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Process of a Net Zero Energy Building

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Abstract: The 21st century is shaping up to be a transitional era for the way humanity dwells on the earth. The unsustainable pressure on non-renewable resources, increasing demands and scarcity has been a driving force to find solutions to completely divulge from these practices and find lesser impact solutions.

Much of the stress we impose on earth is manifested in the way we design, construct and use our built environments. A building contributes to smog, poor water quality and depletion of natural resources which causes health threats, social inequalities and ecological damage.

An ideal solution would be to have buildings that are economically, socially and environmentally beneficial to the society. Such a concept can be a Net Zero Energy building. Zero is the point at which the building no longer consumes energy but rather produces it. In order to reduce the energy consumption of the commercial building sector it is required to create technologies and design approaches that lead to marketable zero energy commercial buildings.

Along with detailed explanation of a net zero energy building and all corresponding definitions .This paper covers the need and the 'how' to achieve a Net zero energy buildings as a sustainability solution to the built environment problems.

Keywords: Net zero energy, passive design, green building, energy efficiency, solar energy.

I. DEFINING A NET ZERO ENERGY BUILDING

A building that in totality uses renewable energy sources (or may produce enough to offset or exceed the non-renewable energy) and maintains this through its 'operation', in all seasonal variations can be truly a Net zero energy building. A building that is self-sustaining in energy terms and is economically viable and holistically designed to reduce the energy needs can achieve a Net Zero target.

The 4 definitions for net zero are , a net – zero site energy building, net zero source energy building, net zero energy cost building, net zero energy emission buildings[3].

Time tested passive solar or artificial conditioning, principles that work with the on-site assets, Sunlight and solar heat, prevailing breezes etc. are all such technologies needed to create zero energy buildings , and these are available off-the-shelf today. A correct application in combination of these technologies with parameters of Zero Energy is the need of the hour, subsequently, There are several definitions and explanation for a net zero energy building. Each definition differs depending on the boundary and metric used to define the building. Zero is the point at which building no longer consumes energy but rather produces it. At the zero point, the sum of the energy flows in equal the sum of the energy flows out.

A. Net Zero Site Energy Building

A net zero site energy building produces at least as much renewable energy as it uses over the course of a year, when accounted for the site, it's a literal measurement that is if a boundary is drawn around a building site and all of the energy within the site boundary is measured and added up and the resulting site energy is measured. It encompasses all elements that require energy on site, lighting, ventilation, maintenance, utility production and any other specific needs in respect to the kind of building, and the production of energy through renewable sources has to match this required quota to be a net zero site energy building.

B. Net Zero Source Energy Building

A net zero source energy building produces or purchases at least as much renewable energy as it uses over the course of a year, when accounted for at the energy source. This measure includes factors related to providing energy to a site. If unable to self-produce a building or a site may purchase equipment for renewable energy source production or indirectly source renewable energy from neighbouring source, leading to a retro fitted zero energy system for a building.

C. Net Zero Energy Emission Building

A net zero energy emissions building produces or purchases enough emissions free renewable energy to offset emissions from all energy used in the building over the course of a year. whereas site and source energy are measured in energy units, energy emissions is measured in mass of carbon equivalent , greenhouse gas emissions related to the energy use of the building.

D. Net Zero Energy cost Building

A net zero energy cost building receives at least as much financial credit for exported renewable energy as it is charged for energy and energy services by the utility over the course of a year, to arrive at this measure, all energy and energy services charges on the utility bill should be included in such a parameter. Thus , a net zero energy goal is achieved through planning, design, construction and occupancy. Currently, designers now aim for an integrated process, with an increase in owner and industry expectations for a building performance and sustainability, the aim is to design and construct a building with renewable energy performance requirement and objectives.

