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SUSTAINABLE DESIGNING OF NET ZERO ENERGY BUILDING

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Abstract

World is entering into technological Era where humans required large amount of energy to run the space. Which results in depletion of non-renewable sources day by day. So peoples around the world join their hands to conserve energy. This project was evoked from a problem, that is India's population can reach highest position in world's population by 2030 which in turn consumes huge amount of energy sources. Around the world 40% energy was consumed by building only. So I suggest net zero energy building is a best conservative measure to reduce energy consumption. A net zero energy building can define as net zero energy consumption, means the whole amount energy used by a building over a year roughly equal to the amount of renewable energy generated in site of building and optimization of building design & electrical appliances. These building also contributes less amount of greenhouse gases into atmosphere. These building works on net zero energy consumption principle which means to reduce dependence on fossil fuels and reduce greenhouse gas production.

Key Words: *NZEB, Thermal performance, Energy modelling, Renewable Energy, Energy optimization, futuristic building design*

1. Introduction

Amid growing concerns about rising energy prices, energy independence, and the impact of climate change, statistics show buildings to be the primary energy consumer in the world. This fact underscores the importance of targeting building energy use as a key to decreasing the nation's energy consumption. The building sector can significantly reduce energy use by incorporating energy-efficient strategies into the design, construction, and operation of new buildings and undertaking retrofits to improve the efficiency of existing buildings. It can further reduce dependence on fossil fuel derived energy by increasing use of on-site and off-site renewable energy sources.

The concept of a Net Zero Energy Building (NZEB), one which produces as much energy as it uses over the course of a year, recently has been evolving from research to reality. Currently, there are only a small number of highly efficient buildings that meet the criteria to be called "Net Zero". As a result of advances in construction technologies, renewable energy systems, and academic research, creating Net Zero Energy buildings is becoming more and more feasible.

2. Literature review

Robert, Amélie Kummert, Michaël, 2017 investigates the use of the downscaling method known as "morphing", proposed by Belcher et al. (2005), to generate weather data files. The impact of using these weather files on the energy performance of an actual NZEB is then assessed. Morphing is applied to typical "horizon years" representative of future climate and also on a month-by-month and year-by-year basis using raw data from a selected GCM. A 50-year series of hourly weather data is obtained and analyzed for two different locations, Montréal (QC) and Massena (NY).

Kapsalaki, M. Leal, V. Santamouris,2018 work developed a methodology and an associated calculation platform in order to identify the economic efficient design solutions for residential Net Zero Energy Building (NZEB) design considering the influence of the local climate, the endogenous energy resources and the local economic conditions. One case study of a detached house for 3 climates was analyzed with the tool developed in order to gain insights on the economic space of NZEB solutions and the influence of the climatic context. A methodology for assisting the choice of economically efficient NZEB solutions from the early design stage is now available. Its use in practice may be of great relevance as the results showed that the differences between an economically efficient and economically inefficient NZEB can be over three times both in terms of initial and life cycle cost.

3. METEDOLOGY

For Design and Energy-simulation of Net Zero Energy Building, data will be collected from appropriate resource data such as REC, and GRIHA council, and LEEDR codes with respect to location. Blue print of building plotted in auto-cad software with defined dimensions. Energy analysis is carried out in IES-ve (Integrated Environmental Simulation). Where calculation of energy consumption of building is done on annual bases with considering varies factors.

Location
Geographical Features
Climatic conditions
Optimizations made in design
And other energy efficiency strategies.

This work developed a methodology and an associated calculation platform in order to identify the economic and energy efficient design solutions for residential (NZEB) design considering the influence of the local climate, the endogenous energy resources and the local economic conditions. Study of a building for 3 climates was analyzed with the tool developed in order to gain insights on the economic space of NZEB solutions and the influence of the climatic context. A methodology for assisting the choice of economically efficient NZEB solutions from the early design stage is now available. Energy use in practice may be of great relevance as the results showed that the differences between an economically efficient and economically inefficient NZEB can be over three times both in terms of initial and life cycle cost. Project data was collect from interface of organization to perform simulation to calculate energy count of the building in different categories. Those categories are classified based on REC Nzeb parameters. These parameters as follow below.

