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Review On Proposing Transformation Of Existing Building Into Net-Zero Energy Building

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Abstract: In India, buildings currently utilize 35% of all energy, and this percentage is escalating at an average rate of 8% each year. In order to stop the current trend of unsustainable escalating energy demand, India must implement energy-efficiency programs directed at the residential sector, as the country's energy consumption for residential development is predicted to increase by more than eight-fold by 2050. One solution to this problem is to make existing structures net-zero energy buildings. This study will explore methods for lowering energy consumption and building net zero energy structures. The IGBC Net Zero Energy Building Rating System serves as the foundation for the study's parameters. The investigation will focus on residential building in the Kolhapur region. The study's objectives include evaluating existing structures for net-zero energy consumption and making suggestions for energy-saving measures. The cost of the dwellings increases by 5 to 10% compared to the cost of a standard residential structure, according to an energy comparison analysis and cost analysis of three buildings. The NZE building is more costly, but it will pay off in the long run. To achieve net-zero energy goals in the future, similar structures can use the techniques and data used in this work.

I. Introduction

A structure that produces equal to or more energy than it consumes is referred to as a "net-zero energy building." Simply said, this means that you can utilize the building's electricity for nothing and reduce your energy costs.

It is not surprising that the Earth's resources are swiftly running out while the planet experiences climate change given the toll that global pollution is having on the environment. You can live in a cleaner environment thanks to net-zero energy buildings because they consume substantially less electricity than conventional residences and lessen their carbon footprint. The issue of zero energy buildings has received a lot of attention recently and has been incorporated as part of the energy policy in many nations due to the worsening environmental issues and the energy crisis. In 2021, India's installed solar energy capacity increased by a record 10 Gigawatts (GW). With capacity expansions, India now ranks fifth in the world for solar power deployment, providing close to 6.5 percent of the total worldwide capacity of 709.68 GW.

The method to achieving zero energy goals must be determined in part by the NZEB definitions, which also have a big impact on architects' and building owners' design preferences. According to the project aims and values of the designer and building owner, different definitions are appropriate for different projects, so it is crucial for them to know which definition would serve their needs the best. the situation in which energy consumption and energy production from local renewable sources are equal or equivalent. Understanding net zero energy in the context of a structure like your house or workplace is helpful. If your house or workplace is operating at net zero energy, it means that it is either producing the same amount of energy as it is consuming or more. A building is considered to be net zero if its annual energy consumption is equal to or lower than the quantity of renewable energy (energy produced on-site from sources that replenish themselves naturally, such as sun, wind, or rain) produced. A net zero facility is often connected to the grid and has the ability to both sell excess energy and purchase more energy when necessary. However, because it cleanly generates as much energy as it consumes, this building will be net zero over the course of a whole year.

In the same way that a net zero energy building uses only as much renewable energy as it generates locally, a net zero energy community, or state, generates all the energy it needs locally and cleanly.

Energy-plus buildings are those that produce more energy than they consume over the course of a year, whereas near-zero energy buildings or ultra-low energy homes are those that produce slightly more energy than they consume.

II. IGBC NET ZERO ENERGY BUILDING RATING SYSTEM

In India, the building industry is expanding quickly and has a substantial impact on the rise in energy demand. Global warming results from an increase in Green House Gas (GHG) emissions, which in turn are caused by an increase in energy consumption. By increasing building energy efficiency and using renewable energy sources in part to meet energy needs, the green building movement in India, led by the Indian Green Building Council (IGBC), has made a significant contribution to lowering GHG emissions.

The implementation of energy-efficient practices and technologies can result in a 25–30% reduction in energy consumption relative to national baselines, as shown by the green buildings. Green buildings have also adopted onsite/offsite renewable energy generation to meet their requirement to the extent of roughly 10–15%, depending on the space on site and the cost economics.

The IGBC Net Zero Energy Buildings Rating System is intended for both new and existing structures, as well as for structures with and without air conditioning.

Offices, IT parks, banks, shopping complexes, hotels, hospitals, airports, convention halls, educational institutions (colleges, universities), factory structures, schools, etc. are only a few examples of these structures.

The incorporation of renewable energy sources and energy efficiency are covered under the IGBC Net Zero Energy Buildings Rating System. Buildings of different sizes and types can be designed and constructed thanks to the specifications provided under each mandatory requirement and credit (as defined in scope).

Both new and existing buildings can use the IGBC Net Zero Energy Buildings Rating System. Using a checklist, the project team can assess every single point that could be used in the grading system. If the project can achieve all necessary conditions and prove that its net annual energy consumption is zero, it may apply for IGBC Net Zero Energy Buildings Rating System certification.