II. STRATEGIES AGAINST BARRIERS TO NET ZERO ENERGY BUILDING

If the strategy and technologies exist to build more energy efficient buildings, then the question is how come all buildings in the country are not moving towards net-zero. The fault may be in the traditional way of designing buildings is still considered the best, as well as perceived associated higher costs with green buildings. In a traditional building design process, the architectural team works with the owner to create a building to satisfy the program requirements, and then the project engineers design the electrical and mechanical system and evaluate compliance with energy codes and acceptable levels of environmental comfort. In contrast ,the Net zero design would include architects, engineers(lighting, electrical and mechanical), energy and other consultants, and owner to sit together to set and understand the energy performance goals. The cost of such a project varies greatly depending on the strategy undertaken to reduce energy use and the climate in which the building is constructed into consideration. Let us first define what is energy used for in a building, and what are thermal comfort, lighting, equipment and plug load requirements. First and foremost a building must be designed on principals of passive architecture- it is the use of architecture and climate to provide heating, cooling , ventilation and lighting., the passive strategies response to project specific parameters such as climate, microclimate, site and program and makes it possible to provide a high interior environmental quality coupled with low energy requirements.

The following applications for passive strategies must be followed:

1) Evaluate the climate and site for available passive resources.
2) Determine the building needs and performance requirements/metrics.
3) Research passive strategy options.
4) Assess available passive resources against performance requirements.
5) Test and refine building program, zoning , massing and orientation approaches for passive design application
6) Test and refine building envelope approaches for passive design application.
7) Develop, quantify, and integrate project –specific passive design strategies.
8) Integrate passive and active strategies.
9) Plan for occupant interaction and controls.

Passive strategies can be found as fundamental characteristics of vernacular architecture across the globe, which has more efficient climate responsive design , climate was the most essential parameter of such designs and with coming of Industrial revolution materials like steel, concrete and later glass, which took the energy consumption to higher levels, the solution lies to first and foremost re apply passive strategies in the most efficient manner. Once such responsive and passive design strategies have been applied to a commercial building though it cannot be expected to meet all desired interior functions of light, comfort, air quality and hot water as they take up about 50 and 75 percent of energy in buildings. Thus, singularly all elements needed to be treated for maximum energy efficiency.

A. Lighting

Light is vital element in any building, its controls provide for functionality, flexibility and convenience in the operation of a lighting system. In designing of such control to achieve energy savings is to make "off" the default position. effective energy management will control the energy use of lighting by adjusting to variety of control inputs or scenarios. In the case, a Photovoltaic systems make use of the 'photovoltaic effect'. Sunlight is composed of photons, or 'packets' of energy. These photons have various amounts of energy corresponding to different wavelengths of light . When photons strike a PV cell, they may be reflected or absorbed, or they may pass right through the surface (causing heat only). When a photon is absorbed, the energy of the photon is transferred to an electron in an atom of the cell, a semiconductor based material (such as silicon).[2] With its newfound energy, the electron is able to escape from its normal position associated with that atom, to become part of the current in an electric circuit. By leaving this position, the electron leaves a hole behind. While the electron is negatively charged, the hole is positively charged and contributes to the current. The PV cell has a built in electric field , providing the voltage needed to drive the current through external load , such as light bulb. Thus, using photovoltaic system leads to efficient renewable source to power a building.

B. Thermal Comfort and air quality

The purpose of a HVAC system is to ensure adequate comfort and air quality in the occupied space, a low energy approach will compromise of 2 main methods, those that reduce energy through the distribution system , and those that reduce energy through the primary equipment . Various Low energy distribution strategies are:

1) *Avoid air for heat distribution:* In comparison of water based and air based thermal energy transfer water based is more energy efficient. The volumetric heat capacity of water is 4.1796 J/cm3 . k and the volumetric heat capacity of air is 0.0012 J/cm3.k. This means that water can hold almost 3,500 times more thermal energy than air[4]. Therefore, a much smaller pipe can be used to distribute the same amount of heat as much larger duct.
2) *Decouple ventilation and temperature control:* Water is great for transferring energy, but it does not help ventilate or dehumidify a space.by separating the ventilation and dehumidification air from the temperature control water , we can actually control these better through the facility , reaping energy, thermal comfort and air quality benefits,
3) *Use modest temperatures:* Conventional HVAC systems use fairly extreme temperatures in the working fluid. Common air supply temperatures are 55 degree F for cooling and 90degree F for heating, chilled water is typically needed at about 45 F , heating hot water ranges from 160F to 200F. by using warmer water for cooling , and cooler water for heating, we can rely more often on natural sources for heating and cooling, and the primary equipment does not have to work as hard when it is in operation using less extreme temperatures does mean that more working of the working fluid to distribute the same amount of heat, which will lead to more pump fan energy, this additional energy should be minimised by avoiding air as the working fluid , and should be outweighed by the use of free heating and cooling sources[1]
4) *Minimise reheat energy:* one big energy consumer in commercial building is heating air that has been already cooled down. This is built into the operation of most air-based HVAC systems, using modest distribution temperatures, and separating ventilation from temperature control, can minimise , or even prevent entirely , wasting energy for reheat.

C. Hot water source

Solar thermal hot water is an obvious approach to generate domestic hot water for a low zero energy building. Solar fraction or the portion of the total water heating load met with solar energy , is usually limited, for three reasons: the efficiency of the solar collector drops off at higher temperatures, rejecting excess heat becomes a bigger issue, and storage requirement increase. Heat pumps can be used for space heating.[3] Alternately, a separate heat pump water heater, dedicated to domestic hot water production, when combined with photovoltaics or other on site energy generation , these units offer an overall efficiency that is on par with solar thermal. The final outcome calls for a net zero energy building, combination of sensible environment design along with use of passive technologies to help achieve the objective, but one of the main concerns and target is to translate projected energy performance during design into real energy performance during building operation .The integrated delivery process is a key part of the solution. Specifically, the integrated delivery process should , from the outset , involve in participation of building management operatives. One of the major hinderances being controls.- software programming, setup, sensor hardware errors, operator errors and intentional override of controls by operators[5]. Conclusively , a building with consciousness from inception stage should be aimed at a net zero energy target, its design strategies pre thought for energy saving, then meeting the electrical needs through renewable technologies and applying efficient technologies for the same and a proper energy modeller control systems to achieve the same, that at later stage will reach its projected energy needs economically as well in the long term of a building life span.

III. ADVANTAGES AND DISADVANTAGES OF NET ZERO ENERGY BUILDINGS

A. Advantages

1) Isolation for building owners from future energy price increases
2) Increased comfort due to more-uniform interior temperatures
3) Reduced total cost of ownership due to improved energy efficiency
4) Reduced total net monthly cost of living
5) Improved reliability – photovoltaic systems have 25-year warranties and seldom fail during weather problems
6) Extra cost is minimized for new construction compared to an afterthought retrofit
7) Higher resale value as potential owners demand more ZEBs than available supply
8) The value of a ZEB building relative to similar conventional building should increase every time energy costs increase
9) Future legislative restrictions, and carbon emission taxes/penalties may force expensive retrofits to inefficient buildings

B. Disadvantages

1) Initial costs can be higher – effort required to understand, and apply.
2) Very few designers or builders have the necessary skills or experience to build Zero energy buildings.
3) Challenge to recover higher initial costs on resale of building.

IV. CONCLUSIONS

A net Zero energy building construction in planning and strategic development is a complex and a unified effort of owner, designer ,builders and various engineers, but conclusively it take the construction industry to its long aimed goal of sustainable construction practices resulting in less energy consumption, renewable energy sources and ultimately ecologically beneficial to our surroundings and ecosystem, beginning from the inception stage to the operation stage and to its final demolition a building must not only serve its purpose to provide comfort and shelter but also be a stable component in its environment., wastage , pollution and nonrenewable energy consumption should be avoided and a future of self-sustaining buildings must become a practice as well as a norm.

V. ACKNOWLEDGMENT

This paper is product of inspiring text of various authors and architects who have revived the dialogue of construction Industry to be responsible for its product, and taking responsibility of usage of its design, aesthetic and operational value in self-sustaining environmentally conscious manner.