- Energy Efficiency
- Water Efficiency
- Environmental protection
- Indoor Environmental quality
- Other green feature's

Building envelope is most curical segment, which involves in designing thermal performance, day light, artificial light, ventilation and other energy consuming segment. Most of experienced designers belive façade design will optimize energy count of the building. To approach zet zero energy detailed façade analysis is required. Tracking pathing of the sun will give data of temperature rise in building respect to time period. Ventilation is optimized by tracking wind current around site environment. The building envelope is all of the elements of the outer shell that maintain a dry, heated, or cooled indoor environment and facilitate its climate control. Building envelope design is a specialized area of architectural and engineering practice that draws from all areas of building science and indoor climate control.

Site Area	8,000 m2
Gross Floor Area	91,419 m2
Building Type	Mixed Use, Commercial
No. of toreys	B1 & B2 – Level of Basement Carpark 1st Floor – Food Square 2nd Floor – Retail / Commercial 3rd – 7th Floor – Above Ground Car Park 8th – 9th Floor – Recreation / Function Space 10th – 13th Floor – Hotel/Service Apartment 14th – 15th Floor – Office 16th – 29th Floor – Duplex Service Apartment 31st – 32nd Floor – Penthouse office including Mezzanine Office
Typical Floor Area	3,472 m2
No. of Car Park Lots	500 lots

Table 1 project Data

4. Site Orientation

Site of building selected in Singapore city, Berman street. Which is high cosmopolitan area with higher pollution. Orientation of the building was studied based on sun path and wind current which are estimated based on weather reports for last 10 years.

5. Energy Modelling

5.1 Thermal Performance

Thermal performance of a building refers to the process of modeling the energy transfer between a building and the surroundings. Understanding the thermal performance of buildings calculates the cooling load and hence it helps to estimate the capacity, size and selection of an air conditioning apparatus. For an unconditioned building, it calculates the temperature variation within a building. These are very essential and enable us to determine the effectiveness of the design of the building. The design load is based on inside and outside design conditions.

5.2 Air Conditioning System

Air conditioning is the process of altering the properties of air (primarily temperature and humidity) to more conditions. The control of these conditions may be desirable to maintain the health and comfort of occupants, or to meet the requirements of industrial processes irrespective of the external climatic conditions.

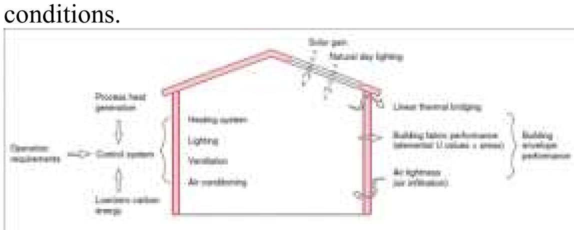

Figure 1 Air conditioning system

5.3 Energy Efficiency

Energy Efficiency covers wide-ranging topics related to energy efficiency, energy savings, energy consumption, energy sufficiency, and energy transition in all sectors across the globe. Coverage includes energy efficiency policies at all levels of governance enabling social, organizational, and economic factors of sufficient and efficient behavior and decisions; analysis and modeling of energy efficiency performance, measures, policies, outcomes, and impacts; energy management systems and energy services; the role of energy efficiency and demand-side management in energy planning, energy markets and risk assessment; local sustainable energy planning; energy behavior; acceptability of policy, technology, and new energy systems; and emerging technologies and approaches to improve energy efficiency.

5.4 Day Light

Daylight, or the light of day, is the combination of all direct and indirect sunlight during the daytime. This includes direct sunlight, diffuse sky radiation, and (often) both of these reflected by the Earth and terrestrial objects, like landforms and buildings. Sunlight scattered or reflected by objects in outer space (that is, beyond the Earth's atmosphere) is generally not considered daylight. Thus, daylight excludes moonlight, despite it being indirect sunlight. Daytime is the period of time each day when daylight occurs. Daylight happens because Earth rotates, and either side on which the Sun shines is considered daylight.