Sr. No	Particulars	Credits
MR 1	Energy Performance	Required
MR 2	Thermal Comfort, Indoor Temperature and RH	Required
Credit 1	Simulation Approach	75
	Excellence in Energy Performance – Prescriptive Approach	
Credit 2.1	Energy Efficient Building Envelope	15
	Option 1: Compliance at component level	
	Roof assembly	
	U value of roof assembly	3
	SRI value of roof	2
	Wall assembly	
	U value of wall assembly	5
	Glazing	3
	U value of glazing	2
Credit 2.2	Air Conditioning	42
	Specific Energy Consumption of Chiller	30
	Auxiliaries	12
Credit 2.3	Lighting	10
	Day lighting	3
	Interior Lighting	5
	exterior Lighting	2
Credit 2.4	Appliances	8
	Percentage of connected load of appliances	8
Credit 2.5	Renewable Energy	25
	Total Credits	**100**

Table No. 1 IGBC Rating System

III. LITERATURE REVIEW

Haorong Li, .Yong Cho, .Dongming Peng., (2012)- In this study, a low-cost building information modelling method was proposed, in which house information was extracted from photographs of dwellings using digital image processing techniques. The proposed vertical view information extraction method and floor plan frame identification algorithm are explained. Elevation and vertical view information can be retrieved quickly using these two created techniques. In our test, the developed algorithms successfully analyses 90 house photos, with a success rate of 95 percent. We demonstrate how to make "virtual" representations of existing buildings' energy and environmental performance. Second, this paper introduced a non-invasive 3D energy performance modelling technique using the proposed hybrid system, which consists of a 3D LIDAR and an IR camera. A 3D as-built model of the building can be quickly created by using hybrid technology to scan the structure. Moreover, a newly developed IR camera calibration method reduced thermal image distortion, enabling more precise mapping of temperature data to the 3D model. Additionally, users can get precise data for applications like heat loss computation, thermal resistance calculation, and building energy simulation by having access to the information of each point in the building model. Building and residential 3D energy performance models were created for the initial field test, and these models were simply used to retrieve all pertinent data from the created graphical user interface, such as location coordinates, intensity, and temperature[5].

A. Ahmed (2014)- Tools for energy simulation are being used more and more to analyse building energy performance and occupant thermal comfort. These analyses can be performed using a variety of building performance simulation software packages with various user interfaces and simulation engines. It is essential to comprehend the tools' limitations and the complexity of these simulations given the wide variety of simulation tools available. The practical application of these tools depends heavily on the consistency of data exchange and the simplicity and usability of the interfaces. Effective data exchange and software interfaces are essential to enabling the quicker and more dependable performance of the simulation tools due to the enormous amount of data that must be input and the availability of rich 3D geometry rendering engines. We have selected a 17000 square foot office building for our project. The structure had two storage units, and it used 314339 units of energy each year. following the various energy saving measures. To 290830 units, the energy consumption decreases. Furthermore, the rooftop solar system generates nearly 610,512 kWh of PV annually. The building utilises 314339 kWh of energy. It denotes that the office uses net positive energy, and if it were to be twice as large, it would still be a net-zero structure[2].

Santosh D Jadhav (2014-2016)- According to Mr. Santosh's assertion in this research paper, Net Zero Energy Buildings serve as a bridge between the use of renewable energy sources and energy-efficient technology. Engineers, architects, and policymakers from all over the world are looking into how to create extremely energy-efficient buildings whose reduced energy demand is met by clean, renewable energy. As policymakers and leaders move toward the "net zero building" concept, the emphasis on achieving deep energy efficiency has focused on integrated technologies as well as methods to link buildings to the natural environment. To balance the energy supply and demand, both in terms of quantity and energy form, there are some situations where interaction with the current energy infrastructure is essential. The idea of a Net Zero Energy Building purposefully leaves out seasonal storage inside the structure. However, with the aid of a smart grid system, buildings can sell extra energy to a nearby building in place of seasonal storage. The conclusions of this study are aimed at decision-makers and building managers in the commercial and public sectors, among others, who are attempting to maximise cost and resource efficiency (including waste, water, and energy) as part of long-term building resource methodologies[6].

Kishor Kumar Sridharan (2016)- In this paper, he has described how to turn a current structure into a Zero Energy Building (ZEB) in three significant cities: London, Patras, and Chennai, which are located in the United Kingdom, Greece, and India, respectively. The overall Heat losses coefficient (UA)b for each building in each city is first calculated. The building's thermal loads, which include heating (space heating, domestic hot water, and heat losses), are then calculated using the proper equations for the seasonal months (Jan, Apr, Jul, Oct). Furthermore, the electric loads of the structures in the three cities are computed. The thermal demand (Space Heating Load) of the building is decreased through the use of passive solar techniques that take solar gain through the windows into account. Solar collectors are taken into account in order to meet the thermal load demand with renewable energy sources. A daily hourly simulation is run to determine the collector output, after which the area of the collectors needed for various loads fractions is determined. The Heat Pump is sized to meet Chennai's cooling needs. A standalone PV system is made to supply the necessary electricity. Additionally, a crucial comparison is made in the thesis between the two methods used to determine the Space Heating Load and the two methods used to determine the size of the standalone PV. The economic analysis used to determine the scenario with the greatest economic viability in the dissertation's conclusion calculates the Internal Rate of Return (IRR) and Net Present Value (NPV) for various fractions of thermal needs by Solar Collector[8].