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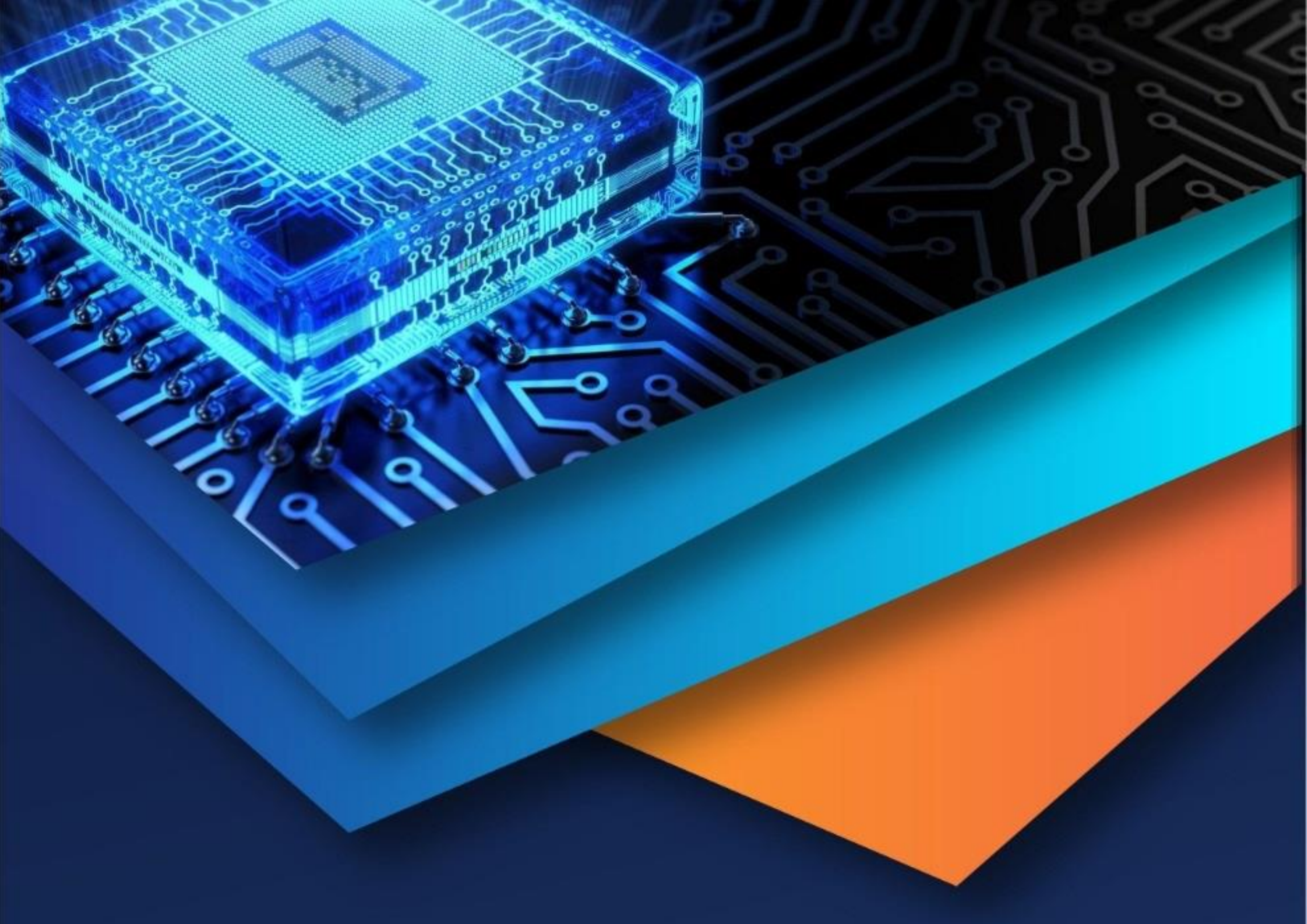

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