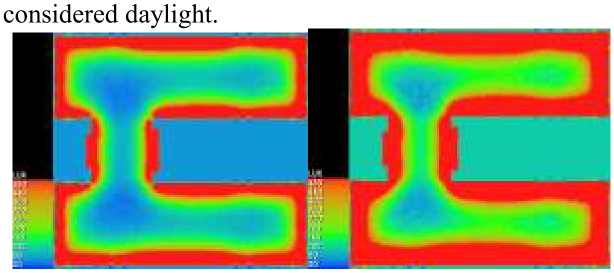

Figure 2 lighting levels

5.5 Artifical Light

Artificial light, as opposed to natural light, refers to any light source that is produced by electrical means. Artificial lighting has many different applications and is used both in home and commercially. Artificial lights are available in a wide variety of shapes, sizes, colors of light emitted, and levels of brightness. The use of artificial lighting is crucial in agriculture and gardening, particularly in indoor cultivation.

5.6 Ventilation

Ventilation is the intentional introduction of ambient air into a space and is mainly used to control indoor air quality by diluting and displacing indoor pollutants; it can also be used for purposes of thermal comfort or dehumidification. The correct introduction of ambient air will help to achieve desired indoor comfort levels although the measure of an ideal comfort level varies from individual to individual.

The intentional introduction of subaerial air can be categorized as either mechanical ventilation, or natural ventilation. Mechanical ventilation uses fans to drive the flow of subaerial air into a building. This may be accomplished by pressurization (in the case of positively pressurized buildings), or by depressurization (in the case of exhaust ventilation systems). Many mechanically ventilated buildings use a combination of both, with the ventilation being integrated into the HVAC system. Natural ventilation is the intentional passive flow of subaerial air into a building through planned openings (such as louvers, doors, and windows). Natural ventilation does not require mechanical systems to move subaerial air, it relies entirely on passive physical phenomena, such as diffusion, wind pressure, or the stack effect. Mixed mode ventilation systems use both mechanical and natural processes. The mechanical and natural components may be used in conjunction with each other or separately at different times of day or season of the year. Since the natural component can be affected by unpredictable environmental conditions it may not always provide an appropriate amount of ventilation.

In this case, mechanical systems may be used to supplement or to regulate the naturally driven flow. In many instances, ventilation for indoor air quality is simultaneously beneficial for the control of thermal comfort. At these times, it can be useful to increase the rate of ventilation beyond the minimum required for indoor air quality. Two examples include air-side economizer strategies and ventilation pre-cooling. In other instances, ventilation for indoor air quality contributes to the need for - and energy use by - mechanical heating and cooling equipment. In hot and humid climates, dehumidification of ventilation air can be a particularly energy intensive process.

Figure 3 Ventilation in parkinglot

Ventilation should be considered for its relationship to "venting" for appliances and combustion equipment such as water heaters, furnaces, boilers, and wood stoves. Most importantly, the design of building ventilation must be careful to avoid the backdraft of combustion products from "naturally vented" appliances into the occupied space. This issue is of greater importance in new buildings with more air tight envelopes. To avoid the hazard, many modern combustion appliances utilize "direct venting" which draws combustion air directly from outdoors, instead of from the indoor environment. Fresh air in a building brings health benefits and increased comfort level to its occupants. Fresh air provision is considered as an efficient and a healthy solution as it reduces the need for mechanical means to ventilate a building. For nzeb design goal, passive design measures can be judiciously used to influence movement of outside air into a built space by bringing in fresh air. These interventions can reduce and in some cases (in certain climates) completely eliminate reliance on mechanical means to ventilate a building. Thus largely affecting air-conditioning loads.

6. Results

Results are obtained from simulation of selected building by applying necessary criteria's in design without effecting comfort levels of public. Results are checked out on bases of LEED standards with considering green building codes. Results are classified on energy consumption bases with comparing present and proposed design in energy modelling.