Meher Shahedi (2016)- The author of this report claims that over the past few decades, concerns about global warming and climate change have grown. Since homes and businesses use the most energy, resources are being depleted much more quickly now than in previous decades. According to recent statistics, 14% of people actively participate in environmental protection, with another 48% showing sympathy but not taking any action. In this chapter, tools and applications for designing net-zero energy buildings are presented. These tools and applications can assist architects and building designers in creating net-zero energy buildings for both the commercial and residential sectors. Case studies that highlight the advantages and difficulties of various designs for a net-zero energy building (NZEB) will be provided[7].

Muhammad Irfan, Muhammad Shoaib Saleem (2018)- Climate change is a current problem that all nations are dealing with, and it was covered in this essay. The environment's entropy is growing over time, which has an impact on the ozone layer and raises the risk of global warming. The primary cause of the climate change in Pakistan is the release of Greenhouse Gases (GHGs), which are produced when gases are released into the atmosphere and fossil fuels are used to produce electricity. Both residential and commercial buildings use the majority of the energy. Buildings must be built in such a way that they consume less energy due to efficient design and produce on-site energy for both their own use and to export excess energy to the utility. When these sources are not available, these Net Zero Energy Buildings (NZEB) use energy from utilities. NZEB is essential to the use of sustainable energy, energy security, and environmental friendliness. In this essay, the electricity consumption of a conventional building and a NZEB are compared. The benefits of NZEB are also examined using the idea of smart metering [11].

Ajla Aksamija (2016)- This paper mentions the viability of retrofitting commercial buildings to achieve net-zero energy goals. To illustrate the research process, design methods, and results, a specific case study is presented. In order to better the building's performance and lower energy consumption, passive design strategies and energy-efficient building systems were chosen as the research target for an existing commercial building in Holyoke, Massachusetts. Additionally, the goal was to look into ways to use renewable energy sources for a building's energy needs in maximise energy savings and achieve net zero energy goals. On the basis of extensive energy modelling and simulations, a variety of design factors were examined, including material choice, building envelope improvements, retrofitting of HVAC and lighting systems, occupancy loads, and the use of renewable energy sources. It was determined how to reduce energy consumption and how specific techniques result in energy savings by analysing simulation results. According to the study's findings, this commercial structure can achieve net-zero energy use with the right design modifications and the use of a variety of renewable energy sources. The methodologies and strategies can be used to improve the energy efficiency of existing buildings and other projects involving adaptive reuse and retrofit. The methodology used in this study can be replicated and used in other retrofit projects to increase the energy efficiency of the existing building stock, which is its main contribution [3].

Mohammad Y. Abu Grain and Halil Z. Alibaba (2017)- In order to achieve net-zero energy as a response to rising fossil fuel prices, this study explores the potential for energy savings in an existing multi-story building in the Mediterranean region. The goal of this study was to investigate and assess the Colored building at the Faculty of Architecture, Eastern Mediterranean University, Cyprus, in order to learn how energy efficiency strategies could be implemented in the building to lower annual energy consumption. Since the goal of this research is to create a plan for achieving net-zero energy in existing buildings, case study and problem-solving methodologies were used to evaluate the building's design in this study. These methods were combined with an energy modelling simulation to produce results that were both desirable and addressed the issues. After improving the building's energy efficiency, an alternative energy simulation of the structure was created in order to conduct an energy comparison analysis that produces trustworthy results. To achieve net-zero energy, similar buildings can use the methodologies and techniques developed for this study[1].

Tarek Samarji, Adnan Jouni, Ali Karaki (2016)- This essay's goals are to highlight the meaning of NZEBs, discuss the Lebanese context for this issue, and consider NZEBs' potential applications in Lebanon. The challenge of the practical portion of this thesis is to determine whether it is possible and feasible to apply net zero energy concepts in Lebanon and, in accordance, to establish minimal standards for NZEB applications there in the future. We used the thermal standard compliance software TSBC, the meteorological data software METEONORM, the solar water heater simulation software T-Sol, the photovoltaic simulation software PV-Sol, and the building energy simulation software Design builder for this purpose[9].

