhas etc.
- Double skin façade/Trombe wall
- Passive down draught evaporative cooling coupled with solar chimney/turbo ventilator
- Use of high mass/latent heat storage such as Phase Change BuildingMaterials/Labyrynth which absorbs the heat in day and reject in the night thus resulting in less peak load and lesser HVAC system size.
- Fresh air Plants (produces oxygen in abandon quantity during day and night) to maintain proper Indoor Air- Quality.

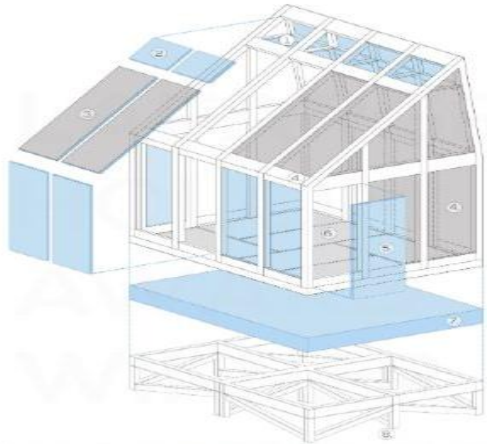

Figure 4: Water filled windows can both heat & cool buildings

The new building will use solar energy for air-conditioning through solar power vapor absorption machine. The Air-side system will be either energy efficient passive chilled beams or underflow air-distribution along with heat recovery wheel. The daylighting will be enhanced through application ofLight tubes/Optical fiber daylight technologies and automated louvers/Shadings.

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4. Conclusion:

A series of studies produced in this paper by identifying and practical application of Architectural body and planning solutions to reduce the heat loss through building envelope technique. The suggested techniques to be followed in order to improve the energy efficiency of the designed building, which are the subject of this current study:

The advanced lightings controlled with occupancy and daylight sensors will be used in the project. High efficient appliances will be used to further reduce the energy requirement of the building.

Building will be planned and deigned using well recognized energy and daylight simulation tools and with an integrated design process; a number of building solutions will be considered and analysis will take place to compare strategies and to determine which ones are appropriate to achieve the desired performance.

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