	Category	Present Score	Max Score	Total Score	Investment	Saving / Yr
Part 1	Energy Efficiency	8.7	116	86	Rs4,760,365.00	Rs1,464,833.00
Part 2	Water Efficiency	1	17	15.75	Rs198,700.00	Rs 20,000.00
Part 3	Environmental Protection	10	42	27	Rs 80,000.00	Rs -
Part 4	Indoor Environmental Quality	4	8	6	Rs 110,000.00	Rs -
Part 5	Other Green Features	0	7	3	Rs 110,000.00	Rs -
	Total	23.7	190	136.25	Rs5,149,065.00	Rs1,484,833.00

S. no	Category	Present Score	Max Score	Target Score	Investment	Saving / Yr
Part 1	Energy Efficiency					
1.1	Building Envelope - ETTV	0	12	12	Rs 76045627	Rs -
1.2	Air-conditioning System	2	30	30	Rs 56210392	Rs 41128010
1.3	Building Envelope – Design/Thermal Parameter	0	35	0	Rs -	Rs -
1.4	Natural Ventilation / Mechanical Ventilation	0	20	0	Rs -	Rs -
1.5	Day lighting	0	6	0	Rs -	Rs -
1.6	Artificial Lighting	0	12	12	Rs 61556717	Rs 17587642
1.7	Ventilation in Carpark	3.2	4	3.43	Rs 1584283	Rs 1520912
1.8	Ventilation in Common Areas	1	5	2	Rs -	Rs -
1.9	Lifts and Escalators	2	2	2	Rs 19011406	Rs 8117870

1.10	Energy Efficient Practices & Features	0.5	12	0	Rs -	Rs -
1.11	Renewable Energy (Bonus Points)	0	20	0	Rs -	Rs -
	Sub-Total for Energy Efficiency	8.7	116 (max)			

	Category	Present Score	Max Score	Target Score	Investment	Saving / Yr
Part 2	Water Efficiency					
2.1	Water Efficient Fittings	0	10	6.75	Rs 50,000.00	Rs -
2.2	Water Usage and Leak Detection	1	2	2	Rs -	Rs -
2.3	Irrigation System	0	3	1	Rs -	Rs -
2.4	Water Consumption of Cooling Tower	0	2	2	Rs -	Rs -
	Sub-Total for Water Efficiency	1	17	11.75	Rs 198,700.00	Rs 20,000.00
Part 3	Environmental Protection					
3.1	Sustainable Construction	0	10	5	Rs -	Rs -
3.2	Sustainable Products	0	8	5.5	Rs75,000.00	Rs -
3.3	Greenery Provision	1	8	3	Rs -	Rs -
3.4	Environmental Management Practice	7	7	7	Rs -	Rs -
3.5	Green Transport	1	4	3.5		
3.6	Refrigerants	1	2	2	Rs 5,000.00	Rs -
3.7	Stormwater Management	0	3	1		
	Sub-Total for Environmental Protection	10	42	27	Rs 80,000.00	Rs -

	Category	Present Score	Max Score	Total Score	Investment	Saving / Yr
Part 4	Indoor Environmental Quality					
4.1	Thermal Comfort	1	1	1	-	-
4.2	Noise Level	1	1	1	-	-
4.3	Indoor Air Pollutants	2	2	2	-	-
4.4	Indoor Air Quality (IAQ) Management	0	2	1	-	-
4.5	High Frequency Ballasts	0	2	2	-	-
	Sub-Total for IAQ	4	8	7	-	-
Part 5	Other Green Features					
5.1	Green Features & Innovations	0	7	4	Rs 110,000.00	-
	Sub-Total for Other Green Features	0	7	4	Rs 110,000.00	-

1. Conclusion

Main objective of this report is to give an overview of exiting NZEB definitions and concepts of Net Zero approaches in wide range based on similarities and differences from worldwide literatures. And design techniques of NZEB are discussed. The energy modelling for building is explained well with step to step.

Energy is most prominent element, which runs whole world. Generation of energy from Renewable and Non-Renewable sources is reducing drastically. India is a developing nation which largely dependent on fossil fuel imports to meet its energy demands, by 2030 India's dependence on energy is expected to exceed 53% of the country's total energy consumption. Population also increasing day to day, by 2030 it is expected that India will be most populated nation in world. And world is driving itself to conserve energy.

Energy conservation became great work to save our Nature, from getting Extinct, if not, there is risk of depletion energy sources, need to construct more number of power plants, which further results in environmental pollution, global warming, and habitat destruction. Thus energy conservation is more important to sustain on earth, so peoples started to find ways to conserve energy, in such practices making construction more energy efficient is one idea, since construction worldwide consumes 14% energy sources in form of both fossil fuels and electricity.

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