Zaheer Abbasa(2018)- This article's main goal is to examine existing structures, analyse them, and provide a general overview of how to transform existing structures into ideal Net Zero Energy Buildings. A net zero energy building's overall concept is very challenging to comprehend. As is common knowledge, buildings have a big impact on energy consumption and the environment, which in turn affects how the modern era develops. The absence of conventional energy sources currently encourages the development of NZEBs. According to the survey, buildings have a significant impact on the level of global energy consumption, accounting for about 40% of all energy consumption, making them a significant primary energy-consumptive component of the global structure. The demand and fuel supply strategies, as well as conversion accounting, are appropriate to achieve a ZEB goal, according to the ZEB definition[11].

IV. PROBLEM STATEMENT

Due to increase in population and urbanization the energy demand is increasing day by day, there is also shortage of coal in India. To tackle this problem there is need to fulfill the energy demand by NZEB application.

V. OBJECTIVES

1. To analyze existing building for net zero.
2. To suggest measures for existing building for net zero.
3. To compare the cost of energy used in the existing building with the suggested net zero building.

VI. SIGNIFICANCE

In the current scenario, the demand of energy boosts up by 2.3% compared to the year 2021 to tackle this problem the existing building should be transformed to Net Zero Energy Building. Net zero energy buildings offer a feasible way to reduce energy consumption and enable lifetime reduced maintenance costs. The design and construction of these buildings are planned, so that they generate all the energy they need by combining energy-efficiency and renewable energy technologies. In order to achieve their net zero energy goals, NZEB’s must first sharply reduce energy demand using energy efficient technologies, and then utilize renewable energy sources (RES) to meet the residual demand. In such buildings, efficiency gains enable the balance of energy needs to be supplied with renewable energy technologies. This is the most logical approach to reach NZEB goal.

VII. METHODOLOGY

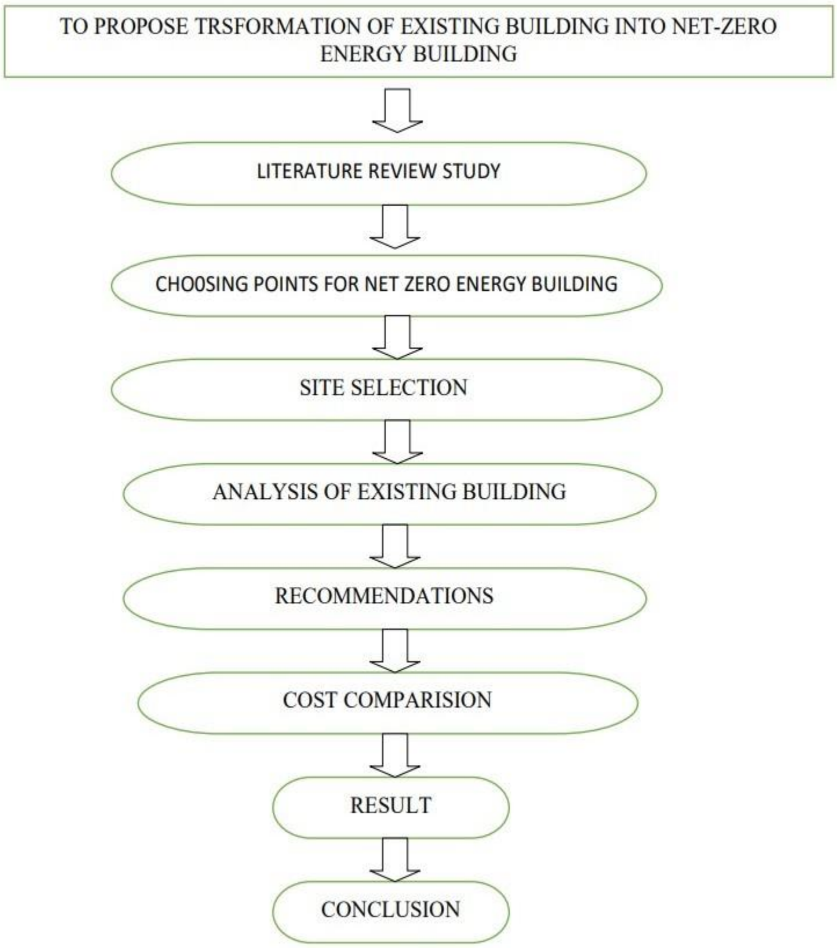

Figure 1. Methodology

VIII. DISCUSSION

After the analysis study following points could be found-

1. Awareness of use of energy efficiently in Kolhapur city.
2. Scope of improvement in the building studied.
3. Ranking of building according to IGBC.
4. Suggestions/Recommendations for turning analysed building into NZEB if necessary.
5. Cost efficiency of NZEB.

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